

**North Carolina  
Division of Marine Fisheries**

**2022 Fishery Management Plan  
Review**

**August 2023**



## INTRODUCTION

The Fishery Management Plan Review is a compilation of annual updates for each State, Federal, and Atlantic States Marine Fisheries Commission managed species where North Carolina is directly involved in the fishery management plan. 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 about the latest status of fisheries in North Carolina. The document is organized into two primary sections: State managed species and interjurisdictional managed species which are managed by either a Federal or Atlantic States Marine Fisheries Commission management plan. The interjurisdictional section is further divided into species which do or do not directly use North Carolina surveys to produce indices. Indices are indirect measurements used to assess stocks in Fishery Management Plans.

There are 13 State Fishery Management Plans, 12 of which are updated annually in this document. The North Carolina Fishery Management Plan for Interjurisdictional Fisheries does not require annual updates. This plan adopts, by reference, management measures appropriate for North Carolina contained in Federal Council or Atlantic States Marine Fisheries Commission fishery management plans.

Management measures for interjurisdictional fisheries are implemented by Marine Fisheries Commission and the Division to provide compliance or consistency with approved interjurisdictional 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 goal 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:

- Fishery Management Plan History
- Management Unit
- Goal and Objectives
- Description of the Stock
- Description of the Fishery
- Monitoring Program Data (fishery-dependent and fishery-independent data)
- Research Needs
- Management Strategy; and
- Fishery Management Plan Schedule Recommendations.

Due to the COVID-19 pandemic, several sampling programs were disrupted in 2020 and portions of 2021. Specific impacts are provided in each species update as needed.

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STATE MANAGED SPECIES – BAY SCALLOP

**FISHERY MANAGEMENT PLAN UPDATE  
BAY SCALLOP  
AUGUST 2023**

**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:	August 2020	
Schedule Changes:	None	
Comprehensive Review:	2025	

The North Carolina Bay Scallop Fishery Management Plan (FMP) was adopted in November 2007. The FMP implemented prohibited take from 2006 to 2008 until an independent sampling re-opening indicator was established 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 (DMF) evaluation of sampling results in this region. Expanded sampling is to occur in all areas including areas south of Bogue Sound and improving 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. has established 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. Due to an extended period of low abundance and lack of open seasons in any area or sector, no new management was deemed necessary during the formal review in 2020. Subsequently, the 2020 FMP update served as the Bay Scallop 2020 FMP Information Update.

## **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 N.C. Bay Scallop 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:

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

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

Bay scallops are estuarine-dependent mollusks found in seagrass beds. Bay scallops are hermaphroditic (contain both sex cells) bivalves and mature and spawn in a year (Brousseau 2005). Their lifespan is approximately 12 to 26 months. In North Carolina, bay scallops spawn predominantly from August through January and again from March through May (Gutsell 1930). The larvae go through several swimming stages before attaching to a suitable substrate such as seagrass. Upon reaching a size of approximately 1 inch (20-30 mm), bay scallops drop to the bottom. Although other benthic structures can be used for attachment, bay scallops use seagrass beds almost exclusively, and are therefore highly dependent on this habitat for successful recruitment (Thayer and Stuart 1974). Bay scallops are filter feeders and feed on benthic diatoms (Davis and Marshall 1961). Predators of the bay scallop include cownose rays, blue crabs, starfish, whelks, and sea birds (Gutsell 1930; Peterson et al. 1989).

### **Stock Status**

There are insufficient data to conduct a traditional stock assessment for bay scallop in North Carolina. Bay scallops 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 the red tide event of 1987. Bay scallops are vulnerable to overharvest because of these factors affecting their survival.

Bay scallop fishery independent data have been collected by the DMF since 1975, and consistently collected since 1998 to evaluate recruitment into the population and into the fishery for the current fishing season. Analyses of these data have demonstrated trends between DMF fishery 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 bay scallop abundance from fishery independent sampling are evaluated annually. Standardized bay scallop population level indicators were first established as progressive triggers for opening the harvest season in Amendment 1 of the N.C. Bay Scallop FMP in 2010 (NCDMF 2010). These triggers are based on DMF 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). These triggers allow for flexibility to open the fisheries as the bay scallop population recovers and determines harvest limits based on 50, 75, and 125% of the natural log of the Catch Per Unit Effort (lnCPUE) target (Tables 2 and 3).

Fishery independent data shows most samples 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. 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.

Trends in the past 10 years show bay scallop abundance is low in all regions but increasing the past three years in Core Sound and the past two years in Back Sound (Figures 1, 2, and 3). Since the inception of the harvest opening index of abundance, the season has opened for five years (2009, 2010, 2013, 2021, and 2022) in specific regions, and at the lowest allowed harvest levels. Four of the five open harvest seasons saw very little catch (Figure 4). Expanding the sampling coverage or number of stations in all areas was recommended in Amendment 2 of the FMP and implemented to improve estimates of bay scallop abundance. As bay scallop abundances expand and retract from year to year, broader sampling coverage of these areas has helped identify more precisely what is happening to the population before entering the harvest season.

### **Stock Assessment**

A stock assessment is not available for this species.

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

The season can occur from the last Monday in January through April 1st and there is no minimum size limit for both the commercial and recreational fisheries. 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 DMF fishery independent sampling abundance levels determining the levels of harvest (NCDMF 2015). There was an open harvest season for bay scallops in Core Sound in 2022 because abundance levels met the minimum threshold for opening the season. No other areas in the state had an open harvest season in 2022.

### **Commercial Fishery**

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% of the adult bay scallops in Bogue and Back sounds and reduced recruitment of juvenile bay scallops the following spring to only 2% 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 bay scallop stocks to recover after the red tide event, fishing pressure, and predation.

A prohibited take on harvest occurred from 2006 to 2008 through proclamation and continued by the 2007 FMP (NCDMF 2007). Amendment 1 initiated abundance estimates to determine if the fishery should open 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). In 2019 and 2020 a small amount (less than 300 pounds of meat) was landed from commercial private leases (Figure 4). Despite an open harvest season in Core Sound in 2021, no commercial harvest was reported in the state (Figure 4). In 2022 a small amount (less than 300 pounds of meat) was landed from public bottom in Core Sound during the open harvest season.

### **Recreational Fishery**

The state recreational shellfish survey added a question about bay scallop harvest in 2016, but only two open seasons in 2021 and 2022 have occurred since. There was no reported recreational harvest from the open season in 2021 or 2022. Due to this, no estimation of recreational harvest can be made.

## **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.

Sampling occurs four times a year in Pamlico, Core, Back, and Bogue sounds and areas south of Bogue Sound during the second or third week of the month in January, April, July, and October. In Pamlico Sound, standardized sampling occurs using a one meter-square ( $m^2$ ) quadrat, and in Core, Back, and Bogue sounds, and areas south of Bogue Sound, a bay scallop dredge is towed. 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 bay scallops have historically been found. 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. Sampling also occurs at five fixed stations and five non-core stations off Hatteras Island. Bay scallops are collected with a rake or by hand for ten  $1\text{-}m^2$  samples within the station in Pamlico Sound. The PVC  $1\text{ m}^2$  quadrat is randomly placed 10 separate times within the area. Catch per unit effort (CPUE) is defined as the number of bay 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 bay scallop abundance at the given time of year. The natural log (ln) of the catch per unit effort (lnCPUE), measured as the number of bay scallops per minute (dredges) and number of bay scallops per meter squared (quadrat), is taken to avoid bias towards occasional large catches. A constant of 0.1 is added to all catches so that tows/quadrats with zero catches can be included in the estimate of the mean. All tows/quadrats taken at a station are averaged to get a single value for each station and are referred to as a sample. 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). Trends in the past 10 years show bay scallop abundance is low in all regions but increasing the past three years in Core Sound and the past two years in Back Sound (Figures 1, 2, and 3). There was a significant increase in bay scallop abundance in Core Sound in 2020, resulting in an open harvest season at the 50% progressive trigger level (Table 1; Table 4). This increasing trend in Core Sound continued in 2021 and 2022 with abundances exceeding the 50% harvest trigger. Back Sound also had a significant increase in abundance, although it failed to exceed any harvest trigger.

From 2017 to 2020 the opening trigger was calculated by performing a log transformation of the CPUE of bay scallops on a waterbody/regional basis after the CPUE was averaged. This calculation method was inconsistent with the FMP and previous years where the log transformation occurred at the sample level. The incorrect method used from 2017 to 2020 had negligible effect on reported abundances except for Core Sound in 2020, when it indicated an opening should occur

when in fact abundance was below any opening trigger (Table 1; Table 4). Triggers for 2017 to 2020 have been recalculated using the correct method.

## **RESEARCH NEEDS**

The list below is presented in order as it appears in Amendment 2 of the Bay Scallop FMP. 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 bay scallop resource cannot occur until some of these research needs are met. The research recommendations include:

### **High**

- Develop better methods to quantify the population including the means to have more precise measures of spatial and temporal variability both within and between sound scales.
- Identify viable stock enhancement techniques.

### **Medium**

- Continue to identify strategic coastal habitats that will enhance protection of bay scallops and accelerate mapping of all shell bottom in North Carolina.
- Develop surveys of recruitment and spat settlement and identify critical areas for these.
- Identify role water quality and nutrient loading has in failed recruitment and develop methods for improvement.

## **MANAGEMENT STRATEGY**

The current management strategy for the bay scallop fisheries is to allow the DMF Director to open a region to limited bay scallop harvest when sampling indicates bay scallop abundance is at 50% of the 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% or 125% of 1984-1985 lnCPUE levels (Tables 2 and 3). The open season may 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. See Table 5 for current management strategies and the status on the implementation of each.

## FISHERY MANAGEMENT PLAN SCHEDULE RECOMMENDATIONS

The 2020 FMP update served as the formal review of Amendment 2 to the North Carolina Bay Scallop FMP. All management strategies in Amendment 2 will be maintained as outlined in the state FMP. Stock conditions will be monitored and reported through each subsequent annual FMP update and the Marine Fisheries Commission will continue to receive the FMP review schedule annually. The next scheduled comprehensive review of this plan will begin in July 2025.

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## TABLES

Table 1. Target and progressive triggers based on the lnCPUE (natural log of the number of bay scallops per 1-minute tow) for the October–December 1984–1985 period for Back, Bogue, and Core sounds. Target and progressive triggers for lnCPUE (natural log of the number of bay scallops per meter squared) in Pamlico Sound are 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 125%	-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 lnCPUE Jan 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 Thurs	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 Thurs	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

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 lnCPUE 1984–1985 (Oct–Dec) target indicators for Core, Bogue, and Back sounds and the lnCPUE Jan 2009 target indicator for Pamlico Sound.

Progressive triggers and target	Trip limit	Days open in week	Allowed gears	Season
Less than 50% of target	No allowed harvest			
50% or greater of target	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 1 m<sup>2</sup> 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			-2.30	0.00	-1.54	0.50	-1.02	0.34		
2007			-1.24	0.50	-2.00	0.30	-1.57	0.34		
2008			2.94	0.35	-1.41	0.40	1.21	0.57		
2009	-0.18	0.79	-1.01	0.42	-1.31	0.45	1.34	0.27	0.94	0.75
2010	0.32	0.67	-0.54	0.39	-1.10	0.54	-1.12	0.54	-2.30	0.00
2011	-1.99	0.13	-0.63	0.57	0.83	0.26	0.38	0.34	-1.77	0.37
2012	-1.66	0.26	-1.71	0.38	-0.56	0.78	1.18	0.25	-0.91	0.36
2013	-1.21	0.11	-2.30	0.00	-2.30	0.00	-0.41	0.71	-1.19	0.42
2014	-1.54	0.31	-2.00	0.30	-1.01	0.42	-2.00	0.20	-1.64	0.34
2015	-1.86	0.39	-2.14	0.16	-2.06	0.16	-1.80	0.19	-1.69	0.16
2016	-2.29	0.01	-1.93	0.25	-1.94	0.19	-1.87	0.16	-2.00	0.20
2017	-2.30	0.00	-2.18	0.12	-1.55	0.25	-1.97	0.14	-0.75	0.26
2018	-2.21	0.08	-2.02	0.75	-2.18	0.46	-2.30	0.00	-2.30	0.00
2019	-2.26	0.24	-2.06	0.16	-2.30	0.00	-2.05	0.11	-2.19	0.09
2020	-2.26	0.24	-0.07	0.49	-2.02	0.19	-1.96	0.14	-1.50	0.26
2021	-2.26	0.24	0.87	0.74	-0.18	0.92	-1.81	0.20	-1.84	0.31
2022	-2.21	0.06	0.62	1.01	-0.84	0.66	-1.81	0.19	-0.55	0.75

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

Management Strategy	Implementation Status
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

Management Strategy	Implementation Status
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	Ongoing through recreational shellfish survey, but limited to CRFL holders
MANAGEMENT	
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; Not yet implemented
STOCK ENHANCEMENT	
Establish a pilot program with the Shellfish Research Hatchery to distribute cultured seed on private bottoms	Shellfish Hatchery staff has begun providing juveniles to interested private culturists
Contingent on results to distribute seed on private bottom, expand the pilot program to include public bottom	Dependent on results from previous management strategy.

# FIGURES

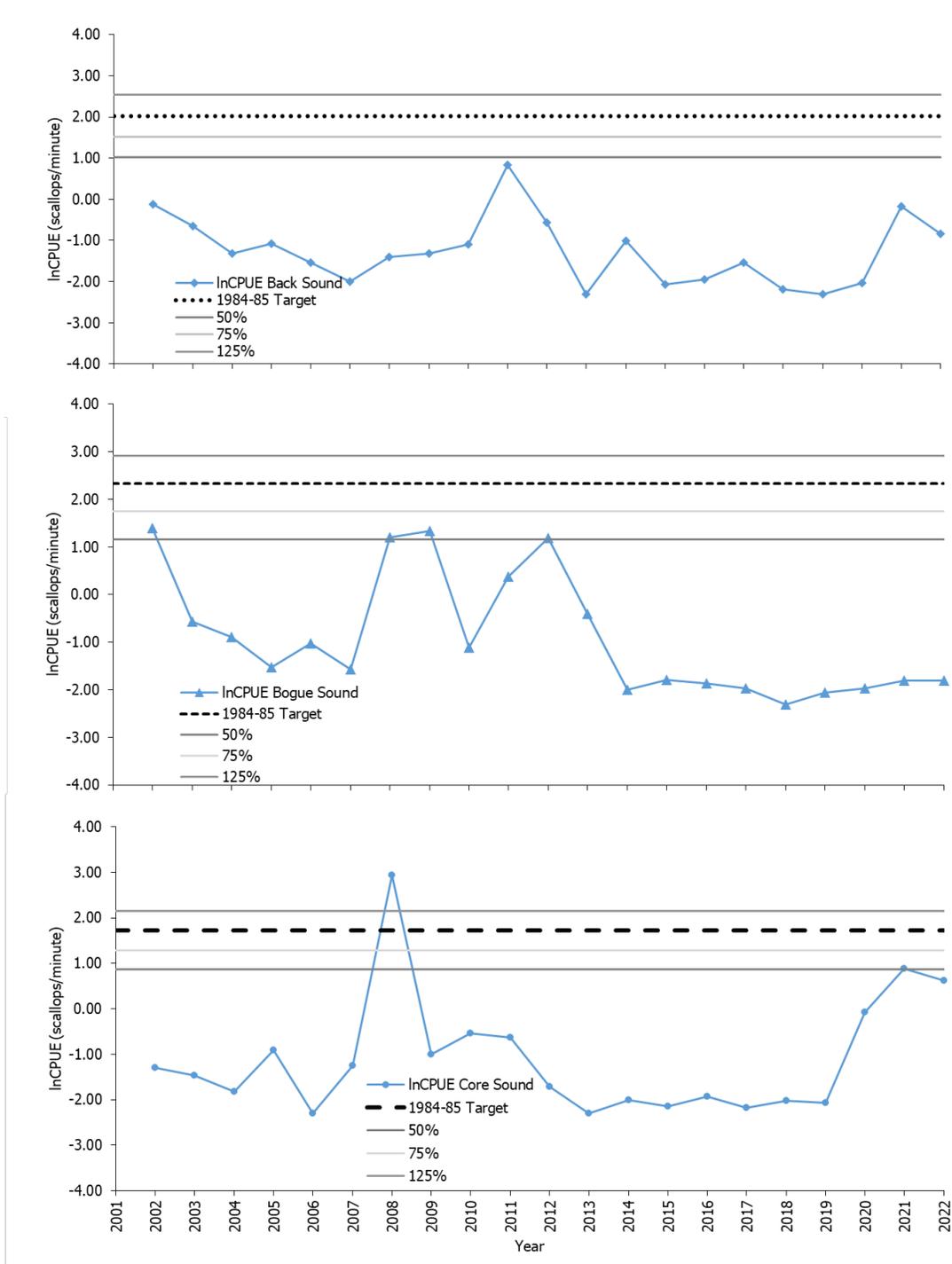


Figure 1. The mean number of bay scallops (InCPUE; bay scallops/minute) for Back, Bogue, and Core sounds during the October-December sampling time-period and average InCPUE (target) for the 1984–1985 period showing progressive triggers at 50, 75, and 125% of the target. Year indicates the sampling year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

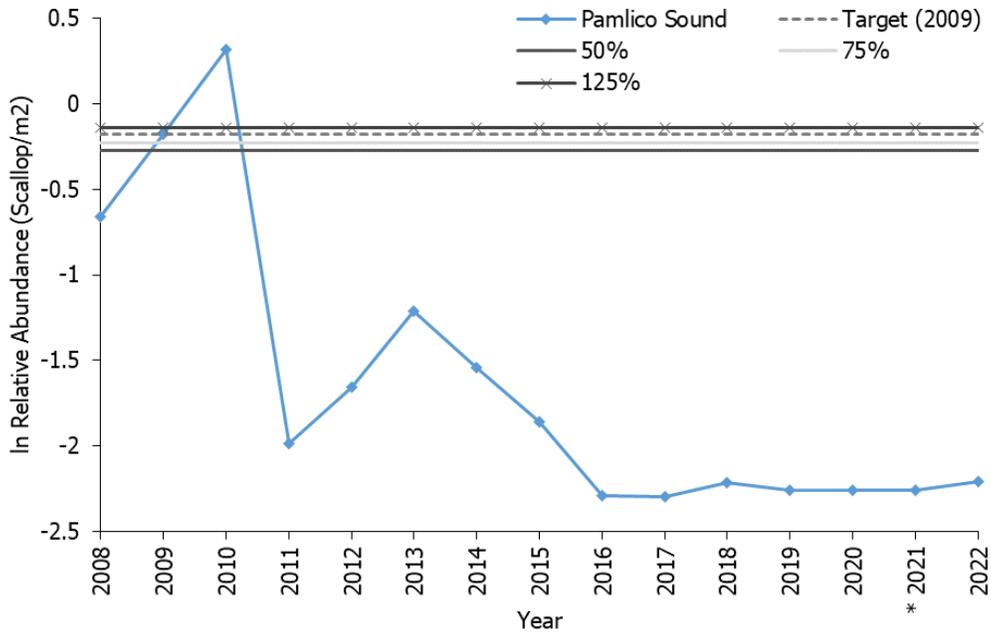


Figure 2. The mean number of bay scallops, lnCPUE (ln(bay scallops/m<sup>2</sup>)), for Pamlico Sound during the January sampling time period and target for the January 2009 period showing progressive triggers at 50, 75, and 125% of the target. Year indicates the sampling year which is used to determine the harvest season for the same calendar year. \*Sampling in 2021 was not conducted until March due to staffing issues and inclement weather.

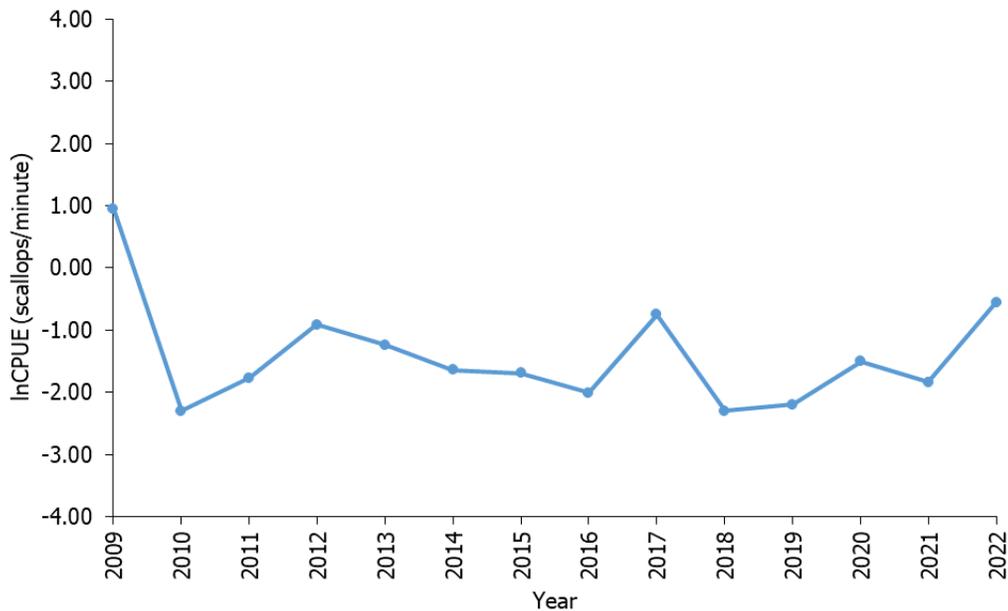


Figure 3. The mean number of bay scallops (lnCPUE) (bay scallops/minute) for areas south of Bogue Sound in October 2009–2022. Target opening estimates and progressive triggers will not be defined for this region until sampling is expanded and a longer time series is established.

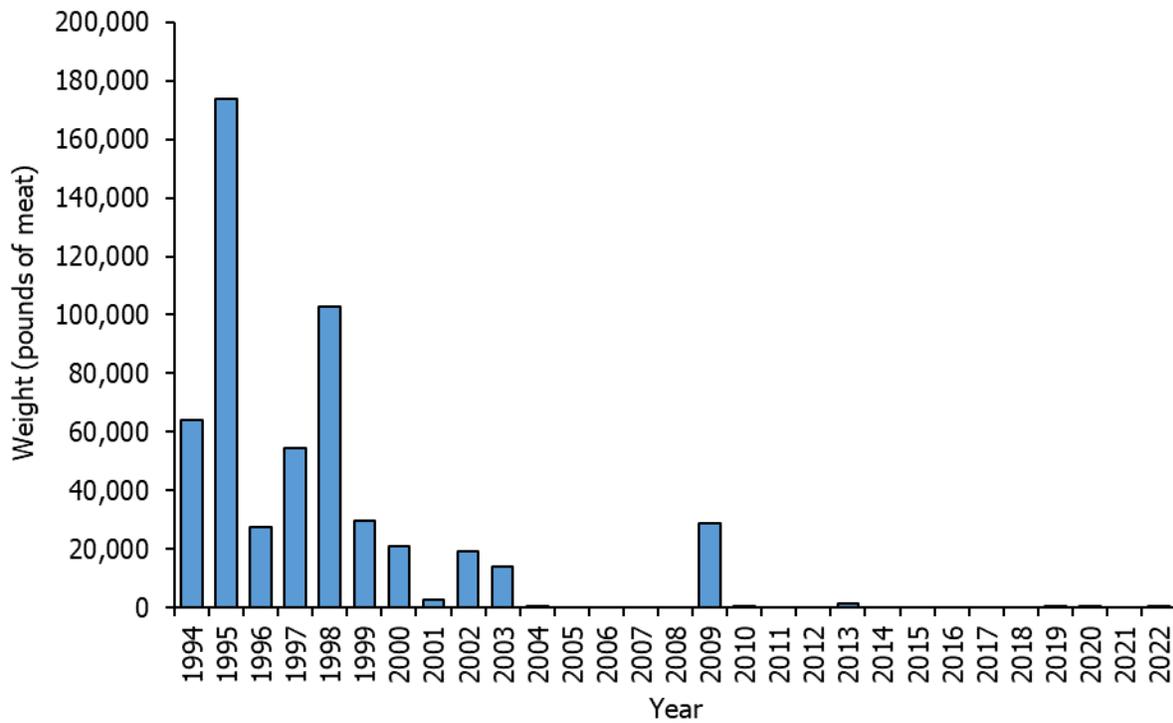


Figure 4. Bay scallop landings (wild and aquaculture in pounds of meat) in North Carolina, 1994–2021. Landings occurred in 2010, 2013, 2019, 2020, and 2022 but are not evident in the figure due to the scale required to show the range of landings for the time series.

STATE MANAGED SPECIES – BLUE CRAB

**FISHERY MANAGEMENT PLAN UPDATE  
BLUE CRAB  
AUGUST 2023**

**STATUS OF THE FISHERY MANAGEMENT PLAN**

**Fishery Management Plan History**

Original FMP Adoption:	December 1998	
Amendments:	Amendment 1	December 2004
	Amendment 2	November 2013
	Amendment 3	February 2020
Revisions:	Revision to Amendment 2	May 2016
	Revision to Amendment 3	May 2020
Supplements:	None	
Information Updates:	None	
Schedule Changes:	August 2016	
Comprehensive Review:	2023	

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 March 1–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) prohibited the possession of white line peelers June 1–30, (6) changed the unattended pot rule from ten days to seven days, (7) prohibited 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) established 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) established 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) prohibited 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) extended the pot cleanup period by nine days, (5) changed the unattended pot rule from seven days to five days, (6) required a four-inch stretch mesh tail bag for crab trawls in western Pamlico Sound (including the Pamlico, Pungo, Bay, and Neuse rivers), (7) separated hard and peeler crab trawl

landings on trip tickets, (8) modified channel net rule to incorporate limited blue crab bycatch provisions identical to those for shrimp trawls, (9) modified user conflict rule to resolve user conflicts on a regional basis, (10) allowed crab pots in all designated long haul areas in Hyde, Beaufort, and Pamlico counties, (11) modified the dates for designated crab pot areas from May 1–October 31 to June 1–November 30, (12) changed designated pot area boundary description to a standardized six foot depth contour in many areas, and (13) prohibited 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) repealed the spawner index trigger (and associated maximum size limits for mature female and peeler blue crabs) and replaced it with adaptive management framework based on the results of the annual Traffic Light Stock Assessment update, (2) opened long haul areas in the Pungo River to pots, (3) added Lower Broad Creek to non-pot areas in rule, (4) modified crab dredging rule to conform to current harvest management, (5) incorporated Pamlico Sound four-inch crab trawl line into rule, (6) redefined criteria for exempting escape rings in crab pots from the 1.5-inch pot mesh size to un-baited pots and pots baited with a male crab, (7) repealed proclamation authority that allowed for the exemption of escape ring requirement to allow harvest of peeler crabs, (8) adopted the 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) modified trawl nets rule to identify Pamlico, Back, and Core sounds as areas that can open to peeler trawling by proclamation, (10) modified rule to clearly state the intent of the exceptions, culling tolerance, and separation requirements for various crab categories, and (11) established proclamation authority to require terrapin excluders in crab pots and establish a framework for developing criteria and terrapin excluder specifications.

The North Carolina Marine Fisheries Commission (MFC) adaptive management strategy for blue crabs under Amendment 2 relied on the Traffic Light Stock Assessment to provide information on relative condition of the stock. The reference years (1987–2009) for assigning the signals in the Traffic Light Stock Assessment remained constant and the analysis was updated annually by July each year. The name of this analysis comes from assigning a color (red, yellow, or green) to categorize relative levels of different indicators for either a fish population or a fishery. The Traffic Light Stock Assessment effectively illustrates long term trends in the population.

Based on results of the annual Traffic Light update with 2015 data, management action was required by the MFC. At its May 19, 2016 business meeting, the MFC 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 MFC 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) April 1–April 30 each year; and include dark sponge crabs in the culling tolerance; (4) lower the culling tolerance from 10% to 5% for all crabs, except mature

females; and (5) prohibit the harvest of crabs with dredges except incidental to lawful oyster dredging as outlined in 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 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 MFC are documented in the May 2016 Revision to Amendment 2 to the N.C. Blue Crab FMP (NCDMF 2016).

Comprehensive Review of the Blue Crab FMP was originally scheduled to begin in July 2018, but at its August 2016 business meeting, the MFC voted to begin the review immediately to assess the status of the blue crab stock and identify more comprehensive management strategies. Consequently, review of the Blue Crab FMP for development of Amendment 3 began in August 2016. The stock assessment was completed and accepted for management use, and Amendment 3 was adopted by the MFC at its February 19, 2020 business meeting (NCDMF 2020a). The amendment maintained measures implemented with the May 2016 Revision to the Blue Crab FMP and implemented several management changes including: 1) crab harvest and pot closure periods (January 1–31 north of the Highway 58 bridge to Emerald Isle and March 1-15 south of the Highway 58 bridge, 2), a 5-inch minimum size limit for mature female crabs statewide, 3) replacing the annual Traffic Light Stock Assessment update with an adaptive management framework based on an interim update of the 2018 benchmark assessment, 4) removal of all cull ring exempted areas, 5) revised the boundaries for crab spawning sanctuaries in Drum Inlet and Barden Inlet and established new crab spawning sanctuaries in Beaufort, Bogue, Bear, Browns, New River, Topsail, Rich, Mason, Masonboro, Carolina Beach, Cape Fear River, Shallotte, Lockwoods Folly, and Tubbs inlets with March 1–October 31 closure, 6) crab trawling prohibition in areas of the Pamlico, Pungo, and Neuse rivers where trawling for shrimp was prohibited, 7) crab bycatch allowance in oyster dredges reduced to 10% of the total weight of the combined oyster and crab catch or 100 pounds, whichever is less 8) adopted a framework to designate Diamondback Terrapin Management Areas, and 9) addressed water quality issues requiring partnering with other commissions and state agencies.

The Diamondback Terrapin Management Area (DTMA) framework in Amendment 3 contains the criteria required to identify areas of the state where terrapin excluder devices are required. Two DTMA's were established in May 2020 in Masonboro Sound and the lower Cape Fear River. This action, taken by the MFC, is documented in the May 2020 Revision to Amendment 3 to the N.C. Blue Crab FMP and implemented by Proclamation PT-1-2021 (NCDMF 2020b). These areas have documented terrapin populations and waterbody characteristics in which diamondback terrapins are susceptible to incidental capture. Beginning in March 2021, all pots in these areas are required to be modified with a North Carolina Division of Marine Fisheries (DMF) approved diamondback terrapin excluder device in each funnel March 1–October 31. The February 2023 revision to Amendment 3 to the Blue Crab FMP updated the approved list of terrapin excluder device types and sizes required or gear modifications to be used in crab pots fished within designated DTMA's.

The Blue Crab FMP, Amendments, and Revisions are available on the DMF website at: <https://deq.nc.gov/about/divisions/marine-fisheries/managing-fisheries/fishery-management-plans#state-managed-species>

## **Management Unit**

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

## **Goal and Objectives**

The goal of Amendment 3 to the North Carolina Blue Crab FMP is to manage the blue crab fishery to achieve a self-sustaining population that provides sustainable harvest using science-based decision-making processes. The following objectives will be used to achieve this goal:

- Implement management strategies that maintain/restore the blue crab spawning stock with multiple cohorts and adequate abundance to prevent recruitment overfishing.
- Restore, enhance, and protect habitat and environmental quality necessary to maintain or increase growth, survival, and reproduction of the blue crab population.
- Use biological, environmental, habitat, fishery, social, and economic data needed to effectively monitor and manage the blue crab fishery and its ecosystem impacts.
- Promote stewardship of the resource through increased public awareness regarding the status and management of the blue crab fishery, including practices that minimize bycatch and discard mortality.

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

The blue crab is common to all North Carolina coastal waters but are most abundant in the Albemarle and Pamlico sounds and their tributaries. Blue crabs mature at approximately 12–18 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 rivers from late spring to early fall, and spawning occurs in high-salinity waters near ocean inlets from early summer to fall (Forward et al. 2003; Whitaker 2006). The first larval stage is carried offshore by ocean currents where several stages of development occur (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 (Binion-Rock 2018). 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 its shell and claws and a T-shaped apron on its underside. Female crabs are called "sooks" as adults and "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 its abdomen.

### **Stock Status**

Results of the 2018 benchmark blue crab stock assessment (2016 terminal year) indicate the stock is overfished and overfishing is occurring (NCDMF 2018).

### **Stock Assessment**

The 2018 benchmark 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 and several fishery-independent surveys (Program 100, Program 120, Program 195). Only hard crab landings were incorporated in the model, neither recreational nor 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 (Figure 1). Females had higher natural mortality estimates than males. The estimated fishing mortality remained high before 2007 and decreased by approximately 50% afterward (Figure 1).

The status of the blue crab stock was evaluated using biological reference points (BRPs) based on maximum sustainable yield (MSY). The MSY-based 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 (FMSY) was set to be the threshold for overfishing, and 0.75 FMSY was set to be the target fishing mortality. The spawner abundance at FMSY (SPMSY) and 0.75 FMSY were set to be the threshold and target for an overfished population, respectively. In the current stock assessment, the population is determined to be

overfished if the average spawner abundance in 2016 falls below SPMSY and is determined to be undergoing overfishing if the average F in 2016 is above FMSY.

The 2018 benchmark stock assessment is available on the DMF website at: <https://www.deq.nc.gov/about/divisions/marine-fisheries/managing-fisheries/fishery-management-plans#BlueCrab-8716>.

## **DESCRIPTION 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)
- 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 MFC 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 DMF 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, that 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 all hard blue crabs. It is unlawful to possess mature female hard crabs with a dark (brown or black) sponge from April 1 through April 30 statewide. Juvenile female hard crabs may not be harvested. Soft crabs shall be separated where taken and placed in a 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 were 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. 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 of the DMF, may by proclamation, close the harvest of blue crabs and may impose any or all the following restrictions on the commercial and recreational harvest of blue crab: 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.

From January 1 to January 31, it is unlawful to possess blue crabs taken from all Coastal Fishing Waters of the state north and east of a line extending southeast from the Highway 58 Bridge to a point offshore at 34° 36.3292'N, 77° 2.5940'W to the North Carolina/Virginia state line (15A

NCAC 03R .0118(1)). From March 1 to March 15, it is unlawful to possess blue crabs taken from all Coastal Fishing Waters of the state south and west of a line extending southeast from the Highway 58 Bridge to a point offshore at 34° 36.3292'N, 77° 2.5940'W to the North Carolina/South Carolina state line (15A NCAC 03R .0118(2)). 15A NCAC 03L .0201 (a) and (b).

### 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 from March 1 through August 31 for the crab spawning sanctuaries described in 15A NCAC 03R .0110(1) and from March 1 through October 31 for the crab spawning sanctuaries described in 15A NCAC 03R .0110(2). During the remainder of the year the Director may, by proclamation, close these areas and may impose any or all 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 DMF. 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, 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).
- 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, 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 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 the weight of the crabs shall not exceed; 50% 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 may be possessed. 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 where 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).

## 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).
- From January 1 to January 31, it is unlawful to use crab pots in Coastal Fishing Waters of the state north and east of a line extending southeast from the Highway 58 Bridge to a point offshore at 34° 36.3292'N, 77° 2.5940'W to the North Carolina/Virginia state line (15A NCAC 03R .0118(1)). From March 1 to March 15, it is unlawful to use crab pots in Coastal Fishing Waters of the state south and west of a line extending southeast from the Highway 58 Bridge to a point offshore at 34° 36.3292'N, 77° 2.5940'W to the North Carolina/South Carolina state line (15A NCAC 03R .0118(2)). 15A NCAC 03J .0301 (a)(1)(a) and (b).
- 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 any shade of yellow or any shade of hot pink, or any combination of colors that include any shade of yellow or any shade of hot pink. The pot owner's last name and initials shall be engraved on the attached buoy or identified by attaching engraved metal or plastic tags to the buoy. If a vessel is used, the identification shall include either the pot owners current motor boat registration number or vessel documentation name. 15A NCAC 03J .0301(c)(1) and (2)
- It is unlawful to use crab pots in coastal fishing waters unless each pot contains no less than three unobstructed escape rings that are at least 2 and 5/16 inches inside diameter and two must be located in the opposite outside panels of the upper chamber of the pot and at least one must be located within one full mesh of the corner and one full mesh of the bottom of the divider in the upper chamber of the pot except: unbaited pots, pots baited with a male crab 15A NCAC 03J .0301(g).
- 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).

#### Crab Dredging

- It is unlawful to take blue crabs with dredges except incidental to lawful oyster dredging operations provided the weight of the crabs does not exceed 10% of the total weight of the combined oyster and crab catch or 100 pounds, whichever is less. 15A NCAC 03L .0203 (1) & (2)

#### Diamondback Terrapin Management Areas

- For areas described in Proclamation PT-1-2022 including the Masonboro Island and Bald Head Island areas, from March 1 through October 31 it is unlawful to set or use crab pots without the correct use of Division of Marine Fisheries Approved Diamondback Terrapin Bycatch Reduction Devices. PT-1-2022.

#### 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**

#### Blue Crab 15A NCAC 10C .0413

- 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 .0413(a)(b).
- There is no closed season. 15A NCAC 10C .0413(c)
- Blue crabs shall not be sold. 15A NCAC 10C .0413 (d).

#### Taking Nongame Fishes By Special Device For Bait Or Personal Consumption 15A NCAC 10C .0402

- A single, multiple bait line for taking crabs not to exceed 100 feet in length, marked on each end with a solid float no less than five inches in diameter, bearing legible identification of the user's name and address, and under the immediate control and attendance of the person using the device, with a limit of one line per person and no more than one line per vessel. 15A NCAC 10C .0402(b)(12).

- A collapsible crab trap with the largest open dimension not greater than 18 inches, and that by design is collapsed at all times when in the water, except when being retrieved or lowered to the bottom, with a limit of one trap per person. 15A NCAC 10C .0402(b)(13).
- It is unlawful to sell nongame fishes or aquatic animals. 15A NCAC 10C .0402(c).

#### Special Devices 15A NCAC 10C .0404

- 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 Fishery**

Since 1994, the North Carolina Trip Ticket Program (NCTTP) has collected data on the commercial harvest of blue crab. Commercial blue crab landings (hard, soft, and peeler crabs) averaged 36.6 million pounds for the period 1995–2016 (stock assessment years; Table 1). Generally, commercial blue crab landings have been lower since around 2012 and ranged from a high of 67.1 million pounds in 1996 to a low of 9.5 million pounds in 2022, which was 26% lower than 2021 and 73% lower than the 36-year average (Table 1; Figure 2). Commercial blue crab landings have been below the stock assessment years' average since 2003 (Figure 2). Crab pots account for most commercial blue crab landings (96.54% in 2022) followed by peeler pots (3.18% in 2022), crab trawls (0.2% in 2022), and other gears, including gill nets and shrimp trawls (0.1% in 2022; Figure 3). Most crabs landed in 2022 were hard crabs (95.58%), followed by peeler (3.04%) and soft (1.38%) crabs (Figure 4).

### **Recreational Fishery**

A survey of Recreational Commercial Gear License (RCGL) holders conducted during 2002–2008 by the DMF indicated blue crabs were the most abundant species landed (by weight) by RCGL participants. During this time, on average, blue crabs accounted for 20% (116,797 pounds) of the total poundage (587,172 pounds) of all species landed by RCGL holders. This survey was discontinued in 2009 due to lack of funding; meaning 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 using 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 generate recreational harvest estimates for blue crab. One weakness of the survey is that 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 2011–2022 (Table 1; Figure 5). Generally, recreational blue crab harvest estimates are low, ranging from 47,766 blue crabs (approximately 15,922 pounds, using an average of three

crabs per pound) in 2018 to 120,979 blue crabs (approximately 40,326 pounds) in 2012. During 2011–2022, the average annual recreational harvest of blue crab was 66,744 blue crabs (approximately 22,248 pounds).

## **MONITORING PROGRAM DATA**

### **Fishery-Dependent Monitoring**

The number of blue crab lengths obtained from fishery-dependent sources from 1995 through 2022 ranged from 7,254 in 2022 to 33,007 in 1995 (Table 2). Mean carapace width (CW) varied little and ranged from 5.6 inches to 5.9 inches. Minimum CW ranged from 1.2 inches to 3.9 inches. Maximum CW ranged from 7.8 inches to 9.1 inches. In general, the commercial fishery harvests a narrow size range of blue crab, with most crabs ranging from 4.5 to 6.5 inches CW. The length composition and modal length of blue crab caught in the commercial fishery have varied little over time (Figure 6).

The annual length of 50% maturity is compared to the mean from the stock assessment years of 1995–2016 (113.4 mm CW [4.5 inches]). In 2022, the length of 50% maturity was 112.6 mm CW (4.4 inches), slightly below the mean for the stock assessment years. (Figure 7).

### **Fishery-Independent Monitoring**

The blue crab stock assessment uses several fishery-independent indices for the recruit and fully recruited indices, including the Estuarine Trawl Survey (Program 120), the Pamlico Sound Survey (Program 195), and the Juvenile Anadromous Trawl Survey (Program 100). The base years used for the blue crab stock assessment were 1995–2016.

### **Recruit Abundance**

The recruit indices use data from the Estuarine Trawl Survey and the Pamlico Sound Survey to monitor blue crab recruit abundance. Each index consists of blue crabs less than 127 mm CW (5.0 inches). Two indices are derived from Program 120: a male recruit index and a female recruit index (Figure 8). Four recruit indices are derived from Program 195: June indices by sex and September indices by sex (Figures 9 and 10).

Male recruit abundance in Program 120 has been below the stock assessment years' mean (4.5 crabs/tow) since 2012 when relative abundance was 5.5 crabs/tow (Figure 8A). Female recruit abundance has also been below the stock assessment years' mean (2.8 crabs/tow) since 2012 (3.3 crabs/tow; Figure 8B). In 2022, male recruit abundance fell to the lowest in the time series at 0.7 crabs/tow. The lowest female recruit abundance was in 2020 with 0.4 crabs/tow. In 2022, female recruit abundance increased slightly to 0.5 crabs/tow.

Recruit abundance for Program 195 varies greatly from year to year. In June 2022, male recruit abundance increased to 9.9 crabs/tow from a time series low in 2021 of 4.9 crabs/tow (Figure 9A). In June 2022, female recruit abundance increased to 6.7 crabs/tow from a time series low in 2021 of 3.9 crabs/tow (figure 9B).

In September 2022, male and female recruit abundance increased compared to time series lows in 2021. Male recruit abundance increased to 0.4 crabs/tow and female recruit abundance increased to 0.3 crabs/tow. It should be noted the COVID pandemic impacted sampling in 2020 and 2021. In 2020, sampling was limited to 28 stations sampled in June and 35 stations sampled in September. A total of 35 stations were sampled in June 2021 and 32 stations were sampled in September 2021. Limited sampling likely impacted abundance indices calculated from Sound Survey data in these years.

### **Fully Recruited Abundance**

The adult indices include data from the Juvenile Anadromous Trawl Survey (Program 100) and the Pamlico Sound Survey (Program 195). Indices consist of blue crabs greater than or equal to 127 mm CW (5.0 inches). Four indices are derived from Program 100, a male fully recruited index and a female fully recruit index by season (summer and fall; Figures 11 and 12). Program 195 is also used to derive June fully recruited indices by sex and September fully recruited indices by sex (Figures 13 and 14).

In 2022, male fully recruited summer abundance in Program 100 fell to 0.6 crabs/tow which is below the stock assessment years' mean (1.3 crab/tow) and female fully recruited summer abundance was 0.2 crabs/tow which is below the stock assessment years' mean (0.5 crabs/tow) (Figures 11A and 11B). In 2022, male fully recruited fall abundance increased from 2021 (0.6 crabs/tow) to 1.1 crabs/tow but remains below the stock assessment years' mean (2.1 crabs/tow). Female fully recruited fall abundance increased from 2021 (0.3 crabs/tow) to 1.1 crabs/tow, which is still below the stock assessment years' mean (2.4 crabs/tow; Figures 12A and 12B).

Program 195 fully recruited abundance does not vary in the same way as recruit abundance and is more variable in June compared to September for female blue crabs. In 2022, male fully recruited June abundance was 0.2 crabs/tow which is below the stock assessment years' mean (1.6 crabs/tow; Figure 13A). Female fully recruited June abundance was 0.6 crabs per/tow in 2022 which is below the stock assessment years' mean (3.2 crabs/tow) (Figure 13B). In 2022, male fully recruited September abundance was 0.08 crabs/tow which is below the stock assessment years' mean (1.6 crabs/tow; Figure 14A). The female fully recruited September abundance was 0.05 crabs/tow in 2022 which is below the stock assessment years' mean (3.4 crabs/two; Figure 14B). To note: the COVID pandemic impacted Program 195 sampling in 2020 and 2021. In 2020, sampling was limited to 28 stations sampled in June and 35 stations sampled in September. A total of 35 stations were sampled in June 2021 and 32 stations were sampled in September 2021. Limited sampling likely impacted abundance indices calculated from the Pamlico Sound Survey data.

### **RESEARCH NEEDS**

Several research needs were identified in N.C. Blue Crab Fishery Management Plan Amendment 3; the bulleted list below outlines the specific needs and highlights the priority of each management and research need.

## **High**

- Implement long-term monitoring of blue crab discards in other fisheries (e.g., gill net, trawl).
- Develop statewide fishery-independent survey(s) to monitor the abundance of all blue crab life stages.
- Expand time and area coverage of existing fishery-independent surveys.
- Better characterize the magnitude of recreational harvest.
- Develop better estimates of life-history parameters, especially growth and natural mortality.
- Explore alternative biological reference points.
- Research interaction rates of non-target species in the blue crab fishery and identify factors that may lead to interactions (e.g., migration patterns, habitat utilization).
- Identify biological characteristics of submerged aquatic vegetation beds of ecological value to blue crab and implement restoration and conservation measures.
- Research mature female migration routes and seasonal habitat use (e.g., inlets, staging areas).
- Research gear modifications to minimize interactions with non-target species (e.g., diamondback terrapin) in the blue crab fishery.
- Research the impacts of land use activities and shoreline clearing on water quality and the blue crab stock.
- Research the impact of endocrine disrupting chemicals on the various life stages of blue crabs and ways to reduce their introduction into estuarine waters, including discharge from wastewater treatment plants.

## **Medium**

- Characterize the harvest and discard of blue crabs from crab shedding operations.
- Explore alternative model types.
- Research the impact of increased predator abundance on the blue crab stock.
- Identify key environmental factors that significantly impact North Carolina's blue crab stock and investigate assessment methods that can account for these environmental factors.
- Identify, map, and protect habitat of ecological value to blue crab (in particular juvenile habitat) and implement restoration and conservation measures.
- Assess the impact of inlet dredging activities on mature female blue crabs.
- Implement monitoring of hazardous events (e.g., hurricane, extreme hot or cold weather) affecting blue crab population dynamics and harvest.
- Research the extent, causes, and impacts of hypoxia and anoxia on blue crab behavior and population abundance in estuarine waters.

- Research the impact of invasive species (e.g., blue catfish) on the blue crab stock.

## **Low**

- Investigate and support research on promising methods to age blue crabs.
- Evaluate the genetic stock structure of blue crabs within North Carolina and the magnitude of mixing between populations.
- Identify programs outside the DMF that collect data of potential use to the stock assessment of North Carolina's blue crabs.
- Research and identify key market forces and their effects on the blue crab industry.

## **MANAGEMENT STRATEGY**

Amendment 3 adopted an adaptive management framework, replacing the traffic light assessment, based on the peer-reviewed and approved stock assessment model. Division staff will update the stock assessment at least once between full reviews of the FMP. If the stock is overfished and/or overfishing is occurring or it is not projected to meet sustainability requirements, management measures will be adjusted using the director's proclamation authority. If the stock is not overfished and overfishing is not occurring, management measures may be relaxed provided it will not jeopardize the sustainability of the blue crab stock. Any quantifiable management measure with the ability to achieve sustainable harvest (as defined in the stock assessment), either on its own or in combinations, may be considered. The director's proclamation authority for adaptive management is contingent on consultation with the Northern, Southern, and Shellfish/Crustacean advisory committees as well as approval by the MFC. Several management issues were explored in Amendment 3.

## **FISHERY MANAGEMENT PLAN SCHEDULE RECOMMENDATIONS**

Amendment 3 management measures were fully implemented as of January 1, 2021. An update to the 2018 benchmark stock assessment will begin in 2023. Results of the stock assessment update will be used to inform future management.

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## TABLES

Table 1. Blue crab recreational harvest (number and weight) and releases (number; Recreational Mail Survey) and commercial harvest (weight; North Carolina Trip Ticket Program), 1987–2022. Recreational harvest weight is calculated using a standard conversion of 3 crabs per pound.

Year	Recreational			Commercial	Total Weight Landed
	Number Landed	Number Released	Weight Landed (lb)	Weight Landed (lb)	
1987	-	-	-	32,423,604	32,423,604
1988	-	-	-	35,604,423	35,604,423
1989	-	-	-	34,724,673	34,724,673
1990	-	-	-	38,070,328	38,070,328
1991	-	-	-	41,829,676	41,829,676
1992	-	-	-	41,068,374	41,068,374
1993	-	-	-	43,672,732	43,672,732
1994	-	-	-	53,513,124	53,513,124
1995	-	-	-	46,443,653	46,443,541
1996	-	-	-	67,080,200	67,080,200
1997	-	-	-	56,090,109	56,090,109
1998	-	-	-	62,076,170	62,076,171
1999	-	-	-	57,545,843	57,546,676
2000	-	-	-	40,638,384	40,638,384
2001	-	-	-	32,179,345	32,180,390
2002	-	-	-	37,736,319	37,736,319
2003	-	-	-	42,769,797	42,769,797
2004	-	-	-	34,130,608	34,130,608
2005	-	-	-	25,430,119	25,430,119
2006	-	-	-	25,343,158	25,343,158
2007	-	-	-	21,424,960	21,424,960
2008	-	-	-	32,916,691	32,916,691
2009	-	-	-	29,707,232	29,707,232
2010	-	-	-	30,683,011	30,683,011
2011	114,426	81,763	38,142	30,035,392	30,073,534
2012	120,979	79,072	40,326	26,785,669	26,825,995
2013	94,174	61,452	31,391	22,202,623	22,234,014
2014	100,597	67,413	33,532	26,231,112	26,264,644
2015	71,587	60,135	23,862	32,099,183	32,150,905
2016	72,645	82,781	24,215	25,460,121	25,491,033
2017	72,645	67,667	24,215	19,263,702	19,297,371
2018	47,766	57,024	15,922	17,013,532	17,028,276
2019	81,815	78,784	27,272	22,989,674	23,014,642
2020	78,646	78,742	26,215	13,549,083	13,575,299
2021	48,675	42,561	16,225	12,790,419	12,806,644
2022	72,910	37,768	24,303	9,507,688	9,531,991
Mean	66,744	53,024	22,248	33,917,520	34,624,762

Table 2. Blue crab length (carapace width [CW], inches) data from commercial fish house samples, 1995–2022.

Year	Mean CW	Minimum CW	Maximum CW	Total Number Measured
1995	5.6	2.0	8.3	33,007
1996	5.7	2.7	8.3	23,333
1997	5.6	2.7	8.1	22,001
1998	5.7	3.4	7.9	15,246
1999	5.6	1.2	7.8	13,456
2000	5.7	3.4	8.0	15,560
2001	5.7	2.9	9.1	18,316
2002	5.6	3.5	8.3	11,417
2003	5.8	3.3	7.8	11,802
2004	5.7	3.2	8.6	17,386
2005	5.6	3.2	8.3	10,474
2006	5.6	3.3	8.1	10,867
2007	5.7	3.4	8.0	14,898
2008	5.9	3.0	8.7	20,420
2009	5.9	3.7	8.7	17,910
2010	5.8	2.7	8.4	16,123
2011	5.8	2.9	8.3	16,461
2012	5.8	3.8	8.6	12,918
2013	5.8	1.9	8.5	17,616
2014	5.9	2.3	8.5	11,304
2015	5.8	2.2	9.0	14,681
2016	5.8	3.5	9.0	13,531
2017	5.8	3.6	8.1	9,978
2018	5.8	3.7	8.1	7,698
2019	5.7	3.9	8.4	11,814
2020	5.6	1.9	7.9	7,832
2021	5.7	3.3	7.8	10,294
2022	5.9	3.6	8.7	7,254

## FIGURES

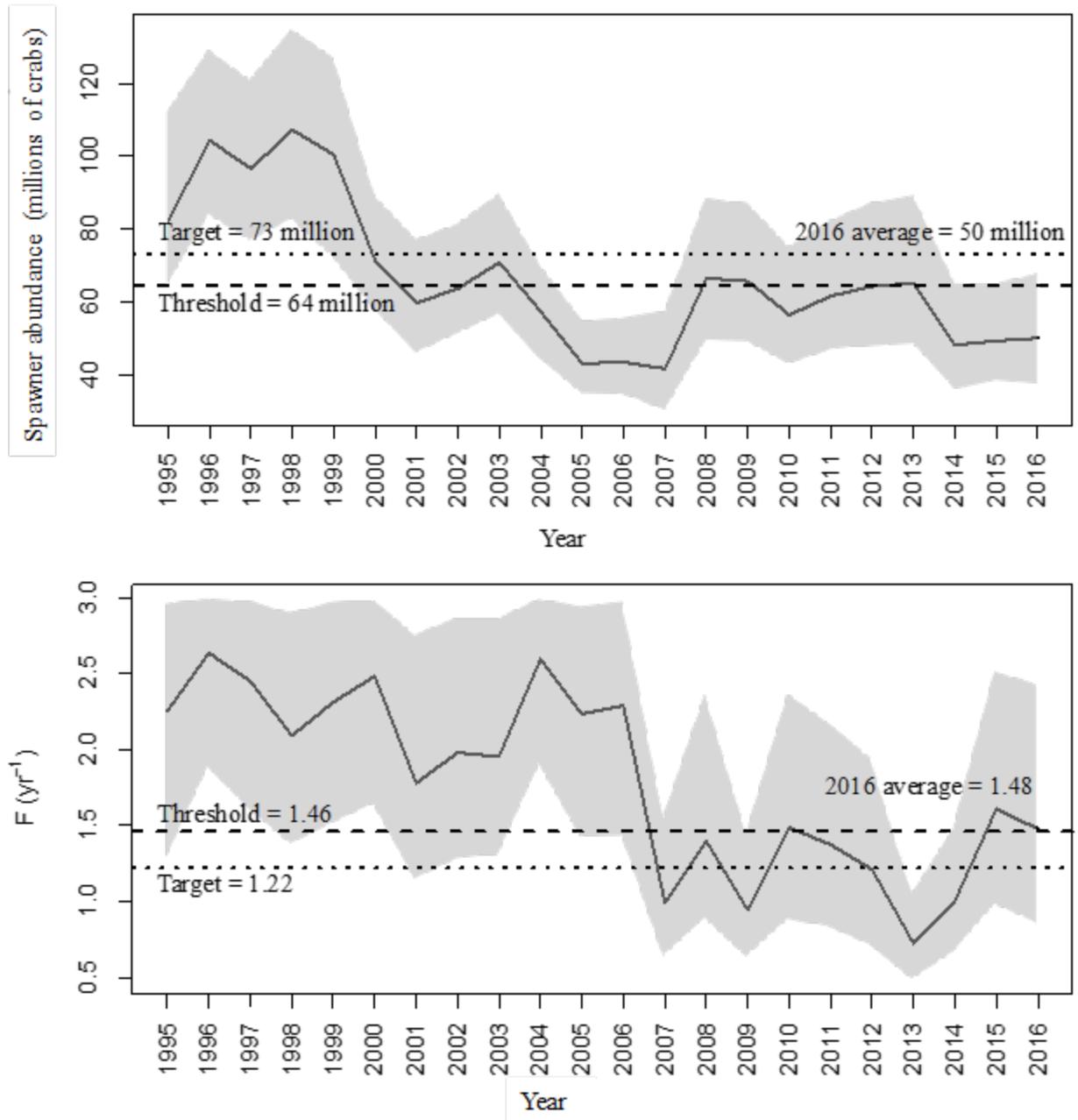


Figure 1. Estimated spawner abundance (mature female blue crabs; top) and fishing mortality (F; bottom) from the 2018 blue crab stock assessment (NCDMF 2018). The solid lines represent the posterior mean and the shaded area represents the 95% credible interval. The threshold and target values are the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

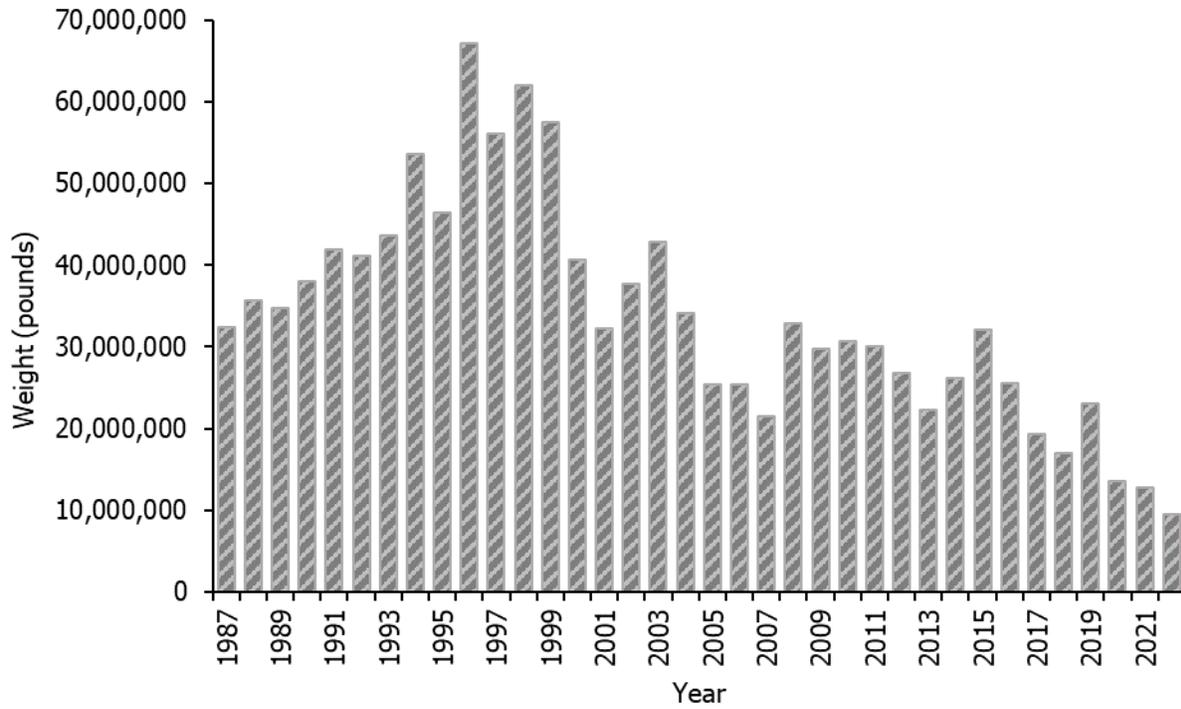


Figure 2. Annual blue crab commercial landings (North Carolina Trip Ticket Program), 1987–2022. Landings include hard, soft, and peeler crabs.

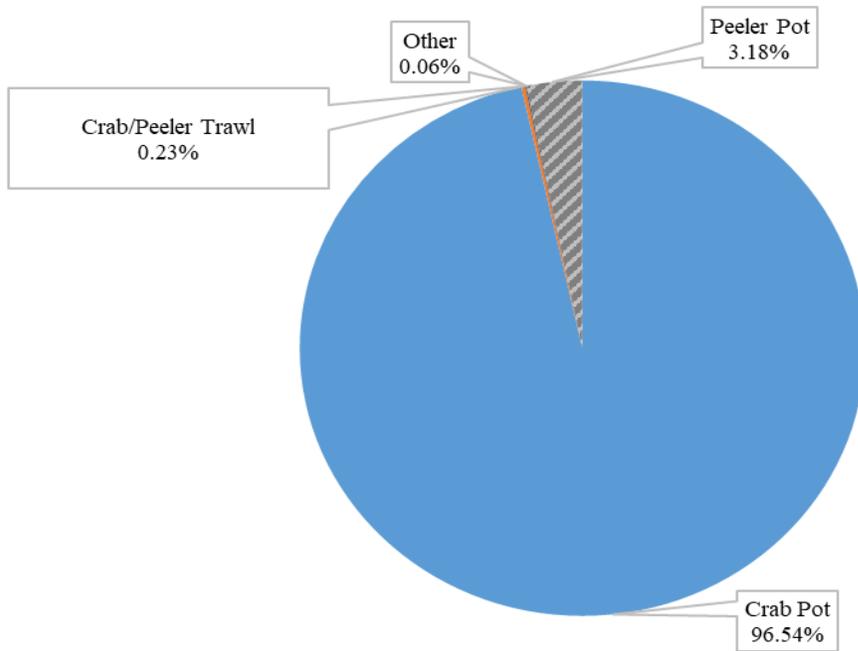


Figure 3. Commercial harvest (pounds) of blue crab by gear, 2022.

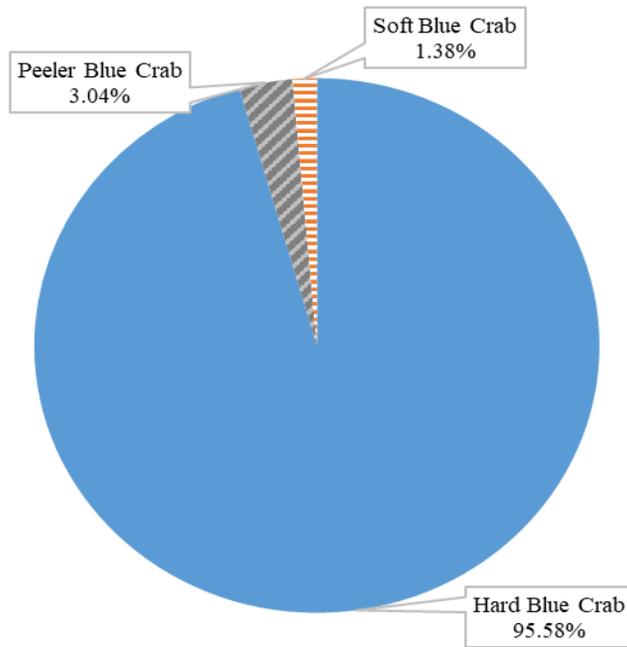


Figure 4. Commercial harvest (pounds) of blue crab by crab type, 2022.

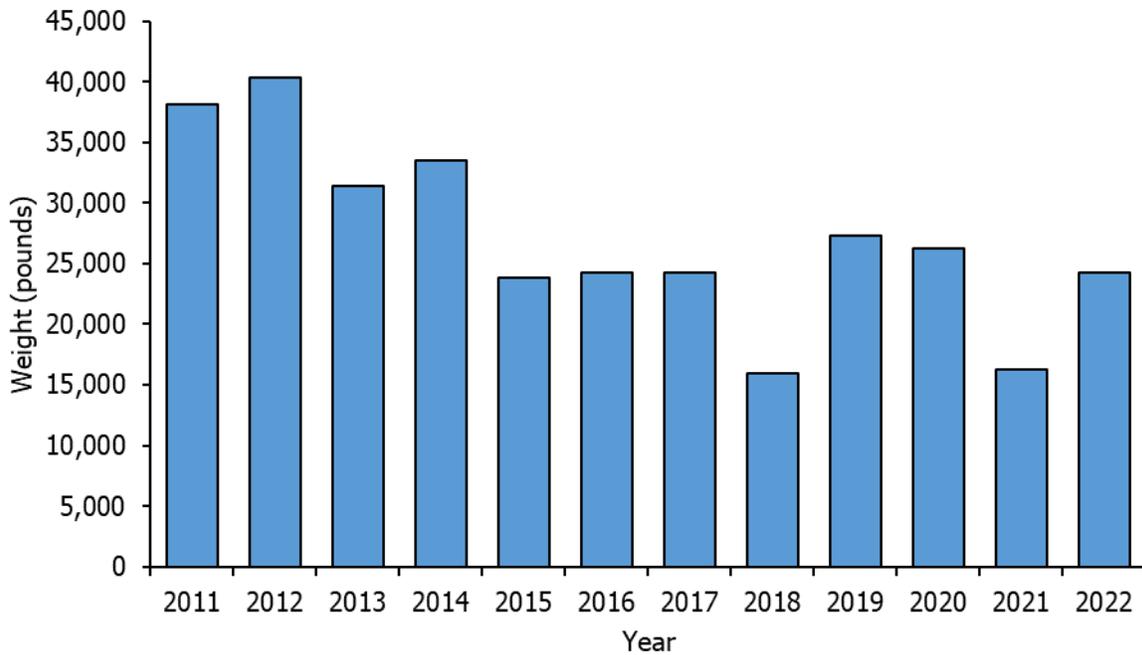


Figure 5. Annual blue crab recreational harvest, 1987–2022. Recreational mail survey began in October 2010 with the first full year of data available for 2011.

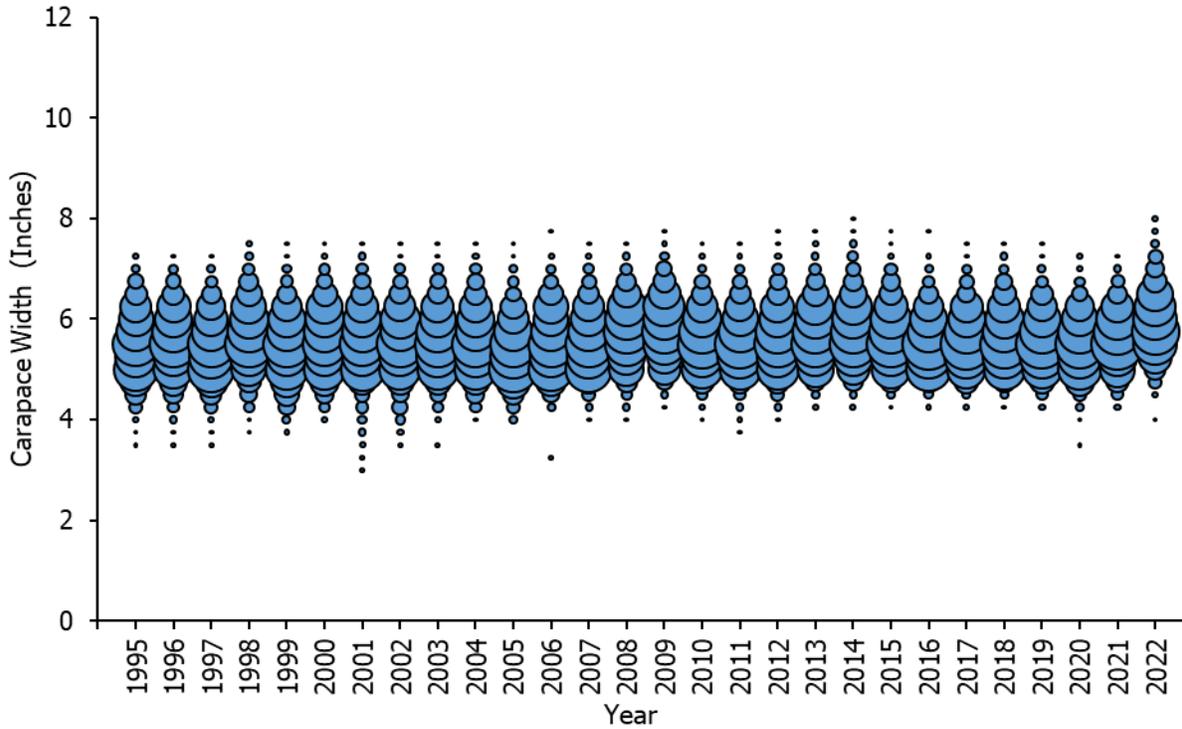


Figure 6. Commercial length frequency (carapace width, inches) of hard blue crab harvested, 1995–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

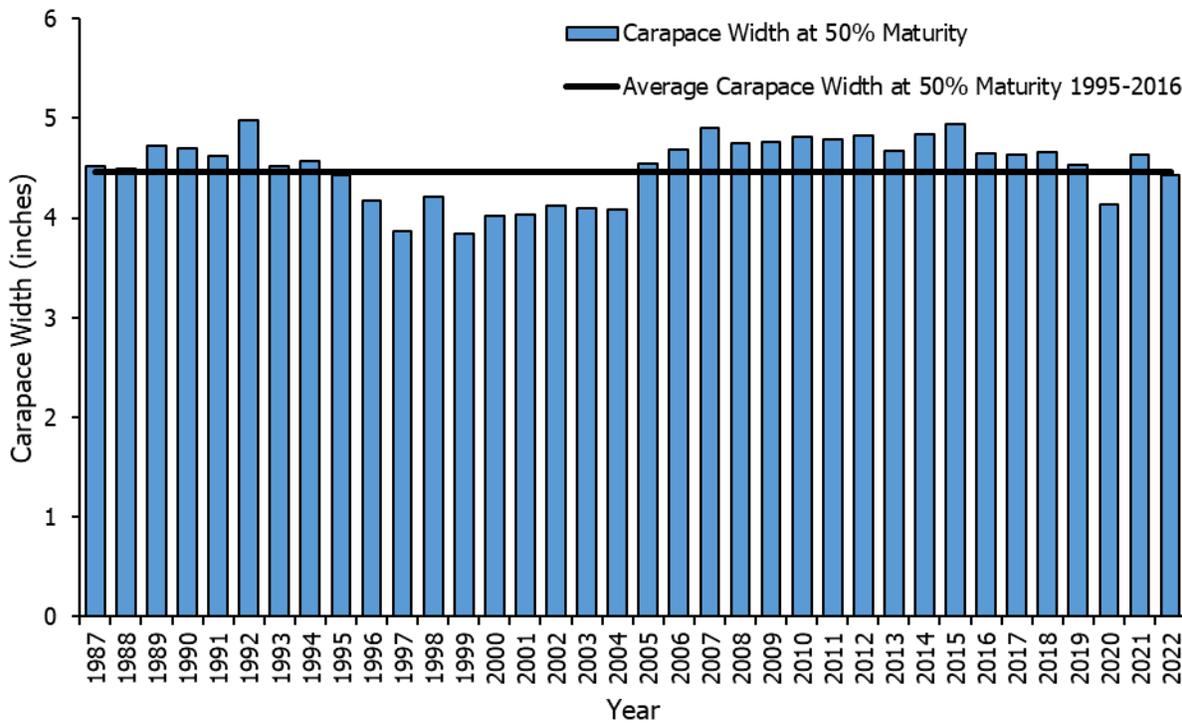


Figure 7. Length at 50% maturity for female blue crabs compared to stock assessment years, 1995–2016. Fishery-dependent and independent data were included in the analysis.

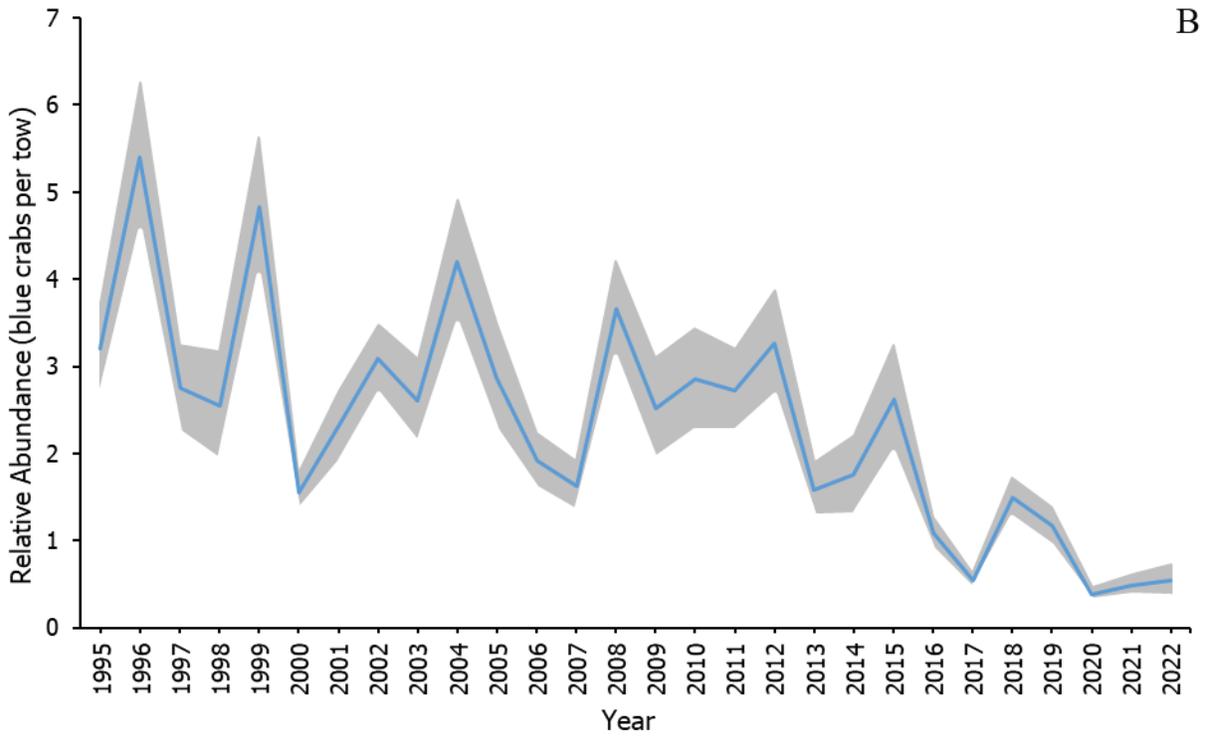
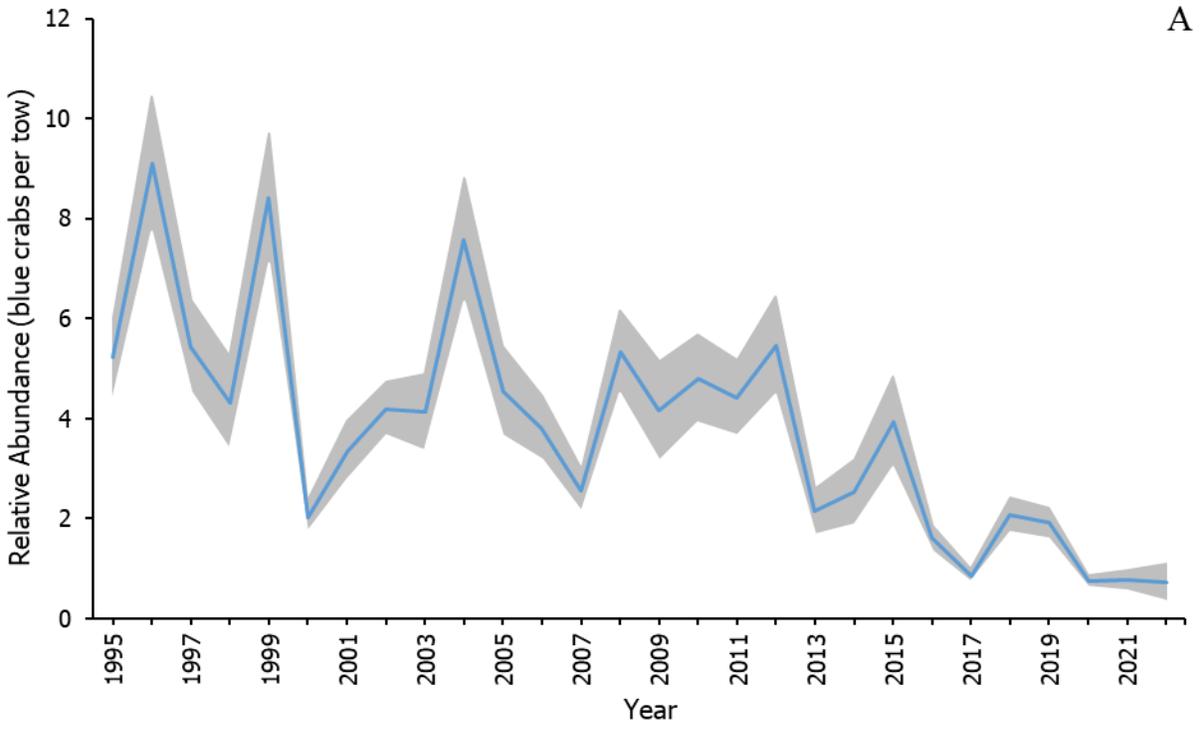


Figure 8. Nominal index (number of crabs per tow) of recruit crab relative abundance (<127 mm CW) captured in Program 120 in May and June by male (A) and female (B), 1995–2022.

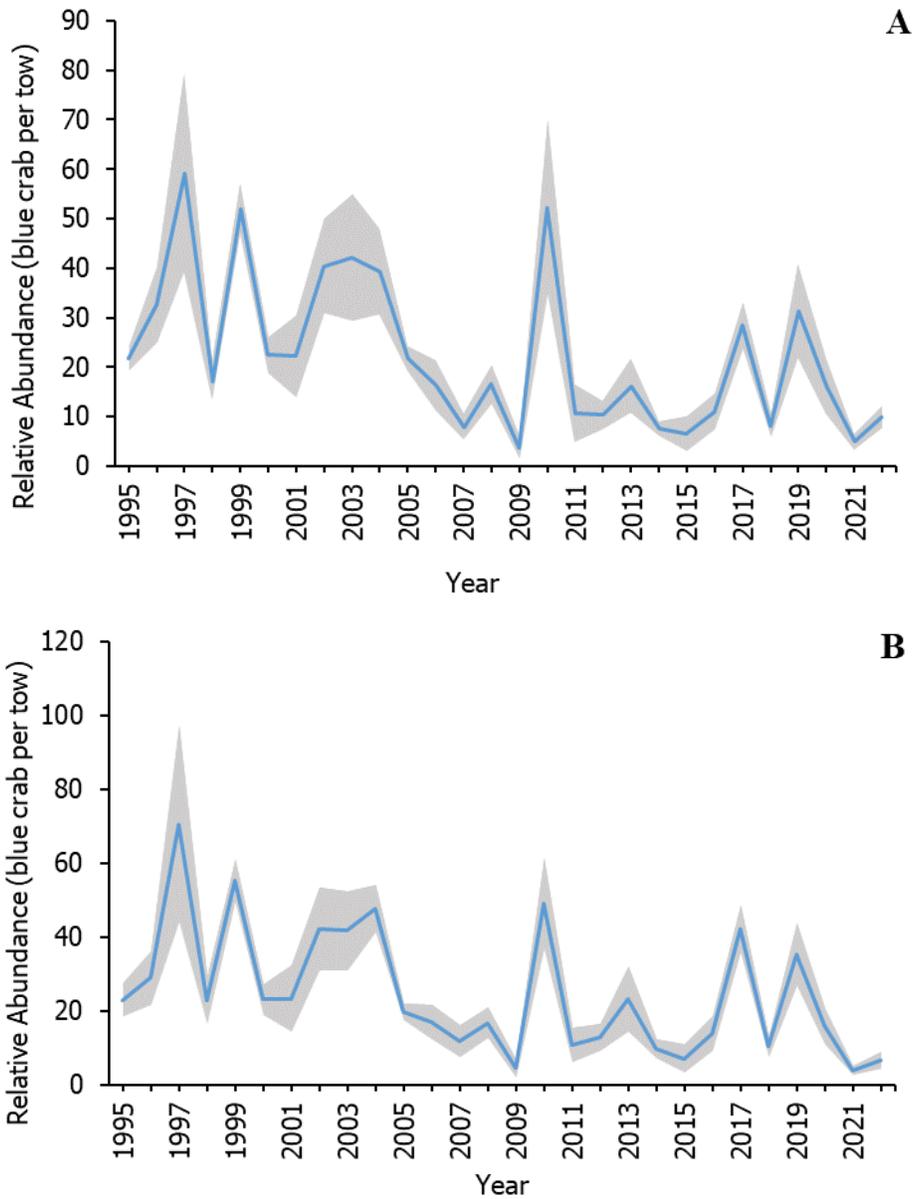


Figure 9. Nominal index (number of crabs per tow) of recruit crabs relative abundance (<127 mm, 5 inches, CW) captured in Program 195 by June male (A), June female (B), 1995–2022 for all strata combined. [Note: in 2020 and 2021 less than 54 stations were sampled]

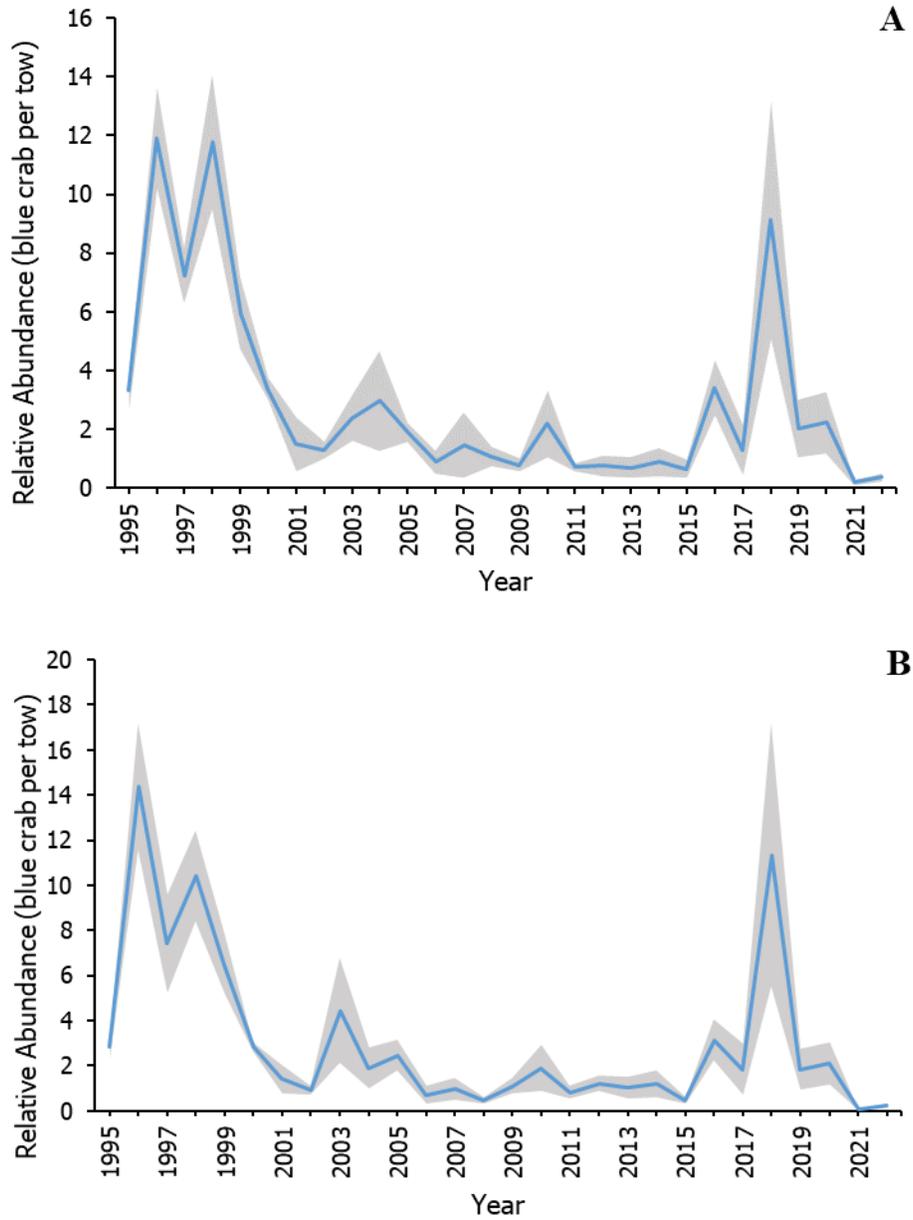


Figure 10. Nominal index (number of crabs per tow) of recruit crabs relative abundance (<127 mm, 5 inches, CW) captured in Program 195 by September male (A), September female (B), 1995–2022 for all strata combined. [Note: 2018 September sampling was conducted in October and in 2020 and 2021 less than 54 stations were sampled in both months]

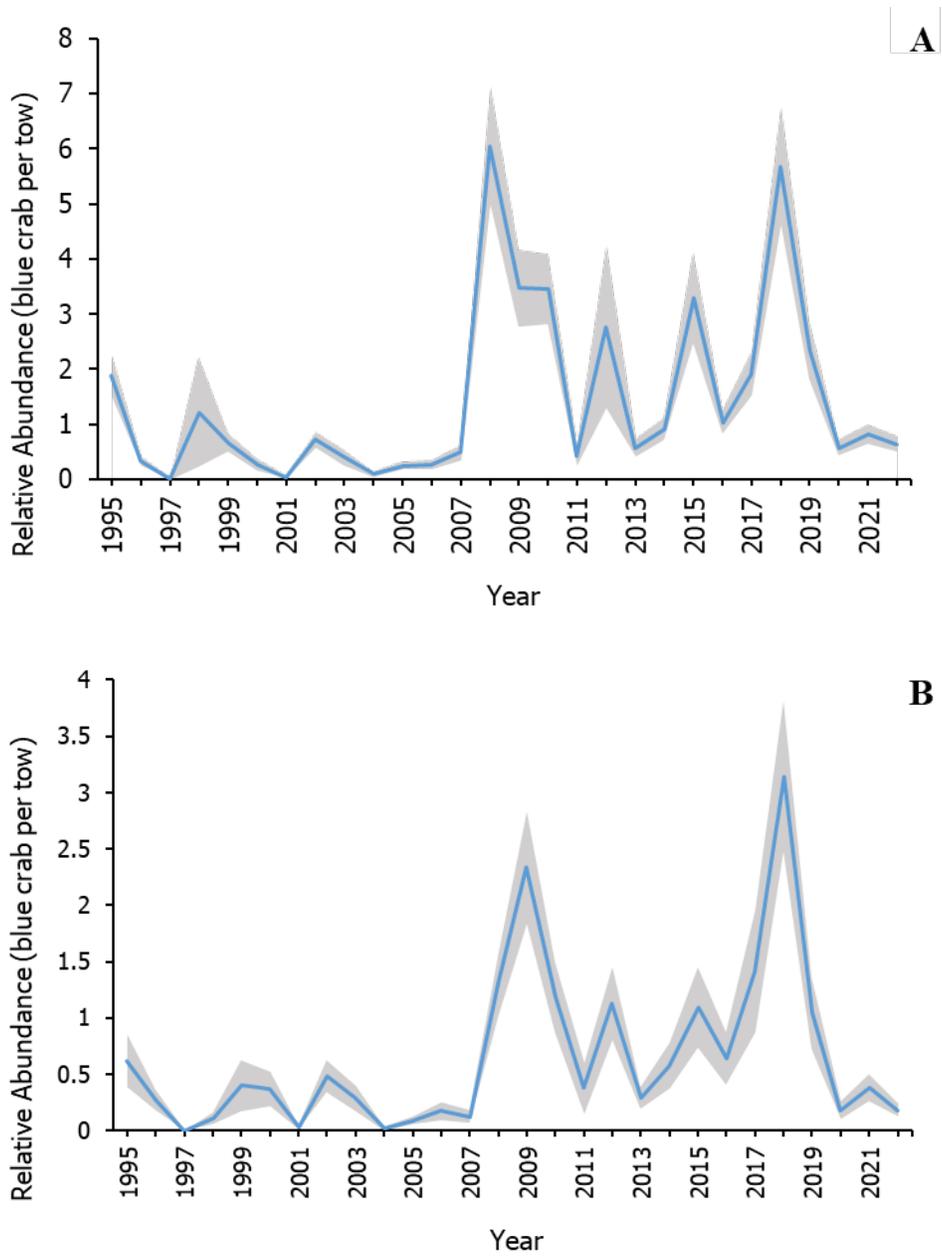


Figure 11. Nominal index (number of crabs per tow) of fully recruited crabs relative abundance ( $\geq 127$  mm, 5 inches; CW) captured in Program 100 in summer for male (A) and female (B), 1995–2022.

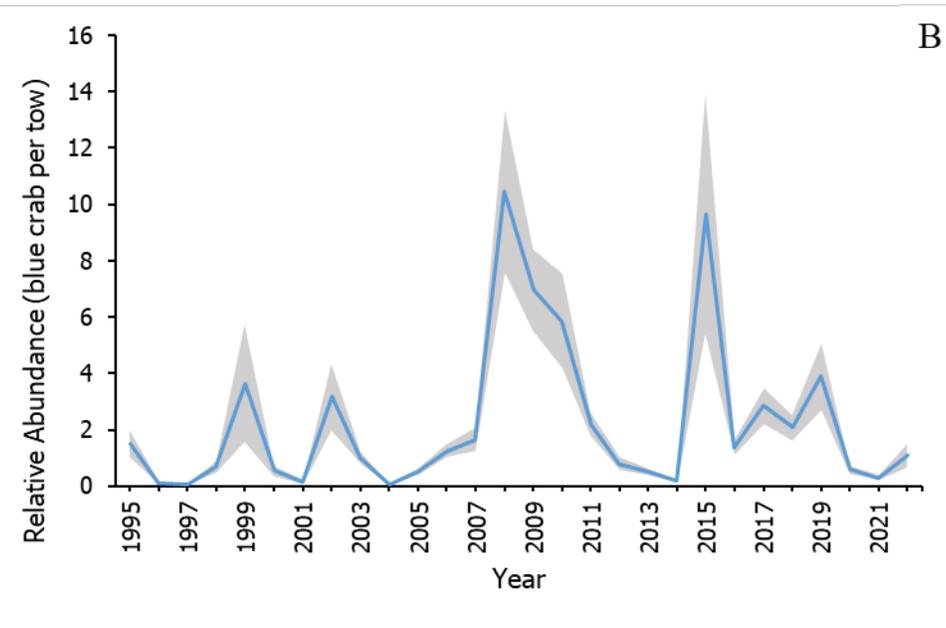
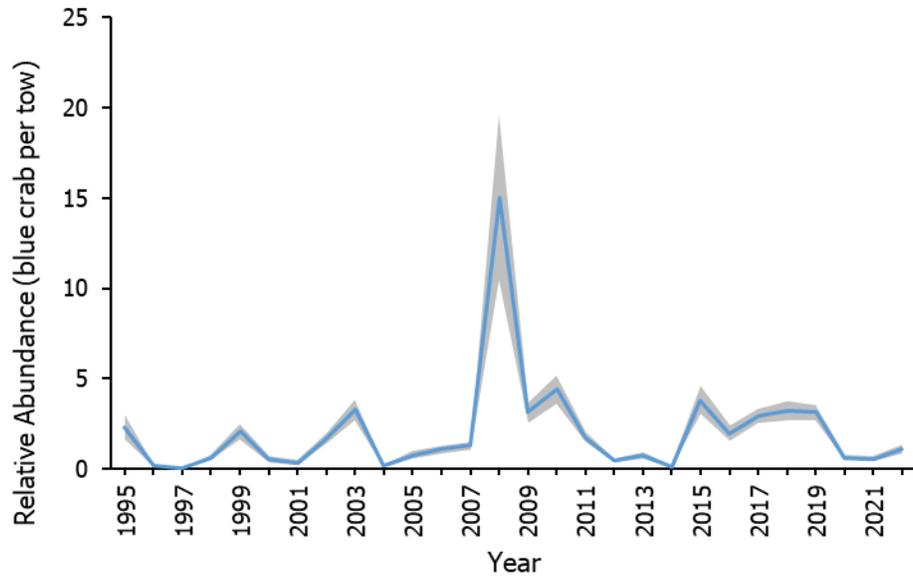


Figure 12. Nominal index (number of crabs per tow) of fully recruited crabs relative abundance ( $\geq 127$  mm, 5 inches; CW) captured in Program 100 in fall for male (A) and female (B), 1995–2022.

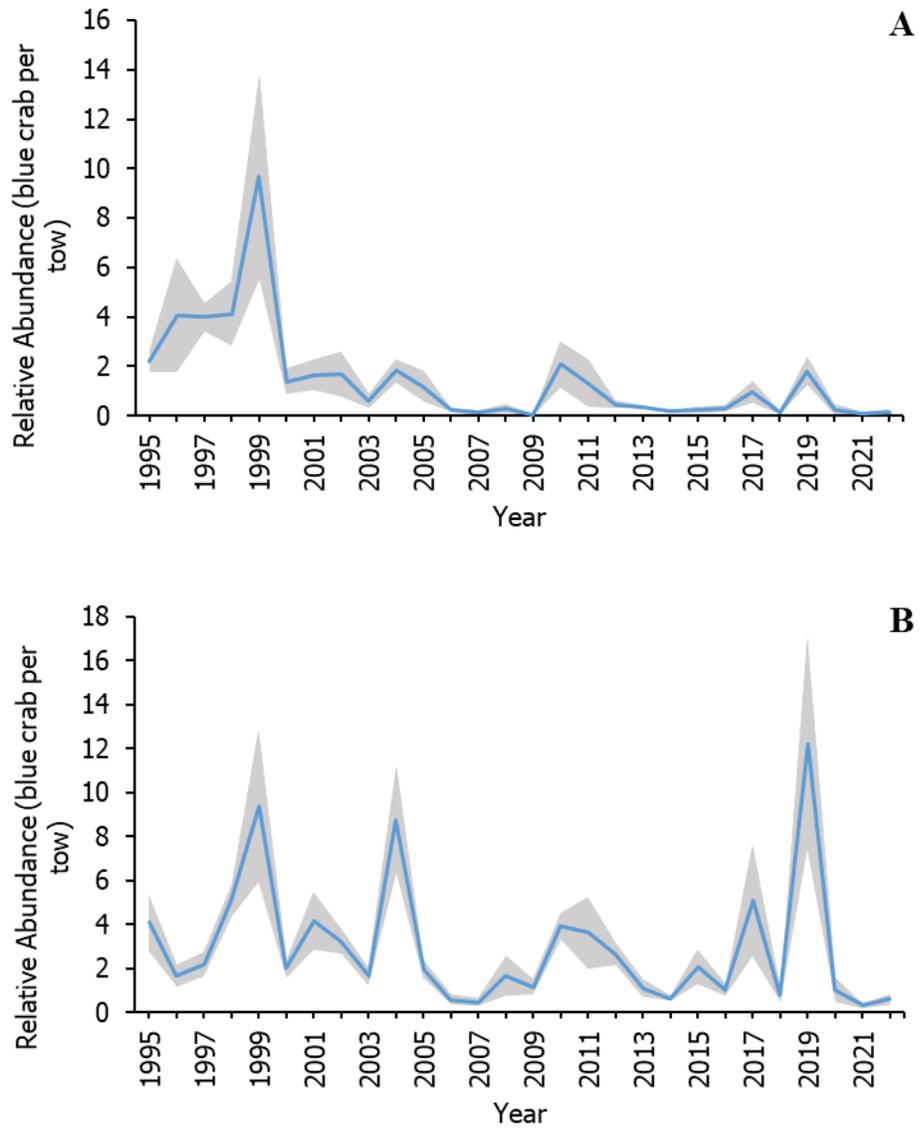


Figure 13. Nominal index (number of crabs per tow) of fully recruited crabs relative abundance ( $\geq 127$  mm, 5 inches, CW) captured in Program 195 for June male (A) and female (B), 1995–2022 for all strata combined. [Note: in 2020 and 2021 less than 54 stations were sampled in both months]

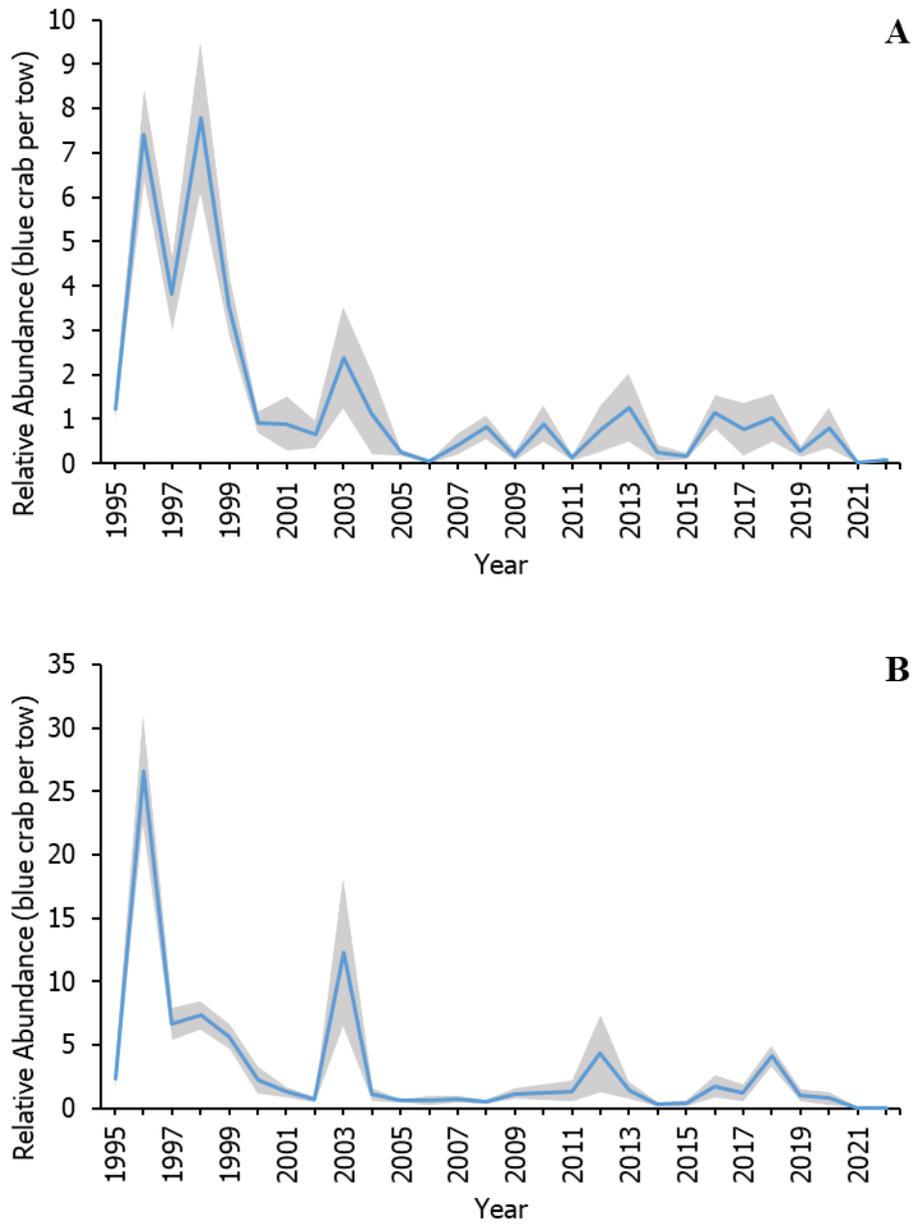


Figure 14. Nominal index (number of crabs per tow) of fully recruited crabs relative abundance ( $\geq 127$  mm, 5 inches, CW) captured in Program 195 for September male (A) and female (B), 1995–2022 for all strata combined. [Note: 2018 September sampling was conducted in October and in 2020 and 2021 less than 54 stations were sampled in both months]

STATE MANAGED SPECIES – EASTERN OYSTER

**FISHERY MANAGEMENT PLAN UPDATE  
EASTERN OYSTER  
AUGUST 2023**

**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
Comprehensive Review:	September 2023

The original Oyster Fishery Management Plan (FMP) was adopted by the North Carolina Marine Fisheries Commission (MFC) 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 Oyster FMP Amendment 1 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 Oyster FMP Amendment 2 included adopting a 15-bushel harvest limit in the 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 the Pamlico Sound to 20 bushels and created a monitoring system for determining when to close mechanical harvest in that area (NCDMF 2010). The Oyster FMP Amendment 3 created two seed oyster management areas in Onslow County (NCDMF 2014). Amendment 4 was adopted in February 2017 with selected management measures that included: 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 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 (NCDMF 2017).

### **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 Amendment 4 to the North Carolina 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 (NCDMF 2017). To achieve this goal, it is recommended that the following objectives be met:

- Identify, restore, and protect oyster populations as important estuarine habitat.
- 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.
- 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.
- Consider the socioeconomic concerns of all oyster resource user groups, including market factors.
- 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.
- Identify and encourage research to improve understanding of oyster population ecology and dynamics, habitat restoration needs, and oyster aquaculture practices.
- Initiate, enhance, and continue studies to collect and analyze economic, social, and fisheries data needed to effectively monitor and manage the oyster resource.
- Promote public awareness regarding the ecological value of oysters and encourage public involvement in management and enhancement activities.

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

The eastern oyster 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 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, 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 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 DMF, 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% 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% of trips by hand gears equaled (39.3%) or exceeded (12.1%) 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% (42.9% 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 DMF, to develop a subtidal oyster population survey with the potential to become a long-term DMF biological sampling program. Concurrent with these efforts and outside the scope of this pilot project, The Nature Conservancy is collaborating with the DMF 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 from dredges. The DMF is also developing a biological sampling program for intertidal oysters using existing bottom mapping sampling program data to delineate oyster reefs and evaluate changes over time for intertidal oysters in the southern region of the state.

## DESCRIPTION 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% to five percent off public bottom based on management measures adopted in Amendment 4 of the Oyster FMP.

### 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 DMF 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 hand harvest 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 twenty times between the 1996-1997 and 2022-2023 seasons.

The daily hand harvest limit for oysters in the Pamlico Sound outside the bays is 15 bushels 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 2019 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 more Shellfish License holders are onboard the vessel (NCDMF 2017). Hand harvesters with the Standard Commercial Fishing License (SCFL) could continue landing the higher daily harvest limits in all areas.

The mechanical harvest season for oysters in 2022-2023 was opened November 15, 2021, and was restricted to deeper portions of the sounds, rivers, and bays north of the Pamlico Sound. These

mechanical harvest 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 2021-2022 season (November 15 – March 31). Beginning in the 2017-2018 harvest season, the six-week open period for the bays was split into two potential open periods. The first opening in the bays could begin on the Monday of the week prior to Thanksgiving and run through the Friday after Thanksgiving. The second opening of the bays could begin two weeks before Christmas and remain open for the remaining four weeks.

Areas outside the bays open to mechanical harvest were limited to a daily harvest limit of 15-bushels of oysters per operation and limited to 10 bushels of oysters per operation within the bays.

The mechanical harvest season can close sooner for areas in the Pamlico Sound if sampling by DMF indicates that oysters of legal size have been reduced to below 26% of the live oysters sampled for two consecutive sampling trips, as directed by Amendment 4 of the Oyster FMP.

There are also further restrictions 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 uncultured catch onboard a vessel. Only material on the culling tray is exempt from culling restrictions.

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

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.

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

There is a specific application process and public comment period required for an individual to obtain a franchise or lease for the culture of oyster on private bottom. Owners of shellfish leases and franchises must provide annual production reports to the division. Failure to furnish production reports can constitute grounds for termination, and cancellation proceedings will begin for failure to meet production requirements and interfering with public trust rights. Public bottom must meet certain criteria 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.

The minimum size limit for oysters from private bottom is a three-inch shell length with a five percent culling tolerance, which is only required during the open public harvest season. During the rest of the year there is no minimum size or culling requirement for oysters taken from private bottom. There is no daily maximum harvest limit applied to the taking of oysters from private bottom. Permits are required to use mechanical methods for oysters on a lease or franchise.

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.

### **Commercial Fishery**

Landings in the North Carolina oyster fishery are impacted by both biotic and abiotic factors that influence oyster survival and growth.

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 neurotoxic dinoflagellate bloom (*Karenia brevis*) that caused closure of over 361,000 acres of public bottom to shellfish harvest from November 1987 to May 1988. Hand harvest landings of oysters failed to reach their potential that same year since the majority of the hand-harvest-only areas were also closed because of the red tide. Hand harvest landings are the most consistent contributor to the state's oyster fishery. Hand harvest landings have exceeded 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. Once infected with this protist, oysters suffer reduced growth, poor condition, diminished reproductive capacity and ultimately mortality (Ray and Chandler 1955; Haskin et al. 1966; Ford and Figueras 1988; Ford and Tripp 1996). 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, and Dermo infection was determined to be the cause by the Virginia Institute of Marine Science (VIMS) and the Cooperative Oxford Laboratory (NCDMF 2008).

Throughout the 1990s, DMF sampling indicated that Dermo infections were on the rise in southern estuaries however, moderate and high Dermo infection levels during late summer 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 the 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 the 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 the 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 and hurricanes) began affecting the fishery in 2011 (Figure 2).

Bioeroders (organisms that tunnel into oyster shell), in particular boring sponge (*Cliona* sp.), are also of concern 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 can cause mortality by weakening the shell, preventing the oyster from protecting 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 the Pamlico Sound. The study found boring sponge infestations in all oyster communities sampled, with the exception of 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.

Commercial oyster landings from private bottom have generally been increasing annually while landings off public bottom have been much more variable (Figure 2). Over the last six years an increasing trend in landings from production on private bottom coupled with decreasing landings from public bottom has led to landed bushels from private culture exceeding public landings every year since 2017 (Figure 2). Hand harvest landings exceeded the mechanical landings from public bottom in 2012, 2013, and 2015 to 2022 (Figure 3). 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 SCFL. Hand harvest landings are relatively stable across years when compared to the fluctuations in landings from the mechanical fishery and are an important component of the public bottom oyster fishery. In 2019, due to hurricane impacts to subtidal oyster populations in mechanical harvest area, commercial landings by hand harvest were over 30 times higher than mechanical harvest landings off public bottom (Figure 3).

## Mechanical Harvest Fishery Off Public Bottom

In the summer prior to the 2012-2013 mechanical harvest season, a severe low dissolved oxygen event occurred in the Neuse River that caused virtually a 100% 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 the 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 County were covered in tunicates the previous year and little spat was seen in these locations during this season. The Neuse River area was limited in locations to harvest oysters and closed early during this season. Effort was highest in the Pamlico River at the beginning of the season and then after Christmas effort shifted to areas outside of Northern Hyde area.

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). By late December the few oyster harvesters seen on the water were having to move around a lot to find oysters. Mechanical harvest was closed for the remainder of the season in mid-January for the Neuse River and Northern Dare areas. 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%) 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 five percent following the adoption of Amendment 4. 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. 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 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.

In September 2018, Hurricane Florence made landfall in North Carolina and caused significant impacts on the oyster resource. Extended periods of hypoxic (dissolved oxygen < 2-3 mg/L) or anoxic (dissolved oxygen = 0 mg/L) conditions occurred in many of the deep-water areas of Pamlico sound during the following weeks. Dive surveys of reefs on the Middle Grounds were conducted by NC State University researchers and they observed large-scale oyster mortality due to Hurricane Florence. Observations by their team did not suggest that oyster reefs in the shallow bays were as impacted. During initial sampling, the Neuse River, Pamlico River, and Northern Dare areas all showed low numbers of living oysters and were all below the 26% legal size threshold. The initial sampling at Northern Hyde areas showed a legal percentage of 27%, just above the threshold. Mechanical fishing effort was relatively low due to poor catch, and the mechanical season was closed in all management areas on December 13, 2018. This closure prevented the second opening period of the bays to mechanical harvest. Impacts from Hurricane Florence are reflected in both reduced mechanical and overall oyster landings for the 2018-2019 season (Figures 2 and 3).

In September 2019, a decline in water quality from Hurricane Dorian negatively impacted the already reduced subtidal oyster populations in Pamlico Sound. All mechanical harvest management areas were below the 26% legal management trigger during pre-season sampling in 2019. The percentage of legal oysters in both Neuse River and Dare County management areas was lower in the 2019-2020 pre-season sampling than it was at the close of the 2018-2019 mechanical season, showing the deep-water oyster mortality that occurred in these areas from the storm event. Following the protocol established in Amendment 4 of the Oyster FMP, the mechanical harvest season was opened on November 18, 2019, and closed on November 29, 2019, for all areas except Northern Hyde County, which closed January 6, 2020. While open to mechanical harvest, the small amount of effort and landings occurred in the shallow water bays where oyster populations were not as significantly reduced by the storm events of 2018-2019 season. Mechanical landings for 2019 were the lowest reported during the last 25 years (Figure 3).

Pre-season sampling in the deep-water areas in both the Neuse and Pamlico Management Areas showed very low percentages of legal oyster prior to the start of the 2020-2021 mechanical harvest season, and these areas both tripped the management trigger twice and closed to mechanical harvest on December 14, 2020. The bays in the Pamlico Management area maintained relatively high legal percentages for the entire possible six-week season, and harvesters reported harvesting a full limit before noon, even up to the last few days of the possible season. Legal percent in the Northern Dare management area remained above the trigger threshold for a relatively long time

when compared to the previous three oyster seasons and remained open to mechanical harvest until February 14, 2021.

The Northern Hyde and Dare Management areas started the 2021-2022 mechanical harvest season below the management trigger and were closed to mechanical harvest on December 13, 2021, after the management trigger was tripped during first in-season trigger sampling event. Abundance and size of oysters in the deep-water areas of the Neuse and Pamlico River Management areas continued to be very low. Mechanical harvest in these two Management Areas was supported by oysters found in the bays during the six-week season.

Neuse River, Pamlico River, Northern Hyde, and Northern Dare Management areas were all below 26% legal management trigger during the 2022-2023 pre-season sampling. However, due to no fishery effort occurring at the time of data collection, pre-season sampling did not originally count towards the management trigger at the onset of this sampling program. In 2018, the Director made the decision to count the pre-season data towards the management trigger. This decision was made in response to impacts to the sub-tidal oyster population from hurricane and storm events. For the 2022-23 mechanical oyster season, after several years of recovery post major impact events, upper Fisheries Management made the decision to revert to the original management approach of not including the pre-season sampling data to better align the management trigger with fishery effort. The Northern Hyde and Dare Management Areas have both tripped the trigger for two consecutive sampling events, due to large amounts of spat and small sub-legal oysters occurring in the samples. All Mechanical Harvest Management Areas were closed effective 20 January 2023.

#### 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 two to six 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 Oyster FMP in 2008, the MFC adopted the strategy to promote a more habitat friendly fishery by increasing the hand harvest limits to match dredging limits in the bay areas of the Pamlico Sound (NCDMF 2008). Amendment 2 put in place a 15 bushel per day hand/mechanical harvest limit per commercial fishing operation in the 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 the Pamlico Sound. This management option raised the limits of hand harvest to encourage less destructive harvest methods in those particular bays and open waters.

Hand harvest limits are 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 SCFL. As of October 2018, harvesters holding a Shellfish License statewide are limited to two bushels of oysters per person per day no more than four bushels per vessel, following the selected management strategy adopted by the MFC in Amendment 4 of the Oyster FMP (NCDMF 2017). 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 1). 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 hand harvest south of the Highway 58 Bridge generates a significant amount of the overall oyster landings even though the area only encompasses five percent of the total area open to harvest of shellfish in the state.

The 2017-2018 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. In September 2018, Hurricane Florence caused oyster mortality in many of the hand harvest areas south of the Highway 58 Bridge. Market demand for local North Carolina oyster early in the 2018-2019 season in the southern region of the state was low due to public perception of water quality issues which may have been caused by the storm.

The oyster season typically closes 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 the harvest of shellfish. 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 number of legal-sized oysters available to harvesters much quicker than in most other areas.

#### Permanent and Temporary Shellfish Closures

Microbial contamination from fecal matter is important to DMF 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/100 mL [NCMFC Rules 15A NCAC 18A Section .0900 Classification of Shellfish Waters], where MPN denotes "most probable number." The DMF 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 2011 and 2014, there were 1,427 acres of water permanently closed to shellfish harvesting in North Carolina, while between 2015 and early 2019, 6,876 additional acres were

closed (Table 1). On February 4, 2015, approximately 314,710 acres were closed administratively in lower resource areas because 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 the harvest of shellfish, 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. For 2019, an additional classification of "restricted" was adopted for "areas that do not meet approved area criteria but is not grossly polluted" and can be used for limited shell fishing activities such as relay.

Throughout the North Carolina coast, 2018 was a record year for precipitation, with the landfall of Hurricane Florence contributing greatly to the total rainfall amounts. Temporary closures during the beginning of the oyster season were directly attributed to that event, with some area closures in the southern portion of the state lasting for over 30 days past the storm.

### Private Culture

Authority to lease bottomland for private shellfish cultivation can be traced back to a state statute adopted in 1909. The DMF administers the shellfish lease program whereby state residents may apply to lease estuarine bottom and water columns for the commercial production of shellfish. The DMF 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% 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 only account for 12% of all oyster landings (NCDMF 2017). However, due to increase interest in private culture of oysters and lower landings off public bottom, private culture harvest accounted for 76% of the total oyster landings in 2022 (Figure 2).

As of January 2023, the shellfish lease program had 454 leases, with 43 bottom lease and 41 water column amendment applications during the year. Currently, shellfish leases take up about 1,848 acres of bottom (O. Mulvey-McFerron; Lease Program Coordinator, NCDMF; June 2023).

## **Recreational Fishery**

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.

## **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**

#### 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% 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 recently deceased oysters (known as “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 pre-season 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 DMF 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 ( $\geq 76$  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 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.

### Spatfall Evaluation

DMF conducts 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. Patent tongs and hand tongs may also be used to obtain cultch samples. Intertidal sites are sampled by hand at low tide in all applicable intertidal areas of the Southern District and patent or 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, sea scallop, or marl) is noted. The total number of spat on each piece of cultch is counted, 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. An annual spatfall index 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 index over the last 10 years.

The spatfall index has been somewhat variable from year to year, but overall showing a declining trend for the past 10 years (Figure 4). The 2018 and 2019 indices were the lowest and below the 10-year average (annual average number of spat across all sampling sites) (Figure 4). The spatfall evaluation program was discontinued in 2020. Beginning in 2021, new methodology was adopted to better quantify recruitment and abundance of oysters on cultch planting sites.

## **RESEARCH NEEDS**

The specific research recommendations from Amendment 4 to the North Carolina Oyster FMP (NCDMF 2017). The list below outlines the specific needs and highlights the priority and status of each. 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 oyster. Specifically, the proposed implementation actions on sedimentation within the CHPP are considered a high priority.

### **High**

- Support all proposed implementation actions under the priority habitat issue on sedimentation in the CHPP — Ongoing through the CHPP

- Improve the reliability for estimating recreational shellfish harvest — Ongoing
- Survey commercial shellfish license holders without a record of landings to estimate oyster harvest from this group —Needed
- Develop regional juvenile and adult abundance indices (fisheries-independent) — Pilot study in progress with The Nature Conservancy and N.C. State University)
- Determine alternative substrates for reef development and monitoring of intertidal and subtidal reefs (cost-benefit analysis for reefs and cultch planting) —Ongoing
- Quantify the impact of current fishing practices on oyster habitat suitability in North Carolina —Needed
- Develop a program to monitor oyster reef height, area, and condition — Ongoing
- Estimate longevity and yield of oysters on cultch planting sites — Needed
- Develop methods to monitor abundance of the oyster population — Pilot study in progress with the Nature Conservancy and N.C. State University

### **Medium**

- Complete socioeconomic surveys of recreational oyster harvesters — Needed
- Support collaborative research to track bacterial sources more efficiently for land-based protection and restoration efforts — Ongoing
- Quantify the relationship between water quality parameters and the cumulative effect of shoreline development units (e.g., docks, bulkhead sections) — Needed
- Develop peer reviewed, standardized monitoring metrics and methodologies for oyster restoration and stock status assessments — Needed

### **Low**

- Continue to complete socioeconomic surveys of commercial oyster fishermen — Needed
- Identify number and size of sanctuaries needed — Ongoing
- Identification of larval settlement cues which influence recruitment to restored reefs (i.e., sound, light, current, etc.) — Ongoing
- Further studies on the effects of dredge weight and size on habitat disturbance and oyster catches —Needed
- Estimate oyster mortality associated with relay — Needed

## **MANAGEMENT STRATEGY**

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

Amendment 4 was adopted in February 2017 and associated rule changes became effective May 1, 2017. The selected management strategies adopted by the MFC in Amendment 4 of the Eastern Oyster FMP can be found in Table 2.

## FISHERY MANAGEMENT PLAN SCHEDULE RECOMMENDATIONS

The division recommends maintaining the current timing of the scheduled review in 2022.

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## TABLES

Table 1. Classification of shellfish waters in acreage, 2012–2022 (Source: DMF Shellfish Sanitation and Recreational Water Quality Section).

Year	Open Area		Closed Area		
	Approved	Conditionally Approved Open	Conditionally Approved Closed	Restricted	Prohibited
2012	1,732,888	44,599	12,708		428,835
2013	1,733,069	44,649	11,834		429,531
2014	1,733,155	44,261	11,827		429,796
2015*	1,418,373	43,849	11,739		745,169
2016	1,416,960	44,785	12,008		745,597
2017	1,414,709	44,425	12,209		747,759
2018**	1,414,525	44,122	11,859	18,933	729,761
2019	1,415,007	43,216	12,721	20,260	730,550
2020	1,416,683	43,085	9,919	18,117	736,128
2021	1,459,163	42,801	9,917	18,168	736,690
2022	1,415,971	43,309	5,914	6,683	752,266

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

\*\* First year “Restricted” waters were differentiated from “Prohibited” waters.

Table 2. Summary of the N.C. Marine Fisheries Commission management strategies and their implementation status for Amendment 4 of the Oyster Fishery Management Plan adopted February 2017.

Management Strategy	Implementation Status
<b>OYSTER MANAGEMENT</b>	
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 DMF monitoring; Working with the Nature Conservancy
<b>PRIVATE CULTURE</b>	
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

Management Strategy	Implementation Status
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

# FIGURES

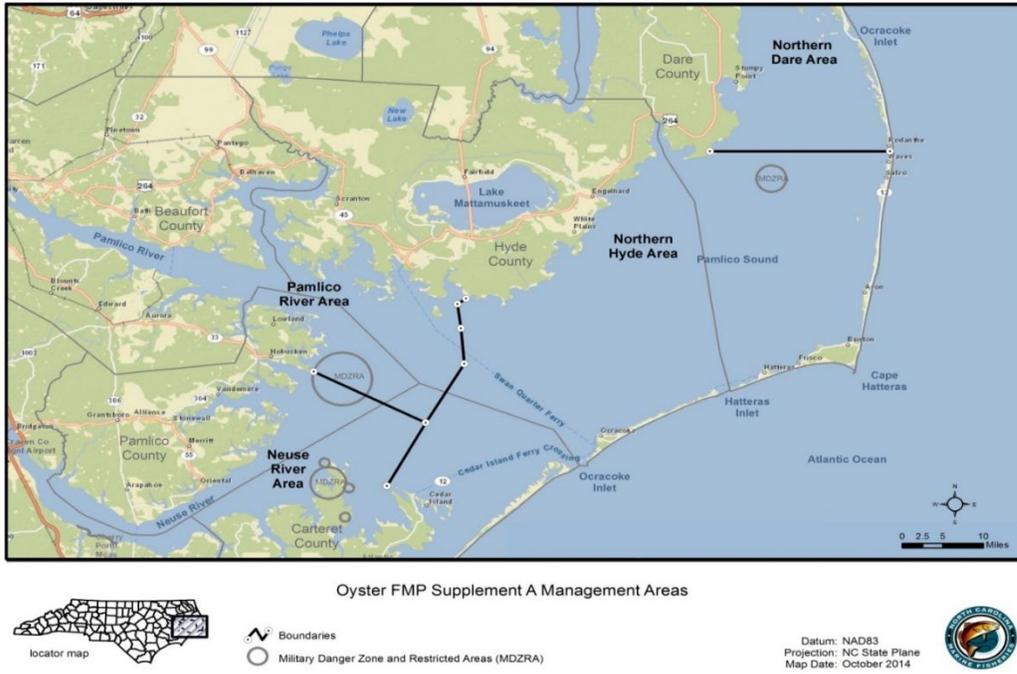


Figure 1. Mechanical harvest management areas from Amendment 4 of the Oyster Fishery Management Plan.

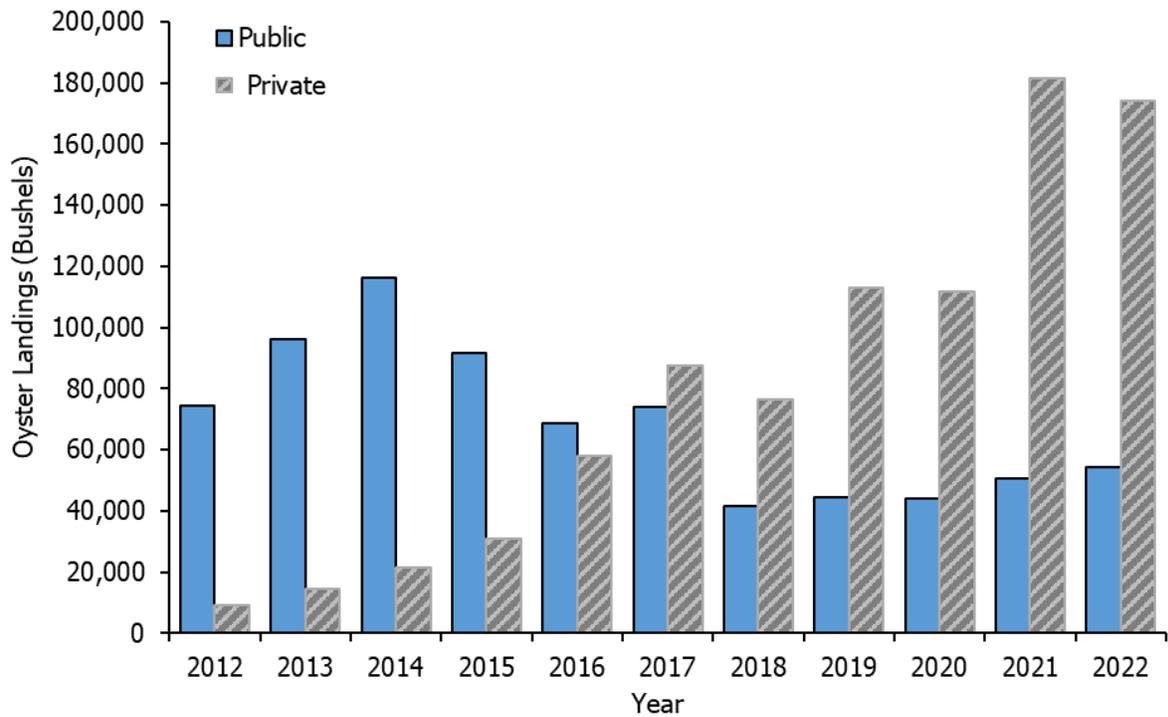


Figure 2. Annual commercial oyster landings (bushels) separated by private and public bottom in North Carolina, 2012–2022 (Source: DMF Trip Ticket Program).

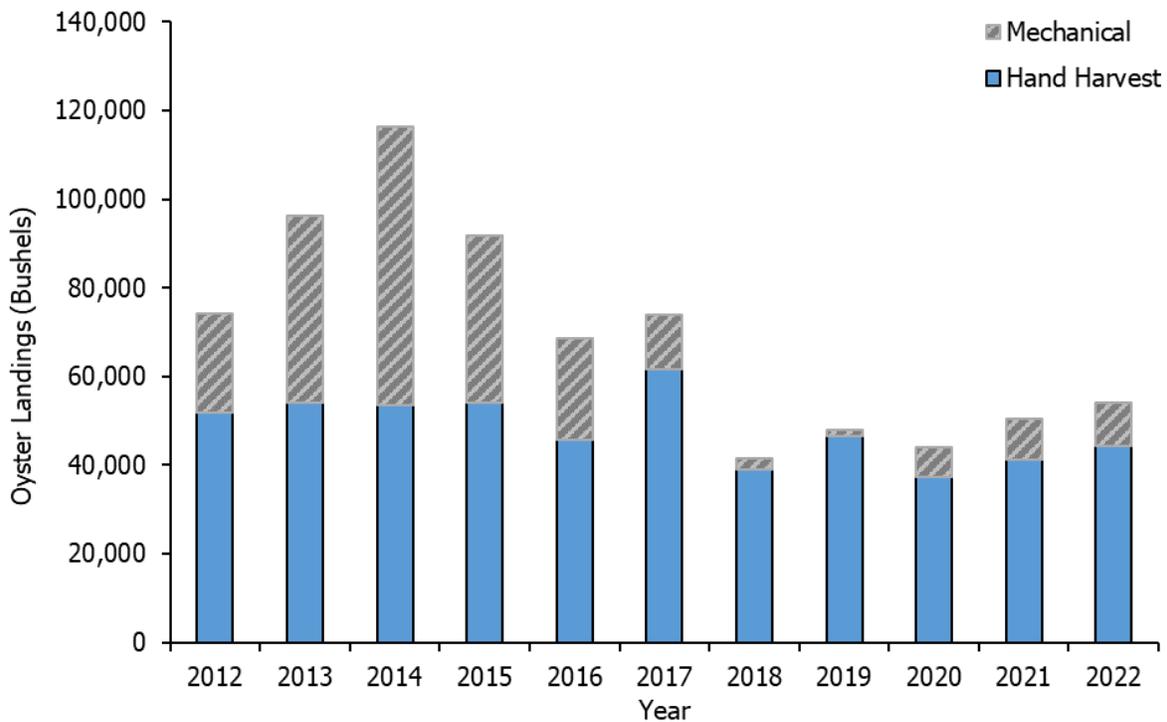


Figure 3. Annual commercial oyster landings (bushels) from public bottom separated by mechanical and hand harvest methods 2011–2021 (Source: DMF Trip Ticket Program).

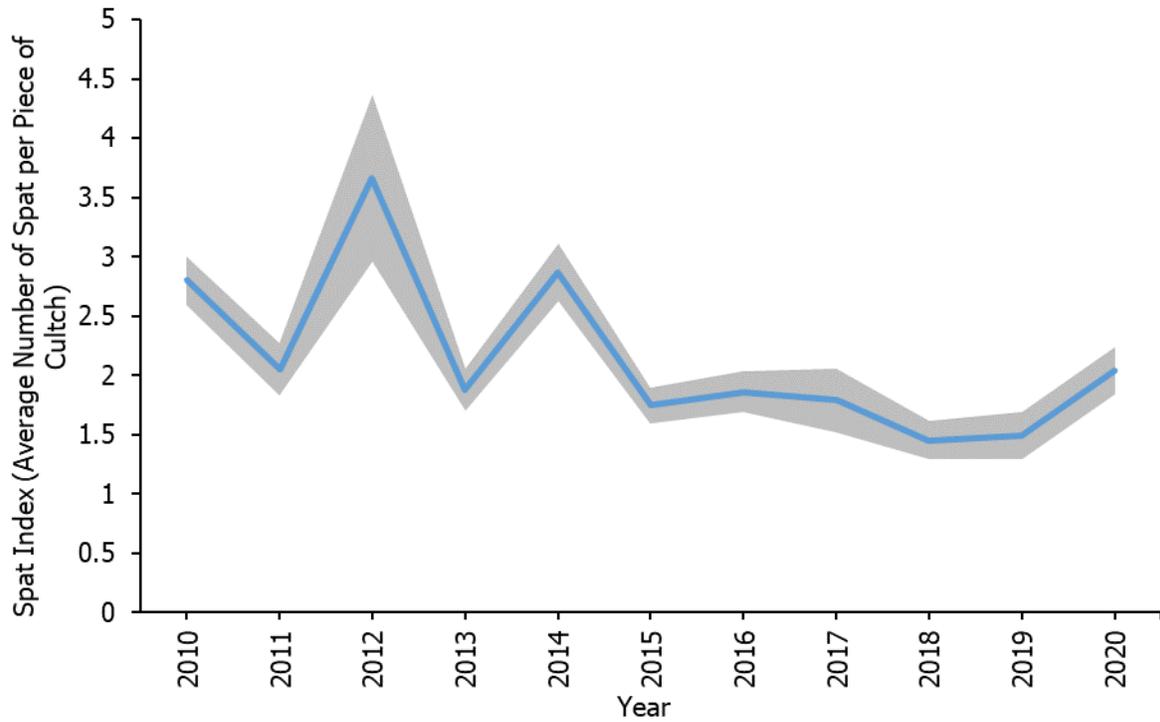


Figure 4. The annual average number of oyster spat across all sampling sites with standard error shaded in gray, 2010–2020 (Source: DMF Habitat and Enhancement Section). Shaded area represents + one standard error. This sampling program was discontinued and replaced with improved methodology in 2021.

STATE MANAGED SPECIES – ESTUARINE STRIPED BASS

**FISHERY MANAGEMENT PLAN UPDATE  
ESTUARINE STRIPED BASS  
AUGUST 2023**

**STATUS OF THE FISHERY MANAGEMENT PLAN**

**Fishery Management Plan History**

Original FMP Adoption:	January 1994 May 2004
Amendments:	Amendment 1            May 2013 Amendment 2            November 2022
Revisions:	Revision to Amendment 1    November 2014 Revision to Amendment 1    November 2020
Supplements:	Supplement A            February 2019
Information Updates:	None
Schedule Changes:	August 2016
Comprehensive Review:	2027

Estuarine striped bass (*Morone saxatilis*) in North Carolina are managed under Amendment 2 to the North Carolina Estuarine Striped Bass Fishery Management Plan (FMP). It is a joint plan between the North Carolina Marine Fisheries Commission (MFC) and the North Carolina Wildlife Resources Commission (WRC). The Striped Bass FMP, Revisions, Amendments, and Supplement (DMF and WRC 1994, 2004, 2013, 2014, 2019, 2020, and 2022) are available on the North Carolina Division of Marine Fisheries (DMF) [website](#).

The MFC and the WRC implemented a Memorandum of Agreement in 1990 to address management of the striped bass stock in the Albemarle Sound and Roanoke River (A-R). The original Estuarine Striped Bass FMP was approved by the MFC in November 1993 and was targeted at the continued recovery of the A-R stock, which was at historically low levels of abundance and experiencing chronic spawning failures (Laney et. Al. 1993). The comprehensive plan addressed the management of all estuarine striped bass stocks in the state, satisfying a 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.

Amendment 1, adopted in 2013, lays out separate management strategies for the A-R stock and the Central and Southern stocks in the Tar-Pamlico, Neuse, and Cape Fear rivers. Management programs in Amendment 1 consist of daily possession limits, open and closed harvest seasons, gill net mesh size and yardage restrictions, seasonal attendance requirements, barbless hook requirements in some areas, minimum size limits, and slot limits to maintain a sustainable harvest and reduce regulatory discard mortality in all sectors. Amendment 1 also maintains the stocking regime in the Central and Southern systems (Central Southern Management Area, CSMA) and the harvest moratorium on striped bass in the Cape Fear River and its tributaries (NCDMF 2013). Striped bass fisheries in the Atlantic Ocean of North Carolina are managed under the Atlantic States Marine Fisheries Commission's (ASMFC) Amendment 7 to the Interstate FMP for Atlantic Striped Bass.

In response to the 2013 benchmark A-R striped bass stock assessment that indicated fishing mortality was above the target, the MFC approved a Revision to Amendment 1 in November 2014 (NCDMF 2014). The November 2014 Revision reduced the total allowable landings (TAL) for the A-R stock from 550,000 pounds to 275,000 pounds, split evenly between the commercial and recreational sectors. Stock assessment projections indicated a TAL of 275,000 pounds would maintain fishing mortality and spawning stock at their respective targets, providing a sustainable harvest. The November 2014 Revision maintained the 25,000-pound commercial TAL for the CSMA, daily possession limits and a closed summer season to control recreational harvest, and a total harvest moratorium in the Cape Fear River and its tributaries. The November 2014 Revision utilizes 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 at sustainable levels in the A-R and the CSMA is for landings only, not landings and discards. Discards are accounted for in the stock assessment model but are not part of the TAL.

In August 2016, the MFC approved a change to the FMP review schedule so the comprehensive review of the Estuarine Striped Bass FMP would begin in July 2017 instead of July 2018 due to concerns about the high percentage of stocked fish and minimal natural recruitment in the CSMA systems.

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

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

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

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

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

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

The most recent A-R striped bass benchmark stock assessment (Lee et al. 2020) was completed and approved for management use in 2020. The assessment indicated the resource is overfished and is experiencing overfishing (Lee et al. 2020). In response to the overfished and overfishing stock status, the MFC approved a Revision to Amendment 1 in November 2020 (NCDMF 2020). The November 2020 Revision to Amendment 1 to the North Carolina Estuarine Striped Bass Fishery Management Plan reduced the striped bass TAL from 275,000 pounds to 51,216 pounds in the Albemarle Sound and Roanoke River Management Areas to remain in compliance with Amendment 1 to the North Carolina Estuarine Striped Bass Fishery Management Plan (FMP) and the Atlantic States Marine Fisheries Commission (ASMFC) Addendum IV to Amendment 6 to the Interstate FMP for Atlantic Striped Bass. The new TAL was effective January 1, 2021.

The CSMA Estuarine Striped bass Stocks report (Mathes et al. 2020), completed in 2020, is a collection of (1) all data that have been collected, (2) all management effort, and (3) all major analyses that have been completed for CSMA stocks to serve as an aid in development of Amendment 2. No stock status determination was performed, and no biological reference points were generated for CSMA striped bass stocks.

Amendment 2 to the North Carolina Estuarine Striped Bass FMP was developed collaboratively by the DMF and WRC and adopted by the MFC in November 2022 (NCDMF 2022). Management measures for the A-R stock in Amendment 2 include continuing to use the stock assessment to set a TAL for sustainable harvest, implementing pound-for-pound payback in the following year if a TAL is exceeded by a fishery, continuing to manage the ASMA commercial harvest as a bycatch fishery, implementing a 18-25 inch slot limit with no fish above 25 inches in the ASMA, and prohibiting harvest of fish over 22 inches in the RRMA.

Management measures for the Tar-Pamlico and Neuse rivers stocks in Amendment 2 continued the no-possession measure in Supplement A to Amendment 1. It also maintained the gill net closure above the ferry lines and the use of 3-foot tie-downs below the ferry lines. Additionally, in 2025, data through 2024 will be reviewed to determine if populations are self-sustaining and if sustainable harvest can be determined. In addition, the approved motion included language to: “maintain the gill net prohibition through 2024 to allow for assessment of its performance”.

In the Cape Fear River, Amendment 2 maintained the harvest moratorium. Under adaptive management, juvenile striped bass surveys and parentage-based tagging (PBT) analysis will be used to monitor natural reproduction and if levels of natural reproduction increase or decrease, management measures may be re-evaluated and adjusted using the proclamation authority of the DMF and WRC directors. Management measures which may be adjusted include means and methods, harvest area, season, size and creel limit (as allowed for in rule). Management measures may be adjusted contingent on evaluation by the Striped Bass Plan Development Team (PDT) and consultation with the Finfish Advisory Committee (AC).

### **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 striped bass harvest management areas: the Albemarle Sound Management Area (ASMA) and the Roanoke River Management Area (RRMA). The ASMA includes the Albemarle Sound and all its coastal, joint and inland water tributaries, (except for the Roanoke, Middle, Eastmost and Cashie rivers), Currituck, Roanoke, and Croatan sounds and all their joint and inland water tributaries, including Oregon Inlet, north of a line from Roanoke Marshes Point across to the north point of Eagle Nest Bay in Dare County. The RRMA includes the Roanoke River and its joint and inland water tributaries, including Middle, Eastmost and Cashie rivers, up to the Roanoke Rapids Dam. The striped bass stock in these two harvest management areas is referred to as the A-R stock, and its spawning grounds are in the Roanoke River in the vicinity of Weldon, NC. Implementation of recreational and commercial striped bass regulations within the ASMA is the responsibility of the MFC. Within the RRMA, commercial regulations are the responsibility of the MFC while recreational regulations are the responsibility of the WRC. The A-R stock is also included in the management unit of Amendment 7 to the ASMFC Interstate FMP for Atlantic Striped Bass.

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

To ensure compliance with interstate requirements, North Carolina also manages the A-R striped bass stock under the North Carolina Fishery Management Plan for Interjurisdictional Fisheries (IJ FMP). The goal of the IJ FMP is to adopt fishery management plans, consistent with N.C. law, approved by the Mid-Atlantic Fishery Management Council, South Atlantic Fishery Management

Council, or the ASMFC by reference and implement corresponding fishery regulations in North Carolina to provide compliance or compatibility with approved fishery management plans and amendments, now and in the future. The goal of these plans established under the Magnuson-Stevens Fishery Conservation and Management Act (federal council plans) and the Atlantic Coastal Fisheries Cooperative Management Act (ASMFC plans) are like the goals of the Fisheries Reform Act of 1997 to “ensure long-term viability” of these fisheries (NCDMF 2015).

## **Goal and Objectives**

The goal of Amendment 2 is to manage the estuarine striped bass fisheries to achieve self-sustaining populations that provide sustainable harvest based on science-based decision-making processes. If biological and/or environmental factors prevent a self-sustaining population, then alternate management strategies will be implemented that provide protection for and access to the resource. The following objectives will be used to achieve this goal.

- Implement management strategies within North Carolina and encourage interjurisdictional management strategies that maintain and/or restore spawning stock with adequate age structure and abundance to maintain recruitment potential and to prevent overfishing.
- Restore, enhance, and protect critical habitat and environmental quality in a manner consistent with the Coastal Habitat Protection Plan (CHPP), to maintain or increase growth, survival, and reproduction of the striped bass stocks.
- Use biological, social, economic, fishery, habitat, and environmental data to effectively monitor and manage the fisheries and their ecosystem impacts.
- Promote stewardship of the resource through public outreach and interjurisdictional cooperation regarding the status and management of the North Carolina striped bass stocks, including practices that minimize bycatch and discard mortality.

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

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

Females in the A-R stock are 29% mature at age 3 and 97% mature at age 4, while females in the Tar-Pamlico and Neuse rivers are 50% mature at 2.7 years and 98% mature by age 3 (Knight 2015). The length at 50% maturity for striped bass in the A-R stock is 16.8 inches (Boyd 2011). Female striped bass in both systems produce large quantities of eggs which are broadcast into

riverine spawning areas and fertilized by mature males, age 2 and older. In the Tar-Pamlico and Neuse rivers, fecundity ranges from 223,110 eggs for Age-3 females to 3,273,206 eggs for Age-10 females (Knight 2015). Fertilized eggs drift with downstream currents and need 1.5 to 3 days to hatch and then continue to develop through the larval stage for several more days, eventually arriving at river mouths and the inland portions of coastal estuaries where they develop into juveniles. Striped bass require flowing, freshwater habitats to spawn successfully, allowing the eggs to remain suspended until they hatch, and to transport larvae to nursery areas. Environmental conditions including temperature, rainfall and river flows are important factors in determining the number of juveniles produced annually. Spawning in North Carolina takes place from late March until early June. Peak spawning activity for the A-R stock occurs when water temperature reaches 62 to 67 degrees Fahrenheit in the Roanoke River at Weldon. Spawning grounds are not clearly defined in CSMA systems as access to spawning areas is influenced by river flows as well as impediments to migration. Natural reproduction and successful juvenile recruitment occur infrequently and at low levels in the Tar-Pamlico, Neuse and Cape Fear rivers. The CSMA stocks are supported by continuous stocking efforts as evidenced by stocked fish comprising nearly 100% of the striped bass on the spawning grounds and in internal coastal fishing waters of the Tar-Pamlico, Neuse, and Cape Fear rivers (O'Donnell and Farrae 2017).

Striped bass are relatively long-lived and capable of attaining moderately large sizes. Fish weighing 50 or 60 pounds are not exceptional. In general, females grow larger than males with reported maximum lengths of 60 inches and 45 inches. The oldest observed striped bass in the A-R stock was 31 years. The oldest observed striped bass within the CSMA were 7 years in the Cape Fear River and 12 years in the Tar-Pamlico and Neuse rivers. The largest striped bass on record are several females caught in the early 1900s in Albemarle Sound which weighed 125 pounds each. Large Roanoke River striped bass (>900 mm TL) rapidly emigrate (~59 km/d) after spawning to distant (>1,000 km) northern ocean waters (New Jersey to Massachusetts), where they spend their summers and migrate southward in the fall to overwintering habitats off Virginia and North Carolina and complete their migration circuit the following spring by returning to the Roanoke River to spawn (Callihan et al. 2015). Estuarine striped bass from the A-R stock contribute minimally to the total coastal migratory stock when compared to the contributions from larger systems like the Chesapeake Bay, Delaware, and Hudson rivers. Striped bass populations in the CSMA are considered to have a primarily endemic riverine life history, having limited or no adult oceanic migration (Setzler et al. 1980; Rulifson et al. 1982a; Callihan 2012).

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

## **Albemarle Sound-Roanoke River Management Area**

### **Stock Status: A-R Stock**

The most recent assessment of the A-R striped bass stock was completed in 2022, utilizing data from 1991–2021. Results from the 2022 A-R striped bass stock assessment indicate the stock is overfished and overfishing is occurring (Lee et. al 2022). The estimate of  $F$  in the terminal year of the assessment (2021) was 0.77, above the  $F_{35\%SPR}$  Threshold of 0.18 (Figure 1) and the estimate of

SSB was 35,494 pounds, below the  $SSB_{35\%SPR \text{ Threshold}}$  of 267,390 pounds (Figure 2). Estimates of  $F$  have been above the  $F_{35\%SPR \text{ Threshold}}$  in 20 out of the 30 years of the time period of the assessment (Figure 1). Female SSB declined steadily from a high of 587,516 pounds in 2000 to 45,418 pounds in 2013. Female SSB increased through 2015 to 167,053 pounds and has declined since to a low of 35,494 pounds in 2021 (Figure 2). Results of the assessment also show a period of strong recruitment (as measured by the number of age-0 fish coming into the stock each year) from 1993 to 2000, then a period of much lower recruitment from 2001 to 2021, which has contributed to the decline in SSB since 2003. Average recruitment during 1993–2000 was 1,085,650 age-0 fish per year while average recruitment for years 2001–2021 was 333,745 age-0 fish per year.

Several years of poor recruitment occurred during 2001–2004 at a time when SSB was at high levels, indicating factors other than abundance of SSB may be contributing to poor spawning success in some years. Appropriate river flow during the spawning period has long been recognized as an important factor in spawning success for A-R striped bass (Hassler et. al 1981; Rulifson and Manooch 1990). Low to moderate flows have been identified as favorable to strong year-class production while high flows (10,000 cubic feet per second or greater) are unfavorable to the formation of strong year classes. The peer reviewers of the 2022 assessment recognized the importance of river flow on recruitment and noted declining recruitment in the time series does not appear to result solely from reduced abundance due to harvest (Lee et. al 2022).

### **Stock Assessment: A-R Stock**

Stock Synthesis text version 3.30 (Methot 2000, 2012; Methot and Wetzel 2013) was used to model the striped bass stock and to calculate reference points (Lee et al. 2020). The Stock Synthesis model incorporates information from multiple fisheries and 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 that 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. The model was peer reviewed and approved for use in management by an outside panel of experts and the ASMFC Atlantic Striped Bass Management Board. The DMF also approved it for management use.

### **DESCRIPTION OF THE FISHERY: ASMA/RRMA**

Annual spawning success of striped bass is largely dependent upon environmental conditions, both natural and manmade. Even when female spawning stock biomass is high, poor reproductive success can occur due to unfavorable environmental conditions. This fact is important to keep in mind when discussing trends in landings data and stock abundance. For species that have long term juvenile abundance surveys, this phenomenon is evident when we observe a year with above average spawning success (termed a “strong year class”) followed by a year when practically no eggs survive to the juvenile stage (a “weak year class”). This cycle of spawning success and failure results in annual harvests that increase and decrease depending on the abundance of the year classes available to the fishery.

## **Current Regulations: ASMA/RRMA**

Harvest in the ASMA commercial sector in 2022 was limited by an annual TAL of 25,608 pounds. There is also an 18-inch minimum total length (TL) size limit. The commercial fishery is prosecuted as a non-directed bycatch fishery, with most landings occurring in large mesh ( $\geq$  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. Harvest in the newly developing strike net fishery for blue catfish has also increased in recent years. 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. Dependent on available quota, a fall harvest season can be opened from October 1 through December 31 and a spring harvest season can be opened 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 of all small mesh ( $<$  5-inch stretched mesh) gill nets during May–November 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 by the ASMA recreational sector in 2022 was limited by an annual TAL of 12,804 pounds. The recreational sector also has an 18-inch total length minimum size limit and a one 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 DMF for the most recent proclamation on striped bass harvest limits including trip limits and bycatch requirements.

Commercial harvest in the RRMA is prohibited. The RRMA recreational sector also had a TAL of 12,804 pounds in 2022. Due to the reduced TAL, the 2022 harvest season for striped bass in the RRMA was open April 23–24, and April 28–April 29, 2022. There is an 18-inch total length minimum size limit and a no possession slot where fish between 22- and 27-inches TL may not be possessed. There was a one 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 April 1–June 30.

## **Commercial Fishery: ASMA**

Commercial landings in the ASMA have been controlled by an annual TAL since 1991 (Table 1). Due to gill net mesh regulations and minimum size limits in place, most harvest consists of fish 4–6 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 declined, commercial landings no longer reached the annual TAL, even with increases in the number of harvest days and daily

possession limits. During 2005–2009 landings steadily declined and averaged about 150,000 pounds, even though gill net trips remained steady during that period (Figure 3).

The decline in landings during 2005–2009 was due to poor year classes produced from 2001 to 2004. An increase in landings in 2010 to over 200,000 pounds was due to the strong 2005-year class. Since 2013 landings have been reduced in part because of a shortened American shad season resulting from sustainability parameters being exceeded in the American Shad Sustainable Fishery Plan. Most landings traditionally have come during the American shad season. Length frequency distribution in 2022 is presented in Figure 4. Length at age for all commercial samples collected 1972–2021 are presented in Figure 5. Commercial length frequencies are represented in Figure 6. Modal length increased in 1991 and has stayed steady due to the 18-inch minimum. A larger abundance of older fish was present in 2004 and there was a decrease in modal length in 2018. Fish between 18–24 inches TL dominate the fishery.

### **Recreational Fishery: ASMA/RRMA**

The recreational sector's landings in the ASMA are dominated by fish aged 3 to 5. Landings in the ASMA have been controlled by a TAL since 1991 (Table 1). Starting in 1998 the TAL was split evenly between the commercial and recreational sectors. The recreational TAL increased incrementally from 29,400 pounds in 1997 to 137,500 pounds in 2003. The recreational sector reached its TAL consistently until 2002, when landings started declining. Recreational landings peaked in 2001 at 118,506 pounds. (Figure 3). The harvest season increased from four days a week to seven in the fall of 2005 and the daily recreational possession limit increased from two to three fish in the fall of 2006, but landings continued to decline. Several poor year classes produced since 2001 have accounted for the decline in stock abundance and recreational harvest since 2006. The recreational limit was decreased to two fish per person per day in January 2016 and further to one fish in January 2021. Recreational harvest during 1991–2022 has averaged 42,296 pounds in the ASMA. 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 19,838 fish (Table 2). Length frequency distribution in 2022 is presented in Figure 4. ASMA recreational length frequencies for 1996–2022 are presented in Figure 7. Since 1996 the shift in abundance of younger fish is apparent with older fish still showing up in the fishery. Since 2014 the abundance of younger fish has increased likely due to the large 2014- and 2015-year classes with a slight uptick in landings for 2019 and 2020 from the previous several years (2016–2019). Landings were substantially lower from 2021–2022 than previous years as a result of a reduced TAL.

The recreational sector's landings in the RRMA are dominated by fish aged 3 to 5 due to a no possession rule of fish 22–27 inches TL in the RRMA, a statewide rule that prohibits possession of river herring cut bait or whole river herring over six inches in length while engaged in fishing activities, and general angling techniques in the RRMA. Very few anglers use the large size artificial lures or natural bait required to catch striped bass over 28 inches, so very few fish over nine or 10 years old are observed in the creel survey. Plus, these older fish make up a relatively small portion of the total overall stock abundance. Harvest from 1991 through 2022 has averaged 57,366 pounds in the RRMA (Table 1). Many more striped bass are caught and released by recreational anglers each year than are harvested, especially in the RRMA where concentrations of fish on the spawning grounds can be dense. Annual discards from 2011 through 2022 in the RRMA have averaged 101,342 fish (Table 2).

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 3). The total number of fish caught per angler during the spring fishery in the RRMA can be large; catches of 100 fish per day are not uncommon, but angler catch rates can be impacted by spring water flows. The hydropower company operating the dams on the Roanoke River, along with the U.S. Army Corps of Engineers and biologists with the USFWS and WRC, 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, ( $\geq 20,000$  cfs) flood stage flow conditions in some years. During these low or high flow years, angler success can be greatly diminished. Length frequency distribution in 2022 is presented in Figure 4. RRMA recreational length frequencies for 2005–2022 are presented in Figure 8. Since 2005 abundance of older fish in the recreational creel survey has decreased.

## **MONITORING PROGRAM DATA: A-R STOCK**

### **Fishery-Dependent Monitoring: A-R Stock**

The length, weight, sex, and age of the commercial harvest of striped bass has been consistently monitored through sampling at fish houses conducted by the division since 1972. Since 1994 anchored gill nets have accounted for 87.8% of the harvest in the ASMA (Figure 9). Pound nets account for most of the remaining landings with minor catches coming from fyke nets, hoop nets, and pots. The mean total length from 2005 to 2022 was 21.6 inches (Table 3).

The recreational harvest of striped bass in the ASMA and RRMA has been consistently monitored by the DMF since 1990 and the WRC since 1988 respectively. The mean total length during 2005–2022 was 20 inches total length for the ASMA and RRMA (Tables 4 and 5). Age data from the dependent and independent surveys in the ASMA are presented in Table 6. The minimum and maximum age for the independent and dependent surveys are 1 and 17 years respectively with an average age of 5.

### **Fishery-Independent Monitoring: A-R Stock**

A young-of-year (age-0) A-R striped bass juvenile abundance survey used to calculate a juvenile abundance index (JAI) was initiated by Dr. William Hassler of North Carolina State University in 1955. The DMF 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 July–October. Sampling gear is an 18-foot semi-balloon trawl towed for 15 minutes. Catch per unit effort is the number of striped bass captured per tow. The JAI provided by the survey is usually a reliable indicator of relative abundance and future harvest potential. Data from the survey reveal the highly variable inter-annual spawning success of striped bass. The long time-series of data also clearly shows the extended period of spawning failure that occurred when the stock was at historical levels of low abundance during the 1980s. Starting in 1993 the stock began producing successful spawns once again, due to improved water quality, agreements about water flow regimes on the Roanoke River during the spawning season, favorable environmental conditions during the spawning season, and severe management restrictions that allowed stock abundance to increase. Within an eight-year period spanning 1993–2000, the stock produced the four highest JAI values in the entire 46-year

time series. The average JAI during 1993–2000 was 24.04, over three times higher than the average of the JAI prior to the stock crashing (1955–1977 JAI = 7.9; Figure 10). However, from 2001 to 2010 the JAI was below average for most years, above average for only one year (2010), and several years including some back-to-back (2003 and 2004), which were considered spawning failures. This cycle starting in 1993 led to overall stock abundance increasing steadily through the mid-2000s to all-time highs, followed by a period of stock decline. From 2010 to 2016 the stock saw improved annual spawning success, with above average JAI values in 2011, 2014, and 2015, with one year (2013) below the spawning failure threshold. However, the JAI values since 2018 averaged 0.60 and are all below the spawning failure threshold of 1.33 (ASMFC 2010) (Figure 10).

A fall/winter fishery independent gill net survey has been conducted by the DMF throughout the Albemarle and Croatan sounds since the fall of 1990 (Program 135). The survey utilizes a stratified random sampling design, employing mesh sizes from 2½-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. Sampling in 2020 was suspended due to COVID-19 restrictions and Atlantic sturgeon protected species interactions but resumed in the fall of 2021. After resuming sampling in 2021 survey methods were altered to decrease sturgeon interactions. As a result of these changes from 2021 onward catch per unit of effort is measured as the abundance of fish per 40-yard net soaked for 12 hours.

A spring survey employs the same methodology as the fall/winter survey but is conducted in the western Albemarle Sound only, near the mouth of the Roanoke River. The goal of the survey is to characterize the spawning portion of the A-R stock. The survey is conducted from March 1 through the end of May. Data from the surveys are used in the A-R stock assessment as an independent measure of stock abundance. No index of abundance is available for the spring survey in 2020 and 2021 or the winter survey in 2021. Sampling did not occur in 2020 due to COVID-19 restrictions and Atlantic sturgeon protected species interactions but resumed in March of 2022.

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 4–6-year-old abundance. The trend in abundance of 4–6-year-old shows 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 4–6-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 11). One weakness of the gill net surveys is they collect very few older fish and under-represent the expansion of fish in the 9+ age group that has occurred since 2000. They also don't capture the decline in abundance of age 9+ fish that has occurred since the period of poor spawning success during 2001–2010. In 2022 the abundance of 4–6-year-old fish was below average in the fall/winter portion of the survey and increased in the spring. The spring index has been increasing since 2018 with a slight increase from 2019 to 2022 (Figure 11). It should be noted that beginning with the 2022 fall/winter survey changes were made to the independent gillnet survey that may increase rate of catch of striped bass, making the survey from 2022 forward not directly comparable to previous years. Expectations are the abundance of 4–6-year-old fish will decline over the next few years because of the repeated spawning failures the

stock has experienced since 2018 (Figure 10). 2022 had the lowest fall/winter age 4-6 abundance since 2017 and may be an indicator of the expected decline.

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

The trend in total abundance from the electrofishing survey is similar to the trends of age 4–6 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 2017 of 50 fish per hour (Figure 12). The abundance of fish in 2022 was 69 fish per hour. Both surveys exhibit a few years with high inter-annual variability, but this is common with fisheries surveys in which environmental conditions affect relative abundance in the survey area and the catch efficiency of the gear. The electrofishing survey does a better job at tracking the abundance of the age 9+ group, and clearly shows the emergence of the 1993 cohort into this age group in 2002. The age 9+ group has been on a downward trend since the 2006 peak of 14 fish per hour. In 2018 no age 9+ fish were captured. In 2022 the survey caught 0.99 fish per hour which was the highest rate since 2015 but well below the time series average of 3.88 fish per hour (Figure 13). The strong year classes produced from 1993–2000 supported the increased abundance of fish in the 9+ age group, but since the below average spawning and several years of spawning failure during 2001–2011, the abundance of the 9+ age group is declining. The oldest fish seen recently in the population is a 31-year-old fish based on a tag returned by an angler in 2019 in the Roanoke River. When the survey started in 1990 fish older than seven were rarely observed in the survey. Age 9+ fish abundance has decreased in recent years and for years 2016–2022 is similar to the abundance levels seen in the early to mid 90's.

### **Tagging Program: A-R Stock**

In 2014, a mark-recapture tagging program was initiated utilizing both volunteer anglers and DMF staff throughout the state. Striped bass collected in good condition during DMF fishery independent and electrofishing sampling are tagged with conventional internal anchor tags. The total number of striped bass tagged in 2022 in the ASMA, was 1,234 resulting in 59 recaptures (Table 7; Figure 14, 25). The time series average was 203 days at large with an average distance travelled of 61 miles (Table 7). Most recaptures occur within the state of North Carolina, however, the maximum distance travelled was 579 miles off the coast of New Jersey (Figure 14. 15). The maximum days between release and recapture was 1,905 days or just over five years (Table 7). Data collected from the tagging programs may serve as a recovery indicator and help guide future research needs for the ASMA striped bass stocks. The tagging data from this survey will be used to help determine hatchery contribution to the stocks, as well as movement and migration patterns.

## **RESEARCH NEEDS: A-R STOCK**

The research recommendations listed below (in no particular order) are intended to improve future assessments of the A-R striped bass stock. The bulleted items outline the specific issue and are organized by priority ranking.

### **High**

- Improve estimates of discard mortality rates and discard losses from the ASMA commercial gill-net fisheries (ongoing through observer program).
- Identify environmental factors (e.g., flow, salinity, predation, dissolved oxygen, algal blooms) affecting survival of striped bass eggs, larvae, and juveniles and investigate methods for incorporating environmental variables into stock assessment models.
- Expand, modify, or develop fishery-independent sampling programs to fully encompass all bass life stages (egg, larval, juvenile, and adult). (Ongoing through preliminary larval tows)
- Collect data to estimate catch-and-release discard losses in the ASMA recreational fishery during the closed harvest season.
- Investigate relationship between river flow and striped bass recruitment for consideration of input into future stock assessment models.

### **Medium**

- Transition to an assessment that is based on ages derived from otoliths.
- Improve estimates of catch-and-release discard losses in the RRMA recreational fishery during the closed harvest season.
- Incorporate tagging data directly into the statistical catch-at-age model.
- Improve the collection of length and age data to characterize commercial and recreational discards.
- Explore the direct input of empirical weight-at-age data into the stock assessment model in lieu of depending on the estimated growth relationships.

### **Low**

- Re-evaluate catch-and-release mortality rates from the ASMA and RRMA recreational fisheries incorporating different hook types and angling methods at various water temperatures (e.g., live bait, artificial bait, and fly fishing).
- Investigate the potential impact of blue catfish on the A-R striped bass population (e.g., habitat, predation, forage).

## **MANAGEMENT STRATEGY: A-R STOCK**

Estuarine striped bass in North Carolina are managed under Amendment 2 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 7 to the Interstate FMP for Atlantic Striped Bass. 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. The 2020 A-R striped bass stock assessment indicated that the A-R striped bass stock is overfished with overfishing occurring in the terminal year (2017). Adaptive management measures within Amendment 1 to the Striped Bass FMP required a reduction in TAL to reduce fishing mortality (F) to the target level. This reduction was implemented through a revision to Amendment 1 which reduced the TAL from 275,000 to 51,216 pounds starting in January of 2021 (NCDMF 2020). 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 recruitment failure trigger. If the JAI is below 75 % of all values from a fixed time series 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. The JAI values for 2018, to 2022 were between 0.4 and 0.7 and are all below the spawning failure threshold of 1.33 indicating that the recruitment failure trigger has been met (ASMFC 2010).

### **Central Southern Management Area**

#### **Stock Status: CSMA Stocks**

There is no stock status determination for the CSMA stocks in the Tar-Pamlico, Neuse, and Cape Fear rivers. No formal peer-reviewed stock assessments have been conducted for CSMA striped bass.

A demographic matrix model was developed to evaluate different stocking and management measures for striped bass in all three CSMA river systems. Results from the matrix model indicate that striped bass populations in the CSMA are depressed to an extent that sustainability is unlikely at any level of fishing mortality, and it also provides evidence that natural recruitment is the primary limiting factor influencing Tar-Pamlico and Neuse River stocks and if stocking was stopped the populations would decline (Mathes et al. 2020). The demographic matrix model does not provide population abundance or mortality estimates. A tagging model was developed to estimate striped bass abundance in the Cape Fear River. Tagging model results showed a consistent decline in abundance estimates for striped bass (2012–2018), and that abundance in 2018 was reduced to less than 20% of the abundance in 2012, even with a total no-possession provision for striped bass in place in the Cape Fear River since 2008.

#### **Stock Assessment: CSMA Stocks**

A stock assessment is not available for these stocks.

## **Current Regulations: CSMA**

Commercial and recreational harvest in the CSMA is prohibited. Amendment 2 to the Estuarine Striped Bass FMP adopted by the MFC in November 2022 maintained the no-possession and gill net measures in Supplement A to Amendment 1. The WRC hook-and-line closure proclamation had the effect of suspending rules 15A NCAC 10C .0107 (l) and 10C .0314 (g), and the measures maintained in Amendment 2 included:

- Commercial and recreational no possession measure for striped bass (including hybrids) in coastal and inland fishing waters of the CSMA (FF-6-2019). A no-possession requirement already exists for the Cape Fear River by rule.
- Additionally, consistent with Amendment 1, commercial set gill-net restrictions requiring tie-downs and distance from shore (DFS) measures will apply year-round (M-5-2019). Proclamation M-6-2019 maintained the year-round tie-down and distance from shore restrictions for large mesh gill nets and prohibited the use of all gill nets upstream of the ferry lines from the Bayview Ferry to Aurora Ferry on the Tar-Pamlico River and the Minnesott Beach Ferry to Cherry Branch Ferry on the Neuse River to further reduce bycatch of striped bass.

## **Commercial Fishery: CSMA**

Due to the no possession measure approved in Supplement A and maintained in Amendment 2, the commercial striped bass fishery has been closed since 2019. From 1994–2018 commercial landings in the CSMA were constrained by an annual TAL of 25,000 pounds. Landings closely follow the annual TAL, except for 2008 when less than half of the TAL was landed. From 2004 through 2018 striped bass commercial landings in the CSMA averaged 24,179 pounds and ranged from a low of 10,115 pounds in 2008 to a high of 32,479 pounds in 2004 (Table 8, Figure 16A). Most commercial landings come from the Tar-Pamlico and Pungo rivers and the Neuse and Bay rivers, with the remainder coming from Pamlico Sound. From 2004 to 2018, there was only a spring harvest season, opening March 1 each year and closing when the TAL was reached.

## **Recreational Fishery: CSMA**

The DMF started collecting recreational striped bass data in the major rivers of the CSMA in 2004. In 2013, due to comparatively low recreational striped bass catch in the Cape Fear River, creel survey methodology was adjusted for American and hickory shad to become the target species. Due to the recreational no possession measure in Supplement A, there was minimal recreational harvest in February 2019 (959 pounds) until the recreational season closed in March 2019, with the no recreational possession measure continuing through 2022. Recreational landings fluctuated during 2004–2018, ranging from lows in 2008 and 2009 to a high of 26,973 pounds in 2017 (Table 8; Figure 16B).

Since 2011, harvest in the Tar-Pamlico and Neuse rivers has fluctuated little, ranging from 4,000 pounds to 9,000 pounds, however in 2016 and 2017 there was a sharp increase in recreational harvest (25,260 and 26,973 pounds, respectively). In 2018, recreational harvest dropped sharply by more than half of the 2016 and 2017 values (Table 8). Harvest on the Pungo River remained consistent at a relatively low level compared to fluctuations in the Tar-Pamlico and Neuse rivers.

In 2016 and 2017 the number of trips and hours spent targeting striped bass in the CSMA increased although there was a moderate decline observed in 2018 (Table 9).

Although the recreational striped bass season in the CSMA has remained closed since March 2019, data collection characterizing fishing effort and release dispositions have continued. Within the CSMA there is a significant catch-and-release fishery and releases during the last ten years (2012-2021) have averaged 47,212 fish annually (Table 9; Figure 17). Undersized discards peaked in 2017 mainly due to the large number of undersized striped bass available in the Tar-Pamlico River system. In 2022, the number of striped bass discards was 30,026, which was a slight increase from 2021, but below the ten-year average of 50,710 fish. Under sized discards (n=10,639), remained below the ten-year average of 38,351 fish. In 2022, discards of legal sized striped bass slightly increased (n=14,685) from the past two years, after a high of 26,501 in 2017. Fish released that were within the slot limit, have fluctuated since 2004 and have ranged from lows in 2004, 2006, and 2007 of zero fish to a high of 6,779 fish in 2016 (Table 9). In 2022, there were approximately 4,701 discarded striped bass that were within the slot limit. CSMA recreational length frequencies are presented in Figure 18. In 2018, the modal length of striped bass in the recreational harvest from the Tar-Pamlico/Pungo rivers was 18 inches with few fish over 22 inches harvested, and the modal length from the Neuse River was 19 inches with few fish over 20 inches harvested (Figure 19).

## **MONITORING PROGRAM DATA: CSMA STOCKS**

### **Fishery-Dependent Monitoring: CSMA**

Monitoring of the commercial fishery in the CSMA follows the same methodology as in the ASMA. There has been a commercial and recreational harvest moratorium in the Cape Fear River since 2008 and in the Tar-Pamlico/Pungo and Neuse rivers since March 2019. From 2004 to 2018, length data from the commercial harvest shows that on average striped bass harvested in the Neuse and Bay rivers are slightly larger than fish harvested in the Pamlico and Pungo rivers (Table 10). Additionally, maximum lengths are generally larger in the Neuse and Bay rivers compared to the Pamlico and Pungo rivers.

In 2018, the modal length of CSMA striped bass in the commercial harvest from the Tar-Pamlico/Pungo rivers was 20 inches with few fish over 25 inches harvested and, in the Neuse/Bay rivers striped bass modal length was 23 inches with few fish over 27 inches harvested (Figure 19). CSMA commercial length frequencies are represented in Figure 20 and show that striped bass are routinely harvested up to 30 inches total length, and that few fish under the 18-inch total length minimum size limit are harvested.

From 2004 to 2018, the CSMA recreational creel survey sampled on average 160 striped bass per year. In 2018, the creel survey measured 155 striped bass that averaged 19 inches and ranged in length from 16 to 29 inches, however, only 27 striped bass were measured in 2019 that averaged 20 inches and ranged in length from 16 to 26 inches due to the season closure in March 2019 (Table 11).

## **Fishery-Independent Monitoring: CSMA**

The Fishery Independent Gill Net Survey (Program 915) was initiated by the DMF in May of 2001 in Pamlico Sound. The survey was expanded to the Tar-Pamlico, Pungo, and Neuse rivers in 2003, expanded to the Cape Fear and New rivers in 2008, and expanded into Core Sound, Bogue Sound, and the White Oak River in May 2018. Pamlico Sound and Pungo River data is excluded from striped bass abundance calculations due to mixed stock concerns (Mathes et al. 2020). Overall, the percent frequency of occurrence is lower and PSE values are typically higher in the deep stratum; thus, only the shallow stratum was used in the relative abundance calculations for striped bass. The months of April and October–November are used in index calculation because striped bass are most available to the survey during these months. In the Cape Fear River, although striped bass catch rates are low, data were used to calculate relative abundance. New River data were not used to calculate relative abundance because striped bass are seldom captured. P915 sampling in 2020 was suspended due to COVID-19 restrictions and protected species interactions and was not resumed until July 2021.

Over the past fifteen years (2004–2022), striped bass relative abundance has been higher in the Tar-Pamlico and Neuse rivers when compared to the Cape Fear River and New rivers (Table 12). Since 2004, striped bass relative abundance in the Tar-Pamlico and Neuse rivers ranged from 0.83 to 9 fish per sample, whereas relative abundance in the Cape Fear River ranged from 0 to 0.35 fish per sample (Table 12). In 2022, striped bass relative abundance in the Tar-Pamlico River (0.83 fish per set) was the lowest in the time series and well below the time series average of 4.2 striped bass per set (Table 12; Figure 21). In the Neuse River, striped bass relative abundance was 1.17 fish per set, the lowest value in the time series and well below the time series average of 3.6 striped bass per set (Table 12; Figure 22). In 2022, relative abundance in the Cape Fear River (0.05 fish per set) was below the time series average of 0.11 striped bass per set (Table 12; Figure 23).

Length frequencies from P915 are represented in Figure 24. Length frequency distributions are variable between years but generally range 10–25 inches TL, however in 2016–2017 in the Tar-Pamlico/Pungo River and 2015–2017 in the Neuse River there was a higher percentage of small fish that could represent the two year classes of striped bass thought to be the result of successful natural reproduction in 2014 and 2015. In 2018 and 2019, there were larger fish in the Tar-Pamlico/Pungo and Neuse rivers that could represent growth and perpetuation of the two year classes of striped bass which continued in 2021 and 2022. Length frequency distributions are not provided for the Cape Fear and New rivers due to low numbers of striped bass captured in the fishery independent gill net survey. Samples collected from P915 on the Tar-Pamlico and Neuse rivers show most striped bass were captured in the upper and middle portions of the rivers.

In 2017, the Juvenile Anadromous Survey (Program 100) was expanded to include the Tar-Pamlico, Neuse, Cape Fear, and Northeast Cape Fear rivers. The survey employs seines (June–July) and trawls (July–October) to monitor the status of the striped bass stocks in North Carolina and to assess the effectiveness of management measures aimed at promoting natural reproduction within the CSMA.

In 2021, two juvenile striped bass were captured on the Tar-Pamlico River, which PBT analysis indicated were not of hatchery origin (Table 13). In 2022, 25 juvenile striped bass were collected in the Tar-Pamlico and Neuse rivers. Subsequent PBT analysis of 24 juvenile striped bass captured

in 2022 revealed all of these fish were hatchery origin released as phase-I size (25–50 mm; 1–2 in) striped bass fingerlings.

In the Northeast Cape Fear River, 24 juvenile striped bass were captured in 2018, four in 2019, and one in 2020 (Table 14). Subsequent PBT analysis of five of the 24 juvenile striped bass captured in 2018 revealed these striped bass were not hatchery origin and therefore were most likely wild fish.

Age data are presented in Table 15 and Figure 25; from 2004 to 2022, a total of 2,486 otolith samples were aged and from 2016 to 2022, 1,552 genetic samples were collected to provide striped bass ages and hatchery origin (Table 15). Figure 25 shows an increasing trend of size at length with a maximum age of 12 years old. Limited age data was collected in 2019 from the recreational creel survey (n=15) and no commercial samples were collected. Otolith age data from 2022 are considered preliminary, and genetic ages for 2020–2022 are not currently available.

Electrofishing surveys have been conducted by the WRC on CSMA spawning grounds since 1996 (Figure 26; Tar-Pamlico River), 1994 (Figure 27; Neuse River), and 2003 (Figure 28; Cape Fear River). The objectives of the WRC spawning ground surveys are to monitor and quantify population metrics of striped bass migrating to the spawning grounds during spring of each year. The survey uses a stratified random sampling design in the Tar-Pamlico and Neuse rivers, and a fixed station survey design in the Cape Fear River. Relative abundance is measured as the number of fish captured per hour of electrofishing. The WRC did not sample in 2020.

Since 1996, striped bass abundance in the Tar-Pamlico River has ranged from a low of 18.2 striped bass per hour to a peak of 100.0 per hour in 2010 (Figure 26). In 2022, the relative abundance was 33.5 fish, which is near the time series average of 40.0 fish per hour. Since 1994, striped bass abundance in the Neuse River has been highly variable ranging from a low of 4.4 fish per hour to a high of 20.4 striped bass (Figure 27). Data are not currently available in the Neuse River for 2021 and 2022. Since 2003, striped bass relative abundance in the Cape Fear River has ranged from a low of 6.5 striped bass to a high of 25.4 fish per hour (Figure 28). In 2022, the relative abundance was 18.6 fish per hour which was an increase from the 2021 relative abundance value and was above the time series average of 11.9 fish per hour.

### **Tagging Program: CSMA**

In 2014, a mark-recapture tagging program was initiated utilizing both volunteer anglers and DMF staff throughout the state. Striped bass collected in good condition during DMF fishery independent and electrofishing sampling are tagged with conventional internal anchor tags. In addition, approximately 9,000 (3,000 per system) phase-II (125–200 mm; 5–8 in) size striped bass fingerlings are tagged annually prior to stocking in the Tar-Pamlico, Neuse, and Cape Fear river systems. The total number of striped bass tagged in 2022 from CSMA systems, excluding the Cape Fear River, was 6,640 resulting in 71 recaptures (Table 16; Figure 27). The time series average was 279 days at large with an average distance travelled of 25 miles (Table 16). Most recaptures occur within the state of North Carolina, however, the maximum distance travelled was 527 miles off the coast of Rhode Island (Figure 28). The maximum days between release and recapture was 2,192 days or just under six years (Table 16). In the Cape Fear River, the total number of striped bass tagged in 2022 was 529 resulting in 56 recaptures (Table 17; Figure 31). The time series

average was 317 days at large with an average distance travelled of 15 miles (Table 16). Most recaptures occur within the state of North Carolina; however, the maximum distance travelled was 566 miles into Long Island Sound, Connecticut (Figure 32). The maximum days between release and recapture was 1,944 days or just over five years (Table 17). Data collected from the tagging programs may serve as a recovery indicator and help guide future research needs for the CSMA striped bass stocks. The tagging data from this survey will be used to help determine hatchery contribution to the stocks, as well as movement and migration patterns.

## **RESEARCH NEEDS: CSMA**

The research recommendations listed below are intended to improve future assessments of the CSMA striped bass stocks. The bulleted items outline the specific issue and are organized by priority ranking.

### **High**

- Acquire life history information: maturity, fecundity, size and weight at age, egg, and larval survival (ongoing through CRFL funded projects and DMF P930 data collection; see Knight, 2015 for recent work on maturation and fecundity in the Neuse and Tar-Pamlico rivers).
- Conduct delayed mortality studies for recreational and commercial gear during all seasons factoring in relationships between salinity, dissolved oxygen, and water temperature.
- Develop better estimates of life-history parameters, especially growth and factors influencing rates of natural mortality for all striped bass life stages (growth is ongoing through DMF P930 data collection; for natural mortality, see recent publications Bradley 2016 and Bradley et al. 2018b).

### **Medium**

- Determine factors impacting survivability of stocked fish in each system (Bradley et al. 2018b).
- Implement a random component to DMF program 100 juvenile sampling in the CSMA.
- Conduct a power analysis to determine minimum sample sizes needed for determining the representative age structure.

### **Low**

- Determine if contaminants are present in striped bass habitats and identify those that are potentially detrimental to various life history stages (ongoing through N.C. Division of Water Quality but could be expanded; in 2017, NCSU was awarded a CRFL grant to conduct research on striped bass eggs, including evaluating for Gen X).
- 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.
- Evaluate factors influencing catchability of striped bass, particularly larger striped bass, in electrofishing surveys conducted on the spawning grounds.

- Obtain improved commercial discard estimates from the estuarine gill-net fisheries (i.e., anchored, runaround, and strike gill nets) in the CSMA systems to better characterize harvest and discards.
- Investigate factors influencing mixing rates between A-R and CSMA striped bass stocks.
- Identify water quality parameters that impact spawning, hatching, and survival of striped bass in CSMA systems.
- Develop a consistent ageing approach across agency sampling programs.
- Continue PIT tagging striped bass in the Cape Fear River and expand PIT tagging to the Tar-Pamlico and Neuse rivers to estimates of spawning population size.
- Investigate factors influencing rates of natural mortality for all striped bass life stages in the CSMA systems.

## **MANAGEMENT STRATEGY: CSMA STOCKS**

Estuarine striped bass in North Carolina are managed under Amendment 2 to the North Carolina Estuarine Striped Bass FMP. Due to concerns about the high percentage of stocked fish and minimal natural recruitment in the CSMA systems, the comprehensive review of the Estuarine Striped Bass FMP began in July 2017 instead of as originally scheduled in 2018. Since adoption of the 2004 FMP there has been little change in the size and age distribution, with few age-6 and older fish observed in any system. The need for continued conservation management efforts is supported by the constrained size and age distributions, low abundance, the absence of older fish in all stocks, and the high percentage of stocked fish in the population (Cushman et al. 2018; Farrae et al. 2018). Results from genetic testing of sampled fish in 2017 suggest there were two recent naturally spawned year classes and in February 2019, Amendment 2 maintains a recreational and commercial no-possession limit in the CSMA initially implemented under Supplement A to Amendment 1 in March 2019. The measure provides additional protection for non-hatchery fish.

## **FISHERY MANAGEMENT PLAN SCHEDULE RECOMMENDATIONS**

The next comprehensive FMP review is scheduled in 2027. In 2025 data through 2024 from the Tar-Pamlico and Neuse Rivers will be reviewed to determine if populations are self-sustaining and if sustainable harvest can be determined. In addition, the review will allow for the assessment of the gill net provision through 2024.

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## TABLES

Table 1. ASMA and RRMA recreational harvest (number of fish landed and weight in pounds) and releases (number of fish) and ASMA commercial harvest (weight in pounds) of striped bass from North Carolina, 1990–2022.

Year	ASMA Recreational			RRMA Recreational			ASMA Commercial	Total Weight (lb)
	Numbers Landed	Numbers Released	Weight Landed (lb)	Numbers Landed	Numbers Released	Weight Landed (lb)	Weight Landed (lb)	
1990	-	-	-	-	-	-	103,757	103,757
1991	14,395	23,540	35,344	26,934	-	72,529	108,555	216,428
1992	10,542	19,981	30,758	13,372	-	36,016	100,641	167,415
1993	11,404	13,241	36,049	14,325	-	45,145	109,570	190,764
1994	8,591	-	30,217	8,284	-	28,089	102,471	160,777
1995	7,343	-	30,564	7,471	-	28,883	87,920	147,367
1996	7,433	-	29,186	8,367	52,698	28,178	90,213	147,577
1997	6,901	30,771	26,581	9,364	163,452	29,997	96,210	152,788
1998	19,566	91,888	64,580	23,109	291,765	73,541	124,032	262,153
1999	16,967	40,321	61,338	22,479	189,978	72,967	163,010	297,315
2000	38,085	78,941	116,158	38,206	163,555	120,091	214,223	450,472
2001	40,127	61,418	118,506	35,231	93,148	112,805	220,462	451,773
2002	27,896	51,555	92,649	36,422	71,003	112,698	223,108	428,455
2003	15,124	25,281	51,794	11,157	55,775	39,170	266,539	357,503
2004	28,004	41,041	97,097	26,506	38,256	90,191	273,814	461,102
2005	17,954	21,220	63,477	34,122	187,331	107,530	232,808	403,815
2006	10,711	9,455	35,997	25,355	157,697	84,521	186,555	307,073
2007	7,143	13,599	26,633	19,306	65,524	62,492	171,828	260,953
2008	10,048	36,975	31,628	10,541	52,501	32,725	74,979	139,332
2009	12,069	40,563	37,313	23,248	189,638	69,581	95,879	202,773
2010	3,504	16,200	11,470	22,445	135,964	72,037	200,003	283,510
2011	13,341	21,572	42,536	22,102	123,910	71,561	136,378	250,475
2012	22,345	24,971	71,456	28,847	107,693	88,271	115,698	275,425
2013	4,299	16,381	14,897	7,718	63,018	25,197	68,409	108,503
2014	5,529	23,086	16,867	11,058	74,221	33,717	71,055	121,639
2015	23,240	49,534	70,008	20,031	165,539	58,962	114,596	243,566
2016	4,794	10,352	14,487	21,260	108,240	65,218	123,216	202,921
2017	4,214	24,659	15,480	9,899	52,644	32,569	76,059	124,108
2018	3,465	25,639	11,762	8,741	78,447	26,796	116,144	154,702
2019	8,502	34,968	29,005	16,582	187,214	53,379	136,820	219,204
2020*	6,849	50,009	22,951	20,376	187,192	27,243	124,385	174,579
2021	2,258	7,782	8,258	7,795	10,999	27,546	27,930	63,734
2022	2,789	6,166	8,417	1,949	123,704	6,069	24,026	38,512
Mean	12,982	31,418	42,296	18,519	116,011	57,366	132,766	229,408

\*Due to Covid restrictions, the creel surveys during the spring of 2020 were cut short. Creel estimate for the spring ASMA survey is for the period January 1–March 27, 2020. Creel estimate for the spring RRMA survey is for the period March 1 to March 18, 2020 with data imputed for April based on harvest in April 2015 and 2016.

Table 2. Recreational striped bass effort, harvest, and discards from the ASMA and RRMA (2011–2022).

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
<b>ASMA</b>									
2011	13,114	85,325	13,341	42,536	317	20,114	1,141	N/A	21,572
2012	14,490	102,787	22,345	71,456	1,024	19,977	3,970	N/A	24,971
2013	7,053	50,643	4,299	14,897	31	16,034	316	N/A	16,381
2014	7,264	40,478	5,529	16,867	18	22,558	510	N/A	23,086
2015	11,132	75,009	23,240	70,008	1,573	45,559	2,402	N/A	49,534
2016	7,023	42,276	4,794	14,486	252	8,822	1,278	N/A	10,352
2017	8,822	41,371	4,214	15,479	55	24,003	599	N/A	24,659
2018	9,057	34,764	3,465	11,763	281	21,388	3,970	N/A	25,639
2019	19,864	61,645	8,502	34,968	2,301	34,452	1,625	N/A	38,378
2020#	20,559	84,584	6,849	22,951	32,805	15,256	1,947	N/A	50,009
2021	8,080	29,174	2,258	8,258	689	5,684	1,408	N/A	7,782
2022	14,175	49,949	2,789	8,417	967	4,626	573	N/A	6,166
<b>Total</b>	<b>140,633</b>	<b>698,005</b>	<b>101,625</b>	<b>332,086</b>	<b>40,313</b>	<b>238,473</b>	<b>19,739</b>	<b>N/A</b>	<b>298,529</b>
<b>RRMA</b>									
2011	27,311	122,876	22,102	71,561	Disposition of discards not available for all years.			80,828	
2012	27,151	110,982	28,847	88,539				40,772	
2013	19,539	100,391	7,718	25,197				49,148	
2014	15,960	80,256	11,058	33,717				93,471	
2015	22,827	111,419	20,031	58,962				78,401	
2016	25,036	129,132	21,260	65,218				34,753	
2017	19,688	101,565	9,899	32,569				68,693	
2018	18,280	95,447	8,741	26,797				121,969	
2019	20,633	99,259	16,582	53,379				117,550	
2020†	26,648	131,565	20,376	27,243				54,622	
2021	12,976	69,281	7,795	27,546				57,188	
2022	3,373	17,014	1,949	6,069				123,704	
<b>Total</b>	<b>239,422</b>	<b>1,169,187</b>	<b>176,358</b>	<b>516,797</b>				<b>1,216,099</b>	

# Creel estimate for the spring survey is for the period January 1–March 27, 2020.

† Creel estimate for the spring survey is for the period March 1 to March 18, 2020 with data imputed for April based on harvest in April 2015 and 2016.

Table 3. Striped bass total length (inches) data from commercial fish house sampling from the Albemarle Sound Management Area (ASMA), North Carolina, 2005–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
2005	21	17	43	719
2006	22	17	44	926
2007	22	17	47	860
2008	22	18	46	547
2009	21	18	41	813
2010	21	17	48	940
2011	21	18	39	990
2012	22	18	39	648
2013	22	18	45	543
2014	23	18	43	484
2015	22	18	43	794
2016	22	18	43	604
2017	22	18	41	246
2018	20	16	41	456
2019	20	17	40	566
2020	22	17	40	191
2021	22	19	28	165
2022	23	18	40	250

Table 4. Striped bass total length (inches) data from recreational landings from the Albemarle Sound Management Area (ASMA), North Carolina, 2005–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
2005	20	16	36	1,653
2006	20	17	32	743
2007	20	17	39	412
2008	20	18	30	632
2009	20	18	42	549
2010	20	17	28	337
2011	20	18	34	979
2012	20	18	36	1,059
2013	20	18	32	527
2014	19	18	28	802
2015	20	17	30	1,523
2016	21	18	28	423
2017	21	18	32	489
2018	18	17	29	312
2019	18	17	27	555
2020	20	16	30	683
2021	21	17	28	290
2022	21	11	31	242

Table 5. Striped bass total length (inches) data from recreational landings from the Roanoke River Management Area (RRMA), North Carolina, 2005–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
2005	20	17	40	981
2006	20	17	39	1,059
2007	20	18	39	709
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
2018	20	17	28	688
2019	20	17	30	1,032
2020	19	18	24	155
2021	20	18	40	630
2022	20	18	28	374

Table 6. Striped bass age data from dependent (commercial) and independent (independent gill net survey) surveys from the ASMA, North Carolina, 2005–2022.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
2005	4	1	14	1,258
2006	5	1	14	1,262
2007	5	1	14	1,188
2008	3	1	16	1,191
2009	4	1	14	1,040
2010	5	1	17	885
2011	5	1	11	1,429
2012	2	1	14	802
2013	5	1	13	921
2014	4	2	11	728
2015	4	1	11	713
2016	5	2	12	555
2017	2	2	13	504
2018	4	1	10	674
2019	5	1	14	482
2020	5	1	11	301
2021	5	4	9	120
2022*	3	1	11	551

\*Preliminary data from independent survey only.

Table 7. Summary of ASMA striped bass tagging and recapture data, 2014 – 2022.

Year Tagged	Total Fish Tagged (#)	Total Fish Recaptured (#)	Average Days At Large	Max Days At Large	Average Distance Traveled (miles)	Max Distance Traveled (miles)
2014	270	42	231	524	88	270
2015	2,341	281	278	1,905	76	279
2016	1,197	107	192	1,538	43	242
2017	1,159	106	205	1,311	59	189
2018	1,533	197	157	1,345	44	165
2019	1,831	257	193	1,082	56	272
2020	340	42	246	949	62	133
2021	1,212	116	173	589	64	579
2022	1,234	59	65	227	70	378

Table 8. Recreational harvest (number of fish landed and weight in pounds) and releases (number of fish) and commercial harvest (weight in pounds) of CSMA striped bass from North Carolina, 1994–2022.

Year	Recreational			Commercial	Total Weight (lb)
	Numbers Landed	Numbers Released	Weight Landed (lb)	Weight Landed (lb)	
1994				19,858	19,858
1995				14,325	14,325
1996				33,250	33,250
1997				28,520	28,520
1998				25,973	25,973
1999				33,959	33,959
2000				31,048	31,048
2001				24,705	24,705
2002				37,585	37,585
2003				41,384	41,384
2004	6,141	13,557	22,958	32,479	55,437
2005	3,832	16,854	14,965	27,132	42,097
2006	2,481	14,895	7,352	21,149	28,501
2007	3,597	23,527	10,794	25,008	35,802
2008	843	17,966	2,990	10,115	13,105
2009	895	6,965	3,061	24,847	27,908
2010	1,757	7,990	5,537	23,888	29,425
2011	2,728	24,188	9,474	28,054	37,528
2012	3,922	43,313	15,240	22,725	37,964
2013	5,467	32,816	19,537	28,597	48,134
2014	3,301	30,209	13,368	25,245	38,613
2015	3,934	31,353	14,269	27,336	41,605
2016	6,697	75,461	25,260	23,041	48,301
2017	7,334	131,129	26,973	23,018	49,991
2018	3,371	49,122	10,884	20,057	30,941
2019	959	36,080	3,562	0	3,562
2020	0	19,420	0	0	0
2021	0	23,216	0	0	0
2022	0	30,026	0	0	0
Mean	3,181	33,057	11,457	23,332	30,697

Table 9. Recreational striped bass effort, harvest, and discards from the CSMA (2004–2021). In the CSMA, there was a limited recreational harvest season in 2019 prior to closing (January 1–March 19, 2019). The recreational season remained closed in 2022.

Year	Striped Bass Fishing (Angler Trips)	Striped Bass Effort (Angler Hours)	Number Harvested	Pounds Harvested	Striped Bass Discards				Total Discards
					Number Over-Creel	Number Under-Sized	Number Legal-Sized	Number Slot-Sized	
2004	12,782	63,791	6,141	22,958	85	11,729	1,743	0	13,557
2005	16,414	69,370	3,832	14,965	152	15,609	1,016	77	16,854
2006	10,611	42,066	2,481	7,352	33	12,548	2,314	0	14,895
2007	10,971	46,655	3,597	10,794	147	21,673	1,707	0	23,527
2008	6,621	28,413	843	2,990	2,838	11,721	3,316	91	17,966
2009	5,642	26,611	895	3,061	7	4,471	1,769	718	6,965
2010	6,559	25,354	1,757	5,537	29	5,200	2,401	360	7,990
2011	12,606	51,540	2,728	9,474	9	16,659	5,397	2,123	24,188
2012	18,338	71,964	3,922	15,240	439	26,343	13,621	2,910	43,313
2013	20,394	86,918	5,467	19,537	539	19,302	10,619	2,357	32,816
2014	15,682	70,316	3,301	13,368	1,449	19,185	7,934	1,641	30,209
2015	18,159	79,398	3,934	14,269	217	22,272	8,052	813	31,353
2016	23,675	110,453	6,697	25,260	215	57,874	10,593	6,779	75,461
2017	26,125	119,680	7,334	26,973	549	101,787	26,501	2,293	131,129
2018	16,393	69,917	3,371	10,884	871	34,128	12,232	1,890	49,122
2019*	8,820	40,580	959	3,562	924	24,857	7,817	2,481	37,039
2020**	2,846	13,272	0	0	0	10,439	7,575	1,406	19,420
2021**	4,772	18,241	0	0	0	9,124	12,322	1,769	23,216
2022**	5,200	17,885	0	0	0	10,639	14,685	4,701	30,026
Total	242,610	1,052,424	57,259	206,224	8,503	435,561	151,615	32,409	628,087

\* Limited harvest season (Jan 1–March 19, 2020)

\*\* Closed harvest season

Table 10. Mean, minimum, and maximum length of striped bass (total length – inches) and number (N) collected from the commercial harvest, 2000–2022.

Year	Tar-Pamlico/Pungo rivers				Neuse/Bay rivers			
	Length (inches)				Length (inches)			
	Mean	Min	Max	N	Mean	Min	Max	N
2000	23	20	35	126	25	22	31	5
2001	23	21	26	116	25	23	31	12
2002	24	19	39	96	25	19	29	31
2003	23	18	37	173	24	19	37	19
2004	24	20	42	131	25	19	37	74
2005	23	20	37	127	24	20	36	70
2006	22	18	37	119	24	19	36	144
2007	22	19	33	112	22	19	27	63
2008	22	18	43	84	23	19	44	39
2009	22	19	31	99	22	18	31	85
2010	22	19	26	194	23	19	32	263
2011	23	18	27	284	23	19	42	195
2012	24	15	30	254	24	19	29	96
2013	25	18	40	225	25	18	39	301
2014	22	18	39	52	24	20	38	56
2015	24	19	40	97	24	19	44	97
2016	24	17	29	257	23	19	28	78
2017	24	19	31	151	24	19	50	97
2018	23	19	32	76	24	18	38	163
2019	-	-	-	-	-	-	-	-
2020	-	-	-	-	-	-	-	-
2021	-	-	-	-	-	-	-	-
2022	-	-	-	-	-	-	-	-

Table 11. Mean, minimum and maximum length of striped bass (total length – inches) and number collected from the recreational harvest, 2004–2021 (includes striped bass and hybrid striped bass). There was a limited recreational season in 2019 (Jan 1-March 19) and the season remained closed in 2022.

Year	Mean Total Length	Minimum Total Length	Maximum Total Length	Total Number Measured
2004	22	17	32	430
2005	22	18	32	318
2006	22	18	30	132
2007	22	17	30	129
2008	21	18	26	50
2009	21	17	24	95
2010	21	18	26	74
2011	21	18	28	140
2012	21	18	28	153
2013	20	17	28	169
2014	21	18	30	115
2015	21	16	27	106
2016	20	18	33	144
2017	20	17	30	202
2018	19	16	29	155
2019	20	17	26	27
2020	-	-	-	-
2021	-	-	-	-
2022	-	-	-	-

Table 12. Relative abundance (Index) of striped bass (number of individuals per sample), total number of striped bass collected, and the number of gill net samples (N) in the Tar-Pamlico and Neuse rivers (April, and October–November, shallow water sets (2004–2022), and in the Cape Fear and New rivers (February–December, all sets; 2008–2022) The Percent Standard Error (PSE) represents a measure of precision. No sampling occurred in 2020 and limited sampling occurred in 2021 (July–December).

Year	Tar-Pamlico River				Neuse River				Cape Fear and New Rivers			
	Index	No. of Striped Bass	N	PSE	Index	No. of Striped Bass	N	PSE	Index	No. of Striped Bass	N	PSE
2004	3.94	71	18	24	2.83	68	24	44	-	-	-	-
2005	4.61	83	18	17	3.75	90	24	42	-	-	-	-
2006	4.06	73	18	41	2.33	56	24	25	-	-	-	-
2007	3.56	64	18	49	2.83	68	24	28	-	-	-	-
2008	4.61	83	18	37	3.21	77	24	44	0.04	3	84	100
2009	2.78	50	18	36	2.13	51	24	41	0.03	3	119	67
2010	5.67	102	18	26	6.25	150	24	39	0.01	1	120	100
2011	7.72	139	18	32	4.75	114	24	30	0.04	4	120	50
2012	3.28	59	18	39	2.25	54	24	36	0.03	3	120	67
2013	3.22	58	18	36	2.54	61	24	31	0.02	2	120	50
2014	4.56	82	18	20	6.75	162	24	28	0	0	120	-
2015	2.67	48	18	33	5.33	128	24	27	0.14	15	120	36
2016	2.44	44	18	27	2.04	49	24	24	0.11	12	120	45
2017	2.44	44	18	29	3.21	77	24	24	0.08	9	120	50
2018	9.00	162	18	29	3.75	90	24	31	0.03	3	113	67
2019	5.06	91	18	33	4.21	101	24	32	0.01	1	120	100
2020	-	-	-	-	-	-	-	-	-	-	-	-
2021	0.92	11	12	43	4.25	68	16	38	0.03	3	88	67
2022	0.83	15	18	73	1.17	28	24	82	0.05	4	79	40

Table 13. Relative abundance of striped bass (number of individuals per sample), total number of striped bass collected, and the number of beach seine and trawl samples (N) in the Tar-Pamlico and Neuse rivers, 2017-2022.

Year	Tar-Pamlico River						Neuse River					
	Seine			Trawl			Seine			Trawl		
	Striped bass (N)	Samples (N)	Relative Abundance	Striped bass (N)	Samples (N)	Relative Abundance	Striped bass (N)	Samples (N)	Relative Abundance	Striped bass (N)	Samples (N)	Relative Abundance
2017	0	54	0.00	0	48	0.00	0	54	0.00	0	48	0.00
2018	0	30	0.00	0	36	0.00	0	30	0.00	0	36	0.00
2019	0	36	0.00	0	48	0.00	0	36	0.00	0	48	0.00
2020	0	48	0.00	0	48	0.00	0	48	0.00	0	48	0.00
2021*	2	48	0.04	0	48	0.00	0	48	0.00	0	48	0.00
2022†	21	48	0.44	0	36	0.00	4	48	0.08	0	36	0.00
Total	23	264	0.09	0	264	0.00	4	264	0.02	0	264	0.00

\* PBT analysis: natural reproduction

† PBT analysis: hatchery origin

Table 14. Relative abundance of striped bass (number of individuals per sample), total number of striped bass collected, and the number of beach seine and trawl samples (N) in the Cape Fear and Northeast Cape Fear rivers, 2017-2022.

Year	Cape Fear River						Northeast Cape Fear River					
	Seine			Trawl			Seine			Trawl		
	Striped bass (N)	Samples (N)	Relative Abundance	Striped bass (N)	Samples (N)	Relative Abundance	Striped bass (N)	Samples (N)	Relative Abundance	Striped bass (N)	Samples (N)	Relative Abundance
2017	0	25	0.00	0	32	0.00	0	29	0.00	0	32	0.00
2018*	0	58	0.00	0	10	0.00	0	34	0.00	24	27	0.89
2019	0	47	0.00	0	23	0.00	4	32	0.13	0	40	0.00
2020	0	11	0.00	0	24	0.00	1	8	0.13	0	40	0.00
2021	0	44	0.00	0	21	0.00	0	22	0.00	0	27	0.00
2022	0	34	0.00	0	19	0.00	0	19	0.00	0	31	0.00
Total	0	219	0.00	0	129	0.00	5	144	0.03	24	197	0.12

\* PBT analysis: natural reproduction (n=5 of 24 striped bass analyzed)

Table 15. CSMA striped bass otolith and genetic age data from fishery dependent (commercial and recreational creel survey) and independent (independent gill net survey) surveys, 2004–2022. Otolith age data from 2022 are considered preliminary, and genetic ages for 2020 – 2022 are not currently available.

Year	Modal Age		Minimum Age		Maximum Age		Total Number Aged	
	otolith	genetic	otolith	genetic	otolith	genetic	otolith	genetic
2004	3	-	1	-	11	-	50	-
2005	2	-	1	-	9	-	78	-
2006	3	-	1	-	9	-	111	-
2007	3	-	1	-	9	-	86	-
2008	3	-	1	-	8	-	103	-
2009	4	-	1	-	6	-	37	-
2010	5	-	1	-	9	-	154	-
2011	3	-	2	-	6	-	56	-
2012	3	-	1	-	7	-	205	-
2013	3	-	1	-	8	-	156	-
2014	3	-	1	-	11	-	172	-
2015	3	-	1	-	9	-	113	-
2016	2	3	1	2	8	6	38	323
2017	2	4	1	1	9	7	98	247
2018	3	4	1	1	12	8	109	201
2019	4	3	1	1	11	9	307	183
2020	5	-	1	-	9	-	147	172*
2021	3	-	1	-	10	-	352	265*
2022	3	-	1	-	11	-	114	161*

\* Number of genetic sampled collected, ages are not currently available.

Table 16. Summary of CSMA striped bass tagging and recapture data, 2014 – 2022.

Year Tagged	Total Fish Tagged (#)	Total Fish Recaptured (#)	Average Days At Large	Max Days At Large	Average Distance Traveled (miles)	Max Distance Traveled (miles)
2014	6,233	46	556	2,129	36	133
2015	6,751	154	368	1,643	30	527
2016	6,680	158	348	1,881	44	223
2017	6,986	237	257	2,077	33	180
2018	7,002	141	229	1,002	39	203
2019	6,785	159	322	1,315	39	248
2020	6,709	181	237	964	21	208
2021	6,959	134	190	565	26	112
2022	6,640	71	105	259	25	84

Table 17. Summary of Cape Fear River striped bass tagging and recapture data, 2014 – 2022.

Year Tagged	Total Fish Tagged (#)	Total Fish Recaptured (#)	Average Days At Large	Max Days At Large	Average Distance Traveled (miles)	Max Distance Traveled (miles)
2014	3,047	13	490	1,383	22	129
2015	3,692	159	484	1,944	17	281
2016	3,600	158	368	1,329	15	566
2017	3,367	75	262	1,544	11	98
2018	3,422	66	237	1,443	15	78
2019	3,279	73	368	1,039	16	157
2020	3,265	89	223	784	14	138
2021	3,323	78	185	680	14	270
2022	529	56	100	338	11	66

**FIGURES**

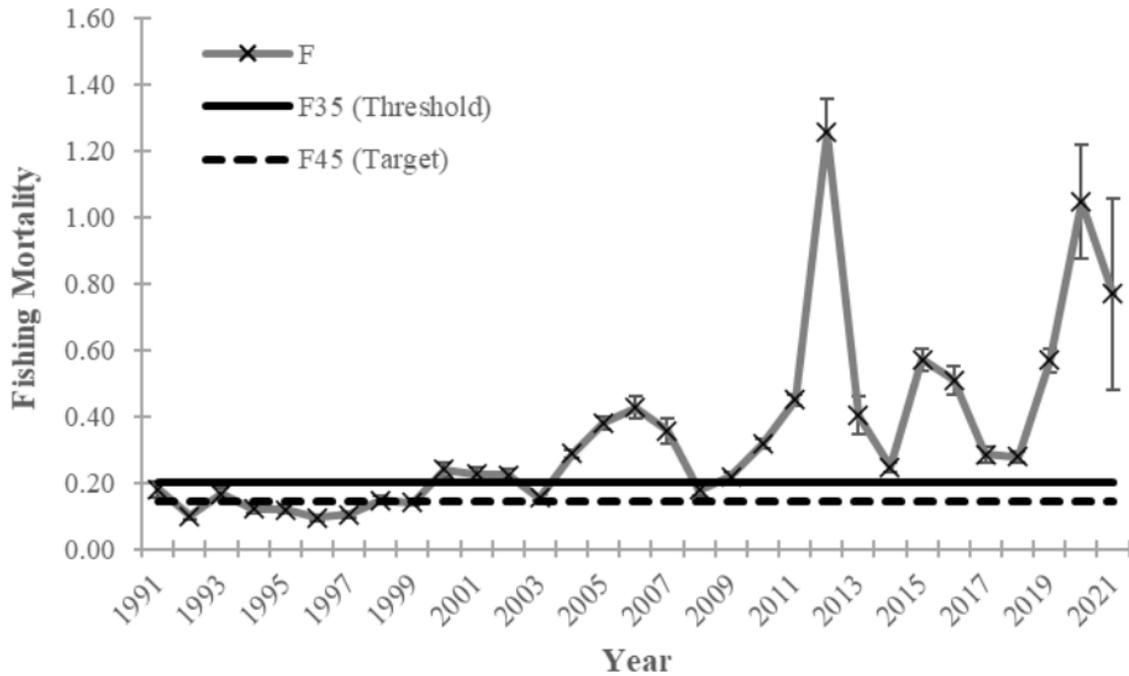


Figure 1. Estimates of fishing mortality ( $F$ ) Albemarle-Roanoke striped bass stock, 1991–2021. Error bars represent  $\pm$  two standard errors. Source: Lee et al. 2022.

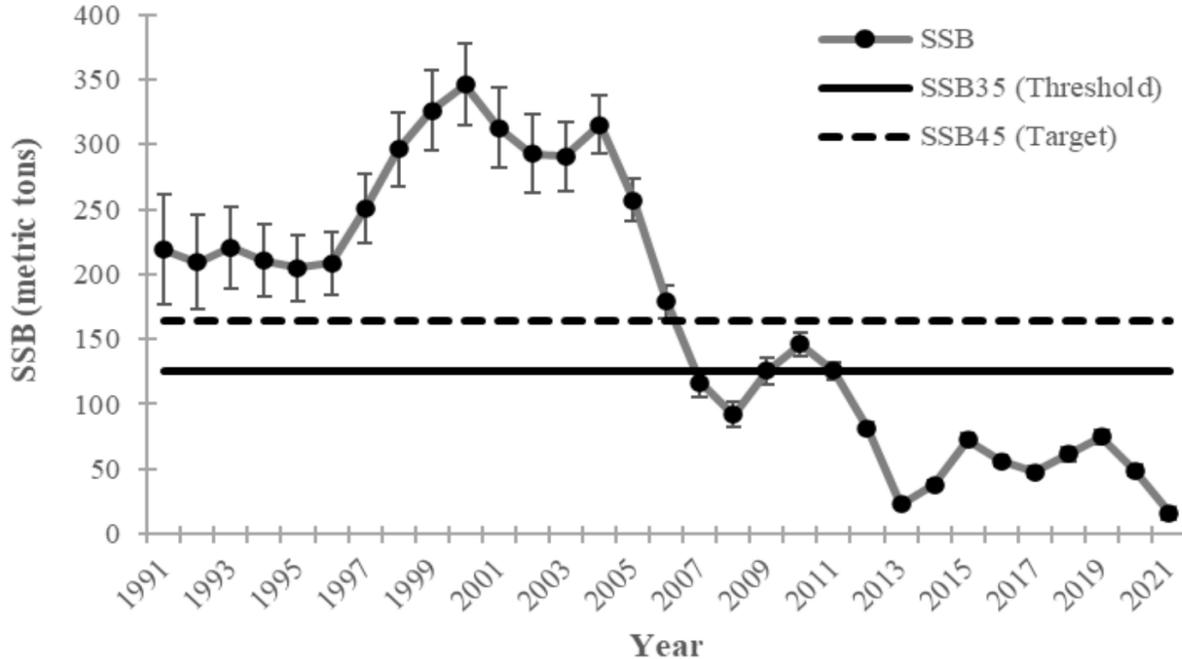


Figure 2. Estimates of spawning stock biomass (SSB) each year for the Albemarle-Roanoke striped bass stock, 1991–2021. Error bars represent  $\pm$  two standard errors. Source: Lee et al. 2022

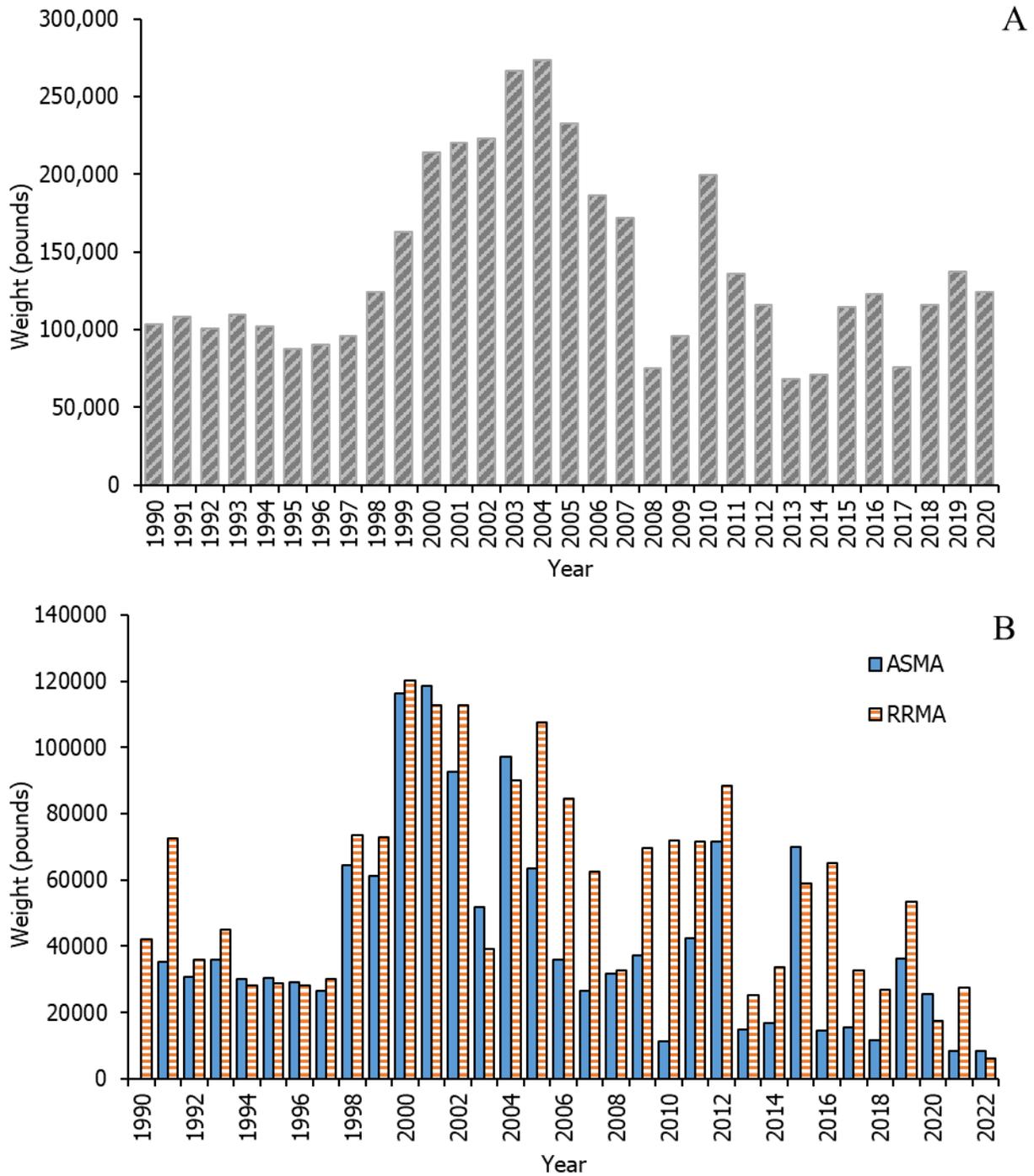


Figure 3. ASMA commercial (A), ASMA recreational (Blue), and RRMA recreational (Orange stripes) (B) striped bass landings in pounds, NC, 1990–2022. RRMA 2020 recreational landings are for March only. ASMA 2020 landings are from January–March.

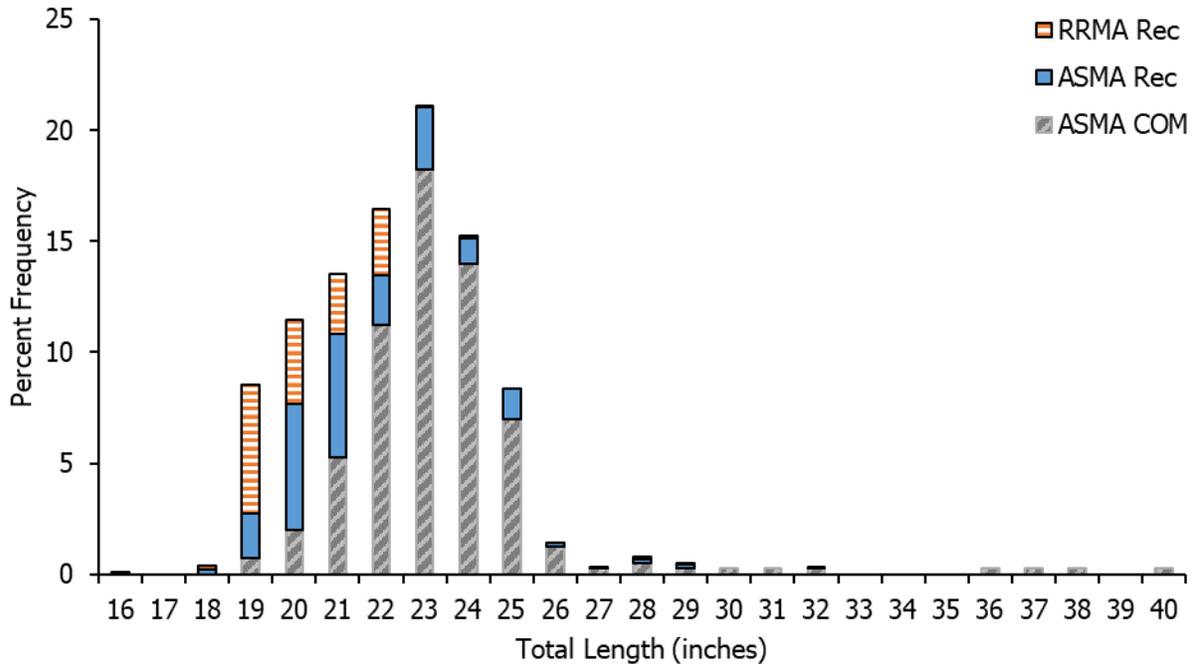


Figure 4. ASMA commercial, ASMA recreational, and RRMA recreational length frequency distribution from striped bass harvested in 2022.

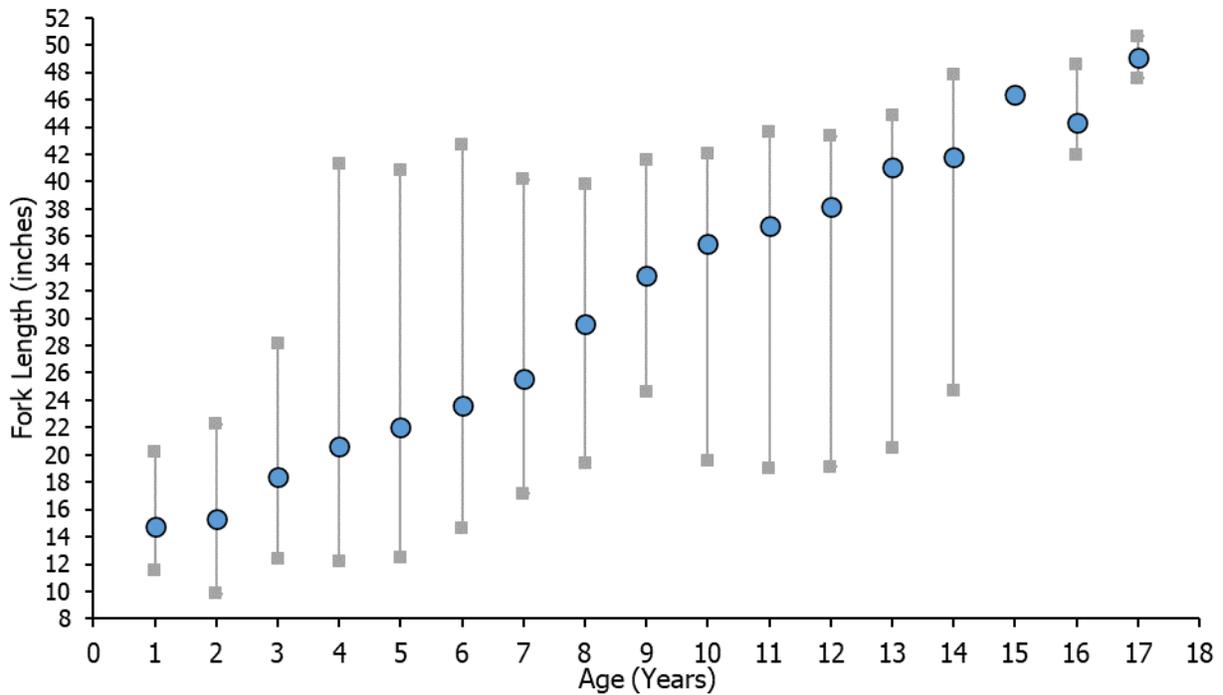


Figure 5. Striped bass length at age based on all commercial samples, 1972–2021. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age. Age data for 2022 were not available at time of publication.

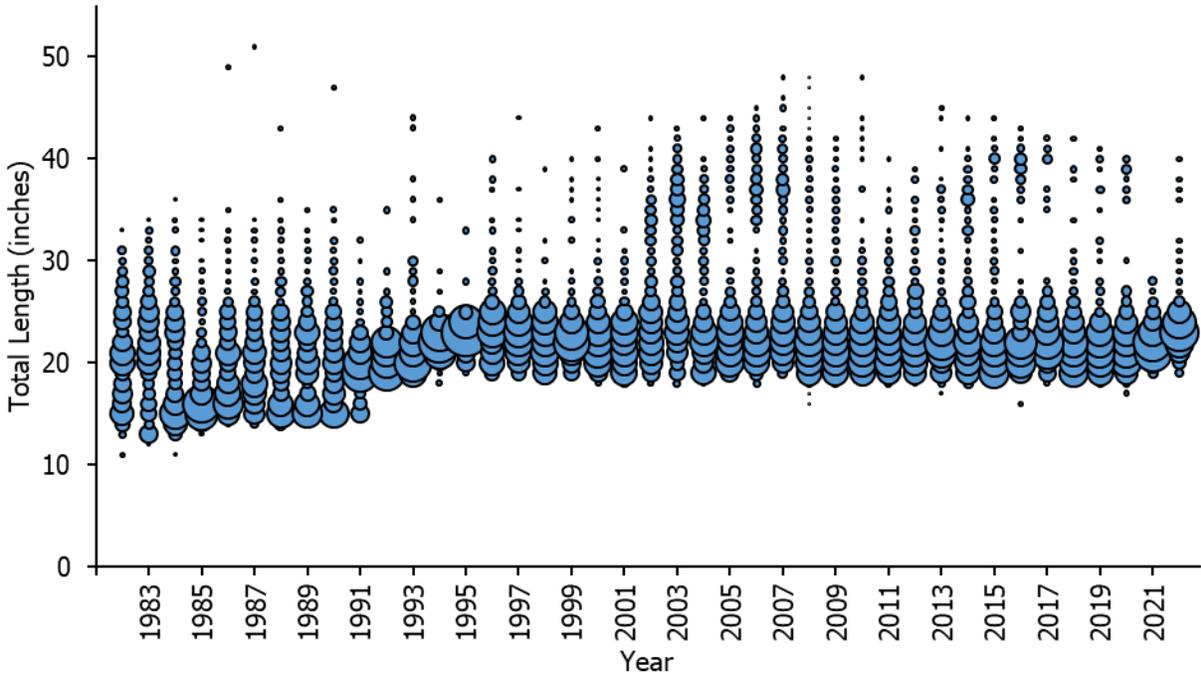


Figure 6. Commercial length frequency (total length, inches) of striped bass harvested in the ASMA, NC, 1982–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

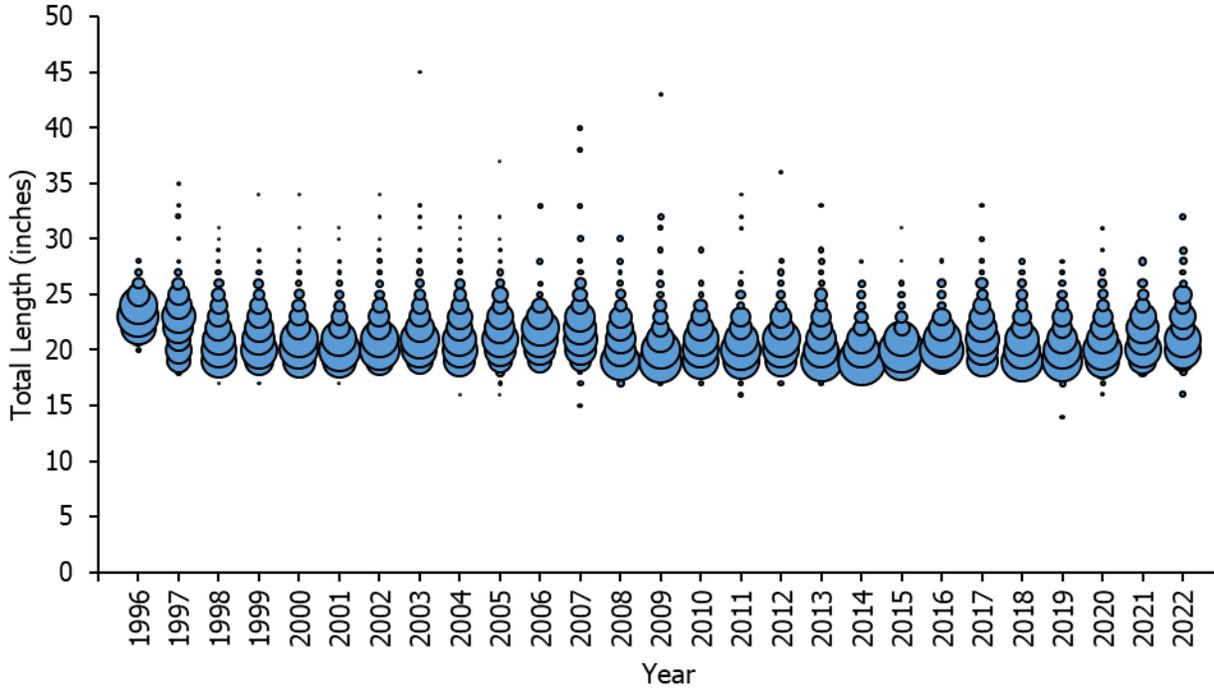


Figure 7. Recreational length frequency (total length, inches) of striped bass harvested in the ASMA, NC, 1996–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

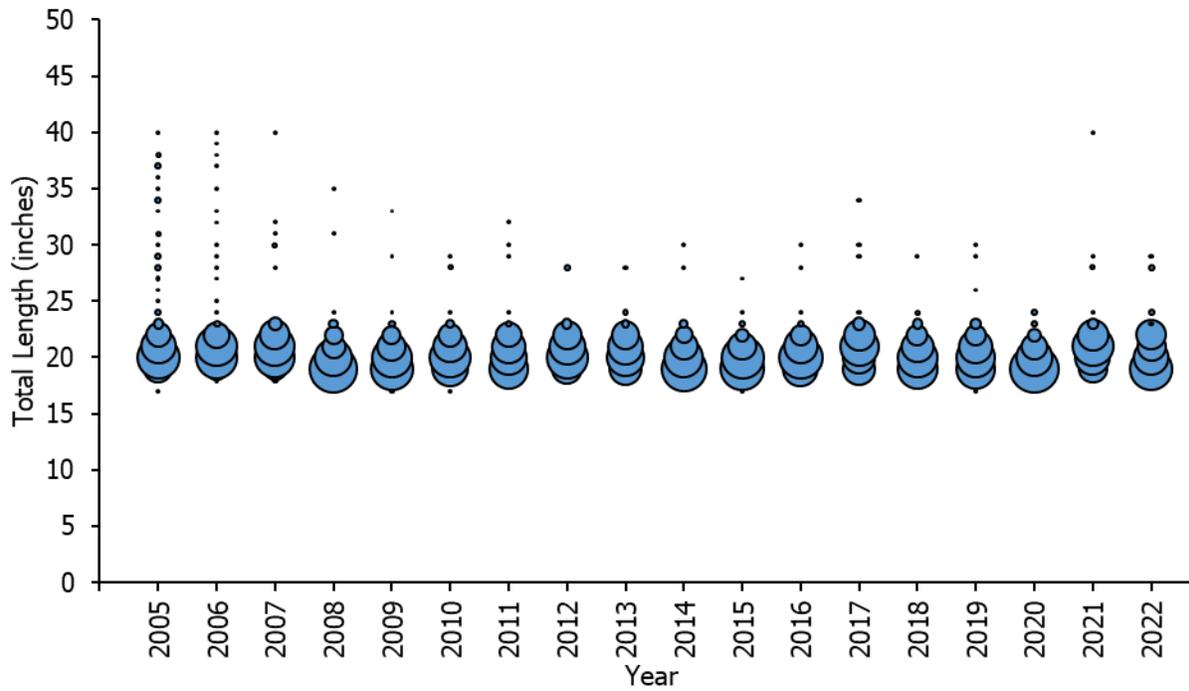


Figure 8. Recreational length frequency (total length, inches) of striped bass harvested in the RRMA, NC, 2005–2021. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

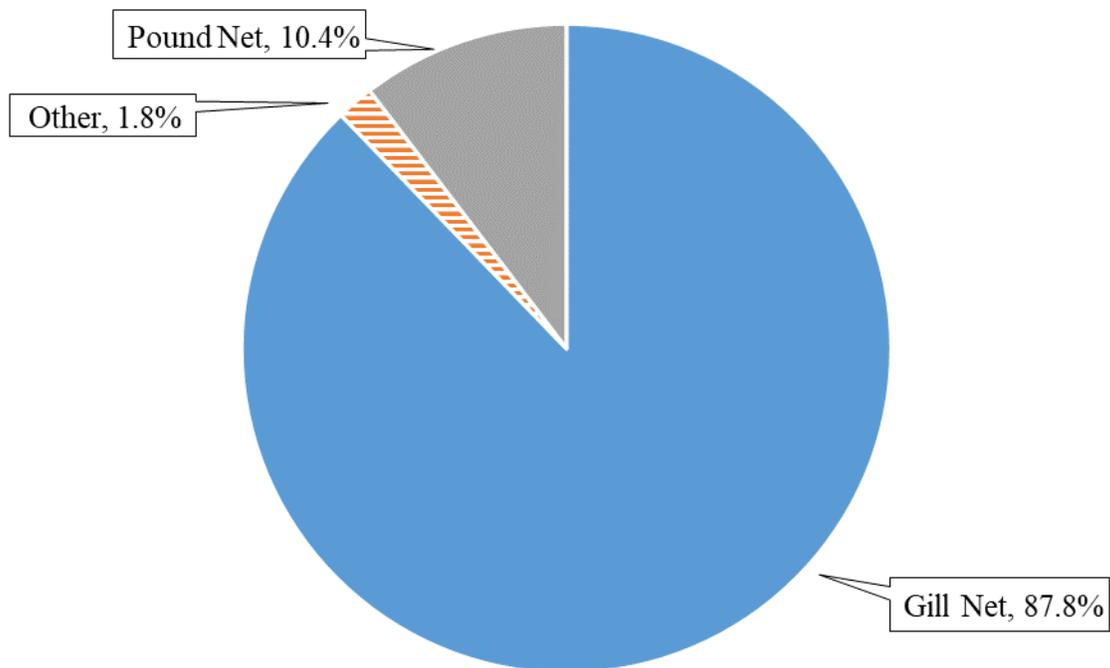


Figure 9. Commercial striped bass landings broken out by major gears in the ASMA, NC, 1994–2022.

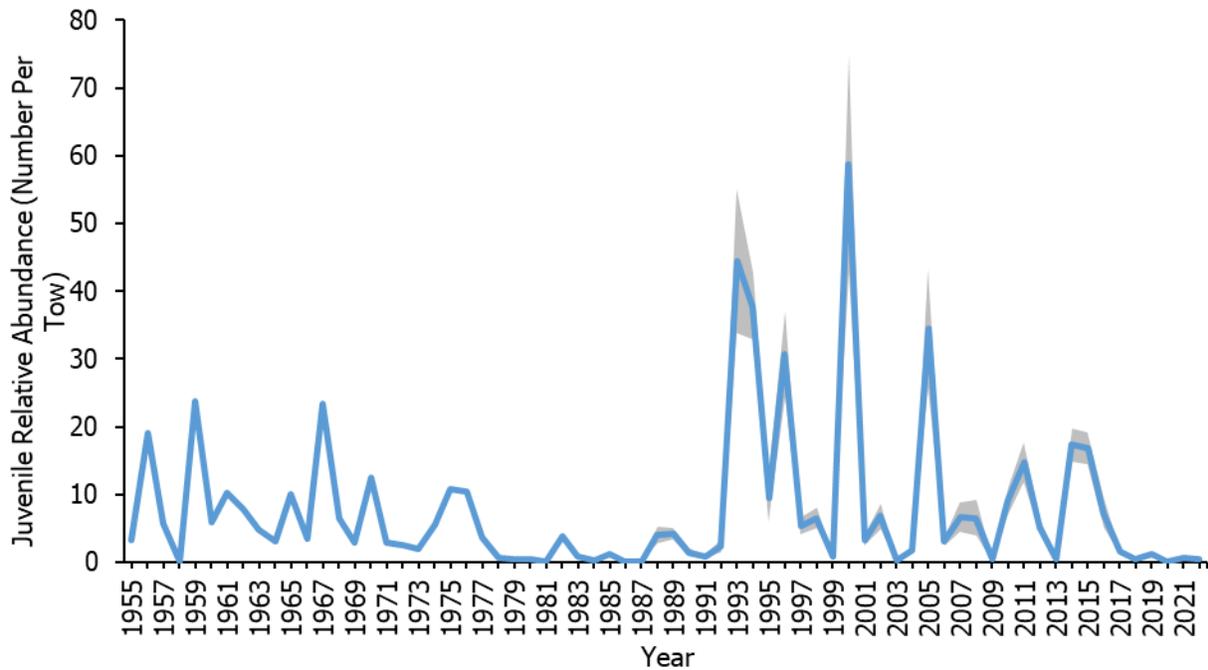


Figure 10. Juvenile abundance index (JAI) of Albemarle-Roanoke striped bass from the DMF juvenile trawl survey, western Albemarle Sound, NC, 1955–2022.

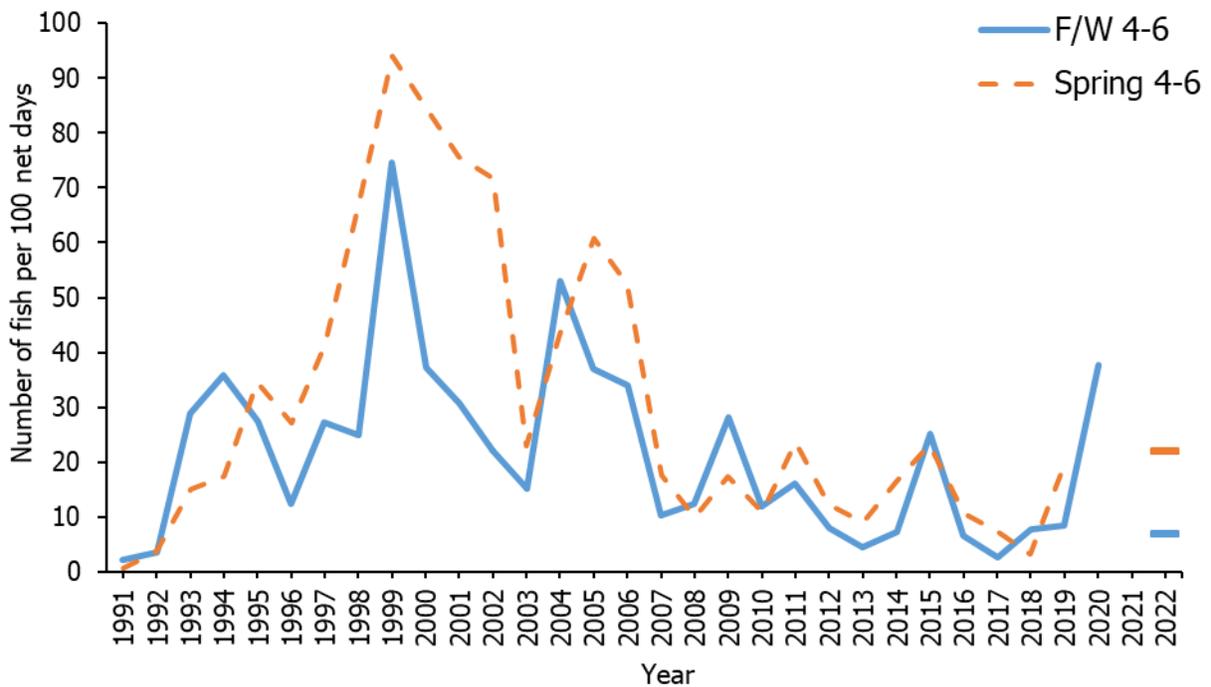


Figure 11. Relative abundance of age 4–6 Albemarle-Roanoke striped bass from the DMF fall/winter and spring independent gill net surveys, Albemarle Sound area, NC, 1991–2022. Age data for 2022 are preliminary.

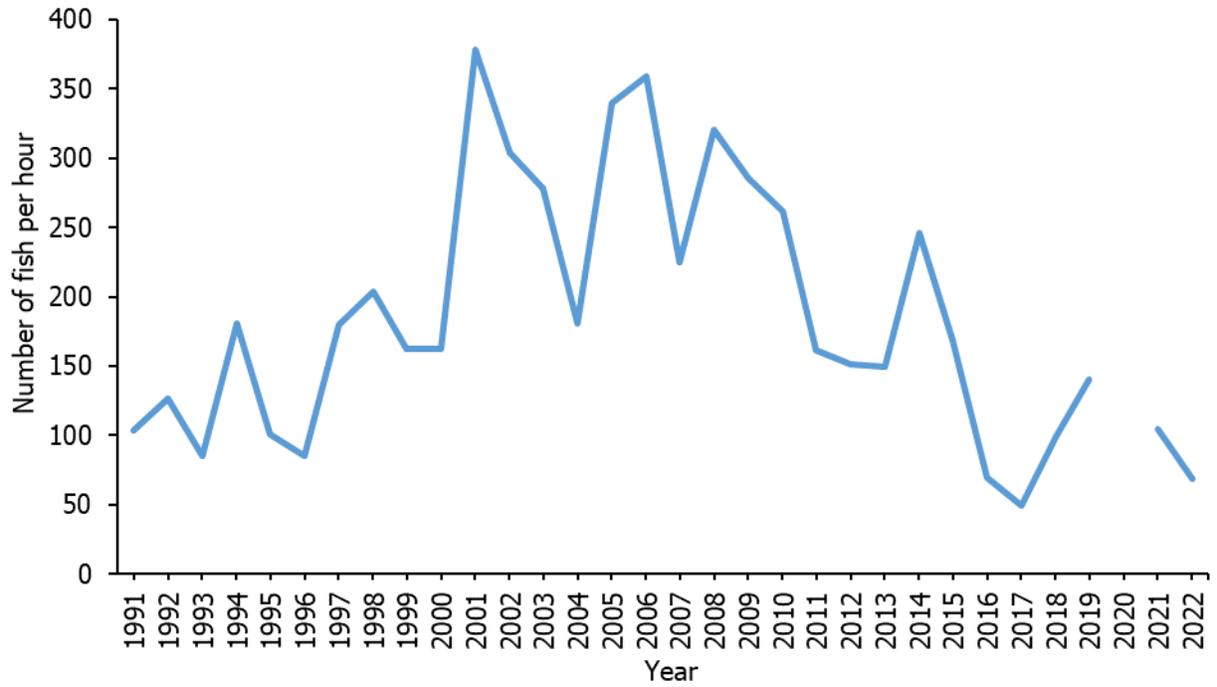


Figure 12. Relative abundance of Albemarle-Roanoke striped bass from the WRC spawning grounds electrofishing survey, Roanoke River at Weldon, NC, 1991–2022.

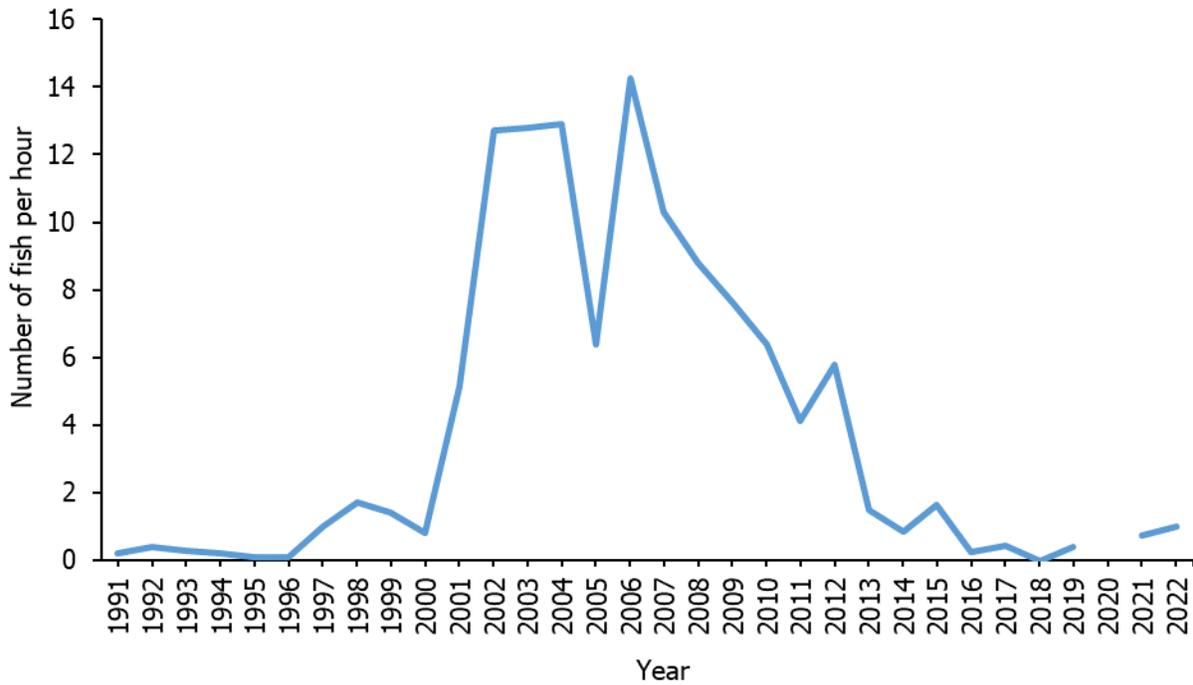


Figure 13. Relative abundance of age 9+ Albemarle-Roanoke striped bass from the WRC spawning grounds electrofishing survey, Roanoke River at Weldon, NC, 1991–2022.

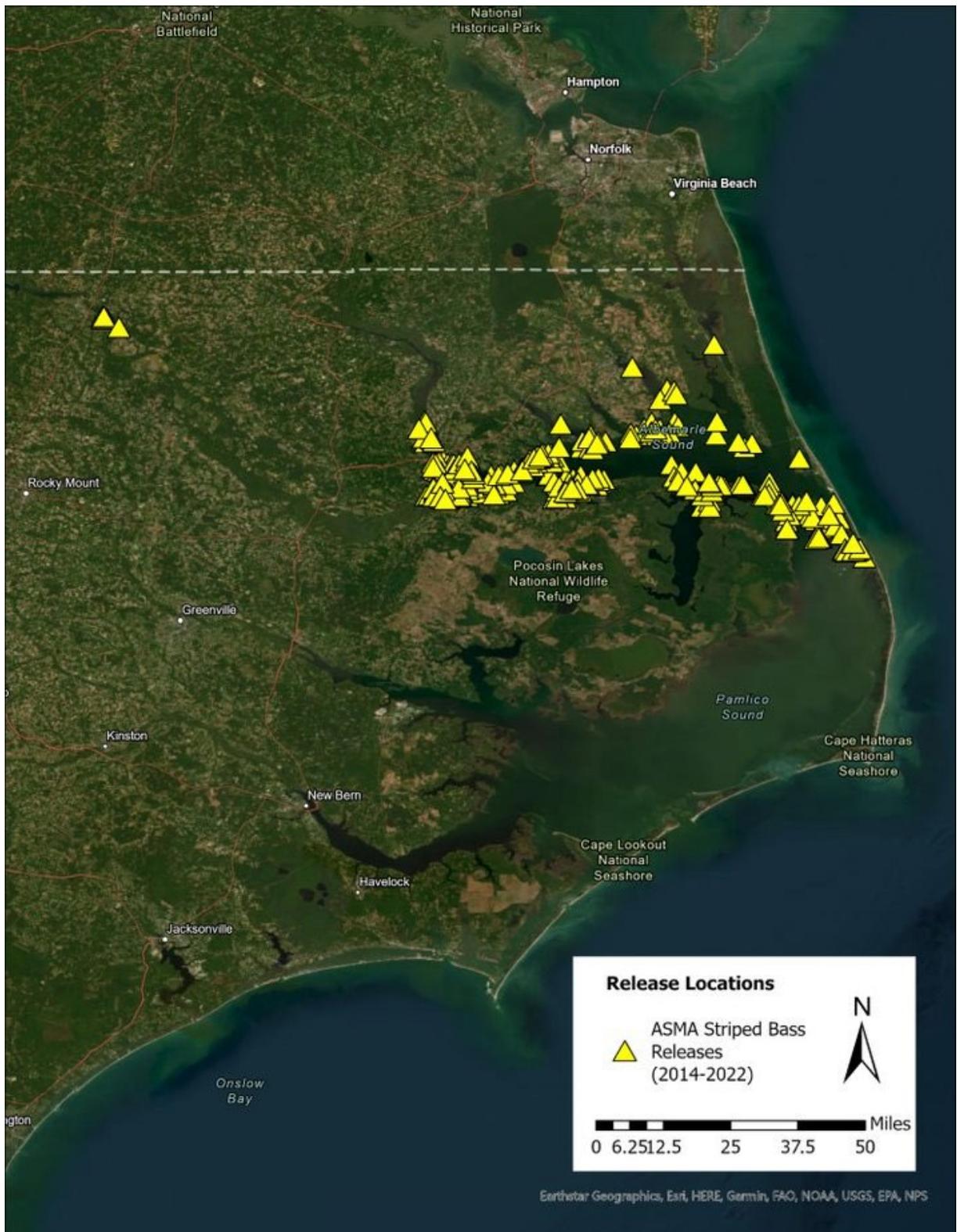


Figure 14. ASMA (Roanoke River and Albemarle Sound) striped bass tagging release locations, 2014-2022.

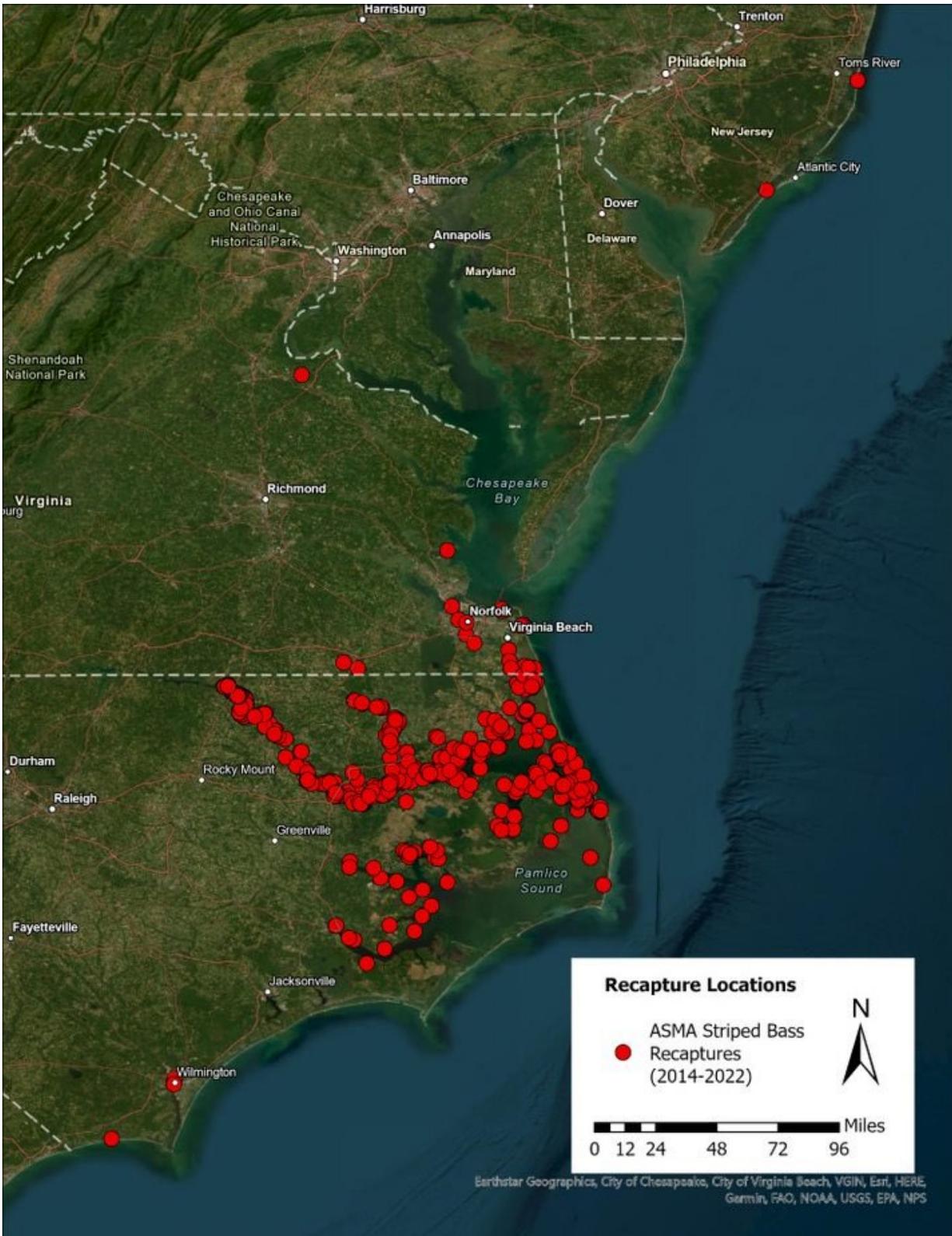


Figure 15. ASMA (Roanoke River and Albemarle Sound) striped bass tagging recapture locations, 2014-2022.

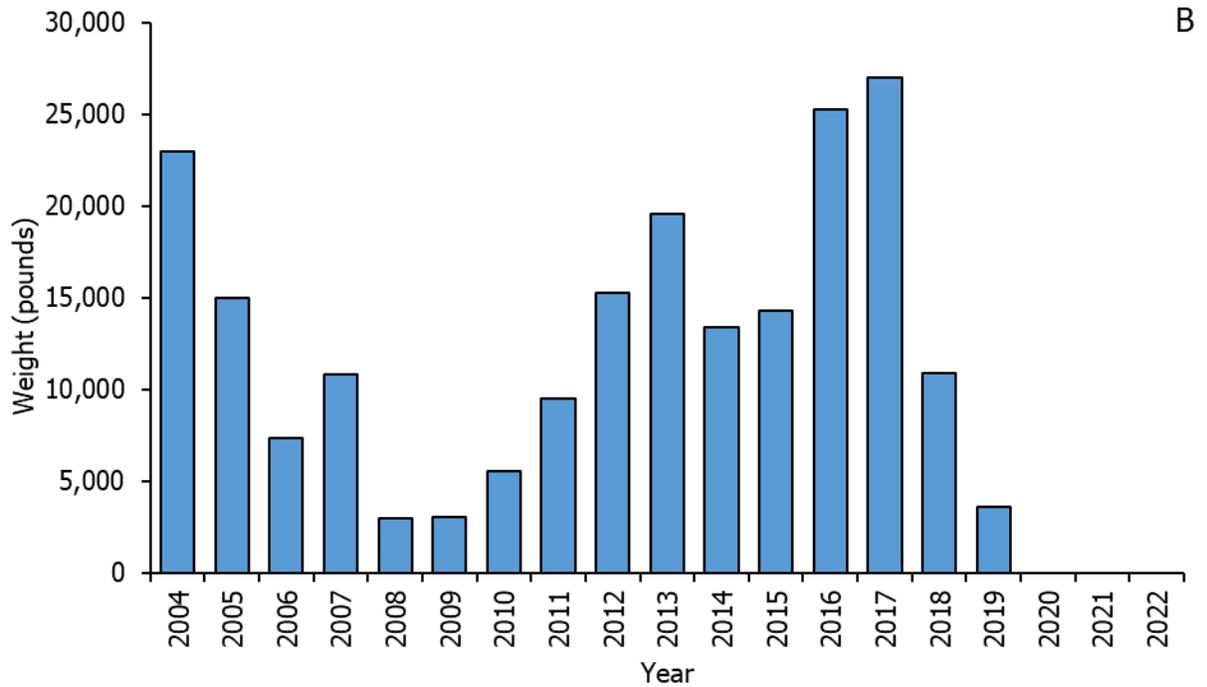
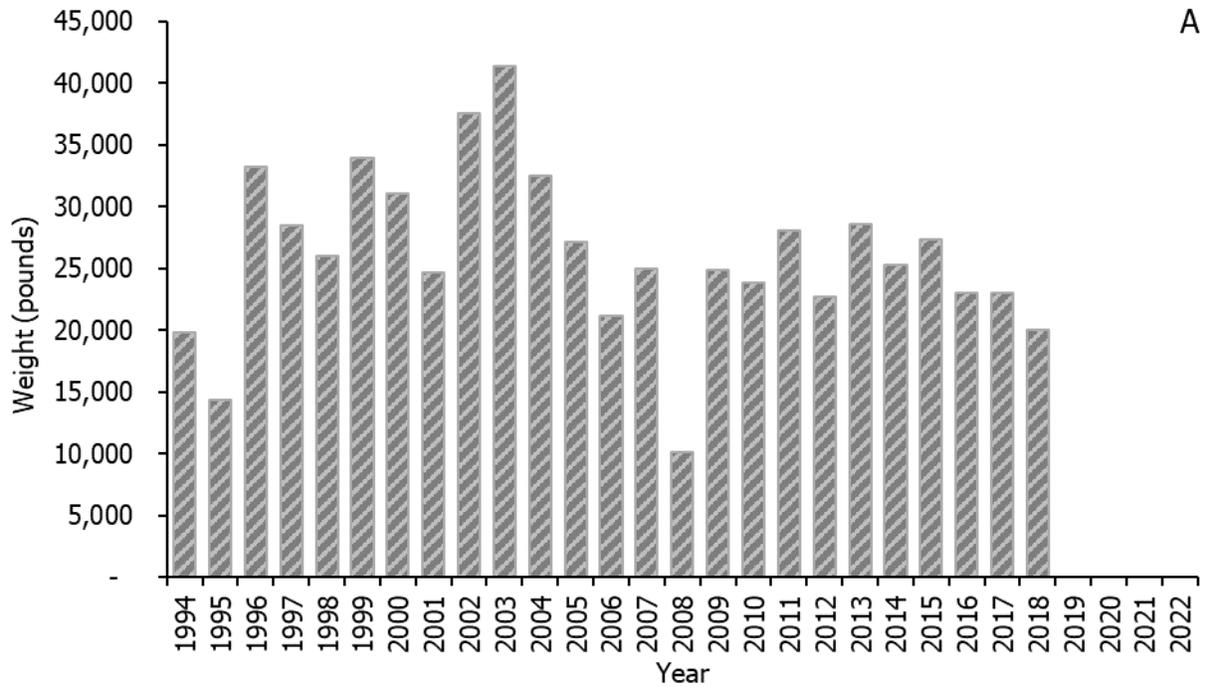


Figure 16. Annual commercial landings (pounds) reported through the North Carolina Trip Ticket Program, 1994–2022 (A), and recreational landings (pounds) estimated from the CSMA Recreational Creel Survey, 2004–2022. There was no commercial season and a limited recreational season in 2019, lasting from January 1 to March 19, 2019. Commercial and recreational seasons remained closed in 2022.

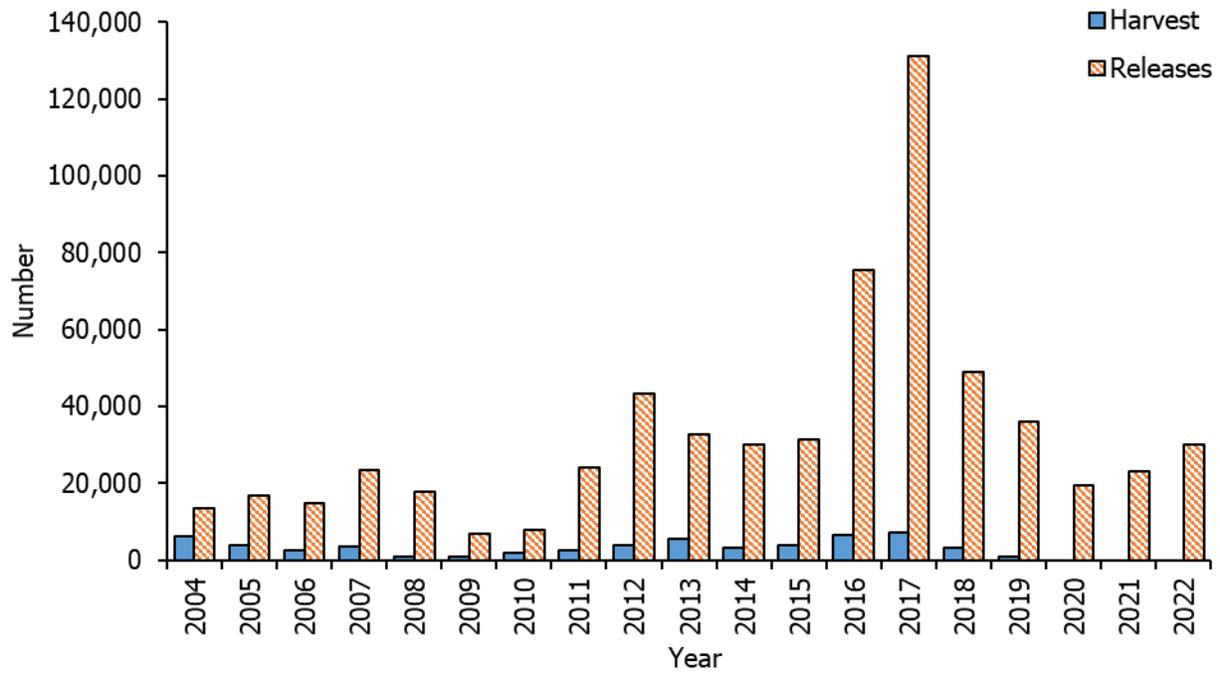


Figure 17. Annual recreational catch (harvested and/or released) of striped bass in the CSMA, 2004–2022. There was a limited recreational harvest season in 2019 prior to the closure, lasting from Jan 1 to Mar 19, 2019. The harvest season remained closed in 2022.

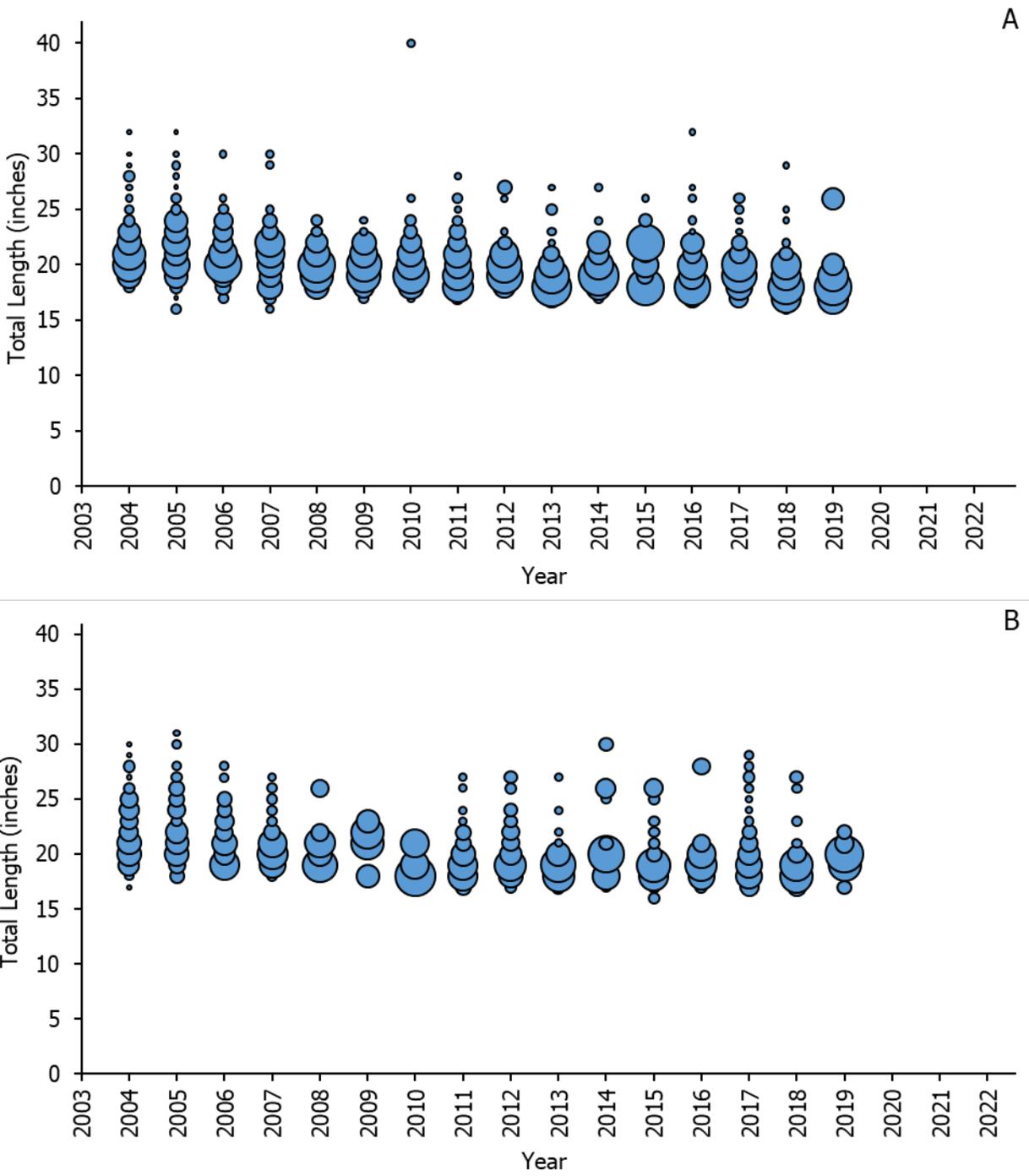


Figure 18. Recreational length frequency of CSMA striped bass harvested in the Tar-Pamlico/Pungo rivers (A), and the Neuse River (B), 2004–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length. There was a limited recreational season in 2019 prior to the closure, lasting from Jan 1 to Mar 19, 2019. The recreational season remained closed in 2022.

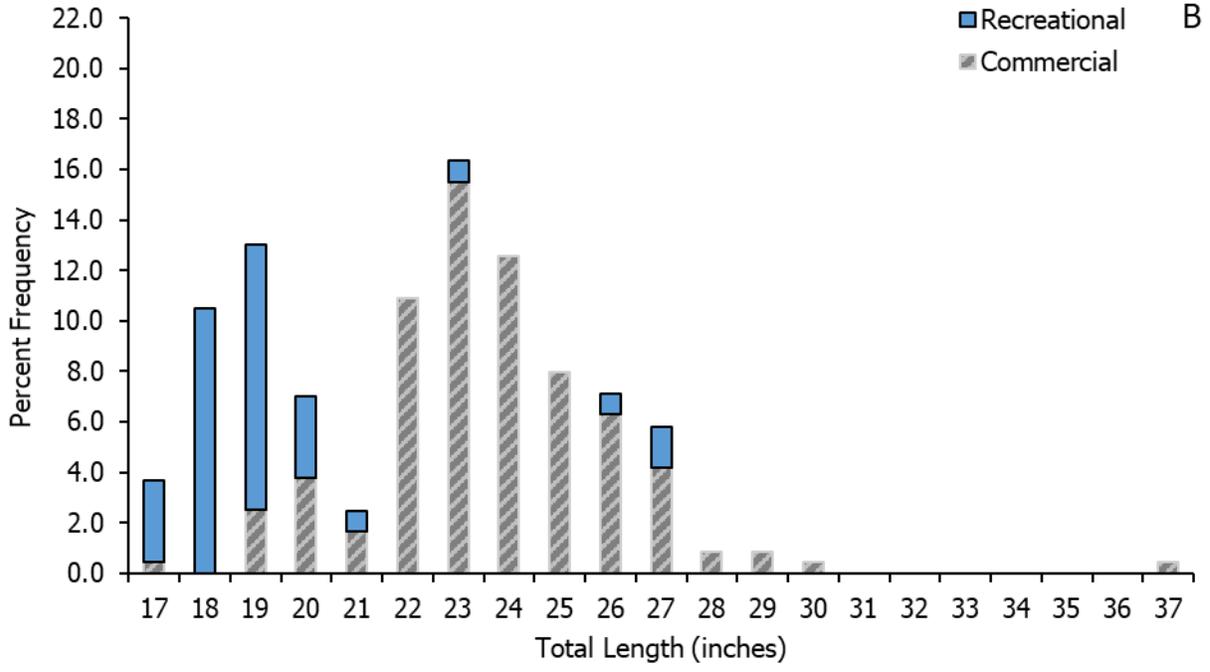
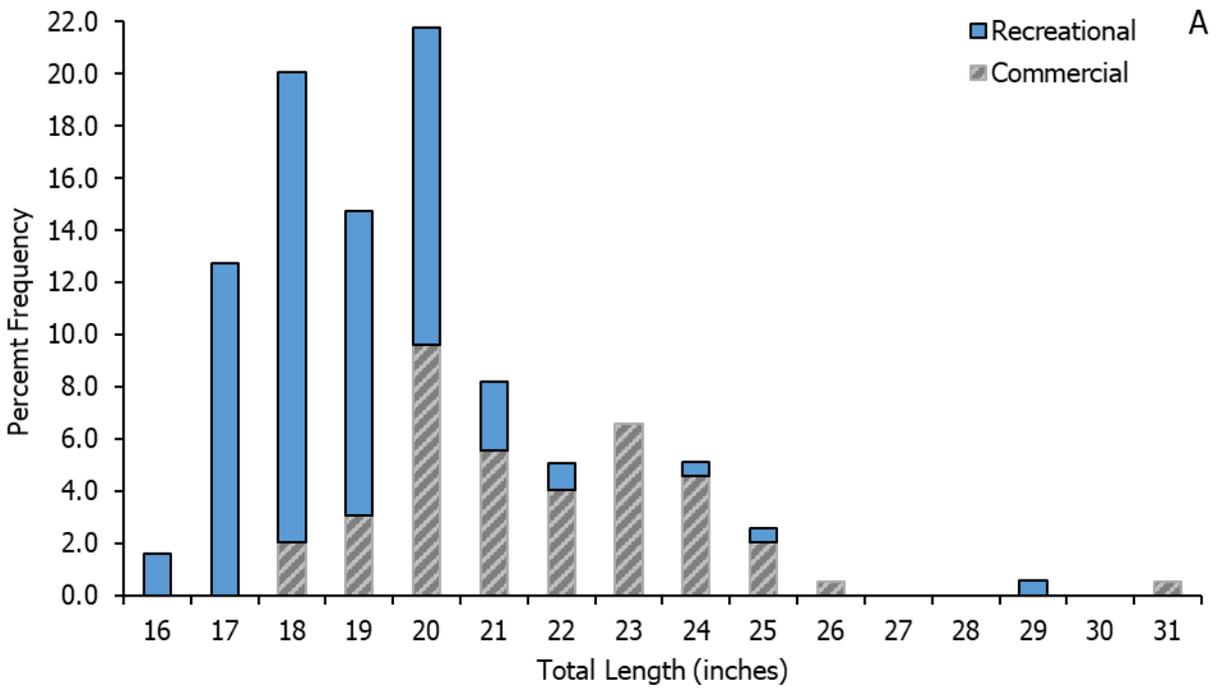


Figure 19. Commercial and recreational length frequency distributions from CSMA striped bass harvested in 2018 from the Tar-Pamlico/Pungo rivers (A) and the Neuse/Bay rivers (B).

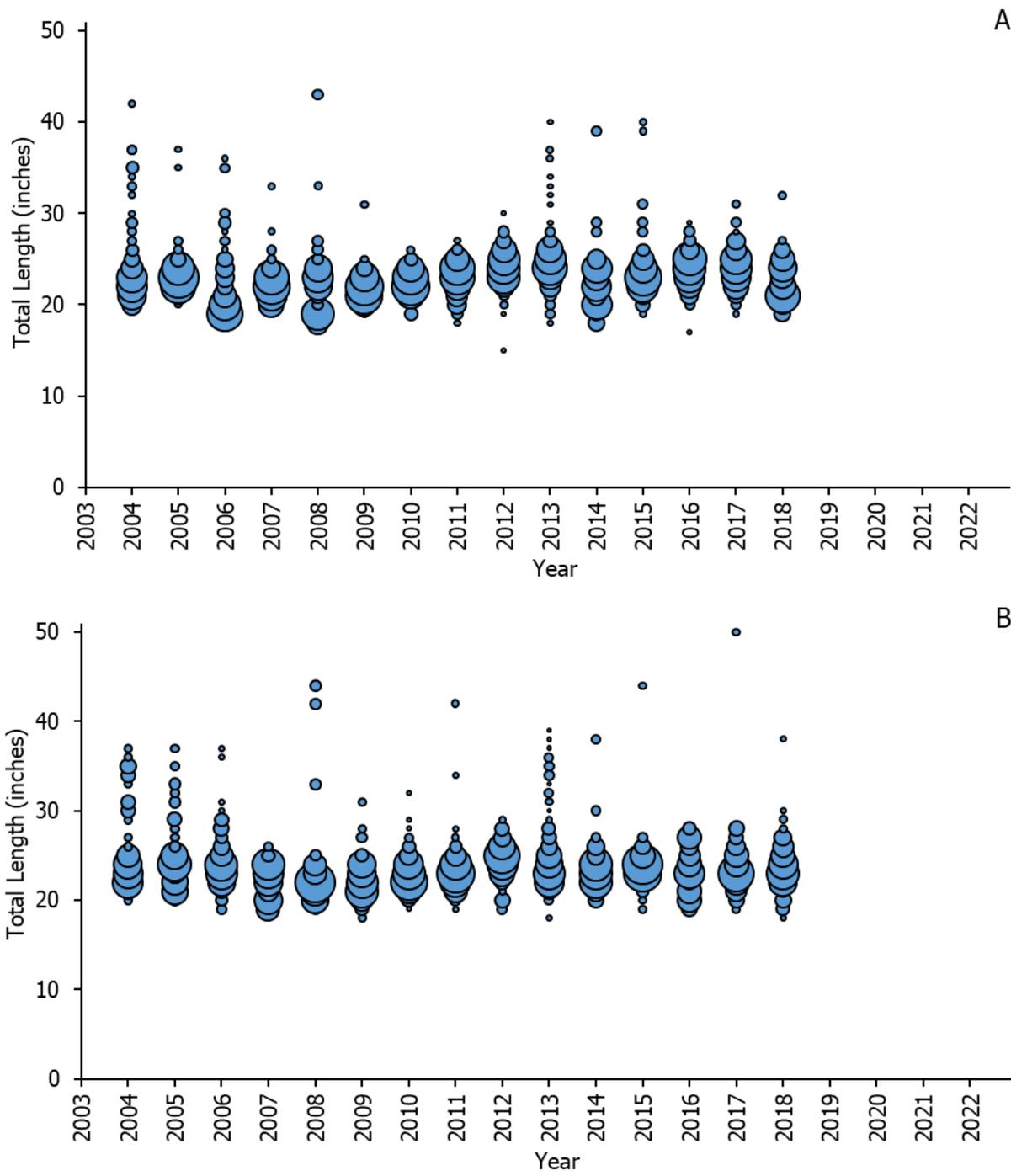


Figure 20. Commercial length frequency of CSMA striped bass landed in the Tar-Pamlico/Pungo rivers (A), and the Neuse/Bay rivers (B) from 2004–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length. The commercial season remained closed in 2022.

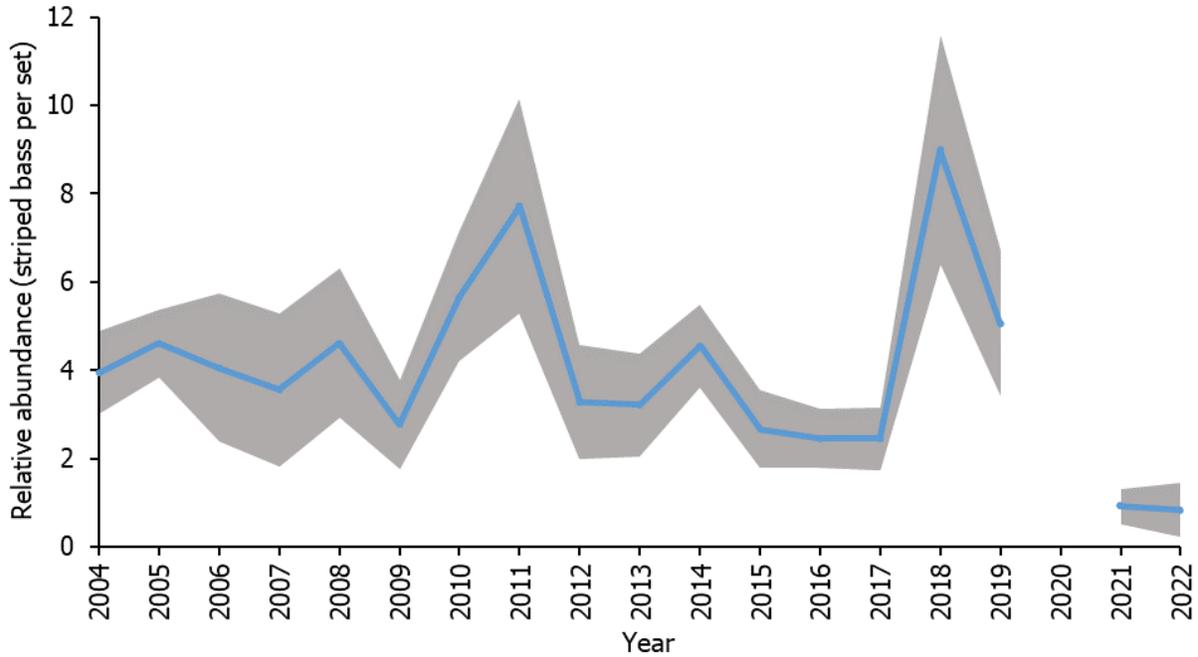


Figure 21. Annual index of adult striped bass relative abundance from the Fisheries Independent Gill Net Survey (P915) in the Tar-Pamlico River during April, and October–November, in shallow water sets, 2004–2022. No sampling occurred in 2020 and limited sampling occurred in 2021 (July–December). Error bars represent  $\pm 1$  standard error.

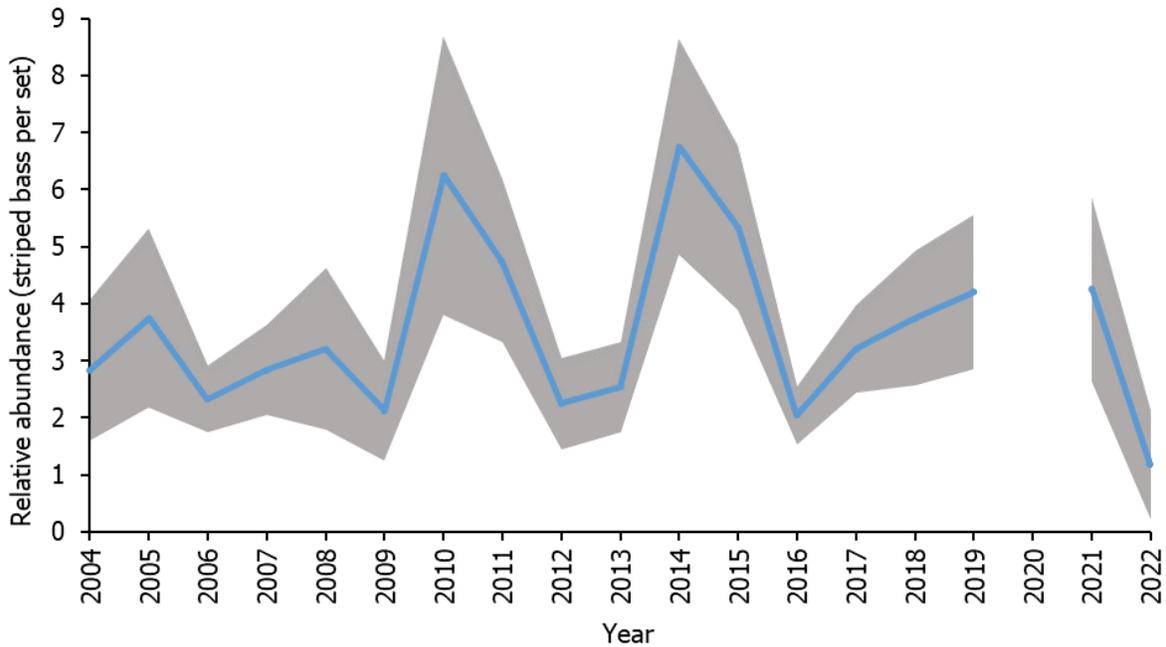


Figure 22. Annual index of adult striped bass relative abundance in the Fisheries Independent Gill Net Survey (P915) in the Neuse River during April, and October–November, in shallow water sets, 2004–2022. No sampling occurred in 2020 and limited sampling occurred in 2021 (July–December). Error bars represent  $\pm 1$  standard error.

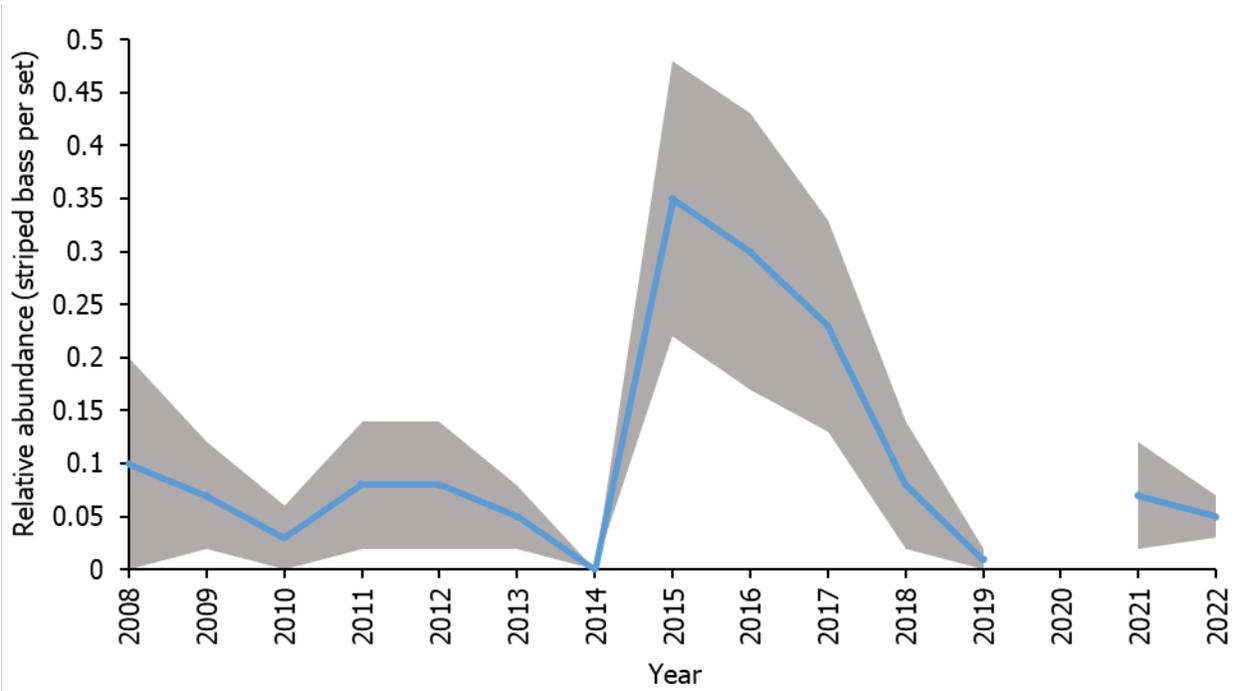


Figure 23. Annual index of adult striped bass relative abundance in the Fisheries Independent Gill Net Survey (P915) in the Cape Fear and New rivers, 2008–2022. No sampling occurred in 2020 and limited sampling occurred in 2021 (July–December). Error bars represent  $\pm 1$  standard error.

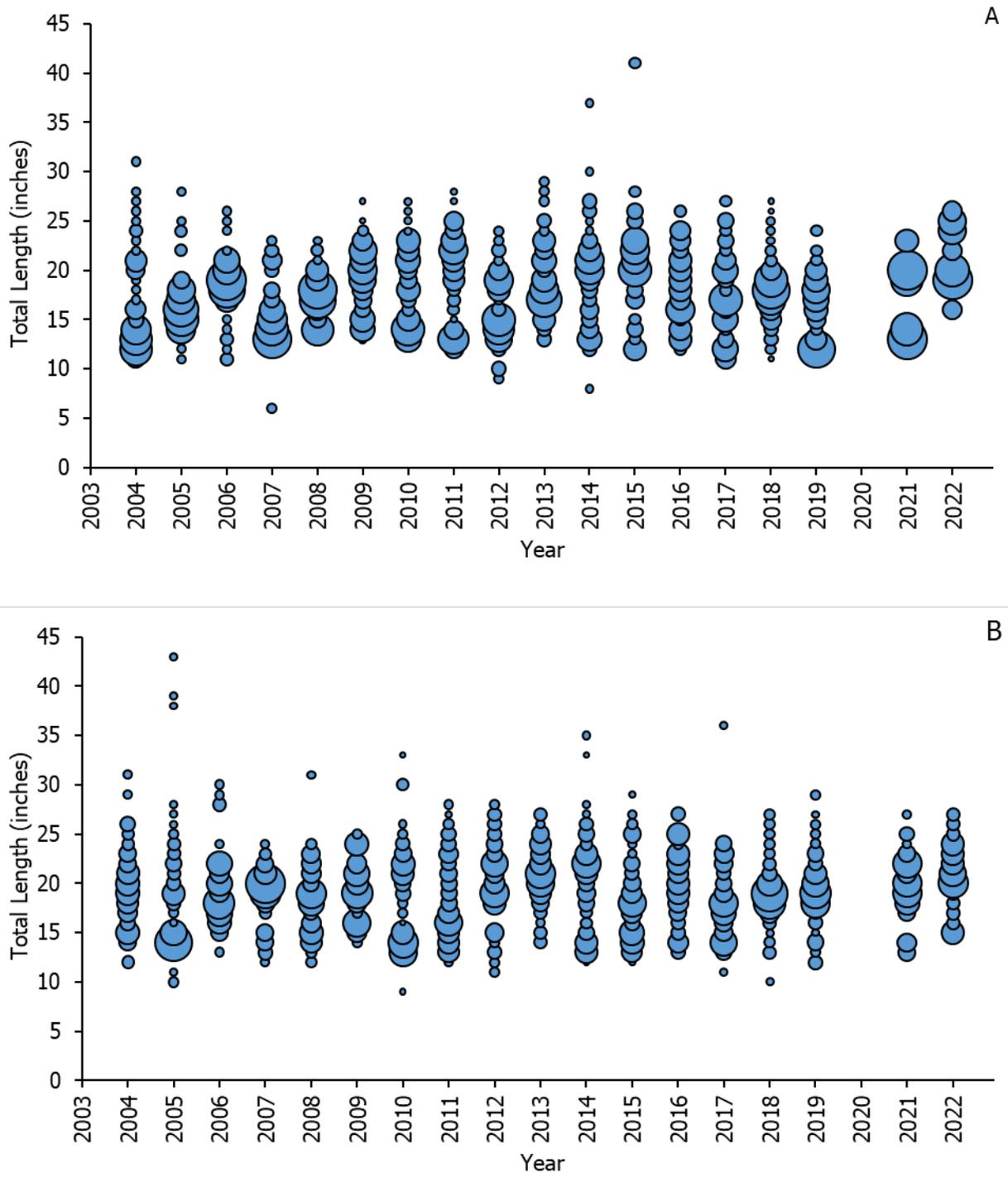


Figure 24. Length frequency of striped bass captured in the Fisheries Independent Gill Net Survey (P915) in the Tar-Pamlico River (A), and the Neuse River (B) during April, and October–November, in shallow water sets (2004–2022). No sampling occurred in 2020 and limited sampling occurred in 2021 (July–December). Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

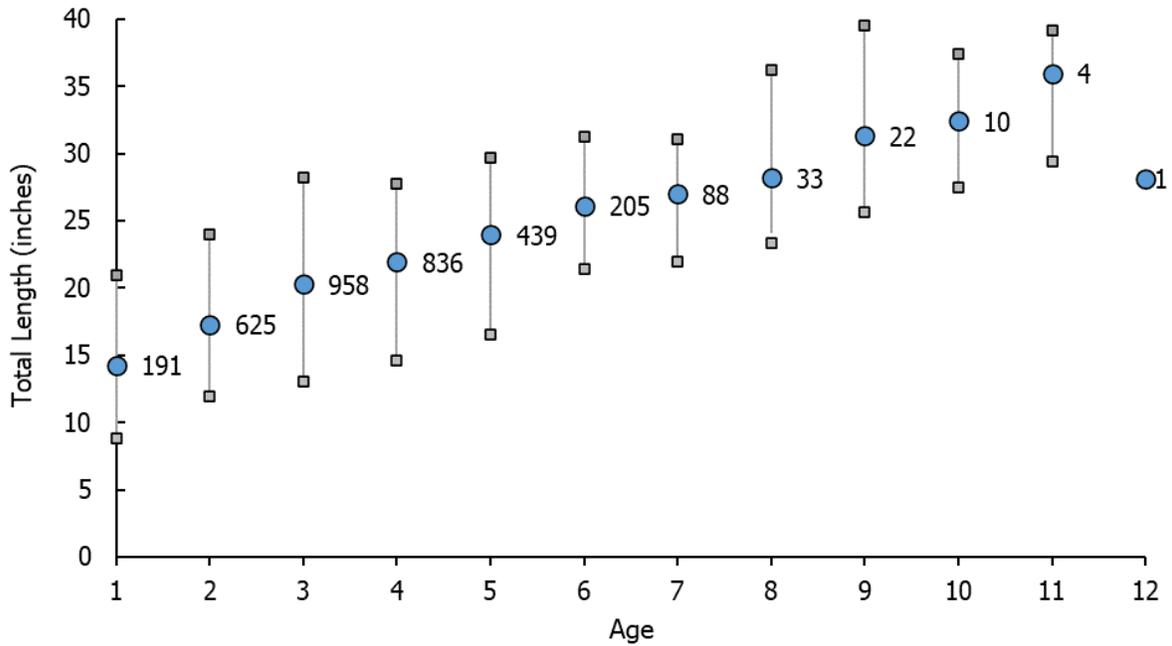


Figure 25. CSMA striped bass length at age based on otolith and genetic age samples collected, 2004–2022. Blue circles represent the mean size at a given age with the number of samples. The grey squares represent the minimum and maximum observed size for each age. Otolith age data from 2022 are considered preliminary, and genetic ages from 2020 - 2022 are not currently available.

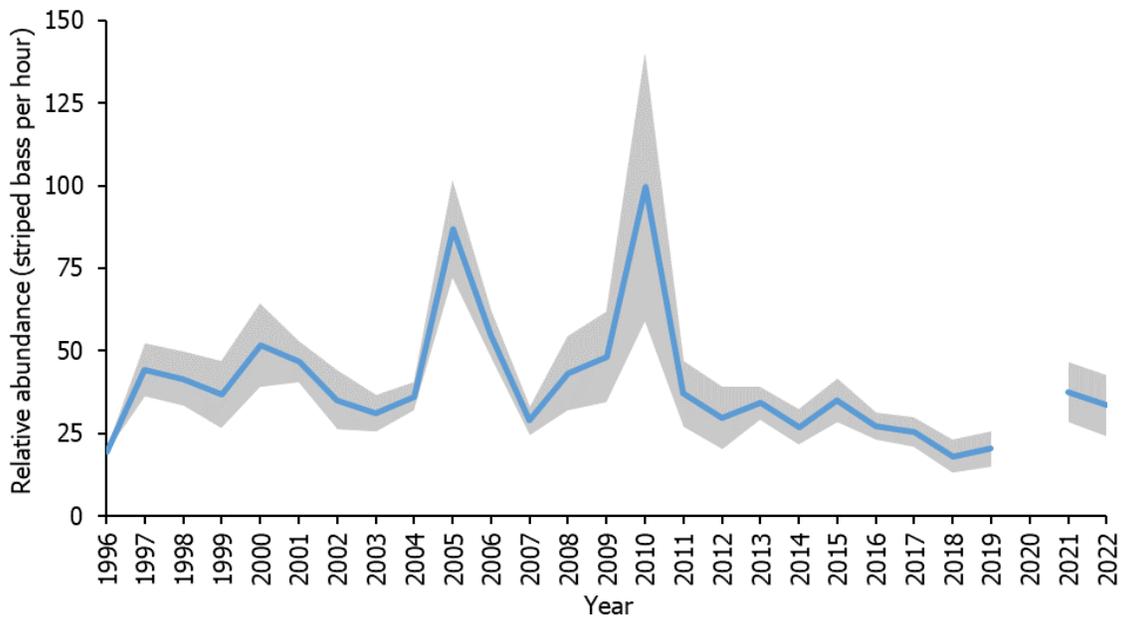


Figure 26. Relative abundance of Tar-Pamlico River striped bass from the WRC spawning grounds electrofishing survey, 1996–2022. No sampling occurred in 2020. Error bars represent  $\pm 1$  standard error.

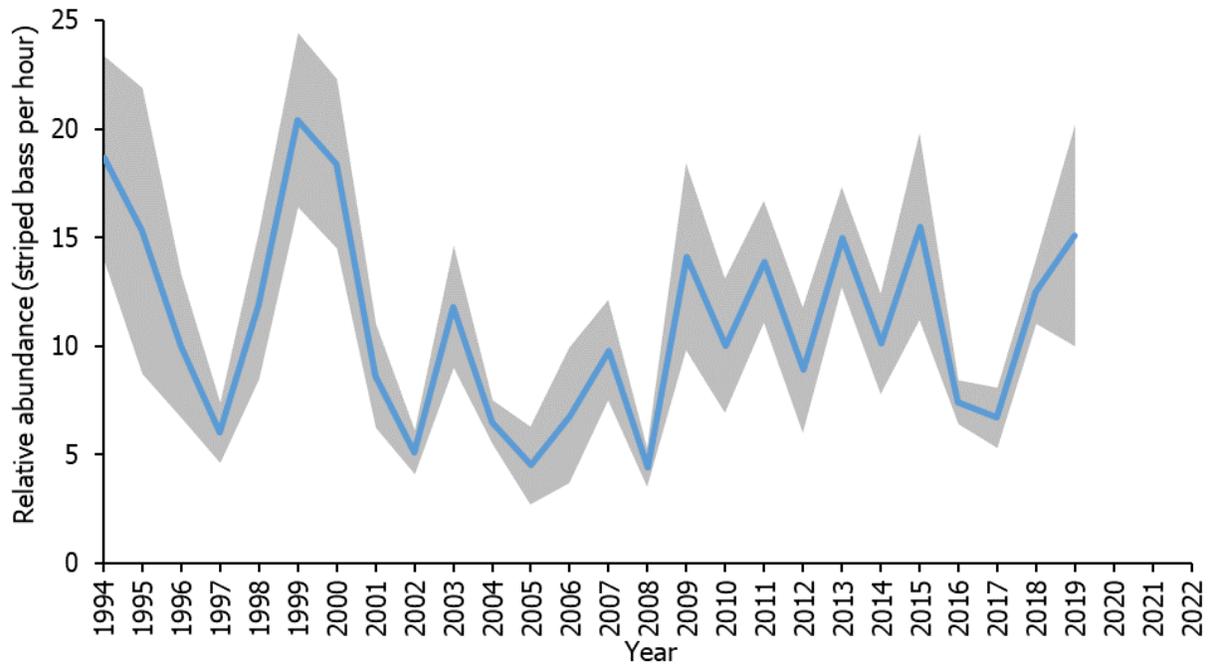


Figure 27. Relative abundance of Neuse River striped bass from the WRC spawning grounds electrofishing survey, 1994–2022. No sampling occurred in 2020, Data are not currently available for 2021 and 2022. Error bars represent  $\pm 1$  standard error.

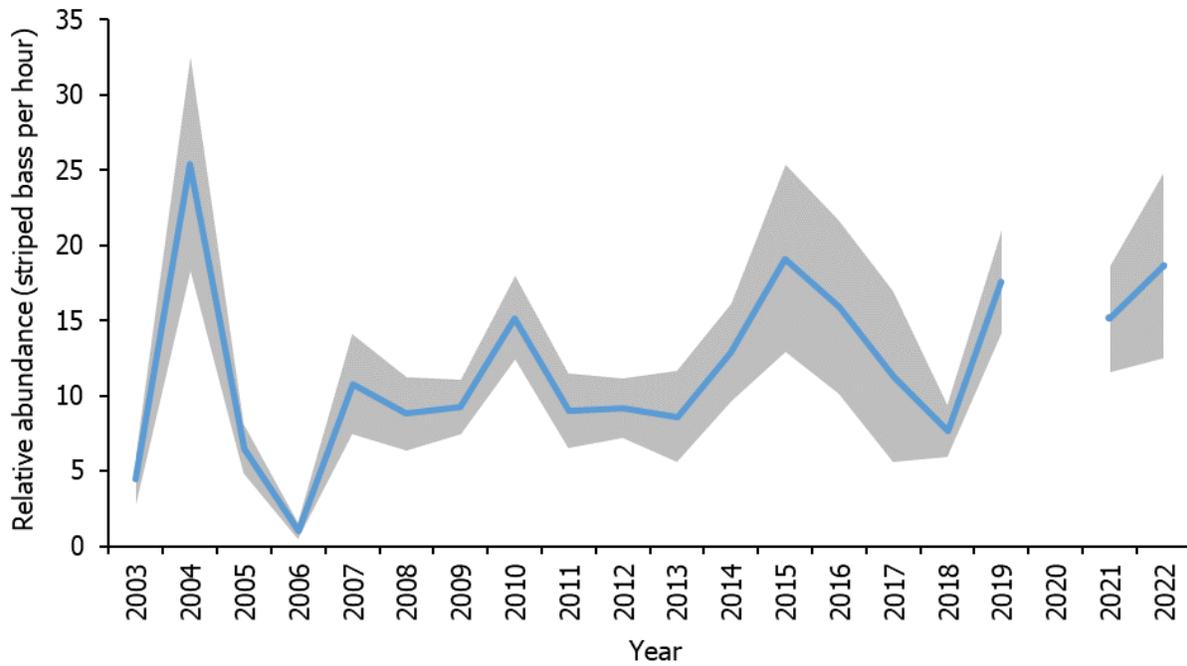


Figure 28. Relative abundance of Cape Fear River striped bass from the WRC spawning grounds electrofishing survey, 2003–2022. No sampling occurred in 2020. Error bars represent  $\pm 1$  standard error.

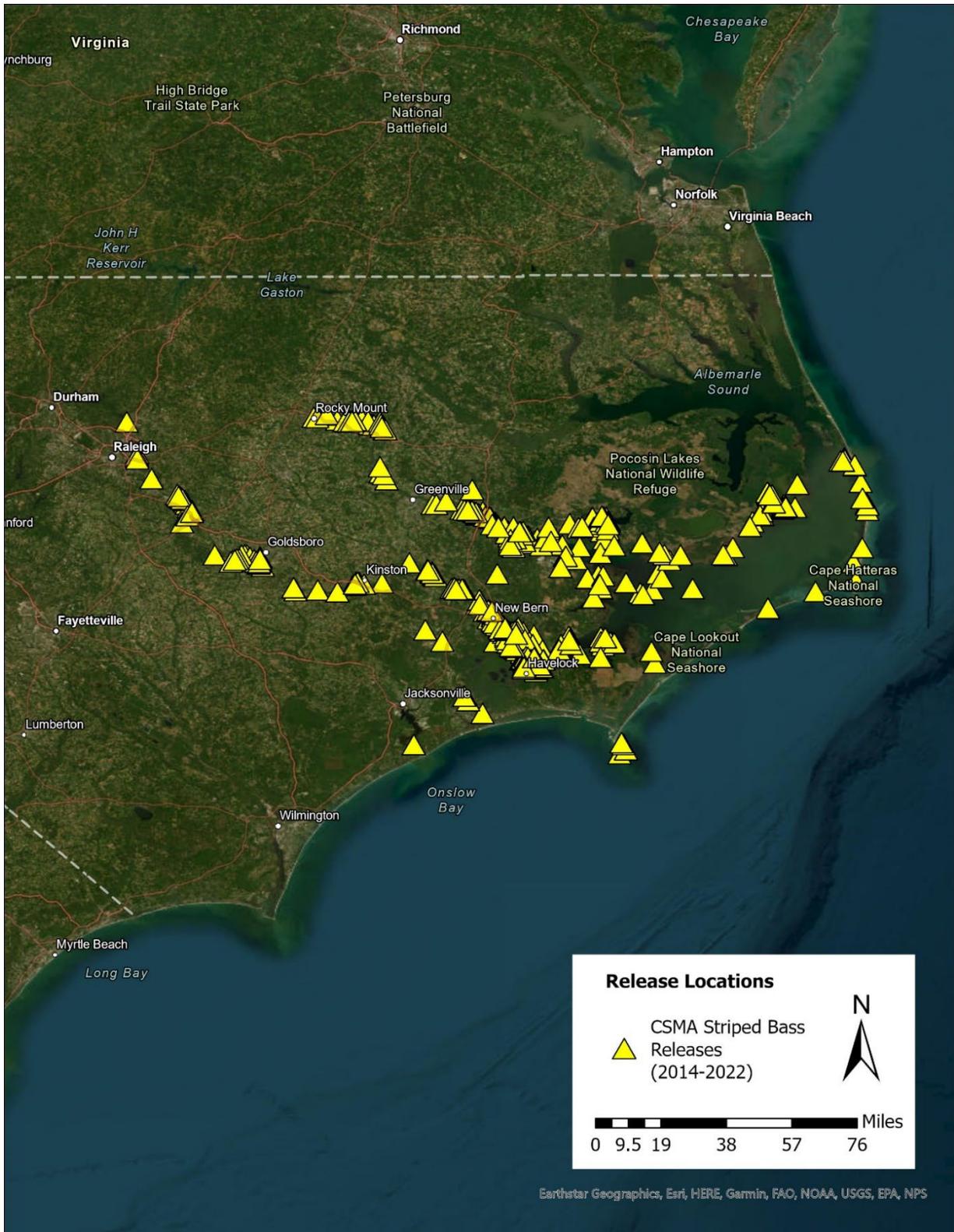


Figure 29. CSMA striped bass tagging release locations, 2014-2022.

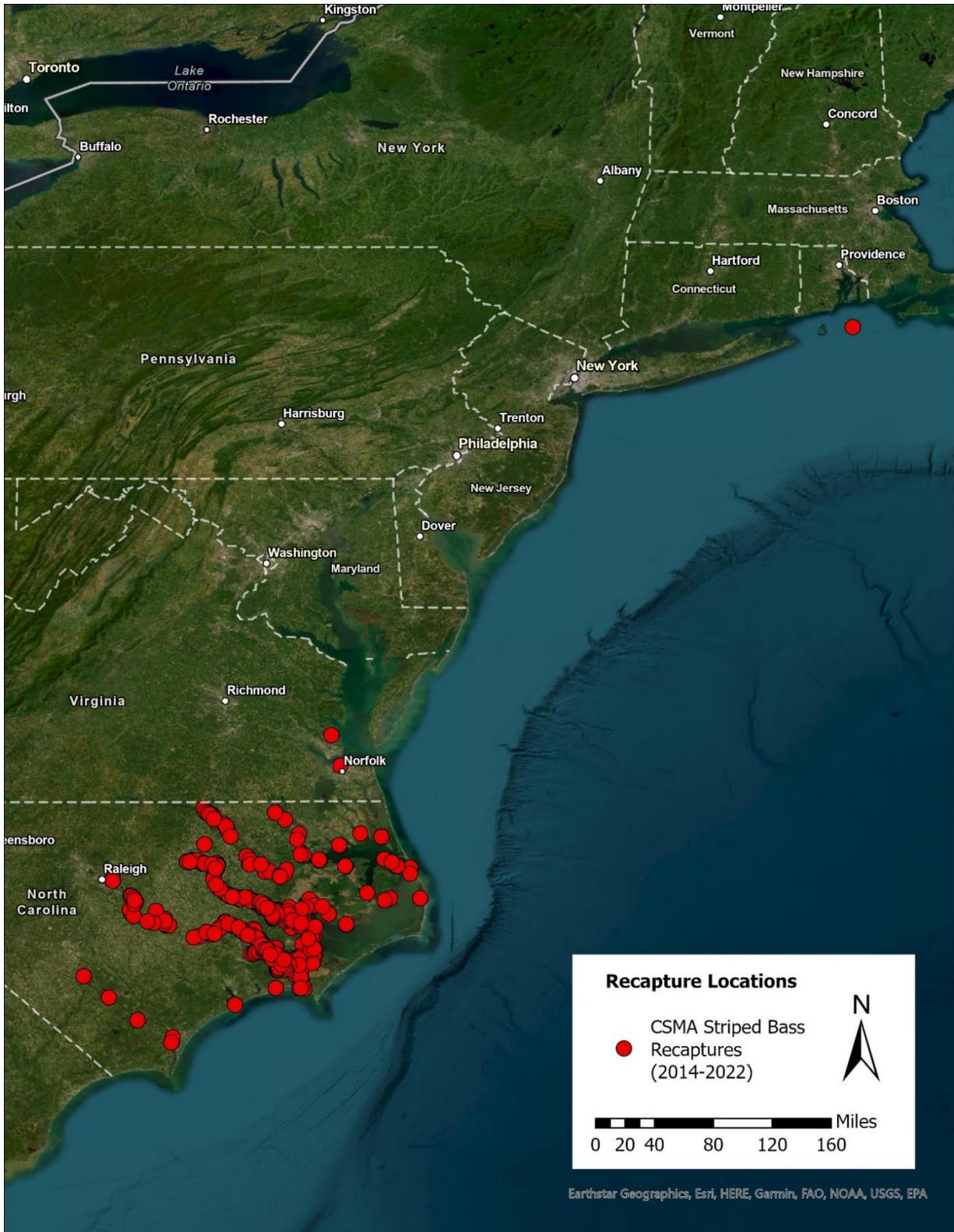


Figure 30. CSMA striped bass tagging recapture locations, 2014-2022.

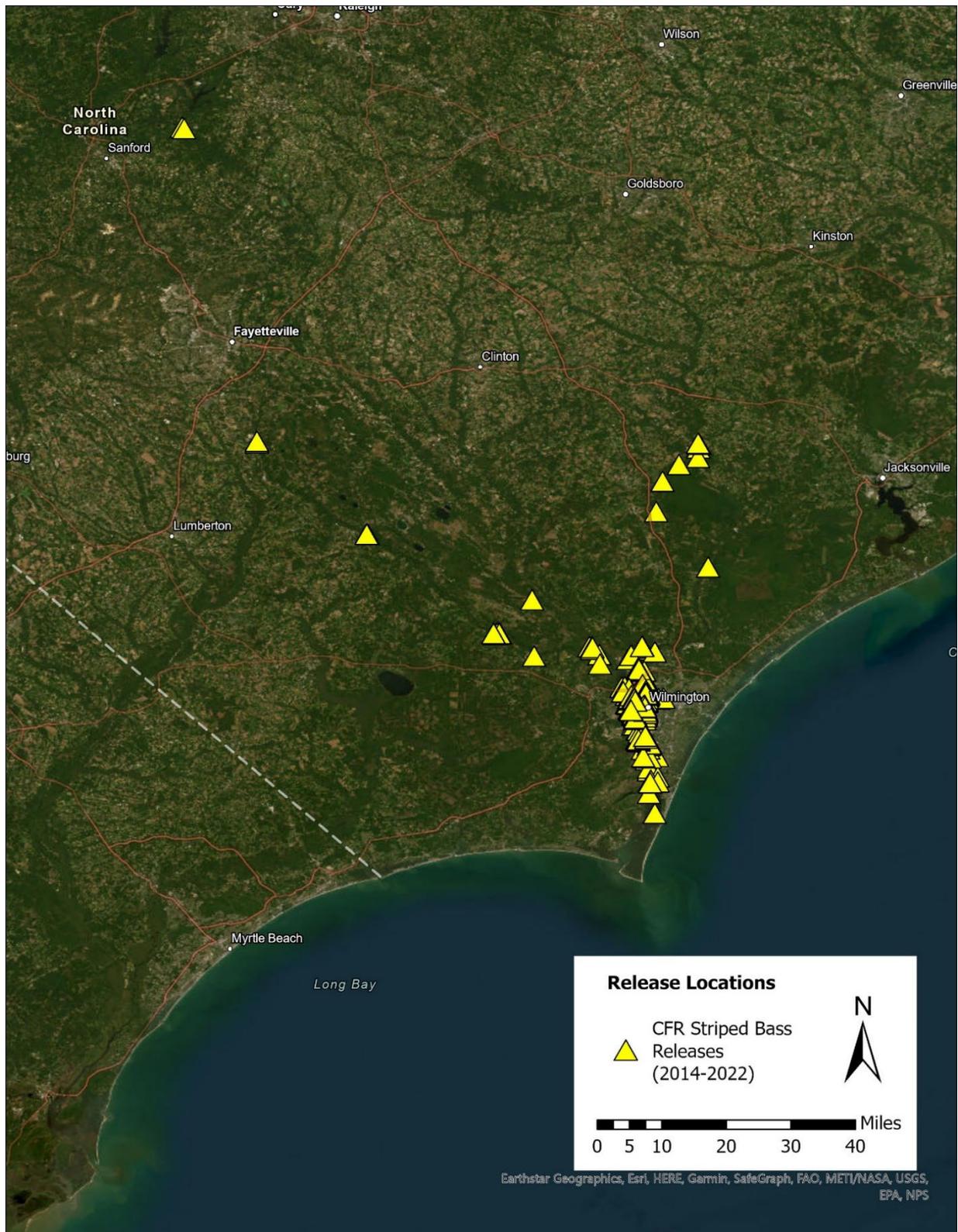


Figure 31. CSMA (Cape Fear River) striped bass tagging release locations, 2014-2022.

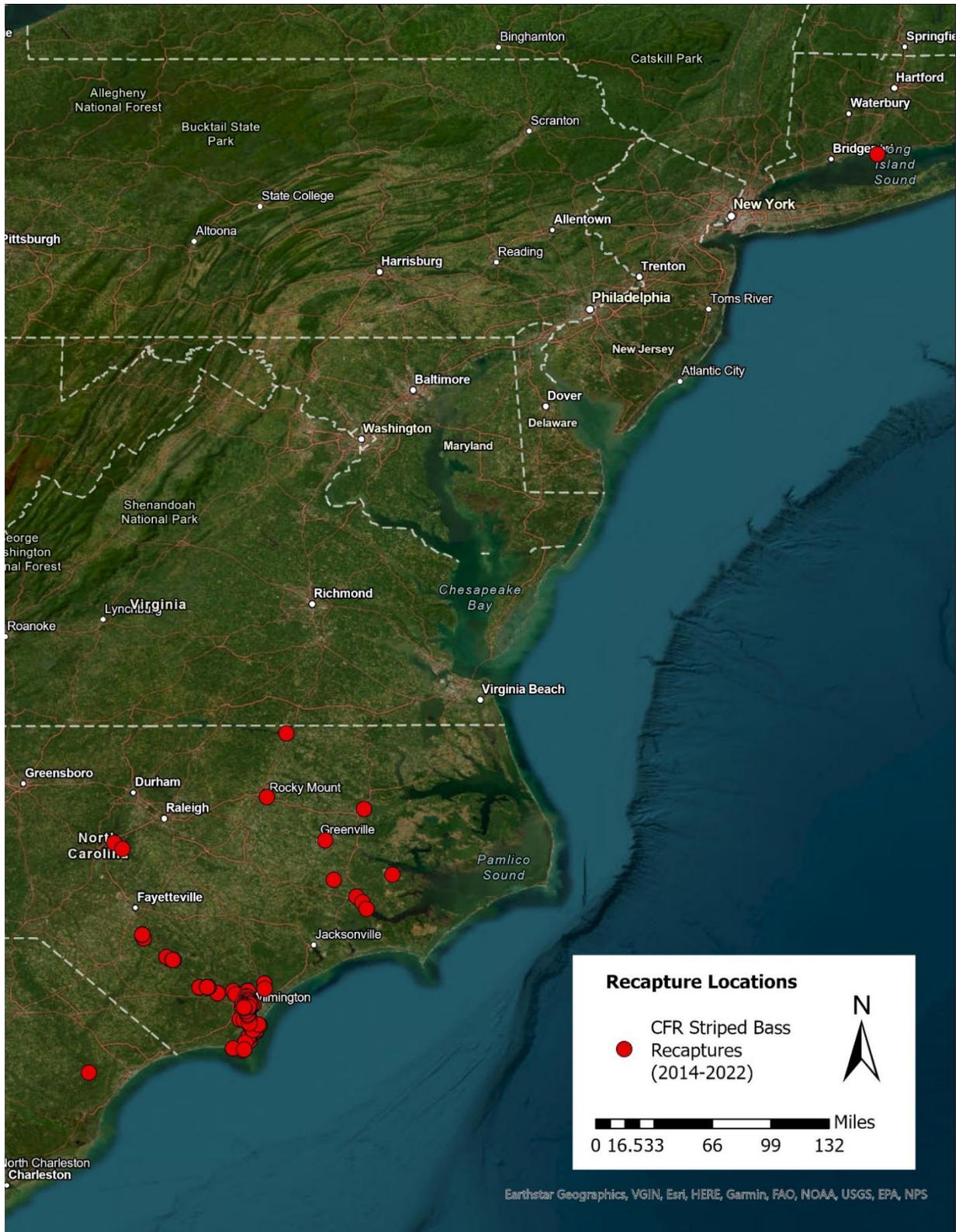


Figure 32. CSMA (Cape Fear River) striped bass tagging recapture locations, 2014-2022.

STATE MANAGED SPECIES – HARD CLAM

**FISHERY MANAGEMENT PLAN UPDATE  
HARD CLAM  
AUGUST 2023**

**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	
Comprehensive 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 (MFC) 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 convictions of theft on shellfish leases and franchises to the types of violations that could result in license suspension or revocation.

Review of the FMP was initiated in 2022, following the FMP review schedule.

## **Management Unit**

Includes the hard clam (*Mercenaria mercenaria*) and its fisheries in all waters of coastal North Carolina.

## **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:

- 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.
- Identify, develop, and promote research to improve the understanding of hard clam biology, ecology, population dynamics, and aquaculture practices.
- Initiate, enhance, and continue studies to collect and analyze economic, social, and fisheries data needed to effectively monitor and manage the hard clam fishery.
- Identify, develop, and promote efficient hard clam harvesting practices while protecting habitat.
- Promote the protection, restoration, and enhancement of habitats and water quality so that the production of hard clams is optimized.
- Consider the socioeconomic concerns of all hard clam resource user groups, including market factors.
- Promote public awareness regarding the status and management of the North Carolina hard clam stock.

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

Hard clams are mostly estuarine-dependent, filter-feeding shellfish found in sandy and vegetated bottoms from Prince Edward Island, Canada to the Yucatan Peninsula, Mexico (Eversole et al. 1987). Spawning occurs from May through November when water temperatures are between 68 degrees and 86 degrees Fahrenheit (Loosanoff and Davis 1950). 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 shell length of about 1.3 inches, and the timing is therefore dependent on the rate of growth (Eversole et al. 1987). 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.

## **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.

Data limitations prevent the North Carolina Division of Marine Fisheries (DMF) 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.

Data were obtained from the North Carolina Trip Ticket Program for 1994 through 2013. 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, 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.

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 DMF, 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 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**

A stock assessment is not available for this species.

## DESCRIPTION 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.

### 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 of submerged aquatic vegetation or in an established bed of saltwater cordgrass.

The public mechanical hard clam harvest season can occur from December 1 through March 31 and is opened by proclamation in specific locations. The mechanical harvest season usually begins the second Monday in December and extends through the week of March 31st. Harvest is allowed 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 include 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 were 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. A 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 area

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.

### 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 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 DMF. 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 Fishery**

Hard clam harvest has fluctuated historically, often in response to changes in demand, improved harvesting, and increases in polluted shellfish area closures. Since 2007 about 90% (2007-2016 combined estimates; NCDMF 2017) of the total commercial hard clam harvest came 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 environmental impacts to clam harvest occurred in 1987-1988 due to red tide. The red tide bloom caused the closure of over 361,000 acres of public bottoms to shellfish harvest from November 1987 to May 1988. These closures affected 98% 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.

Seventeen hurricanes 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 periods. Hard clams are a live product and must go to market relatively quickly after harvest. Competition with hard clams grown in private culture from other states is 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 1994-2022 was 22.4 million clams (Figure 1). Annual landings in 2022 were the third lowest in the 29-year period at 4.4 million clams. This continues the trend of the low harvest levels seen in 2020 and 2021. There has been a steady decline in commercial landings since the early 2000s. The landings during the last ten years are roughly one third of the peak seen from 1994-2001.

### Hand Harvest Fishery

Hand harvest is a year-round fishery and has average landings of 17.6 million clams a year (1994-2022; Figure 2; NCDMF 2017). Most hand harvest for clams occurs in the spring and summer when warm water is conducive to wading. Annual hand harvest for hard clams has declined steadily over the 25-year time series to its third lowest level of 4.0 million clams in 2022 (Figure 2; NCDMF 2017).

### Mechanical Harvest Fishery

Hard clam landings from mechanical methods have averaged 3.9 million clams each fishing year (1994-2022; 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% of the total mechanical harvest landings are from this area (NCDMF 2017).

### Private Culture

The DMF administers the shellfish lease program whereby state residents may apply to lease estuarine bottom and water columns for the commercial production of shellfish. The DMF does not differentiate between clam, oyster, bay scallop, and mussel leases; allowing shellfish growers to grow out multiple species simultaneously or as their efforts and individual management strategy allows. Since 1994, roughly 35% of all private culture operations harvested only clams (NCDMF 2017).

Private enterprise has provided roughly 13.9% of the total commercial hard clam harvest in North Carolina between 1994 and 2022 (Figure 3). The annual average hard clam landings from 1994 to 2022 from private production were 2.7 million clams. In 2022, harvest from private culture was 0.60 million clams, the second lowest in the 29-year time series.

## **Recreational Fishery**

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). Harvest and catch rate have been declining since 2013 (Figure 4). In 2022 recreational harvest was roughly one half of that in 2020 and only 30% of the time series average.

## **MONITORING PROGRAM DATA**

### **Fishery-Dependent Monitoring**

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.

The number of hard clam shell lengths from fishery dependent sources from 1999 through 2022 ranged from 304 in 2005 to 10,670 in 2011 (Table 3). Mean shell length has ranged from 35 mm (1.2 inches) in 2004 to 40 mm (1.6 inches) in 2008, 2017, 2018, and 2019, with a minimum shell length of 20 mm (0.8 inch) to a maximum shell length of 82 mm (3.2 inches) for clams measured from the commercial fishery (Table 3).

The modal shell length of hard clams caught in the commercial fishery remained the same as 2021 at 1.5 inches in 2022 (Figure 5).

### **Fishery-Independent Monitoring**

A fisheries-independent monitoring program (Program 640) in Core Sound to provide baseline data on hard clam abundance and gather environmental information has been ongoing since 2007 (Table 4). 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 in August 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.

Very few hard clams are caught in this program due to the nature of the gear and random stratified sampling design. The relative abundance, or number of clams per station, has ranged annually from 0.1 clams per station in 2020 and 2022 to 1.27 clams per station in 2009 (Table 4). No trend is apparent from this sampling and new fishery-independent programs for monitoring relative abundance of hard clams are being considered by the division (Figure 6).

## **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 High or Medium. A lower 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:

### **High**

- Develop hard clam sampling methodology to monitor regional adult abundance.
- Map and characterize hard clam habitat use by bottom type.
- Develop a survey to better quantify recreational harvest.

### **Medium**

- Determine natural mortality estimates.
- Survey commercial shellfish license holders without a record of landings to estimate hard clam harvest from this group.

## **MANAGEMENT STRATEGY**

There are no management triggers or methods to track stock abundance, fishing mortality, or recruitment between benchmark reviews of the 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 effective 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 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 hard clams on a vessel, during transport to a dealer, or storage on a dock from June through September.

See Table 5 for FMC selected management options under Amendment 2.

**FISHERY MANAGEMENT PLAN SCHEDULE RECOMMENDATIONS** Review of the FMP was initiated in 2022, following the FMP review schedule.

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## TABLES

Table 1: Current daily mechanical hard clam harvest limits by water body. Season can 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	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.

Table 2. Estimated number of trips, number of clams harvested, and catch rate (clams per trip) per year of Coastal Recreational Fishing License holders, 2010–2022.

Year	Number Trips	Clam Harvest	Catch Rate
2010*	528	8,731	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
2018	2,362	26,769	11.3
2019	5,088	114,042	22.4
2020	6,557	62,164	9.5
2021	1,765	15,471	8.8
2022	6,628	28,241	4.3

\*Partial year of sampling

Table 3. Observed annual mean, minimum and maximum shell length (inches) of hard clams measured from commercial catches at the dealer, 1999–2022.

Year	Mean Shell Length	Min Shell Length	Max Shell Length	Total Number Measured
1999	1.5	0.9	3.0	3,999
2000	1.4	0.9	2.8	2,137
2001	1.5	0.9	3.1	3,265
2002	1.4	0.9	2.2	1,900
2003	1.4	0.8	2.2	836
2004	1.5	0.9	2.2	1,212
2005	1.5	1.1	3.2	304
2006	1.5	1.0	2.9	1,540
2007	1.5	1.0	2.5	1,405
2008	1.6	0.9	2.6	1,383
2009	1.5	1.0	2.7	1,859
2010	1.5	0.9	2.5	5,358
2011	1.5	0.8	2.6	10,670
2012	1.4	0.9	2.5	5,851
2013	1.5	0.8	2.6	4,750
2014	1.4	0.9	2.6	7,444
2015	1.4	0.8	2.6	6,216
2016	1.4	0.9	2.4	6,454
2017	1.6	0.9	2.6	3,420
2018	1.6	1.0	2.5	1,946
2019	1.6	0.9	2.6	1,786
2020	1.5	0.9	2.3	684
2021	1.5	0.7	2.2	646
2022	1.5	1.0	2.3	418

Table 4. Fishery independent hard clam sampling (Program 640) annual estimates of relative abundance (number of clams per station) and their standard deviations, 2007–2022 for Core Sound.

Year	Total number of stations	Number of stations with zero catch	Number of clams	Relative Abundance (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
2018	30	23	8	0.27	0.52
2019	30	23	9	0.30	0.13
2020	30	27	3	0.10	0.31
2021	30	27	6	0.20	0.76
2022	30	27	3	0.10	0.31

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

Management Strategies	Implementation Status
<b>MANAGEMENT OF PUBLIC BOTTOM</b>	
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
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
<b>PRIVATE CULTURE</b>	
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
<b>ENVIRONMENT AND PUBLIC HEALTH</b>	
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

## FIGURES

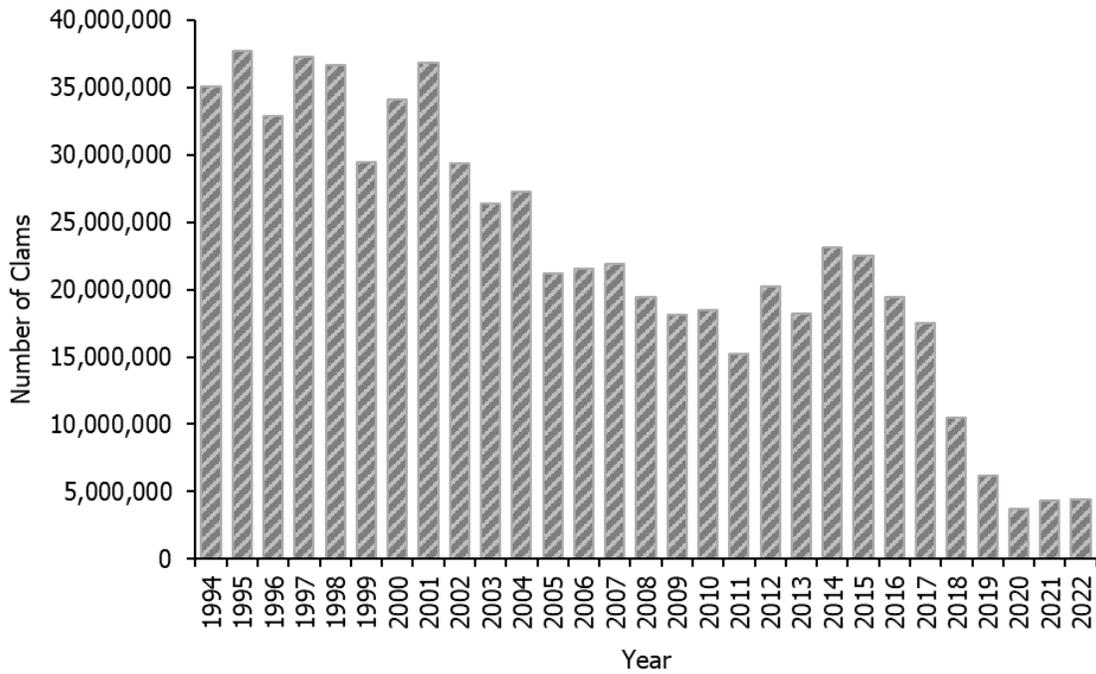


Figure 1. Combined annual commercial (1994–2022) hard clam landings (number of clams) from private and public bottom in North Carolina.

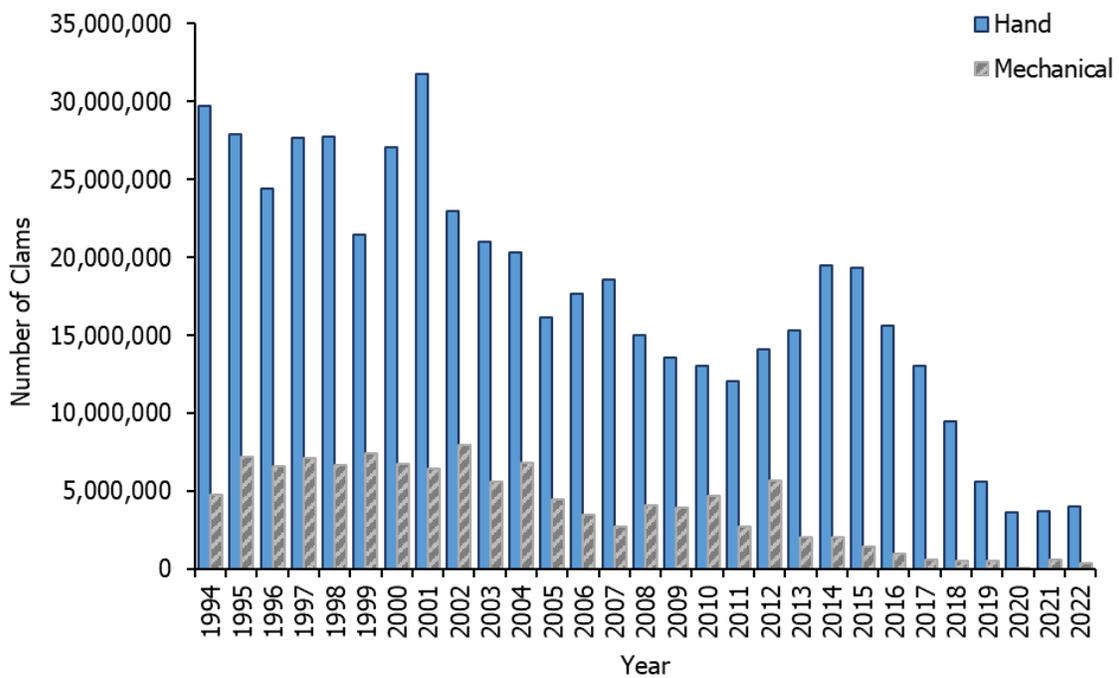


Figure 2. Annual hard clam landings (Number of clams) from hand and mechanical harvest in North Carolina, 1994–2022.

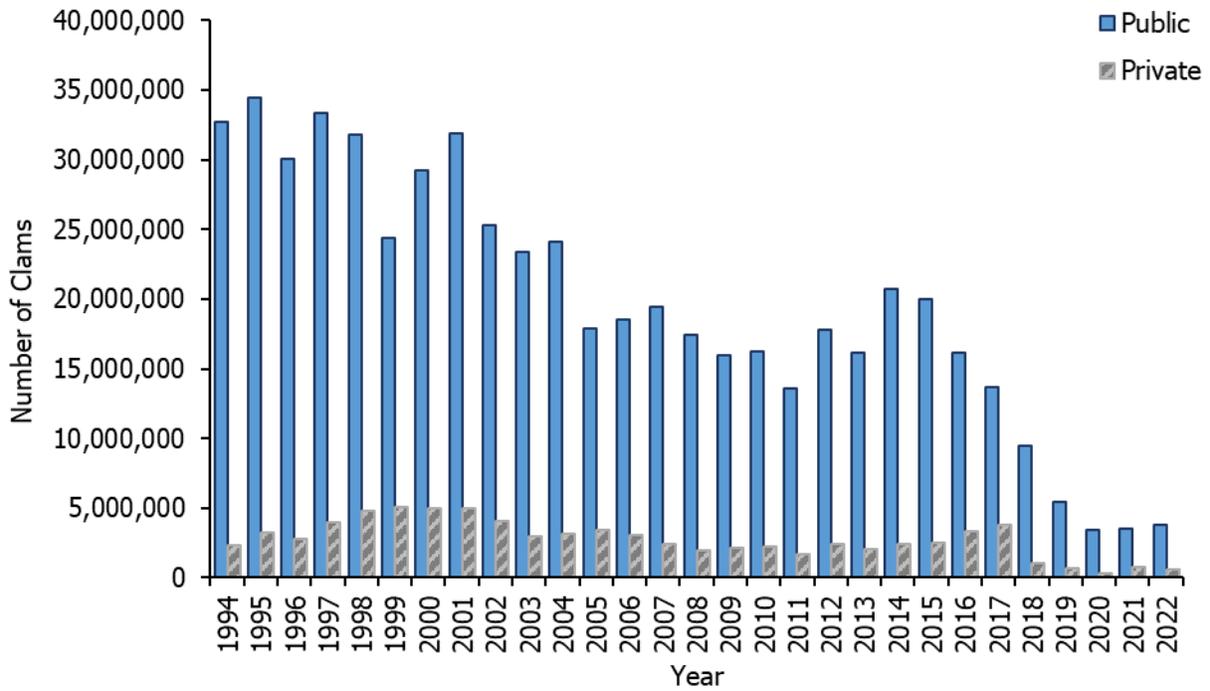


Figure 3. Annual hard clam landings (Number of clams) from private and public bottom, 1994–2022.

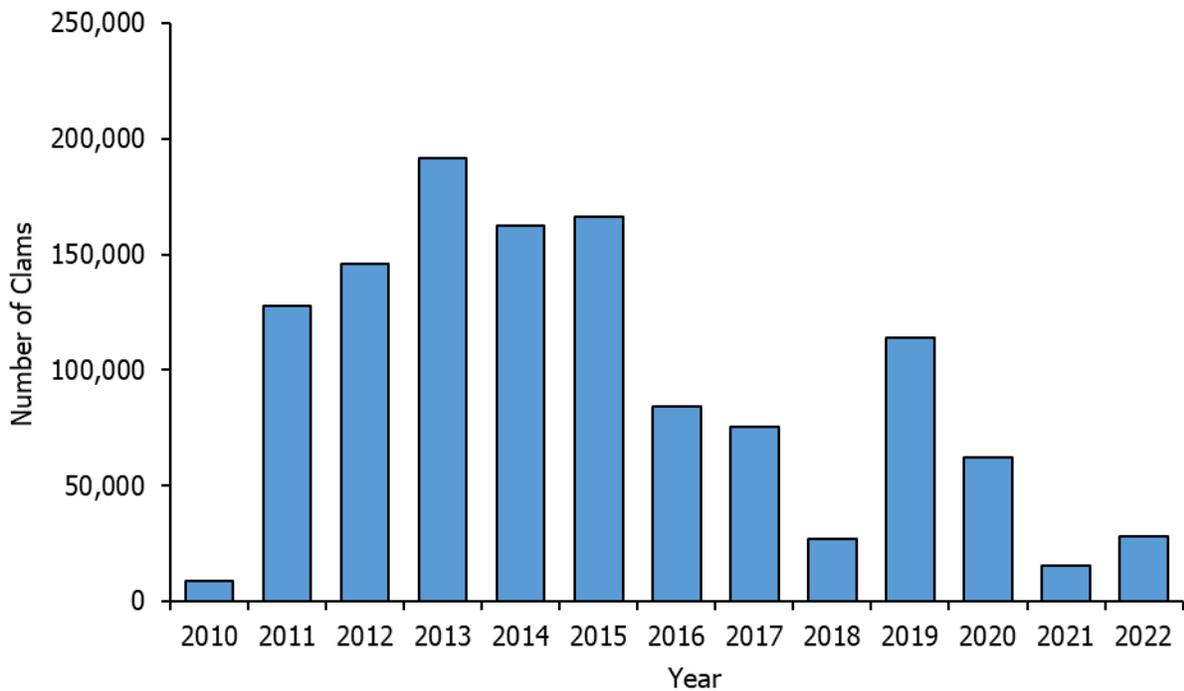


Figure 4. Annual recreational hard clam landings (number of clams) in North Carolina, 2010–2022. Data from 2010 represent a partial year of sampling.

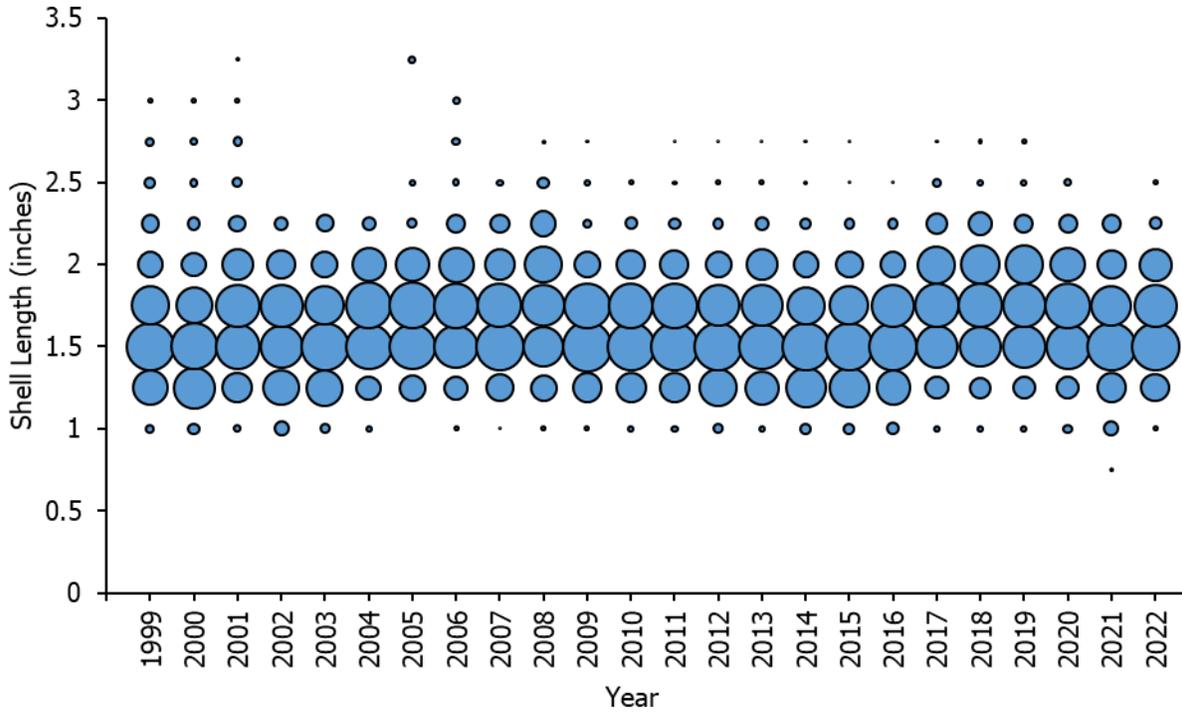


Figure 5. Length frequency (shell length, inches) of hard clams harvested, 1999–2022. Bubbles represent clams at length and the bubble size is proportional to the number of clams at that length.

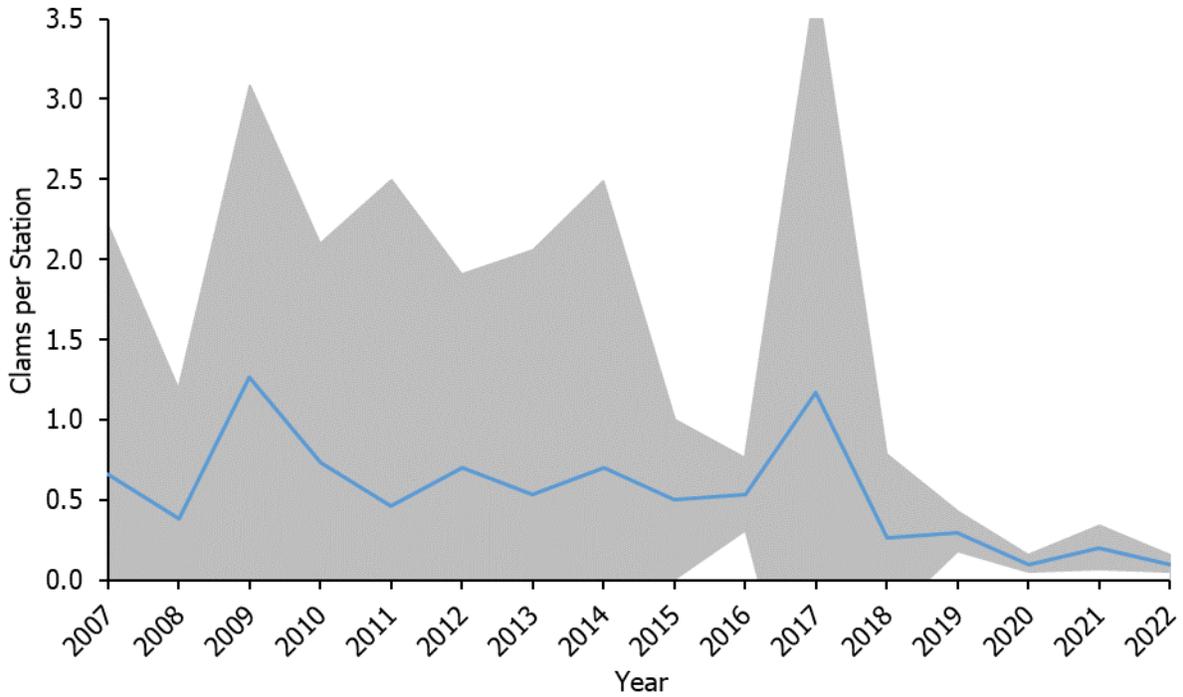


Figure 6. Annual catch per unit effort (Number of clams per stations) of hard clams in Core Sound from fishery independent sampling (Program 640), 2007–2022. Shaded area represents standard error.

## STATE MANAGED SPECIES – KINGFISHES

### FISHERY MANAGEMENT PLAN UPDATE KINGFISHES AUGUST 2023

#### STATUS OF THE FISHERY MANAGEMENT PLAN

##### Fishery Management Plan History

Original FMP Adoption:	November 2007
Amendments:	None
Revisions:	None
Supplements:	None
Information Updates:	December 2015 August 2020
Schedule Changes:	None
Comprehensive Review:	2025

The original 2007 North Carolina Kingfish Fishery Management Plan (FMP) developed management strategies that ensure a long-term sustainable harvest for recreational and commercial fisheries in 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 N.C. Kingfish FMP in November 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 the 2015 Information Update. The annual FMP Update in 2020 served as the formal review of the N.C. Kingfish FMP. The next review will begin in July 2025.

##### Management Unit

The N.C. Kingfish FMP includes the kingfishes in all coastal fishing waters of North Carolina. The fishery includes three species: southern kingfish (*Menticirrhus americanus*), gulf kingfish (*M. littoralis*), and northern kingfish (*M. saxatilis*). 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. For this reason, a state-specific stock assessment cannot be conducted, and a regional stock assessment approach is recommended as the most appropriate mechanism for determining stock status and the long-term viability of these stocks (NCDMF 2007).

## **Goal and Objectives**

The goal of the 2007 N.C. Kingfish FMP was to determine the health of the stocks and ensure the long-term sustainability of the kingfish stocks in North Carolina (NCDMF 2007). To achieve this goal, it is recommended that the following objectives be met:

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

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

Three species of kingfishes occur in North Carolina: southern, gulf, and northern. 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 stocks of kingfish are unassessed, thus overfishing and overfished status cannot be determined. 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**

A quantitative stock assessment is not available for kingfishes 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 kingfishes 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, kingfishes management in North Carolina continues to fall solely within the framework of the state FMP process.

The 2007 Kingfish FMP selected the use of trend analysis with management triggers as the management strategy to monitor the viability of the kingfish stocks in North Carolina (NCDMF 2007). During the review of the 2007 N.C. Kingfishes FMP as part of the 2015 FMP Information Update and 2020 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 the 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 based on southern kingfish use fishery independent indices of relative abundance for young-of-year (YOY), adult fish, the proportion of catch greater than size at 50% maturity (L50), and a relative fishing mortality index. Young-of-year fish includes new fish that enter the population that year. The L50 is the length at which 50% of the adult population is sexually mature and ready to spawn.

## **DESCRIPTION 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 kingfishes in any other fisheries.

### **Commercial Fishery**

Commercial landings for kingfishes include southern, northern, and gulf kingfishes combined. Landings have fluctuated historically but have been increasing since 2020. In 2022, landings (838,753 lb) increased 4 percent from 2021 (808,049 lb; Table 1; Figure 1). The average landings from 2013 to 2022 was 751,759 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 Fishery**

Recreational landings of kingfishes are estimated from the Marine Recreational Information Program (MRIP). Recreational estimates across all years have been updated and are now based on the new Fishing Effort Survey-based calibrated estimates. For more information on MRIP see <https://www.fisheries.noaa.gov/topic/recreational-fishing-data>.

Recreational landings for kingfishes include southern, northern, and gulf kingfishes. Total recreational landings fluctuate but have been generally increasing since 2006. The low landings year in 2018 was likely due to impacts from Hurricane Florence. In 2022, recreational landings (1,268,065 lb) decreased 77% from 2021 (5,676,092 lb; Table 1; Figure 1). Recreational landings in 2022 were the highest on record (previous high was 3,425,201 lb in 2014). Most kingfishes are landed from the ocean and 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 by anglers fishing from private vessels. Recreational harvest of kingfishes is seasonal with most fish harvested during the spring and the fall, and lowest during the summer.

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. Citations awarded through the North Carolina Saltwater Fishing Tournament for kingfishes have varied by year throughout the time series, averaging 234 citations (Figure 2). The number of awarded citations in 2022 (74 citations) decreased from the previous year (120 citations). The decrease in 2021 may be partially due to the increase in weight required to qualify for a citation from one and one-half pounds to two pounds on beginning May 1, 2021.

## **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 North Carolina. A total of 29,915 kingfishes were measured from 2013 to 2022 (25,878 southern, 2,104 northern and 1,933 gulf; Table 2; Figure 10). Mean total length for southern kingfish ranged from 11.4 to 12.1 inches, with a minimum of 6.5 inches and a maximum of 24.8 inches. Mean length for northern kingfish ranged from 12.1 to 13.9 inches, with a minimum of 8.6 inches and a maximum of 18.6 inches. Mean length for gulf kingfish ranged from 12.0 to 12.9 inches with a minimum of 6.4 inches and a maximum of 18.3 inches. The length composition and modal length of kingfish caught in the commercial fishery has been stable since 2003 (Figure 12).

Recreational lengths are collected as part of MRIP by recreational port agents. A total of 4,815 kingfishes were measured from 2013 to 2022 (3,707 southern, 99 northern and 1,009 gulf; Table 3). Mean fork length for southern kingfish ranged from 10.4 to 11.7 inches, with a minimum of 6.1 inches and a maximum of 19.9 inches. Mean length for northern kingfish ranged from 9.2 to 13.2 inches, with a minimum of 6.2 inches and a maximum of 14.8 inches. Mean length for gulf kingfish ranged from 10.4 to 15.2 inches, with a minimum of 6.0 inches and a maximum of 17.2 inches. Most of the recreational catch consists of kingfishes from 8 to 12 inches (Figure 13).

## **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).

### Pamlico Sound Survey

The Pamlico Sound Survey catches the most kingfishes 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. The sample area covers all of Pamlico Sound, 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, since most kingfishes are caught in Pamlico Sound, only those stations are used for the associated triggers.

The June portion of the Pamlico Sound Survey is used to calculate a maturity index tracking the proportion of adults larger than the length at which 50% (L50) of the adult population is sexually mature. This index has been variable through the time series, however it generally increased through 2003, then entered a more stable lower period from 2004 through 2019 (Figure 7). During 2020 and 2021, sampling was impacted during June due to the COVID-19 pandemic. All stations were not sampled as only day trips were permitted. In June 2020, 15 of the 41 stations used in the L50 index were sampled, and in June 2021, 22 of the 41 stations used in the L50 index were sampled. Thus, the L50 indices may not be representative of the population and were not included for those years.

The September portion of the Pamlico Sound Survey is used to calculate a YOY index of relative abundance because more YOY southern kingfish are more abundant in the fall. The Program 195 YOY relative abundance index peaked in 2009, was on a decreasing trend through 2013 and remained low through 2019, though it increased slightly in 2022 (Figure 3; Table 5).

During 2020 and 2021, sampling was impacted during September due to the COVID-19 pandemic. All stations were not sampled as only day trips were permitted. In September 2020, 23 of the 41 stations used in the YOY index were sampled and in September 2021, 20 of the 41 stations used in the YOY index were sampled. Thus, the YOY indices may not be representative of the population and were not included for those years.

### SEAMAP-SA Coastal Survey

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). 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 spring portion of the SEAMAP-SA Coastal Survey is used as part of a relative fishing mortality index. 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 YOY index of abundance. After a peak in 2012, the SEAMAP-SA Coastal Survey adult index of relative abundance has been on a declining trend, which continued in 2018, peaking again in 2019 and declining in 2022 (Figure 4; Table 5). The YOY index of relative abundance increased to well above the average in 2015 and has since returned to approximately the average in 2022 (Figure 5; Table 5). The survey did not occur in 2020 or in spring and summer of 2021, due to the COVID-19 pandemic.

### Independent Gill Net Survey

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. Gill net sets are determined using a random stratified survey design, based on area and water depth. The L50 management trigger is based on a conservative proportion of adults in the population from July through September. This is the length at which 50 percent of the population is mature. For southern kingfish, this is 8.25 inches (210 mm) in total length. One of the data sources for this management trigger comes from the Independent Gill Net Survey (Program 915) and has been stable over the time series, ranging from 0.947 to 1.00 (Figure 6).

During 2020 no index of abundance is available for southern kingfish from the fishery-independent assessment (Program 915). Sampling in this program was suspended in February 2020 due to COVID-19 restrictions and protected species interactions but resumed July 2021.

Table 4 summarizes the age data for kingfishes (southern, northern, and gulf), collected from 2013 through 2022. 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 7 years old. Northern kingfish ages ranged from 0 to 5 years old. Gulf kingfish ages ranged from 0 to 7 years old. The modal age has ranged from 1 to 4 years for southern, gulf, and northern kingfishes.

## **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:

### **High**

- Conduct a coast-wide stock assessment of southern kingfish along the Atlantic Coast including estimation of biological reference points for sustainable harvest. — No Action

- Validate YOY and adult indices used in trend analysis. — 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. — No Action
- Collect observer data from commercial fishing operations to estimate at-sea species composition of the catch, discard rates, and lengths. — 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. — Steps have been taken to improve sampling in recreational fisheries, including a carcass collection program.
- Develop tagging study to estimate natural and fishing mortality, to investigate stock structure, and to understand movement patterns. — No Action
- Collect histological data to develop maturity schedule with priority to southern kingfish. — NCDMF currently collecting histology samples in order to validate and update maturity schedules.
- Conduct an age validation study with priority to southern kingfish. — No Action

### **Medium**

- Improve dependent commercial data collection of more sample sizes for life history information. — 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. — No Action
- Continue bycatch reduction device studies in the shrimp trawl fishery to decrease bycatch. — Ongoing research through NCDMF and various federal agencies.
- Conduct study to estimate fecundity with priority to southern kingfish. — No Action
- Conduct study to identify spawning areas with priority for southern kingfish. — No Action

### **Low**

- Determine stock structure using genetics of kingfishes along North Carolina and the Atlantic Coast. — Grant approved for UNCW and NCDMF to use genetic markers to delineate the population structure.
- Sample inlets and river plumes to determine the importance of these areas for kingfishes and other estuarine-dependent species. — 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. — 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. — 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. — NCDMF conducted a study of CRFL holders in 2009/2010.
- Update information on the participants in the recreational kingfish fishery. — Socioeconomic study was conducted by NCDMF on piers.

## 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 southern kingfish stock in North Carolina (NCDMF 2007; Table 6). 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. Southern kingfish is designated as the indicator species for this assemblage. 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 L50 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 total length. Data sources for this management trigger come from three fisheries-independent surveys: the summer component of the SEAMAP-SA Coastal Survey, the July-September component of Independent Gill Net Survey, and the June component of the Pamlico Sound Survey.

Relative F is a simple method for estimating trends in fishing mortality (Sinclair 1998). It is estimated as harvest (commercial landings plus recreational harvest) divided by a fisheries-independent index of relative abundance. Here, harvest (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 the majority of harvest occurs in the spring.

The southern kingfish management triggers are summarized as follows:

### Biological Monitoring

Proportion of adults  $\geq$  length at 50 percent maturity (L50) for NCDMF Program 195 June (Figure 7)

Proportion of adults  $>$  L50 for NCDMF Program 915 (Figure 6)

Proportion of adults  $\geq$  L50 for SEAMAP-SA Coastal Survey summer (Figure 8)

- If the proportion of adults  $\geq$  L50 falls below 2/3 of the average proportion of adults  $\geq$  L50 for the time series (through 2017), 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.

#### 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 4. Bold values indicate years when a particular management trigger was activated. For 2020, none of the seven triggers were able to be updated with 2020 data due to impacts from COVID-19 pandemic. For 2021, two of the seven triggers were able to be updated with 2021 data due to the impacts from the COVID-19 pandemic and staffing issues with the division's survey vessel. One of the two updated triggers was activated in 2021. For 2022, all seven triggers were able to be updated, with two management triggers activated (the YOY index from the fall SEAMAP Coastal Survey and the adult index from the summer SEAMAP Coastal Survey). The 2022 trigger review serves as the first year of two consecutive years where two triggers must be activated to initiate further review of available data and possible management action.

## **FISHERY MANAGEMENT PLAN SCHEDULE RECOMMENDATIONS**

The management program currently in place for kingfishes has resulted in a stock that has met ongoing management targets. All management strategies in place will be maintained as outlined in the state FMP. Stock conditions will be monitored and reported through each subsequent annual FMP update and the NCMFC will continue to receive the FMP review schedule annually. The next scheduled review of this plan will begin in July 2025.

## **LITERATURE CITED**

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Sinclair, A.F. 1998. Estimating trends in fishing mortality at age and length directly from research survey and commercial catch data. *Canadian Journal of Fisheries and Aquatic Sciences*. 55(5):1248–1263.

## TABLES

Table 1. Recreational harvest (number of fish landed and weight in pounds) and releases (number of fish) and commercial harvest (weight in pounds) of kingfishes from North Carolina for the period 1987–2022.

Year	Recreational			Commercial	Total Weight (lb)
	Number Landed	Number Released	Weight Landed (lb)	Weight Landed (lb)	
1987	1,857,068	260,871	992,633	959,928	1,952,561
1988	2,890,243	437,608	901,222	503,949	1,405,171
1989	694,996	232,077	354,489	562,424	916,913
1990	2,185,356	794,834	1,045,318	738,612	1,783,930
1991	2,556,003	797,605	1,342,855	864,651	2,207,506
1992	2,101,326	622,123	1,205,802	851,708	2,057,510
1993	1,713,370	363,653	970,140	1,194,224	2,164,364
1994	1,905,437	704,638	932,088	620,841	1,552,929
1995	1,566,976	887,357	877,355	1,058,785	1,936,140
1996	1,594,185	604,856	824,301	528,260	1,352,561
1997	1,377,757	315,294	764,540	872,888	1,637,428
1998	887,493	542,905	543,575	399,313	942,888
1999	1,434,966	879,223	789,732	607,465	1,397,197
2000	2,650,504	1,943,897	1,747,843	551,940	2,299,783
2001	2,425,319	1,059,193	1,374,961	489,743	1,864,704
2002	1,640,675	968,687	987,857	619,737	1,607,594
2003	1,480,769	1,920,446	962,157	652,636	1,614,792
2004	2,638,463	2,528,681	1,656,167	567,659	2,223,826
2005	1,796,386	1,814,579	961,919	296,263	1,258,182
2006	2,649,617	2,509,056	1,476,769	559,440	2,036,209
2007	2,277,856	2,408,418	1,397,901	817,588	2,215,489
2008	2,783,237	2,344,633	1,480,223	921,120	2,401,343
2009	3,785,900	4,711,527	2,070,355	721,924	2,792,279
2010	3,745,586	4,465,523	2,213,702	886,841	3,100,543
2011	2,345,068	2,631,056	1,444,020	486,853	1,930,873
2012	3,444,198	3,665,650	1,876,114	596,249	2,472,363
2013	5,878,620	6,069,055	2,892,756	603,186	3,495,942
2014	5,545,372	6,959,626	3,425,201	955,087	4,380,288
2015	5,503,438	4,850,505	3,110,112	784,753	3,894,865
2016	4,149,467	4,076,760	2,224,575	834,771	3,059,346
2017	3,387,471	4,075,827	2,316,609	942,946	3,259,556
2018	1,731,339	2,180,732	1,008,600	407,173	1,415,772
2019	3,370,636	4,152,005	1,888,848	702,328	2,591,176
2020	3,865,040	3,461,090	2,505,507	640,759	3,146,265
2021	8,425,767	5,593,293	5,676,092	808,049	6,484,141
2022	5,594,759	4,197,190	1,268,065	838,753	2,106,818
Mean	2,885,574	2,389,735	1,597,735	706,912	2,304,424

Table 2. Summary of length data (total length, inches) sampled from kingfishes in the commercial fishery, 2013–2022.

Southern Kingfish				
Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
2013	12.1	6.5	16.1	1,390
2014	11.9	8.3	20.9	2,880
2015	11.9	7.7	15.8	3,286
2016	12.0	7.1	17.2	3,107
2017	11.6	7.9	16.1	2,504
2018	11.4	6.8	16.1	1,264
2019	11.4	8.0	24.8	4,360
2020	11.4	7.8	20.0	2,086
2021	11.4	7.5	16.0	2,485
2022	11.7	7.9	17.9	2,516
Northern Kingfish				
Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
2013	13.1	8.6	16.0	815
2014	13.4	9.5	16.7	216
2015	12.7	10.0	16.6	100
2016	12.4	8.8	17.0	227
2017	13.3	9.8	17.4	177
2018	13.9	9.7	17.7	64
2019	12.1	8.1	16.1	148
2020	13.5	10.0	18.6	175
2021	13.5	9.9	18.4	153
2022	13.2	10.6	18.0	29
Gulf Kingfish				
Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
2013	12.9	8.3	17.4	470
2014	12.2	8.6	15.5	182
2015	12.7	9.2	16.3	168
2016	12.4	8.1	18.3	193
2017	12.3	9.4	16.7	257
2018	12.5	9.0	18.0	161
2019	12.0	8.9	16.9	154
2020	12.8	9.3	17.0	130
2021	12.7	6.4	16.8	138
2022	12.5	10.5	16.1	80

Table 3. Summary of length data (fork length, inches) sampled from kingfishes in the recreational fishery, 2013–2022.

Southern Kingfish				
Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
2013	10.4	6.1	15.8	370
2014	11.7	7.8	19.9	383
2015	10.7	6.4	18.7	258
2016	11.2	7.8	16.5	490
2017	11.0	7.8	15.4	472
2018	11.5	7.8	15.2	290
2019	10.9	6.3	15.7	374
2020	11.2	7.6	16.9	467
2021	11.5	7.5	16.1	347
2022	11.0	7.5	15.6	256
Northern Kingfish				
Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
2013	10.9	6.2	14.8	26
2014	11.2	9.3	13.5	2
2015	10.9	8.5	14.1	7
2016	10.8	7.9	11.8	3
2017	13.2	9.8	14.4	24
2018	9.2	6.4	13.1	2
2019	10.9	10.9	10.9	1
2020	11.7	10.7	12.4	7
2021	10.6	8.3	13.1	15
2022	11.1	8.3	13.7	12
Gulf Kingfish				
Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
2013	10.4	6.0	17.2	180
2014	11.5	6.5	17.2	203
2015	11.3	8.5	16.0	63
2016	10.7	6.9	14.1	81
2017	12.1	7.5	15.8	126
2018	11.6	6.5	17.0	83
2019	11.1	6.2	15.0	72
2020	12.1	7.4	16.0	92
2021	12.2	7.9	15.5	44
2022	15.2	11.5	15.5	65

Table 4. Kingfishes age data collected from all sources (commercial and recreational fisheries and fishery independent sampling programs) combined, 2013–2022.

Southern Kingfish				
Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
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
2018	1	0	7	308
2019	2	1	7	386
2020	2	0	7	249
2021	2	1	6	423
2022	3	1	7	516
Northern Kingfish				
Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
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
2018	3	3	3	1
2019	-	-	-	0
2020	4	3	4	6
2021	3	1	5	9
2022	2	1	4	29
Gulf Kingfish				
Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
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
2018	2	0	6	95
2019	1	0	6	183
2020	1	0	5	170
2021	2	0	7	205
2022	3	1	7	298

Table 5. Summary of management trigger organized by category. Bold values indicate years a trigger was activated.

Year	BIOLOGICAL MONITORING			FISHERIES-INDEPENDENT SURVEYS			OTHER
	Proportion of Adults $\geq$ L50			YOY Indices		Adult Index	Relative <i>F</i>
	Program 195 June	Program 915 July-September	SEAMAP Summer	Program 195 September	SEAMAP Fall	SEAMAP Summer	
1987	0.61			<b>0.61</b>			
1988	0.45			<b>0.89</b>			
1989	<b>0.30</b>		0.58	<b>1.12</b>	<b>6.80</b>	<b>6.77</b>	23,594
1990	0.56		0.46	<b>2.30</b>	<b>7.90</b>	22.00	<b>89,646</b>
1991	0.67		0.89	<b>3.57</b>	<b>11.50</b>	32.67	<b>46,965</b>
1992	0.43		0.62	<b>2.68</b>	<b>8.40</b>	15.56	26,378
1993	0.54		0.46	<b>0.10</b>	<b>3.60</b>	15.44	<b>56,929</b>
1994	0.79		0.92	<b>3.61</b>	<b>13.30</b>	<b>1.33</b>	<b>189,414</b>
1995	0.44		0.49	6.34	<b>3.30</b>	<b>8.11</b>	30,973
1996	0.87		0.78	<b>0.32</b>	<b>6.60</b>	<b>5.61</b>	29,753
1997	0.59		<b>0.37</b>	<b>0.33</b>	<b>4.70</b>	<b>4.17</b>	22,764
1998	1.00		0.77	<b>0.17</b>	<b>6.70</b>	<b>5.06</b>	12,679
1999	0.92		0.61	<b>2.77</b>	61.70	23.83	20,679
2000	0.73		0.93	6.09	<b>8.10</b>	<b>6.89</b>	<b>113,767</b>
2001	0.66	0.98	<b>0.30</b>	4.18	<b>0.00</b>	23.65	30,646
2002	0.70	0.98	0.88	5.77	40.00	<b>3.13</b>	35,893
2003	0.87	0.98	0.65	5.65	<b>7.50</b>	13.83	9,530
2004	0.51	0.97	<b>0.28</b>	<b>3.83</b>	22.30	41.45	5,851
2005	0.59	0.97	0.67	<b>2.20</b>	32.90	15.27	6,659
2006	0.55	0.98	0.42	20.59	<b>9.70</b>	20.79	15,229
2007	<b>0.34</b>	0.98	0.52	6.89	<b>6.50</b>	<b>5.86</b>	28,204
2008	0.49	0.98	0.58	11.94	<b>9.90</b>	<b>2.26</b>	29,237
2009	0.59	1.00	0.39	31.91	<b>7.40</b>	11.30	40,569
2010	0.52	0.98	0.79	<b>1.74</b>	39.60	<b>3.81</b>	20,813
2011	0.43	1.00	0.51	18.48	44.00	12.45	43,989
2012	0.51	1.00	<b>0.37</b>	5.18	<b>16.50</b>	39.36	12,636
2013	0.66	0.95	0.56	17.87	<b>15.90</b>	24.03	11,238
2014	0.42	0.98	0.55	5.88	<b>15.50</b>	30.71	24,626
2015	0.53	0.98	0.55	6.89	285.00	30.97	16,194
2016	<b>0.36</b>	0.95	<b>0.34</b>	<b>2.24</b>	30.90	14.21	5,651
2017	0.50	0.96	0.68	<b>3.36</b>	18.60	<b>9.24</b>	3,260
2018	0.64	1.00	0.40	4.96	<b>1.40</b>	13.07	19,217
2019	0.53	0.97	0.45	6.00	20.90	30.55	19,687
2020	*	*	*	*	*	*	*
2021	*	1.00	*	*	<b>14.80</b>	*	*
2022	0.79	1.00	0.50	7.94	<b>9.83</b>	<b>3.00</b>	25,787
Threshold	<0.39	<0.65	<0.39	<3.99	<17.11	<10.34	>46,151
Total Years	34	21	32	34	33	32	32
Years Trigger Activated	3	0	5	17	23	13	5

Table 6. 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
<b>Fisheries Management</b>	
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
<b>Habitat and Water Quality</b>	
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"> <li>• improvement and continuation of urban and agricultural BMPs,</li> <li>• more stringent sediment controls on construction projects, and</li> <li>• implementation of additional buffers along coastal waters.</li> </ul>	Endorsed through the CHPP

## FIGURES

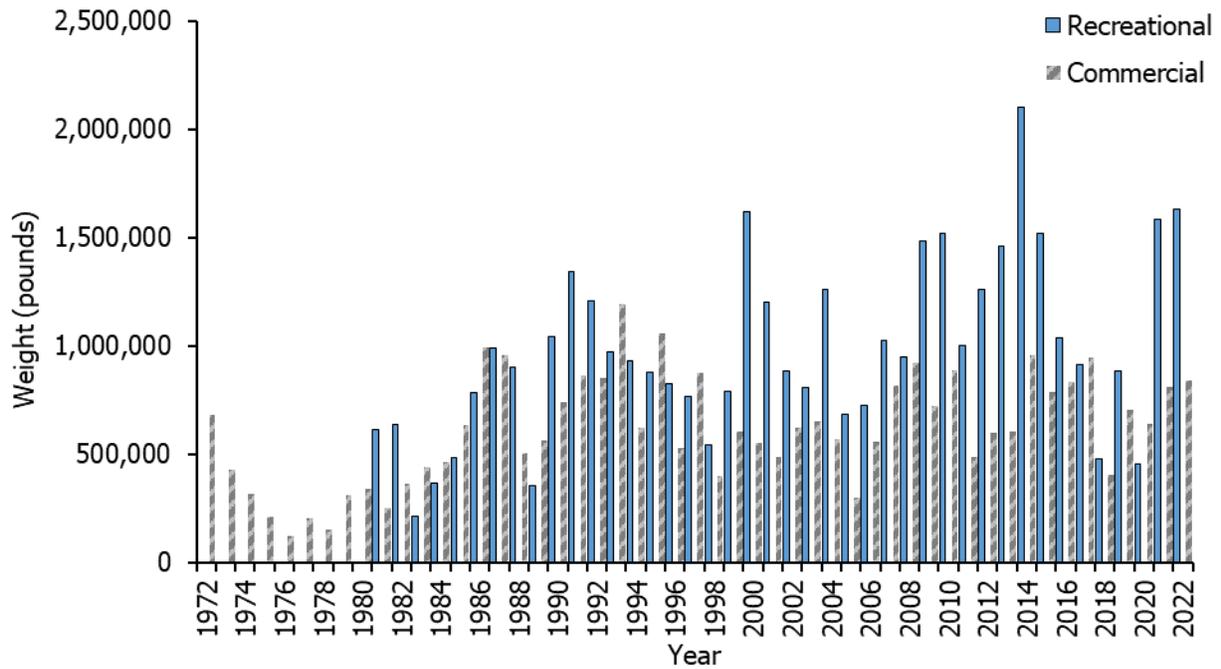


Figure 1. Commercial landings (pounds) reported through the North Carolina Trip Ticket Program and recreational landings (Type A + B1; pounds) estimated from the Marine Recreational Information Program survey for North Carolina from 1972–2022.

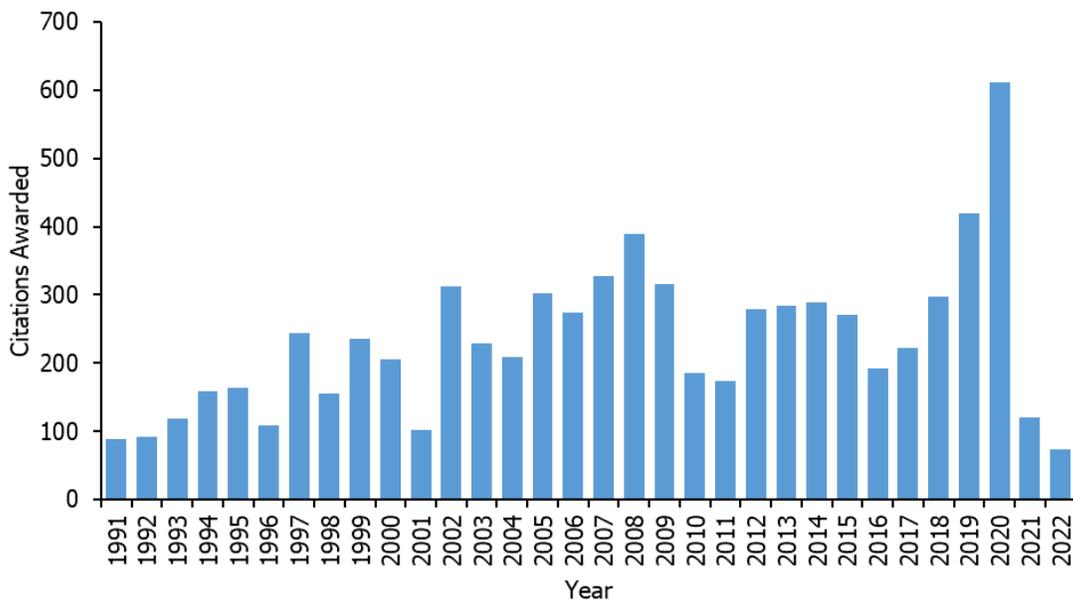


Figure 2. North Carolina Saltwater Fishing Tournament citations awarded for kingfishes, 1991–2022. Citations are awarded for kingfishes > two pounds landed. Prior to May 1, 2021, citations were awarded for kingfishes > one and one-half pounds landed.

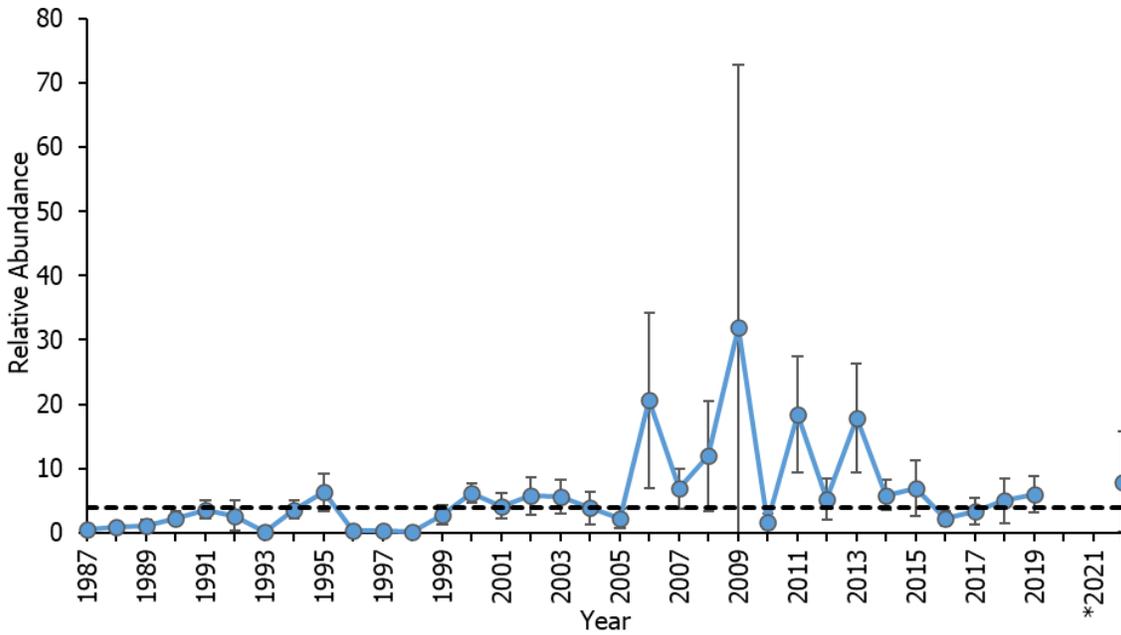


Figure 3. Annual index of relative YOY abundance for southern kingfish derived from the September component of the NCDMF Program 195 survey (excluding strata from the Neuse, Pamlico, and Pungo rivers), 1987–2022. The dotted line represents 2/3 of the average of the base years, 1987–2017. \*Data for 2020 and 2021 not included due to incomplete sampling in those years.

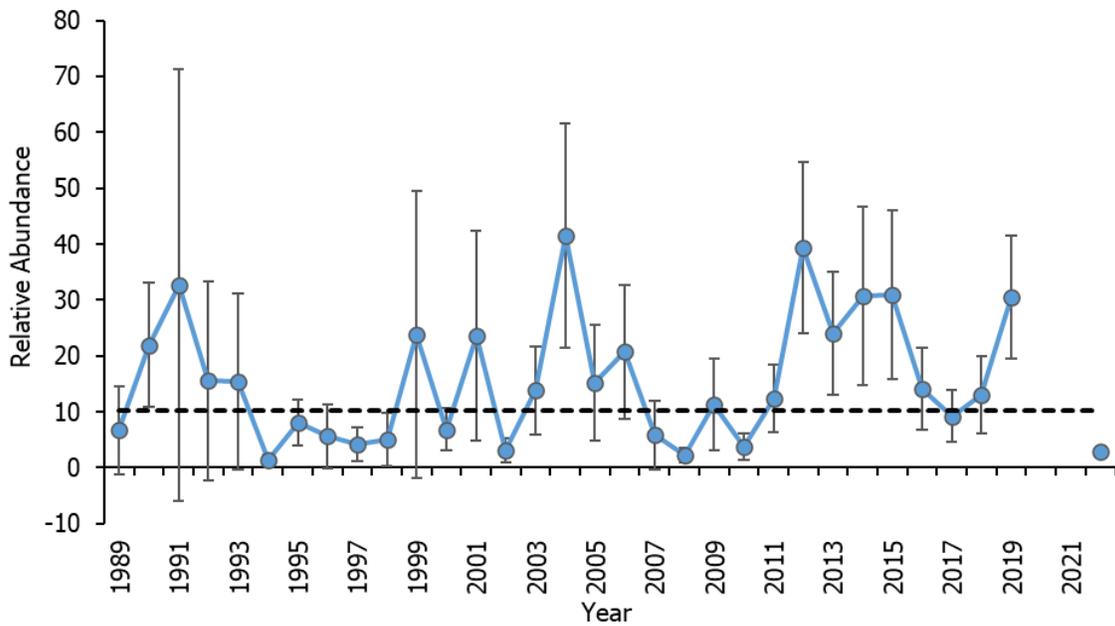


Figure 4. Annual index of relative adult abundance for southern kingfish derived from the summer component of the SEAMAP-SA Coastal Survey (Onslow, Raleigh, and Long bays, inner—shallow—strata), 1989–2022. Survey not conducted in 2020 or 2021. The dotted line represents 2/3 of the average of the base years, 1989–2017.

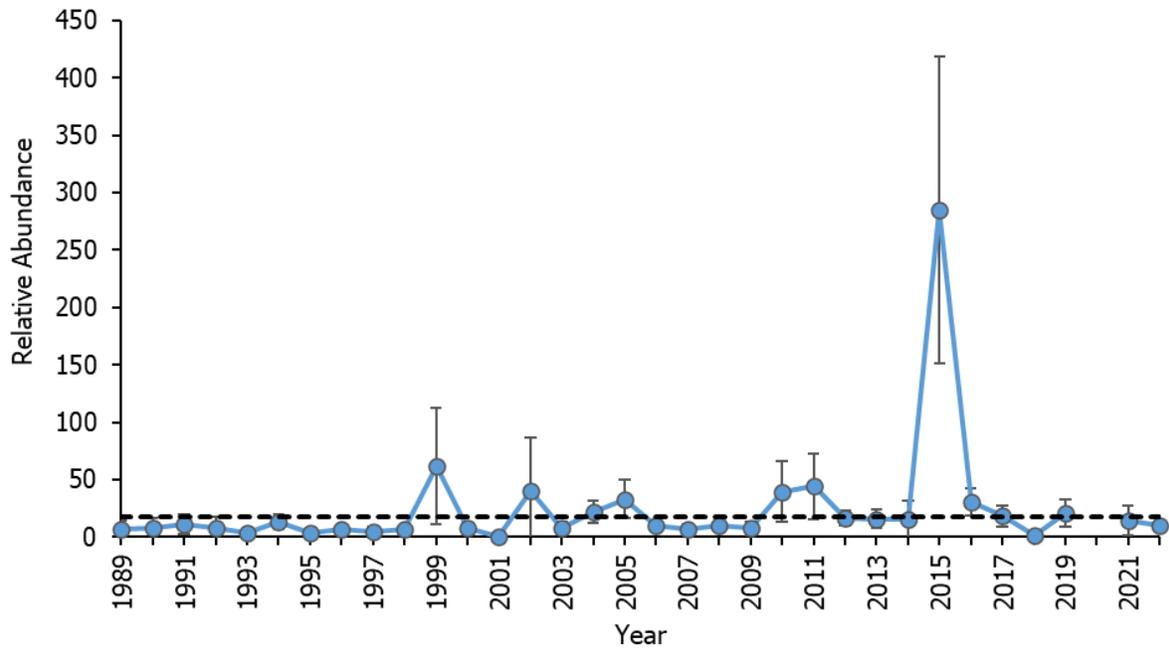


Figure 5. Annual index of relative YOY abundance for southern kingfish derived from the fall component of the SEAMAP-SA Coastal Survey (Onslow, Raleigh, and Long bays, inner—shallow—strata), 1989–2022. Survey not conducted in 2020 or 2021. The dotted line represents 2/3 of the average of the base years, 1989–2017.

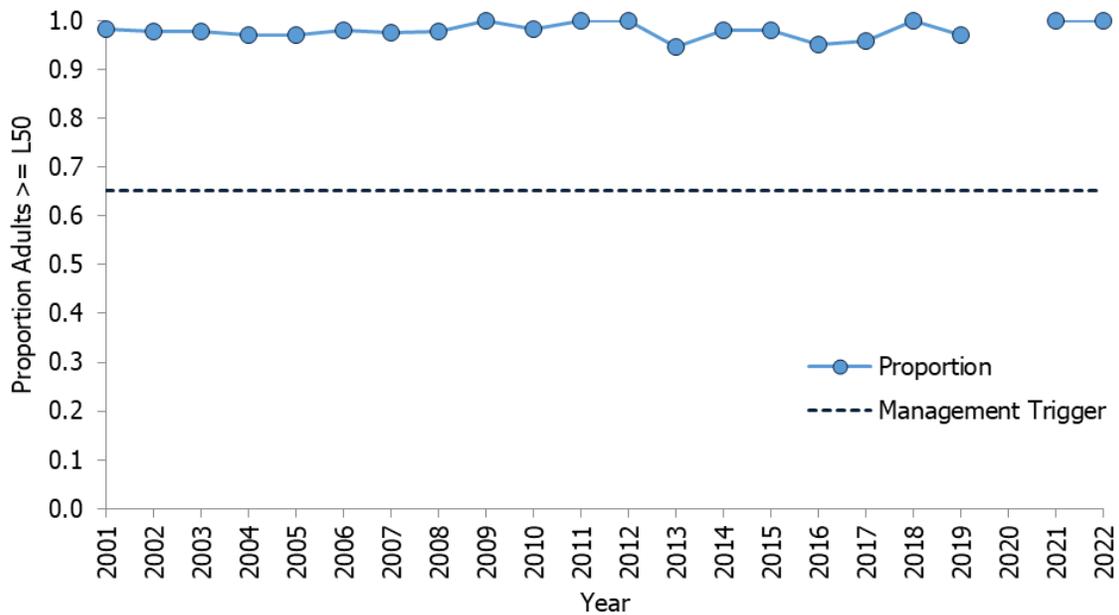


Figure 6. Annual proportion of adults (southern kingfish) greater than or equal to the length at 50% maturity occurring in the July through September component of the NCDMF Program 915 survey (Pamlico Sound, deep strata only), 2001–2022. The dotted line represents 2/3 of the average of the base years, 2001–2017.

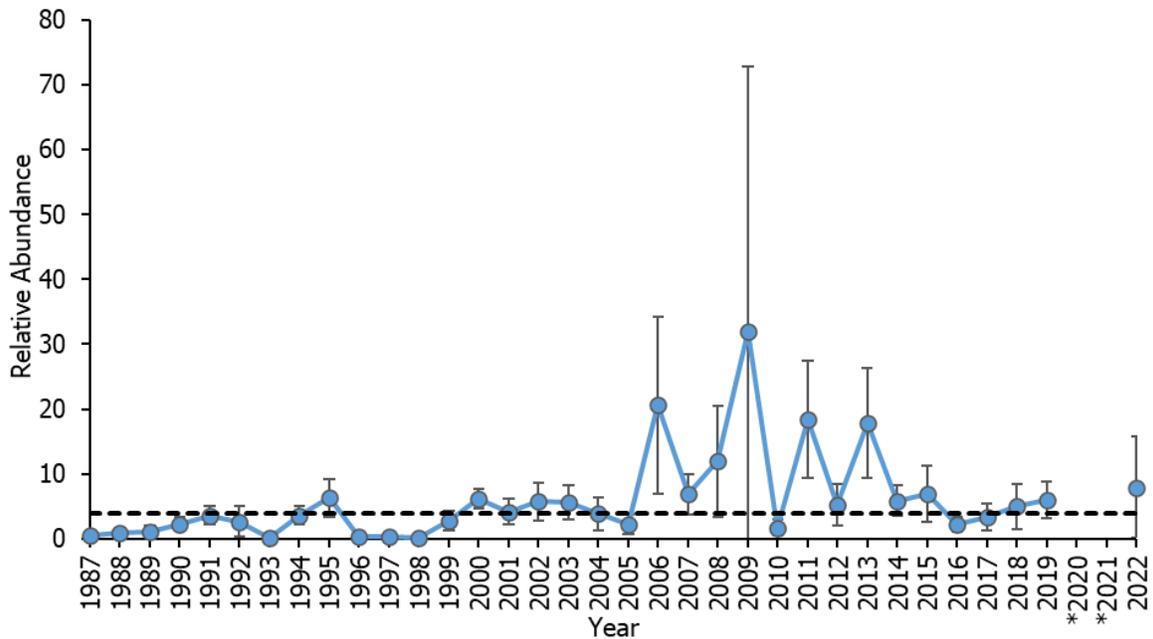


Figure 7. Annual proportion of adults (southern kingfish) greater than or equal to the length at 50% maturity occurring in the June component of the NCDMF Program 195 survey (excluding strata from the Neuse, Pamlico, and Pungo rivers), 1987–2022. The dotted line represents 2/3 of the average of the base years, 1987–2017. \*Data for 2020 and 2021 not included due to incomplete sampling in those years.

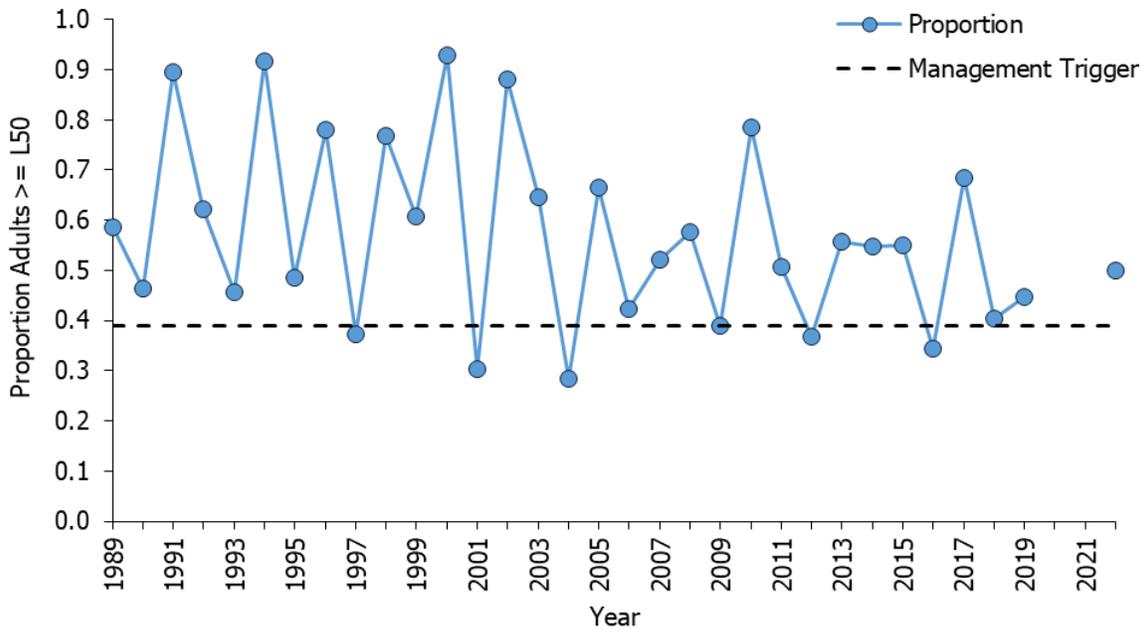


Figure 8. Annual proportion of adults (southern kingfish) greater than or equal to the length at 50% maturity occurring in the summer component of the SEAMAP-SA Coastal Survey (Onslow, Raleigh, and Long bays, inner—shallow—strata), 1989–2022. Summer component of the survey not conducted in 2020 or 2021. The dotted line represents 2/3 of the average of the base years, 1989–2017.

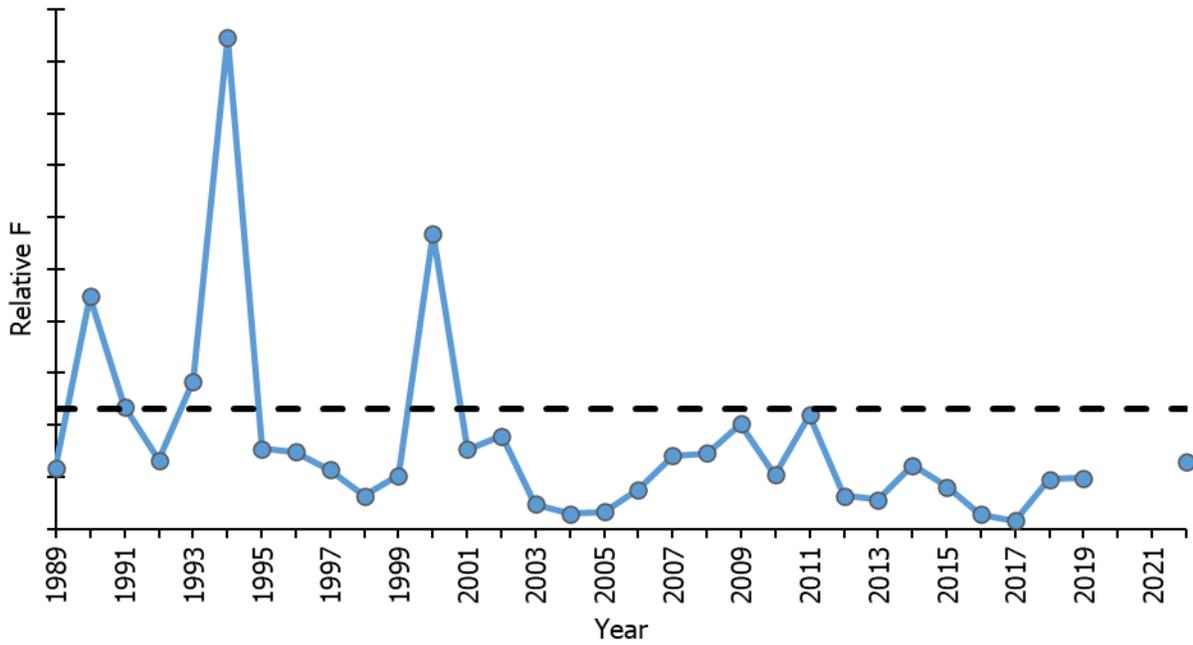


Figure 9. Relative F, as estimated as harvest (commercial and recreational) divided by the SEAMAP-SA Coastal Survey spring index (Onslow, Raleigh, and Long bays, inner—shallow—strata) of relative abundance for southern kingfish, 1989–2022. Spring component of the survey not conducted in 2020 or 2021. The dotted line represents the average plus 1/3 of the average of the base years, 1989–2017.

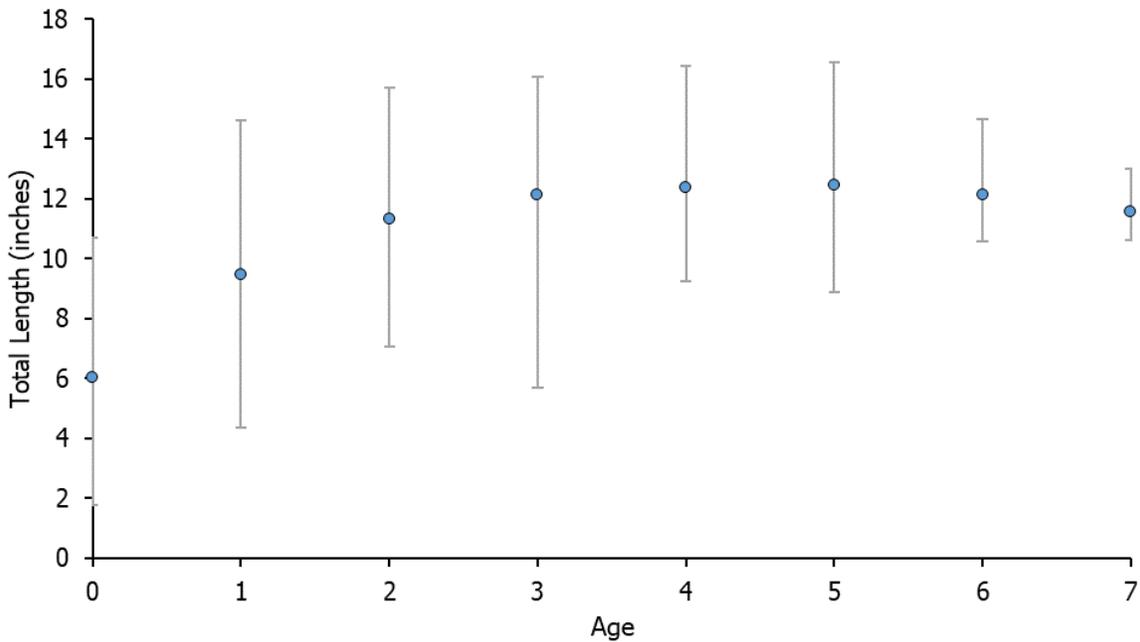


Figure 10: Southern kingfish total length at age based on all samples collected, 1997–2022. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum length observed for each age.

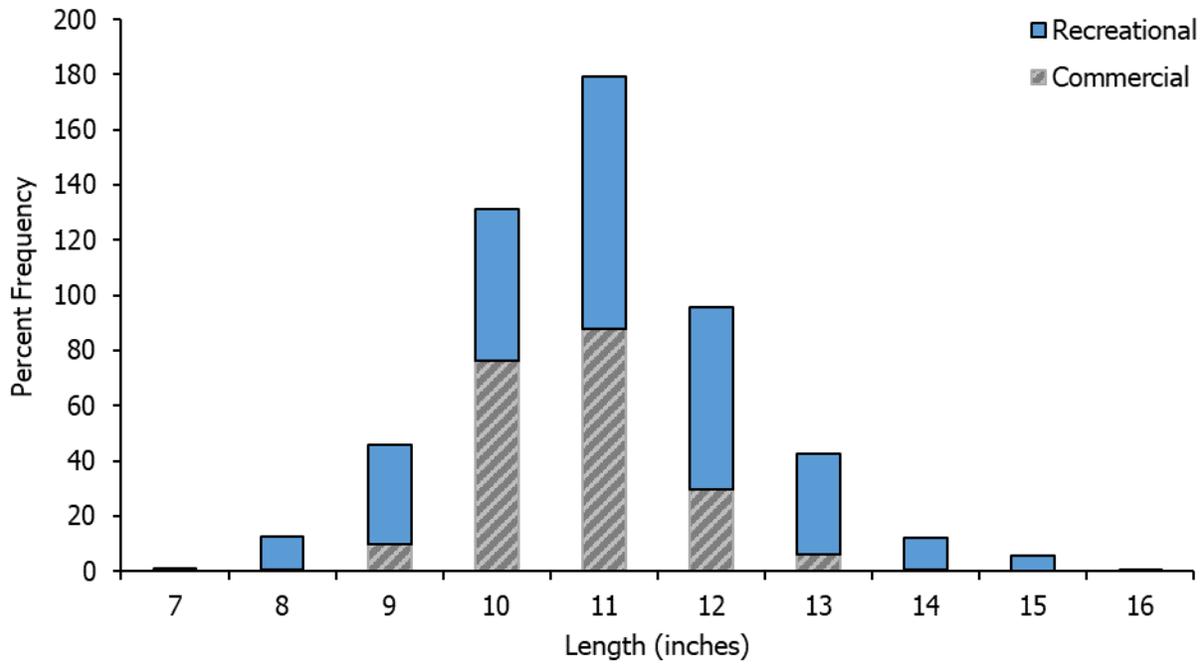


Figure 11: Commercial total length and recreational fork length frequency distribution of kingfishes harvested in 2022.

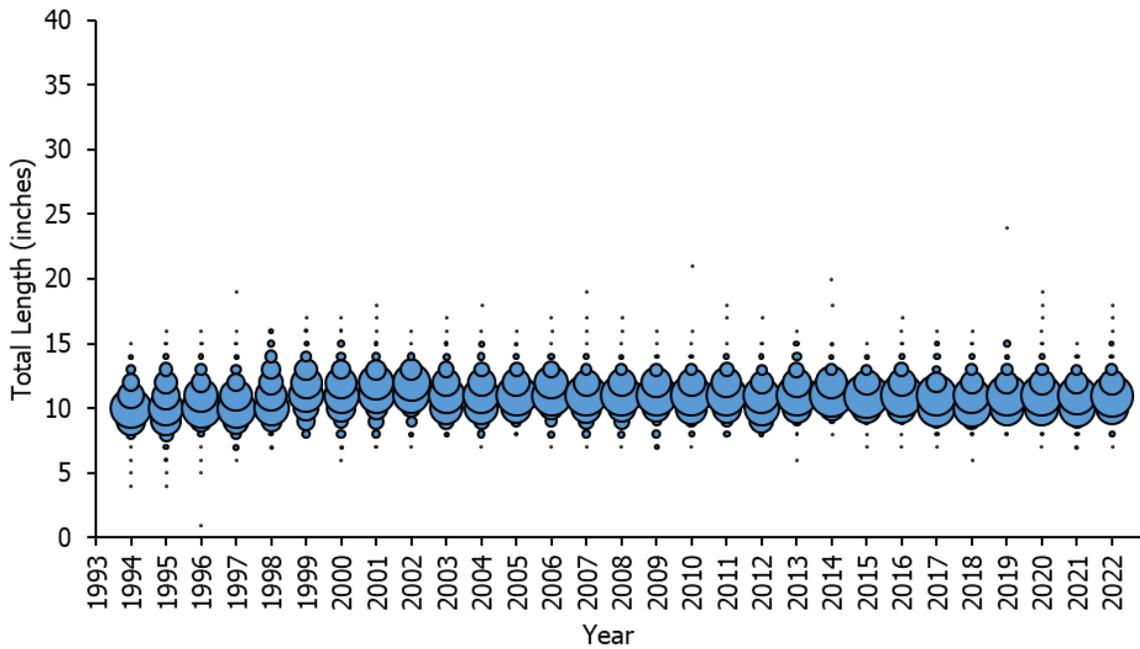


Figure 12: Commercial total length frequency of kingfishes harvested, 1994–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

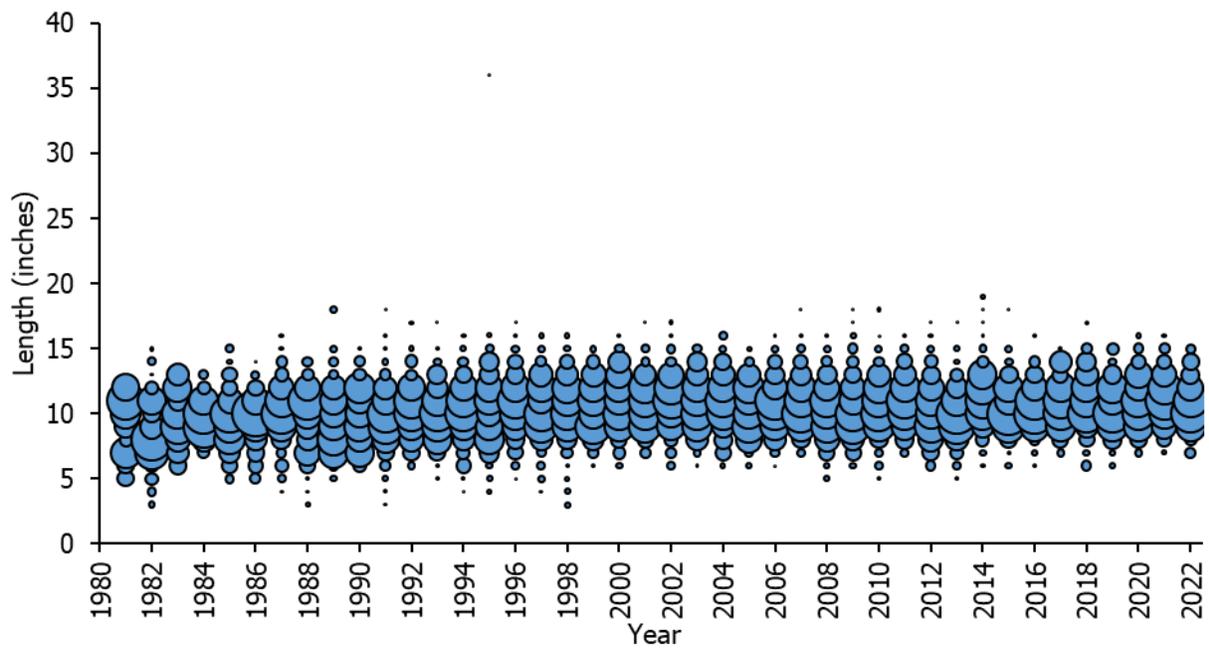


Figure 13: Recreational fork length frequency of kingfishes harvested, 1981–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

## STATE MANAGED SPECIES – RED DRUM

### FISHERY MANAGEMENT PLAN UPDATE RED DRUM JUNE 2023

#### 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:	2022	
Schedule Changes:	None	
Comprehensive Review:	2024	

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 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 implement regulations requiring circle hooks along with fixed weights and short leaders in the summer adult red drum recreational fishery in Pamlico Sound; and expanded gill net attendance requirements originally implemented as part of the original 2011 North Carolina Red Drum FMP (NCDMF 2001) to reduce the impact of discard mortality.

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 under development. 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 a five fish bag limit); implemented a daily trip limit for the commercial fishery that is set by the North Carolina Division of Marine Fisheries (DMF) 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. Final approval of the North Carolina Red Drum FMP final occurred in March 2001 and interim measures implemented in October of 1998 were maintained. Stock assessments conducted since implementation of the 2001 FMP have all indicated 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 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 2003. Further, the plan also continues to require that states maintain management strategies that ensure 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 when Amendment 2 to the ASMFC plan was passed. Since that time, both the 2009 and 2017 assessments for red drum have indicated 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 the ASMFC plan.

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 2022).

## **Management Unit**

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.

## **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 this goal, the FMP lists the following objectives:

- 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.
- 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.
- 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.
- Develop regulations that while maintaining sustainable harvest from the fishery, consider the needs of all user groups and provides adequate resource protection.
- Promote harvest practices that minimize the mortality associated with regulatory discards of red drum.
- In a manner consistent with the Coastal Habitat Protection Plan, restore, improve and protect essential red drum habitat and environmental quality to increase growth, survival, and reproduction of red drum.
- 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.
- Initiate, enhance, and continue studies to collect and analyze the socio-economic data needed to properly monitor and manage the red drum fishery.

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

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 designated as the state's official saltwater fish. Large red drum (up to 90 pounds) inhabit the coastal waters throughout the year and are 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 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 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 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. A new benchmark assessment is scheduled to begin in 2022 and will be complete in 2024.

## **Stock Assessment**

Only the overfishing 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 year's fishing mortality rate relative to the spawning stock biomass survival rates if no fishing mortality was occurring. Based on results of the 2017 benchmark 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 harvest rates (relaxation of current regulations) of red drum should only be allowed if 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).

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

### **Commercial Fishery**

North Carolina's commercial landings combined from all months of 2022 were 175,029 pounds; a decrease from 2021 landings (200,825 pounds; Table 1 and Figure 2A). Landings were greater than the 10-year mean (146,885 pounds). Since 1989, landings have fluctuated with no consistent trend.

The North Carolina Red Drum FMP (2001) 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 142,318 pounds. The 2007/2008, 2009/2010 and 2013/2014 fishing years had overages (Table 2). All overages were deducted from the following year's cap allowance. The 2021/2022 fishing year resulted in 216,528 pounds of red drum landings, well below the 250,000-pound annual cap.

## **Recreational Fishery**

Recreational fishing activity is monitored through the Marine Recreational Information Program. For information on MRIP methodology see <https://www.fisheries.noaa.gov/topic/recreational-fishing-data>. Recreational landings in 2022 were 1,615,108 pounds; above the 2011-2021 10-year average (1,188,984 pounds) and above 2021 landings (1,479,550 pounds; Table 1 and Figure 2B). Recreational releases totaled 2,160,742 fish in 2022; below the ten-year average of 2,426,725 fish and below the time-series average of 1,269,917 (Table 1). Recreational releases have increased over time, averaging around 340,000 releases per year for the period of 1991 to 1998 compared to over 2 million releases per year in the most recent 10-year period (2012-2022).

The DMF offers award citations for exceptional catches of red drum. Red drum captured and released that measure greater than 40 inches total length are eligible for an award citation. Since 1991, award citations for red drum have steadily increased from just over 300 awarded in 1991 to a time-series high of 3,634 awarded in 2022 (Figure 3).

## **MONITORING PROGRAM DATA**

### **Fishery-Dependent Monitoring**

Commercial fishing activity is monitored through fishery-dependent sampling conducted by the DMF 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 2022, 91% of the red drum harvest was taken in gill nets, followed by pound nets with 8% (Figure 4). In all, 550 red drum, primarily from set gill nets, were measured from the commercial fishery in 2022 (Table 3). The average size in 2022 was 23 inches fork length. Average size has varied little over time ranging from 17 to 23 inches fork length since 1989. Due to the slot limit of 18 to 27 inches total length, red drum harvested in both the commercial and recreational fishery are of similar size (Figure 5). In the commercial fishery, a shift in the size of harvest is apparent between 1991 and 1992, when the minimum size limit was increased from 14 to 18 inches (Figure 6). Additionally, as the harvest of larger fish was disallowed during the 1990's, fish above 27 inches are now rarely observed in landings due to regulations. With the current slot limit on harvest for both the commercial and recreational fisheries, nearly all landings consist of age-1 and age-2 fish. Similar to the commercial fishery, average size varies little from year to year in the recreational fishery (Table 4; Figure 7). Harvest of red drum over 27 inches was eliminated in 1998, although occasionally larger fish are still observed in the recreational harvest (Figure 7). In 2022, the average size of recreational fish harvested was 22 inches fork length. From 1989 to 2022, this range varied little (17 to 23 inches fork length).

## **Fishery-Independent Monitoring**

The DMF 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; sampling occurs 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 8). In 2022, 176 juvenile red drum were taken in 120 seine samples for an overall relative abundance index of 1.47 red drum per haul. The 2022 index was less than 2021 (5.51) and below the long-term average of the survey of 5.61 (Figure 8). Information gathered from this survey is currently being considered as an input parameter in the upcoming ASMFC Atlantic coast red drum stock assessment.

A fishery-independent gill net survey was initiated by the DMF 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 stock without relying solely on commercial and recreational fishery-dependent data. The overall red drum index was 1.83 red drum per set in 2022, below the time series average of 2.66 (Figure 9). It should be noted that sampling in this program was suspended in February 2020 due to COVID-19 restrictions and protected species interactions. Sampling resumed July 2021. The survey is currently used in the ASMFC Atlantic coast red drum stock assessment as an annual index of relative abundance for sub-adult red drum.

North Carolina initiated an adult red drum longline survey in 2007. 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 2022 season, 150 red drum were captured out of 64 stratified random sets (2.34 red drum per set) which is below the time series average of 4.46 red drum per set (Figure 10). The study has recently been impacted by significant events. Samples in 2019 were adversely impacted by Hurricane Dorian which hit the North Carolina coast at the peak of the sampling season and negatively impacted the survey. During 2020, sampling did not occur due to the COVID pandemic. Sampling efforts in 2022 were limited to the months of August and September due to mechanical issues with sampling gear. This survey is used in the ASMFC red drum stock assessment.

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 2022, 773 red drum were collected, ranging in age from 0 to 43 years (Table 5). Most red drum collected from dependent sources (18 to 27 inches total length) are age 1 or 2. Red drum over 27 inches are protected from harvest in North Carolina, a measure designed to protect the spawning portion of the population, so age samples from larger fish come almost exclusively from fishery-independent sources. Red drum in North Carolina are long-lived with the oldest red drum being aged at 62 years. Growth in length is rapid for the first several years of life and then slows as fish reach maturity (100% mature by age 4- and 32-inches total length). Beyond age-4, the relationship of length and age for red drum is less predictable with much overlap in age for a given length (Figure 11).

## Tagging Program

In 2014, a mark-recapture tagging program was initiated utilizing both volunteer anglers and DMF staff throughout the state. Red drum under 27 inches total length are tagged with an internal anchor tag, and red drum over 27 inches total length are tagged with a stainless-steel dart tag. The total number of red drum tagged in 2022 was 1,064 resulting in 83 recaptures (Table 6; Figure 12). The time series average was 243 days at large with an average distance travelled of 17 miles (Table 6). Most recaptures occur within the state of NC, however, the maximum distance travelled was 559 miles into the state of New Jersey (Figure 13). The maximum days between release and recapture was 2,258 days or just over 6 years (Table 6). Information gathered from this survey is currently being considered as an input parameter in the upcoming ASMFC Atlantic coast red drum stock assessment.

## 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).
- Improve catch and effort data for the red drum recreational fishery, particularly for the fishery that occurs at night (needed).
- Develop independent surveys to monitor both the sub-adult and adult red drum populations (ongoing through DMF gillnet and longline surveys).
- Continue 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 DMF; maturity through DMF; recent diet work through NCSU).
- Identify 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 DMF 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 DMF 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).
- 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).

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

## **FISHERY MANAGEMENT PLAN SCHEDULE RECOMMENDATIONS**

No schedule change recommended. Both the state and ASMFC red drum plans have identical management goals (30% threshold and 40% target static spawning potential ratio). Stock status is determined by the formal, peer reviewed stock assessment conducted by the ASMFC. The next red drum stock assessment is scheduled for completion in 2024 and will coincide with the next planned formal review of the North Carolina Red Drum FMP set to begin in July of 2024. It should

be noted that any changes to the state FMP must consider compliance requirements of the ASMFC plan.

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- 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), 1989–2022. All weights are in pounds.

Year	Recreational			Commercial	
	Number Landed	Number Released	Weight Landed (lb)	Weight Landed (lb)	Total Weight (lb)
1991	111,787	336,524	345,911	96,045	441,956
1992	48,099	140,866	233,100	128,497	361,597
1993	107,235	442,230	538,175	238,099	776,274
1994	72,245	185,906	349,317	142,169	491,486
1995	151,145	373,695	692,063	248,122	940,185
1996	90,177	97,663	391,364	113,338	504,702
1997	22,829	426,993	98,079	52,502	150,581
1998	164,693	388,288	843,571	294,366	1,137,937
1999	151,062	633,951	701,002	372,942	1,073,944
2000	127,165	443,747	655,251	270,953	926,204
2001	57,929	538,370	290,901	149,616	440,517
2002	127,559	1,515,679	571,102	81,370	652,472
2003	73,202	215,277	359,181	90,525	449,706
2004	58,543	369,326	245,163	54,086	299,249
2005	103,275	967,892	470,914	128,770	599,684
2006	127,412	1,042,564	569,699	169,206	738,905
2007	157,577	818,037	789,430	243,658	1,033,088
2008	112,938	1,510,133	523,607	229,809	753,416
2009	214,317	1,238,158	1,028,339	200,296	1,228,635
2010	179,828	1,670,693	835,143	231,828	1,066,971
2011	156,484	587,369	737,853	91,980	829,833
2012	152,005	4,939,534	648,342	66,519	714,861
2013	520,758	1,892,171	2,214,045	371,949	2,585,994
2014	324,303	1,086,967	1,674,595	90,650	1,765,245
2015	143,876	1,308,072	567,730	80,388	648,118
2016	169,195	3,203,452	633,496	77,101	710,597
2017	353,716	2,165,656	1,475,852	187,039	1,662,891
2018	299,577	1,729,260	1,452,358	144,610	1,596,968
2019	97,186	2,976,601	436,219	56,419	492,638
2020	413,419	2,686,150	1,758,789	165,670	1,924,459
2021	325,662	2,545,371	1,479,550	200,364	1,679,914
2022	336,280	2,160,742	1,615,108	175,029	1,790,137
Mean	173,484	1,269,917	788,289	165,169	952,161

Table 2. North Carolina's annual commercial harvest based on a fishing year beginning September 1 and ending August 31. September 1 fishing year began through FMP in 2001/2002 fishing year.

Fishing Year	Landings (lb)	Annual Cap
2001/2002	61,504	250,000
2002/2003	105,704	250,000
2003/2004	70,175	250,000
2004/2005	61,838	250,000
2005/2006	159,379	250,000
2006/2007	172,166	250,000
2007/2008	326,211	250,000
2008/2009*	134,161	173,789
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	262,756	250,000
2014/2015***	140,887	237,244
2015/2016	64,150	250,000
2016/2017	109,954	250,000
2017/2018	198,625	250,000
2018/2019	105,804	250,000
2019/2020	54,175	250,000
2020/2021	207,694	250,000
2021/2022	216,528	250,000
Mean	142,318	

\* adjusted to pay back overage in 2007/2008 fishing year

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

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

Table 3. Red drum length (fork length, inches) data from commercial fish house samples, 1989–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1989	22	11	51	123
1990	17	13	46	511
1991	18	12	48	183
1992	23	11	49	311
1993	23	16	45	602
1994	23	12	41	142
1995	22	16	31	496
1996	23	16	26	120
1997	20	10	37	272
1998	19	12	37	1,082
1999	21	13	30	1,008
2000	22	16	31	725
2001	22	17	28	419
2002	21	13	30	483
2003	21	17	28	387
2004	22	16	28	326
2005	21	14	28	811
2006	22	14	29	1,258
2007	22	16	31	1,502
2008	23	13	29	1,206
2009	22	14	35	1,166
2010	22	14	31	1,134
2011	22	17	31	646
2012	21	16	28	359
2013	21	12	27	1,664
2014	23	18	28	444
2015	23	17	28	429
2016	21	16	27	681
2017	21	17	28	672
2018	23	12	28	561
2019	22	14	29	174
2020	21	17	27	549
2021	22	13	27	759
2022	23	17	28	550

Table 4. Red drum length (fork length, inches) data from Marine Recreational Information Program recreational samples, 1989–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1989	19	13	44	101
1990	17	15	39	73
1991	18	11	42	101
1992	22	17	43	42
1993	22	10	41	117
1994	23	12	40	90
1995	22	18	29	240
1996	21	14	30	114
1997	20	9	44	30
1998	22	15	42	534
1999	23	15	27	199
2000	23	18	26	130
2001	23	17	26	73
2002	21	18	29	86
2003	22	19	26	52
2004	21	18	27	38
2005	22	18	26	48
2006	22	14	30	79
2007	22	17	27	71
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
2018	23	17	28	206
2019	21	13	27	87
2020	21	10	38	419
2021	22	17	27	430
2022	22	14	29	266

Table 5. Summary of red drum age samples collected from both dependent (commercial and recreational fisheries) and independent (surveys) sources, 1989–2022. Age sampling was limited in 2020 due to the adult long line survey not being conducted.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
1989	1	0	56	312
1990	1	0	52	345
1991	1	0	48	259
1992	1	0	56	440
1993	1	0	62	428
1994	1	0	41	297
1995	1	0	47	482
1996	1	0	54	383
1997	1	0	56	465
1998	1	0	31	612
1999	1	0	26	530
2000	1	0	17	470
2001	1	0	41	466
2002	1	0	24	361
2003	1	0	28	262
2004	1	0	25	342
2005	1	0	34	484
2006	1	0	32	641
2007	1	0	37	495
2008	1	0	35	574
2009	1	0	36	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	38	653
2017	1	0	39	726
2018	1	0	42	594
2019	1	0	33	722
2020	1	0	16	315
2021	1	0	43	998
2022	2	0	43	773

Table 6. Summary of red drum tagging and recapture data 2014–2022.

Year Tagged	Total Fish Tagged (#)	Total Fish Recaptured (#)	Average Days At Large	Max Days At Large	Average Distance Traveled (miles)	Max Distance Traveled (miles)
2014	1,197	53	290	1,908	34	174
2015	2,124	191	272	2,258	22	230
2016	2,572	227	274	2,060	18	276
2017	2,570	223	268	1,986	17	137
2018	1,601	156	225	1,267	19	135
2019	1,355	160	300	1,068	15	141
2020	1,274	191	215	906	15	559
2021	1,187	132	165	568	12	111
2022	1,064	83	107	279	10	153

## FIGURES

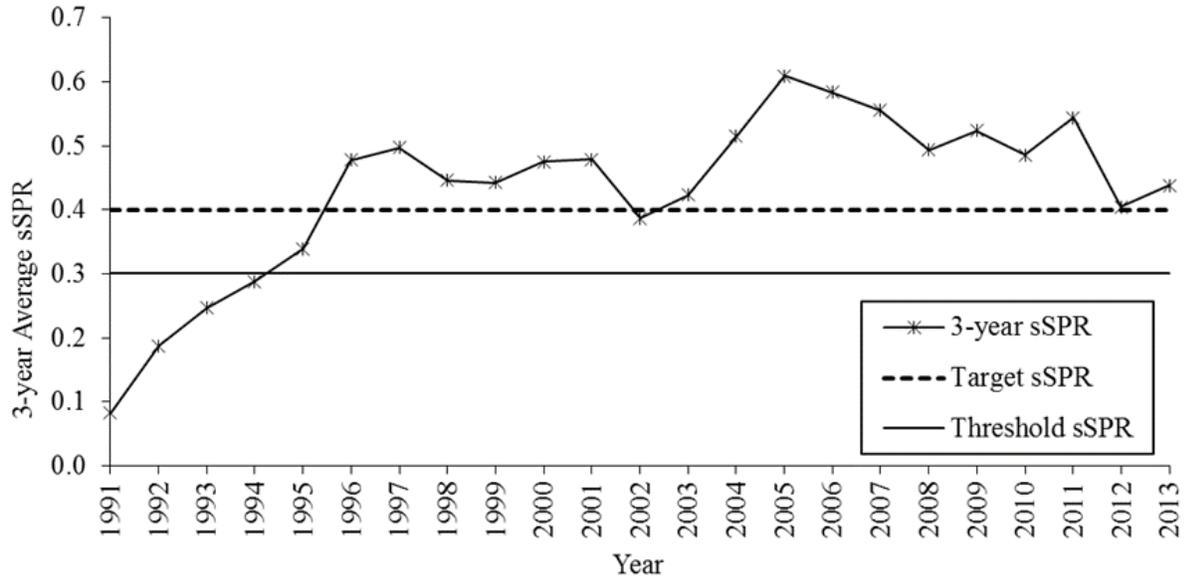


Figure 1. Northern region (North Carolina north) red drum estimates of three-year average static spawning potential ratios (sSPR). Three-year average includes current and previous two year's sSPR estimates. The dashed line shows the 30% overfishing threshold and the solid line shows the 40% target sSPR (Source: ASMFC 2017).

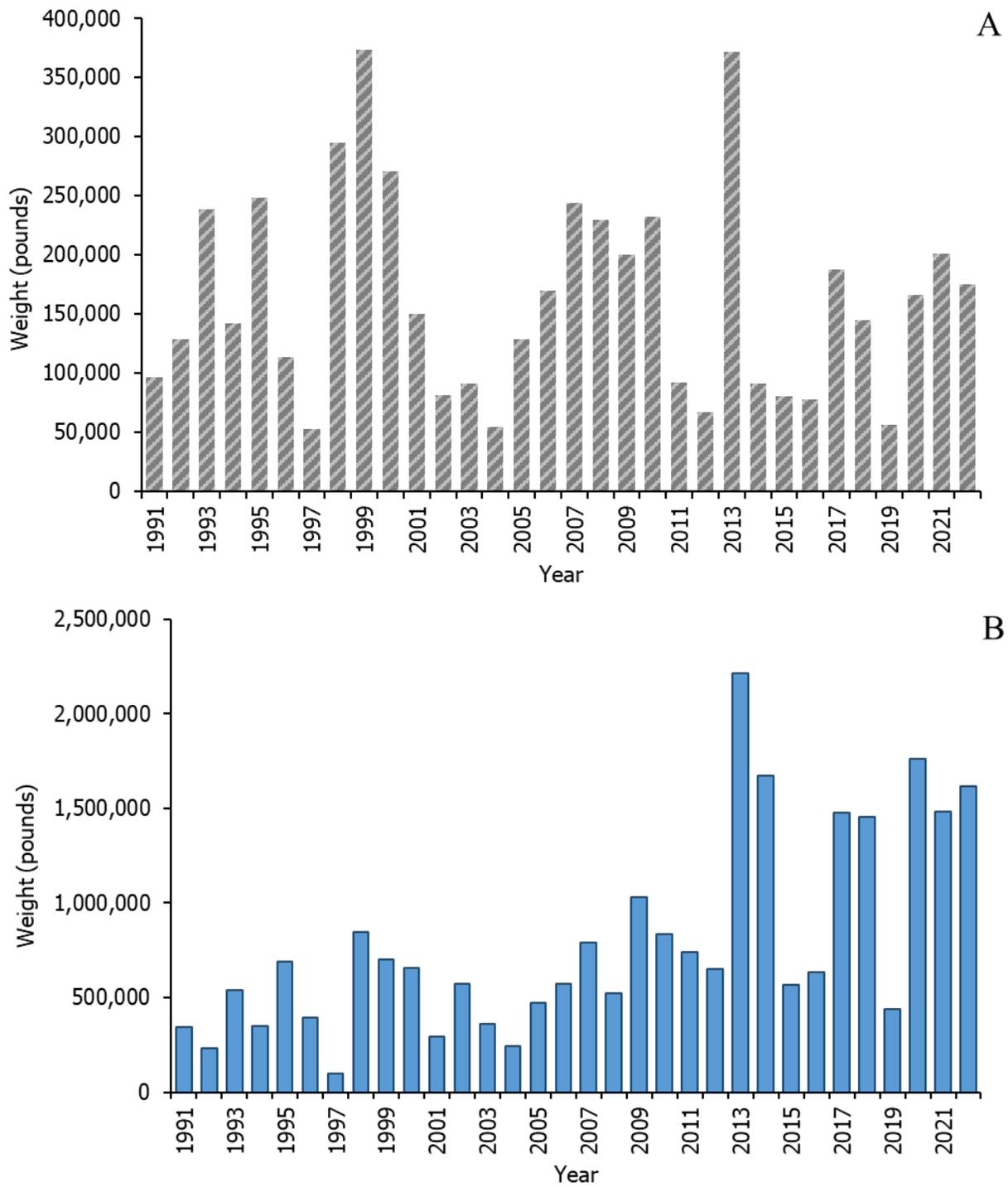


Figure 2. Annual commercial (A) and recreational (B) landings in pounds for red drum in North Carolina from 1991–2022.

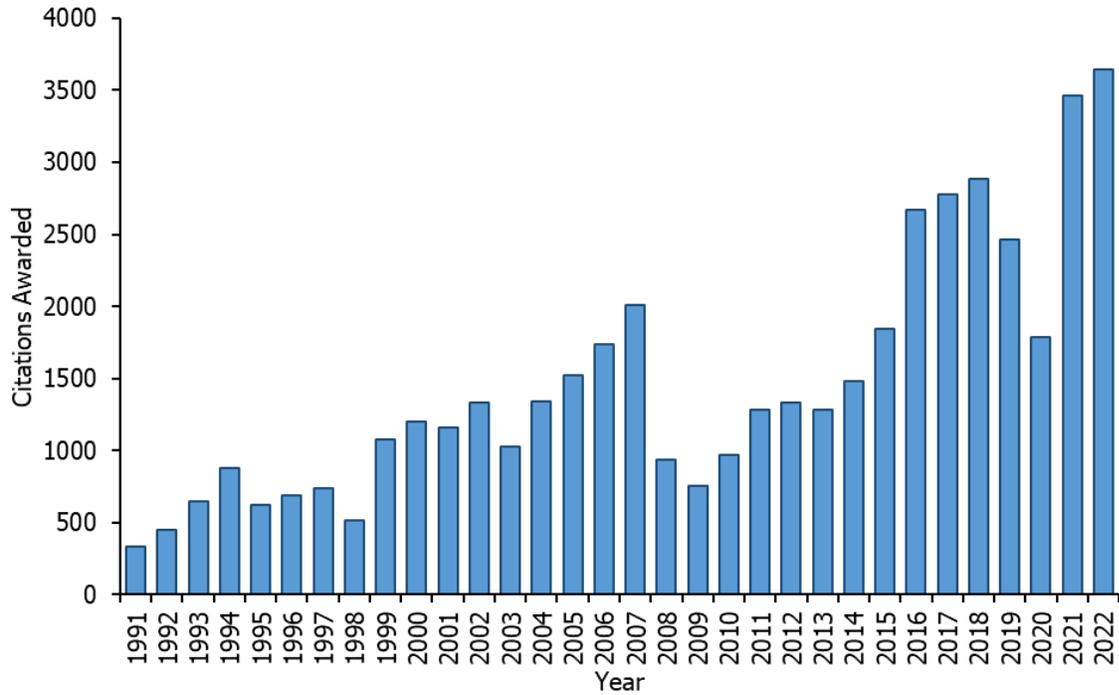


Figure 3. North Carolina Saltwater Fishing Tournament citations awarded for red drum, 1991–2022. Citations are awarded for red drum greater than 40 inches total length. Prior to 1998, citations were awarded for either a red drum released ( $\geq 40$  inches total length) or harvested ( $\geq 40$  pounds). Since 1998, all citations are for released fish only.

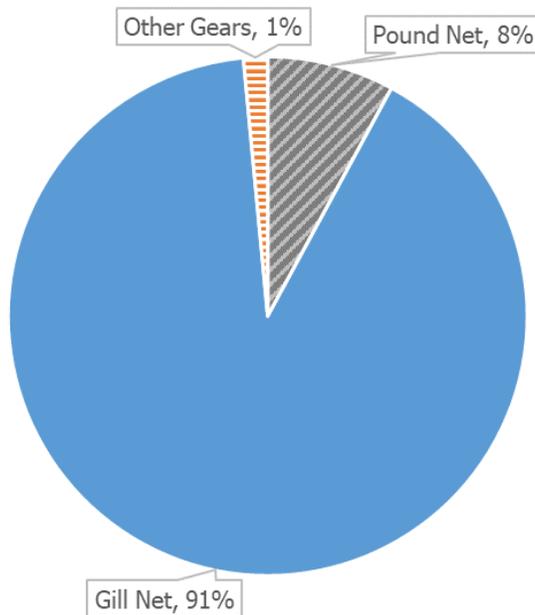


Figure 4. Red drum commercial harvest in 2022 by gear type.

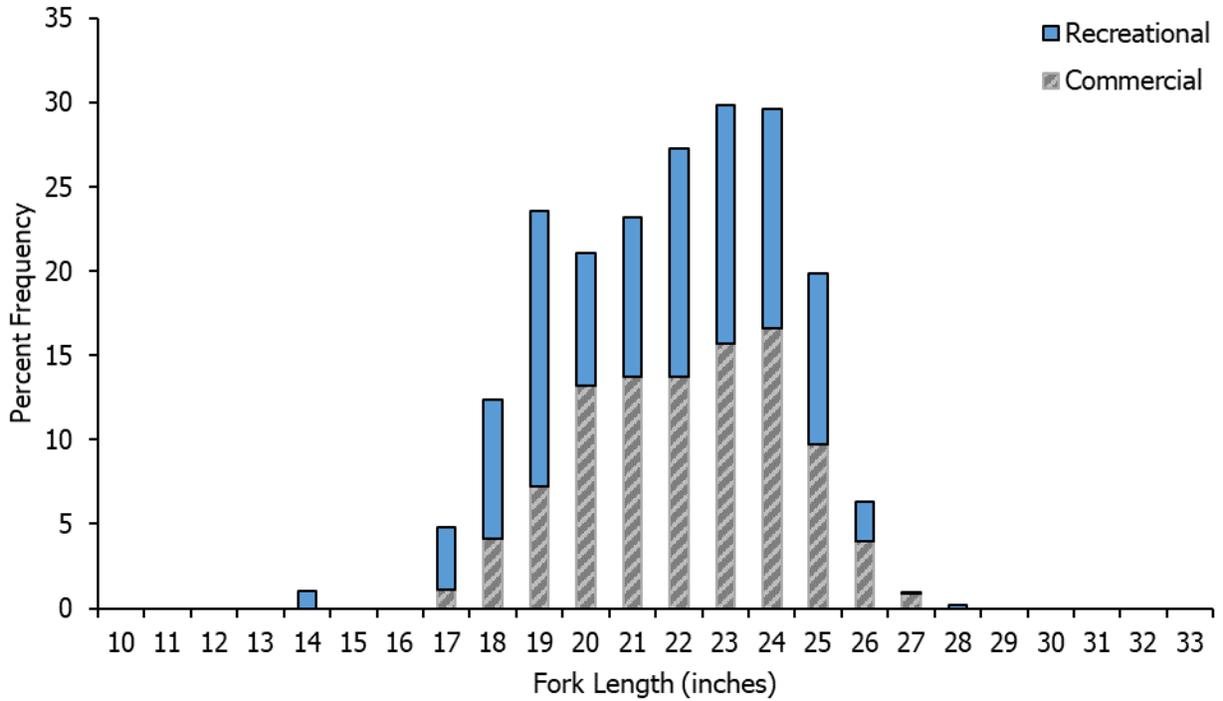


Figure 5. Commercial and recreational length frequency distribution from red drum harvested in 2022.

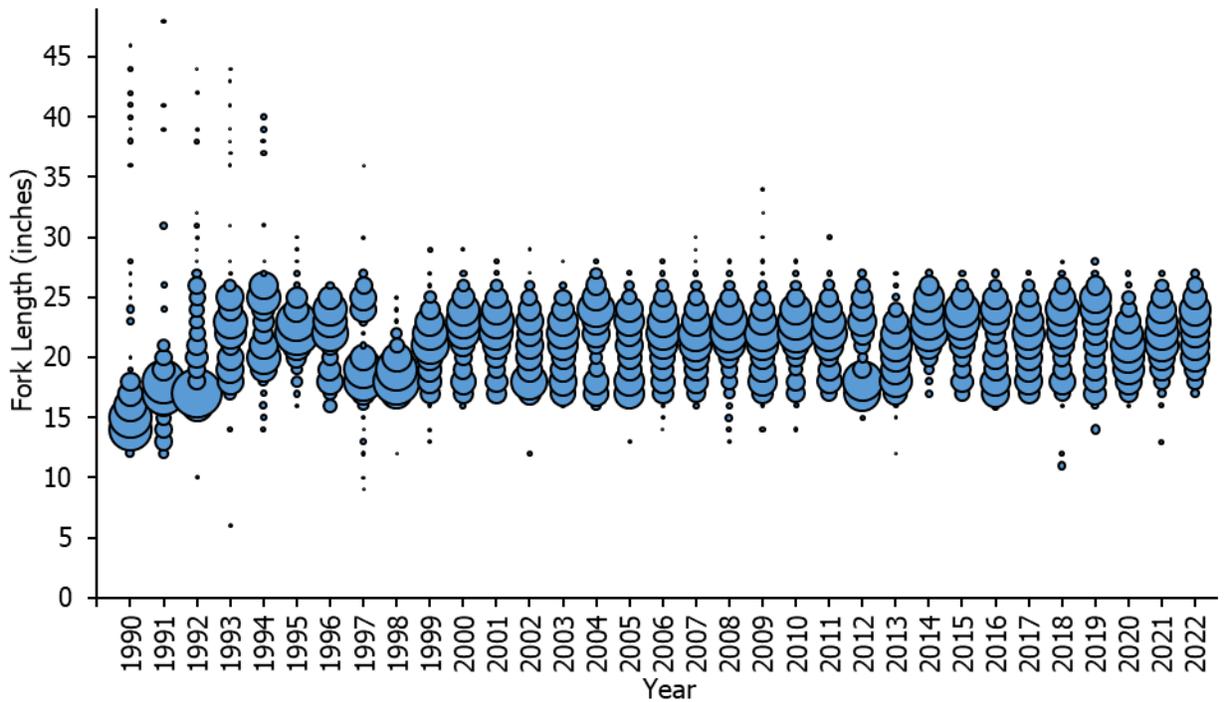


Figure 6. Commercial length frequency (fork length, inches) of red drum harvested, 1990–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

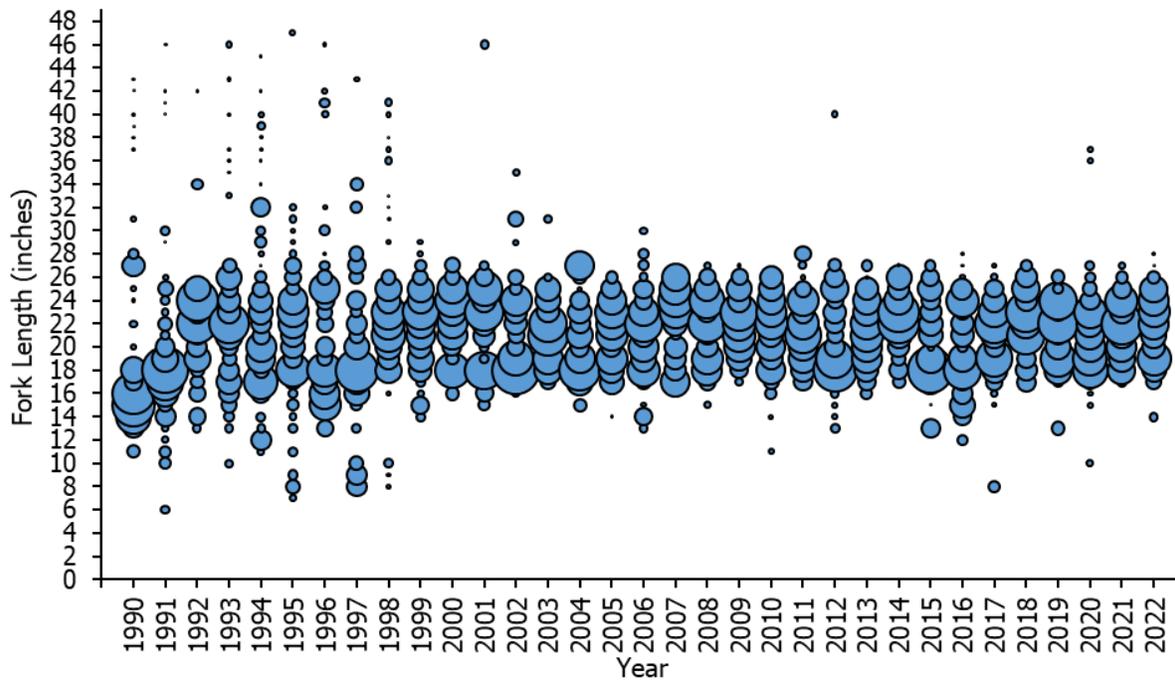


Figure 7. Recreational length frequency (fork length, inches) of red drum harvested, 1990–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

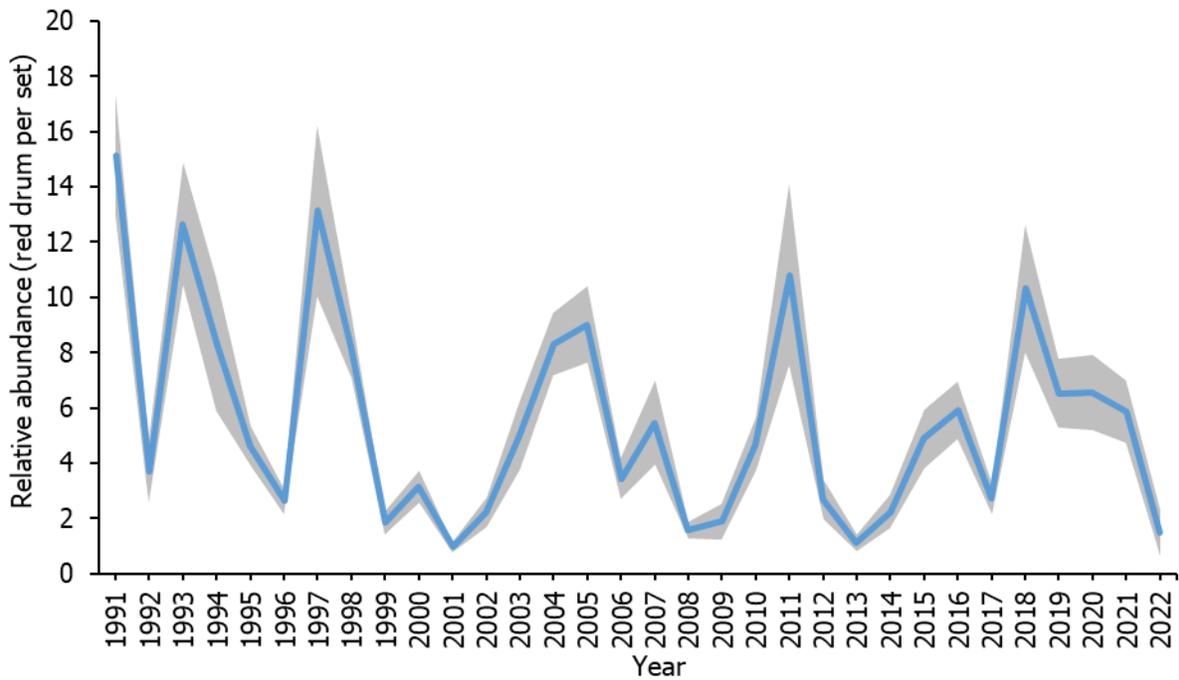


Figure 8. The annual juvenile (age-0) abundance index with standard error shaded in gray from the North Carolina Red Drum Juvenile Seine Survey, 1991–2022.

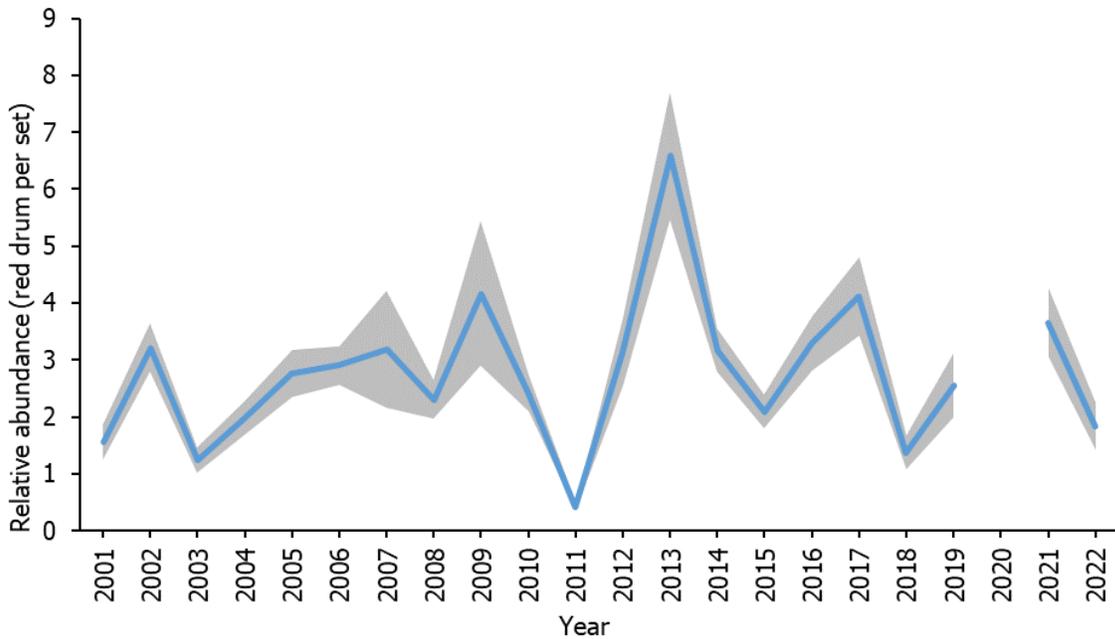


Figure 9. Annual weighted red drum index (number captured ages combined) with standard error shaded in gray from the North Carolina Pamlico Sound Independent Gill Net Survey, 2001–2022. Survey was not conducted in 2020 due to COVID pandemic.

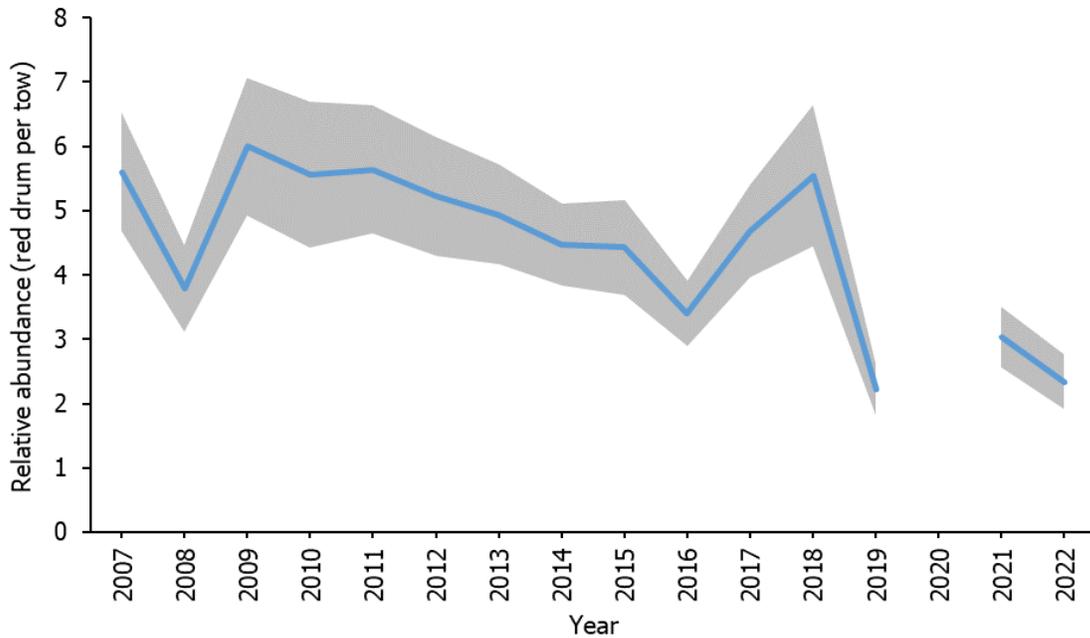


Figure 10. Annual adult red drum index (number captured for ages combined) with standard error shaded in gray from the North Carolina Red Drum Longline Survey, 2007–2022. Sampling in 2019 was adversely impacted by a hurricane event and survey was not conducted in 2020 due to COVID pandemic. Sampling resumed in July of 2021. Sampling in 2022 was limited to August and September due to mechanical issues with sampling gear (64 sets).

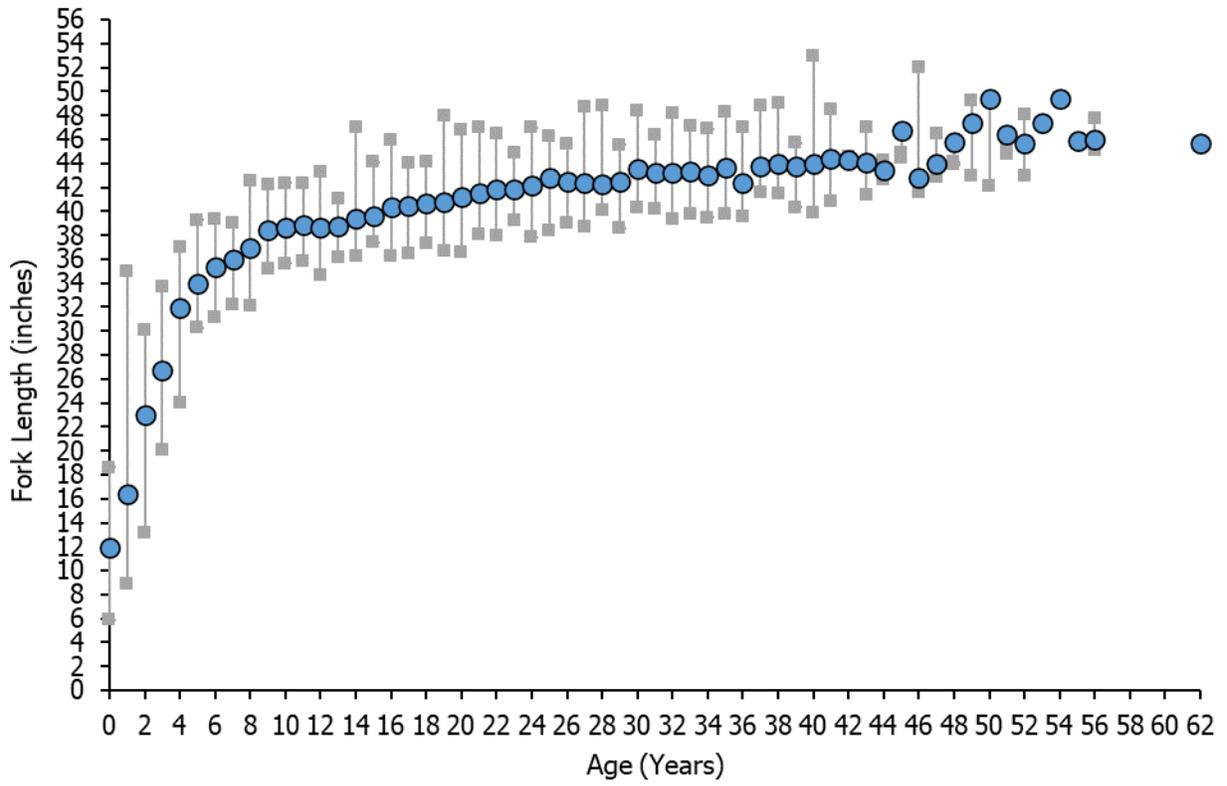


Figure 11. Red drum length-at-age based on all age samples collected, 1983–2022. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age.

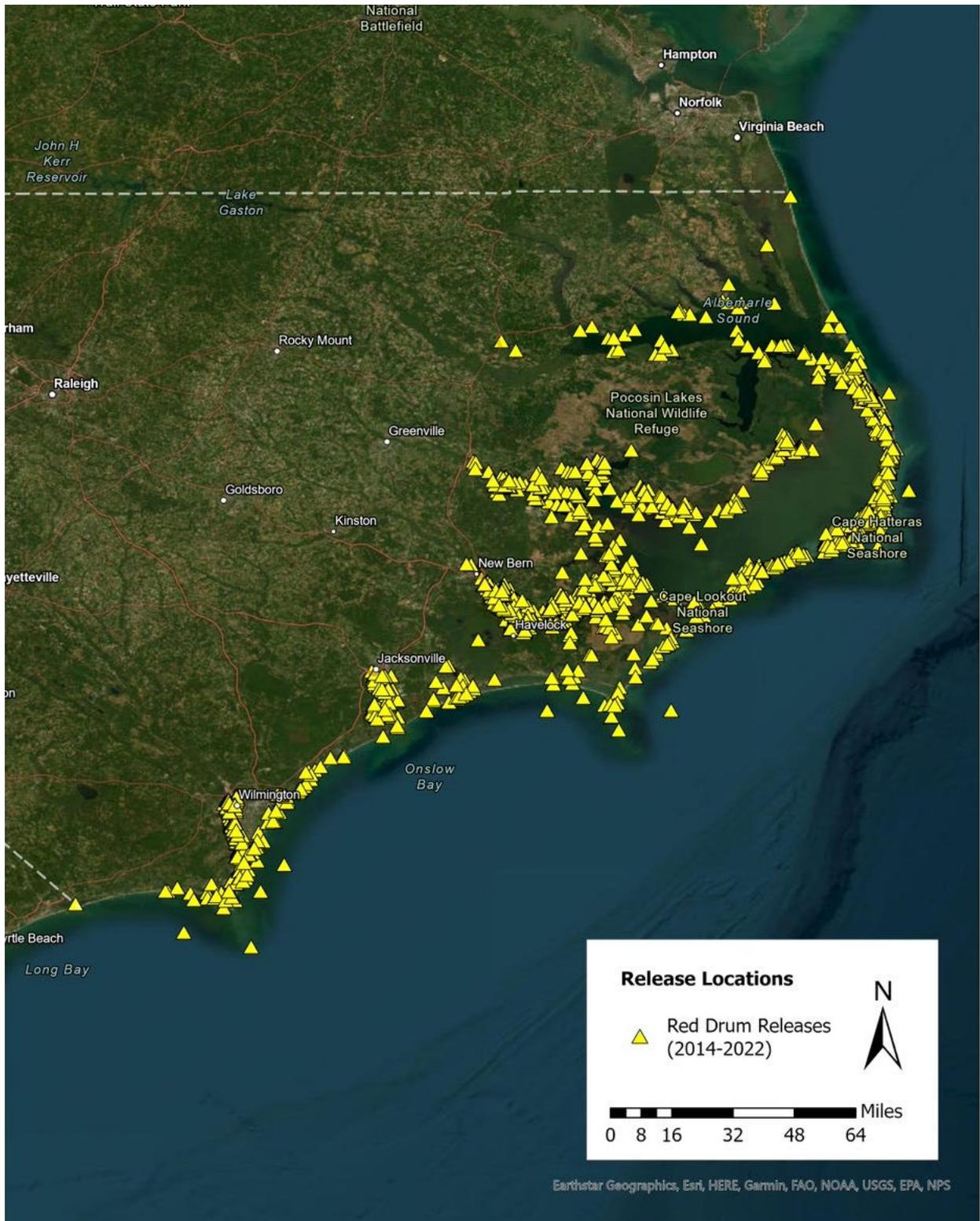


Figure 12. Red drum tagging release locations 2014-2022.

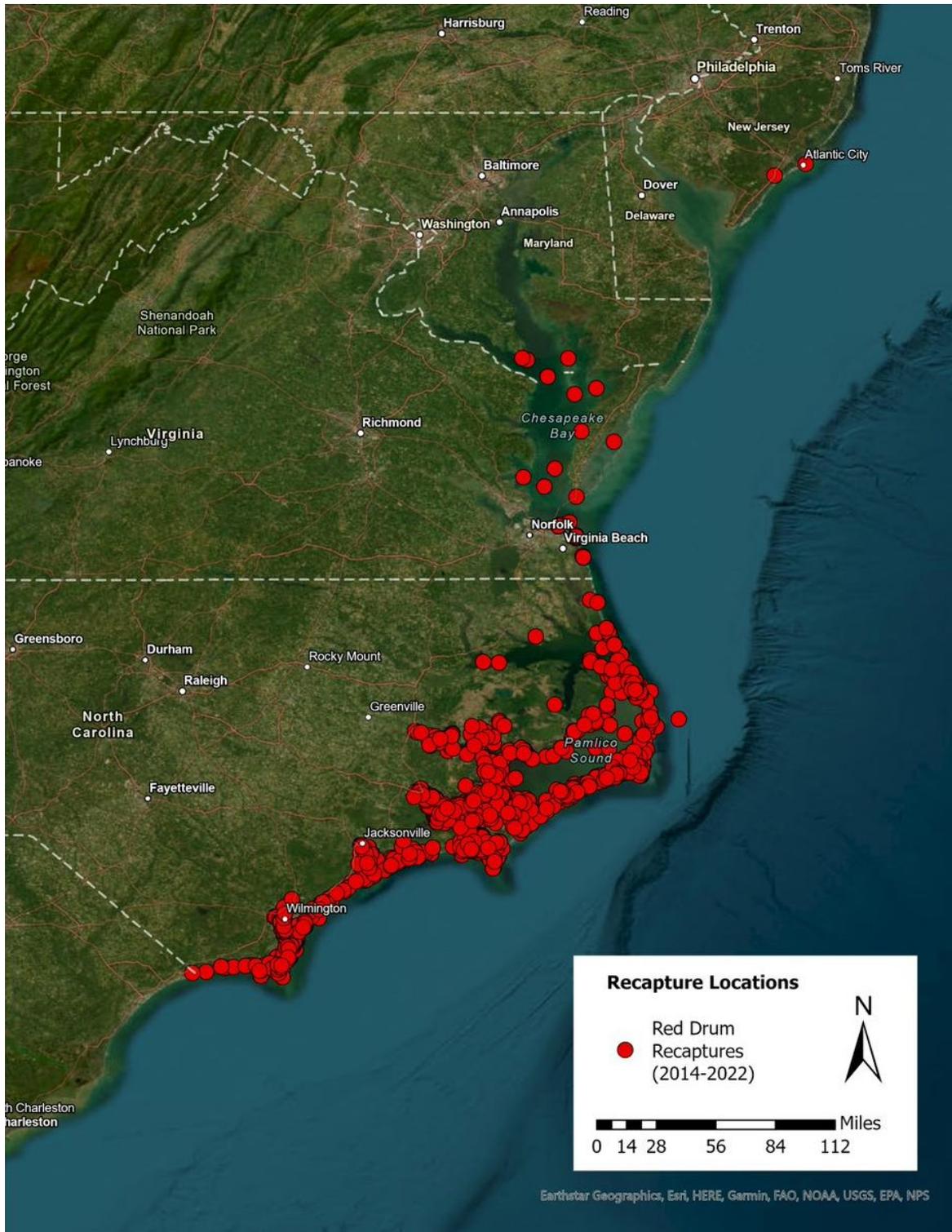


Figure 13. Red drum tagging recapture locations 2014-2022.

STATE MANAGED SPECIES – RIVER HERRING

**FISHERY MANAGEMENT PLAN UPDATE  
RIVER HERRING  
AUGUST 2023**

**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	
Comprehensive Review:	2027	

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 Fishery Management Plan (FMP) for River Herring. The original FMP, adopted February 2000, focused on issues pertaining to stock conditions (overfished and recruitment overfishing), habitat degradations, and research/monitoring expansion to provide assessment and socioeconomic data (NCDMF 2000). Amendment 1 implemented a no-harvest provision for commercial and recreational fisheries of river herring in coastal waters of the state, effective in 2007 (NCDMF 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 (Grist 2005). Additional management strategies included gear restrictions and stock recovery indicators (based on blueback herring). Amendment 1 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 DMF Director allocated a maximum of 4,000 pounds to be used for this discretionary harvest season by permitted fishermen, 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 was finalized in 2015 with three management issues: 1) eliminating the discretionary river herring harvest season and permit since it was not serving 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 (NCDMF 2015a).

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, river herring 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 (ASMFC 2009). Additionally, Amendment 2 requires that states and jurisdictions develop sustainable FMPs to maintain a commercial and/or recreational river herring fishery past January 2012. Since a no-harvest provision is in place, North Carolina does not have a sustainable FMP. If Amendment 2 established targets are met in the future and allowing harvest is desired, a sustainable FMP would need to be developed by the state and approved by the ASMFC.

To ensure compliance with ASMFC interstate requirements, North Carolina also manages river herring 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 2015b).

## **Management Unit**

Blueback herring and alewife management authority lies with the ASMFC. Responsibility for management action in the Economic Exclusive Zone (EEZ), located 3–200 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 DMF 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:

- Identify and describe population attributes necessary to sustain long-term stock viability.
- Protect, restore, and enhance spawning and nursery area habitats.
- 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.
- 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:

- Prevent further declines in river herring (alewife and blueback herring) abundance.
- Improve our understanding of bycatch mortality by collecting and analyzing bycatch data.
- 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.
- Retain existing or more conservative regulations for American shad and hickory shad.
- Promote improvements in degraded or historic alosine critical habitat throughout the species' range.

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

River herring is a collective term for alewife and blueback herring. River herring are anadromous fish, meaning they migrate from the ocean, into coastal bays and sounds, and 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 abundant in waters from the Chesapeake Bay south. Mature alewife (ages 3–9) and blueback herring (ages 3–9) 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 river herring after they emigrate to the sea and before they mature and return to freshwater to spawn.

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 river herring stock assessment update was completed in August 2017, with data through 2015, by the ASMFC. 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 ASMFC 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), the stock remains overfished. The factors leading to the stock status remain largely unchanged since the 2012 stock assessment, despite insignificant fishing pressure. The spawning stock biomass (SSB) for blueback herring, a stock status indicator, remains 12% 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 to 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 North Carolina Amendment 2 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%, but has exceeded the target since 2011 to the highest level in 22 years of 16.8% in 2015. The SSB for blueback herring has been increasing since 2010 but remains at approximately 12% of the target of 3.9 million pounds. The ASMFC is conducting a benchmark stock assessment for river herring with data through 2021. The results of the assessment are expected to be available in early 2024.

It is worthy to note the importance habitat and water quality play in the recovery of the river herring stocks in North Carolina and coastwide (NCDMF 2009). In North Carolina, considerable habitat 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 years. The DMF initiated a survey of culverts and obstructions following Amendment 1 to the North Carolina River Herring FMP. The list created from the survey has resulted in the replacement of failing culverts and prioritized others for replacement or repair.

## **DESCRIPTION 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 (MFC) 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 (blueback herring and alewife) greater than six inches aboard a vessel or while engaged in fishing from the shore or a pier.

### **Commercial Fishery**

North Carolina landings of river herring from 1972 through the mid-1980s peaked at 11.5 million pounds (Table 1, Figure 2). Most landings occurred in the Chowan River and Albemarle Sound system. River herring landings declined sharply starting in 1986, prior to the implementation of regulations specific to river herring, first implemented in 1995. Amendment 1 implemented a no-harvest provision in 2007, allowing only for a limited discretionary harvest to provide local herring to festivals and continue DMF data collection from commercial fisheries. Table 2 includes information on landings data from 2007 through 2014 when the limited research set-aside season was prosecuted before being eliminated under Amendment 2 in 2015.

### **Recreational Fishery**

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 DMF since 1972 in the Chowan River. 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.

Table 3 and Table 4 describe the mean, minimum, and maximum length data for blueback herring and alewife from 1972 to 2022. In 2022, a total of 600 blueback herring and 1,099 alewife were measured from the Chowan River pound net survey. The overall average size of blueback herring was 8.75 inches fork length and 9.25 inches fork length for alewife. Variation in modal, minimum, and maximum ages throughout the fishery-dependent monitoring is described in Table 5 for blueback herring and Table 6 for alewife, with little variation across the time-series. Figure 3 and

Figure 4 illustrate the overall length at age (mean, minimum, and maximum) for blueback herring and alewife from all age samples collected at any given age from 1972 to 2021. Age data for 2022 are not available for this update and will be included in the 2023 update.

The DMF has monitored river herring repeat spawning since 1972 (Table 7, Figure 5). Percent repeat spawners for blueback herring from the Chowan River spawning stock is one of the stock recovery indicators identified in North Carolina River Herring FMP Amendment 2. The Chowan River blueback herring spawning stock should contain at least 10% repeat spawners (percent of the spawning stock that have spawned more than once). Since 2011, percentages of blueback herring have increased to levels above the restoration target, with the exception of 2017. For alewife percentages have been above the restoration target since 2007, with the exception of 2014. Repeat spawner data for 2022 is not available for this update and will be included in the 2023 update.

Total pound-net effort (operable nets per week) estimated total river herring catch (pounds), and CPUE for the Chowan River Pound Net Survey (Table 8) shows a downward trend through 2012 followed by an increasing trend through 2017. Since 2017, CPUE has declined with 2021 having the lowest CPUE in the time series. The participating pound net fishermen contributed environmental conditions, such as drought and a warm spring, to the decrease in estimated river herring landings in 2021. In 2022, the CPUE increased and was above average for the time series. Approximately 36% of the estimated total river herring catch were blueback herring, based on the weekly subsample of river herring from the survey. The Chowan River Pound Net Survey was operated for 16 weeks in 2022, from late January to middle of May. Alewife were present in the weekly subsample for 14 weeks (starting in late January) and bluebacks were present for nine weeks (starting in early March).

### **Fishery-Independent Monitoring**

The DMF has conducted the Juvenile Anadromous Survey (Program 100) for river herring, annually since 1972. The survey has been conducted twice a month, using seines, at eleven fixed sites, in the Albemarle Sound-Chowan River area from June through October. Only the first sample from each month is used to calculate the CPUE for juvenile river herring (age 0). CPUE of blueback herring is one of the stock status indicators identified in Amendment 2. The blueback herring CPUE should exceed the three-year moving average threshold of 60-fish per haul, the average for 2020–2022 is 5.53 blueback herring per haul. The three-year average CPUE of juvenile blueback herring has remained well below the threshold of 60-fish per haul since the mid-1980's (Figure 6). Due to the low numbers of juvenile alewife caught across the time series, these data have not been used for management and are only shown here as an illustration of the trend in abundance (Figure 7). In 2022 overall CPUE was 11.06 for blueback herring, which was an increase from the previous year (1.49 blueback herring per haul). The 2022 overall CPUE was 0.45 for alewife, which was a decrease from the previous year (14.63 alewife per haul).

Adult river herring are monitored using the DMF Albemarle Sound Independent Gill Net Survey (Program 135). Program 135 began collecting biological data on adult river herring in 1991 but did not start collecting aging structures until 1999. The survey uses a stratified random sampling scheme designed to characterize the size and age distribution for key estuarine species in the Albemarle Sound.

Program 135 was suspended in February 2020 due to COVID-19 restrictions and protected species interactions. The survey resumed in the fall of 2021. In November 2021, the Albemarle Sound Independent Gill Net Survey (IGNS) expanded from six to eight zones and reduced soak time from 24-hours to 12-hours. Additionally, in March 2022, sink gill nets were removed from the survey, reducing effort to 480 yards per set (12 units of effort). Additional zones were added to meet DMF research priorities to expand the spatial coverage of the survey. Soak times were reduced and sink nets were removed to reduce interactions with endangered species through ongoing consultation with the United States Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Association (NOAA Fisheries). It should be noted that with such a major change in survey design, the index derived from this survey starting in November 2021 will not be directly comparable to the prior historical time series. When calculating blueback herring and alewife relative abundance using historical IGNS data, all sink gill nets were removed. It is important to note that most blueback herring and alewife intercepted in the IGNS survey are from float gill nets. Therefore, the removal of sink gill nets from the data set did not significantly impact the relative abundance estimates of American shad from the survey.

The river herring relative abundance index has been calculated from Program 135 since 1991 from the 2.5 and 3.0 inch stretched mesh (combined, float net only). Blueback herring and alewife relative abundance index from January through May for the period 1991–2022, are shown in Table 9 and Figure 8. Catch of both species has increased since 2012. No index of abundance is available for 2020 and 2021.

Table 10 and Table 11 describe the mean, minimum and maximum length data for blueback and alewife from Program 135 for the period 1991–2022. Variation in modal, minimum, and maximum ages throughout Program 135 is described in Table 12 for blueback herring and Table 13 for alewife, with little variation since aging began in 2004. Figure 9 and Figure 10 illustrate the overall length at age (mean, minimum, and maximum) for blueback herring and alewife from all age samples collected at any given age from Program 135 for the period 1999–2021. Age data for 2022 is not available for this update and will be included in the 2023 update.

## **RESEARCH NEEDS**

On an annual basis the ASMFC publishes a prioritized list of short term and long-term research needs for American shad and river herring in the Review of the Atlantic States Marine Fisheries Commission Fishery Management Plan for Shad and River Herring (ASMFC 2020).

For more information on research needs for River herring please see: [https://asmfc.org/uploads/file/64010087Approved\\_SRH\\_FMP\\_Report\\_FY\\_2021\\_2.2.23.pdf](https://asmfc.org/uploads/file/64010087Approved_SRH_FMP_Report_FY_2021_2.2.23.pdf)

## **MANAGEMENT STRATEGY**

Amendment 1 to the North Carolina River Herring FMP implemented four stock recovery indicators to evaluate stock status. Under Amendment 2 to the North Carolina 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, using blueback herring as the indicator species. The three stock status indicators were adopted by the North

Carolina 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.

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

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 stock status indicator for percent repeat spawners of blueback herring has exceeded the target of 10% 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 threshold 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. The estimate for spawning stock biomass will be updated with data through 2021 during the next ASMFC coastwide stock assessment for river herring, scheduled for completion in early 2024.

The MFC implemented a series of management strategies under North Carolina River Herring FMP Amendment 2. These management strategies and their implementation status are listed in Table 14.

## **FISHERY MANAGEMENT PLAN SCHEDULE RECOMMENDATIONS**

Amendment 2 to the North Carolina River Herring FMP was adopted by the Marine Fisheries Commission in 2015. An Atlantic coastwide stock assessment update for river herring was completed in August 2017, with data through 2015, by the ASMFC. Results indicate that river herring remain depleted and at near historic lows on a coastwide basis (ASMFC 2017). The 5-year FMP review that was scheduled for 2020 was postponed through 2021. The 2021 FMP update was adopted by the MFC as the 5-year review at the August 2022 business meeting.

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## TABLES

Table 1. Commercial harvest (weight in pounds) of river herring from North Carolina, 1972–2006. Commercial harvest prohibited since 2007.

Year	Commercial Weight Landed (lb)	Year	Commercial Weight Landed (lb)
1972	11,237,143	1990	1,157,625
1973	7,925,898	1991	1,575,378
1974	6,209,542	1992	1,723,178
1975	5,952,067	1993	916,235
1976	6,401,360	1994	644,334
1977	8,523,813	1995	453,984
1978	6,607,153	1996	529,503
1979	5,119,150	1997	334,809
1980	6,218,523	1998	521,930
1981	4,753,723	1999	443,494
1982	9,437,703	2000	332,336
1983	5,868,332	2001	306,761
1984	6,516,109	2002	174,860
1985	11,548,278	2003	199,716
1986	6,814,323	2004	188,541
1987	3,194,975	2005	250,021
1988	4,191,211	2006	109,847
1989	1,491,077		
		Mean	3,114,461

Table 2. Harvest (weight in pounds) and value of river herring from the North Carolina discretionary river herring harvest season, 2008–2014.

Year	Permits Issued	Quota (lb/permit/ period)	Weight landed (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

Table 3. Mean, minimum, and maximum lengths (fork length, inches) of blueback herring measured from the Chowan River commercial fisheries, 1972–2022. \*In 2007 a no-harvest provision for river herring went into effect and the Chowan River Pound Net survey began in 2009.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1972	9.75	7.00	11.50	2,564
1973	9.75	5.50	11.50	2,208
1974	9.75	7.25	11.50	1,622
1975	9.50	6.00	11.00	2,428
1976	9.75	8.25	11.25	1,564
1977	9.75	5.50	11.75	1,425
1978	10.00	8.25	11.75	1,342
1979	10.00	8.25	12.25	1,218
1980	10.00	8.25	11.50	1,229
1981	10.00	8.50	12.00	1,469
1982	9.75	8.75	11.50	851
1983	9.50	8.25	11.25	482
1984	9.25	7.75	11.25	450
1985	9.50	8.50	11.25	388
1986	9.50	7.25	10.75	347
1987	9.50	8.00	11.00	318
1988	9.25	8.00	11.25	314
1989	9.25	8.25	10.75	273
1990	9.25	8.00	10.75	275
1991	9.25	8.00	11.00	357
1992	9.25	8.00	10.75	368
1993	9.25	7.50	10.50	160
1994	8.75	8.00	10.75	84
1995	9.25	8.25	10.50	322
1996	9.50	8.00	11.25	626
1997	9.50	8.00	11.25	625
1998	9.25	6.00	11.00	1,361
1999	9.50	7.75	11.00	720
2000	9.00	7.75	11.00	1,213
2001	9.25	7.75	10.75	667
2002	9.25	8.00	10.75	338
2003	9.00	7.50	10.50	304
2004	9.00	7.75	10.25	245
2005	9.00	7.75	10.75	305
2006	8.75	7.75	10.00	156
2007	9.00	7.75	10.75	231
2008	8.75	7.50	11.00	928
2009*	9.00	7.75	10.50	546
2010*	8.75	7.50	10.25	833
2011*	9.00	7.50	10.50	500
2012*	9.00	7.00	10.50	412
2013*	9.00	7.75	10.75	492
2014*	8.50	7.50	10.25	691
2015*	8.75	7.75	10.75	589
2016*	8.75	7.75	11.00	456
2017*	9.00	7.50	10.25	528
2018*	9.00	7.75	10.50	1,232
2019*	9.25	8.00	10.50	868
2020*	9.25	8.00	10.75	733
2021*	9.00	7.50	10.25	525
2022*	8.75	7.50	10.75	600

Table 4. Mean, minimum, and maximum lengths (fork length, inches) of alewife measured from the Chowan River commercial fisheries, 1972–2022. \*In 2007 a no-harvest provision for river herring went into effect and the Chowan River Pound Net survey began in 2009.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1972	10.25	6.25	12.25	1,337
1973	10.00	7.75	12.25	1,471
1974	9.00	5.75	11.25	616
1975	9.75	7.75	12.00	2,440
1976	9.75	8.25	12.00	2,029
1977	10.00	5.00	12.25	2,024
1978	10.25	7.75	11.50	997
1979	10.00	7.75	11.50	1,143
1980	10.00	8.50	12.25	551
1981	9.75	8.50	11.25	1,052
1982	9.75	8.50	12.00	752
1983	9.75	8.00	11.00	457
1984	9.75	8.75	11.75	351
1985	9.75	8.25	11.00	272
1986	9.25	8.25	11.00	203
1987	9.25	8.00	11.50	389
1988	9.50	8.00	10.75	312
1989	9.50	8.25	10.75	262
1990	9.50	8.00	11.00	194
1991	9.50	7.75	11.25	502
1992	9.25	7.75	11.00	300
1993	8.50	7.50	10.00	183
1994	8.50	8.00	9.00	2
1995	9.75	8.75	10.25	41
1996	9.50	8.50	10.50	42
1997	9.50	8.75	10.75	47
1998	9.50	7.75	11.00	55
1999	9.25	8.25	10.00	6
2000	9.25	7.75	10.50	798
2001	9.50	8.25	10.75	835
2002	9.75	7.75	10.75	963
2003	9.50	7.75	11.50	1,004
2004	9.50	8.00	11.25	720
2005	9.50	7.75	11.25	539
2006	9.50	7.75	12.25	553
2007	9.00	7.75	11.00	45
2008	9.00	7.50	11.25	1,872
2009*	9.25	7.75	10.75	1,000
2010*	9.50	8.00	11.00	822
2011*	9.75	8.00	11.25	806
2012*	9.75	7.50	11.25	641
2013*	9.25	7.75	13.00	854
2014*	9.25	8.00	11.50	1,037
2015*	9.25	8.00	11.00	998
2016*	9.25	7.75	11.25	773
2017*	9.25	7.75	14.00	1,336
2018*	9.25	7.75	11.25	1,360
2019*	9.50	8.00	11.25	1,004
2020*	9.50	8.00	11.25	1,266
2021*	9.25	7.50	11.00	873
2022*	9.25	8.00	11.25	1,099

Table 5. Modal age, minimum age, maximum age, and number aged for blueback herring collected through DMF fishery-dependent sampling programs, 1972–2021. \*In 2007 a no-harvest provision for river herring went into effect and the Chowan River Pound Net survey began in 2009. Age data for 2022 are unavailable.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
1972	5	2	8	1,215
1973	5	3	8	1,092
1974	4	3	8	920
1975	4	3	8	951
1976	4	3	9	862
1977	5	3	8	767
1978	4	3	7	694
1979	5	3	8	942
1980	5	3	8	1,079
1981	5	3	9	794
1982	4	3	9	478
1983	4	3	8	314
1984	4	3	8	283
1985	5	3	7	249
1986	5	3	7	230
1987	4	3	7	208
1988	4	3	7	201
1989	4	3	6	184
1990	4	2	7	189
1991	4	2	7	242
1992	4	3	7	220
1993	5	2	8	112
1994	4	3	7	71
1995	5	3	7	192
1996	5	3	7	279
1997	4	3	7	180
1998	5	2	7	462
1999	5	3	7	389
2000	4	3	9	512
2001	5	3	7	311
2002	5	3	7	164
2003	5	3	7	147
2004	4	3	6	130
2005	4	3	6	162
2006	4	3	5	86
2007	5	3	6	143
2008	4	3	7	474
2009*	4	3	7	251
2010*	4	3	7	247
2011*	4	3	6	175
2012*	4	3	7	189
2013*	5	3	7	217
2014*	4	3	7	198
2015*	4	3	7	184
2016*	4	3	8	226
2017*	5	3	7	250
2018*	4	3	6	272
2019*	4	3	7	276
2020*	4	3	7	253
2021*	5	3	7	221

Table 6. Modal age, minimum age, maximum age, and number aged for alewife collected through DMF fishery-dependent sampling programs, 1972–2021. \*In 2007 a no-harvest provision for river herring went into effect and the Chowan River Pound Net survey began in 2009. Age data for 2022 are unavailable.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
1972	4	3	9	783
1973	4	3	9	721
1974	4	2	7	417
1975	4	2	9	842
1976	4	3	7	853
1977	5	3	8	759
1978	4	3	8	736
1979	4	3	8	701
1980	5	3	8	492
1981	5	4	8	532
1982	4	3	7	444
1983	4	3	7	295
1984	4	3	7	248
1985	5	3	7	195
1986	4	3	6	146
1987	4	3	7	266
1988	4	2	6	228
1989	4	3	7	179
1990	4	2	7	153
1991	5	3	7	319
1992	5	2	8	242
1993	4	2	7	130
1994	4	4	4	2
1995	5	4	6	40
1996	4	3	7	41
1997	4	3	7	18
1998				
1999	3,6	3	6	6
2000	5	3	7	300
2001	5	3	7	369
2002	5	3	7	341
2003	4	2	7	350
2004	5	2	7	318
2005	5	3	7	253
2006	4	3	7	260
2007	4	3	6	30
2008	5	4	8	588
2009*	5	3	7	342
2010*	6	3	7	277
2011*	6	3	8	211
2012*	6	3	8	259
2013*	5	2	7	308
2014*	4	2	6	328
2015*	4	3	7	206
2016*	4	3	8	311
2017*	5	3	7	346
2018*	4	3	7	375
2019*	4	3	7	286
2020*	4	4	8	310
2021*	4	3	9	335

Table 7. Blueback herring and alewife percent (%) repeat spawners from the Chowan River pound net survey, 1972–2021. Blueback herring percent repeat spawner is a stock status indicator. Repeat spawner data are unavailable for 2022.

Year	Percent (%)	
	Blueback Herring	Alewife
1972	22	15
1973	17	14
1974	18	4
1975	6	10
1976	11	8
1977	9	5
1978	6	8
1979	16	9
1980	19	18
1981	48	29
1982	11	1
1983	14	2
1984	7	34
1985	10	12
1986	16	4
1987	22	
1988	11	6
1989	4	9
1990	12	17
1991	31	21
1992	26	48
1993	12	5
1994	5	
1995	6	8
1996	13	29
1997	15	29
1998	7	
1999	13	67
2000	14	8
2001	9	13
2002	13	38
2003	16	30
2004	9	20
2005	13	15
2006	0	9
2007	9	10
2008	5	14
2009	3	14
2010	6	41
2011	12	27
2012	13	29
2013	14	11
2014	13	5
2015	17	18
2016	16	20
2017	7	33
2018	11	31
2019	13	24
2020	11	35
2021	16	37

Table 8. River herring total pound net effort, estimated catch (weight in pounds) and catch per unit effort for the Chowan River pound net survey, 2009–2022.

Year	Total Effort (Active Sets)	Total RH (lbs)	Total CPUE
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
2018	276	86,605	313.8
2019	238	54,932	230.8
2020	249	53,810	216.1
2021	233	9,074	38.9
2022	215	84,497	393.0
Mean	250.7	62,852	258.0

Table 9. Relative abundance index (fish per net) of river herring collected January–May in Program 135 (2.5- and 3.0-inch stretch mesh) in the Albemarle Sound, 1991–2022. \*Survey suspended February 20, 2020, and did not resume until fall 2021.

Alewife					Blueback Herring				
Year	Effort	Sum	CPUE	PSE	Year	Effort	Sum	CPUE	PSE
1991	235	76	0.32	22	1991	235	1,249	5.31	15
1992	273	429	1.57	18	1992	273	1,230	4.51	12
1993	279	72	0.26	36	1993	279	827	2.96	15
1994	264	54	0.20	30	1994	264	305	1.16	25
1995	257	118	0.46	21	1995	257	978	3.81	14
1996	256	67	0.26	46	1996	256	825	3.22	16
1997	262	42	0.16	23	1997	262	1,093	4.17	14
1998	257	36	0.14	21	1998	256	939	3.67	15
1999	270	126	0.47	31	1999	272	1,246	4.58	13
2000	260	556	2.14	15	2000	260	1,447	5.57	12
2001	246	746	3.03	12	2001	246	989	4.02	15
2002	251	202	0.80	14	2002	251	821	3.27	15
2003	276	242	0.88	15	2003	276	1,118	4.05	13
2004	249	243	0.98	16	2004	249	740	2.97	16
2005	252	177	0.70	14	2005	252	786	3.12	17
2006	258	533	2.07	13	2006	258	873	3.38	14
2007	253	1,369	5.41	10	2007	253	707	2.79	16
2008	252	748	2.97	11	2008	250	482	1.93	19
2009	222	583	2.63	12	2009	225	522	2.32	18
2010	207	502	2.43	14	2010	207	409	1.98	21
2011	214	323	1.51	18	2011	211	262	1.24	20
2012	178	197	1.11	13	2012	181	174	0.96	23
2013	188	590	3.14	14	2013	188	677	3.60	17
2014	195	1,014	5.20	11	2014	193	505	2.62	19
2015	223	942	4.22	11	2015	223	839	3.76	15
2016	229	1,091	4.76	11	2016	229	1,019	4.45	14
2017	227	1,037	4.57	10	2017	225	888	3.95	15
2018	189	1,128	5.97	11	2018	189	1,124	5.95	13
2019	228	1,272	5.5789	11	2019	230	1,104	4.8	13
2020*	73	525	7.1918	15	*2020	73	74	1.0137	34
2021*					*2021				
2022	126	1533	12.1667	11	2022	126	542	4.3016	18

Table 10. Mean, minimum, and maximum lengths (fork length, inches) of blueback herring measured from Program 135, 1991–2022. \* Survey suspended February 20, 2020, and did not resume until fall 2021.

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Total Number Measured
1991	9.75	6.50	13.25	2,315
1992	9.75	8.00	11.75	2,140
1993	9.75	7.50	13.25	1,334
1994	9.75	8.25	13.25	555
1995	9.50	6.50	11.25	1,324
1996	9.50	5.75	13.25	1,090
1997	9.25	5.00	12.75	1,530
1998	9.50	8.00	11.25	1,230
1999	9.50	6.50	14.50	1,918
2000	9.50	8.25	11.25	2,740
2001	9.50	6.50	11.50	1,862
2002	9.75	5.50	11.00	1,339
2003	9.50	7.75	11.75	1,924
2004	9.50	8.25	17.25	1,157
2005	9.25	5.00	15.00	1,040
2006	9.25	7.25	13.25	1,790
2007	9.25	8.00	10.75	1,202
2008	9.25	4.75	10.75	694
2009	9.25	5.25	11.00	814
2010	9.25	7.75	12.25	609
2011	9.25	7.25	13.75	439
2012	9.50	8.00	10.75	295
2013	9.00	7.75	14.25	1,163
2014	9.25	7.75	13.00	797
2015	9.25	8.00	13.50	1,203
2016	9.50	4.25	17.00	1,555
2017	9.50	8.00	14.25	1,431
2018	9.50	8.00	11.25	1,764
2019	9.50	7.75	17.75	1,689
2020*	9.50	8.50	10.75	92
2021*	-	-	-	-
2022	9.50	7.75	11.50	820

Table 11. Mean, minimum, and maximum lengths (fork length, inches) of alewife measured from Program 135, 1991–2022. \* Survey suspended February 20, 2020, and did not resume until fall 2021.

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Total Number Measured
1991	10.00	5.75	12.00	235
1992	10.00	8.50	13.75	860
1993	9.50	8.00	13.25	143
1994	9.25	8.50	11.00	99
1995	9.50	6.75	15.00	212
1996	9.75	4.50	13.50	102
1997	10.00	8.25	14.25	65
1998	9.75	7.75	11.50	64
1999	9.00	8.00	15.25	228
2000	9.25	8.25	15.75	1,437
2001	9.75	5.25	17.75	1,934
2002	10.00	8.00	11.00	477
2003	9.75	7.75	14.50	553
2004	9.75	8.00	14.00	388
2005	9.50	5.75	17.00	275
2006	9.25	8.00	14.25	1,008
2007	9.25	4.50	15.50	2,344
2008	9.50	6.25	12.00	1,218
2009	9.50	5.75	14.25	995
2010	9.75	8.00	13.75	1,035
2011	10.00	8.00	11.75	491
2012	10.25	7.75	12.00	359
2013	9.25	7.75	13.50	1,004
2014	9.50	8.00	13.75	1,929
2015	9.75	4.50	12.50	1,780
2016	9.75	7.75	14.75	2,043
2017	9.75	7.75	12.75	1,529
2018	9.25	7.75	12.00	1,950
2019	9.50	7.75	11.75	2,063
2020*	9.75	8.25	11.50	749
2021*	-	-	-	-
2022	9.75	8.25	12.75	2,226

Table 12. Modal age, minimum age, maximum age, and number aged for blueback herring collected from Program 135, 1991–2021. \* Survey suspended February 20, 2020, and did not resume until fall 2021. Age data are unavailable for 2022.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
1999	5	3	7	241
2000				0
2001				0
2002				0
2003				0
2004	4	3	6	98
2005	4	2	7	174
2006	4,5	3	7	213
2007	5	3	7	173
2008	4,5	4	7	45
2009	4,5	4	7	72
2010	4	3	5	45
2011	4	3	6	100
2012	4	3	8	80
2013	3	2	7	107
2014	3	2	5	40
2015	4	3	6	139
2016	5,6	3	7	157
2017	5	3	7	176
2018	4	3	7	228
2019	4	3	7	211
2020*	5	3	7	59
2021*	-	-	-	-

Table 13. Modal age, minimum age, maximum age, and number aged for alewife collected from Program 135, 1991–2021. \* Survey suspended February 20, 2020, and did not resume until fall 2021. Age data are unavailable for 2022.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
1999	5	4	7	18
2000	4	3	7	190
2001	5	3	6	289
2002	6	4	7	81
2003	4	4	7	127
2004	4	3	6	106
2005	5	3	7	148
2006	4,5	3	7	283
2007	4	3	8	266
2008	5	4	7	96
2009	5	2	7	125
2010	6	4	7	122
2011	5	3	8	137
2012	6	3	8	129
2013	4	2	6	168
2014	4	3	6	110
2015	5	3	7	263
2016	5	3	7	173
2017	5	3	8	249
2018	4	3	8	331
2019	4	3	8	239
2020*	5	4	7	18
2021*	-	-	-	-

Table 14. 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

## FIGURES

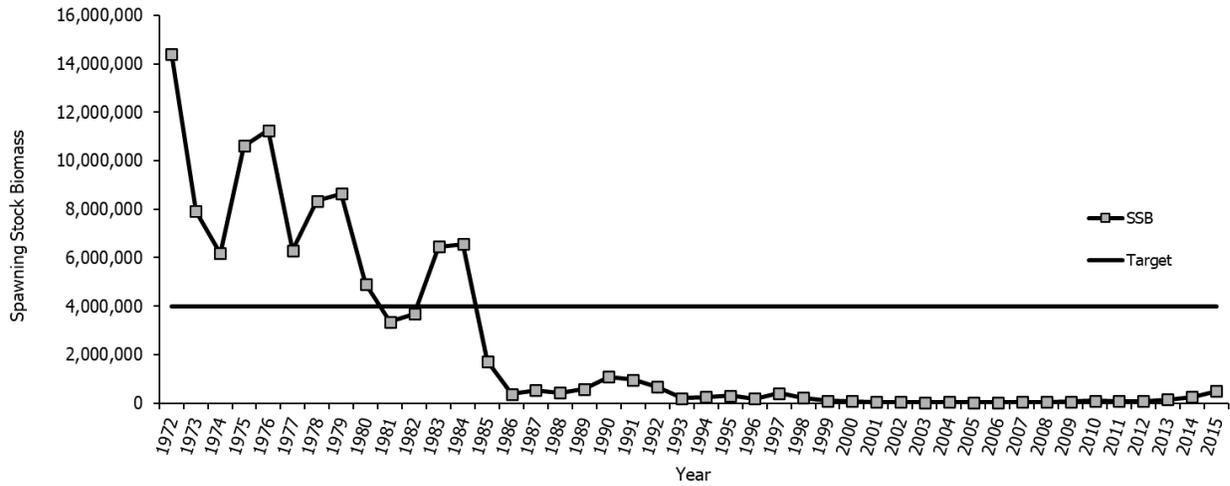


Figure 1. Annual predicted spawning stock biomass (SSB) in pounds for the Chowan River blueback herring stock, compared to the SSBTarget, 1972–2015. SSB is a stock status indicator and 2015 is the terminal year for the last river herring stock assessment update (ASMFC 2017).

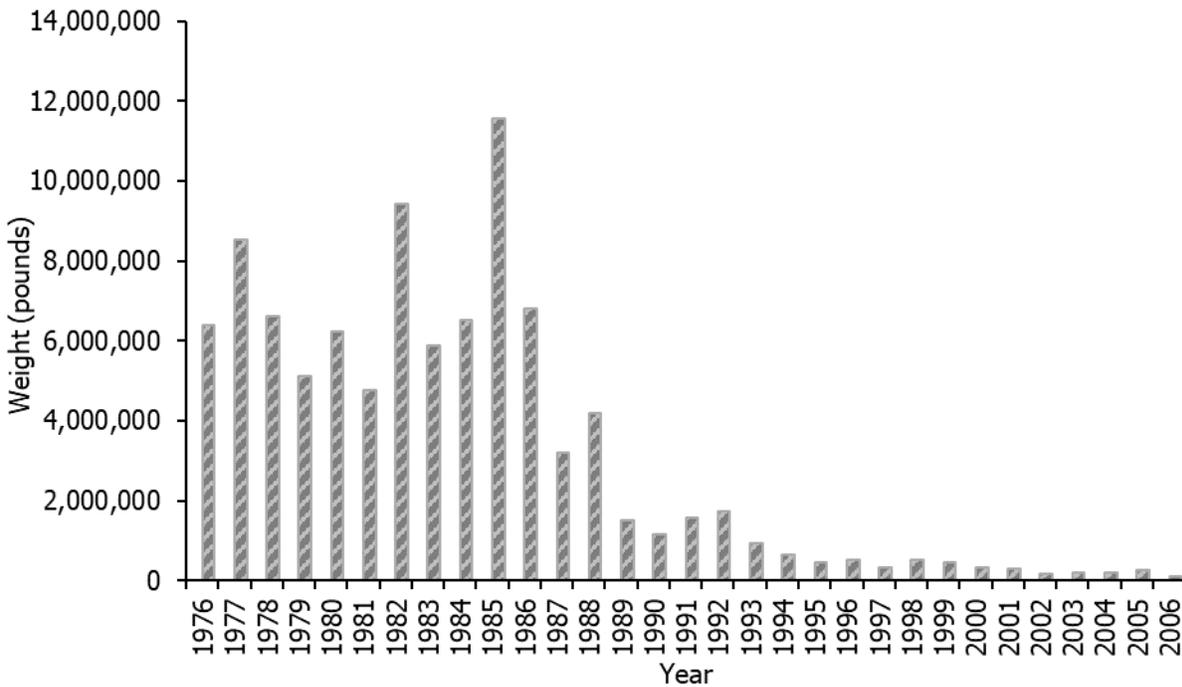


Figure 2. Commercial harvest (weight in pounds) of river herring from North Carolina, 1972–2006. Commercial harvest prohibited since 2007.

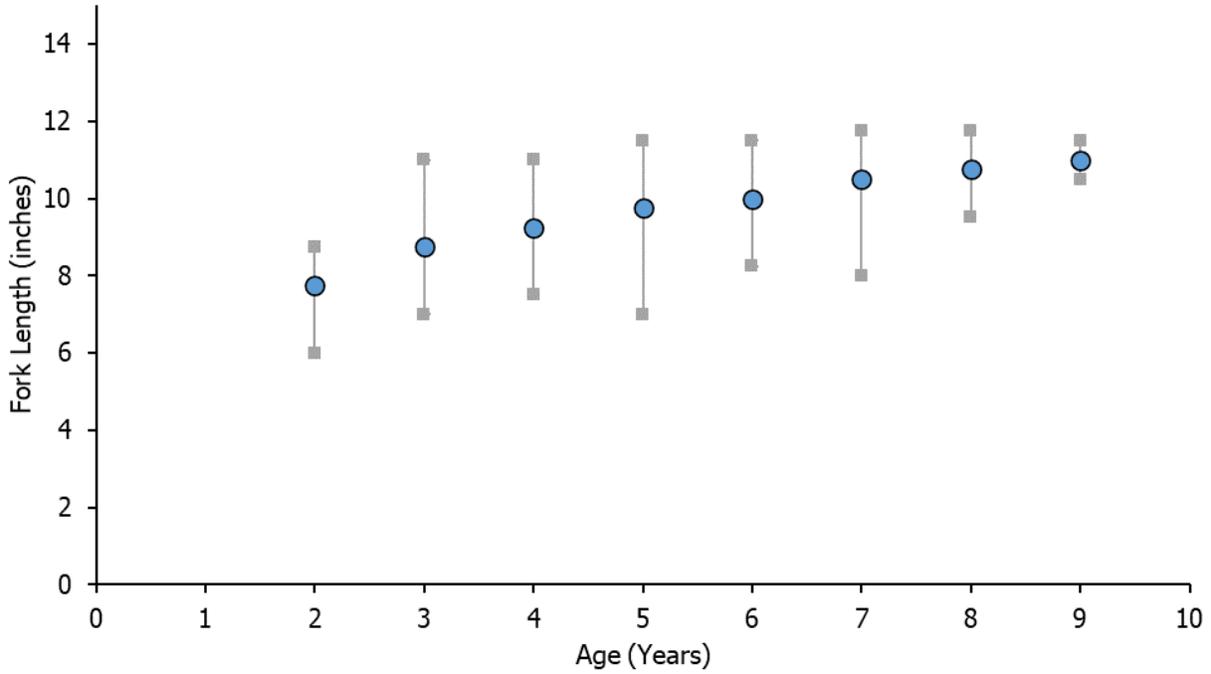


Figure 3. Blueback herring length at age from all age samples collected from fishery-dependent monitoring, 1972–2021. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age. Age data from 2022 is unavailable.

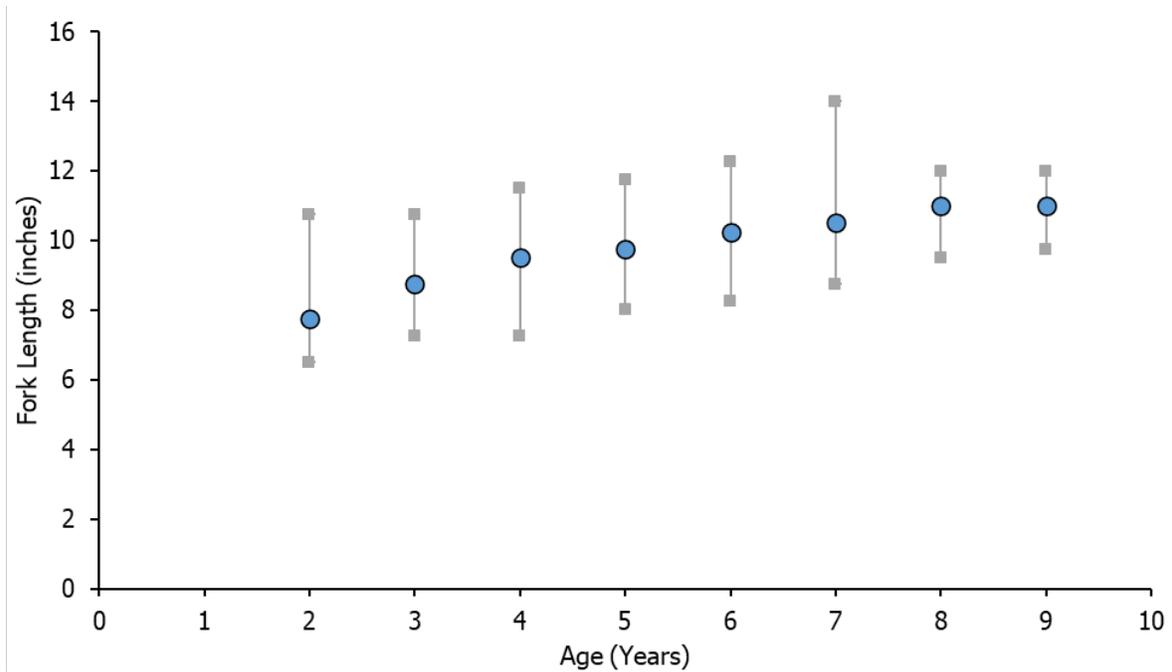


Figure 4. Alewife length at age from all age samples collected from fishery-dependent monitoring, 1972–2021. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age. Age data from 2022 is unavailable.

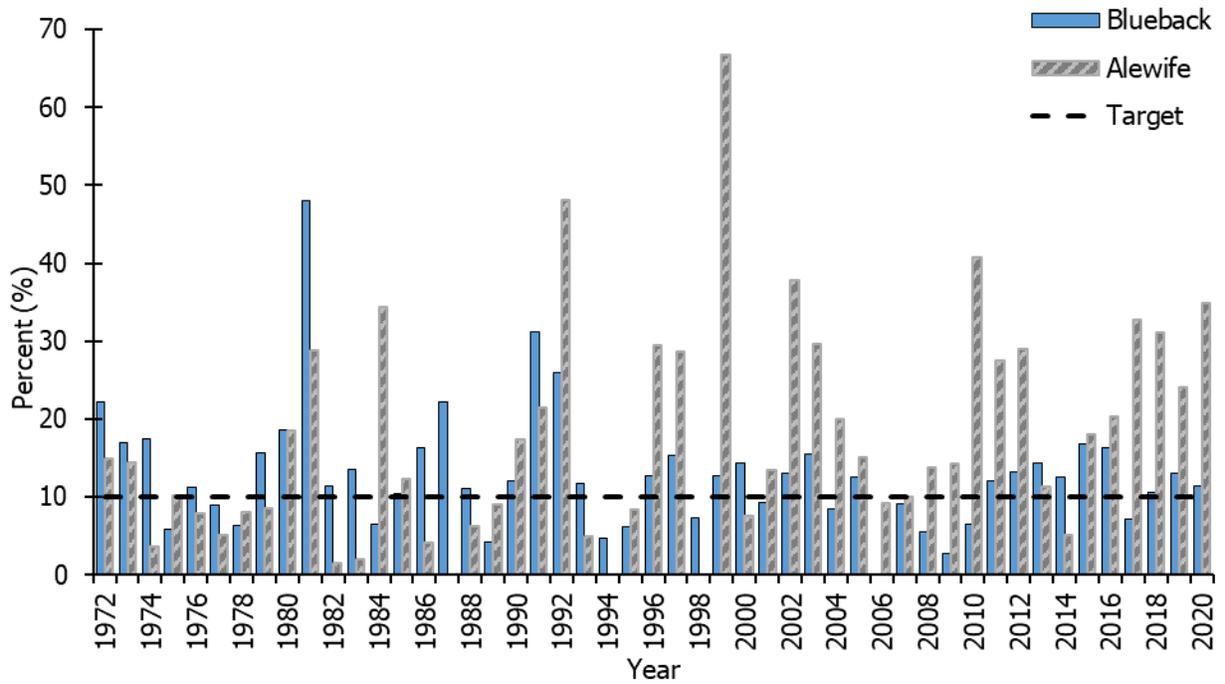


Figure 5. Annual percent of repeat spawners (blueback herring and alewife) and target from the Chowan River Pound Net Survey, 1972–2021. Blueback herring percent repeat spawner is a stock status indicator. Repeat spawner data from 2022 is unavailable.

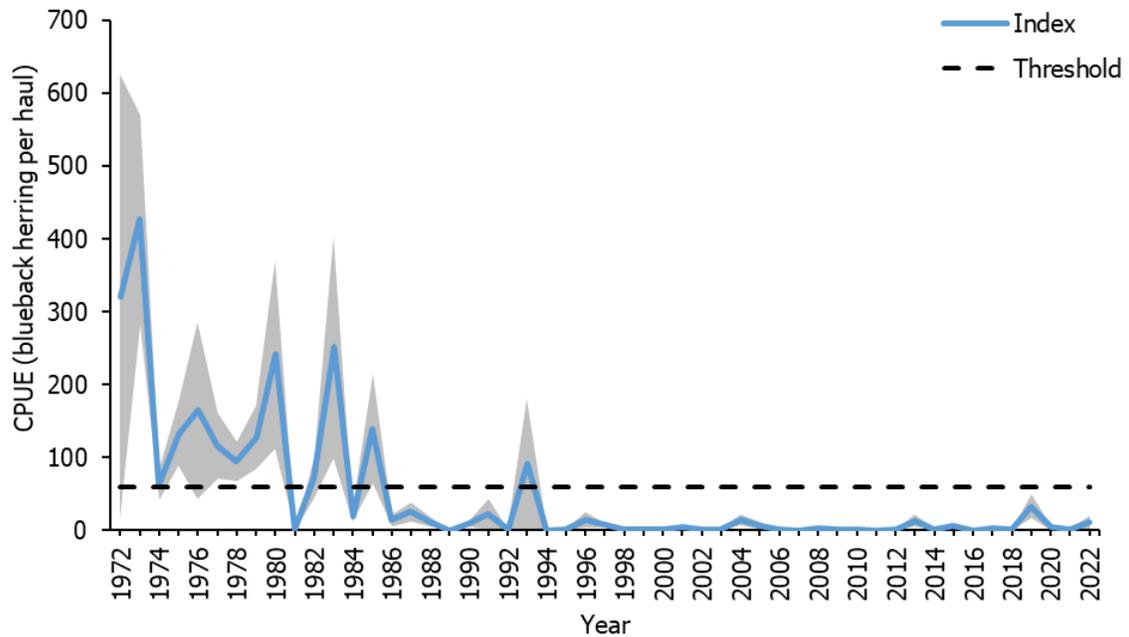


Figure 6. Catch per unit effort (fish per haul) and target of blueback herring collected from Program 100 in Albemarle Sound during June through October 1972–2022. Error bars represent  $\pm 1$  standard error. Blueback herring relative abundance is a stock status indicator.

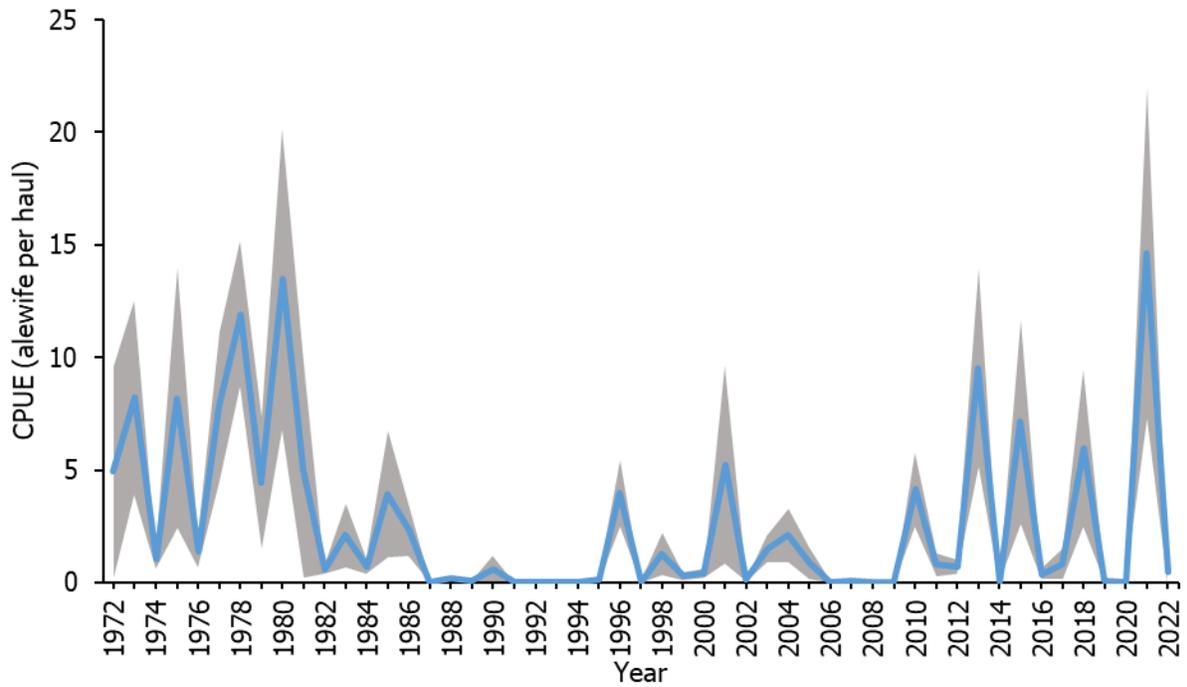


Figure 7. Catch per unit effort (fish per haul) of alewife collected from Program 100 in Albemarle Sound during June through October 1972–2022. Error bars represent  $\pm 1$  standard error.

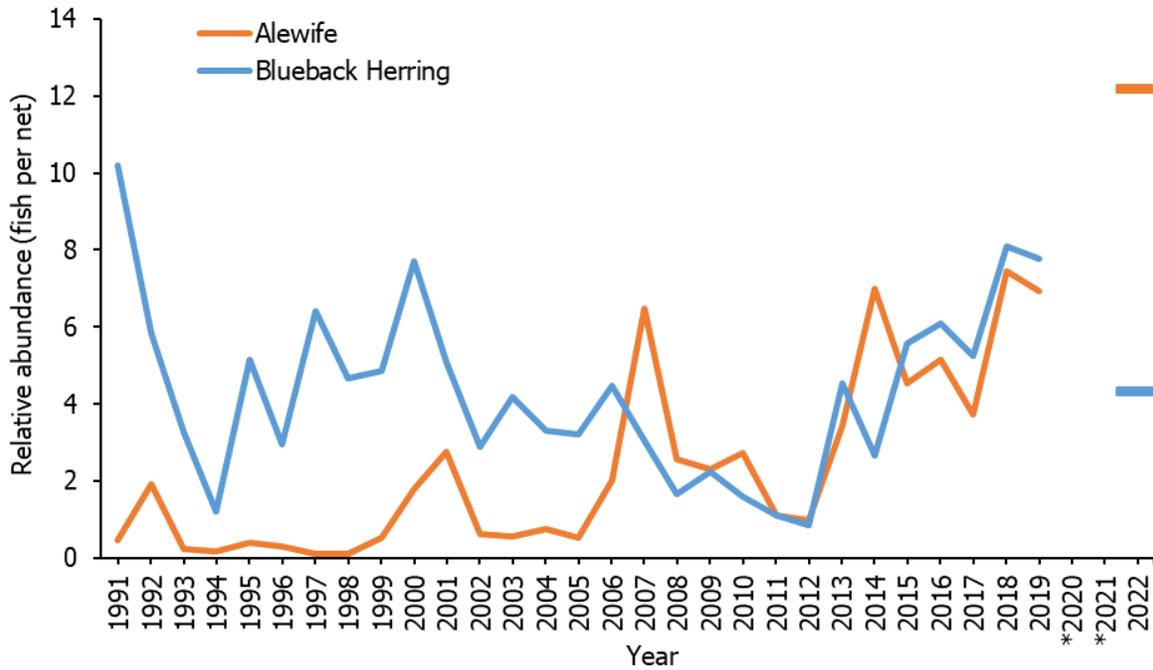


Figure 8. Relative abundance index of river herring (fish per net, 2.5- and 3.0-inch stretch mesh only) collected from Program 135 in Albemarle Sound during January through May 1991–2022. \* Survey suspended February 20, 2020 and did not resume until fall 2021.

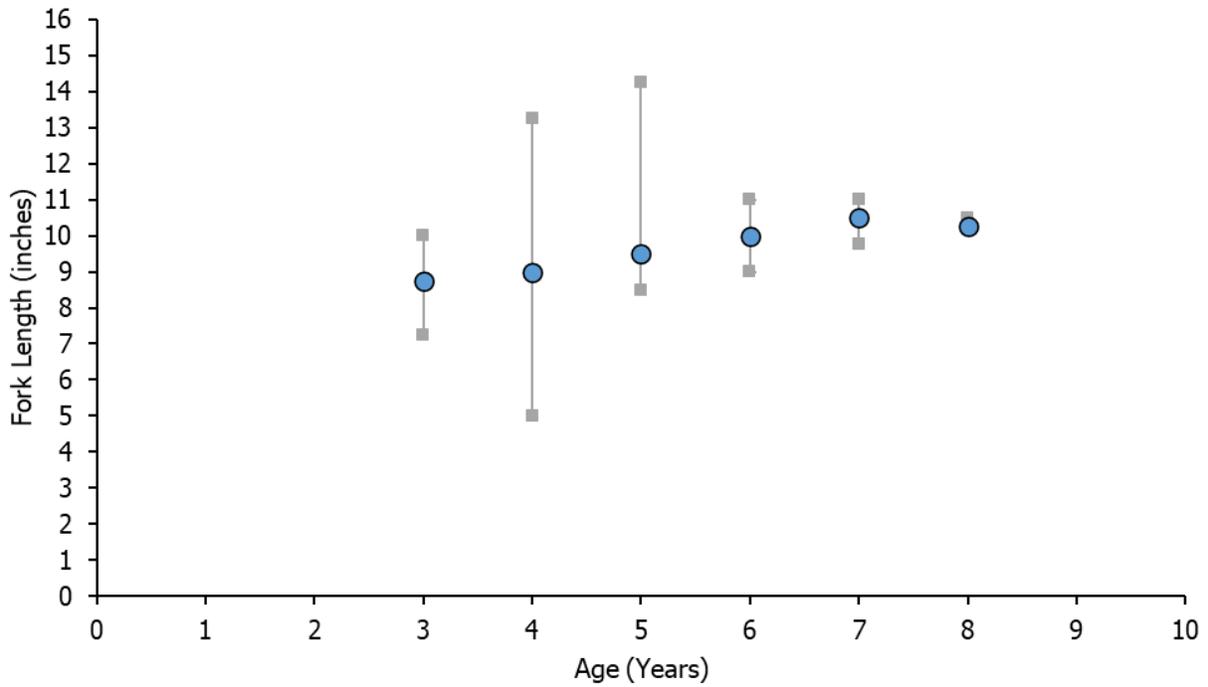


Figure 9. Blueback herring length at age from all age samples collected from Program 135 in the Albemarle Sound, 1972–2021. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age. \* Survey suspended February 20, 2020, and did not resume until fall 2021. Age data from 2022 is unavailable.

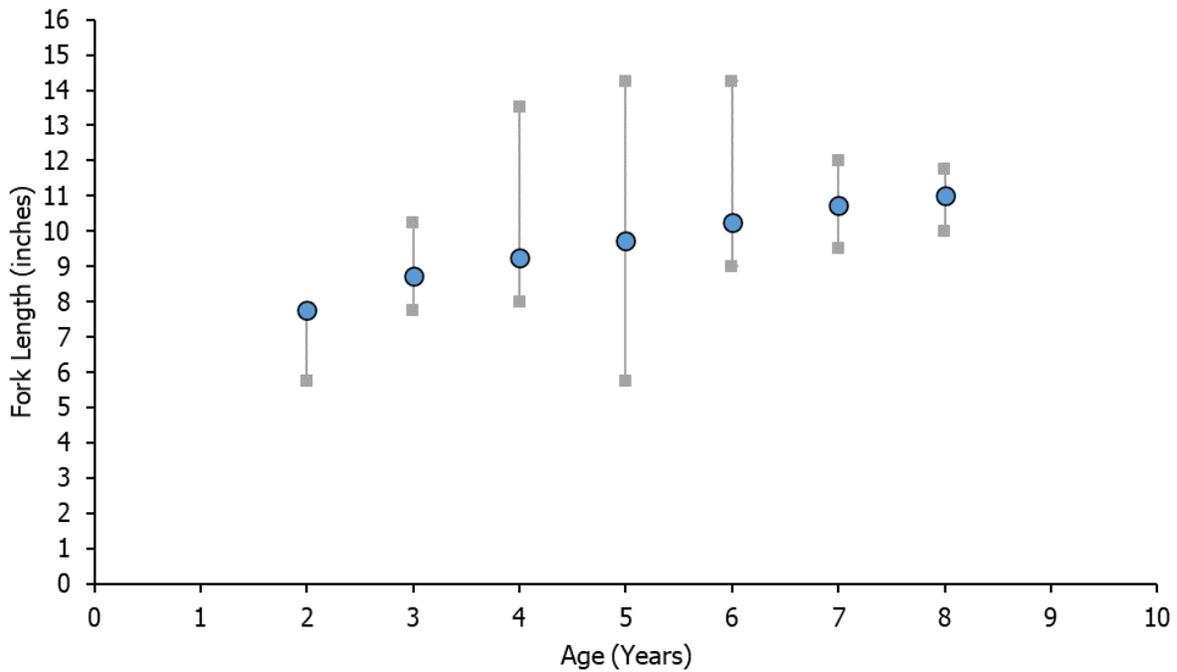


Figure 10. Alewife length at age from all age samples collected from Program 135 in the Albemarle Sound, 1972–2021. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age. \* Survey suspended February 20, 2020, and did not resume until fall 2021. Age data from 2022 is unavailable.

## STATE MANAGED SPECIES – SHEEPSHEAD

### FISHERY MANAGEMENT PLAN UPDATE SHEEPSHEAD AUGUST 2023

#### 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
Comprehensive Review:	None

Sheepshead (*Archosargus probatocephalus*) was previously managed in the South Atlantic Fishery Management Council (SAFMC) Snapper Grouper Fishery Management Plan (FMP). The plan restricted recreational anglers to an aggregate 20 fish bag limit, no commercial trip limit, and no size limit. In state waters, North Carolina deferred management to the Council regulations. In April 2012, sheepshead was removed from the SAFMC snapper grouper management complex through the Comprehensive Annual Catch Limit Amendment (Amendment 25; SAFMC 2011). Subsequently, North Carolina Division of Marine Fisheries (DMF) Director proclamation authority for sheepshead management was invalidated since sheepshead was no longer part of the North Carolina FMP for Interjurisdictional Fisheries or a Council managed species. In November 2012, the N.C. Marine Fisheries Commission (MFC) requested a rule be developed for sheepshead; and approved the rule in November 2013 that specifies the Director's proclamation authority, including the ability to implement size, bag, and trip limits, as well as season and gear restrictions (NCMFC 15A NCAC 03M .0521). In July 2014, the DMF began developing potential management measures for sheepshead to present to the MFC. In 2015, the Commission implemented new regulations that included size, bag, and trip limits to prevent overharvest, as well as to allow a greater number of fish 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).

## **Goal and Objectives**

None

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

Sheepshead are a relatively large, 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 coastal waters ranging from inshore brackish waters to offshore rocky bottom (Hildebrand and Cable 1938). Juveniles are associated with shallow vegetated habitat as well as hard structures that offer protection (Parsons and Peters 1987). As sheepshead grow larger, they move to typical adult habitat including oyster reefs, rocks, pilings, jetties, piers, and wrecks (Johnson 1978). Sheepshead exhibit strong site fidelity much of the year and, except for a seasonal spawning migration, tend to stay in the same areas (Wiggers 2010). 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 (Jennings 1985; Wiggers 2010).

Sheepshead are omnivores, eating plants as well as animals (barnacles, crabs, oysters; Jennings 1985). Sheepshead grow quickly up to age 6, and then their growth slows. After their first year, sheepshead average 10 inches fork length (FL), at this size less than 50% of the fish are sexually mature (McDonough et al. 2011). Most sheepshead mature at age-2 (12 inches fork length) and all sheepshead are mature by ages 3 to 5 (14 inches FL; McDonough et al. 2011). In North Carolina, sheepshead commonly reach a length of 20 to 25 inches FL with weight ranging from 5 to 15 pounds. The maximum reported age in North Carolina is 34 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**

There is not an approved stock assessment for sheepshead in North Carolina. A coast-wide stock assessment (from Virginia through Georgia) was developed by a doctoral candidate at North Carolina State University, with data through 2019. The assessment is being reviewed.

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

In 2015, the MFC implemented a 10-inch FL minimum size limit for both recreational and commercial fisheries (Proclamation FF-28-2015). 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.

## **Commercial Fishery**

Commercial landings of sheepshead in North Carolina have been available since 1950. However, monthly landings were not available until 1974. North Carolina instituted mandatory reporting of commercial landings through the Trip Ticket Program starting in 1994. Landings information collected since 1994 is considered the most reliable. Landings have fluctuated from year to year, ranging from 9,782 pounds in 1981 to 180,225 pounds in 2013. In 2021, 69,258 pounds of sheepshead were landed in the commercial fishery (Table 1; Figure 1A).

Sheepshead are primarily caught as bycatch in several of North Carolina's commercial fisheries (e.g., gill nets, pound nets, haul seines). Estuarine gill nets and pound nets have made up greater than 50% of the landings for most of the time series. A targeted spear fishery developed in the 15-years, and the gig fishery has also become more popular (Table 2). While the long-haul fishery used to account for up to 20% of the landings, this fishery has accounted for less than one percent of the harvest in recent years. In 2022, 81% of commercial landings came from pound nets (56%) and gill nets (24%; the majority from estuarine gill nets). An additional 9% was landed by spears and gigs, combined (Table 2; Figure 2).

## **Recreational Fishery**

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 estimates have been available since 1981. Recreational estimates across all years have been updated and are now based on the Marine Recreational Information Program (MRIP) new Fishing Effort Survey-based calibrated estimates. For more information see <https://www.fisheries.noaa.gov/topic/recreational-fishing-data>.

On average, recreational harvest accounts for 81% of North Carolina total harvest (pounds) from 1981 – 2021. In 2022, recreational harvest accounted for 94% of the total harvest (Table 1). Like commercial harvest, landings have fluctuated annually, with a low of 19,285 pounds harvested in 1983 and a high of 1,456,396 pounds in 2007 (Table 1; Figure 1B). In 2022, 1,024,623 pounds of sheepshead were landed recreationally; the third highest landings in the time series. Recreational releases decreased in 2022 to 570,444 fish (Table 1). Since 2019, recreational catch (harvest + releases, numbers) has been increasing, potentially the result of normal fluctuations in availability or possibly the result of increased regulations for other species such as southern flounder. In the last four years, a larger targeted fishery has developed for this species. Annual catch, as well as survey data, will continue to be monitored to determine trends for this stock.

The DMF offers award citations for exceptional catches of sheepshead. Harvested sheepshead weighing greater than eight pounds are eligible for an award citation. Since 1991, approximately 2,600 citations for sheepshead have been issued. From 1991 through 2007 the number of award citations was under 50 citations per year. From 2008 through 2014 the number of award citations

increased steadily but then started to decrease (Figure 3). In 2021 and 2022, the number of citations increased, and citations issued in 2022 represent a 170% increase from 2021. In 2022, 311 citations were issued; the highest awarded in the time series.

## **MONITORING PROGRAM DATA**

### **Fishery-Dependent Monitoring**

Commercial fishing activity is monitored through fishery-dependent sampling programs conducted by DMF. Data collected in these programs allow the size and age distribution of sheepshead to be characterized by gear and fishery. In 2022, 431 lengths were measured at fish houses or on the water, the majority of which came from the estuarine gill net, spear, and pound net fisheries. The average size of commercial caught sheepshead was 13 inches FL (Table 3). This has varied from year to year (10 to 20 inches FL), with the average and minimum sizes being smaller when there was no size limit prior to 2015. The majority of sheepshead landed in 2022 were between 9 inches and 15 inches FL (Figure 4).

Similar to the commercial fishery, average size varies little from year to year in the recreational fishery (Table 4). In 2022, the average size recreational sheepshead was 14 inches FL (Table 4). The majority of sheepshead landed in 2022 were between 9 inches and 17 inches FL (Figure 5). In both fisheries, sublegal fish (<10 inches FL) are still being harvested (Tables 3 and 4; Figure 6). This is most likely due to fishermen confusing sheepshead and black drum regulations. While the size limits differ, black drum are measured for total length and sheepshead for FL.

### **Fishery-Independent Monitoring**

In 2001, the DMF initiated a fishery-independent gill net survey in Pamlico Sound (Program 915). The objective of this project is to provide annual, independent, relative-abundance indices for key estuarine species in the nearshore 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 half-inch increments). By continuing a long-term database of age composition and developing a relative 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 index of abundance (number of sheepshead per set) was 0.92 in 2022 and was above the time series average (Table 5; Figure 7); 2022 represents the highest relative abundance in the time series.

For 2020, indices of abundance are not available for sheepshead from the Fishery-Independent Gill-Net Survey (Program 915) due to the COVID pandemic. Sampling in this program was suspended in February 2020 due to COVID-19 restrictions and protected species interactions but resumed July 2021.

Data collected by Program 120 (Estuarine Trawl Survey) were used to calculate a relative Juvenile Abundance Index (JAI) by the doctoral candidate working on the coast-wide stock assessment. 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 database 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 were added in 2004 and are sampled during the months of June and July. Data from the seatrout specific stations are used to generate an index of relative abundance of age zero sheepshead, calculated as the average number of fish per tow. The resulting relative abundance index for the time series is variable with no significant trend and peaks in 2008 and 2015 suggesting relatively higher recruitment in those years (Table 6; Figure 8). The Program 120 relative abundance index in 2022 was 0.02, which was a decrease from the previous year and one of the lowest values.

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; though there are samples going back to 2008, collection of sheepshead otoliths was not made a sampling priority until 2013. The majority of sheepshead collected were ages 1 to 8 (Table 7). In 2021, 273 sheepshead were collected ranging in age from 0 to 24; in 2022, 458 otoliths were collected, however they have not yet been aged. The age-length relationship is hard to predict as there is overlap in age for a given length (Figure 9).

## **RESEARCH NEEDS**

The following have been identified as research needs for sheepshead in North Carolina.

- Initiate a sheepshead tagging program to develop estimates of growth, natural mortality, fishing mortality, and track the movement of adults throughout the stock's range; include methods to estimate tag retention, reporting rate, and tagging-induced mortality.
- Conduct reproductive studies including spawning periodicity, age- and size-specific fecundity, update maturity schedule, and conduct spawning area surveys in North Carolina and throughout the stock's range.
- Expand discard sampling to collect information on gear, depth, location, and age and size distribution of discarded fish for the recreational and commercial sectors.
- Conduct studies on size- and age-specific selectivity by gear type.
- Determine the patterns and triggers of inshore-offshore migrations.

## **MANAGEMENT STRATEGY**

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

## **FISHERY MANAGEMENT PLAN SCHEDULE RECOMMENDATIONS**

Not Applicable

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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; Atlantic Coastal Cooperative Statistics Program and N.C. Trip Ticket Program) of sheepshead from North Carolina, 1981 – 2022. All weights are in pounds.

Year	Recreational			Commercial	Total Weight Landed(lb)
	Number Landed	Number Released	Weight Landed (lb)	Weight Landed (lb)	
1981	83,626	12,772	262,503	9,782	272,285
1982	61,765		183,768	13,922	197,690
1983	5,930		19,285	28,224	47,509
1984	21,156		32,152	36,267	68,419
1985	12,691		42,573	61,190	103,763
1986	132,061	8,283	399,925	97,355	497,280
1987	52,061	70,117	172,377	81,101	253,478
1988	152,971	7,766	50,046	63,400	113,446
1989	136,175	17,747	243,496	56,940	300,436
1990	103,041	18,679	161,180	68,029	229,209
1991	67,277	34,505	154,193	52,611	206,804
1992	206,241	48,565	434,509	47,526	482,035
1993	221,442	51,981	289,634	57,884	347,518
1994	92,098	31,965	197,128	83,789	280,917
1995	157,769	39,779	407,729	91,198	498,927
1996	77,750	12,798	256,911	82,290	339,201
1997	209,662	55,258	308,381	50,414	358,795
1998	151,473	109,454	209,825	60,184	270,009
1999	255,885	124,676	758,153	60,895	819,048
2000	355,192	94,963	780,622	88,459	869,081
2001	183,781	66,594	654,527	64,522	719,049
2002	181,197	68,317	781,567	57,434	839,001
2003	294,989	85,877	983,640	53,361	1,037,001
2004	86,554	40,263	453,372	82,009	535,381
2005	87,504	65,863	340,227	53,259	393,486
2006	137,312	90,502	445,182	57,481	502,663
2007	433,872	334,014	1,456,396	77,173	1,533,569
2008	503,666	172,604	1,007,914	89,726	1,097,640
2009	362,439	299,221	577,311	132,390	709,701
2010	327,223	190,823	966,467	157,631	1,124,098
2011	196,844	78,821	522,896	120,976	643,872
2012	346,609	269,226	797,963	109,881	907,844
2013	784,747	391,809	1,220,357	180,225	1,400,582
2014	185,267	224,062	389,583	173,376	562,959
2015	181,554	160,447	520,382	124,827	645,209
2016	149,085	212,471	375,328	93,513	468,841
2017	282,480	910,841	810,633	128,269	938,902
2018	343,772	524,967	735,738	90,291	826,029
2019	221,419	312,479	590,150	86,394	676,544
2020	247,390	518,140	592,774	76,501	669,275
2021	324,540	873,080	928,130	85,413	1,013,543
2022	387,924	570,444	1,024,623	69,258	1,093,881
Mean	205,330	179,182	500,364	80,149	580,513

Table 2. Commercial harvest (weight in pounds) of sheepshead by gear type, 2013 – 2022 (Source N.C. Trip Ticket Program).

Year	Spears and Gigs <sup>§</sup>	Estuarine Gillnet	Long Haul	Ocean Gillnet	Pound Net	Trawls	Other*	Total Harvest
2013	15,259	48,194	12,536	3,055	94,780	4,058	2,462	180,343
2014	21,886	39,524	11,805	3,253	92,988	2,581	1,339	173,376
2015	13,695	27,268	400	5,741	73,035	3,998	713	124,850
2016	14,761	30,851	322	2,509	36,839	7,068	1163.35	93,513
2017	10,720	33,770	513	1,677	74,246	7,047	635.5	128,608
2018	9,076	25,722	40	2,936	50,429	1,012	1190.6	90,406
2019	13,858	25,309	843	3,437	36,496	5,567	897.31	86,406
2020	7,391	16,964	838	1,966	47,445	1,600	427	76,630
2021	8,960	18,255	298	5,121	48,842	2,850	1125.95	85,452
2022	6,497	16,972	1679	1,751	38,792	1,100	2466.5	69,258
Mean	12,210	28,283	2,927	3,144	59,389	3,688	1,242	

\* Other gears include fyke nets, crab pots, and hook and line.

§ Spear and gigs have also been combined due to data confidentiality.

Table 3. Sheepshead length (fork length, inches) data from commercial fish house samples, 1982 – 2022.

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Total Number Measured
1982	10	3	24	13
1983	18	8	24	25
1984	20	11	24	8
1985	10	3	13	3
1986	19	15	23	19
1987	16	8	24	53
1988	16	3	22	29
1989	14	3	23	42
1990	16	8	25	162
1991	15	6	23	124
1992	13	3	22	86
1993	13	4	22	107
1994	13	9	22	77
1995	15	5	23	172
1996	15	7	22	137
1997	16	6	24	102
1998	13	6	24	330
1999	13	8	24	492
2000	16	8	28	1,305
2001	15	8	22	306
2002	13	8	24	412
2003	14	9	24	421
2004	16	8	23	305
2005	17	7	25	443
2006	16	8	24	467
2007	14	7	24	850
2008	13	6	24	1,420
2009	12	6	23	1,399
2010	13	7	24	1,743
2011	15	9	24	1,247
2012	13	7	23	1,161
2013	13	7	24	1,283
2014	14	7	23	1,296
2015	15	8	24	982
2016	15	8	24	964
2017	14	9	23	348
2018	14	8	23	694
2019	15	8	24	624
2020	14	9	22	426
2021	13	8	23	586
2022	13	8	22	431

Table 4. Sheepshead length (fork length, inches) data from Marine Recreational Information Program samples, 1981 – 2022.

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Total Number Measured
1981	12	9	20	13
1982	15	8	21	29
1983	18	15	20	3
1984	11	10	13	2
1985	15	13	19	1
1986	15	7	29	29
1987	14	7	23	70
1988	13	6	25	85
1989	12	7	21	76
1990	11	7	22	93
1991	12	5	23	83
1992	12	8	23	54
1993	11	6	22	176
1994	13	7	21	179
1995	14	7	22	174
1996	15	9	26	79
1997	11	6	24	134
1998	11	6	23	191
1999	14	7	29	187
2000	13	8	24	239
2001	15	10	30	132
2002	16	10	23	56
2003	14	8	26	96
2004	17	9	24	54
2005	16	9	23	34
2006	15	7	24	55
2007	15	7	24	118
2008	12	7	21	108
2009	11	7	21	159
2010	14	8	26	221
2011	14	7	25	160
2012	13	6	23	254
2013	11	6	24	351
2014	13	8	25	99
2015	14	9	23	134
2016	14	8	25	106
2017	14	4	22	272
2018	13	9	23	386
2019	14	10	25	243
2020	13	8	25	260
2021	14	8	22	177
2022	14	8	25	222

Table 5. Annual weighted sheepshead index of abundance (number per set, all ages combined) from the North Carolina Pamlico Sound Independent Gill Net Survey, 2001 – 2022. N=number of samples; SE=Standard Error; PSE=Proportional Standard Error. Pamlico Sound Independent Gill Net Survey sampling did not occur in 2020 and the first half of 2021.

Year	N	Index	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	0.3	0.05	17
2010	320	0.18	0.04	22
2011	300	0.16	0.06	38
2012	308	0.12	0.03	25
2013	308	0.3	0.07	23
2014	308	0.45	0.09	20
2015	308	0.26	0.06	23
2016	308	0.2	0.04	20
2017	308	0.44	0.1	23
2018	308	0.41	0.11	27
2019	306	0.33	0.09	27
2020				
2021	168	0.51	0.12	24
2022	308	0.92	0.20	22

Table 6. Annual weighted sheepshead juvenile index of abundance (number per tow) from the North Carolina Juvenile Trawl Survey, 2004 – 2022. N=number of samples; SE=Standard Error; PSE=Proportional Standard Error.

Year	N	Index	SE	PSE
2004	54	0.00	0.00	--
2005	54	0.00	0.00	--
2006	54	0.11	0.11	100
2007	54	0.11	0.05	46
2008	54	0.87	0.44	51
2009	54	0.06	0.03	57
2010	54	0.06	0.06	100
2011	54	0.22	0.13	57
2012	54	0.07	0.04	60
2013	54	0.07	0.05	70
2014	54	0.15	0.09	60
2015	54	0.65	0.50	78
2016	54	0.22	0.13	60
2017	54	0.00	0.00	--
2018	54	0.02	0.02	100
2019	54	0.04	0.04	100
2020	54	0.19	0.09	50
2021	54	0.09	0.05	52
2022	54	0.02	0.02	100

Table 7. Summary of sheephead age samples collected from both dependent (commercial and recreational) and independent (survey) sources, 2008 – 2021\*.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
2008	2	2	8	10
2009	--	3	25	5
2010	6	3	18	10
2011	4	3	10	14
2012	1	1	26	8
2013	2	1	22	162
2014	3	1	24	243
2015	4	1	24	140
2016	5	0	29	211
2017	2	1	28	262
2018	2	0	30	227
2019	3	0	29	345
2020	1	1	34	205
2021*	2	0	24	273
2022*				458

*\*2021 ages are considered preliminary; 2022 otoliths have not yet been aged.*

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

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 ( <a href="#">FF-28-2015</a> )

**FIGURES**

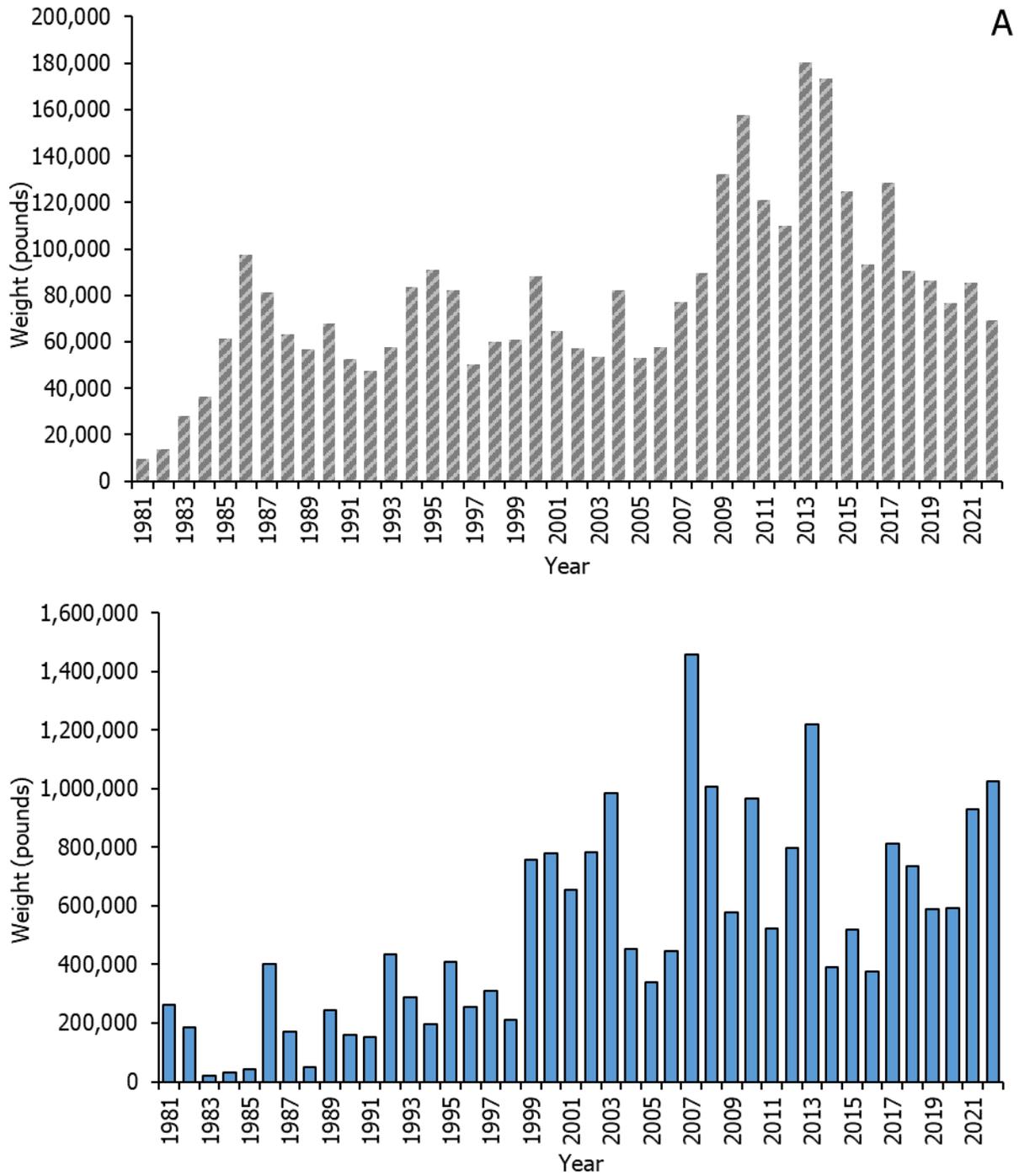


Figure 1. Annual (A) commercial (Atlantic Coastal Cooperative Statistics Program and N.C. Trip Ticket Program) and (B) recreational (MRIP) landings in pounds for sheephead in North Carolina from 1981 – 2022.

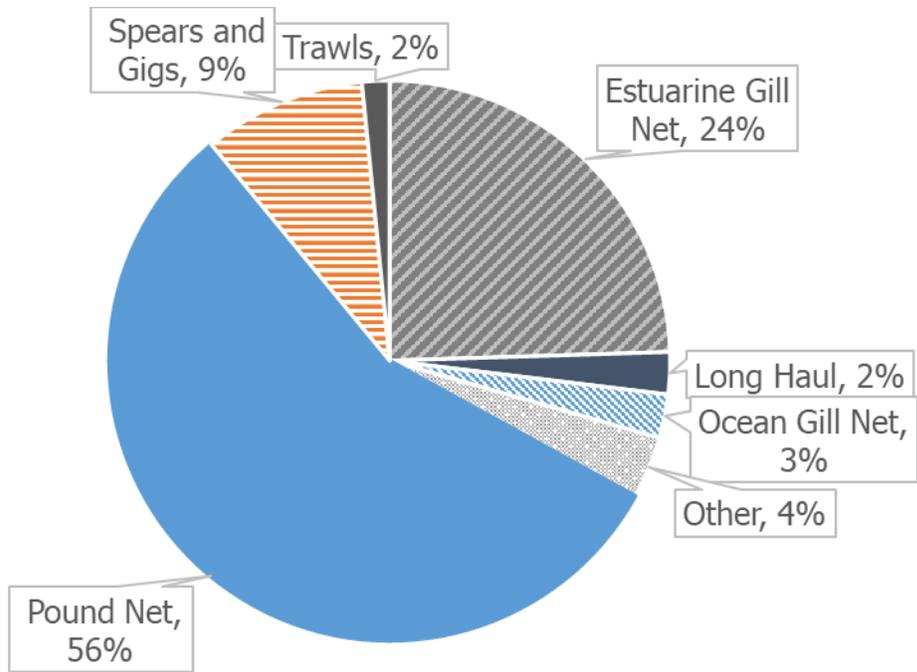


Figure 2. Commercial harvest in 2022 by gear type. Other gears include fyke nets, crab pots, and hook-and-line.

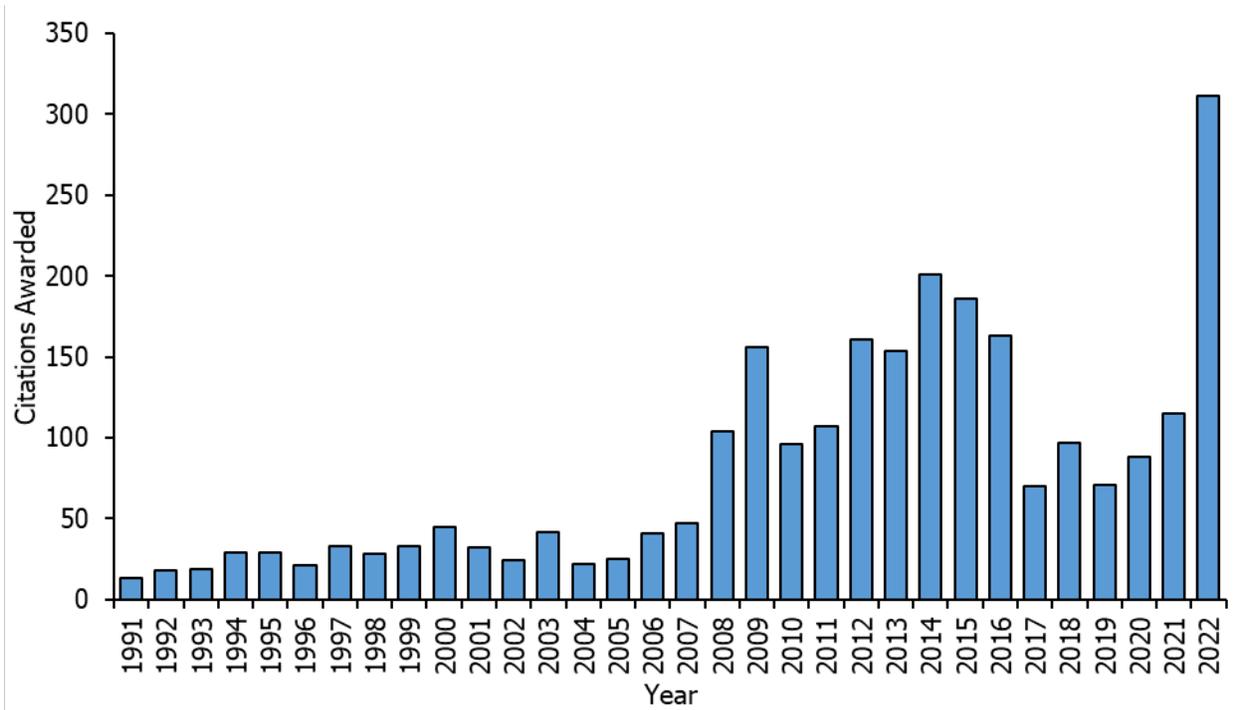


Figure 3. North Carolina Saltwater Fishing Tournament citations awarded for sheephead from 1991 – 2022.

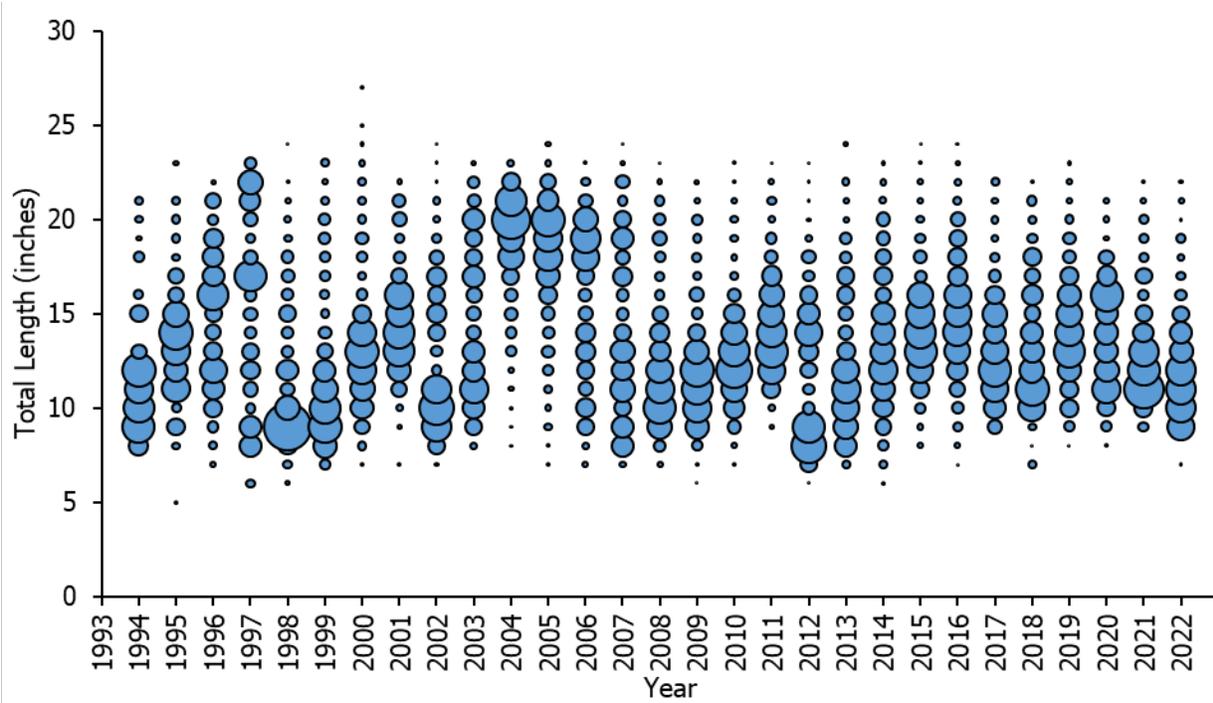


Figure 4. Commercial length frequency (fork length, inches) of sheephead harvested from 1994 – 2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

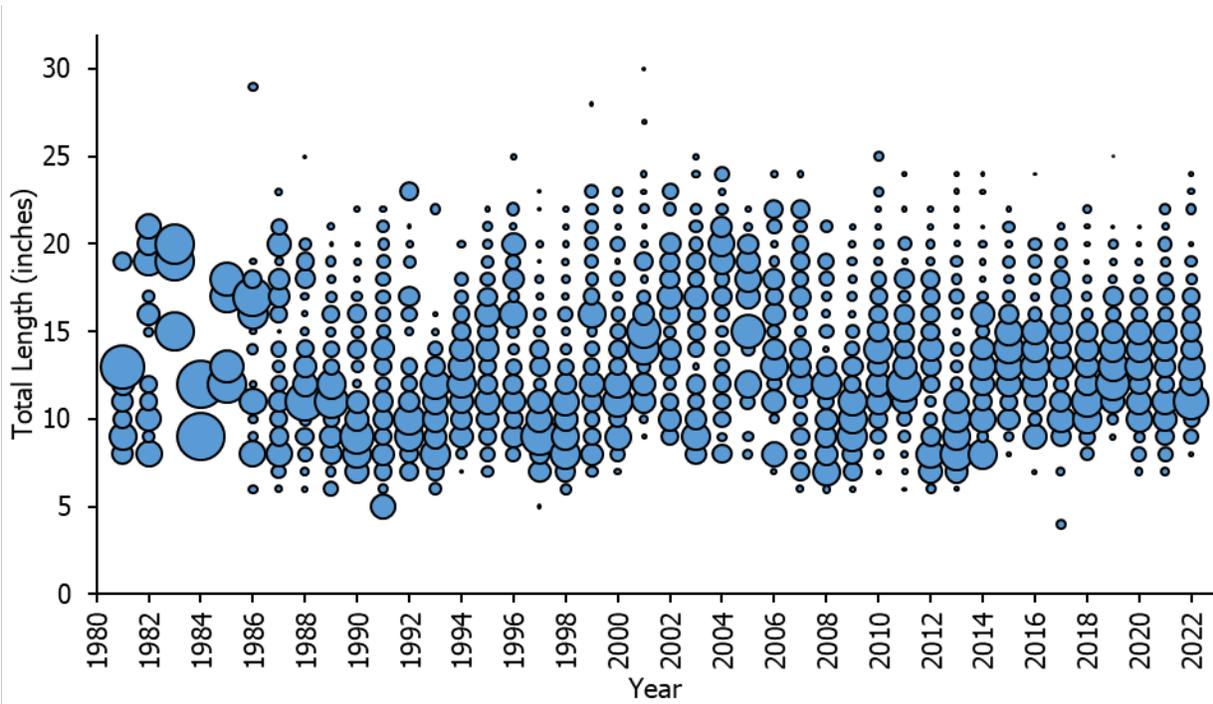


Figure 5. Recreational length frequency (fork length, inches) of sheephead harvested from 1981 – 2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

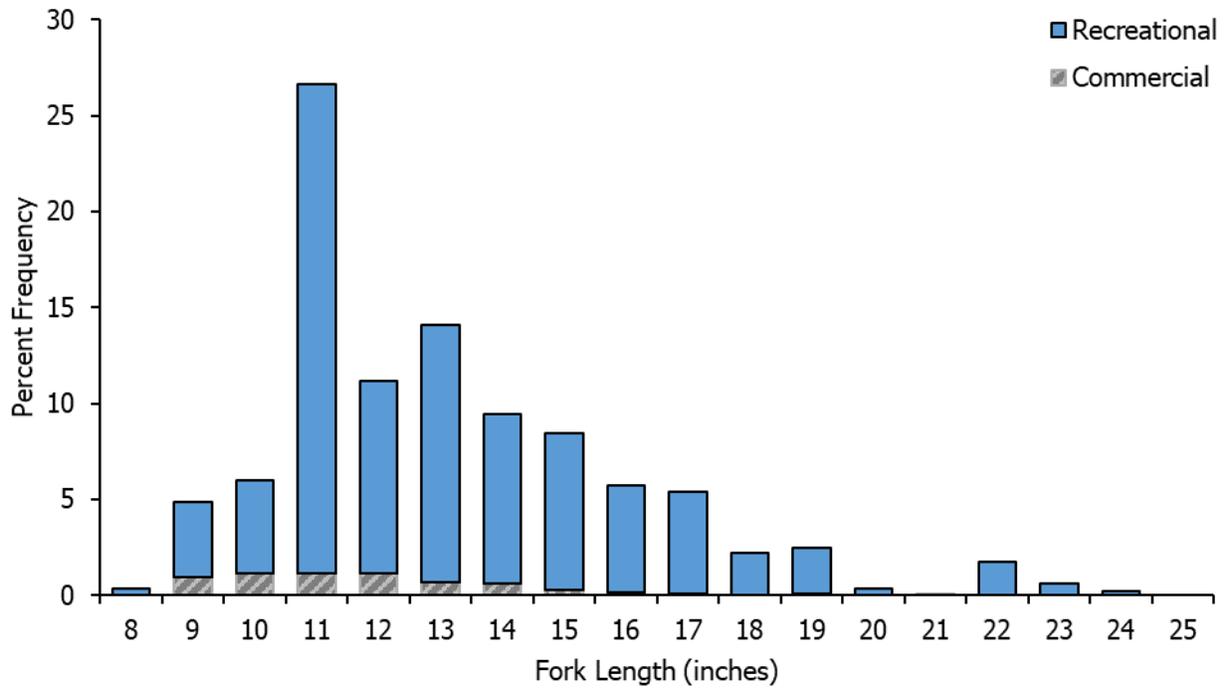


Figure 6. Commercial and recreational length frequency distribution from sheephead harvested in 2022.

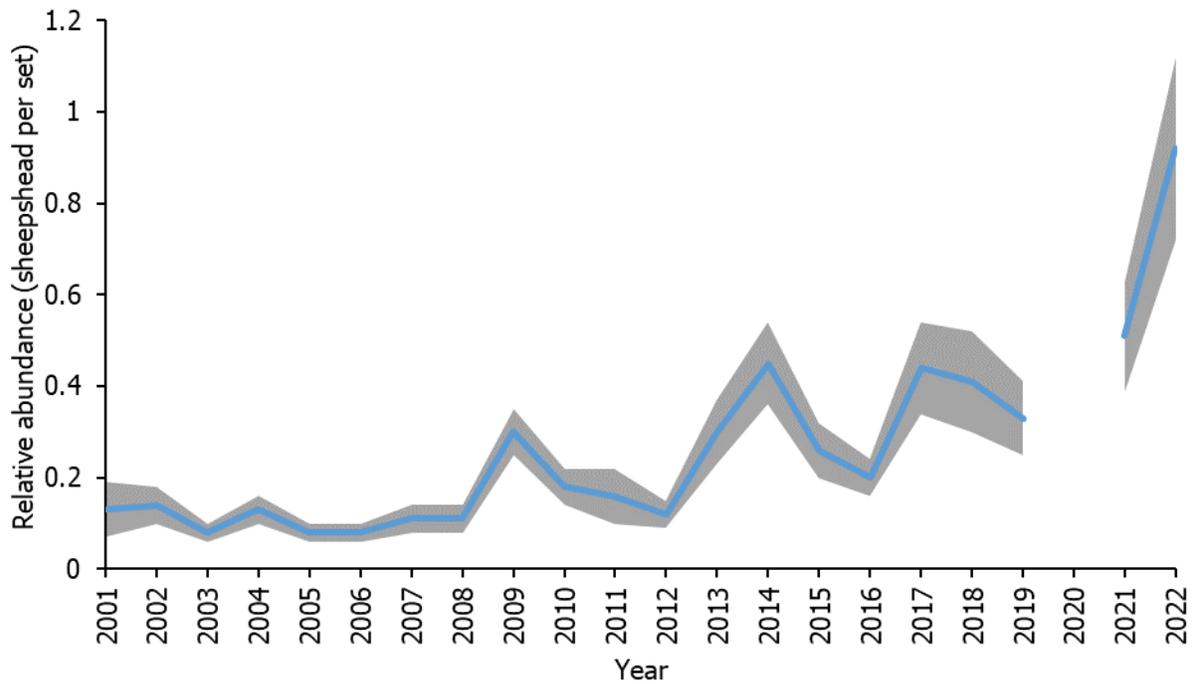


Figure 7. Annual index of abundance of sheephead in the DMF Pamlico Sound Independent Gill Net Survey, 2001–2022. Pamlico Sound Independent Gill Net Survey sampling did not occur in 2020 and the first half of 2021.

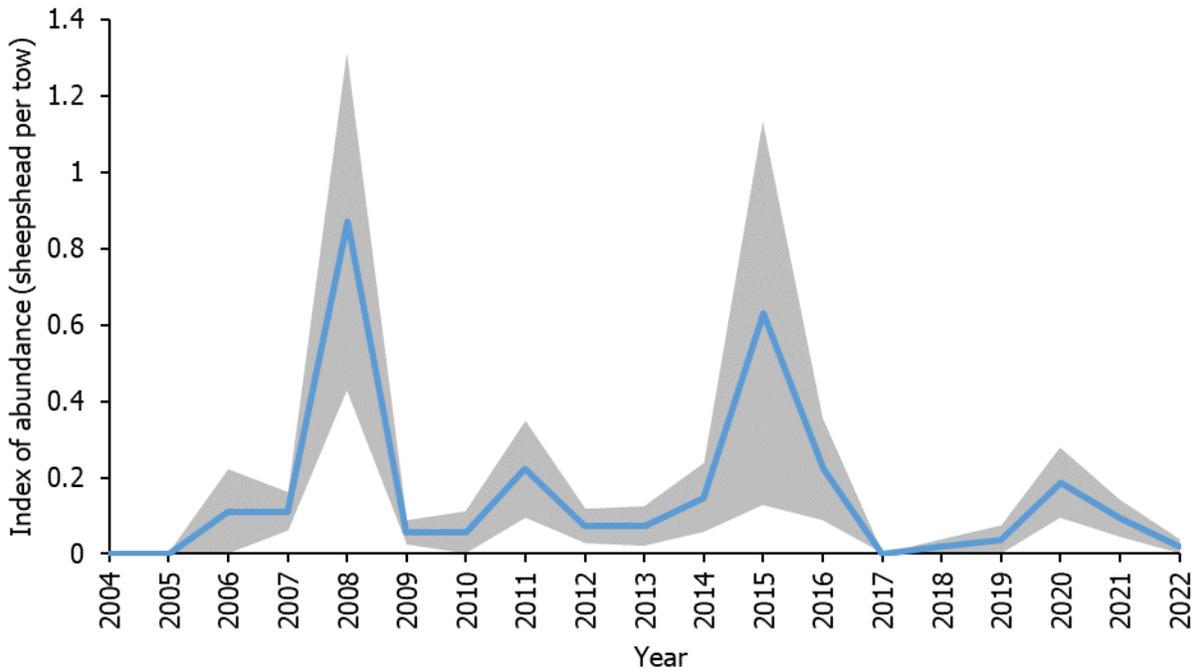


Figure 8. Annual juvenile index of abundance of sheephead in the DMF Juvenile Trawl Survey, 2004 – 2022.

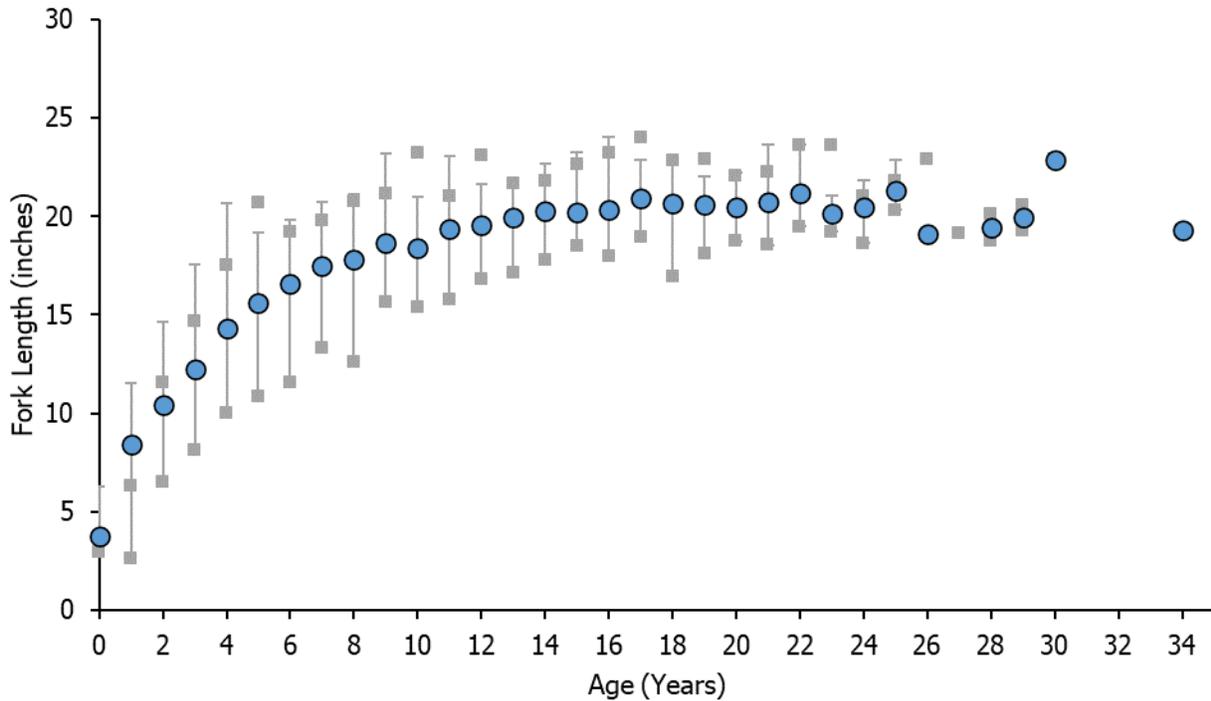


Figure 9. Sheephead length at age based on all age samples collected from 2008 – 2020. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age. Otoliths from 2021 and 2022 are not included as ages from 2021 are preliminary and 2022 have not yet been read.

## STATE MANAGED SPECIES – SHRIMP

### FISHERY MANAGEMENT PLAN UPDATE SHRIMP AUGUST 2023

#### STATUS OF THE FISHERY MANAGEMENT PLAN

##### Fishery Management Plan History

Original FMP Adoption:	April 2006	
Amendments:	Amendment 1	February 2015
	Amendment 2	February 2022
Revisions:	Revision to Amendment 1	May 2018
	Revision to Amendment 1	May 2021
Supplements:	None	
Information Updates:	None	
Schedule Changes:	None	
Comprehensive Review:	2027	

The N.C. Shrimp Fishery Management Plan (FMP) was adopted in April 2006 by the N.C. Marine Fisheries Commission (MFC; NCDMF 2006). The plan included a 90-foot headrope limit in some internal waters and area closures to protect habitats and juvenile finfish. Shrimp management by size was also developed to optimize the use of the resource. Other strategies were implemented to minimize waste through gear modifications, culling practices, and harvest restrictions. The plan allowed the use of skimmer trawls as a Recreational Commercial Gear License (RCGL) gear 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 limited to skimmer trawls only. This strategy was codified into rule through Amendment 1 in 2015.

Amendment 1 was adopted in February 2015 and was limited in scope to bycatch issues in the commercial and recreational fisheries (NCDMF 2015). The plan 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 (Proclamation SH-2-2015). It increased the daily harvest limit for cast nets in closed areas. Amendment 1 established a maximum combined headrope length of 220 feet in all internal coastal waters where there were no existing maximum combined headrope requirements, allowing for a phase-out period until January 1, 2017. Shrimp trawling was prohibited, effective May 1, 2015, in the Intracoastal Waterway (IWW) 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 so live bait fishermen with a permit could fish until 12:00 p.m. (noon) on Saturdays; effective May 1, 2017.

Amendment 1 introduced further industry testing of gears in shrimp trawls to reduce bycatch after adoption of the plan. An industry workgroup was formed to test gear modifications to reduce bycatch, to the extent practicable, with a 40% target reduction in the shrimp trawl fishery. Gear combinations with larger tailbag mesh sizes (>1 ½-inches), reduced TED grid size (3-inch), and larger fisheyes significantly reduced 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%. Shrimp catch between the control and experimental nets ranged from a 16.2% loss to a 9.9% gain.

Results from the industry workgroup testing and recommendation were adopted as a revision to Amendment 1 by the MFC in May 2018 (NCDMF 2018). Under the May 2018 Revision to Amendment 1 and continued through Amendment 2 (NCDMF 2022) fishermen are required to use one of four gear combinations that achieved at least 40% finfish bycatch. The new gear configurations are required in all shrimp trawls, except skimmer trawls, used in inside waters where up to 220 feet of combined headrope is allowed (Pamlico Sound and portions of the Pamlico, Bay, and Neuse rivers) effective July 1, 2019, through Proclamation SH-3-2019 and continues through proclamation SH-1-2022. The commission also recommended 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 FMP. In the fall of 2019, two gear configurations were tested in the Atlantic Ocean using the same methods and goals set forth by the MFC in Amendment 1, including a 40% target reduction of finfish bycatch above the industry standard gear at the time. One gear consisting of two inline federal fisheyes with a 1¾-inch tailbag met the management goal of a 40% reduction, achieving a 52% reduction in finfish bycatch. This gear was previously certified for use in the Pamlico Sound and is required in all shrimp trawls used in the Atlantic Ocean since July 1, 2022, through Proclamation SH-3-2022.

The North Carolina Wildlife Federation submitted a petition for rulemaking on November 2, 2016, and a modification to the petition on January 12, 2017. The Petitioner put forth seven rules to designate nursery areas, restrict gear and seasonality in the shrimp trawl fishery to reduce bycatch of fish (including spot, Atlantic croaker, and weakfish), and establish an 8-inch minimum size limit for spot and a 10-inch minimum size limit for Atlantic croaker. In February 2017, the MFC approved the petitioned rules to begin the rulemaking process. Upon review by the Office of State Budget and Management it was determined that sufficient state funds were not available to implement the proposed rule changes without undue detriment to the agency's existing activities and the rules were never adopted.

With the adoption of Amendment 1, a management strategy included the Habitat and Water Quality Advisory Committee) to provide input on changing the designation of certain Special Secondary Nursery Areas (SSNAs) that had not been opened to trawling since 1991 to permanent Secondary Nursery Areas (SNAs). Due to overlapping issues associated with petitions for rulemaking related to nursery area designations and shrimp management the development of this management measure was delayed. The MFC selected to change the designation of 10 SSNAs that had not been opened to trawling in many years to permanent SNAs and in the May 2021 Revision to Amendment 1 (NCDMF 2021) the designation of SSNAs in Pungo, Scranton, Slade, South, Bond/Muddy, and Saucepan creeks as well as the Newport, Cape Fear and Lockwood Folly rivers were changed to permanent SNAs.

In August 2019, the FMP schedule moved the timeline forward one year to start development of Amendment 2. The goal of Amendment 2 is to further reduce bycatch of non-target species and minimize ecosystem impacts. The MFC adopted the Shrimp FMP Amendment 2 in February 2022. The amendment retained measures implemented with the May 2018 and 2021 revisions to the Shrimp FMP Amendment 1 and implemented several management changes: 1) prohibit all trawling within all Crab Spawning Sanctuaries year-round (Proclamation SH-1-2023), 2) prohibit trawling in Bogue Sound and the Carolina Beach Boat Basin, except within the Intracoastal Waterway (Proclamations SH-1-2023 and SH-2-2023), 3) establish a single, state-wide recreational creel limit for cast nets (48 quarts, heads on or 30 quarts, heads off; Proclamation SH-4-2022), 4) change the flexible opening date in all SSNAs to a static Sept. 1, 5) continue collaboration with the industry workgroup to identify and test gear modifications to further reduce bycatch in the shrimp fishery, 6) provide for adaptive management for future action to address issues related to submerged aquatic vegetation identified through Division collaboration with the Coastal Habitat Protection Plan support staff, the Habitat and Water Quality Advisory Committee, and stakeholder groups, 7) maintain existing headrope limits for shrimp trawls in internal coastal waters but allow for adaptive management to resolve user conflicts, and 8) investigate the feasibility and use of a long-term shrimp trawl observer program that encompasses all seasons, areas, and gears (Table 1).

## **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 Amendment 2 is to manage the shrimp fishery to provide adequate resource protection, optimize long-term harvest, and minimize ecosystem impacts (NCDMF 2022). The following objectives will be used to achieve this goal.

- Reduce by catch of non-target species of finfish and crustaceans, as well as protected, threatened, and endangered species.
- Promote the restoration, enhancement, and protection of habitat and environmental quality in a matter consistent with the Coastal Habitat Protection Plan (CHPP).
- Develop a strategy through the CHPP to review current nursery areas and to identify and evaluate potential areas suitable for designation.
- Use biological, environmental, habitat, fishery, social, and economic data to effectively monitor and manage the shrimp fishery and its ecosystem impacts (i.e., bycatch, habitat degradation).
- Promote implementation of research and education programs designed to improve stakeholder and the general public's understanding of shrimp trawl by catch impacts on fish population dynamics.

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

There are three shrimp species that make up the fishery in North Carolina. They are the brown shrimp, pink shrimp, and white shrimp. The lifecycles of these species are similar in that adult shrimp spawn offshore and eggs are hatched into free-swimming larvae. Larvae develop through several stages into post-larvae. Once post-larval shrimp enter estuaries, growth is rapid and is dependent on salinity and water temperature. As 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 maximum size can range from seven to 11 inches, depending on species (Eldred et al. 1961; Gunter 1961; McCoy 1968, 1972; McCoy and Brown 1967; Williams 1984).

### **Stock Status**

Population size is controlled by environmental conditions, and while fishing reduces the population size over the season, fishing is not believed to impact 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 shrimp species are capable of rebounding from very low population sizes in one year to large populations the next, provided environmental conditions are favorable (MacArthur and Wilson 1967; McCoy and Brown 1967; McCoy 1968, 1972; Perez-Farfante 1969; Purvis and McCoy 1972; Whitaker 1981, 1982, 1983; Morley et al. 2022; Schlenker et al. 2023).

### **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.

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

The MFC has established several rules that directly govern the harvest of shrimp and the use of trawls. Below are rules and excerpts from rules that directly affect the shrimp fishery. The rules below do not cover all gear, area, or other rules which may impact the shrimp fishery. As state and federal regulations may change, please contact the North Carolina Division of Marine Fisheries (DMF) for the most current regulations.

Shrimp cannot be taken by nets until the division Director opens the season by proclamation (NCMFC Rule 15A NCAC 03L .0101). The Director has the proclamation authority to specify hours of day or night or both and any other conditions appropriate to manage the fishery. Areas open to trawling are also considered open areas for shrimp harvest for all other gears including cast nets. Proclamations identifying areas open and closed to the harvest of shrimp can be found

at: <https://deq.nc.gov/fisheries-management-proclamations#currentprocs>.

### Area Restrictions

Shrimp and crab trawl nets cannot be used in any primary or permanent SNA; however, the DMF Director can open SSNAs to trawling by proclamation from August 16 through May 14 (NCMFC Rule 15A NCAC 03N .0104 and .0105). With the adoption of Amendment 2, a static season was established to open all SSNAs, at the Director's discretion, no earlier than September 1. In the Albemarle Sound and its tributaries, the use of shrimp trawls is prohibited (NCMFC Rule 15A NCAC 03J .0104). Additional trawl net prohibited areas are established in parts of Pamlico, Core, and Back sounds (NCMFC Rule 15A NCAC 03J .0104 and 03R .0106). Shrimp trawling is prohibited in military danger zones and restricted areas throughout all internal coastal waters (NCMFC Rule 15A NCAC 03R .0102).

With the adoption of Amendment 2, trawling at all coastal inlets in Crab Spawning Sanctuaries was prohibited year around (SH-1-2023). In designated pot areas, the use of trawls is prohibited from June 1 to November 30 (NCMFC Rule 15A NCAC 03J .0104(b)(6), 03J .0301(a)(2), 03R .0107 and Proclamation SH-1-2023) and within the shoreline to the depth of six feet [NCMFC Rule 15A NCAC 03J .0104(6)]. Trawling is prohibited in oyster seed management areas (NCMFC Rule 15A NCAC 03K .0208 and 03R .0116) and oyster sanctuaries (NCMFC Rule 15A NCAC 03K .0209 and 15A NCAC 03R .0117). In the Pamlico, Pungo, and Neuse rivers as well as portions of New Hanover and Brunswick counties, shrimp trawl prohibited areas were implemented as part of the 2006 Shrimp FMP and Amendment 1 to protect habitat, reduce bycatch, reduce use conflict, and protect small shrimp (NCMFC Rule 15A NCAC 03L .0103(e) and 03R .0114). With the adoption of Amendment 2, shrimp trawling in Bogue Sound and the Carolina Beach Boat Basin was prohibited, except within the Intracoastal Waterway (Proclamations SH-1-2023 and SH-2-2023).

In the Atlantic Ocean, the use of commercial gear is prohibited within 750 feet of licensed fishing piers [NCMFC Rule 15A NCAC 03J .0402(a)(1)(ii)]. Commercial fishing gears are also restricted within 750 feet from piers at specified times of the year in Onslow, Pender, New Hanover counties [NCMFC Rule 15A NCAC 03J .0402(a)(2)(A)(B)(i)(ii)(iii)]. All trawls are restricted from use within one-half mile of the beach between the Virginia line and Oregon Inlet in the Atlantic Ocean (NCMFC Rule NCAC 03J .0202(2)). Additional area restrictions have been implemented in the Southport Boat Harbor, Brunswick County and at the Progress Energy intake canal at the Brunswick County Nuclear Power Plant for public safety (NCMFC Rule 15A NCAC 03J .0206 and .0207).

### Gear Restrictions

The use of otter trawls upstream of Highway 172 Bridge in the New River was prohibited as part of the 2006 Shrimp FMP, limiting trawling to skimmer trawls [NCMFC Rule 15A NCAC 03J .0208(a)(b)]. The 2006 FMP also established a maximum combined headrope limit of 90 feet in internal coastal waters of North Carolina, except in the Pamlico Sound and mouths of the Pamlico and Neuse rivers where up to 220 feet of combined headrope may be used [NCMFC Rule 15A NCAC 03L .0103(c)(d)]. The 220 feet maximum headrope limit was implemented in Pamlico Sound to cap fleet capacity as part of Amendment 1 [NCMFC Rule 15A NCAC 03L .0103(d)(1)].

(2)(3)]. Recreational fishermen possessing a Recreational Commercial Gear License (RCGL) are limited to one shrimp trawl with a maximum headrope length of 26 feet [NCMFC Rule 15A NCAC 03O .0302(2)].

Minimum mesh size requirements for shrimp trawls (otter and skimmer) are one and one-half inches (NCMFC Rule 15A NCAC 03L .0103L). However, in the Pamlico Sound and portions of the Pamlico and Neuse rivers where up to 220 feet of headrope is allowed as well as the Atlantic Ocean the minimum tail bag mesh size is one and three-quarter inches (Proclamations SH-1-2022 and SH-3-2022). Net material used as chafing gear must be four inches mesh length, except smaller mesh may be used along the bottom half of the tailbag (NCMFC Rule 15A NCAC 03L .0103). The minimum mesh size for channel nets, float nets, butterfly nets, and hand seines is one and one-quarter inches [NCMFC Rule 15A NCAC 03L .0103L(a)(2)]. The minimum mesh size for shrimp pots is one and one-fourth inches stretch or five-eighths inch bar [NCMFC Rule 15A NCAC 03J .0301(e)].

Bycatch reduction devices are required in all trawls used to harvest shrimp [NCMFC Rule 15A NCAC 03J .0104(d)]. Proclamation SH-1-2022 describes the BRD requirements for otter trawls in Pamlico Sound and the Pamlico, Bay, and Neuse rivers where up to 220 feet of combined headrope is allowed. Otter and skimmer trawls in all other waters statewide are required to have two BRDs installed on each net (Proclamation SH-2-2022). Primary and secondary BRD requirements for the Croatan and Roanoke sounds, portions of the Pamlico, Bay, and Neuse rivers, and Core Sound to the SC-NC state line are listed in Proclamation SH-2-2022. Proclamation SH-3-2022 describes the BRD requirements for otter trawls in the Atlantic Ocean.

All shrimp trawls must conform with the federal requirements for Turtle Excluder Devices (TEDs) [NCMFC Rule 15A NCAC 03L .0103(h)]. All otter trawl nets are required to have a federally approved TED with bar spacing up to four inches if using mechanical retrieval methods. Federally approved TEDs are listed in United States Code of Federal Regulations Title 50, Section 223.207. Effective August 1, 2021, all skimmer trawls 40 feet and greater must have a federally approved TED installed with a bar spacing no greater than three inches in each net. Skimmer trawls less than 40 feet will not be required to use TEDs but must limit tow times to 55 minutes from April 1 through October 31, and 75 minutes from November 1 through March 31 [50 CFR 223.206(d)(2)(ii)(A)].

Channel nets or other fixed or stationary nets in the IWW are prohibited from blocking more than two-thirds of any natural or manmade waterway, in the middle third of any marked navigation channel [NCMFC Rule 15A NCAC 03J .0101(1)(2)(3)]. Channel nets cannot be set with any portion of the set within 50 feet of the center line of the IWW channel or in the middle third of any navigation channel marked by the Corps of Engineers or the Coast Guard. Channel nets must be always attended [NCMFC Rule 15A NCAC 03J .0106(a)(3)(4)(5)] and not exceed 40 yards in length. 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 with a non-metal line when not attached to the net; metallic floats or buoys to mark sets are prohibited [NCMFC Rule 15A NCAC 03J .0106(b)(c)(d)(e)].

The leads or any fixed or stationary net or device to direct shrimp into shrimp pots is prohibited [NCMFC Rule 15A NCAC 03J .0301(l)]. Recreational fishermen holding a RCGL may use up to

five shrimp pots [NCMFC Rule 15A NCAC 03O .0302(a)(3)]. Recreational pots must be marked with a hot pink buoy and owner's identifying information [NCMFC Rule 15A NCAC 03J .0302(a)]. The use of more than one shrimp pot attached to the shore along privately owned land or to a privately owned pier is prohibited without possessing a valid RCGL [NCMFC Rule 15A NCAC 03J .0302(b)]. A pound net permit is required to deploy a shrimp pound and the set must be operational for a minimum of 30 consecutive days during the permit period [NCMFC Rule 15A NCAC 03J .0501(b)(1)(2)]. Shrimp pounds are defined as pound net set with all pounds (holding pen) 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(6)]. RCGL holders may use one pound net with leads up to 10 feet in length with an enclosure up to 36 inches; attendance is required at all times and all gear must be removed from the water when not being fished [NCMFC Rule 15A NCAC 03O .0302(8)]. Shrimp pound sets must be properly marked with the permittee's identification and Pound Net Set Permit number, marked with a 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 [NCMFC Rule 15A NCAC 03J .0501(b)(c)]. Shrimp pound net sets must be set a minimum of 100 yards from a RCGL shrimp pound net set or 300 yards from an operational permitted shrimp pound net set [NCMFC Rule 15A NCAC 03J .0501(d)(2)].

#### Effort Restrictions

Shrimp trawling is prohibited in internal coastal waters from 9:00 p.m. on Friday through 5:00 p.m. on Sunday [NCMFC Rule 15A NCAC 03J .0104(b)(1)]. However, weekend shrimp trawling is allowed in Atlantic Ocean, with the use of fixed and channel nets, hand, seines, shrimp pots, and cast nets, or for a holder of a Permit for Weekend Trawling for Live Shrimp [NCMFC Rule 15A NCAC 03L .0102, 03O .0503(1)(2)(3)]. In portions of the Pungo, Pamlico, Bay, Neuse, and New rivers the use of trawl nets is prohibited from one hour after sunset to one hour before sunrise prohibited from December 1 through February 28 [NCMFC Rule 15A NCAC 03J .0208]. Upstream of the Highway 172 Bridge in New River shrimp trawling (skimmer only) is prohibited from 9:00 p.m. through 5:00 a.m. when opened by proclamation from August 16 through November 30 (NCMFC Rule 15A NCAC 03J .0208).

#### Incidental Catch

The possession of more than 500 pounds of finfish from December 1 through February 28 and 1,000 pounds of finfish from March 1 through November 30 is prohibited while using a trawl in internal waters [NCMFC Rule 15A NCAC 03J .0104(a)]. Shrimp trawls cannot be used to take blue crabs in internal waters, except when the weight of the crabs does not exceed 50% of the total weight of the combined crab and shrimp catch or 300 pounds, whichever is greater [NCMFC Rule 15A NCAC 03J .0104(f)(2)]. 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 [NCMFC Rule 15A NCAC 03J .0202(5)]. Channel nets are prohibited from taking blue crabs in internal waters, except when the weight of the crabs does not exceed 50% of the total weight of crab and shrimp or 300 pounds, whichever is greater [NCMFC Rule 15A NCAC 03J .0106(h)(1)(A)(B)].

## Recreational Creel Limits

Recreational fishermen using cast nets are limited to no more than 48 quarts (heads on) or 30 quarts (heads off) of shrimp per person per day or per vessel per day if a vessel is used in all Coastal Fishing Waters (Proclamation SH-4-2022). Recreational fishermen using limited amounts of commercial gear authorized under the Recreational Commercial Gear License (NCMFC Rule 15A NCAC 03O .0302) are limited to 48 quarts (heads on) or 30 quarts (heads off) of shrimp per person per day or if vessel is used, per vessel per day. If more than one RCGL holder are on a vessel, a maximum of two limits per vessel are allowed in areas open to shrimping [NCMFC Rule 15A NCAC 03O .0303(e)(f) and Proclamations SH-1-2023 and SH-2-2023].

## **Commercial Fishery**

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 Core and Bogue sounds, and the North, Newport, and White Oak rivers. In the southern portion of the state, the fishery is characterized by a large number of small boats fishing internal waters (primarily the IWW, 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.

A variety of methods are used to catch shrimp including otter trawls, skimmer trawls, channel nets, shrimp pounds, and cast nets. Otter trawls derived their name from the two trawl doors (otter doors/boards) that attach to the bridle that are hydro-dynamically designed to hold the wings of the net open. As the net is pulled along the bottom, the otter boards plane in opposite directions holding the net open. Otter trawls are used for all three species in both the estuary and the ocean. Two-seam trawls are 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. Skimmer trawls consist of two rigid frames attached to each side of a vessel with nets attached along the two sides of the frame. Metal skids keep the frames off the bottom as the nets are pushed through the water column. Unlike otter trawls, the tailbags of skimmer trawls can be checked while fishing. Skimmer trawls are primarily used for white shrimp and are capable of fishing waters as shallow as two feet.

Use of gears other than trawls has increased primarily in the area from New River to Rich's Inlet. Channel nets are stationary nets that use tidal currents to fish the surface and middle depths of the water column. The mouth of the nets is held open by upright wooden shafts attached to a buoy and

anchor on one side and a small vessel on the other. Float and butterfly nets also 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. 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. Trawls, cast nets, and seines are used to harvest 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 2022 have averaged 7,481,925 pounds per year. In 2022, 4,780,857 pounds of shrimp were landed. Total landings decreased 48% from 2021 to 2022. In 2022, 69% of the harvest occurred in estuarine waters, with the remainder occurring in the Atlantic Ocean (less than 3 miles from shore). Landings in the Atlantic Ocean (less than 3 miles from shore) decreased 74% and landings in estuarine waters decreased 4% from 2021 to 2022 (Figure 2). Annual shrimping effort (number of trips) has fluctuated with shrimp abundance but appears to have declined since 1994 (NCDMF 2015, 2022). This may be due to a number of things including cheaper imported shrimp prices, increasing fuel prices, and fishermen retiring. 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). Hurricane Florence (9/17/18) directly hit North Carolina, likely contributing to the decrease in landings in 2018. The number of trips decreased 38% from 2021 to 2022 (Figure 3). Poor ex-vessel prices, cheap imported shrimp, and high fuel prices are presumed to have contributed to the recent decline in effort.

### **Recreational Fishery**

Shrimp are harvested recreationally throughout the state by otter trawls, skimmer trawls, seines, cast nets, shrimp pots and shrimp pounds with specific gear limitations. The NC Coastal Angling Program uses multiple surveys to obtain recreational harvest and landings data; however, the recreational harvest of shrimp is limited to the Cast Net and Seine Mail Survey and the RCGL Survey.

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 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. Recreational landings of shrimp from RCGL gears are currently unknown since there is no directed survey for this gear.

In October of 2011, DMF began surveying Coastal Recreational Fishing License (CRFL) holders to determine if they used cast nets or seines. This mail survey was implemented to develop catch and effort estimates for recreational harvest with these specific gear types, including recreational

shrimp harvest. Catch refers to the number of shrimp harvested by each angler and effort is the number of trips taken by the angler. This data is then extrapolated to represent the population of CRFL holders and presented as catch and effort estimates. The estimated annual average number of shrimp caught (harvest and released) using a cast net and/or seine was 158,441 shrimp from 2012 to 2022 (Table 2; Figure 4). In 2022, 131,567 shrimp were caught. The total number of shrimp harvested increased 18% and the number released increased 11% from 2021 to 2022; however, the number of trips decreased 33%.

## **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 N.C. 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 database 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 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. During 2020, sampling was impacted due to the COVID pandemic. Executive Order (EO) 116, issued on March 10, 2020, declared North Carolina under a State of Emergency and was soon followed by EO 120 which implemented a statewide Stay at Home Order for all non-essential State employees. During this time, sampling did not occur in May, but did occur in early and late-June. In 2021, sampling resumed in the months of May and June.

Annual trends in brown shrimp relative abundance, measured as the number of brown shrimp per station in Program 120 sampling, shows fluctuations from year to year (Figure 5). The annual brown shrimp index of relative abundance increased 21% from 2021 to 2022 (Table 3; Figure 5). The proportional standard error was below 20 in all but four years from 1988 to 2022 (Table 3). 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 index of relative abundance can also be used to determine year class strength. Trends in overall shrimp landings from June and July, months that brown shrimp make up most of the harvest, show similar trends as the Program 120 data (Figure 6). Currently, there are no juvenile indices of abundance for white and pink shrimp in North Carolina.

## RESEARCH NEEDS

The following research needs are from Amendment 2 to the N.C. Shrimp FMP (NCDMF 2022). The list below outlines the specific needs and highlights the priority and status of each.

### High

- Create a long-term shrimp trawl observer program to characterize bycatch across all strata (for example: dominant species, protected species, season, areas, gear type, vessel type, number of nets/rigs, headrope length, TED position, etc.). — Needed
- Improve accuracy of self-reported license gear survey data or investigate other means of accurately obtaining shrimp fleet characteristics. — Needed
- Collect improved effort data (e.g., headrope length, number of nets, tow time, number of tows) to provide bycatch estimates based on actual time fished (or number of tows), rather than number of trips. — Needed
- Create and validate juvenile abundance indices for white and pink shrimp. — Needed
- Determine the cumulative impacts of shrimp trawl bycatch on individual species population dynamics and the ecosystem. — Needed
- Determine the spatial, temporal, and biological characteristics of submerged aquatic vegetation that maximize their ecological value to shrimp for restoration and conservation purposes. — 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.
- Develop alternative non-bottom disturbing gears to efficiently catch shrimp. — Needed

### Medium

- Determine the influence of current bottom disturbing gears patterns (location, frequency, etc.) on sub-tidal shell, and SAV in Pamlico Sound. — Needed
- Continue to locate, map, and quantify the bottom habitat structure, bathymetry, and sediment types in North Carolina estuaries. — Ongoing
- Measure the effects of trawling on sediment size distribution and organic carbon content.
- Establish continuous water quality monitoring in the Pamlico system to evaluate water quality effects on shrimp and the fish habitats in which they rely. — Needed
- Develop research methods to understand costs and benefits of maintaining shrimp habitat and water quality to inform decision-making on shrimp management. — Needed

### Low

- Initiate research to determine the impacts of endocrine disrupting chemicals (EDCs) on the various life stages of shrimp. — Needed

- Expand current social and economic surveys to specifically collect information on shrimp fishermen. — Needed

## MANAGEMENT STRATEGY

There are no management triggers or methods to track stock abundance, fishing mortality, or recruitment between benchmark reviews from the current FMP. Several management issues were explored in Amendment 2; Table 1 outlines the specific issues and the implementation status of each strategy.

## FISHERY MANAGEMENT PLAN SCHEDULE RECOMMENDATIONS

The division is continuing to implement management strategies from Amendment 2, which was adopted by the MFC in February 2022. The next scheduled review of this plan will begin in July 2027.

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## TABLES

Table 1. Summary of management strategies and outcomes from N.C. Shrimp Fishery Management Plan Amendment 2.

Management Strategy	Implementation Status
Prohibit trawling within all Crab Spawning Sanctuaries.	Existing proclamation authority; Proclamation issued, SH-1-2023.
Prohibit trawling in Bogue Sound and the Carolina Beach Yacht Basin, except within the Intracoastal Waterway	Existing proclamation authority; Proclamations issued, SH-1-2023 and SH-2-2023.
Establish a single, state-wide recreational creel limit for cast nets (48 quarts, heads on or 30 quarts, heads off).	Existing proclamation authority; Proclamation issued, SH-4-2022.
Change the flexible opening date in all Special Secondary Nursery Areas to a static Sept. 1.	Existing proclamation authority; Proclamations will be issued if deemed appropriate by the DMF Director.
Continue collaboration with the industry workgroup to identify and test gear modifications to further reduce bycatch in the shrimp fishery.	Ongoing. Issue a press release to solicit members for the shrimp industry workgroup.
Provide for adaptive management for future action to address issues related to submerged aquatic vegetation identified through Division collaboration with the Coastal Habitat Protection Plan support staff, the Habitat and Water Quality Advisory Committee, and stakeholder groups.	Ongoing. Update SAV maps that will be reviewed by the division, CHPP staff, and the Habitat and the Water Quality AC to address SAV impact. Identified recommendations will be brought back to the appropriate committees and the MFC for future action.
Maintain existing headrope limits for shrimp trawls in internal coastal waters but allow for adaptive management to resolve user conflicts.	No action required.
Investigate the feasibility and use of a long-term shrimp trawl observer program that encompasses all seasons, areas, and gears.	Ongoing. Develop an information paper to be brought back to the MFC for future action.

Table 2. Annual number of trips and shrimp taken from cast nets and seines for recreational purposes, 2012-2022. PSE= Percent Standard Error.

Year	Trips		Harvest		Release		Total Catch	
	Number	PSE	Number	PSE	Number	PSE	Number	PSE
2012	127,806	6	159,828	26	19,584	35	179,412	25
2013	142,193	6	204,151	21	20,563	30	224,715	20
2014	206,024	6	200,025	21	29,605	42	229,630	21
2015	217,484	6	192,630	18	32,415	25	225,044	18
2016	194,237	6	237,433	24	59,259	41	296,692	24
2017	192,593	6	123,393	22	32,227	36	155,621	23
2018	95,734	12	89,151	58	1,500	47	90,651	57
2019	176,981	7	83,266	28	27,142	37	110,409	26
2020	185,991	7	209,454	47	52,850	41	262,304	44
2021	272,825	9	111,949	32	22,313	48	134,262	30
2022	182,486	6	131,567	27	24,687	47	156,255	28

Table 3. Program 120 annual sampling for brown shrimp from core stations in May and June combined. Number of samples (stations), brown shrimp index of relative abundance (number 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), 1988-2022.

Year	Number of stations	Relative abundance	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	205	57.8	7.2	102.8	177.6	0	759	11,859	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
2018	208	33.8	5.5	78.9	233.6	0	714	7,028	16
2019	208	31.6	11.7	168.4	532.4	0	2,237	6,580	37
2020	208	24.5	2.9	41.2	168.5	0	284	5,088	12
2021	208	35.9	4.7	67.4	187.8	0	429	7,469	13
2022	208	43.6	7.1	101.7	233.3	0	987	9,072	16

## FIGURES

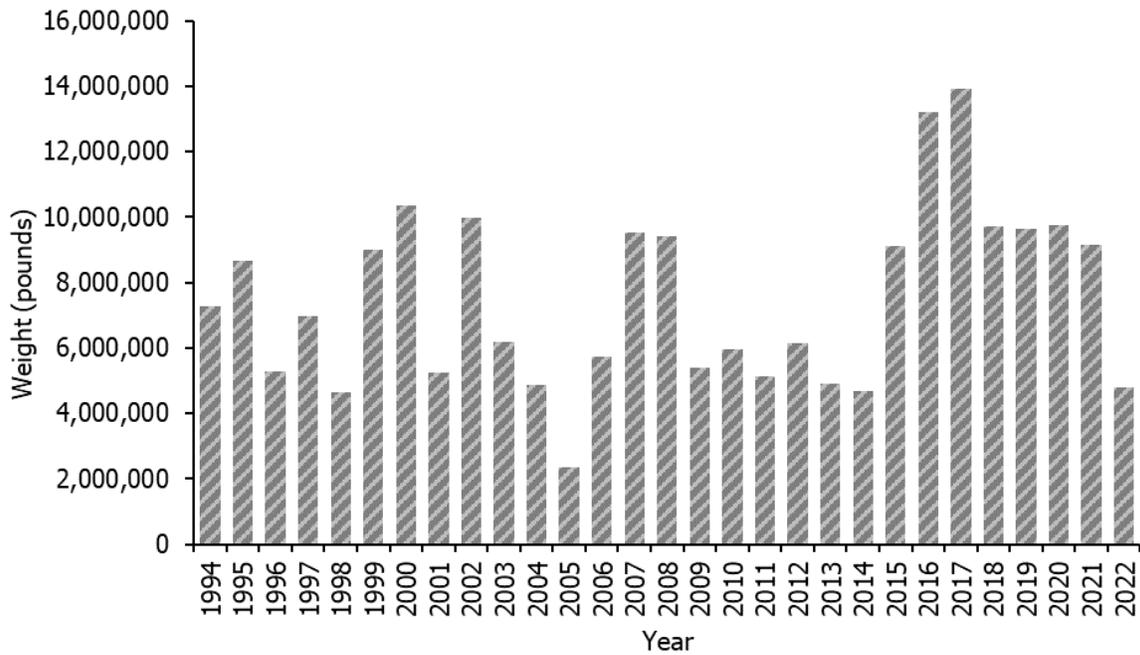


Figure 1. Annual commercial shrimp landings (pounds) from all three shrimp species combined in North Carolina, 1994-2022. Data from the DMF Trip Ticket Program.

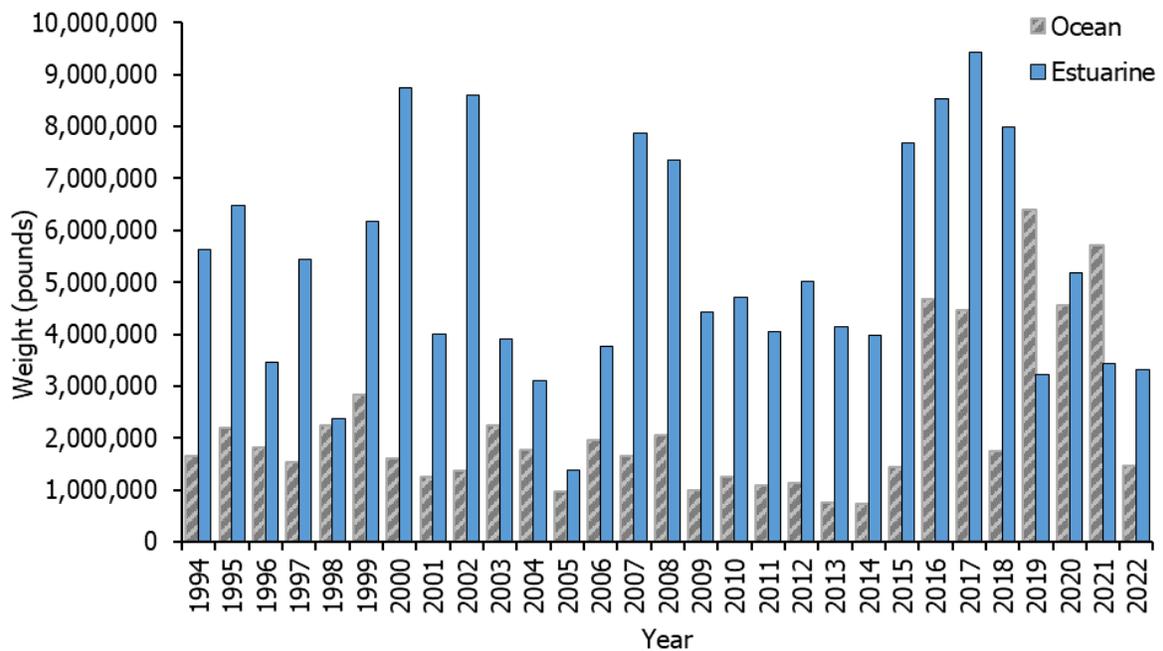


Figure 2. Annual commercial shrimp landings (pounds) by area from all three shrimp species combined in North Carolina, 1994-2022. Data from the DMF Trip Ticket Program.

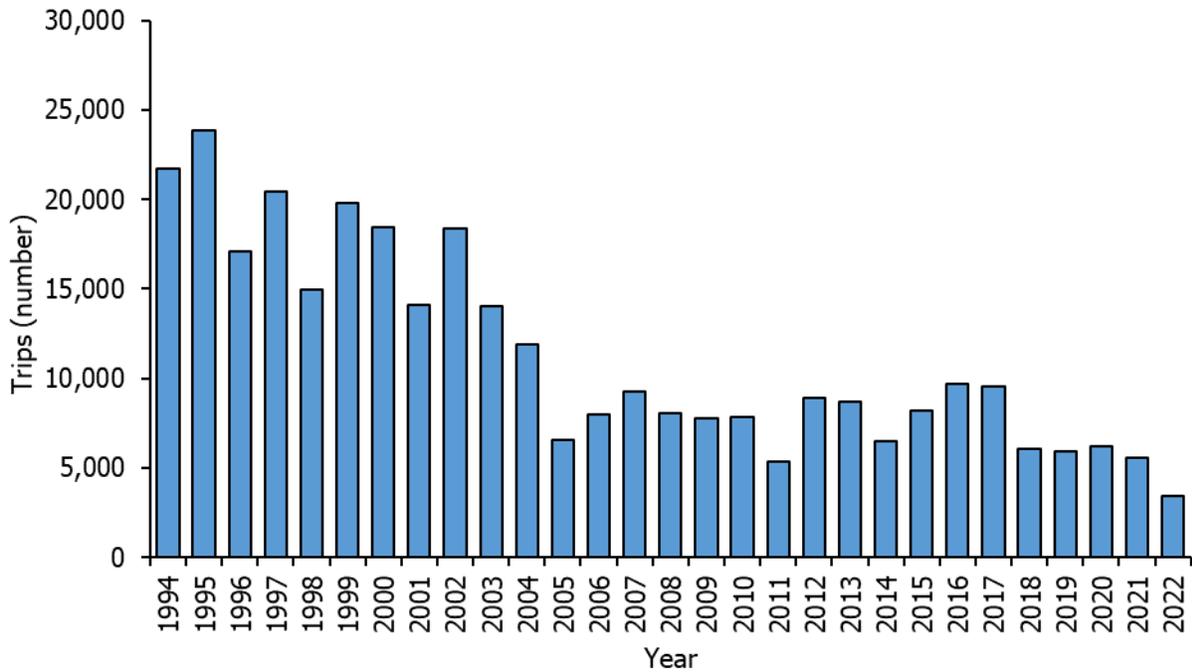


Figure 3. Annual number of commercial trips reported for all three species combined in inside and ocean waters, 1994-2022. Data from the DMF Trip Ticket Program.

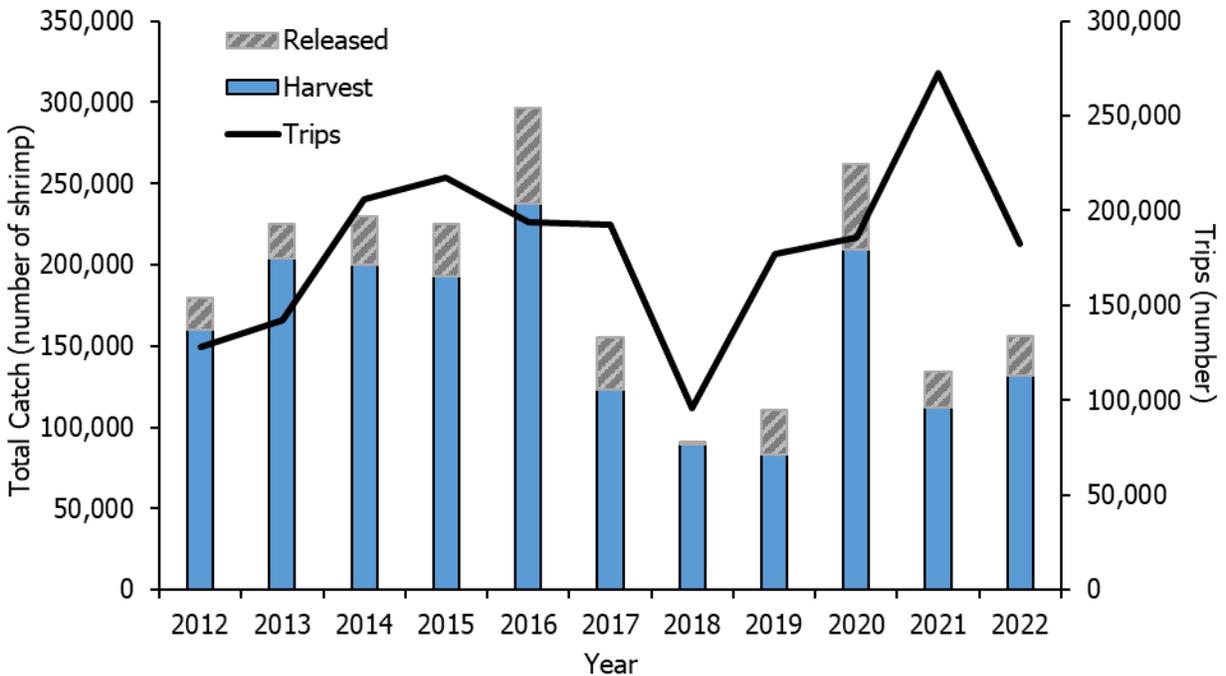


Figure 4. Annual number of trips and shrimp taken from cast nets and seines for recreational purposes, 2012-2022.

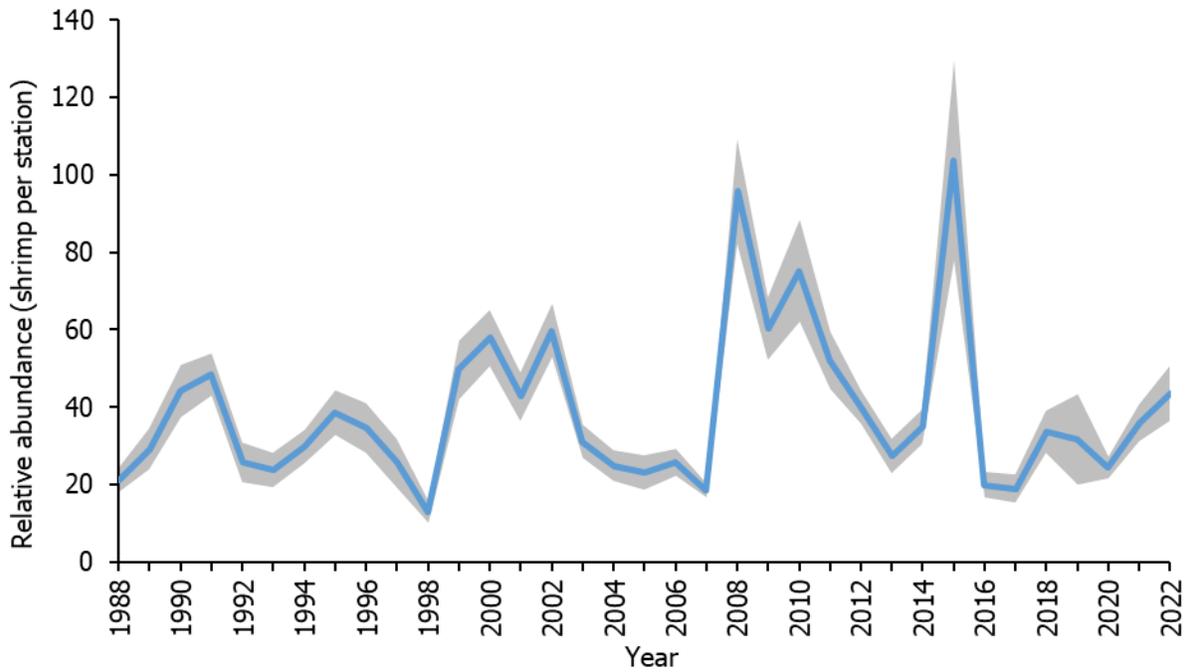


Figure 5. Annual index of relative abundance (shrimp per station) of brown shrimp from Program 120 estuarine trawl survey, 1988-2022. Shaded area represents standard error.

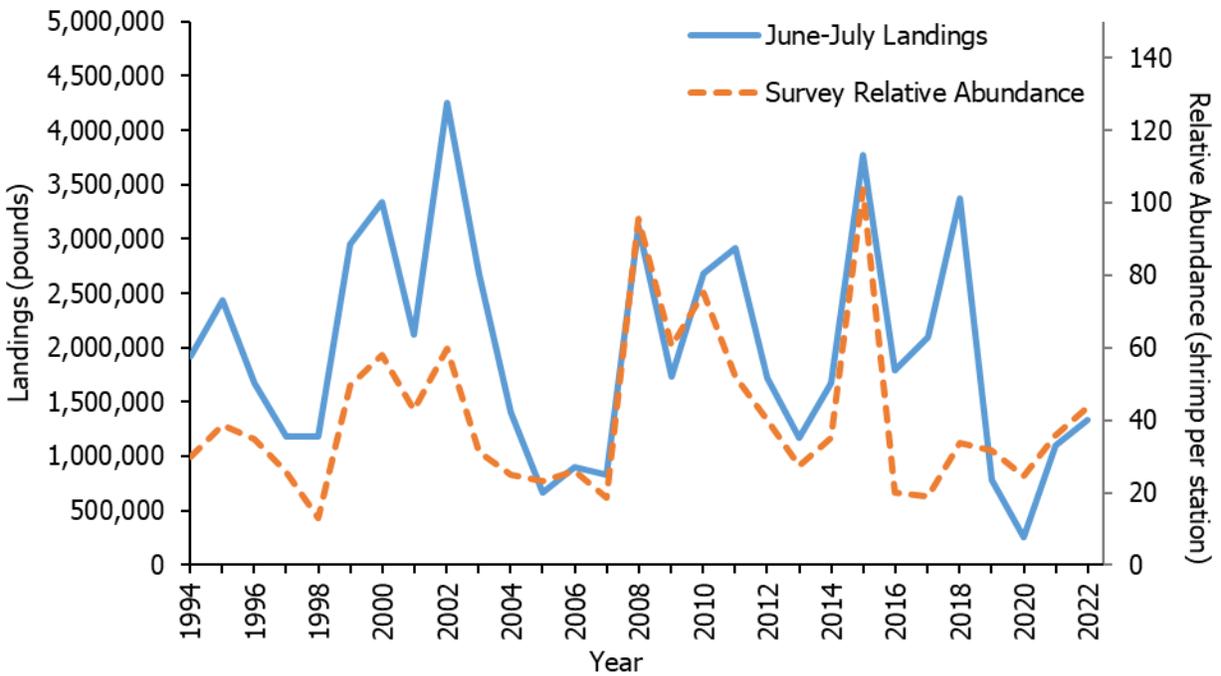


Figure 6. Comparison of brown shrimp commercial shrimp landings (pounds) in the months of June and July to the brown shrimp Program 120 index of relative abundance (shrimp per station), 1994-2022.

STATE MANAGED SPECIES – SOUTHERN FLOUNDER

**FISHERY MANAGEMENT PLAN UPDATE  
SOUTHERN FLOUNDER  
AUGUST 2023**

**STATUS OF THE FISHERY MANAGEMENT PLAN**

**Fishery Management Plan History**

Original FMP Adoption:	February 2005	
Amendments:	Amendment 1	February 2013
	Amendment 2	August 2019
	Amendment 3	May 2022
Revisions:	None	
Supplements:	Supplement A to the FMP	February 2011
	Supplement A to Amendment 1	August 2017
Information Updates:	None	
Schedule Changes:	None	
Comprehensive Review:	2027	

Southern flounder (*Paralichthys lethostigma*) in North Carolina are managed under Amendment 3 to the North Carolina Southern Flounder Fishery Management Plan (FMP; NCDMF 2022). Development of Amendment 3 began upon approval of Amendment 2 to address comprehensive, long-term management strategies to continue the rebuilding of the southern flounder stock started under Amendment 2. Amendment 2 was intended to reduce harvest pressure on the North Carolina portion of the stock quickly before more robust measures were developed. Amendment 2 and Amendment 3 management was based on the 2019 coast-wide stock assessment. The original assessment pooled-sex model (Lee et al. 2018) was updated with data through 2017 and incorporated the new Marine Recreational Information Program (MRIP) estimates that were available (Flowers et al. 2019).

At its May 26, 2022 business meeting, the North Carolina Marine Fisheries Commission (MFC) adopted Amendment 3 to the Southern Flounder FMP as proposed by the North Carolina Division of Marine Fisheries (DMF).

Amendment 3 actions to achieve sustainable harvest include:

- Combine mobile gears (gill nets, gigs, and “other” gears) into one gear category and maintain pound nets as their own separate commercial fishery.
- Divide mobile gears into two areas using the Incidental Taker Permit (ITP) boundary line for management units B-D.

- Divide the pound net fishery into three areas maintaining consistency with areas in Amendment 2.
- Maintain 72% reduction and current sub-allocation for the pound net fishery with direction from the MFC as follows: “In 2024, as the shift in allocation is set to start the Division will provide recommendations to the MFC on approaches to maintaining a sustainable sub-allocation for the commercial pound net fishery, as needed based on the economic and biotic conditions at that time”.
- Implement trip limits for pound nets and gigs only to maximize reopening after reaching division closure threshold.
- Implement a single season for the recreational gig and hook-and-line fisheries to constrain them to an annual quota.
- Reduce the recreational bag limit of flounder to one fish per person per day.
- Do not allow harvest of southern flounder using a Recreational Commercial Gear License (RCGL).
- One-fish recreational ocellated bag limit during March 1 through April 15 in ocean waters only using hook-and-ling gear and a one-fish bag limit consisting of any species of flounder during the southern flounder recreational season.
- Do not establish inlet corridors for southern flounder during spawning migrations.
- Adopt the adaptive management framework based on the peer-reviewed and approved stock assessment.
- At the November 2020 business meeting, the MFC requested analysis of various recreational and commercial allocation percentages. In March 2021, the MFC voted on and approved sector allocations of 70/30 commercial to recreational for 2021 and 2022 and shifting to 60/40 for 2023, and 50/50 parity beginning in 2024.
- Based on recognition of a series of coincident concerns specific to the initial steps in rebuilding the southern flounder fishery, the MFC voted in February 2022 to delay the transition to 50/50 parity by two years (time for at least one cycle of larval to female maturity). The selected allocations will be 70/30 for 2023 and 2024, 60/40 for 2025, and 50/50 parity starting in 2026.
- Do not implement a slot limit and maintain the 15-inch total length (TL) current minimum size limit.
- Continue to allow anchored large-mesh gill nets to harvest southern flounder in the North Carolina southern flounder fishery.

### **Management Unit**

In Amendment 3 to the North Carolina Southern Flounder FMP, the management unit was defined as North Carolina coastal 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

The goal and objectives of Amendment 3 to the North Carolina Southern Flounder FMP were approved by the MFC at their February 2020 business meeting. The goal is to manage the southern flounder fishery to achieve a self-sustaining population that provides sustainable harvest using science-based decision-making processes. The following objectives will be used to achieve this goal:

- Implement management strategies within North Carolina and encourage interjurisdictional management strategies that maintain/restore the southern flounder spawning stock with expansion of age structure of the stock and adequate abundance to prevent overfishing.
- Restore, enhance, and protect habitat and environmental quality necessary to maintain or increase growth, survival, and reproduction of the southern flounder population.
- Use biological, environmental, habitat, fishery, social, and economic data needed to effectively monitor and manage the southern flounder fishery and its ecosystem impacts.
- Promote stewardship of the resource through increased public outreach and interjurisdictional cooperation throughout the species range regarding the status and management of the southern flounder fishery, including practices that minimize bycatch and discard mortality.
- Promote the restoration, enhancement, and protection of habitat and environmental quality in a manner consistent with the Coastal Habitat Protection Plan.

## DESCRIPTION OF THE STOCK

### Biological Profile

Southern flounder is a bottom dwelling species of left eyed flounder found in the Atlantic Ocean, Gulf of Mexico, and estuaries from Virginia to northern Mexico. 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*). Southern flounder supports important commercial and recreational fisheries along the U.S. South Atlantic and gulf coasts and is particularly important to fisheries in North Carolina. Based on tagging and genetic data and aging structures, the biological unit stock for southern flounder includes fish from North Carolina to the east coast of 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.

DMF data collected from fall fisheries suggests that with the onset of maturity, females 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 mature by ages 1 and 2 (at approximately 16 inches TL). Fish collected in the ocean tend to be larger and older, with females growing larger than males. The largest female

southern flounder observed in North Carolina was a 33-inch TL and largest male was 20-inch TL. The maximum observed age was 9 years for a female and 6 years for a male; southern flounder captured in North Carolina represent the oldest ages observed throughout the range.

Juvenile and adult southern flounder typically feed by camouflaging themselves on the bottom and ambushing their prey with a quick upward lunge. Southern flounder diets switch to fish when they are between 3- and 4-inches TL. 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 2019 stock assessment, the probability that fishing mortality in 2017 is above the threshold value of 0.53 is 96.4%, whereas there is a 100% chance the fishing mortality in 2017 is above the target value of 0.35. The probability that the SSB in 2017 is below the threshold or target value (3,900 and 5,452 metric tons, respectively) is 100%. Therefore, the current status of the southern flounder stock is overfished, and overfishing is occurring (Figures 1 and 2).

### **Stock Assessment**

The 2009 stock assessment used a statistical catch-at-age model run using the Age Structured Assessment Program (Takade-Heumacher and Batsavage 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 DMF 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 coast-wide 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.

During 2018, the southern flounder stock assessment sub-committee updated all necessary data inputs for the ASAP model. The pooled-sex model was updated with data through 2017 and

incorporated the new MRIP estimates that were available; the results indicated the stock is overfished and overfishing is still occurring (Figures 1 and 2; Flowers et al. 2019). Analyses that provided projections of reductions to fishing mortality necessary to end overfishing and to determine what reductions would be necessary to rebuild the spawning stock biomass and end the overfished status were completed (Flowers et al. 2019).

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

Commercial regulations include a 15-inches TL minimum size limit from internal waters and 14-inches TL minimum size limit from ocean waters, 6-inch stretched mesh minimum mesh size for gill nets, closed season in internal waters unless opened by proclamation. The 2023 commercial season opening date has yet to be determined. The commercial fishery has operated under a quota since the fall of 2022 with two gear categories; mobile gears which will be divided into two management areas using the B-D boundary line from the turtle and sturgeon ITPs and the pound net fishery which will be divided into three management areas consistent with Amendment 2. There are no current trip limits in internal waters, but they can be implemented for pound nets and gigs only upon reaching a predetermined division closure threshold to reopen the fishery without exceeding the quota and a 100-pound trip limit in ocean waters unless the individual has a License to Land Flounder from the Atlantic Ocean; commercial ocean landings are allowed using trawl gear only.

Recreational regulations include a 15-inches TL minimum size limit, one-fish creel limit from all joint and coastal waters, closed season for internal and ocean waters except if opened by proclamation. The recreational flounder fishery has operated under seasons to constrain the fishery to a quota since 2022. The 2023 recreational internal and ocean waters season will be from September 15 through September 29 with a one-fish per person per day bag limit and a one-fish ocellated bag limit during March 1 through April 15, 2024, in ocean waters only using hook-and-line gear if sufficient quota is available beginning in March 2024.

### **Commercial Fishery**

All landings reported as caught in inshore waters are considered to be southern flounder by the DMF 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 3). Peak commercial landings occurred in 1994 (Table 1; Figure 3). 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 in the Albemarle Sound, but decreased in Pamlico Sound and Core Sound; pound net landings also increased 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 protected species interactions. Pound net harvest surpassed gill net harvest 2014 through 2020 (Figure 3). Gig harvest of southern flounder has generally increased, especially since 2010. Harvest by other commercial gears has generally decreased to its lowest point in 2021 and currently makes up a small portion of commercial harvest. Commercial harvest from 2019 – 2022 was impacted due to regulations implemented through Amendment 2 and Amendment 3 to the NC Southern Flounder FMP. Amendment 2 implemented seasons in the commercial southern flounder fishery for the first time, and Amendment 3 introduced quota management of the fishery. Under Amendment 3 the commercial fishery was separated into two mobile gear management areas (northern and southern) and three pound net management areas. In 2022, the northern mobile gear management area was open a total of 28 days and the southern management area 11 days. The northern pound net management area was open 23 days, the central 21 days, and the southern six days. While the central and southern pound net management areas exceeded their allowed harvest, overall, the commercial southern flounder fishery came in under the quota.

Trends in commercial trips have generally followed landings trends (Figure 4). 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 decreased until 2002, since they have been variable on a lower level. Giggling trips have been variable around an increasing trend since 2010. The number of trips targeting southern flounder have decreased since regulatory changes due to Amendment 2 and Amendment 3 when seasons were implemented limiting the number of days flounder could be harvested.

### **Recreational Fishery**

Recreational harvest of southern flounder is mainly by hook and line and gigs, with a small amount of harvest by spearfishing or RCGL gears. DMF does not have information on long-term trends of the gig fishery; MRIP rarely encounters gig fishermen. A DMF mail-based survey of giggling that began in 2010 indicates the gig harvest from 2010-2020 averaged 11% 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 5). Hook- and-line harvest peaked in 2010 (Table 1). Recreational harvest was impacted in 2020 and 2021 due to regulations implemented through Amendment 2 to the North Carolina Southern Flounder FMP. In addition, the season was shortened from 45 days in 2020 to 14 consecutive days in 2021 due to excessive overages that occurred during the 2020 season. Like the commercial fishery, Amendment 3 implemented a quota for the recreational fishery through a season. In 2022, the season for the recreational fishery was 30 days. The recreational fishery exceeded its expected harvest by 14,267 pounds and the allowed catch (harvest plus discards) by 56,340 pounds.

Trends in recreational trips are somewhat difficult to interpret because they represent all *Paralichthid* 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 *Paralichthid* flounder species were included. Trends in trips and harvest are roughly similar throughout most of the time-series, but trips have been declining since 2014 while harvest has been variable. (Figure 6). Recreational estimates across all years have been updated and are

now based on the Marine Recreational Information Program (MRIP) new Fishing Effort Survey-based calibrated estimates. For more information on MRIP see <https://www.fisheries.noaa.gov/topic/recreational-fishing-data>.

## **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 and fishery. Several DMF 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 the North Carolina Onboard Observer Program and 570 the North Carolina Shrimp Trawl Characterization Study 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 DMF sampling of the recreational fishery through the MRIP collects length data on southern flounder. The DMF 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 DMF Carcass Collection Program.

There were no clear trends in commercial length data from 2005 to 2022 (Table 2). In 2022, 54% of southern flounder were harvest by pound nets, followed by gill nets (31%), gigs (15%), and other gear accounted for >1% (Figure 7). An increase in mean TL was observed due to the changes in minimum commercial size regulation, increasing to 15-inches TL in 2016 (Table 2; Figure 8). In addition, during 2022 harvest of 17-inch fish was greater in proportion to total catch than previous years (Figure 8).

There were no clear trends in recreational length data from 2005 to 2022 (Table 3); in 2022 a higher proportion fish greater than 20-inches was observed. Annual mean lengths collected through age sampling programs have been consistent, 2021 average length of 17 inches TL was consistent with previous years where 17 inches was the mean TL as seen 13 of the last 18 years. MRIP length frequency data show harvest of smaller fish has declined as changes to minimum size limits has occurred (Table 3; Figure 9).

### **Fishery-Independent Monitoring**

Several DMF 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 and Rivers Independent Gill Net Surveys). Program 135 was dropped from this update as the program has had significant changes in sample design that limits its catches of southern flounder thus reducing its usefulness as a data source for this species moving forward. Age data primarily is collected in Program 915, although the other three surveys do collect age data. Methodology for analyzing trends in relative abundance for each survey changed with the 2018 stock assessment

when generalized linear models (GLMs) were used to calculate relative yearly relative abundance index values. These indices were not updated, as a result, nominal relative abundance index values have been included in this report.

There were no clear trends in fishery-independent length data from 2005 to 2022 (Table 4). Annual mean lengths were fairly consistent and 2022 had the second largest mean length in the time-series. However, the number of fish measured in 2020 was the lowest of any year from 2005 to 2022. The reduced number of measurements from independent samples is reflective of the sampling impacts due to the pandemic.

Data collected by Program 915 were used for an index of relative (juvenile and adult) abundance in the January 2019 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 the index of abundance 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 relative abundance index for Program 915 peaked in 2010 and the low point was in 2016 for the time-series analyzed (2003-2022) and has an overall decreasing trend (Table 5; Figure 10). The relative abundance index for 2021 was above the series average (3.63 southern flounder per set) for the first time since 2013, but 2022 had the lowest relative abundance since 2016.

During 2020, and the first part of 2021 no index of abundance is available for southern flounder from the fishery-independent assessment (Program 915). Sampling in this program was suspended in February 2020 due to COVID-19 restrictions and protected species interactions but resumed July 2021.

Data collected by Program 120 were used for a relative Juvenile Abundance Index (JAI) in the January 2019 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 database 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 head rope trawl with a one-fourth inch mesh in the body and one-eighth inch mesh in the tail bag 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 1989 to 2021. The JAI for Program 120 peaked in 1996 and the low point was in 2020 for the time-series analyzed (1989-2022) and shows a variable trend (Table 5; Figure 11) with each of the last 7 years being below the time series average. The JAI in 2022 decreased compared to 2021; and is the third lowest in the time series. The 2020 JAI was the second lowest in the 30-year time series, however, sampling was impacted by the COVID pandemic, and the full sampling regime was not completed. Sampling typically occurs over the months of May and June. Due to the pandemic all sampling was conducted in June. The impacts to the JAI due to the changes to the sampling regime are unknown.

Data collected by Program 195 were not used as a JAI in the January 2019 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 head rope, 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). Data from this survey were used to produce a southern flounder JAI from 1989 to 2022. The JAI for Program 195 peaked in 1996 and the low point was in 1998 for the time-series analyzed (1989-2022; Table 5; Figure 12). However, annual relative abundance for five of the last 10 years has been above the time series average (2.27 southern flounder per tow). The JAI for 2020 and 2021 are incomplete as sampling was conducted only in a portion of the areas typically sampled due to the pandemic. The impacts to the JAI due to the changes to the sampling regime are unknown.

In order to describe the age structure of harvest and indices, southern flounder age structures are collected from various fishery independent (scientific surveys) and dependent (fisheries) sources throughout the year. In 2021 and 2022, southern flounder were aged ranging in age from 0 to 7 years (Table 6). Growth in length is rapid for the first year of life and then slows. The relationship of length and age for southern flounder is unpredictable with much overlap in age for a given length (Figure 13).

## Tagging Data

Since 2014, 8,007 southern flounder have been tagged (Table 7; Figure 14). Five-hundred fifty-one of these fish have been recaptured (Table 7; Figure 15). The average time that a southern flounder is at large (time between the initial tagging event and recapture) is approximately five months or 145 days, though some fish have been at large for as long as five years. On average, southern flounder travel less than 20 miles between the initial tagging event and recapture, and most are caught in the same water body they are tagged. There have been several flounder over the last nine years that have been recaptured south of North Carolina. In 2022, 822 fish were tagged and 28 fish were recaptured. The number of days at large, as well as the distance the flounder traveled, were the lowest in the time series.

From 2014 – 2021, tagging of southern flounder was done by division staff, with the help of several universities. In 2022, a pilot program was started for southern flounder to incorporate volunteer anglers. Positive results from the initial group has meant that moving forward the division will be incorporating more volunteer anglers for southern flounder.

## RESEARCH NEEDS

The management strategies and implementation status from Amendment 3 to the N.C. Southern Flounder FMP can be found in Table 6. The following research recommendations were included in Amendment 3; status of need is provided in parentheses. Those recommendations followed by an asterisk (\*) were identified as the top five high priority research recommendations and are discussed further below.

### High

- Conduct studies to quantify fecundity and fecundity-size/age relationships in Atlantic southern flounder.\*
- Improve estimates of the discard (B2) component (catches, lengths, and ages) for southern flounder from MRIP. — Underway\*
- Expand, improve, or add fisheries-independent surveys of the ocean component of the stock.\*
- Determine locations of spawning aggregations of southern flounder. — Underway\*
- Complete an age validation study using known age fish.\*
- Research and evaluate data on the sub-legal fish in the recreational fishery as it relates to potential future reductions in minimum size limits. — Underway

### Medium

- Promote data sharing and research cooperation across the South Atlantic southern flounder range (North Carolina, South Carolina, Georgia, and Florida).
- Further research on factors that impact release mortality of southern flounder in the recreational hook-and-line fishery.

- Research on deep hooking events of different hook types and sizes on southern flounder.
- Coast-wide at-sea observations of the flounder pound net fishery.
- Develop a survey that will provide estimates of harvest and discards for the recreational gig fisheries in North Carolina, South Carolina, Georgia, and Florida.
- Develop a survey that will provide estimates of harvest and discards from gears used to capture southern flounder for personal consumption.
- 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).
- Expand, improve, or add inshore and offshore surveys of southern flounder to develop indices for future stock assessments.
- Collect age and maturity data from the fisheries-independent Southeast Area Monitoring and Assessment Program (SEAMAP) Trawl Survey given its broad spatial scale and potential to characterize offshore fish.
- Conduct studies to better understand ocean residency of southern flounder.
- 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.
- Work to reconcile different state-level/regional surveys to better explain differences in trends.
- Evaluate the utility of circle hooks in the southern flounder recreational hook-and-line fishery.
- Development of alternative gears to catch southern flounder. — some research completed; more may be needed
- Study revenue variability and profitability of commercial southern flounder fishing in North Carolina based on catch characteristics.
- Generate a stated preference survey of North Carolina recreational anglers to understand perceived value of targeting southern flounder compared to other estuarine finfish species.

## **Low**

- Develop a recreational catch per unit effort (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.

- Explore potential impacts stocking may have on the southern flounder population and the costs associated with implementing a stocking program.
- Continued otolith microchemistry research to gain a better understanding of ocean residency of southern flounder. — Underway
- Implement fishery dependent sampling of the commercial spear fishery for flounder in the ocean.
- Determine harvest estimates and implement fishery dependent sampling of the recreational spear fishery for flounder in the ocean.
- Further research on flatfish escapement devices in crab pots that minimize undersized flounder bycatch and maximize the retention of marketable blue crabs.
- Expand tagging study to ocean component of the stock to estimate emigration, immigration, movement rates, and mortality rates throughout the stock's range.
- 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.
- Further research on the size distribution of southern flounder retained in pound nets with 5.75-Inch Square Mesh (ISM) and 6-ISM escape panels.
- Research on the species composition and size distribution of fish and crustaceans that escape pound nets through 5.75-ISM and 6-ISM escape panels.
- Develop a survey that will estimate harvest and discards from commercial gears used for recreational purposes.
- Continue at-sea observations of the large-mesh gill-net fishery including acquiring biological data on harvest and discards. — Underway
- Develop survey that better represents the for-hire industry.
- Continued gear research in the design of gill nets and pound nets to minimize protected species interactions. — some research completed; more may be needed
- Investigate the impacts of warming water temperature on the southern flounder stock.
- Develop a study that evaluates inlets and their relationship to southern flounder migration.
- Develop studies to investigate the impacts of emerging compounds on southern flounder.

**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.
- 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.

## MANAGEMENT STRATEGY

Amendment 3 was adopted by the MFC in May 2022. This Amendment includes more comprehensive management strategies which will be implemented via proclamation throughout 2022 (Table 8).

In concurrence with the incorporated actions from Amendment 1, Supplement A to Amendment 1 as modified by the Aug. 17, 2017, settlement agreement, and Amendment 2, sustainable harvest was implemented in Amendment 3 to maintain 72% reductions in fishing mortality ( $F=0.18$ ) in the commercial and recreational fisheries to a level that ends overfishing within two years and allows the SSB to increase between the threshold and the target within 10 years of adoption of Amendment 2.

To meet the reduction in fishing mortality, quotas with accountability measures were established for the commercial and recreational sectors for the first time in the North Carolina Southern Flounder Fishery as well as a reduction in the recreational bag limit from four fish per person per day to one fish per person per day and the elimination of RCGL holders from harvesting southern flounder (Table 7). These reductions in total removals allow for increased escapement of spawning stock and expansion of the age structure to continue rebuilding of the stock.

## FISHERY MANAGEMENT PLAN SCHEDULE RECOMMENDATIONS

At its May 2022 business meeting the MFC adopted Amendment 3 to the N.C. Southern Flounder FMP. Actions approved through this plan will be implemented through proclamation in 2022. In addition, the division scheduled an update to the 2019 stock assessment to begin in 2023.

## LITERATURE CITED

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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.

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## TABLES

Table 1. Southern flounder recreational harvest and number released (Marine Recreational Information Program) and commercial harvest (North Carolina Trip Ticket Program) for 1989–2022. All weights are in pounds.

Year	Recreational			Commercial	Total Weight (lb)
	Number Landed	Number Released	Weight Landed (lb)	Weight Landed (lb)	
1989	119,047	125,192	199,850	3,225,955	3,425,805
1990	138,106	152,895	216,960	2,560,459	2,777,419
1991	257,319	791,778	489,865	4,163,374	4,653,239
1992	115,329	433,576	219,720	3,145,020	3,364,740
1993	83,811	370,372	127,860	4,272,368	4,400,228
1994	168,237	562,915	323,869	4,878,609	5,202,478
1995	127,106	459,800	271,703	4,166,966	4,438,669
1996	173,400	449,876	339,228	3,807,009	4,146,237
1997	209,038	873,901	560,323	4,076,793	4,637,116
1998	96,124	411,939	205,569	3,952,729	4,158,298
1999	78,321	209,956	184,969	2,933,331	3,118,300
2000	326,712	942,560	607,053	3,205,792	3,812,845
2001	304,791	990,335	567,568	3,522,136	4,089,704
2002	366,671	1,415,247	789,539	3,436,753	4,226,292
2003	293,793	860,052	621,985	2,198,503	2,820,488
2004	347,492	1,537,924	827,593	2,454,577	3,282,170
2005	298,307	997,132	675,856	1,870,754	2,546,610
2006	352,942	1,287,601	761,069	2,287,823	3,048,892
2007	279,916	1,075,735	572,064	2,083,043	2,655,107
2008	349,860	2,532,079	807,867	2,602,390	3,410,257
2009	329,117	1,889,921	692,704	2,396,240	3,088,944
2010	556,812	2,835,142	1,149,899	1,689,557	2,839,456
2011	388,647	2,087,604	942,373	1,247,450	2,189,823
2012	290,035	2,434,621	701,698	1,646,137	2,347,835
2013	374,215	2,357,529	869,223	2,186,391	3,055,614
2014	209,228	1,856,280	447,337	1,673,511	2,120,848
2015	249,166	1,709,189	558,303	1,202,952	1,761,255
2016	299,273	2,178,145	695,713	899,932	1,595,645
2017	221,321	1,988,000	451,126	1,396,384	1,847,510
2018	217,805	1,002,753	495,289	903,811	1,399,100
2019*	163,045	1,353,286	387,203	800,080	1,187,283
2020*	152,244	1,678,494	398,769	479,984	878,753
2021*	266,421	1,940,051	560,440	478,134	1,038,574
2022*	70,945	2,792,944	166,102	362,062	528,164
Mean	217,786	1,051,122	449,696	2,471,595	2,968,359

\* years with harvest seasons in place; 2022 was the start of quota management.

Table2. Southern flounder total length (inches) data for DMF commercial fishery sampling programs 2005–2022 (includes harvest and some discard information).

Year	Mean Length	Minimum Length	Maximum Length	Total Measured
2005	16	2	31	28,972
2006	16	5	31	39,572
2007	16	4	29	23,768
2008	16	1	28	39,302
2009	16	4	28	33,403
2010	16	5	29	27,176
2011	16	5	30	32,000
2012	16	4	30	29,865
2013	16	1	32	33,776
2014	16	1	28	26,354
2015	16	2	30	19,717
2016	17	6	27	14,712
2017	17	3	30	14,775
2018	17	2	27	8,892
2019	16	8	26	8,355
2020	17	10	28	4,163
2021	16	11	27	4,360
2022	17	7	27	4,133

Table 3. Southern flounder total length (inches) data for MRIP recreational fishery sampling in North Carolina, 2005–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Measured
2005	17	13	26	202
2006	16	10	31	343
2007	17	14	24	220
2008	17	13	27	311
2009	17	12	26	306
2010	17	11	28	754
2011	17	14	26	478
2012	18	14	30	400
2013	17	13	27	390
2014	17	14	26	199
2015	17	14	24	177
2016	17	14	25	225
2017	17	14	26	215
2018	17	13	27	276
2019	18	14	24	131
2020	18	12	26	187
2021	17	15	26	168
2022	18	15	24	110

Table 4. Southern flounder total length (inches) data for DMF fishery-independent sampling programs 2005–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Measured
2005	8	0	25	3,769
2006	9	0	23	3,560
2007	7	0	22	3,812
2008	10	0	27	4,270
2009	10	1	27	3,230
2010	9	1	23	4,168
2011	12	1	28	2,604
2012	10	1	26	4,878
2013	9	1	27	3,534
2014	9	1	25	2,339
2015	9	1	24	2,133
2016	11	2	30	1,426
2017	9	1	22	2,238
2018	9	0	24	2,123
2019	10	0	24	2,664
2020	5	1	18	595
2021	9	0	24	2,529
2022	11	0	24	3,733

Table 5. Annual nominal relative abundance index values for southern flounder and standard error (SE) in DMF independent surveys (programs 120, 195, and 915) 1991–2022. Indices for programs 120 and 195 are considered juvenile (young-of-year) abundance indices. The flounder index for program 915 didn't start until 2003, when the rivers sampling started.

Year	P915 Index	P915 SE	P195 Index	P195 SE	P120 Index	P120 SE
1991			0.6	0.2	1.13	0.17
1992			4.83	1.3	2.49	0.30
1993			3.81	1.1	2.93	0.38
1994			3.33	1.2	1.79	0.24
1995			2.83	0.7	1.69	0.24
1996			9.65	2.0	7.82	0.95
1997			3.1	0.8	2.74	0.29
1998			0.37	0.1	0.90	0.15
1999			1.91	0.5	2.49	0.30
2000			0.77	0.2	3.74	0.43
2001			0.82	0.3	4.38	0.46
2002			3.28	1.5	4.49	0.56
2003	5.63	0.58	2.94	0.8	6.31	1.01
2004	5.14	0.56	1.28	0.2	3.89	0.46
2005	4.37	0.42	3.25	1.0	3.05	0.38
2006	3.04	0.48	1	0.3	2.63	0.33
2007	2.38	0.27	1.07	0.3	3.64	0.39
2008	4.91	0.59	0.94	0.5	2.40	0.33
2009	3.37	0.44	1.28	0.3	1.93	0.26
2010	5.90	0.77	1.14	0.3	5.03	0.66
2011	3.84	0.59	0.6	0.2	1.09	0.19
2012	3.73	0.35	4.44	1.9	3.07	0.39
2013	4.26	0.40	1.05	0.3	2.64	0.33
2014	2.99	0.32	0.64	0.2	1.86	0.30
2015	2.19	0.38	2.46	0.4	1.67	0.27
2016	1.88	0.26	0.73	0.3	0.53	0.11
2017	2.21	0.24	6.02	2.2	1.03	0.16
2018	2.50	0.30	2.94	1.0	1.36	0.18
2019	3.17	0.40	3.74	1.0	1.03	0.20
2020*	NA	NA	1.94	0.88	0.62	0.13
2021*	3.84	0.63	0.78	0.30	2.38	0.36
2022	1.86	0.27	2.53	1.07	0.83	0.14

\* 2020/2021 sampling impacted by Executive Order (EO) 116, issued March 10, 2020.

Table 6. Age data for southern flounder from DMF sampling 2005–2022.

Year	Mean Age	Minimum Age	Maximum Age	Total Aged
2005	2	0	7	803
2006	2	0	6	877
2007	2	0	8	744
2008	2	0	7	1,107
2009	1	0	6	492
2010	1	0	7	1,233
2011	1	0	6	912
2012	1	0	6	1207
2013	1	0	6	972
2014	1	0	7	1,280
2015	2	0	6	834
2016	2	0	5	773
2017	1	0	7	1,178
2018	1	0	5	965
2019	1	0	6	2,119
2020	2	0	5	1,210
2021	2	0	7	1,739
2022	2	0	7	1,478

Table 7. Total number of southern flounder tagged and recaptured, 2014-2022. Recapture information includes average and maximum days at large and distance traveled.

Year Tagged	Total Fish Tagged (#)	Total Fish Recaptured (#)	Average Days At Large	Max Days At Large	Average Distance Traveled (miles)	Max Distance Traveled (miles)
2014	930	128	168	904	25	518
2015	730	58	180	1,753	21	238
2016	715	73	132	697	19	262
2017	1,455	47	188	1,038	17	108
2018	466	69	108	780	6	109
2019	729	32	183	428	22	157
2020	1,054	65	151	414	14	195
2021	1,106	51	107	393	17	155
2022	822	28	35	216	3	45

Table 8. Management action taken as a result of Amendment 3 to the N.C. Southern Flounder FMP.

MANAGEMENT STRATEGY	OUTCOME
Management measures limiting the number of fishing days per week and the amount of yardage allowed for large mesh gill nets in various areas of the state	Implemented through proclamation (refer to Amendment 1)
A minimum distance (area dependent) between gill net and pound net sets, per NCMFC Rule 15A NCAC 03J .0103 (d)	Implemented through proclamation (refer to Amendment 1)
A recreational minimum size limit of 15 inches TL	Implemented through proclamation (Refer to Amendment 1)
Increase minimum mesh size to harvest southern flounder to 6.0- inch stretched mesh	Implemented through Proclamation (Refer to Supplement A to Amendment 1)
Increase minimum size limit for commercial fisheries to 15 inches	Implemented through Proclamation (Refer to Supplement A to Amendment 1)

MANAGEMENT STRATEGY	OUTCOME
Increase minimum mesh size for escape panels to 5.75-inch stretched mesh	Implemented through Proclamation (Refer to Supplement A to Amendment 1)
Removal of all commercial gears targeting southern flounder from the water (e.g., commercial and RCGL anchored large mesh gill nets and gigs) or make them inoperable (flounder pound nets) in areas and during times outside of the seasons implemented. Exceptions will be allowed for commercial large mesh gill net fisheries that target American and hickory shad and catfish species if these fisheries are only allowed to operate during times of the year and locations where bycatch of southern flounder is unlikely	Implemented through Proclamation (Refer to Amendment 2)
Making it unlawful to possess flounder in internal and ocean waters during the closed recreational season.	Implemented through Proclamation (Refer to Amendment 2)
Making it unlawful to possess flounder harvested from the internal waters of the state during the closed commercial season	Implemented through Proclamation (Refer to Amendment 2)
Making it unlawful to use any method of retrieving live flounder from pound nets that cause injury to released fish (no picks, gigs, spears, etc.)	Implemented through Proclamation (Refer to Amendment 2)
Reduce commercial anchored large-mesh gill net soak times to single overnight soaks where nets may be set no sooner than one hour before sunset and must be retrieved no later than one hour after sunrise the next morning in the Neuse, Tar/Pamlico rivers and the Albemarle Sound areas that have previously been exempt	Implemented through Proclamation (Refer to Amendment 2)
Reduce the maximum yardage allowed in the commercial anchored large-mesh gill net fishery by 25% for each Management Unit; allowing a maximum of 1,500-yards in Management Units A, B, and C, and a maximum of 750-yards in Management Units D and E unless more restrictive yardage is specified through adaptive management through the sea turtle or sturgeon Incidental Take Permits (ITP).	Implemented through Proclamation (Refer to Amendment 2)
Reduce daily bag limit for recreational harvest of southern flounder to 1 flounder per person per day	Implemented through Proclamation (Amendment 3)
Implement quota for the commercial mobile gear and pound net fisheries and define management areas	Implemented through Proclamation (Refer to Amendment 3)
Implement recreational (hook and line, gig) seasons to constrain them to an annual quota	Implemented through Proclamation (Refer to Amendment 3)
Eliminate harvest of southern flounder through the use of a Recreational Commercial Gear License	Implemented through Proclamation (Refer to Amendment 3)
Implement trip limits for gigs and pound nets only to maximize reopening only after reaching division closure threshold	Implemented through proclamation (Refer to Amendment 3)
Implement a one-fish ocellated bag limit during March 1 through April 15 in ocean waters only using hook-and-ling gear	Implemented through proclamation (Refer to Amendment 3)
Adopt the adaptive management framework based on the peer-reviewed and approved stock assessment	Implemented through proclamation (Refer to Amendment 3)
The MFC approved a motion to set the allocation for Amendment 3 at 70% commercial and 30% recreational at the February 26, 2021, business meeting	Implemented through proclamation (Refer to Amendment 3)
Continue to allow anchored large-mesh gill nets to harvest southern flounder in the North Carolina southern flounder fishery	Implemented through proclamation (Refer to Amendment 3)

**FIGURES**

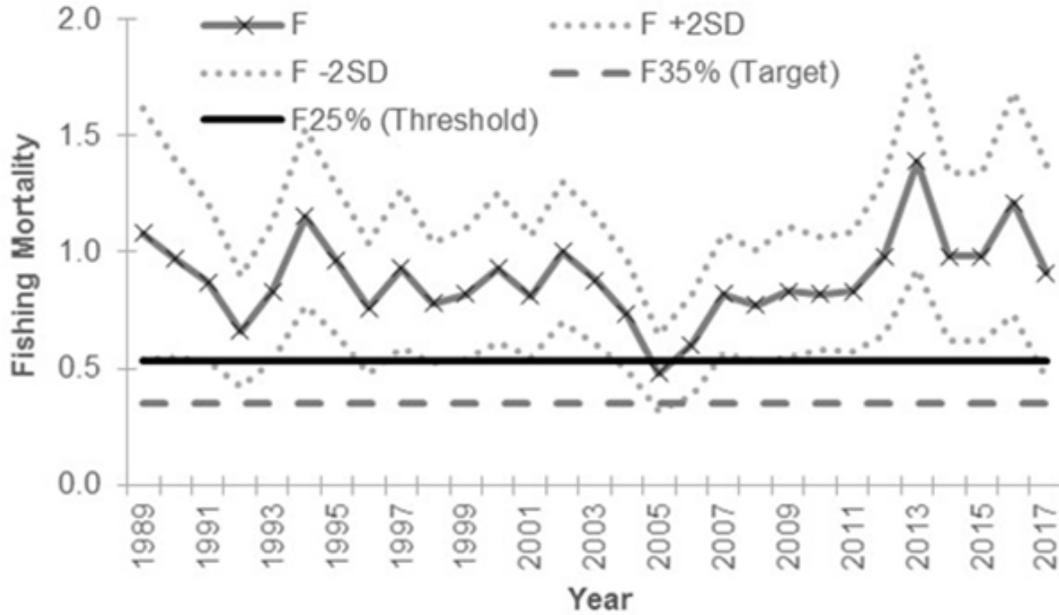


Figure 1. Estimated fishing mortality rates (numbers-weighted, ages 2–4) compared to established reference points, 1989–2017. (Source: Flowers et al. 2019).

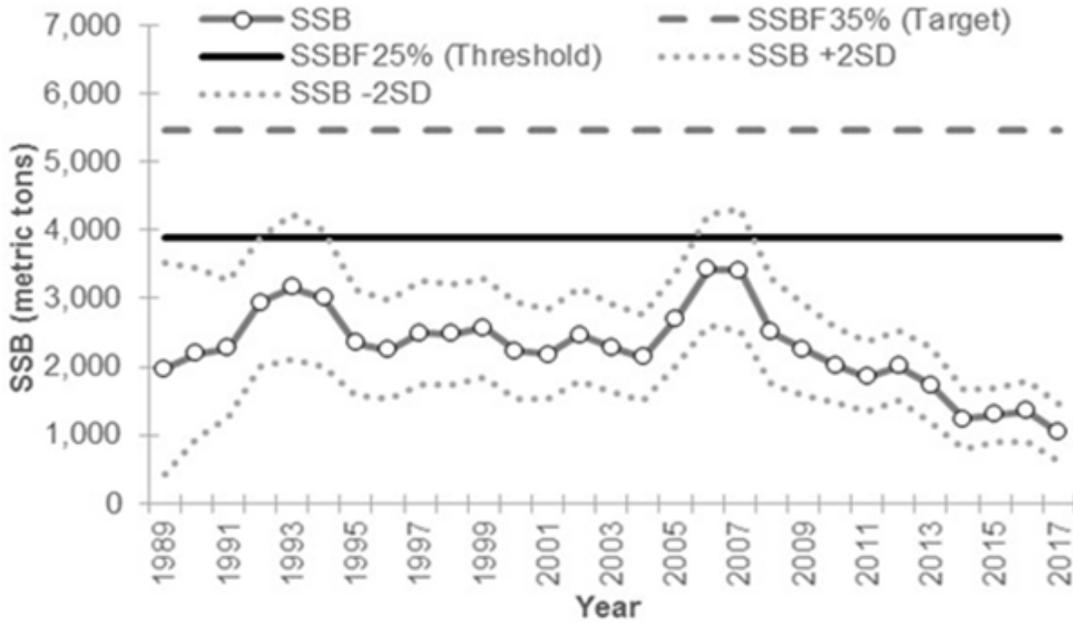


Figure 2. Estimated spawning stock biomass compared to established reference points, 1989–2017. (Source: Flowers et al. 2019).

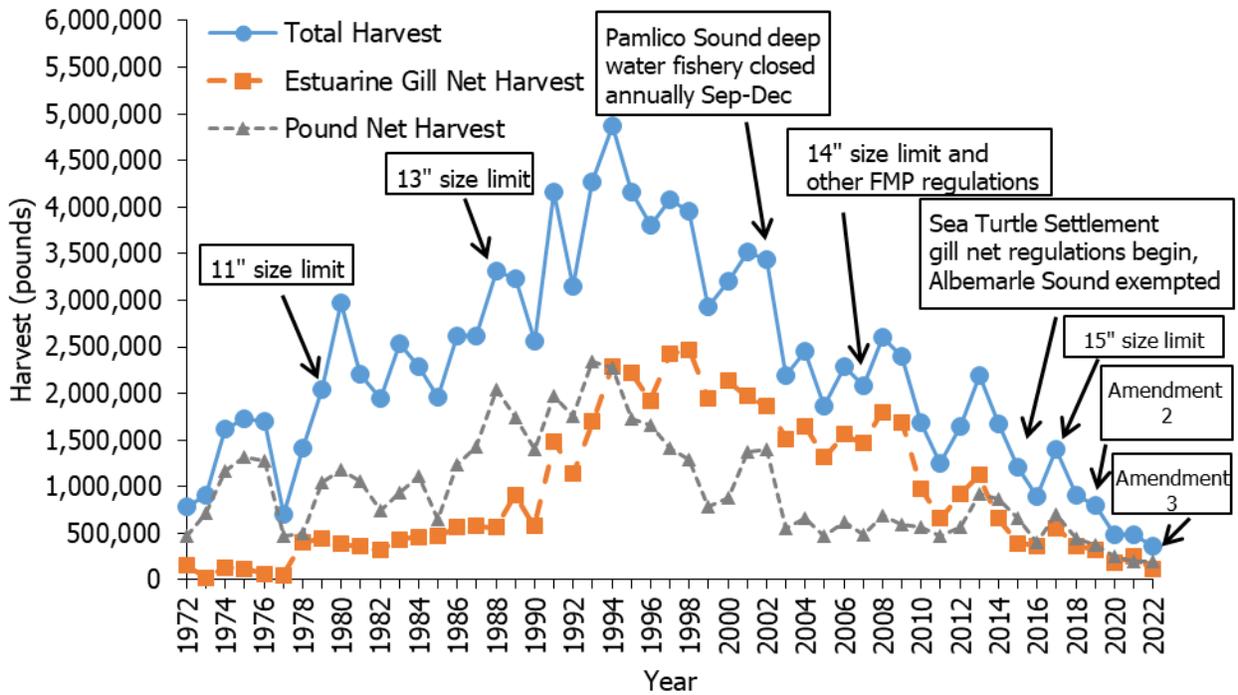


Figure 3. Southern flounder harvest (pounds) for total commercial fishery and top two gears (gill nets and pound nets) from North Carolina Trip Ticket Program 1972–2022 with major fishery regulation changes.

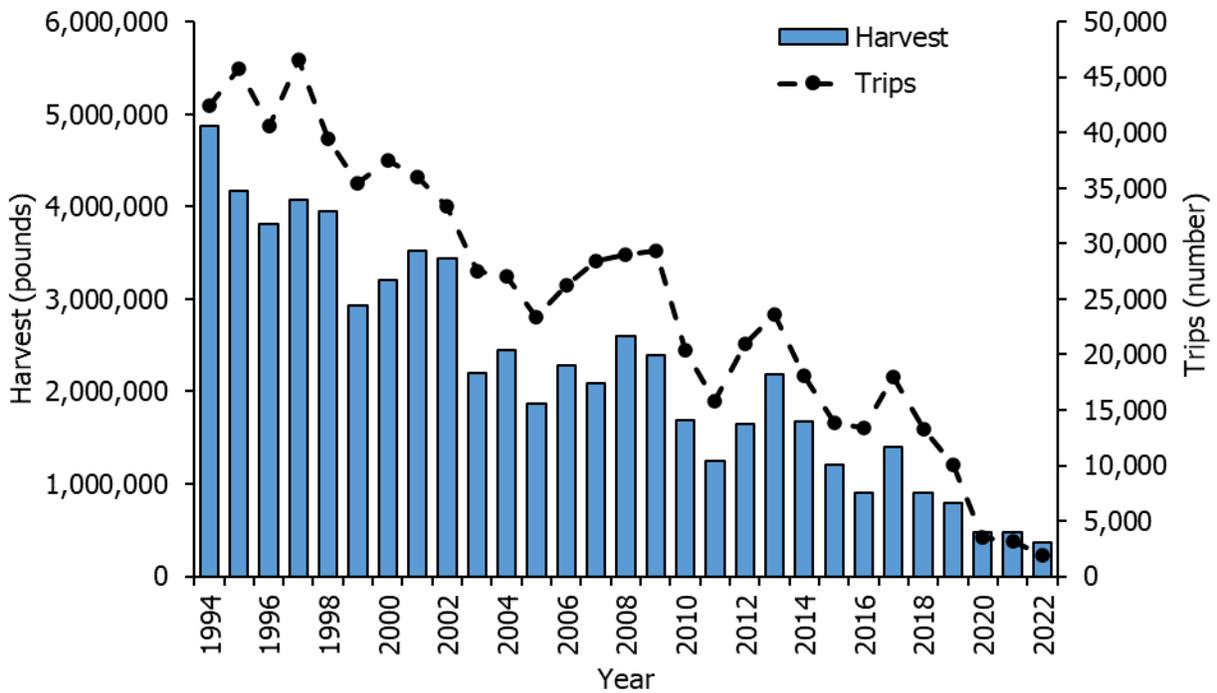


Figure 4. Southern flounder commercial trips (numbers) and harvest (pounds) from N.C. Trip Ticket Program, 1994–2022.

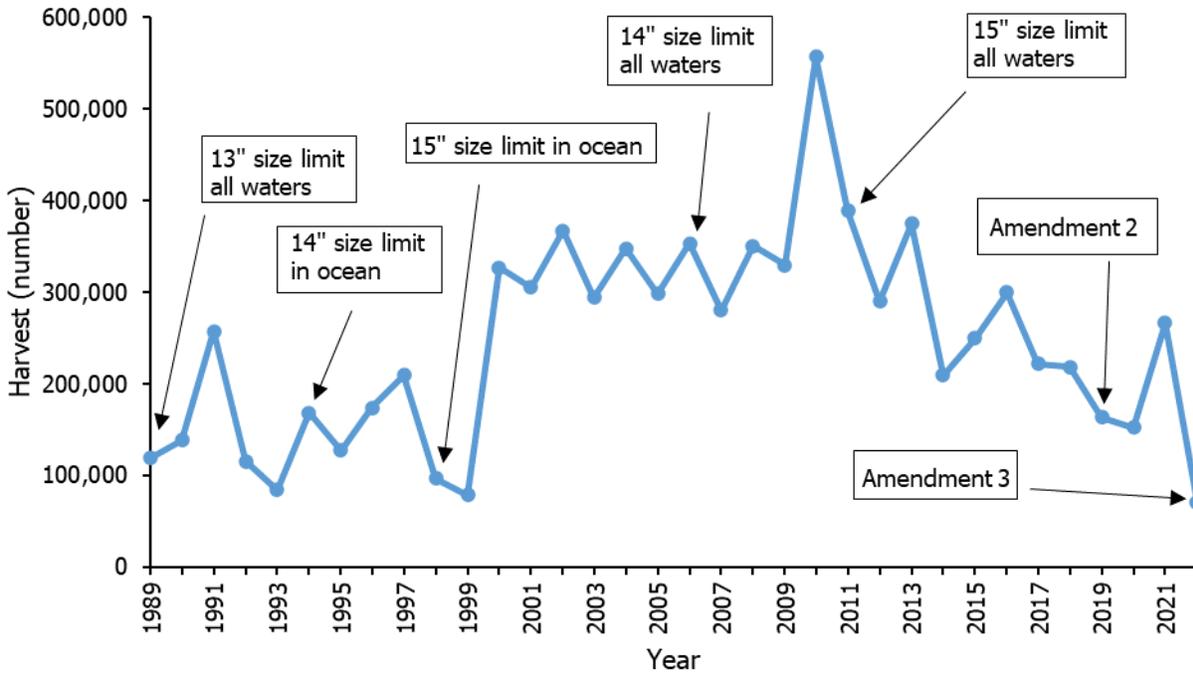


Figure 5. Southern flounder recreational hook and line harvest in numbers of fish from MRIP data 1989–2022 and major fishery regulation changes.

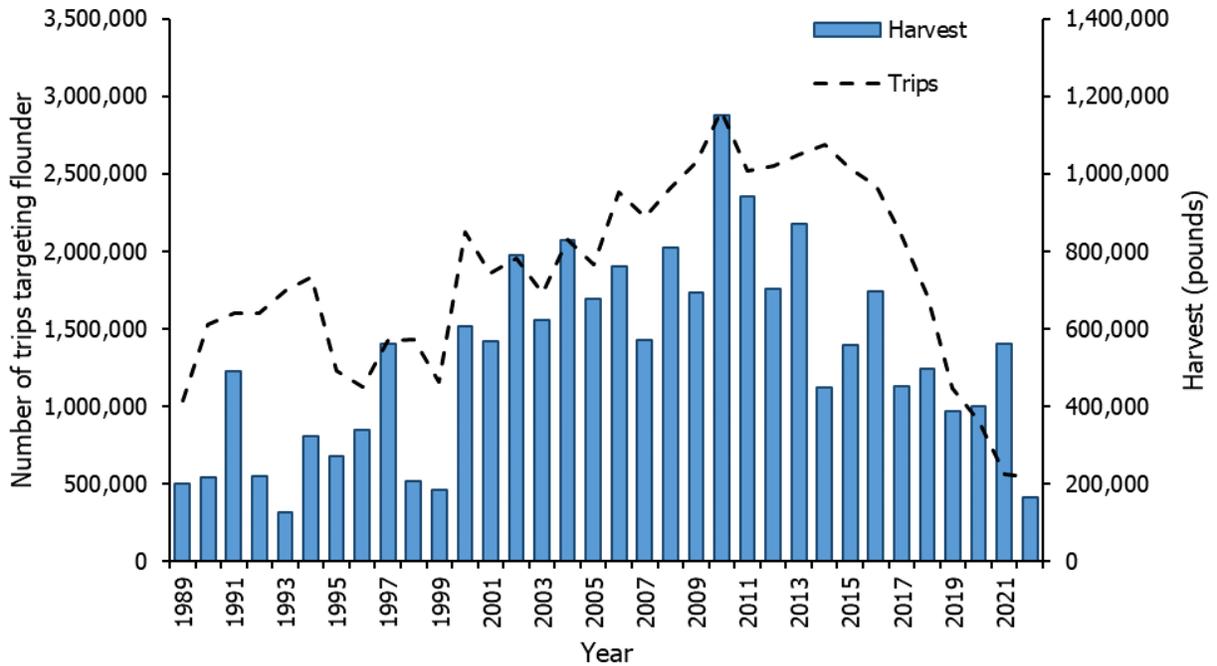


Figure 6. Recreational hook and line harvest (in numbers of fish) and all trips that harvested or released Paralichthid flounder species, from MRIP data 1989–2022. Data from prior to 2004 were calibrated to align with MRIP estimates post-2004.

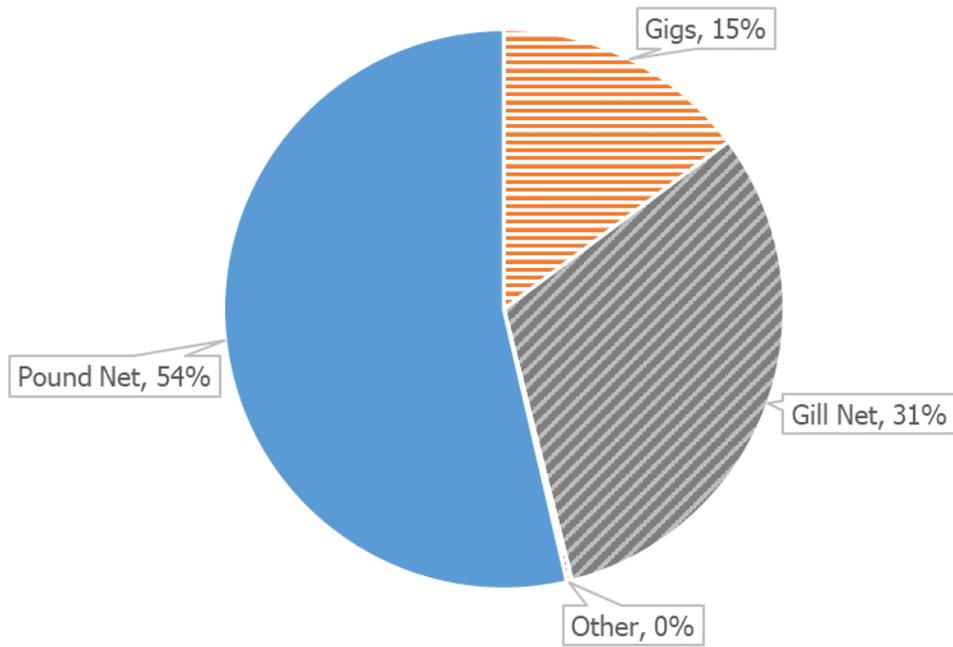


Figure 7. North Carolina commercial harvest of southern flounder in 2022 by gear type.

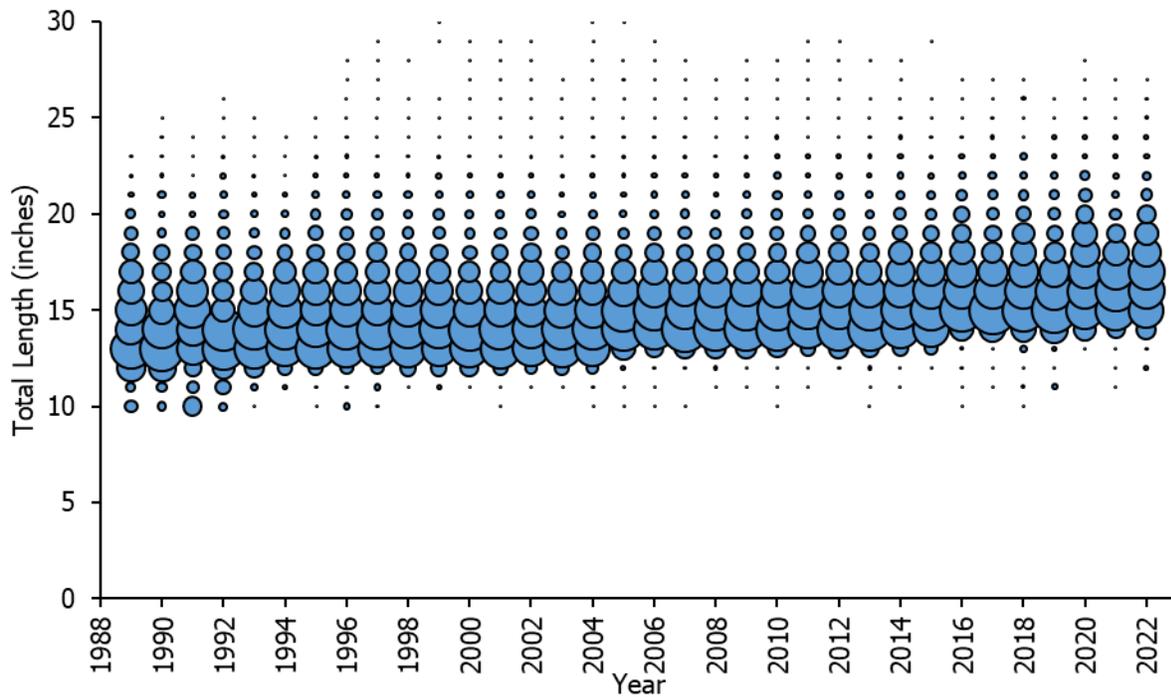


Figure 8. Commercial length frequency (total length, inches) of southern flounder harvested in North Carolina, 1991–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

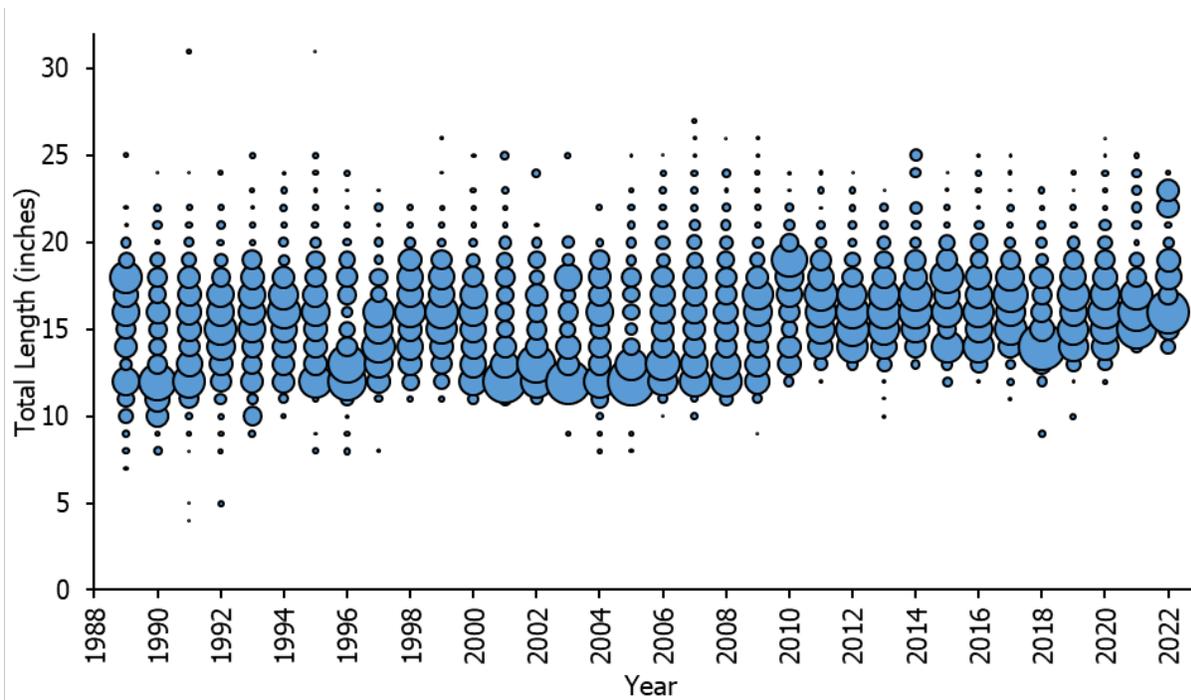


Figure 9. Recreational length frequency (total length, inches) of southern flounder harvested in North Carolina from MRIP, 1991–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

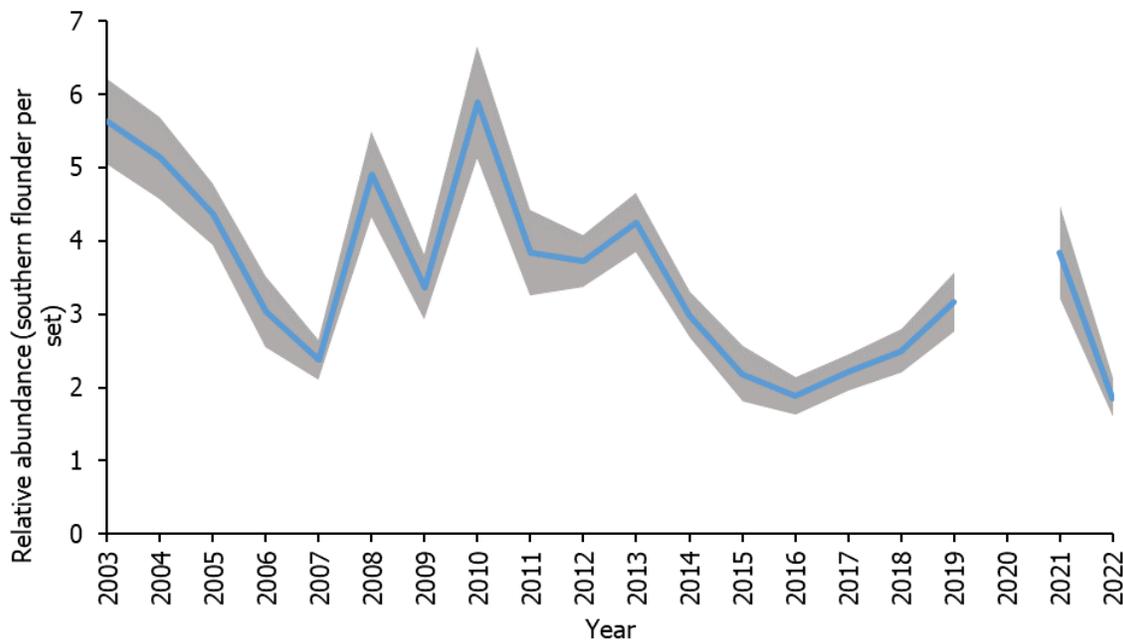


Figure 10. Annual nominal relative abundance index with standard error shaded in gray for southern flounder (juveniles and adults) caught in the North Carolina Pamlico Sound Independent Gill Net Survey, 2003–2022. Note: 2020 and 2021 sampling impacted by Executive Order (EO) 116, issued March 10, 2020.

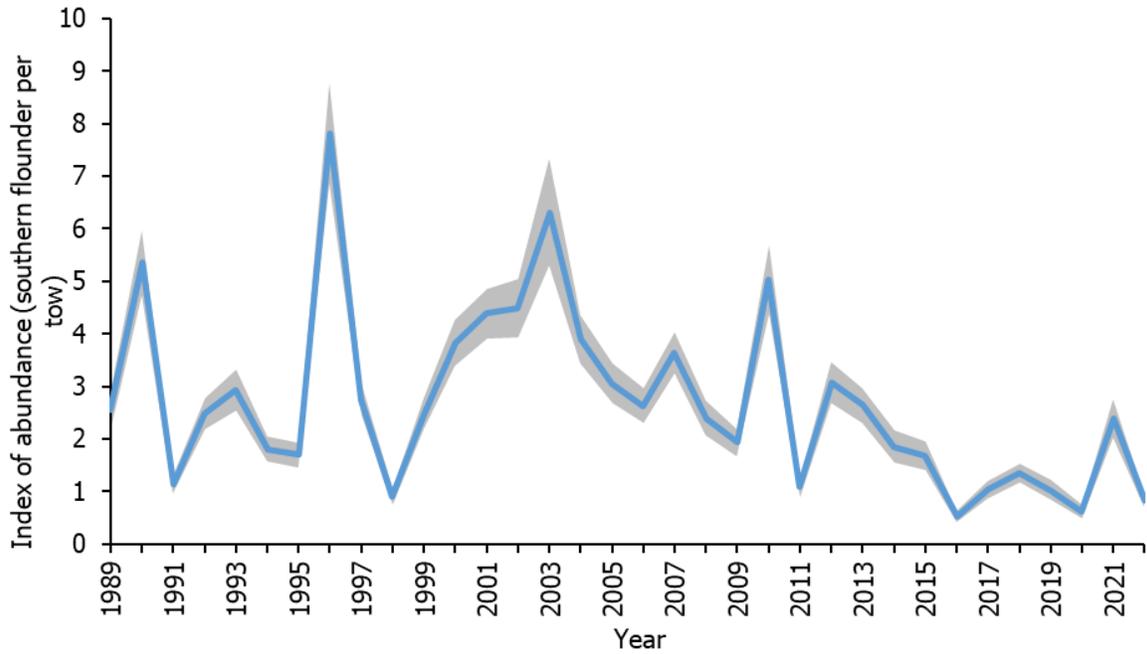


Figure 11. Annual nominal relative abundance index with standard error shaded in gray for southern flounder (juveniles and adults) caught in the North Carolina Estuarine Trawl Survey, 1989–2022. Note: 2020 sampling impacted by Executive Order (EO) 116, issued March 10, 2020.

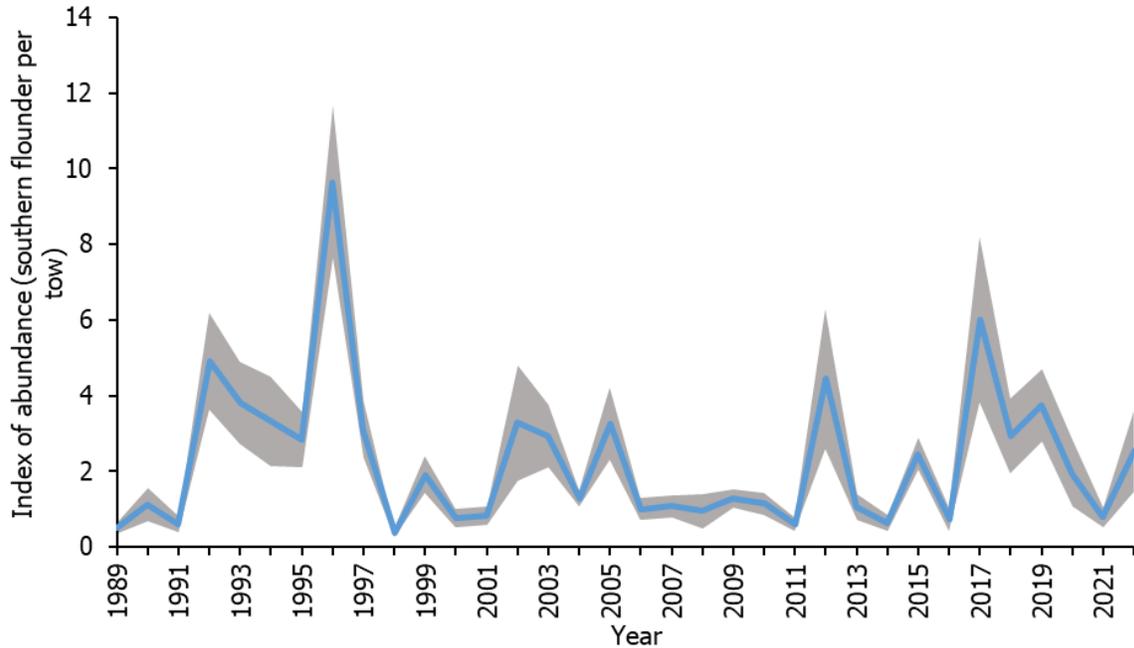


Figure 12. Annual nominal relative abundance index with standard error shaded in gray for southern flounder (juveniles and adults) caught in the North Carolina Pamlico Sound Survey, 1991–2022. Note: 2020 and 2021 sampling impacted by Executive Order (EO) 116, issued March 10, 2020.

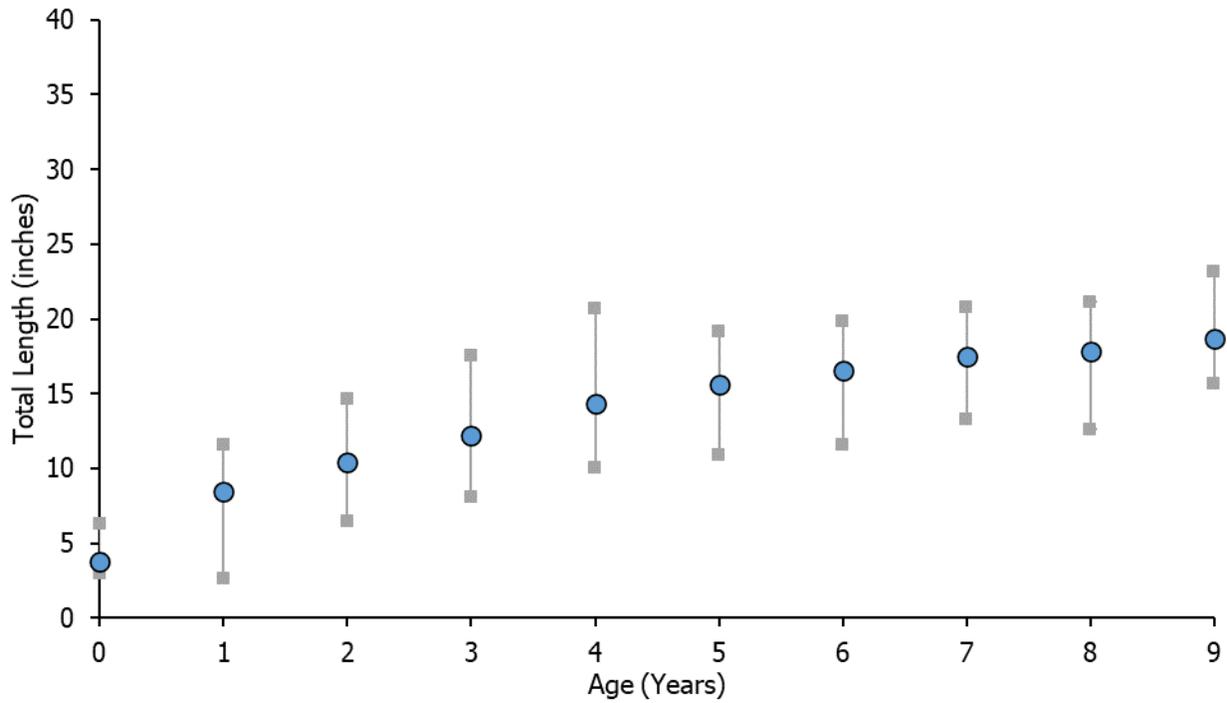


Figure 13. Southern flounder length at age based on all age samples collected in North Carolina, 1991–2022. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age.

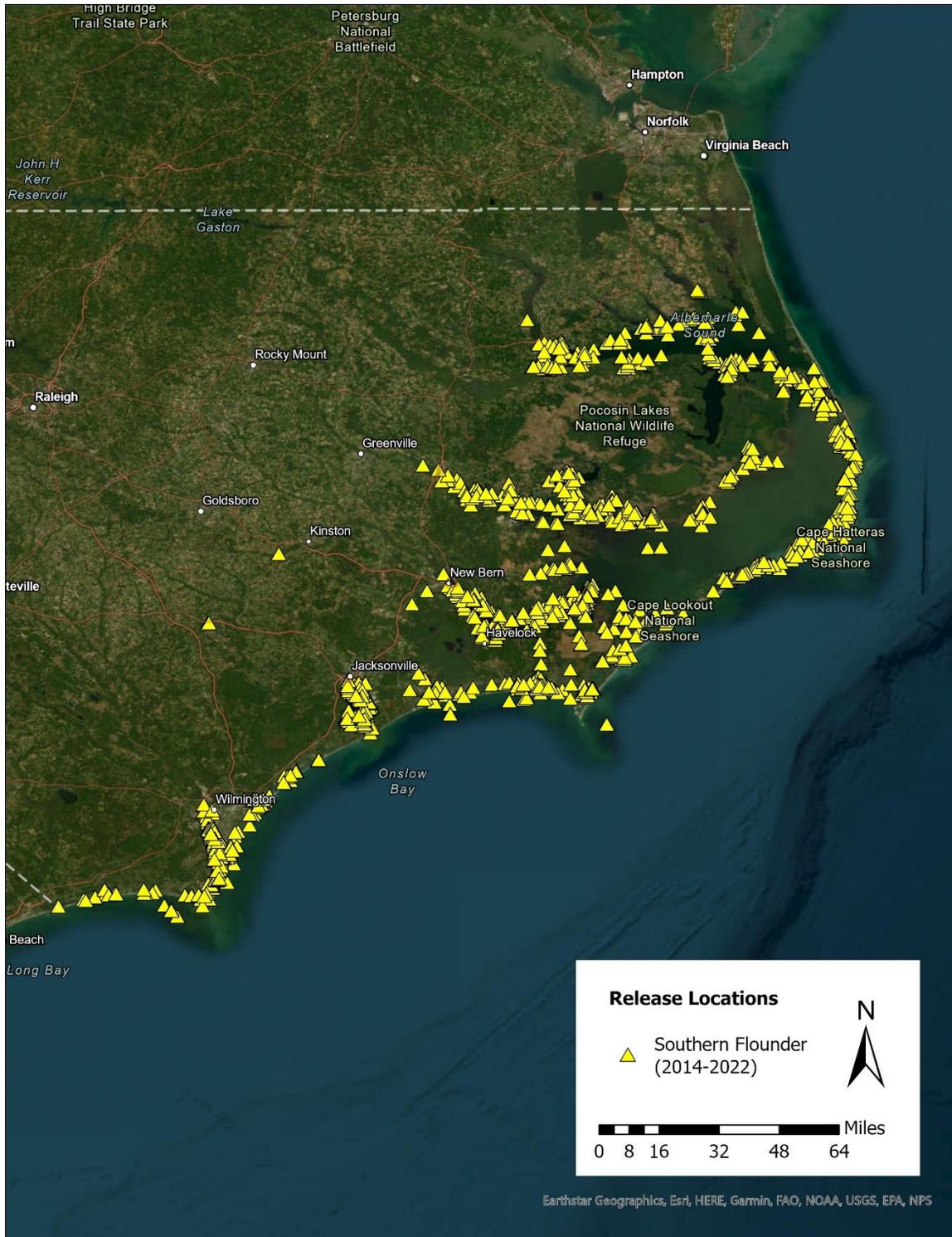


Figure 14. Release locations of southern flounder tagging events, 2014-2022.

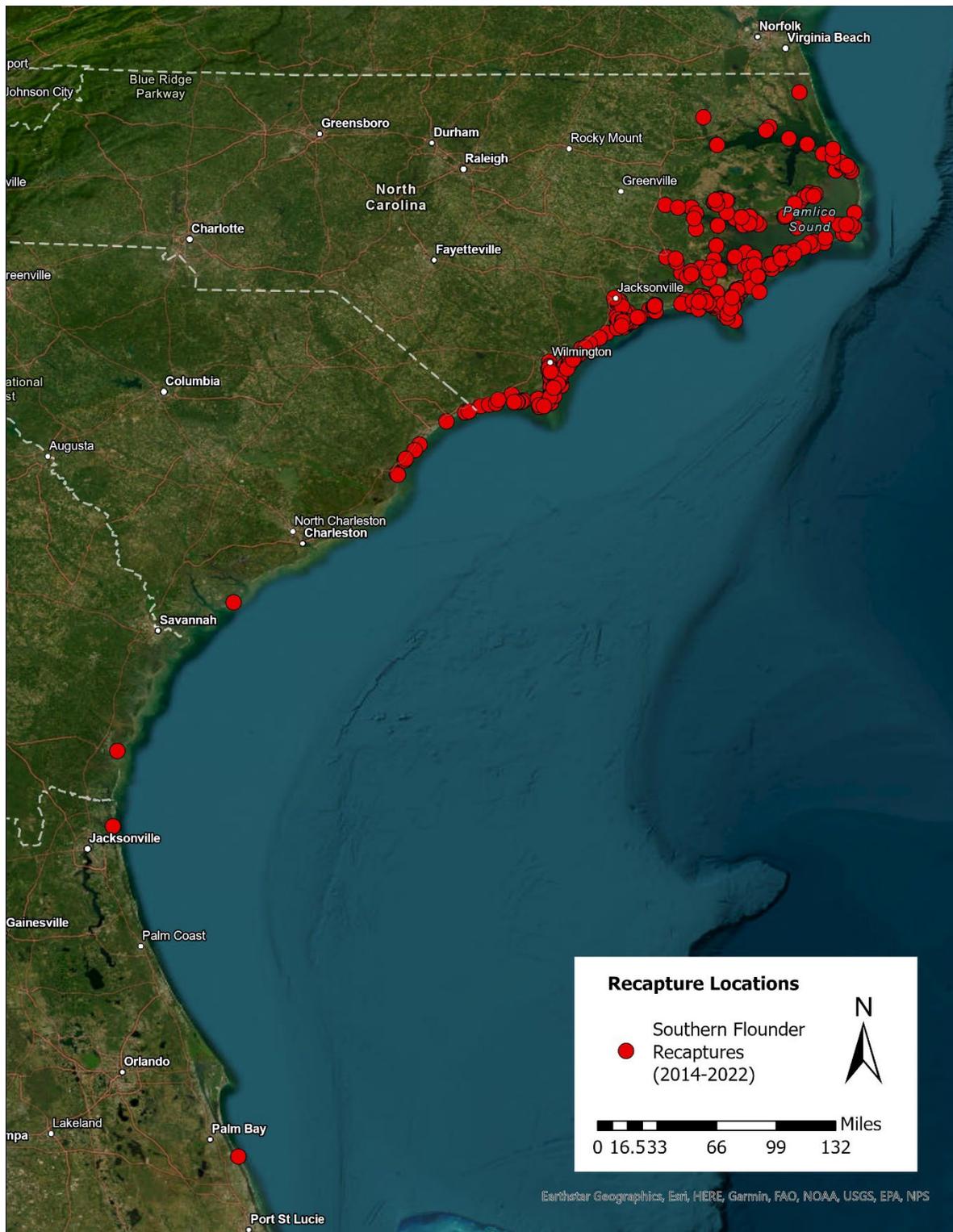


Figure 15. Recapture locations of tagged southern flounder, 2014 – 2022.

## STATE MANAGED SPECIES – SPOTTED SEATROUT

### FISHERY MANAGEMENT PLAN UPDATE SPOTTED SEATROUT AUGUST 2023

#### STATUS OF THE FISHERY MANAGEMENT PLAN

##### Fishery Management Plan History

Original FMP Adoption:	February 2012
Amendments:	None
Revisions:	None
Supplements:	Supplement A to the FMP      February 2014
Information Updates:	None
Schedule Changes:	None
Comprehensive Review:	July 2019

Spotted seatrout (*Cynoscion nebulosus*) is managed under the authority of two state and one interjurisdictional fishery management plans (FMP). The North Carolina Marine Fisheries Commission (MFC) currently manages spotted seatrout under the North Carolina Spotted Seatrout FMP (NCDMF 2012) and the North Carolina FMP for Interjurisdictional Fisheries (NCDMF 2022). Supplement A to the 2012 North Carolina Spotted Seatrout FMP (NCDMF 2014) 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. The 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 its February 2014 business meeting, the MFC 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 Amendment 1 is completed.

As required in the 2012 FMP, a stock assessment (NCDMF 2015a) was completed on schedule (2014-2015), peer reviewed, approved for management, and presented to the MFC at its May 2015 business meeting. A new benchmark stock assessment began in late 2020 and was completed and accepted for use in management October 2022. Results from the 2022 Spotted Seatrout Stock Assessment showed that the North Carolina and Virginia stock of Spotted Seatrout is not overfished, but overfishing is occurring. The North Carolina Division of Marine Fisheries (DMF) is drafting Amendment 1 to the state FMP for spotted seatrout to end overfishing and ensure sustainable harvest.

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 ASMFC spotted seatrout 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 limit).
- Manage the spotted seatrout stock to maintain appropriate 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 (NCDMF 2022). The goal of this 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.

### **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 includes all spotted seatrout 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:

- Develop an objective management program that provides conservation of the resource and sustainable harvest in the fishery.

- Ensure the spawning stock is of sufficient capacity to prevent recruitment-overfishing.
- Address socio-economic concerns of all user groups.
- Restore, improve, and protect important habitats that affect growth, survival, and reproduction of the North Carolina spotted seatrout stock.
- Evaluate, enhance, and initiate studies to increase understanding of spotted seatrout biology and population dynamics in North Carolina.
- Promote public awareness regarding the status and management of the North Carolina spotted seatrout stock.

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

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 (Murphy et al. 2006), however it is rare north of Virginia, United States. Genetic and tagging data support a single unit stock in Virginia and North Carolina (Ellis et al. 2019). In addition, based on genetic data, New River, North Carolina is an area of complex, seasonal mixing between two genetically distinct populations (Ellis et al. 2019): Georgia through Cape Fear River, North Carolina, and Bogue Sound, North Carolina and north (O'Donnell et al. 2014; Ellis et al. 2019). Spotted seatrout inhabit shallow coastal and estuarine waters throughout their range and are considered a euryhaline species (Deaton et al. 2010). In North Carolina, the state record was recorded at 12.5 pounds in 2022. The maximum reported age of spotted seatrout is 9 years in North Carolina for both male and female fish (NCDMF 2012). Most spotted seatrout in North Carolina are mature by age 1 and 7.9 inches for males and 9.9 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 (Burns 1996). Spawning occurs within the first few hours after sunset (Luczkovich et al. 1999) and a single fish is capable of spawning multiple times (batch spawners) throughout the season. In South Carolina and Florida, it has been observed that during peak spawning older spotted seatrout spawn more often than younger fish (Roumillat and Brouwer 2004, Lowerre-Barbieri et al. 2009). Estimates of the number of eggs a female can produce in a year from the Southeast and Gulf Coasts vary based on size, age, and range, from 3 million to 18 million per year (Nieland et al. 2002; Roumillat and Brouwer 2004; Murphy et al. 2011).

### **Stock Status**

The 2022 North Carolina spotted seatrout stock assessment (NCDMF 2022) indicated the spotted seatrout stock in North Carolina and Virginia is not overfished but overfishing is occurring (Figures 1 and 2).

### **Stock Assessment**

The 2022 benchmark stock assessment of spotted seatrout in North Carolina and Virginia was conducted using a seasonal size-structured assessment model applied to data characterizing

commercial and recreational landings and discards, fisheries-independent survey indices, and biological data collected from 1991 through 2019. A nonstationary process was assumed for natural mortality and growth in the model. The seasonal time step and nonstationary natural mortality assumption allows for capturing the cold-stun signals that have been observed for spotted seatrout. Both the observed data and the model predictions suggest a shift in population dynamics around the year 2004 when the survey index data became available. Lower fishing mortality and higher spawning stock biomass and recruitment with greater variation were predicted for the time period after 2004. This trend was also observed in the recreational landing and discards data, with higher values in the time period after 2004. The fishing year was defined as the biological year, March 1 through February 28 or 29, to incorporate cold stun mortalities within a single model year.

In 2019, estimated SSB was 4,980,243 pounds (2,259 metric tons), which is greater than the threshold ( $SSB_{20\%}=2,519,884$  pounds or 1,143 metric tons; Figure 1), indicating the stock is not overfished. The terminal year estimate of fishing mortality ( $F_{2019}$ ) was based on an inverse-variance weighted average of 2017-2019 F values. The 2019 estimate of fishing mortality was 0.75, which is higher than the threshold ( $F_{20\%}=0.60$ ), indicating the stock is experiencing overfishing (Figure 2).

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

The DMF 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 DMF has the authority to close the fishery until the following spawning period. In 2018, the spotted seatrout commercial and recreational fishery was closed from January 5 through June 15 by proclamation due to a state-wide cold stun event. For both commercial and recreational sectors of the spotted seatrout fishery, landings are reported on the biological year which is from March through February of the following year (e.g., biological year 2022 is from March 2022 through February 2023). It is important to note that data from January and February of 2023 is preliminary.

### **Commercial Fishery**

Annual landings have been variable throughout the time series (Table 1; Figure 3). Commercial landings in biological year 2022 (520,994 pounds) decreased by 20% compared to the previous year (654,152 pounds; Table 1; Figure 3). Commercial landings in biological years 2021 and 2020 were similar and the two highest years since biological year 1991. Commercial landings of spotted seatrout increased sharply in biological year 2019 and have remained high. This sharp increase in commercial landings is most likely due to several strong year classes of fish and mild winters from 2019-2022, resulting in high numbers of available fish. Additionally, regulations limiting fall commercial fishing for other species – specifically southern flounder – likely influenced

commercial spotted seatrout effort. During the early to mid-1990s, landings in the ocean and estuarine areas were more similar than in the remainder of the time series (1995-2022) in which estuarine landings have dominated. The primary gear of harvest are estuarine gill nets (anchored and run around).

## **Recreational Fishery**

Recreational landings of spotted seatrout are estimated from the Marine Recreational Information Program (MRIP). Recreational estimates across all years have been updated and are now based on the MRIP's new Fishing Effort Survey-based calibrated estimates. For more information on MRIP see <https://www.fisheries.noaa.gov/topic/recreational-fishing-data>.

Recreational harvest of spotted seatrout estimated by MRIP (Type A + B1) in biological year 2022 was 3,358,921 pounds, or 1,802,527 fish, similar to 2021 (2,839,919 pounds, 1,498,384 fish). Though harvest in biological years 2020, 2021, and 2022 are lower than the timeseries high (2019, 4,221,440 pounds, 2,415,392 fish) landings in these biological years have remained much higher than the time series average prior to biological year 2019 (1991-2018, 1,397,934 pounds, 905,205 fish). Additionally, pounds of spotted seatrout harvested in 2022 were the second highest in the time series and pounds harvested from 2019-2022 represent four of the top five pounds harvested in the time series. Estimated recreational releases in biological year 2022 (11,148,452 fish) were well above the time series average of 3,524,607 fish and the previous biological year's releases of 6,859,777 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. Citations awarded through the North Carolina Saltwater Fishing Tournament for spotted seatrout have varied by year throughout the time series, averaging 371 citations (Table 2; Figure 4). The number of awarded citations in calendar year 2022 (1,094 citations) increased from the previous calendar year (655 citations) and was the highest number of citations in the time-series. Awarded citations for spotted seatrout have generally increased each year since 2015. The number of release citations (fish over 24 inches that are released) awarded in calendar year 2022 (485 release citations) was the highest since release citations began in 2008 and an increase of just over 200 citations from calendar year 2021 (283 release citations). The percentage of spotted seatrout release citations (44%) was the time-series high and represents the second year in a row of a time-series high (Table 2).

## **MONITORING PROGRAM DATA**

### **Fishery-Dependent Monitoring**

Commercial fish houses are sampled monthly to provide length, weight, and age data. 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 average sizes of fish landed by the commercial fishery are typically larger than the recreational fishery and is primarily driven by the larger maximum size observed in the commercial landings; however, modal length for the commercial fishery in 2022 was the same (16 inches fork length) as the recreational fishery (16 inches fork length) and was likely driven by similar maximum sizes in the commercial and

recreational fisheries (Table 3; Figure 5). Undersized fish represent a small portion of the harvest in both sectors; 1.3% of commercial harvest and 3.7% of the recreational harvest was below the 14-inch size limit in 2022 (Figure 5).

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. The mean length of spotted seatrout in 2022 (17.9 inches fork length) was similar to the time series (1991-2021) average (16.6 inches fork length) and the mean length in 2021 (17.5 inches fork length), however, minimum length (13.2 inches fork length) was well above the minimum length in 2021 (10.9 inches fork length; Table 3; Figure 6). For the past four years (2019-2022), minimum length has been consistently greater than the time series average (8.4 inches fork length). Maximum length in 2022 decreased to 28.3 inches fork length and was slightly below the time series average (29.7 inches fork length). Most spotted seatrout landings by the commercial fishery in 2022 came from the run around and anchored gill net fishery (92%) with pound nets (1.6%), and all other gears (5.6%; mainly beach seines, swipe nets, and haul seines) accounting for the rest.

Recreational catch is almost exclusively hook-and-line. The mean length from the recreational fishery in 2022 (17.4 inches fork length) was similar to the previous year (17.0 inches fork length) while the minimum length (12.6 inches fork length) and maximum length (28 inches fork length) were both increases from 2021 (11.1- and 26.5-inches fork length, respectively). All three 2022 length metrics – mean, minimum, and maximum – were greater than the time series (1991-2021) average of each (16.0, 10.4-, and 25.8-inches fork length, respectively; Table 3; Figure 7). Eighty-eight percent of the spotted seatrout sampled from the recreational fishery in 2022 were between 14 and 19 inches (Figure 5).

### **Fishery-Independent Monitoring**

The DMF utilizes numerous fishery independent monitoring programs to provide indices of juvenile (Program 120) and adult (Program 915) relative 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 and June. One of the key objectives of this program is to provide a long-term database 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 were added in 2004 and are sampled during the months of June and July. Data from the spotted seatrout specific stations are used to generate an index of relative abundance of age zero spotted seatrout, calculated as the average number of fish per tow. The resulting relative abundance index for the time series is variable with no significant trend overall, and peaks in 2006, 2008, 2012, 2013, and 2018 suggesting relatively higher recruitment in those years (Figure 8). The Program 120 relative abundance index in 2022 was 0.69 spotted seatrout per tow, which was three times the 2020 value. However, the 2020 value was the lowest value since the time series began in 2004 (0.67 spotted seatrout per tow). The 2022 relative abundance index was a 65% decrease from the time series mean (2004-2021; 1.97 spotted seatrout per tow) and represents the third year in a row of lower than time series average relative juvenile abundance index values.

The DMF 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 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 encompassing 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, the central river stations include the Pamlico, Pungo, and Neuse rivers, and the southern river stations include the Cape Fear and New rivers. In the 2022 Spotted Seatrout Stock Assessment, the northern stations (i.e., the Pamlico Sound and Central River stations) were combined then separated into spring (April-June) and fall (September-November) indices of abundance (NCDMF 2022). During 2020 no indices of abundance are available for spotted seatrout from the fishery-independent assessment (Program 915). Sampling in this program was suspended in February 2020 due to COVID-19 restrictions and protected species interactions but resumed July 2021. Relative abundance in the Fall Index has been relatively consistent since 2006 with some variation around the time series mean (0.83 spotted seatrout per set) with a large spike in relative abundance in 2019 to the time series high (2.10 spotted seatrout per set) followed by a steep drop to the time series low when sampling resumed in 2021 (0.15 spotted seatrout per set) before returning to just above the time series mean in 2022 (0.88 spotted seatrout per set; Figure 9). The Spring Index has been more variable throughout the time series. However, 2019 also represented a timeseries high in relative abundance (1.50 spotted seatrout per set; Figure 10). Sampling Program 915 did not resume until July of 2021, therefore there is no Spring Index in 2021. Relative abundance in 2022 (1.15 spotted seatrout per set) represents the second highest relative abundance value in the time series.

Spotted seatrout age samples are collected from numerous DMF fishery independent and dependent sources. To date, a total of 21,392 otoliths from spotted seatrout have been aged since 1991 (Table 4). With the exception of 2003, the minimum age of sampled spotted seatrout has been age zero for every year the DMF has recorded this information. Maximum ages have varied every year, ranging from age five to age nine. Modal ages, which give an indication of the age of the largest cohort in the fishery, averages age one. Spotted seatrout length-at-age was summarized based on all available age data (1991-2022; Figure 12). Average growth of spotted seatrout slows down around age-4, but fish as large as 24.7 inches have the potential to be young of the year (age-0), demonstrating the species' fast growth. In 2022, the number of fish aged (815 fish) decreased from the previous year (1,006 fish). Spotted seatrout sampled in 2022 had a modal age of 2 and maximum age of 6, which were, respectively, an increase from and the same as the previous year (1, 6).

## **Tagging**

DMF established the Multi-Species Tagging Program in 2014 designed to collect data on habitat use, migration patterns, population structure, and mortality rates of cobia, red drum, southern flounder, spotted seatrout, and striped bass. Specifically, spotted seatrout are tagged with single yellow tags (low reward), single red tags (high reward), or double yellow tags. Since 2014, Division staff and Division trained volunteer taggers have tagged 12,358 spotted seatrout and 795

recaptures of spotted seatrout have been reported (Table 7). In 2022, Division staff and volunteers tagged 800 spotted seatrout and 25 recaptures were reported (Table 7, Figure 12).

## **RESEARCH NEEDS**

The following research needs were compiled from those listed as high research priorities in the 2022 North Carolina Spotted Seatrout Stock Assessment Report. Improved management of spotted seatrout is dependent upon research needs being met. Research needs are not listed in order of priority.

- Test and validate the newly developed size-structured model with known data sets and a simulation study that compares this size-structured model with an age-structured model
- Collect data to characterize annual length distributions of commercial discards and recreational releases to inform selectivity parameterization
- Develop a fishery-independent survey for Virginia waters
- Develop a winter-season survey to capture population dynamics in that period, including collection of length composition data
- Integrate tagging data into stock assessment model so both tagging data and other data sources can work together to give a better picture of the population
- Implement a year-round, fisheries-independent juvenile survey
- Improve estimates of recreational discard mortality

## **MANAGEMENT STRATEGY**

Maintain a spawning potential ratio of 20% to 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 and 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. The Director maintains authority to intervene in the event of a catastrophic cold stun event and close the fishery in specific areas or statewide until June 15. This reduces fishing mortality on spotted seatrout until after the peak in their spawning season.

## **FISHERY MANAGEMENT PLAN SCHEDULE RECOMMENDATIONS**

The review of the plan is underway. A benchmark stock assessment was completed October 2022, incorporating data through February 2020.

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## TABLES

Table 1: Recreational harvest (number of fish landed and weight in pounds) and releases (number of fish) and commercial harvest (weight in pounds) of spotted seatrout from North Carolina for the biological years 1991–2022. The biological year is from March through February of the following year (e.g., biological year 2022 is from March 2022 through February 2023). \*Data from the January and February portion of biological year 2023 is preliminary.

Year	Recreational			Commercial	Total Weight (lb)
	Numbers Landed	Numbers Released	Weight Landed (lb)	Weight Landed (lb)	
1991	973,624	576,139	1,334,162	738,338	2,072,500
1992	908,233	449,085	1,390,746	482,192	1,872,938
1993	569,327	462,573	857,720	487,612	1,345,332
1994	798,937	443,785	1,207,520	479,249	1,686,769
1995	863,057	708,851	1,221,065	540,890	1,761,955
1996	575,357	638,588	699,078	142,742	841,820
1997	779,611	245,747	1,025,110	229,168	1,254,278
1998	702,274	112,315	1,125,898	372,674	1,498,572
1999	1,080,411	718,987	1,878,913	675,136	2,554,049
2000	728,906	170,075	1,095,729	192,130	1,287,859
2001	499,556	515,433	659,893	89,880	749,773
2002	746,908	1,349,460	957,824	222,625	1,180,449
2003	388,715	546,960	515,678	144,086	659,764
2004	570,836	597,766	744,870	127,443	872,313
2005	1,574,164	3,149,889	1,772,342	123,938	1,896,280
2006	1,432,937	1,581,255	2,050,493	385,530	2,436,023
2007	1,242,654	2,232,904	2,002,059	325,267	2,327,326
2008	1,331,397	2,219,488	2,035,508	318,413	2,353,921
2009	1,850,581	4,461,889	2,855,284	362,781	3,218,065
2010	623,597	7,739,240	1,264,714	112,703	1,377,417
2011	758,250	7,580,380	1,466,310	83,875	1,550,185
2012	1,666,056	4,819,440	2,762,953	315,128	3,078,081
2013	1,055,564	4,521,077	1,958,333	364,123	2,322,456
2014	737,345	3,655,134	1,325,748	226,394	1,552,142
2015	202,703	5,426,396	339,433	115,553	454,986
2016	1,130,681	6,225,783	2,013,905	273,848	2,287,753
2017	1,054,500	4,725,746	1,852,474	259,473	2,111,947
2018	499,562	16,426,445	728,401	151,750	880,151
2019	2,415,392	7,050,239	4,221,440	443,638	4,665,078
2020	1,605,722	5,428,135	2,827,646	653,092	3,480,738
2021	1,495,384	6,859,777	2,839,919	654,152	3,494,071
2022	1,802,527	11,148,452	3,358,921	520,994	3,879,915
Mean	1,020,774	3,524,607	1,637,190	331,713	1,968,903

Table 2: Total number of awarded citations for spotted seatrout (>24 inches total length for release or > five pounds landed) from the North Carolina Saltwater Fishing Tournament for the time period of calendar years 1991–2022.

Year	Total Citations	Release Citations <sup>+</sup>	% Release
1991	185		0
1992	203		0
1993	12		0
1994	237		0
1995	483		0
1996	132		0
1997	125		0
1998	332		0
1999	695		0
2000	511		0
2001	518		0
2002	353		0
2003	328		0
2004	378		0
2005	290		0
2006	686		0
2007	1,000		0
2008	428	5	1
2009	434	14	3
2010	168	16	10
2011	37	3	8
2012	143	5	3
2013	162	21	13
2014	197	18	9
2015	176	16	9
2016	214	44	21
2017	464	81	17
2018	198	73	37
2019	468	172	37
2020	579	193	33
2021	655	283	43
2022	1,094	485	44

<sup>+</sup> Spotted seatrout release citations (fish released greater than 24 inches total length) began in 2008.

Table 3: Mean, minimum, and maximum lengths (fork length, inches) of spotted seatrout measured from the commercial and recreational fisheries, calendar years 1991–2022.

Year	Commercial				Recreational			
	Mean Length	Minimum Length	Maximum Length	Total Number Measured	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1991	14.4	7.7	28.7	1,207	15.1	4.9	31.9	745
1992	16.0	8.4	27.9	1,791	15.6	5.1	24.2	543
1993	16.3	8.5	29.7	1,898	15.7	9.3	25.0	485
1994	15.6	7.0	29.1	1,224	16.0	10.6	24.0	1,076
1995	17.1	8.5	29.1	2,728	15.6	8.5	31.6	853
1996	16.0	7.0	27.6	748	14.6	8.9	24.3	307
1997	14.9	8.1	29.9	4,155	15.3	8.9	23.1	622
1998	14.5	8.0	29.9	4,698	16.4	11.0	36.5	551
1999	15.6	7.6	30.2	6,167	16.4	11.6	26.8	699
2000	17.5	6.0	30.7	2,901	15.6	11.3	25.2	330
2001	16.3	7.6	30.7	1,595	14.8	11.5	26.0	326
2002	16.1	8.0	28.9	3,897	14.9	11.8	24.8	283
2003	17.2	9.5	29.6	2,305	14.6	9.9	25.0	130
2004	16.6	9.0	27.9	2,676	15.3	8.9	22.5	294
2005	16.8	8.5	27.5	2,429	14.2	8.7	25.2	664
2006	16.3	8.9	29.3	6,493	15.5	10.1	25.9	706
2007	17.3	9.6	31.0	8,455	15.9	10.8	27.7	521
2008	17.0	7.3	30.3	5,877	15.6	11.5	26.5	790
2009	16.7	5.4	29.5	6,631	16.0	9.1	26.0	779
2010	17.5	11.4	30.9	4,060	17.5	12.4	24.8	336
2011	16.6	8.8	27.8	1,274	17.0	12.3	24.2	638
2012	16.5	7.4	31.1	4,822	16.5	13.0	24.1	939
2013	16.7	8.7	28.5	6,144	16.8	10.1	23.5	865
2014	17.3	5.5	28.3	3,321	17.6	13.1	26.0	381
2015	18.3	8.9	30.9	2,676	16.9	12.8	25.0	154
2016	17.3	9.4	31.7	3,025	16.8	13.0	25.2	647
2017	17.6	7.6	32.9	3,066	17.0	11.6	25.8	864
2018	17.2	10.5	28.0	1,180	15.7	9.3	23.3	274
2019	17.3	10.1	28.9	2,622	16.7	10.7	24.6	1,574
2020	17.5	10.9	33.4	2,851	17.0	12.1	26.8	1,119
2021	17.5	10.9	29.9	3,432	17.0	11.1	26.5	1,019
2022	17.9	13.2	28.3	3,314	17.4	12.6	28.0	632

Table 4: Modal age, minimum age, maximum age, and number aged for spotted seatrout collected through DMF sampling programs, calendar years 1991–2022.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
1991	1	0	7	679
1992	1	0	6	572
1993	1	0	6	645
1994	1	0	9	688
1995	1	0	5	623
1996	1	0	6	734
1997	1	0	6	710
1998	1	0	9	765
1999	1	0	6	869
2000	1	0	7	566
2001	1	0	5	425
2002	1	0	7	713
2003	1	1	7	405
2004	1	0	6	598
2005	1	0	5	727
2006	1	0	8	970
2007	2	0	8	702
2008	1	0	7	616
2009	2	0	6	660
2010	1	0	6	623
2011	1	0	6	421
2012	1	0	5	593
2013	2	0	5	635
2014	1	0	7	530
2015	2	0	5	448
2016	1	0	5	456
2017	1	0	7	881
2018	1	0	5	516
2019	1	0	8	1,167
2020	2	0	5	634
2021	1	0	6	1,006
2022	2	0	6	815

Table 5: Summary of the MFC 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 DMF 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 DMF, Universities, etc.	Preliminary research accomplished (Ellis et al. 2017a, 2017b), additional work ongoing.

Table 6: Summary of the MFC 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 15 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*

\* The MFC approved the 2017 FMP schedule in August 2017, which included a schedule change for spotted seatrout to begin in 2019, two years later than originally planned.

Table 7: Total tagged, total recaptured, average days at large, maximum days at large, average distance traveled (miles), and maximum distance traveled (miles) for spotted seatrout tagged in the DMF Multi-Species Tagging Program from calendar year 2014-2022.

Year Tagged	Total Tagged	Total Recaptured	Average Days at Large	Maximum Days at Large	Average Distance Traveled	Maximum Distance Traveled
2014	634	44	91	431	35	271
2015	1047	37	139	641	17	94
2016	1306	93	133	567	28	214
2017	2581	138	116	1099	29	208
2018	1464	67	200	904	60	202
2019	2619	257	169	1091	37	223
2020	1389	102	144	884	36	298
2021	518	32	100	310	33	151
2022	800	25	87	242	25	92

## FIGURES

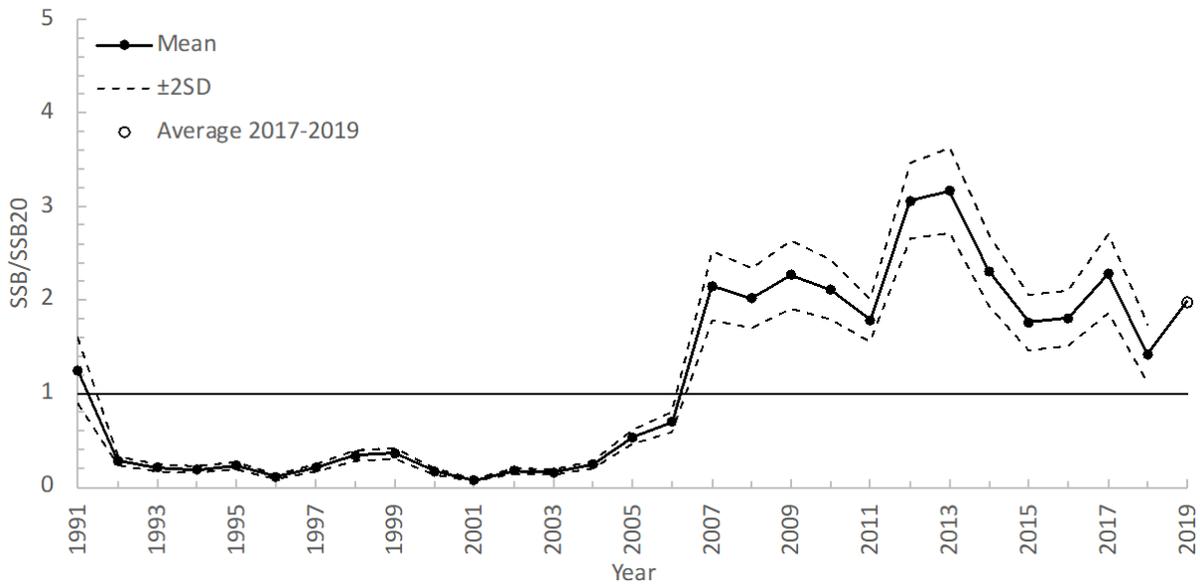


Figure 1. Annual predicted spawning stock biomass (metric tons), relative to the spawning stock biomass threshold ( $SSB/SSB_{20\%}$ ), 1991–2019. 2019 is the terminal year for the most recent spotted seatrout stock assessment (NCDMF 2022). The horizontal black line shows a ratio of one. The terminal-year estimate (open circle) is an average of the most recent three years weighted by the inverse CV values.

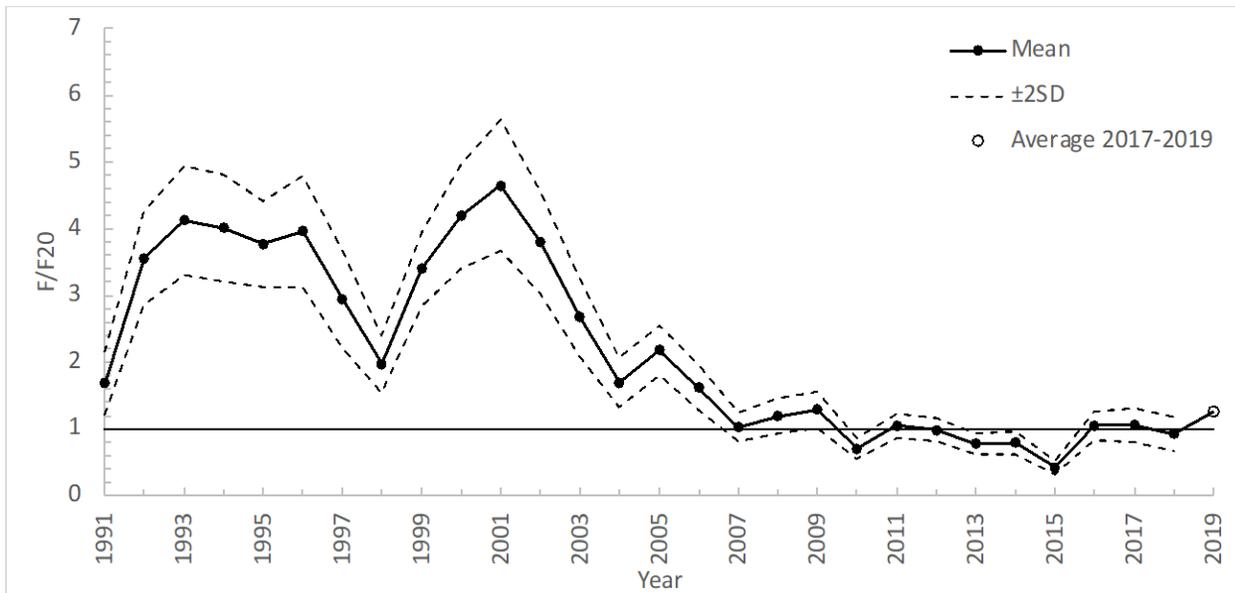


Figure 2. Annual predicted fishing mortality rates relative to the fishing mortality threshold ( $F/F_{20\%}$ ), 1991–2019. 2019 is the terminal year for the most recent spotted seatrout stock assessment (NCDMF 2022). The horizontal black line shows a ratio of one. The terminal-year estimate (open circle) is an average of the most recent three years weighted by the inverse CV values.

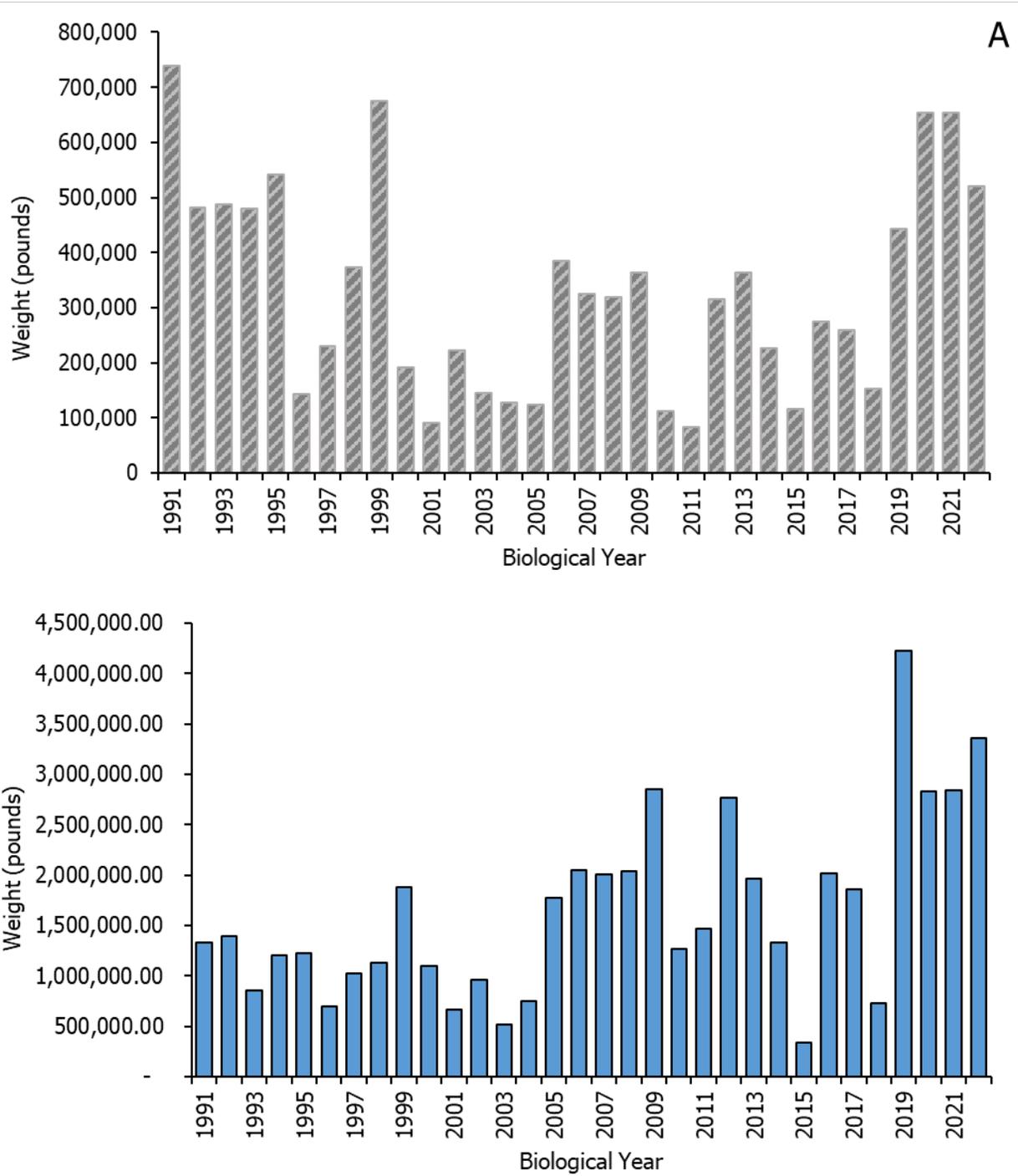


Figure 3. Commercial landings (pounds) reported through the North Carolina Trip Ticket Program (A) and recreational landings (Type A + B1; pounds) estimated from the Marine Recreational Information Program survey (B) for North Carolina, Biological Year 1991–2022. Biological Year is from March through February of the following year (e.g., Biological Year 2022 starts March 2022 and ends February 2023).

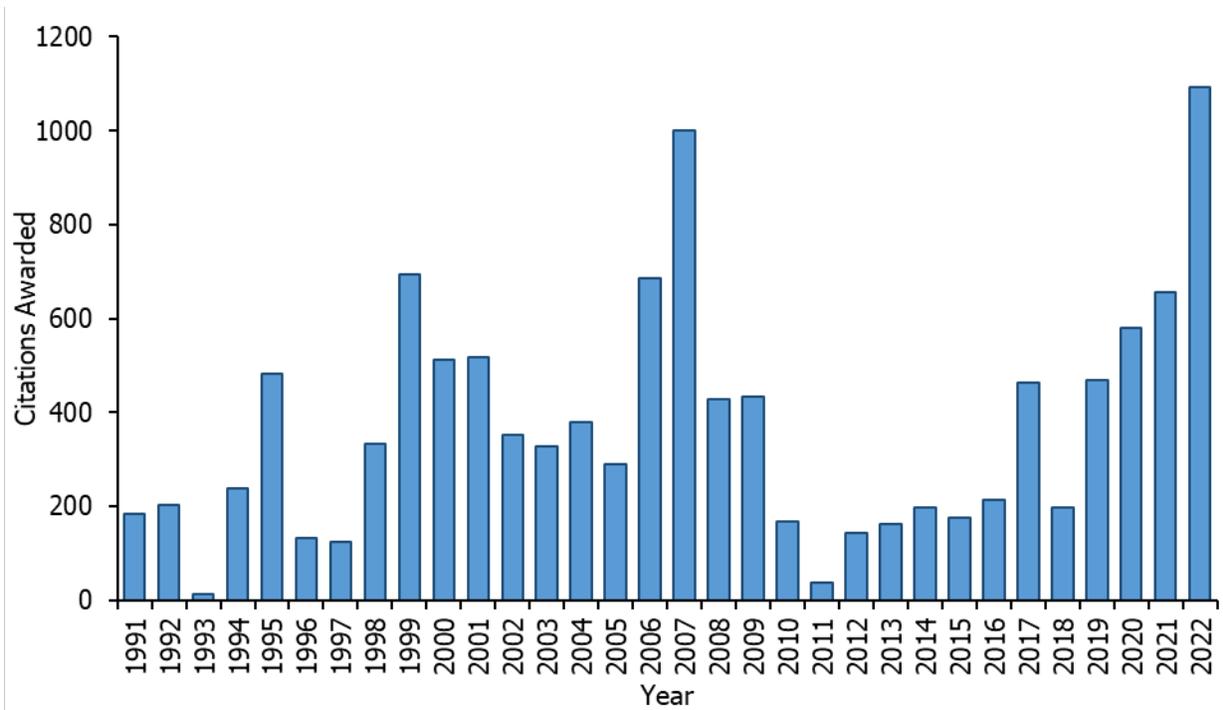


Figure 4. North Carolina Saltwater Fishing Tournament citations awarded for spotted seatrout, calendar years 1991–2022. Citations are awarded for spotted seatrout >24 inches total length for release or >five pounds landed.

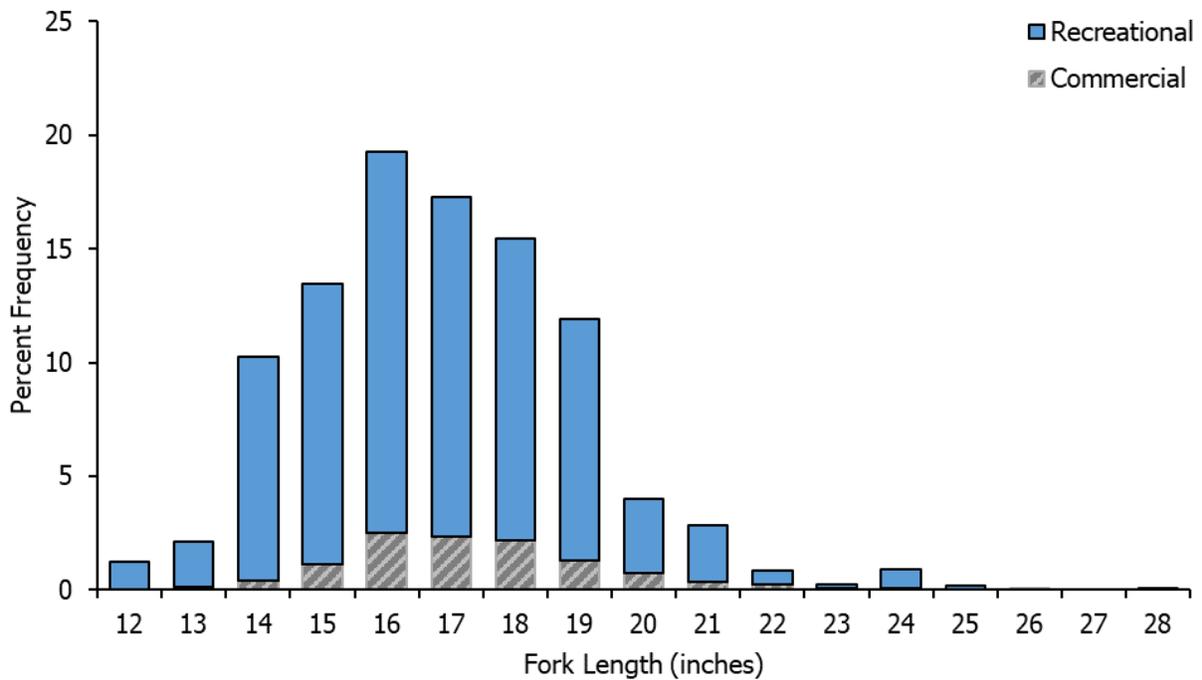


Figure 5. Commercial and recreational length frequency distribution from spotted seatrout harvested in biological year 2022.

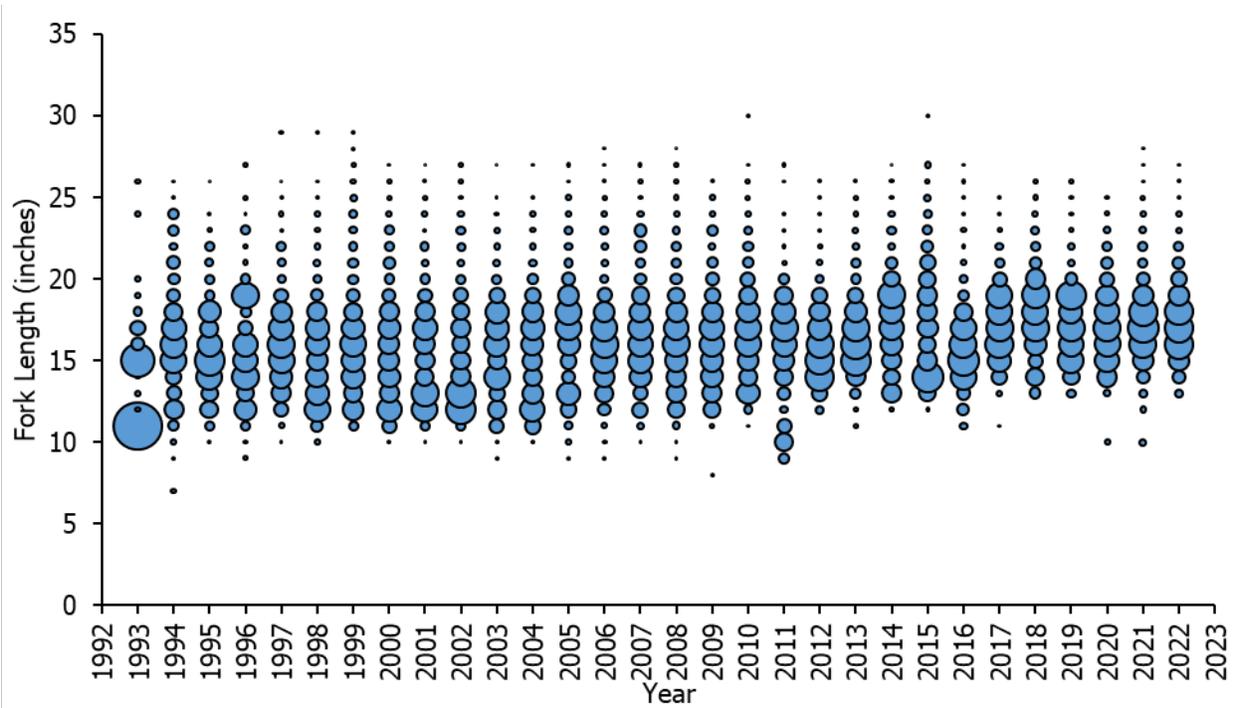


Figure 6. Commercial length frequency (fork length, inches) of spotted seatrout harvested biological year 1993-2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

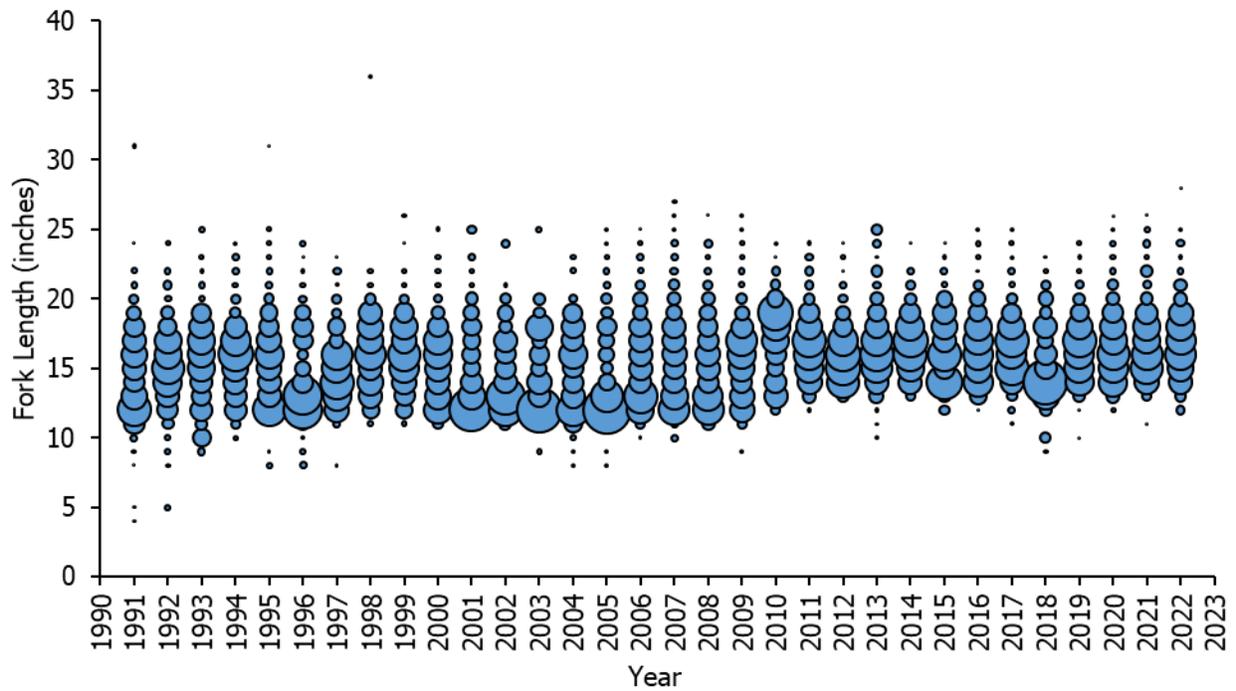


Figure 7. Recreational length frequency (fork length, inches) of spotted seatrout harvested biological year 1991-2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

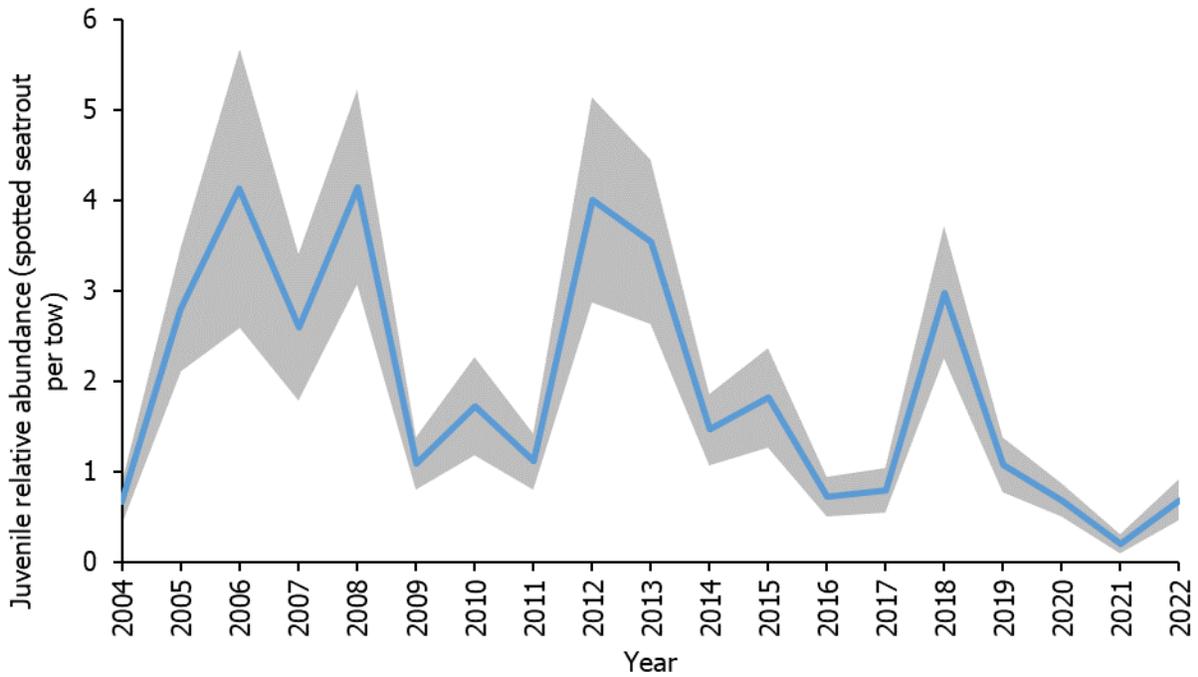


Figure 8. Relative abundance index (fish per tow) from the North Carolina Estuarine Trawl Survey (Program 120) during June and July, 2004–2022. Error bars represent  $\pm 1$  standard error.

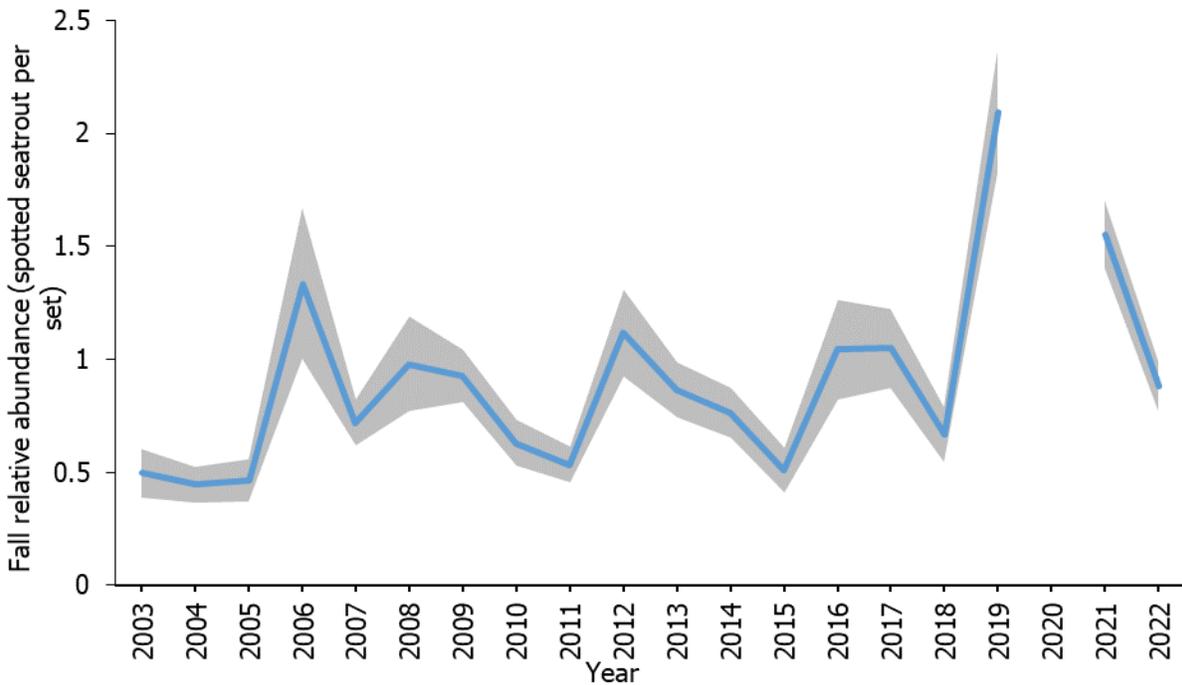


Figure 9. Fall relative abundance index (fish per set) of spotted seatrout collected from Program 915 in Pamlico Sound, Pamlico River, Pungo River, and Neuse River during September, October, and November 2003–2022. Error bars represent  $\pm 1$  standard error. Sampling not conducted in 2020 for the Fall Index.

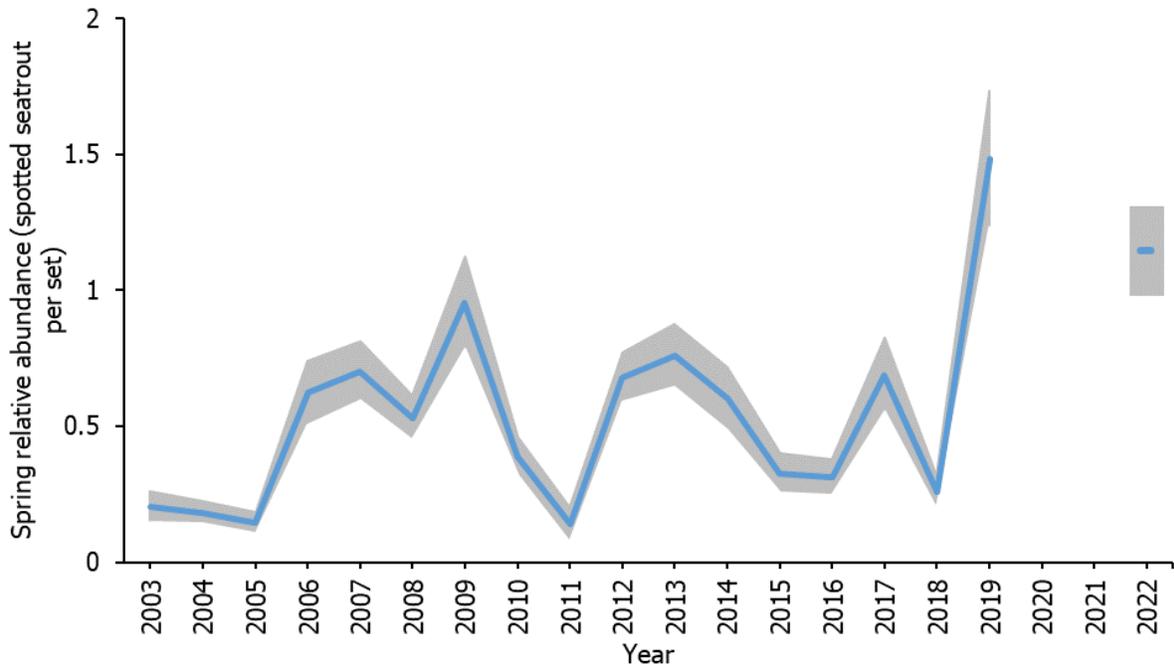


Figure 10. Spring relative abundance index (fish per set) of spotted seatrout collected from Program 915 in Pamlico Sound, Pamlico River, Pungo River, and Neuse River during April, May, and June 2003–2022. Error bars represent  $\pm 1$  standard error. \*Sampling not conducted in 2020 or April, May, and June of 2021.

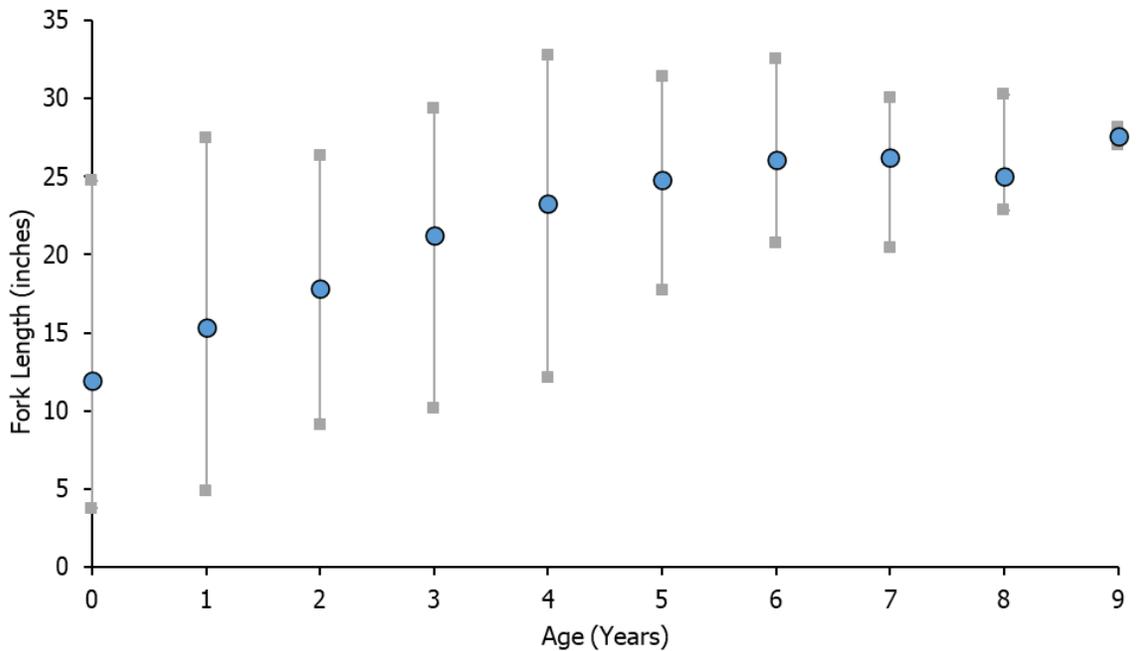


Figure 11. Spotted seatrout length at age based on all age samples collected from calendar year 1991 to 2022. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age.

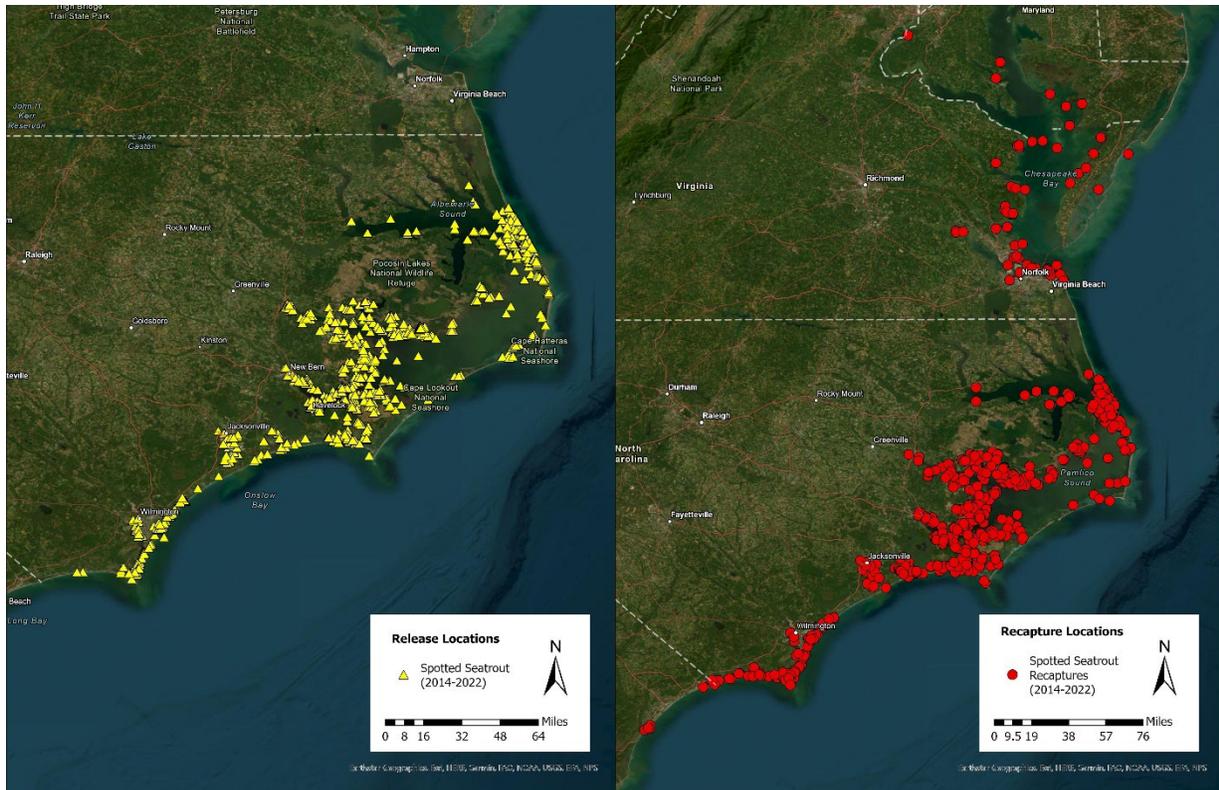


Figure 12. Spotted seatrout release locations (left map, yellow triangles) and recapture locations (right map, red circles) for spotted seatrout tagged in the DMF Multi-Species Tagging Program from calendar year 2014-2022.

## STATE MANAGED SPECIES – STRIPED MULLET

### FISHERY MANAGEMENT PLAN UPDATE STRIPED MULLET AUGUST 2023

#### STATUS OF THE FISHERY MANAGEMENT PLAN

##### Fishery Management Plan History

Original FMP Adoption:	April 2006	
Amendments:	Amendment 1	November 2015
Revisions:	None	
Supplements:	Supplement A	May 2023
Information Updates:	None	
Schedule Changes:	None	
Comprehensive Review:	July 2020	

The North Carolina Striped Mullet Fishery Management Plan (FMP) was adopted in April 2006. The management plan established minimum and maximum commercial landings triggers of 1.3 and 3.1 million pounds (NCDMF 2006). If annual landings fall below the minimum trigger, the North Carolina Division of Marine Fisheries (DMF) would determine whether the decrease in landings is attributed to stock decline, decreased fishing effort, or both. If annual landings exceed the maximum trigger, DMF would determine whether harvest is sustainable and what factors are driving the increase in harvest. The striped mullet FMP established a daily possession limit of 200 mullets (white and striped in aggregate) per person per day in the recreational fishery.

Amendment 1 to the FMP was adopted in November 2015, and the subsequent rules were implemented in April 2016. Amendment 1 resolved issues with Newport River gill net attendance, mitigated known user group conflicts, updated the management framework, and updated minimum and maximum commercial landings triggers to 1.13 and 2.76 million pounds (NCDMF 2015). Amendment 1 maintains the 200-mullet possession limit per person in the recreational fishery.

Commercial landings in 2016 were 965,198 pounds, which is below the minimum landings trigger of 1.13 million pounds (Figure 3A). As required by the FMP, the DMF initiated data analysis in July 2017 to determine whether the decrease was attributed to a stock decline, decreased fishing effort, or both. The DMF presented preliminary findings and recommendations to the North Carolina Marine Fisheries Commission (MFC) during its November 2017 business meeting. It was determined by the DMF that no management actions were necessary at that time, but a more comprehensive analysis with data through 2017 was needed.

The DMF presented results of their comprehensive analysis at the February 2018 MFC business meeting and concluded the stock had likely declined since completion of the 2013 stock

assessment, which had a terminal year of 2011. The DMF recommended updating the stock assessment model to include data through 2017 prior to taking management action. As an assessment update, there were no changes to model parameters and peer review was not required, as the of the peer reviewed model configuration was maintained. Results of the stock assessment indicated overfishing was not occurring through 2017 but could not determine if the stock was overfished (NCDMF 2018).

Subsequent management options were developed by the DMF and presented to the Finfish, Southern, and Northern advisory committees in July 2018 to receive input prior to finalizing the DMF recommendation. Recommendations were then presented to the MFC at its August 2018 business meeting. The DMF and the advisory committees recommended no management action be taken since the stock assessment update indicated overfishing was not occurring. The DMF would, however, continue to monitor trends in the commercial fishery and fishery-independent indices. The recommendation was approved by the MFC.

Review of the 2022 commercial landings indicate neither the maximum or minimum triggers have been exceeded. Review of the FMP was initiated in 2020, following the FMP review schedule.

The 2022 North Carolina striped mullet stock assessment indicated the North Carolina striped mullet stock is overfished and overfishing is occurring in the terminal year of 2019 (NCDMF 2022). In response to stock assessment results, the MFC adopted Supplement A to Amendment 1 to the Striped Mullet FMP in May 2023 to end overfishing (NCDMF 2023). Supplement A establishes season closures for the striped mullet commercial and recreational fisheries that will occur from November 7 through December 31, 2023, north of the Highway 58 Bridge and from November 10 through December 31, 2023, south of the Highway 58 Bridge. Supplement A management will remain in place until adoption of Amendment 2 to the Striped Mullet FMP and the commercial landings triggers established by Amendment 1 will no longer be used to monitor the stock.

## **Management Unit**

Coastal and joint waters of North Carolina.

## **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:

- 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.
- Promote the protection, enhancement, and restoration of habitats and water quality necessary for the striped mullet population.
- Minimize conflict among user groups, including non-fishing user groups and activities.

- Promote research to improve the understanding of striped mullet population dynamics and ecology to improve management of the striped mullet resource.
- Initiate, enhance, and/or continue studies to collect and analyze the socio-economic data needed to properly monitor and manage the striped mullet fishery.
- Promote public awareness regarding the status and management of the North Carolina striped mullet stock.

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

Striped mullet are found in a wide range of depths and habitats but primarily inhabit freshwater to estuarine environments until migrating to the ocean to spawn in 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 and in mud, silt, sand, and 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).

The male and female maximum ages for striped mullet in North Carolina are 14 and 13 years old and a 15-year-old striped mullet of unknown sex was observed in 2017 by the DMF (NCDMF 2022). The maximum size of striped mullet in North Carolina is recorded at 27.5 inches total length (NCDMF 2022).

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). Skipped spawning has been exhibited by striped mullet on the east coast of Florida (Myers et al. 2020) and on the eastern coast of Australia (Fowler et al. 2016). Striped mullet in North Carolina appear to mature at a younger age and larger size than other striped mullet populations (Bichy 2000). Length at 50 percent maturity occurs at 11.1 inches fork length for males (Bichy 2000) and 12.6 inches fork length for females (NCDMF 2021a).

### **Stock Status**

The 2022 North Carolina striped mullet stock assessment (NCDMF 2022) indicated the striped mullet stock in North Carolina is overfished and overfishing is occurring.

### **Stock Assessment**

The North Carolina striped mullet stock was modeled using stock synthesis version 3.30, an integrated statistical catch-at-age, forward-projecting, length based, age-structured model using

data from 1950 to 2019. Input data included commercial landings, recreational harvest estimates, fisheries-independent survey indices (Program 915), and biological data collected.

Both the observed data and the model predictions suggest a decreased presence of larger, older striped mullet in the population. The model has estimated declining trends in age-0 recruitment and female spawning stock biomass (SSB) over the last several decades. Estimates of fishing mortality ( $F$ ) exhibit an increasing trend. Model results also indicate consistent overestimation of biomass and the highest risk for overfishing.

A fishing mortality threshold of  $F_{25\%}$  and a fishing mortality target of  $F_{35\%}$  were maintained from the prior assessment since the fishery continues to target mature female fish during the spawning season and the ecological importance of striped mullet. Complementary reference points for stock size were adopted based on female SSB,  $SSB_{25\%}$  and  $SSB_{35\%}$ . The stock assessment model estimated a value of 0.37 for  $F_{25\%}$  and a value of 0.26 for  $F_{35\%}$ . These estimates represent numbers-weighted values for ages 1 through 5. Predicated  $F$  in 2019 is 0.42, which is larger than the  $F_{25\%}$  threshold and so suggests that overfishing is occurring (Figure 1). The model estimated a value of 1,364,895 (619 metric tons) for the  $SSB_{25\%}$  threshold and a value of 2,238,075 (1,015 metric tons) for the  $SSB_{35\%}$  target. Female SSB in 2019 was estimated at 579,915 pounds (263 metric tons), which is smaller than the  $SSB_{25\%}$  threshold and so suggests the stock is overfished (Figure 2).

An external peer review was held in April 2022. The panel concluded the assessment model and results are suitable for providing management advice for at least the next five years. The Panel considers the current model a substantial improvement from the previous assessment, representing the best scientific information available for the stock.

## **DESCRIPTION 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 in 2006 to exempt mullet from the requirements of the rule to continue allowing mullet to be used for cut bait.

Supplement A, adopted by the MFC in May 2023, establishes season closures for the striped mullet commercial and recreational fisheries that will occur from November 7 through December 31, 2023, north of the Highway 58 Bridge and from November 10 through December 31, 2023, south of the Highway 58 Bridge. Supplement A management will remain in place until adoption of Amendment 2 to the Striped Mullet FMP.

At its August 2022 business meeting, the MFC approved Notice of Text for Rulemaking to begin the process to amend the Mutilated Finfish Rule (15A NCAC 03M .0101). The amended rule would provide flexibility to manage variable conditions for the use of finfish, including mullet, as cut bait by simplifying the rule such that only species subject to a possession limit are subject to the requirements unless otherwise specified in a MFC rule or a proclamation issued under the authority of a MFC rule. The MFC gave final approval of the rule at its February 2023 business meeting and the rule is scheduled to be reviewed for final approval by the Rules Review

Commission in June 2023. The rule is automatically subject to legislative review and cannot be reviewed until the 2024 short session at the earliest.

### **Commercial Fishery**

Historically, beach 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 beach seine fishery. Gill nets (runaround, set, and drift) replaced seines as the dominant commercial gear type in 1979. Because the commercial fishery primarily targets striped mullet for roe, the fishery is seasonal with the highest demand and landings occurring in the fall when large schools form during their spawning migration to the ocean and females are ripe with eggs. Striped mullet are primarily targeted commercially using runaround gill nets in the estuarine and ocean waters of North Carolina. The striped mullet beach seine fishery primarily occurs in conjunction with 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). Typically, stop nets have only been 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). In 2020, 2021, and 2022, the stop net fishery was open from October 15 through December 31 (Proclamations M-17-2020, M-21-2021, M-23-2022). 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. In addition, the use of cast nets in the striped mullet commercial fishery has been increasing since around 2003.

Since 1991, commercial landings have ranged from a low of 965,198 pounds in 2016 to a high 3,063,853 pounds in 1993 (Table 1; Figure 3A). 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. Landings fluctuated annually between 1.5 and 2.0 million pounds from 2010 to 2014 before declining in 2015 and again in 2016, dropping below the minimum commercial landings trigger established by Amendment 1. Commercial landings in 2021 increased to 2,135,952 pounds and increased again in 2022 to 2,720,092 pounds.

### **Recreational Fishery**

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 common, and bait mullet are usually released by anglers before visual verification by creel clerks is possible. As such, mullets are not identified to the species level in the MRIP data (Catch Type B). Beginning in 2002, MRIP began deferring to mullet genus to classify unobserved type B1 (harvested/unavailable catch) and B2 (released/unavailable catch) catch. As a result, the magnitude of recreational harvest for mullet genus in units of numbers far exceeds that of both striped mullet and white mullet. This methodological improvement served to greatly increase the precision of estimates albeit without species level resolution. As such, estimates of recreational harvest for mullet prior to 2002 are considered unreliable.

The 2022 striped mullet stock assessment used the sum of recreational striped mullet harvest and a proportion of the recreational harvest of mullet genus for removals by the recreational fleet (NCDMF 2022). The proportion of mullet genus assumed to be striped mullet in the recreational harvest was 29%, a value derived from a study by the DMF of cast net recreational harvest for striped mullet (NCDMF 2006).

Recreational harvest peaked in 2002 and 2003 at greater than four million fish harvested (Table 1, Figure 3B). From 2004 to 2017 recreational harvest remained stable at around one million fish before declining in 2018, 2019 and 2020 to around 500,000 fish. This decline was likely related to decreased abundance of striped mullet and regulations that drastically shortened the recreational fishing season for southern flounder, a fishery where live mullet is a popular bait. Recreational harvest increased in 2021 to 1,484,850 fish before declining again in 2022 to 292,708 fish, the lowest value in the time series. This decrease may be the result of a short recreational flounder fishing season at a reduced bag limit in place for 2022.

Length-frequency distributions collected in North Carolina's MRIP survey are considered an inaccurate representation of the recreational fishery. This is due to biases in the methodology of the program and angler behavior. Lengths collected in North Carolina's MRIP survey are recorded at the dock and therefore only represent fish brought back to be kept by the angler. Anglers typically only keep the largest mullet, whether it be for personal consumption, or to be saved for use as cut bait. This bias toward keeping only the largest striped mullet has caused them to be disproportionately represented in the MRIP data. The vast majority of striped mullet harvested in the recreational fishery are used as live bait for other fisheries. For this type of fishing, "finger mullet", or age-0 fish, approximately four inches in total length are used.

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 a 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 (NCDMF 2021b).

## **MONITORING PROGRAM DATA**

### **Fishery-Dependent Monitoring**

The number of striped mullet measured per year in fishery-dependent programs between 1994 and 2022 ranged from 123 to 13,212 with the lowest number measured in 1996 (Table 2). In 2022, 7,774 striped mullet were measured from commercial catches. Variation in mean length was low, usually falling between 12.0- and 14.5-inches fork length (FL), with the lowest mean length occurring in 1997 (12.8 inches FL). In 2022, mean length increased to 15.1-inches FL, the highest value in the time series. Minimum and maximum lengths fell within a small range with maximum length ranging from 20.0 to 28.0 inches FL, though in 1994 and 1996, maximum length was below 20.0 inches (Table 3).

From 1994 through 2022 the size range of striped mullet captured in the commercial fishery as determined from commercial fish house samples ranged from 6.0 to 24.0 inches FL (Figure 4). Modal length generally falls between 11.0 and 15.0 inches. In all years there are few striped mullet

over 18.0 inches present in the catch. In 2022, there was a noticeable shift toward higher percentages of larger fish captured in the commercial fishery.

### **Fishery-Independent Monitoring**

The Fishery-Independent Gill-Net Survey (Program 915), began in 2001 and included sampling in the Pamlico Sound along the Hyde and Dare County shorelines. In July 2003, sampling was expanded to include the Neuse, Pamlico, and Pungo rivers. Additional areas in the Southern District including the New and Cape Fear rivers were added in April 2008. A stratified random sampling design is used based on area and water depth. Sampling occurs from mid-February to mid-December using an array of gill nets with stretched mesh sizes ranging from 3.0 inches to 6.5 inches.

To provide the most relevant indices for use in the 2022 stock assessment, Program 915 data were limited to those collected from shallow water during August through December. A combined index, with a starting year of 2008 and data collected from the Pamlico Sound, Pamlico River, Pungo River, Neuse River, and New River was calculated. Relative abundance increased through 2011 before declining in 2015 (Figure 5). From 2015 through 2021 abundance increased, peaking in 2021. Abundance declined substantially in 2022 to the lowest value in the time series.

From 2008 to 2022, the size of striped mullet captured during the August to December portion of Program 915 in the Pamlico Sound, Pamlico River, Pungo River, Neuse River, and New River ranged from 7.0 to 26.0 inches FL (juveniles excluded, see NCDMF 2022 for juvenile length cut offs; Figure 6). Modal length ranged from 11.0 to 13.0 inches FL and was 12.0 inches FL in most years. Few striped mullet less than 10.0 inches FL and greater than 15.0 inches FL are captured in this survey.

During 2020 no indices of abundance are available for striped mullet from Program 915. Sampling in this program was suspended in February 2020 due to COVID-19 restrictions and protected species interactions but resumed July 2021.

Striped mullet age samples are collected from numerous DMF fishery independent and dependent sources. Modal age was two in all years except 1996, 1999, 2001, 2003 and 2005 when modal age was one, and 2017 when modal age was 1-2 (Table 3). Minimum age was zero in every year except 2010 when the minimum age was one. Maximum age ranged from six in 1996, 2012, 2014, and 2015 to 15 in 2017. There is substantial overlap in length at age for striped mullet (Figure 7). Striped mullet grow quickly from age 0 to age 4 before growth slows after age 4.

### **RESEARCH NEEDS**

The following research needs were compiled from those listed in the 2022 Striped Mullet Stock Assessment (NCDMF 2022). Improved assessment and management of striped mullet is dependent upon research needs being met. Research needs are broken into high, medium, and low priority.

## High

- Increase sampling of recreational mullet catches to determine the proportion of striped versus white mullet and improve estimates of recreational landings.
- Improve characterization of the length and age structure of recreational fisheries removals by increasing the number of age samples and number of trips sampled for lengths and ages from fisheries-dependent sources.
- Develop a reliable fisheries-independent abundance index for larger juveniles to characterize trends in recruitment.
- Consider expanding Program 915 to include the northern part of the state (Albemarle sound and major tributaries).
- Evaluate the current sampling methodology of Program 146 and effectiveness for sampling striped mullet; since this survey was not considered useful for the assessment of striped mullet, consider dropping this survey and focusing effort elsewhere if it is not contributing to management of other species.
- Consider running a simpler, single-sex version of the stock assessment model.

## Medium

- Consider a tagging program to provide estimates of stock size,  $F$ , and  $M$ .
- Consider genetic and/or tagging studies to examine extent of the unit stock on a regional basis for the south Atlantic as well as the Gulf of Mexico.
- Expand ichthyoplankton survey to other inlets throughout the state.
- Conduct an age validation study of known age fish to provide estimates of ageing error.
- Consider alternative weighting of data sources in future stock assessments.
- Develop estimates of fecundity for North Carolina striped mullet.

## Low

- Perform an acoustic tagging study to evaluate spatial and temporal variation in habitat use to more effectively design and conduct fisheries-independent surveys.
- Investigate the predation impact on striped mullet; striped mullet is widely believed to be an important forage species but there is little evidence to support this claim in the North Carolina stock.
- Investigate environmental factors that influence the spatial and temporal distribution of larval striped mullet.

## 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; 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 conflicts will continue to be dealt with on a case-by-case basis and management actions will be implemented to address specific fishery-related problems. 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; 2) user group conflicts; 3) updating the management framework for the N.C. striped mullet stock.

The 2022 North Carolina striped mullet stock assessment indicated the North Carolina striped mullet stock is overfished and overfishing is occurring in the terminal year of 2019 (NCDMF 2022). In response to stock assessment results, the MFC adopted Supplement A to Amendment 1 to the Striped Mullet FMP in May 2023 to end overfishing (NCDMF 2023). Supplement A establishes season closures for the striped mullet commercial and recreational fisheries that will occur from November 7 through December 31, 2023, north of the Highway 58 Bridge and from November 10 through December 31, 2023, south of the Highway 58 Bridge. Supplement A management will remain in place until adoption of Amendment 2 to the Striped Mullet FMP and the commercial landings triggers established by Amendment 1 will no longer be used to monitor the stock.

## FISHERY MANAGEMENT PLAN SCHEDULE RECOMMENDATIONS

Striped mullet commercial landings in 2022 were 2,720,092 pounds, which is above the minimum and below the maximum commercial landing triggers established in Amendment 1. Supplement A, adopted in May 2023, implements new management measures, and replaces the triggers adopted in Amendment 1. Review of the plan is underway. As statutorily required, management measures will be developed through Amendment 2 to end overfishing and rebuild spawning stock biomass. Supplement A will remain in place until adoption of Amendment 2.

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## TABLES

Table 1. Recreational harvest (number of fish landed and weight in pounds) and releases (number of fish), 2022-2022, and commercial harvest (weight in pounds) of spotted seatrout from North Carolina, 1991–2022. Number released and weight landed cannot be determined because of uncertainty in reported species identification.

Year	Recreational		Commercial		Total Weight (lb)
	Number Landed	Number Released	Weight Landed (lb)	Weight Landed (lb)	
1991				1,467,448	1,467,448
1992				1,820,494	1,820,494
1993				3,063,853	3,063,853
1994				1,726,242	1,726,242
1995				2,298,446	2,298,446
1996				1,756,863	1,756,863
1997				2,442,657	2,442,657
1998				2,218,108	2,218,108
1999				1,460,850	1,460,850
2000				2,829,086	2,829,086
2001				2,317,655	2,317,655
2002	5,967,684			2,596,304	2,596,304
2003	4,090,368			1,629,314	1,629,314
2004	1,394,707			1,598,617	1,598,617
2005	1,312,234			1,620,394	1,620,394
2006	1,059,444			1,728,607	1,728,607
2007	1,766,373			1,668,804	1,668,804
2008	1,191,633			1,675,859	1,675,859
2009	1,167,086			1,685,615	1,685,615
2010	1,319,070			2,082,832	2,082,832
2011	1,139,786			1,627,894	1,627,894
2012	1,369,975			1,859,587	1,859,587
2013	1,453,038			1,549,157	1,549,157
2014	1,352,690			1,828,351	1,828,351
2015	1,420,378			1,247,044	1,247,044
2016	1,491,533			965,337	965,337
2017	1,537,183			1,366,351	1,366,351
2018	489,321			1,314,385	1,314,385
2019	562,089			1,362,217	1,362,217
2020	531,875			1,299,500	1,299,500
2021	1,484,850			2,140,620	2,140,620
2022	292,708			2,720,092	2,720,092
<b>Total</b>	<b>1,542,573</b>			<b>1,886,441</b>	<b>1,886,441</b>

Table 2. Mean, minimum, and maximum lengths (fork length, inches) of striped mullet measured from the commercial fisheries, 1994–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1994	13.0	6.1	19.1	302
1995	14.5	9.3	21.6	255
1996	13.5	10.0	18.5	123
1997	12.8	9.2	22.8	2,048
1998	13.1	8.6	25.4	1,600
1999	13.4	8.7	23.9	1,759
2000	13.4	8.3	23.5	7,522
2001	14.1	8.1	20.9	5,726
2002	13.2	5.9	21.3	10,989
2003	13.2	6.3	24.5	7,170
2004	13.1	7.6	24.4	12,778
2005	13.5	7.8	22.6	10,270
2006	13.7	7.8	22.2	12,108
2007	13.5	7.1	27.5	12,141
2008	14.1	8.4	24.1	13,212
2009	14.1	8.0	22.4	8,241
2010	13.9	8.1	22.7	10,991
2011	13.9	6.5	22.1	7,750
2012	14.0	7.9	22.2	12,833
2013	14.2	8.3	24.3	8,535
2014	13.8	7.7	24.0	6,517
2015	14.2	8.1	24.9	5,923
2016	14.3	8.9	24.1	5,661
2017	14.2	7.8	28.6	4,480
2018	14.5	8.3	22.5	4,111
2019	14.6	8.7	22.5	4,798
2020	13.8	8.3	21.4	3,748
2021	14.4	8.8	24.7	6,533
2022	15.1	9.1	24.7	7,774

Table 3. Modal age, minimum age, maximum age, and number aged for striped mullet collected through DMF sampling programs, 1996–2022.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
1996	1	0	6	163
1997	2	0	7	344
1998	2	0	7	717
1999	1	0	8	753
2000	2	0	10	1,122
2001	1	0	11	705
2002	2	0	7	625
2003	1	0	13	765
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	769
2016	2	0	8	956
2017	1-2	0	15	695
2018	2	0	10	770
2019	2	0	13	827
2020	2	0	7	269
2021	2	0	11	940
2022	2	0	9	843

## FIGURES

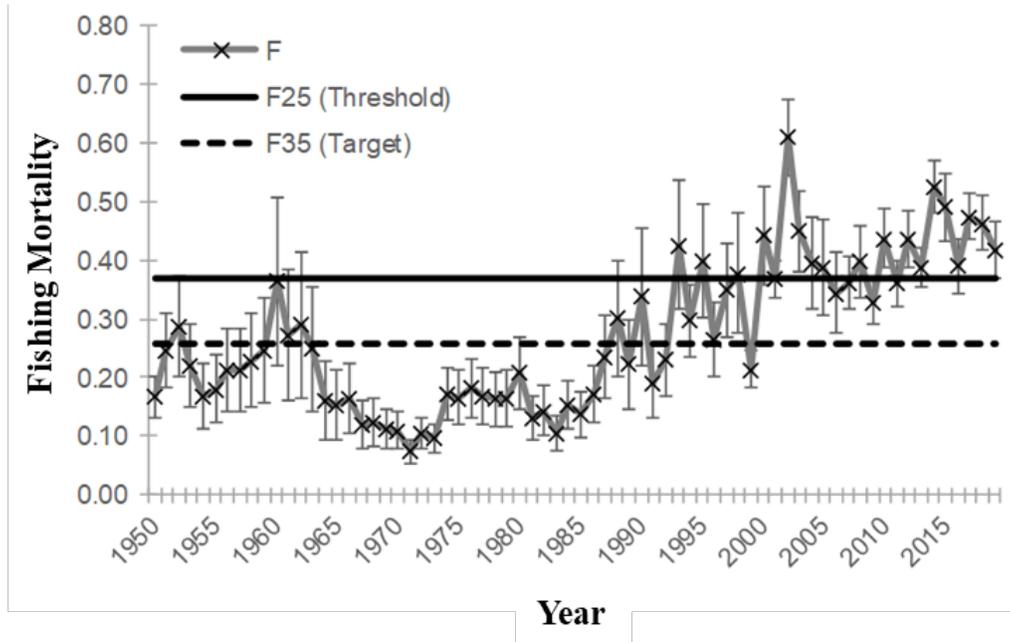


Figure 1. Annual predicted fishing mortality rates (numbers-weighted, ages 1–5) compared to estimated  $F_{\text{Threshold}}$  ( $F_{25\%}$ ) and  $F_{\text{Target}}$  ( $F_{35\%}$ ), 1950–2019. 2019 is the terminal year for the most recent striped mullet stock assessment (NCDMF 2022).

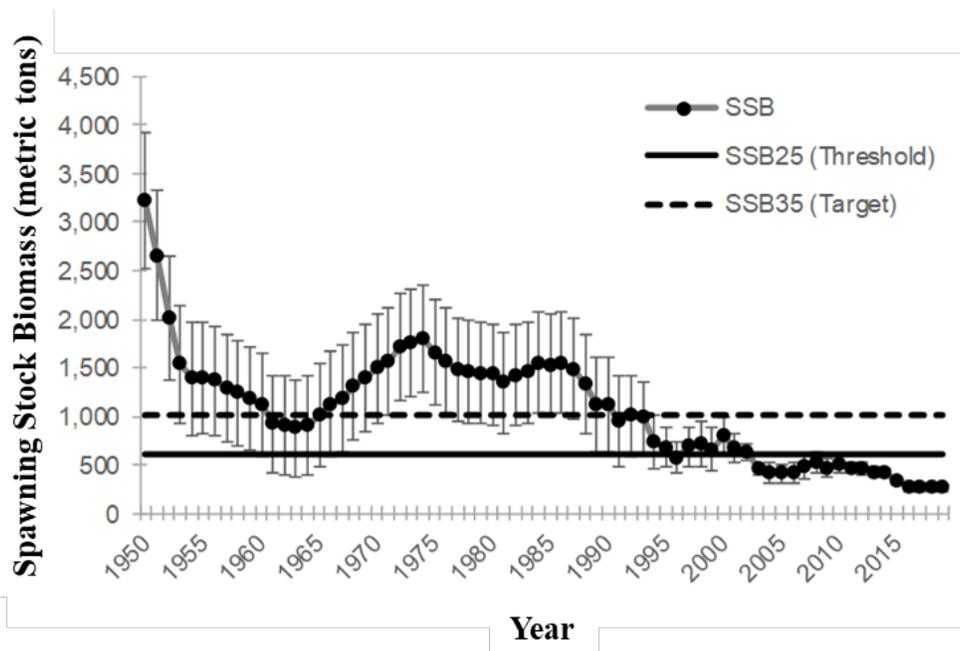


Figure 2. Annual predicted spawning stock biomass in metric tons, compared to estimated  $SSB_{\text{Threshold}}$  ( $SSB_{25\%}$ ) and  $SSB_{\text{Target}}$  ( $SSB_{35\%}$ ), 1950–2019. 2019 is the terminal year for the most recent striped mullet stock assessment (NCDMF 2022).

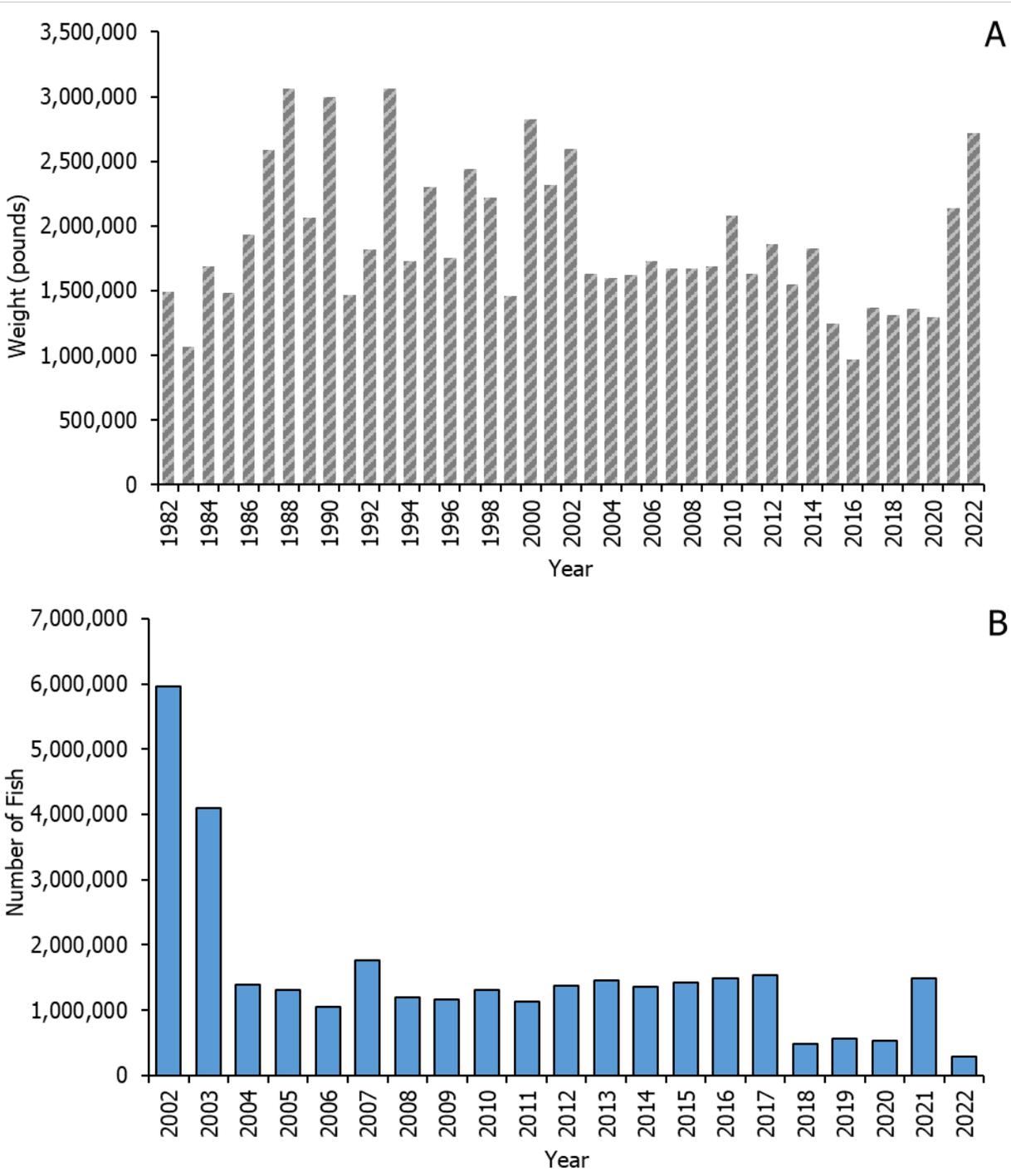


Figure 3. Striped mullet commercial landings (pounds) reported through the North Carolina Trip Ticket Program (A), 1991–2022. Recreational landings (Type A + B1; numbers of fish) includes estimates of striped mullet plus 29% of the mullet genus harvest from the Marine Recreational Information Program survey for North Carolina, 2002–2022 (B).

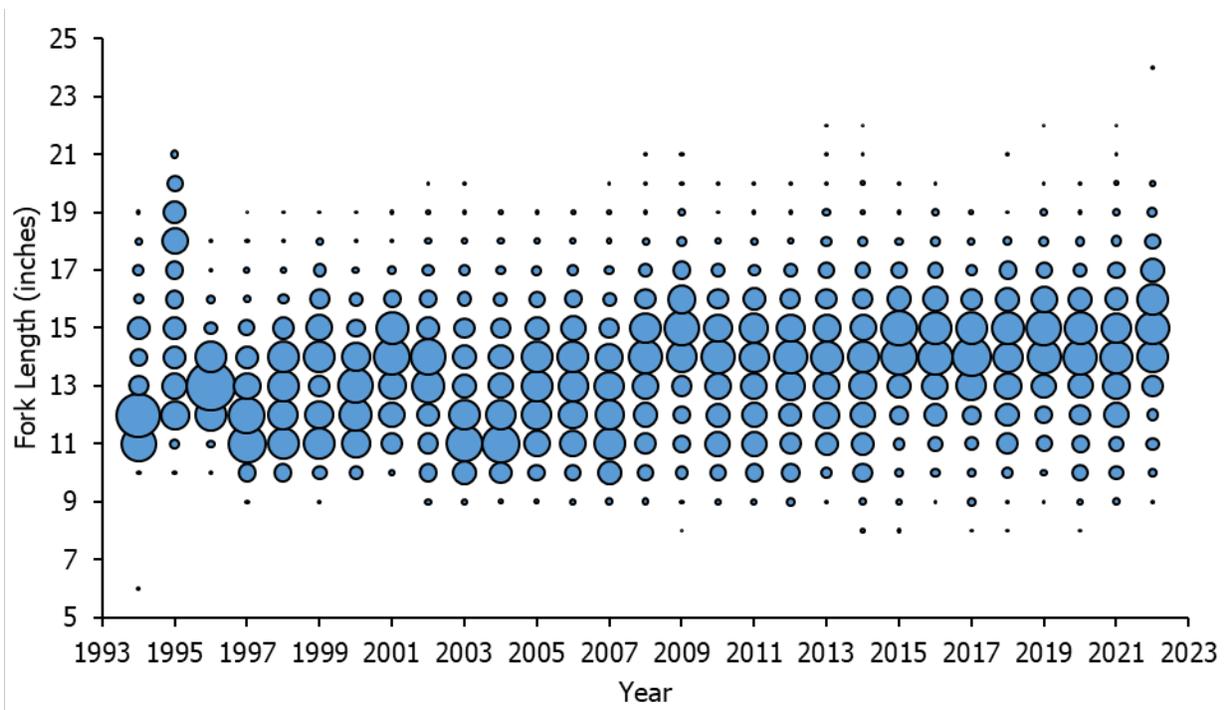


Figure 4. Commercial length frequency (fork length, inches) of striped mullet harvested, 1994–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

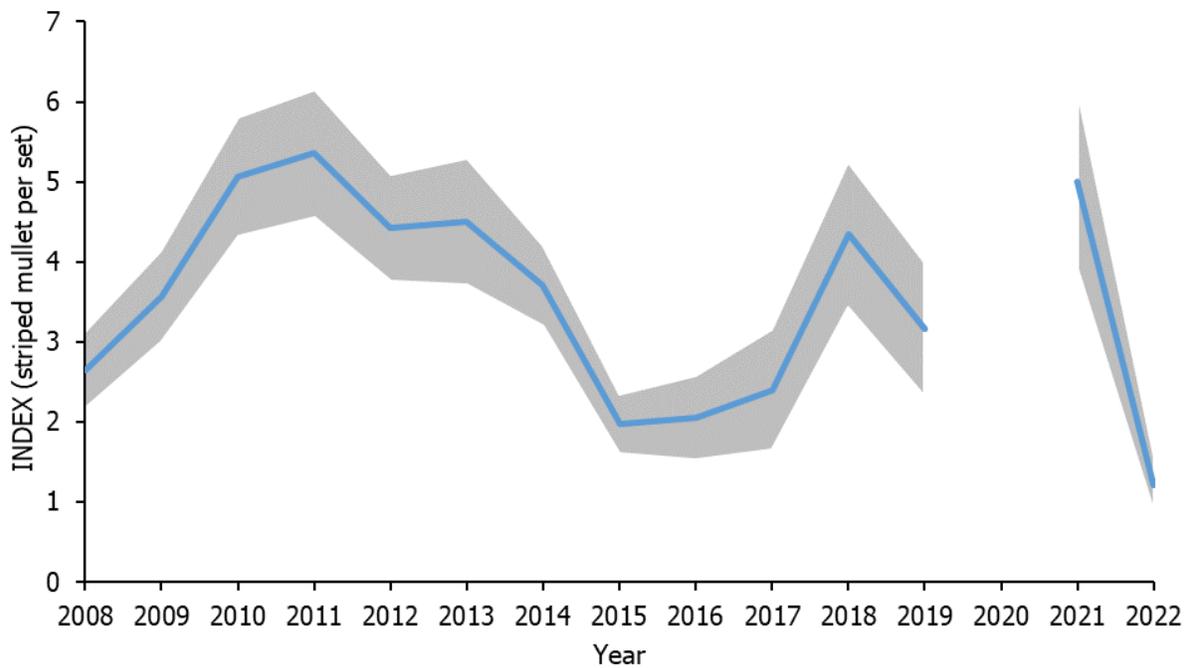


Figure 5. Relative Abundance index (fish per set) of striped mullet collected from Program 915 in Pamlico Sound, Pamlico, Pungo, Neuse and New rivers from August-December 2008–2022. Gray shading represent  $\pm 1$  standard error. Sampling was not conducted in 2020.

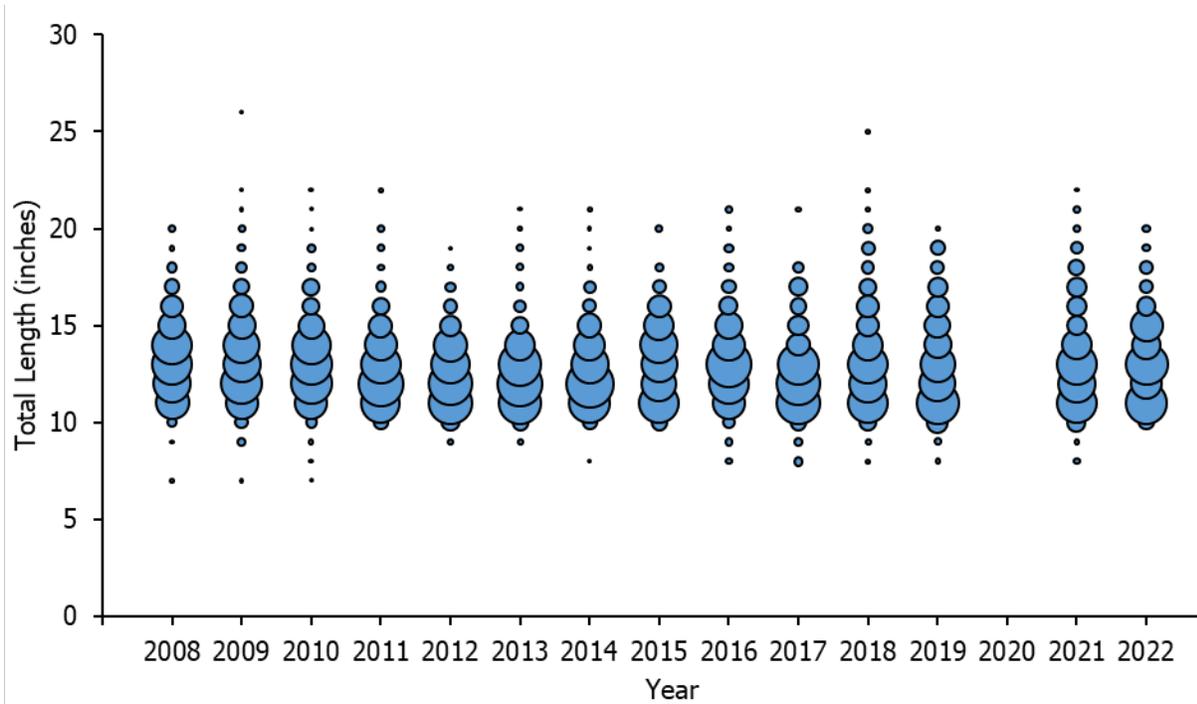


Figure 6. Length frequency (fork length, inches) of striped mullet collected from Program 915 in Pamlico Sound, Pamlico, Pungo, Neuse and New rivers from August-December (juveniles excluded), 2008–2022. Sampling was not conducted in 2020. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

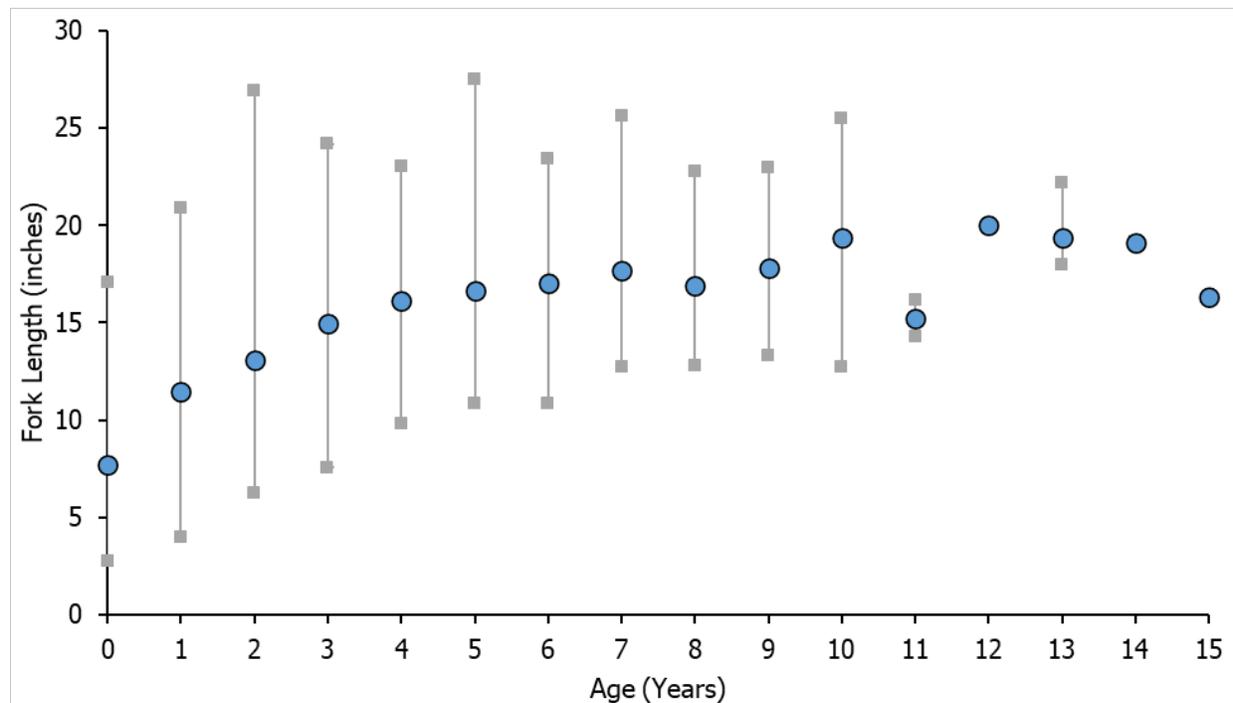


Figure 7. Striped mullet length at age based on all age samples collected, 1996–2022. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age.

**FISHERY MANAGEMENT PLAN UPDATE  
AMERICAN EEL  
AUGUST 2023**

**STATUS OF THE FISHERY MANAGEMENT PLAN**

**Fishery Management Plan History**

FMP Documentation:	ASMFC FMP	November 1999
	Addendum I	February 2006
	Addendum II	October 2008
	Addendum III	August 2013
	Addendum IV	October 2014
	Addendum V	August 2018

Comprehensive Review: 2022

American eel is managed under the Atlantic States Marine Fisheries Commission (ASMFC) Interstate Fishery Management Plan (FMP) for American Eel. The FMP was approved in 1999 (ASMFC 2000) and implements management measures to protect the American eel resource to ensure ecological stability while providing for sustainable fisheries. The FMP required all states and jurisdictions to implement an annual young-of-year (YOY) abundance survey to monitor annual recruitment of each year’s cohort. In addition, the FMP required a minimum recreational size, a possession limit and a state license for recreational fishermen to sell eels. The FMP requires that states and jurisdictions maintain existing or more conservative American eel commercial fishery regulations for all life stages, including minimum size limits.

Addendum I, approved in November 2006, required states to establish a mandatory trip-level catch and effort monitoring program, including documentation of the amount of gear fished and soak time (ASMFC 2006). Addendum II, approved in October 2008, placed increased emphasis on improving the upstream and downstream passage of American eel (ASMFC 2008). No new management measures were implemented by Addendum II.

Addendum III was approved for management use in August 2013, with the goal of reducing mortality on all life stages of American eel. The Addendum was initiated in response to results of the 2012 Benchmark Stock Assessment, which found the American eel stock along the US East Coast was depleted. This addendum predominately focused on commercial yellow eel and recreational fishery management measures (ASMFC 2013). Addendum III implemented new size and possession limits as well as new pot mesh size requirements and seasonal gear closures.

Following approval of Addendum III, the ASMFC American Eel Management Board (Board) initiated the development of Addendum IV, which was approved in October 2014 (ASMFC 2014). 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. The addendum addresses concerns and issues in the commercial glass and silver eel fisheries, and domestic eel aquaculture. Addendum IV established a coastwide catch cap and a mechanism for implementation of a state-by-state commercial yellow eel quota if the catch

cap is exceeded. Under Addendum IV, the coast wide catch cap was set at 907,671 pounds (1998-2010 harvest level, ASMFC 2014). Addendum IV established two management triggers:

- The coastwide catch cap is exceeded by more than 10 percent in a given year (998,438 pounds)
- The coastwide catch cap is exceeded for two consecutive years, regardless of the percent overage.

If either trigger is exceeded, a state-by-state commercial yellow eel quota would be implemented with North Carolina receiving an 11.8 percent allocation (107,054 pounds).

The aquaculture provision in Addendum IV allows states to submit an Aquaculture Plan to allow for limited harvest of glass eels for use in domestic aquaculture facilities. Specifically, states are allowed to request a harvest of up to 200 pounds of glass eels provided the state can objectively show the harvest will occur from a watershed that minimally contributes to the spawning stock of American eel.

In 2017, the 2012 stock assessment was updated with data from 2010-2016, however, neither reference points nor stock status could be determined. The trend analysis and stable low commercial landings support the conclusion that the American eel population in the assessment range remains depleted.

Addendum V was initiated in response to results of the 2017 stock assessment update and concerns that current management triggers do not account for annual fluctuations in landings. If a management trigger is exceeded immediate implementation of state-by-state quotas would pose significant administrative challenges (ASMFC 2019). Adopted in January 2019, Addendum V increases the yellow eel coastwide cap beginning in 2019 to 916,473 pounds due to a correction in the historical harvest; adjusts the method (management trigger) to reduce total landings to the coastwide cap when the cap has been exceeded; and removes the implementation of state-by-state allocations if the management trigger is met. The addendum maintains Maine's glass eel quota of 9,688 pounds.

Under Addendum V, management action is initiated if the yellow eel coastwide cap is exceeded by 10% or more in two consecutive years (10% of the coastwide cap = 91,647 pounds; coastwide cap + 10% = 1,008,120 pounds). If management is triggered, only those states accounting for more than 1% of the total yellow eel landings are responsible for adjusting their management measures.

The aquaculture provision in Addendum V allows states to harvest a maximum of 200 pounds of glass eels annually for use in domestic aquaculture facilities under an approved Aquaculture Plan. The provision from Addendum IV requiring states to demonstrate harvest would occur in watersheds that minimally contribute to the spawning stock was dropped in Addendum V and replaced with considerations that preferred harvest sites; have established or proposed glass eel monitoring programs, are favorable to law enforcement, and are in watersheds that are prone to relatively high mortality rates.

In December 2015, the DMF submitted an American Eel Aquaculture Plan to the ASMFC requesting approval to harvest up to 200 pounds of glass eels from coastal fishing waters which was approved in February 2016 (1 year). A second plan was submitted by DMF in 2016 and

approved by ASMFC that allowed for harvest in 2017 (1 year). The third plan submitted by the DMF in 2017 and approved by the ASMFC covered a 2-year period that allowed for harvest in 2018 and 2019. In May 2019, the DMF submitted another 2-year plan but was only approved by ASMFC for one harvest season (November 2019 through March 2020). The DMF has not submitted an American Eel Aquaculture Plan to the ASMFC since 2020.

For an approved aquaculture operation to legally harvest eels less than 9 inches, the facility needs to have a Declaratory Ruling from the NC Marine Fisheries Commission (MFC) exempting them from the 9-inch minimum size limit to possess, sell or take American eels. The approved aquaculture operation received Declaratory Rulings (2) that allowed for legally harvested American eels less than 9 inches in length to be cultivated or reared in a facility from: 1) outside of North Carolina and imported into the State, and 2) from Coastal Fishing Waters in the State of North Carolina.

In support of American eel aquaculture in North Carolina, several legal actions were taken by North Carolina legislatures. Senate Bill 513 (North Carolina Farm Act of 2015; Section 22.(a)) directed the DMF and the North Carolina Wildlife Resources Commission (WRC) to jointly develop a pilot American Eel Aquaculture Plan for the harvest and aquaculture of American eels. Senate Bill 410 (Marine Aquaculture Development Act; Section 3.1.(c)) allows American eels to be imported from Virginia or South Carolina for aquaculture purposes, and House Bill 374 (Section 17) allows American eels to be imported from Maryland for aquaculture purposes. The use of American eels imported from Maryland, Virginia, or South Carolina in an aquaculture operation are exempt from the permitting requirements of the Importation of Marine and Estuarine Organisms Rule.

In 2020, the ASMFC began work on a benchmark stock assessment which was peer-reviewed in late 2022. The assessment and peer review report were presented to the Board in February 2023 and is still under review.

To ensure compliance with interstate requirements, North Carolina also manages this species under the North Carolina Fishery Management Plan for Interjurisdictional Fisheries (IJ FMP). There are two main goals of the IJ FMP; first 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. Second, to 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 goals 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**

American eel is managed as a coastwide stock, from Maine through Florida, 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 goals of the ASMFC American Eel FMP are 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 with the aim to provide 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:

- 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.
- Increase understanding of factors affecting eel population dynamics and life history through research and monitoring.
- Protect and enhance American eel abundance in all watersheds where eel now occur.
- 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.
- Investigate the abundance level of eels at the various life stages necessary to provide adequate forage for natural predators to support ecosystem health and food chain structure.

## DESCRIPTION OF THE STOCK

### Biological Profile

The American eel (*Anguilla rostrata*) is a catadromous species meaning they are born in saltwater, then migrate into freshwater as juveniles where they grow into adults before migrating back to the ocean to spawn. All American eel comprise one panmictic population meaning they are a single breeding population that exhibits random mating. 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, freshwater streams, rivers and lakes. While American eels spend most their life in brackish and freshwater systems from South America to Canada, spawning occurs in the Sargasso Sea (a large portion of the western Atlantic Ocean south of Bermuda and east of the Bahamas; 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 two years of age, they change to the yellow eel stage and resemble the adult form (Ogden 1970). Individuals can remain in the yellow phase for five to 20 years. In the yellow phase, American eels are nocturnal, feeding at night on a variety of invertebrates and smaller fish, but will also eat dead animal matter. American eels live in a variety of habitats but prefer areas where they can hide with soft bottom and vegetation. Females can grow to five feet in length, and males usually reach about three feet (ASMFC 2000). The mature silver eel life stage occurs at the time of downstream migration when individuals leave the estuaries to spawn and die in the Sargasso Sea (Facey and Van den Avyle 1987). This spawning migration

occurs annually in the late summer and fall. 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.

### **Stock Status**

The 2017 stock assessment update found the American eel population remains depleted in U.S. waters (ASMFC 2017). No overfishing status determination can be made based on the analyses performed. The 2022 benchmark stock assessment was presented to the Board in February 2023 and is still under review.

### **Stock Assessment**

The 2012 stock assessment was updated in 2017 with data through 2016. American eel indices of abundance were analyzed using three methods of trend analysis: Mann-Kendall, Manly, and ARIMA. The Mann-Kendall test detected significant downward trends in six of the 22 YOY indices, five of the 15 yellow eel indices, three of the nine regional YOY and yellow eel indices, and the 30-year and 40-year yellow-phase abundance indices. Only two indices had positive trends, all of the remaining survey indices tested had no trend. The Manly meta-analysis showed a decline in at least one of the indices for both yellow and YOY life stages. Results of ARIMA analysis indicated the probabilities of being less than the 25th percentile reference points in the terminal year for each survey were similar to those in the 2012 stock assessment and three of the 14 surveys had a greater than 50% probability of the terminal year 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, so the assessment maintained the depleted stock status. While it is highly likely the American eel stock is depleted, no overfishing determination can be made based solely on the trend analyses performed.

A benchmark stock assessment for American eel began in 2020 and is ongoing. All potential data sources were reviewed, and the terminal year of the assessment was 2019. Many of the analyses explored in this benchmark assessment indicate decreasing or low population trends (e.g., Conn index, MARSS index, regime shift analysis, delay-difference model, Mann-Kendall Test). All evidence indicates the population is at low levels and the stock status of American eels, as determined by using an index-based method ( $I_{TARGET}$ ), is overfished and likely experiencing overfishing in the last few decades based on the  $I_{target}$  method and additional methods explored in the assessment. As such, the Stock Assessment Subcommittee (SAS) recommend the coastwide yellow eel catch levels should be reduced to around 200,000-300,000 pounds rather than the current coastwide cap of 916,473 pounds. In February 2023, the assessment and peer review report were presented to the Board. The Board tasked the SAS with providing justification for not incorporating the peer review advice. In addition to providing justification, the Board also asked the SAS to provide additional analyses to show the influence of individual surveys on the resulting coastwide yellow eel index, consider other reference periods and configurations for  $I_{TARGET}$ . The peer review panel concluded that additional work is needed to establish threshold reference points in the management tool proposed ( $I_{TARGET}$ ) and that work should be done using a simulation approach with management strategy evaluation (MSE) methods. The peer review panel also stated

that it is more appropriate to consider American eel depleted rather than overfished and likely experiencing overfishing as the SAS suggested.

A Technical Committee (TC) meeting is scheduled on June 27, 2023, where the TC will review the supplemental report, and upon approval from the TC, the report will be presented to the Board in August 2023.

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

Management measures for yellow eels went into effect on January 1, 2014, under North Carolina Marine Fisheries Commission (MFC) 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 25 eels per person per day bag limit for the recreational fishery, and crew members involved in for-hire employment are allowed to maintain the current 50 eels per 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. In June 2021, the NCWRC modified Rule 15A NCAC 10C .0401 to allow eels greater than nine inches in length and with a minimum body depth greater than ½ inch to be cut for use as bait in Inland Fishing Waters.

### **Commercial Fishery**

Average commercial landings from 2012 through 2021 was 31,639 pounds and in 2022, the commercial landings was 4,202 pounds (Table 1). Commercial landings have fluctuated since 1974 with a peak in 1980 and significant declines beginning in the late 1980s (Figure 1). In 1979 and 1980, over 900,000 pounds were landed, however, since the late 1980s landings have averaged less than 100,000 pounds and in 2022 landings were the second lowest recorded in the time-series.

### **Recreational Fishery**

There are no recreational landings data available for American eels, which are not typically a recreationally targeted species. Since American eels are caught incidentally in the estuarine environment by recreational fishermen using hook and line, the Marine Recreational Information Program (MRIP) does not provide reliable harvest data. Also, the MRIP survey design 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**

To comply with Addendum I to the American Eel Fisheries Management Plan, the DMF initiated (January 2007) mandatory reporting of harvest and effort information for American eels harvested by commercial eel pots, including eel pot soak time and number of eel pots fished. Commercial fishermen are required to participate in a monthly logbook program designed to monitor the harvest of American eels by eel pots. Soak time and number of eel pots fished are not reported on trip tickets.

### **Fishery-Independent Monitoring**

The National Oceanic and Atmospheric Administration (NOAA) conducts the Beaufort Bridgenet Ichthyoplankton Sampling Program (BBISP), an ichthyoplankton survey at Beaufort Inlet, which is used to develop a North Carolina young-of-year relative abundance index for American eel. The BBISP samples once-weekly at night during floodtide from a fixed platform on Pivers Island Bridge, Beaufort, NC during October-May. Larvae are collected using a 2 m<sup>2</sup> plankton net fitted with a flow meter. Four replicate sets (tows) are made, with each filtering about 100 m<sup>3</sup>. Between 1987 and 2020, relative abundance of American eel (glass eel) has fluctuated from a low in 1991 to a high in 2005, with a 34-year average of 0.0125 eels per cubic meter (Figure 2). In 2020, American eel relative abundance (0.0127 eels per cubic meter) remained near the time-series average. Lengths of American eels captured in the BBISP from 2001 to 2020 (n=619) ranged from 41 to 153 millimeters (1.6 to 6.0 inches; Figure 3) and averaged 52 millimeters total length (2.0 inches; note: the 60+ millimeter category includes pooled fish lengths of 62, 91, and 153 millimeters). The BBISP continued their long-term sampling program in 2020 (January to March); however, no samples were collected in April and May, or in November and December due to COVID-19 restrictions. Currently, there is a two-year backlog of unsorted samples (2021 to 2022).

The North Carolina Division of Marine Fisheries (DMF) has no 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. From 1973 to 2022, relative abundance has fluctuated from lows in 1973, 2000, and 2020 to a peak in 2011, and a 50-year average of 0.14 American eels per tow (Figure 4). Due to COVID restrictions all 2020 sampling was conducted in June. In 2022 there was an upward trend in relative abundance with a value of 0.10 eels per tow (Figure 4).

## **RESEARCH NEEDS**

The items listed below are updated from the 2017 research recommendations broken down into future research and data collection and assessment methodology. Research recommendations from ASMFC 2012, 2017 remain important, but the following list is specific to what the SAS thinks could improve the next stock assessment. The SAS recommends an update be considered in five years and a new benchmark be considered in ten years.

### Future Research and Data Collection

- Improve upstream and downstream passage for all life stages of American eels.
- Continue to improve the accuracy of commercial catch and effort data through ACCSP and state partners.
- Characterize the length, weight, age, and sex structure of commercially harvested American eels along the Atlantic Coast over time.
- Research coastwide prevalence of the swim bladder parasite *Anguillacolla crassus* and its effects on the American eel's growth and maturation, migration to the Sargasso Sea, and spawning potential.
- Improve understanding of the spawning contribution of unexploited portions of the stock (i.e., freshwater areas of coastal US).
- Characterize the length, weight, and sex structure in unharvestable habitats.
- Conduct a tagging study throughout the species range.
- Quantify recreational removals in marine and freshwater habitats and characterize length, weight, and sex structure.
- Evaluate the passage/passage efficiency of American eels through existing fishways at dams/barriers and evaluate barrier physical attributes (height, material) that can be passed by eel without fishways.
- Evaluate the use vs. availability of habitat in the inland portion of the species range, and how habitat availability has changed through time, including opening of habitat from recent dam and barrier removals. This could and should include assisted migration by trucking around dams.
- To the extent that the data allows, account for the proportion of the population (yellow, silver phase) represented by the inland portion of the species range.
- Evaluate the relative impact that commercial harvest has on population status versus the accessibility to inland habitats.

### Assessment Methods

- Develop methods to assess spawner escapement and biological information pertinent to silver eels in major river basins.
- Perform a range-wide American eel assessment with various countries and agencies (e.g., Canada DFO, ASMFC, USFWS, Caribbean, US Gulf and inland states).
- Explore methods to characterize data by sex to support a female-only delay-difference model.

## **MANAGEMENT STRATEGY**

Under Addendum V, the commercial yellow eel fishery is regulated through an annual coastwide catch cap set at 916,473 pounds. Management action is initiated if the yellow eel coastwide cap is exceeded by 10% in two consecutive years. The management trigger has never been tripped. If the management trigger is exceeded, only those states accounting for more than 1% (9,164 pounds) of the total yellow eel landings will be responsible for adjusting their measures. In 2022, the commercial landings in North Carolina were 4,202 pounds, therefore if the coastwide management trigger was exceeded, North Carolina would not be required to work with other states to adjust

harvest. A workgroup has been formed to define the process to equitably reduce landings among the affected states when the management trigger has been met.

The ASMFC adopted Addendum IV in 2014 that contained a provision allowing states to submit an Aquaculture Plan allowing for the limited harvest of glass eels for use in domestic aquaculture facilities. Specifically, states are allowed to request harvest of up to 200 pounds of glass eels under an Aquaculture Plan. The DMF submitted an American eel Aquaculture Plan to ASMFC requesting approval to harvest up to 200 pounds of glass eels from coastal fishing waters in 2015, 2016, 2017 and 2019. The DMF did not submit an American Eel Aquaculture Plan to the ASMFC in 2022 and does not have an active glass eel fishery.

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## TABLES

Table 1: Commercial landings of American eel (in pounds) in North Carolina, 1974-2022.

Year	Pounds
1974	451,956
1975	237,684
1976	510,083
1977	258,296
1978	695,605
1979	954,534
1980	960,196
1981	436,007
1982	475,524
1983	404,157
1984	706,298
1985	224,263
1986	338,377
1987	127,964
1988	57,369
1989	152,656
1990	56,494
1991	12,082
1992	17,739
1993	32,711
1994	95,991
1995	173,698
1996	141,592
1997	128,668
1998	91,084
1999	99,939
2000	127,099
2001	107,070
2002	59,820
2003	172,065
2004	128,875
2005	49,278
2006	33,581
2007	37,937
2008	23,833
2009	65,481
2010	122,104
2011	61,960
2012	64,110
2013	33,980
2014	60,755
2015	57,791
2016	39,991
2017	24,752
2018	18,058
2019	8,154
2020	3,291
2021	5,505
2022	4,202
Mean	186,749

## FIGURES

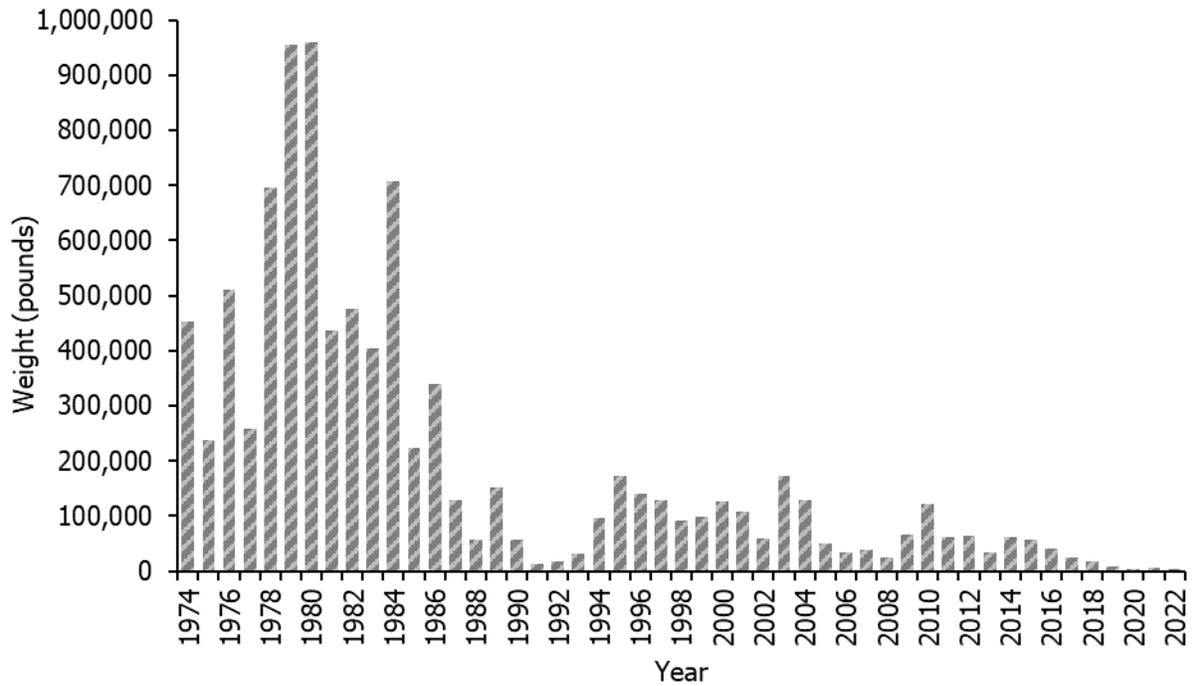


Figure 1: American eel commercial landings (pounds) reported through the North Carolina Trip Ticket Program, 1974–2022.

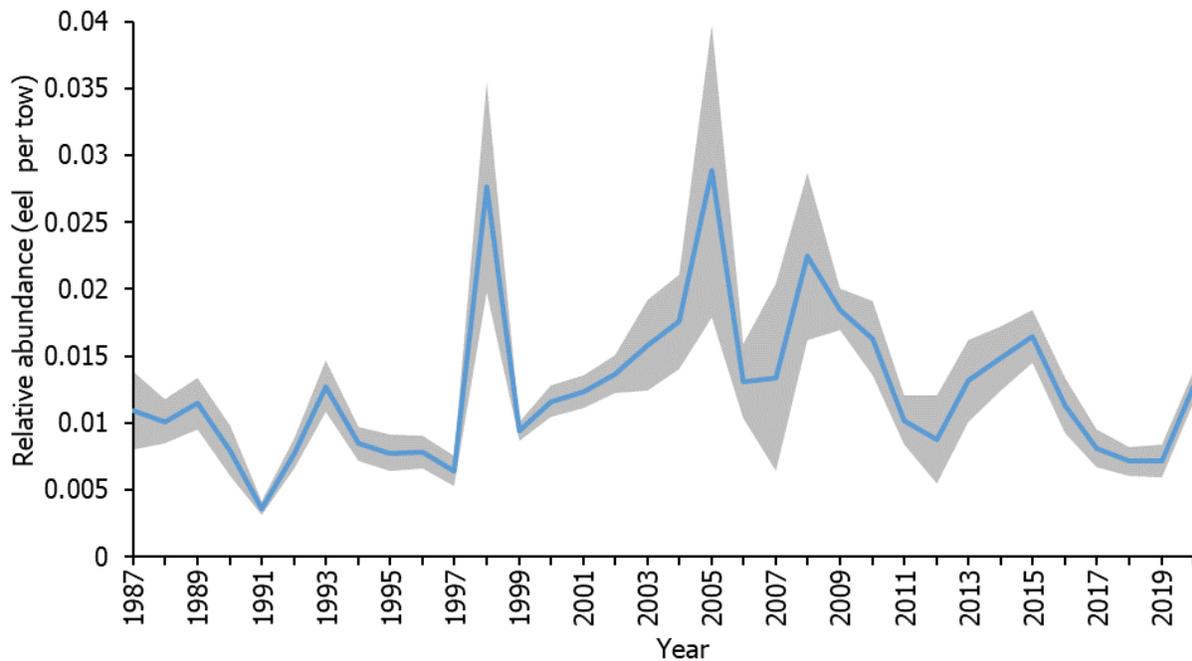


Figure 2: Relative abundance index (larval fish per tow) of American eel collected from the BBISP, 1987–2020. Error bars represent  $\pm 1$  standard error. There is a two-year backlog of unsorted samples (2021–2022).

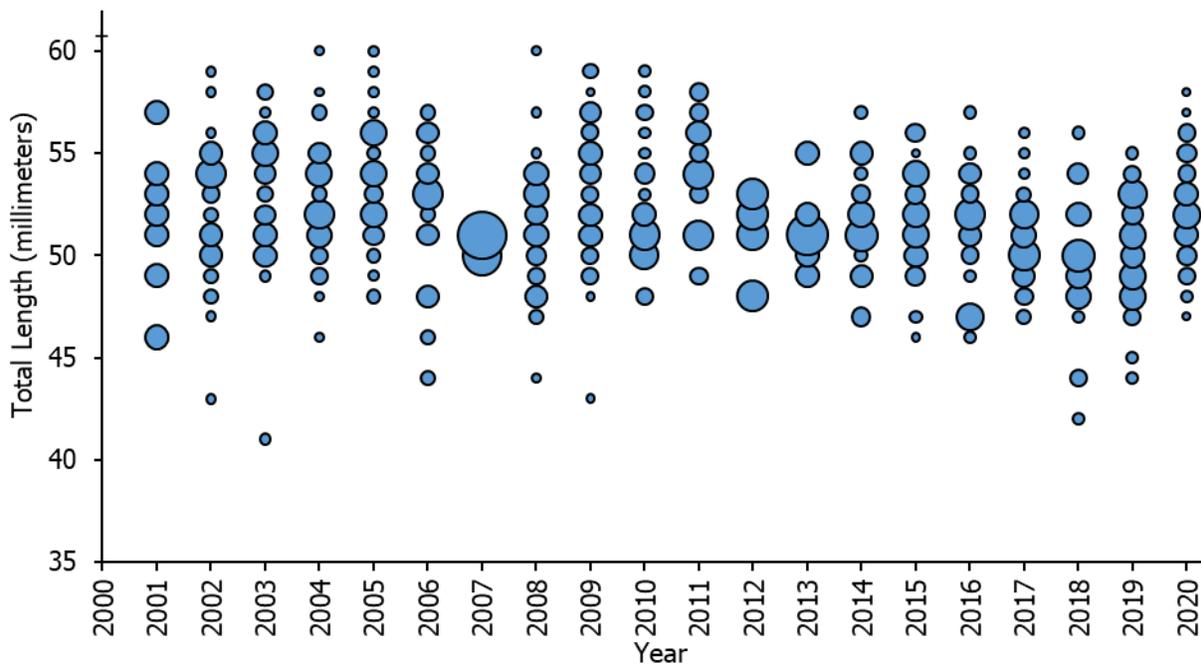


Figure 3: Length frequency (total length, millimeters) of American eel collected in the BBISP, 2001–2020. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length. There is a two-year backlog of unsorted samples (2021–2022). (Note: the 60+ category includes four fish; 61, 62, 91, and 153 millimeters).

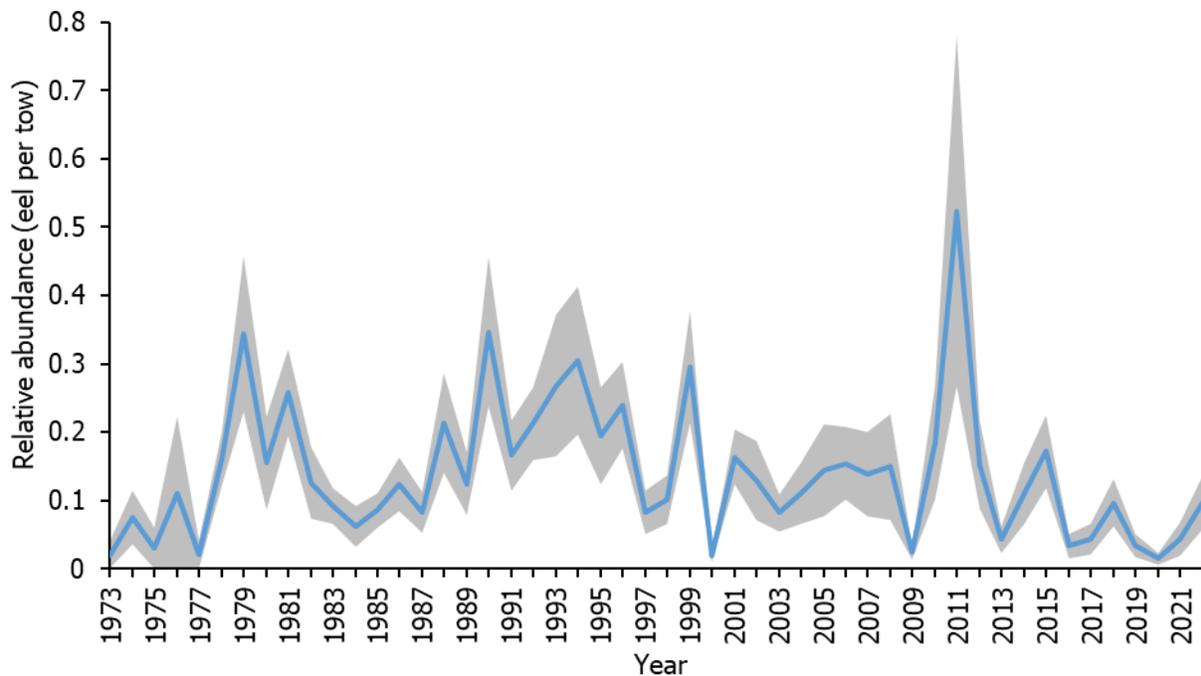


Figure 4. Relative abundance index (fish per tow) of American eel collected from the North Carolina Estuarine Trawl Survey (Program 120) from 1973–2022. Error bars represent  $\pm 1$  standard error.

**FISHERY MANAGEMENT PLAN UPDATE  
AMERICAN SHAD  
AUGUST 2023**

**STATUS OF THE FISHERY MANAGEMENT PLAN**

**Fishery Management Plan History**

FMP Documentation:	October 1985	
	Amendment 1	April 1999
	Technical Addendum 1	February 2000
	Addendum I	August 2002
	Amendment 3	February 2010
Supplements:	Supplement — October 1988	
Comprehensive Review:	To be determined	

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% 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 fishing/recovery plans that meet the requirements of Amendment 3, known as the North Carolina American Shad Sustainable Fishery Management Plan (SFMP) (NCDMF 2011, NCDMF 2017, and NCDMF 2023). North Carolina submitted habitat plans that meet the requirements of Amendment 3, known as the North Carolina American Shad Habitat Plan (NCDMF 2014 and NCDMF 2020).

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:

- Maximize the number of juvenile recruits emigrating from freshwater stock complexes.

- Restore and maintain spawning stock biomass and age structure to achieve maximum juvenile recruitment.
- Manage for an optimum yield harvest level that will not compromise Objectives 1 and 2.
- Maximize cost effectiveness to the local, state, and federal governments, and the ASMFC associated with achieving Objectives 1 through 3.

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

American shad are anadromous fish, meaning they spend most of their adult lives at sea, only returning to freshwater in the spring to spawn. 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 in which they were born 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, including Roanoke River, are sustainable and not depleted, whereas a determination of stock status could not be assigned for the Tar-Pamlico, Neuse, and Cape Fear rivers due to limited information (ASMFC 2020).

### **Stock Assessment**

The 2020 American shad benchmark stock assessment found coastwide populations of American shad to be depleted. Factors such as overfishing, inadequate fish passage at dams, predation, pollution, water withdrawals, channelization of rivers, changing ocean conditions, and climate change are likely responsible for the decline from historic shad abundance levels. The assessment found that American shad recovery is limited by restricted access to spawning habitat, with 40% of historic habitat in the U.S. and Canada currently blocked by dams and other barriers possibly equating to a loss of more than a third of spawning adults. The abundance of American shad relative to historic levels is unknown for most systems but was determined to be depleted for the Potomac River and Hudson River, and not depleted for the Albemarle Sound. Coastwide adult mortality is largely unknown and juvenile mortality status cannot be determined due to insufficient data collection. The stock assessment chose to use the 'depleted' determination instead of 'overfished' because of the impact of fishing on American shad stocks cannot be separated from all other factors that impact abundance. The status for adult mortality rate and abundance could not be determined for the Tar-Pamlico and Cape Fear rivers, except for the Neuse River adult mortality rate was found to be sustainable (ASMFC 2020). The 2020 benchmark assessment for

American shad was endorsed by the Peer Review Panel and accepted by the ASMFC Shad and River Herring Board for management use in August 2020. The ASMFC has not conducted a coastwide assessment of hickory shad.

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

The MFC 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 April 15–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 700 yards and could only be utilized from March 3 through March 14 and must be fished at least once during a 24-hour period (no later than noon each day; M-6-2022). The closing date for this gear occurred when the Albemarle Sound Management Area striped bass harvest quota was met to prevent additional striped bass discards. 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. Gill nets with a mesh length of 3.25–4.0 ISM could not exceed 800 yards and were allowed from January 1 through April 30. The Albemarle Sound area closed to fixed or stationary gill nets with a mesh length of 3.25–4.0 ISM on April 27 due to dead sturgeon takes nearing the authorized amount for this management unit (M-10-2022). Attendance for fixed or stationary small mesh gill nets (3.0–3.75 ISM) was required September 1–November 30 when the area reopened to this gear (M-16-2022). The ASMA was closed to all other gill nets except for 3.0–4.0 ISM run-around, strike, drop, and drift gill nets until the area was opened for flounder season on September 14, 2022 (M-17-2022).

Since May 2016, in other areas outside of the ASMA (excluding the Cape Fear River), a statewide rule limits the amount of large mesh (4.0-inch and greater) gill net set in internal Coastal Fishing Waters to no more than 2,000 yards per vessel. A prior version of the rule (3,000 yards maximum) was suspended for most internal Coastal waters as a result of sea turtle conservation measures to institute no more than 2,000 yards per vessel of 4.0–6.5-inch gill net in the Tar-Pamlico and Neuse rivers systems in earlier years. Additionally, in certain sections of the Tar-Pamlico and Neuse rivers, gill nets with a mesh size less than five inches must be attended at all times. Also, it is unlawful to use any gill nets in Joint Fishing Waters from midnight on Friday to midnight on Sunday each week (except for portions of Albemarle and Currituck sounds). These existing gill net measures have likely reduced American shad harvest since they have remained in effect since the spring 2012 fishing season and remain in effect indefinitely.

In the Cape Fear River there are different gill net restrictions than described above for the Tar-Pamlico and Neuse river systems (i.e., mesh lengths, spacing, set/retrieval days and times). Large mesh gill nets (4.0–6.5-inch) are prohibited in the Cape Fear River (north of the Railroad Bridge) and Northeast Cape Fear River (north of I-40 bridge) north of Wilmington, NC. In other parts of the Cape Fear River, large mesh gill 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. 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, and the maximum yardage allowed is a 1,000-yard limit per vessel. It is unlawful to use gill nets of any mesh size on weekends in the Cape Fear system. This measure will remain in effect indefinitely.

A management response for striped bass has been in effect since March 18, 2019, prohibiting the use of all gill nets upstream of the ferry lines from the Bayview to Aurora ferry in the Tar-Pamlico River and the Minnesott Beach and Cherry Branch ferry in the Neuse River (Proclamation M-6-2019). This prohibition directed by the N.C. Marine Fisheries Commission was in response to Supplement A to Amendment 1 to the N.C. Estuarine Striped Bass FMP, and was intended to reduce striped bass fishing mortality, and has essentially protected American shad as well by removing gill nets from the normal fishing grounds for American shad in the Tar-Pamlico River.

At its August 2022 business meeting, the MFC approved Notice of Text for Rulemaking to begin the process to amend the Mutilated Finfish Rule (15A NCAC 03M .0101). The amended rule would provide flexibility to manage variable conditions for the use of finfish, including hickory shad, as cut bait by simplifying the rule such that only species subject to a possession limit are subject to the requirements unless otherwise specified in a MFC rule or a proclamation issued under the authority of a MFC rule. The MFC gave final approval of the rule at its February 2023 business meeting and the rule is scheduled to be reviewed for final approval by the Rules Review Commission in June 2023. The rule is automatically subject to legislative review and cannot be reviewed until the 2024 short session at the earliest.

### **Commercial Fishery**

North Carolina's commercial landings in 2022 were 9,443 pounds; the lowest in the time series (Table 1, Figure 1). Anchored gill nets configured for harvesting American shad were prohibited in the ASMA (Management Unit A) effective March 15, 2022, due to the ASMA striped bass commercial quota being met (Proclamation M-6-2022). While American shad could still be landed commercially until March 24, 2022, anchored gill nets are the primary gear used for shad in the ASMA and the gear restriction did have an impact on landings. Overall, landings show a decreasing trend until 2013 when average landings leveled off with the implementation of the American Shad SFMP. Commercial harvest is sporadic and cyclical and annual trends show these changes. Figure 2 describes the landings break down by the four areas of the state, as stated in the American Shad SFMP. The Albemarle Sound area accounts for approximately 62% of total state landings in 2022.

### **Recreational Fishery**

Recreational fishing activity is monitored through coordination with the North Carolina Wildlife Resources Commission (WRC) and the DMF, methods were developed to conduct recreational creel surveys on the Roanoke, Tar-Pamlico, and Neuse rivers starting in 2012, and for Cape Fear River 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 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 harvest of 2,666 fish in 2022 (Table 2).

## MONITORING PROGRAM DATA

### Fishery-Dependent Monitoring

Commercial fishing activity is monitored through fishery-dependent sampling conducted by the DMF since 1972, with a sampling gap during 1994–2000 due to lack of funding. Data collected in this program allow the size and age distribution of American Shad to be characterized by sex (female and male). The predominant fishery for American shad are estuarine gill nets and harvest is primarily focused on female American Shad, as they are harvested for their roe (eggs). In 2022, gill nets accounted for greater than 86% of the commercial landings.

A total of 225 females and 41 males was measured from the commercial fishery in 2022 (Table 3, Table 4). The average size was 17 inches fork length for female and 15 inches fork length for male American shad (Figure 3, Figure 4). Variation in modal, minimum, and maximum ages throughout the fishery-dependent monitoring is described in Table 5, for both sexes combined. The modal age has increased over the time series, while the minimum and maximum ages have remained relatively unchanged. Figure 5 and Figure 6 illustrate the American Shad length at age (mean, minimum, and maximum) for females and males from all age samples collected at any given age from 1972 to 2021. Age data for 2022 are incomplete and will be provided in next year's update.

### Fishery-Independent Monitoring

The DMF does not have a dedicated juvenile (age 0) survey for American Shad but conducts two juvenile beach seine surveys in the Albemarle Sound area, Juvenile Anadromous Survey (Program 100). Although the surveys were designed to monitor river herring [blueback herring (*Alosa aestivalis*) and alewife (*Alosa pseudoharengus*)] and striped bass, both surveys capture American shad. The river herring beach seine survey has been conducted in the Chowan River and Albemarle Sound area to monitor Blueback Herring and Alewife abundance since 1972. The survey established 11 stations in the near-shore nursery areas of the Chowan River and Albemarle Sound, sampled twice a month. The striped bass beach seine survey has been conducted in the western Albemarle Sound to monitor juvenile striped bass since 1993. The survey established nine stations in the near-shore nursery areas of the western Albemarle Sound, where early-stage juvenile striped bass would be settling after larval metamorphosis from spawning grounds on the Roanoke River. The stations are sampled once a week, for six weeks (starting the first week in June). American shad captured are recorded but not consistently until 1995. Following the six weeks of sampling, the stations are sampled bimonthly through October.

The ASFMC 2007 benchmark assessment for American Shad only considered the juvenile river herring beach seine survey data for a relative abundance index for American Shad. Due to the consistently low level of catch since 1972, the authors felt that the survey did not adequately reflect the true abundance of juvenile American Shad and should not be used for management. During the ASFMC 2020 benchmark stock assessment for American Shad a combination of seine stations from the river herring survey (five stations) and the striped bass survey (9 stations), all samples June through October, were selected to determine a juvenile abundance starting in 1996 (zero catches in 1995). A Zero-inflated Negative Binomial GLM model was determined as the best recommended predications of relative annual abundance. Water temperature, salinity, month and cloud cover were all shown to significantly impact catch rates and presence. The best performing

model was  $\text{Counts} \sim \text{Year} + \text{water temperature} + \text{salinity} \mid \text{salinity} + \text{cloud cover} + \text{month}$ . Updates to annual trends in abundance are illustrated in Figure 7 as arithmetic mean, in lieu of updating the model annually. The 2022 relative abundance was 1.83 (American shad per tow) a decrease from the relative abundance in 2021 (3.19 American shad per tow).

Adult American shad are monitored using the DMF Albemarle Sound Independent Gill Net Survey (Program 135) and WRC electrofishing surveys to estimate female relative abundance and relative fishing mortality in the Albemarle Sound-Roanoke River area. In other areas of the state, WRC conducts electrofishing surveys to estimate abundance and the relative fishing mortality. These data are incorporated into the North Carolina SFMP for American Shad described in more detail in the Management Strategy section.

Program 135 began collecting biological data on adult American Shad in 2000, sex was not recorded until 2004. The survey uses a stratified random sampling scheme designed to characterize the size and age distribution for key estuarine species in the Albemarle Sound. American Shad intercepted by DMF gill net surveys outside to the Albemarle Sound-Roanoke River area are reported annually to the ASMFC, due to low numbers of catch relative abundance is not estimated.

Program 135 was suspended in February 2020 due to COVID-19 restrictions and protected species interactions. The survey resumed in the fall of 2021. In November 2021, the Albemarle Sound Independent Gill Net Survey (IGNS) expanded from six to eight zones and reduced soak time from 24-hours to 12-hours. Additionally, in March 2022, sink gill nets were removed from the survey, reducing effort to 480 yards per set (12 units of effort). Additional zones were added to meet DMF research priorities to expand the spatial coverage of the survey. Soak times were reduced and sink nets were removed to reduce interactions with endangered species through ongoing consultation with the United States Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Association (NOAA Fisheries). It should be noted that with such a major change in survey design, the index derived from this survey starting in November 2021 will not be directly comparable to the prior historical time series. When calculating female relative abundance using historical IGNS data, all sink gill nets were removed. It is important to note that most American shad intercepted in the IGNS survey are from float gill nets. Therefore, the removal of sink gill nets from the data set did not significantly impact the relative abundance estimates of American shad from the survey.

The female index of abundance for American shad from Program 135 uses the January through May catch of female American shad from float nets in the western Albemarle Sound. For 2022, the female index of abundance for American shad was 0.029 fish per net. Due to the survey suspension index values are not available for 2020 and 2021.

A total of 55 females and 36 males were measured from the DMF fishery-independent monitoring (Tables 6 and 7) from all areas of the state. The average size of female American Shad is 16 inches fork length and male are 14 inches fork length. Variation in modal, minimum, and maximum ages throughout the fishery-independent sampling is described in Table 8, for both sexes combined. The modal age has fluctuated over the time series, while the minimum and maximum ages have remained relatively stable. Figure 9 and Figure 10 illustrate the American Shad length at age (mean, minimum, and maximum) for females and males from all age samples collected from the fishery-independent monitoring at any given age during 2000–2021. Age data for 2022 are incomplete and will be provided in next year's update.

## RESEARCH NEEDS

On an annual basis the ASMFC publishes a prioritized list of short term and long-term research needs for American shad and river herring in the Review of the Atlantic States Marine Fisheries Commission Fishery Management Plan for Shad and River Herring (ASMFC 2020).

For more information on research needs for River herring please see: [https://asmfc.org/uploads/file/64010087/Approved\\_SRH\\_FMP\\_Report\\_FY\\_2021\\_2.2.23.pdf](https://asmfc.org/uploads/file/64010087/Approved_SRH_FMP_Report_FY_2021_2.2.23.pdf)

## 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 NC American Shad SFMP, effective in 2013 through 2017, identified sustainability parameters for four regions of the state: Albemarle-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% of the total American shad landings in a year. The second NC American Shad SFMP, 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.

The third NC American Shad SFMP, approved January 2023 for 2023 through 2027 added a sustainability parameter for juvenile abundance in the Albemarle Sound-Roanoke River and updated female relative  $F$  parameters to include the commercial and recreational harvest for the Tar-Pamlico, Neuse, and Cape Fear river systems. Previously, relative  $F$  was computed for these systems using only information from the commercial harvest of roes (females), in pounds of fish. Commercial harvest of American shad has continued to decline due to management regulations and reduced participation in the fishery in these areas. The addition of recreational data to the relative  $F$  calculation has shortened the time-series, but the estimates are more informative of total removals from the Tar-Pamlico, Neuse, and Cape Fear river systems. Thresholds have been established for indices in each system to define levels needed to reduce mortality and avoid diminishing potential stock reproduction and recruitment. Thresholds for sustainability parameters are fixed using available survey data through 2022 and will remain fixed during the next 5-year management period.

### Albemarle Sound-Roanoke River

The Albemarle Sound-Roanoke River system has four sustainability parameters: juvenile abundance, female CPUE based on the DMF Albemarle Sound Independent Gill Net Survey (IGNS, Program 135), female CPUE based on the WRC electrofishing survey, and female relative fishing mortality ( $F$ ) computed by dividing commercial landings by a hind cast 3-year average of the DMF IGNS index. As written in the 2023 SFMP, exceeding the juvenile abundance, female

CPUE based on Albemarle Sound IGNS or the female relative  $F$  parameters for three consecutive years will trigger management action. The female CPUE based on the WRC electrofishing survey will be used in conjunction with a second index for triggering management action.

Figure 11 shows the juvenile abundance index from the DMF juvenile seine survey. Figure 12 shows the female CPUE based on the DMF Albemarle Sound IGNS. Figure 13 shows the CPUE based on the WRC electrofishing survey. Figure 14 shows the female relative  $F$  based on commercial landings and a hind cast three-year average of the DMF IGNS index.

### **Tar-Pamlico River system**

The Tar-Pamlico system has two sustainability parameters: female CPUE based on the WRC electrofishing survey, and female relative  $F$  based on the WRC electrofishing survey. Female relative  $F$  is calculated using the combined commercial and recreational harvest from the Tar-Pamlico River and the female CPUE index from the Tar-Pamlico River electrofishing survey.

Figure 15 shows the female CPUE based on the WRC electrofishing survey and Figure 16 shows the female relative  $F$  based on the WRC electrofishing survey.

### **Neuse River system**

The Neuse River system has two sustainability parameters: female CPUE based on the WRC electrofishing survey, and female relative  $F$  based on the WRC electrofishing survey. Female relative  $F$  is calculated using the combined commercial and recreational harvest from the Neuse River and the female CPUE index from the Neuse River electrofishing survey.

Figure 17 shows the female CPUE based on the WRC electrofishing survey and Figure 18 shows the female relative  $F$  based on the WRC electrofishing survey.

### **Cape Fear River system**

The Cape Fear River system has two sustainability parameters: female CPUE based on the WRC electrofishing survey, and female relative  $F$  based on the WRC electrofishing survey. Female relative  $F$  is calculated using the combined commercial and recreational harvest from the Cape Fear River and the female CPUE index from the Cape Fear River electrofishing survey.

Figure 19 shows the female CPUE based on the WRC electrofishing survey and Figure 20 shows the female relative  $F$  based on the WRC electrofishing survey.

### **All Other Internal Coastal and Joint Fishing Waters**

The areas without specified sustainability parameters will fall under statewide management measures listed in the following section. The DMF monitors commercial landings through the North Carolina Trip Ticket Program to ensure landings remain low. Dedicated monitoring programs or area closures will be implemented if sudden increases in landings, indicating targeted effort, occur.

## Management Measures for 2023

### Recreational

*Statewide Internal Waters including Albemarle Sound-Roanoke River, Neuse River, except as exempted below:*

- It is unlawful to possess more than ten (10) American shad or hickory shad in the aggregate, per person per day taken by hook-and-line or for recreational purposes and only one (1) of the ten (10) may be an American shad.

*Tar-Pamlico River, Pee Dee River*

- It is unlawful to possess more than ten (10) American shad or hickory shad, in the aggregate, per person per day taken by hook-and-line or for recreational purposes.

*Cape Fear River*

- It is unlawful to possess more than ten (10) American shad or hickory shad in the aggregate, per person per day taken by hook-and-line or for recreational purposes and only five (5) of the ten (10) may be an American shad.

### Commercial

*Albemarle Sound Coastal and Joint Fishing Waters*

- For 2023, a commercial season of February 15–April 14 has been established based on sustainability parameters for this system.
- The commercial season may occur anytime between January 1–April 14 for the 5-year tenure of this plan.

*Tar-Pamlico River, Neuse River Coastal and Joint Fishing Waters*

- For 2023, a commercial season of February 15–April 14 has been established based on sustainability parameters for this system.
- The commercial season may occur anytime between February 15–April 14 for the 5-year tenure of this plan.

*Cape Fear River Coastal and Joint Fishing Waters*

- For 2023, a commercial season of February 20–April 11 has been established based on sustainability parameters for this system.
- The commercial season may occur anytime between February 20–April 11 for the 5-year tenure of this plan.

*All Other Internal Coastal and Joint Fishing Waters*

- For 2023, a commercial season of February 15–April 14 has been established based on the Tar-Pamlico River, Neuse River, and Cape Fear River sustainability parameters.
- The commercial season may occur anytime between February 15–April 14 for the 5-year tenure of this plan.

While none of the selected sustainability parameters for any of the river systems have exceeded the triggers for management since 2013, the above measures for 2023 are considered prudent given the results of the 2020 stock assessment as they pertain to North Carolina. The Albemarle Sound is the only system in North Carolina where abundance status, relative to historic levels, was determined to be not depleted. The overall status for the other areas remains unknown, in large part due to a lack of juvenile data. The Albemarle Sound adult total mortality rate was determined sustainable, and abundance determined to be not overfished. Additionally, the Albemarle Sound juvenile abundance demonstrated an increasing trend during 2005–2017, the selected time period for abundance trends (ASMFC 2020). Given the Albemarle Sound status determination and the management measures in place for striped bass conservation also benefiting American shad (Section 4.2.1), the ASWG elected to expand the potential time frame in which the Albemarle Sound commercial fishery can occur from March 3–24 to January 1–April 14. The expanded time frame allows for flexibility in management to ensure that the fishery remains sustainable while maximizing the opportunity to stakeholders impacted by management restrictions for striped bass in this area. Commercial seasons, for all areas, will be determined after DMF and WRC jointly review the performance of the plan, annually, to determine management measures for the following season. Future changes to creel limits for American shad in the Inland Fishing Waters of the other river systems will also be complemented by DMF for Joint and Coastal Fishing Waters.

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## TABLES

Table 1. Commercial harvest (weight in pounds) of American shad from North Carolina, 1972–2022. Commercial harvest from the Atlantic Ocean prohibited since 2007.

Year	Weight Landed (lb)	Year	Weight Landed (lb)
1972	468,484	1997	219,526
1973	321,000	1998	327,556
1974	368,833	1999	131,617
1975	241,240	2000	297,990
1976	167,190	2001	151,075
1977	120,201	2002	274,657
1978	402,017	2003	395,251
1979	277,818	2004	270,245
1980	199,206	2005	189,462
1981	351,500	2006	184,710
1982	407,034	2007	298,597
1983	380,897	2008	118,855
1984	382,331	2009	167,114
1985	190,044	2010	232,326
1986	279,142	2011	203,755
1987	111,860	2012	235,795
1988	111,567	2013	257,348
1989	52,997	2014	191,302
1990	30,833	2015	95,966
1991	29,037	2016	62,245
1992	38,020	2017	90,868
1993	12,544	2018	53,878
1994	110,975	2019	40,975
1995	205,867	2020	134,566
1996	199,638	2021	58,884
		2022	9,443
		Mean	199,104

Table 2. Recreational harvest (number of fish landed and weight in pounds) and releases (number of fish) and commercial harvest (weight in pounds) of American shad from the North Carolina Central Southern Management Area (CSMA), 2012–2022.

Year	Neuse River					Tar-Pamlico River					Cape Fear River				
	Recreational		Commercial			Recreational		Commercial			Recreational		Commercial		
	Numbers Landed	Numbers Released	Weight Landed (lb)	Weight Landed (lb)	Total Weight (lb)	Numbers Landed	Numbers Released	Weight Landed (lb)	Weight Landed (lb)	Total Weight (lb)	Numbers Landed	Numbers Released	Weight Landed (lb)	Weight Landed (lb)	Total Weight (lb)
2012	968	511	2,277	23,985	26,262	899	4,257	1,711	12,982	14,693				10,341	10,341
2013	1,388	2,699	2,920	17,255	20,175	2,479	7,053	6,830	9,776	16,606	18,484	6,154	42,571	24,888	67,459
2014	413	995	992	9,778	10,770	168	1,314	453	7,472	7,925	7,256	0	23,084	46,148	69,232
2015	94	132	293	3,022	3,314	1,006	2,784	3,262	3,418	6,680	4,136	6,125	11,504	25,039	36,543
2016	252	1,389	426	2,568	2,994	1,051	2,820	3,408	765	4,173	10,244	10,740	28,393	12,937	41,330
2017	518	2,828	1,328	11,451	12,779	898	2,217	2,159	4,412	6,571	1,352	2,669	3,787	11,049	14,836
2018	112	356	286	3,987	4,273	685	2,767	1,588	1,580	3,168	5,384	3,992	13,088	14,931	28,019
2019	215	91	455	1,531	1,986	544	3,028	944		944	2,266	1,101	5,786	5,076	10,862
2020	830	1,933	1,770	109	1,879	209	562	362	129	491	3,582	3,740	7,645	6,038	13,683
2021	36	53	74	16	90	731	4,236	1,945	59	2,004	2,624	6,914	6,623	4,838	11,461
2022	36	170	123	248	371	464	995	1,211	59	1,270	2,666	953	6,103	2,899	9,002

Table 3. Mean, minimum, and maximum lengths (fork length, inches) of female American shad measured from the commercial fisheries, 1972–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1972	19	14	22	244
1973	18	14	21	345
1974	18	15	21	177
1975	18	15	21	774
1976	18	14	23	404
1977	18	14	20	515
1978	18	14	20	554
1979	18	10	22	691
1980	18	14	21	367
1981	19	16	21	374
1982	18	13	21	247
1983	18	12	21	464
1984	19	15	21	613
1985	19	15	23	561
1986	19	15	23	419
1987	19	14	21	360
1988	18	15	22	607
1989	18	15	23	470
1990	18	15	23	156
1991	18	13	20	330
1992	18	15	20	299
1993	17	15	22	220
2000	17	14	20	836
2001	17	13	20	711
2002	18	13	20	794
2003	18	13	22	545
2004	18	12	22	727
2005	17	13	21	847
2006	17	14	20	667
2007	17	12	20	785
2008	17	14	20	740
2009	17	12	22	702
2010	17	12	20	948
2011	17	15	19	1,103
2012	17	15	21	1,169
2013	18	15	21	1,363
2014	18	13	20	870
2015	18	14	20	678
2016	17	15	20	396
2017	17	15	22	456
2018	17	14	20	388
2019	17	14	19	444
2020	15	12	19	281
2021	17	15	19	415
2022	17	13	21	225

Table 4. Mean, minimum, and maximum lengths (fork length, inches) of male American shad measured from the commercial fisheries, 1972–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1972	17	13	19	285
1973	16	12	20	365
1974	15	13	18	225
1975	16	12	20	466
1976	16	12	20	392
1977	16	11	19	253
1978	16	11	22	470
1979	16	13	20	533
1980	16	12	19	429
1981	16	13	19	486
1982	16	11	19	367
1983	16	13	21	630
1984	16	12	19	608
1985	16	13	19	475
1986	16	12	19	348
1987	16	12	19	299
1988	16	11	20	422
1989	16	12	18	346
1990	16	13	19	204
1991	16	12	19	248
1992	16	12	19	232
1993	15	12	19	153
2000	16	13	20	315
2001	15	11	20	130
2002	16	13	21	352
2003	16	10	20	284
2004	16	8	19	239
2005	15	7	18	160
2006	15	11	20	192
2007	15	12	18	216
2008	15	5	20	152
2009	15	12	18	213
2010	15	12	18	199
2011	15	12	18	159
2012	16	10	19	353
2013	15	11	19	175
2014	15	11	18	120
2015	16	12	18	124
2016	15	13	18	50
2017	15	12	17	58
2018	15	13	18	53
2019	14	12	18	85
2020	15	12	17	74
2021	15	13	18	71
2022	15	12	17	41

Table 5. Modal age, minimum age, maximum age, and number aged for American shad (male and female combined) collected through DMF fishery-dependent sampling programs, 1972–2021. Age data unavailable for 2022.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
1972	5	3	9	465
1973	4	3	8	656
1974	4	3	7	389
1975	5	2	9	1,138
1976	5	4	9	664
1977	5	3	7	585
1978	6	3	7	953
1979	5	4	9	1,060
1980	6	4	9	685
1981	6	4	9	528
1982	5	3	9	328
1983	5	3	9	626
1984	5	3	9	707
1985	5	3	8	624
1986	5	4	9	475
1987	5	4	9	403
1988	5	4	9	604
1989	5	3	8	238
1990	6	3	9	233
1991	5	4	8	321
1992	5	4	9	295
1993	5	4	9	221
2000	5	3	7	401
2001	5	3	8	423
2002	5	3	8	580
2003	6	3	8	543
2004	5	3	8	645
2005	5	3	8	477
2006	6	3	8	499
2007	6	3	8	439
2008	6,7	3	9	447
2009	7	4	10	431
2010	6	3	9	453
2011	6	3	8	403
2012	5	3	8	526
2013	7	3	9	449
2014	7	3	9	418
2015	7	4	8	406
2016	7	4	8	280
2017	7	4	9	382
2018	7	3	8	278
2019	6	4	8	273
2020	6	4	8	255
2021	6	4	8	301

Table 6. Mean, minimum, and maximum lengths (fork length, inches) of female American shad measured from DMF fishery-independent sampling programs, 2000–2022.

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Total Number Measured
2000	18	14	20	74
2001	17	15	21	198
2002	18	14	20	144
2003	18	15	20	161
2004	18	15	20	149
2005	18	15	20	106
2006	17	15	20	52
2007	17	14	18	35
2008	16	13	19	45
2009	17	16	19	22
2010	17	15	19	83
2011	17	15	19	14
2012	17	14	19	59
2013	17	13	19	73
2014	17	16	19	28
2015	17	16	18	18
2016	17	13	18	19
2017	17	14	19	65
2018	16	12	19	76
2019	16	6	19	95
2020	17	15	18	41
2021	17	15	18	9
2022	16	14	18	55

Table 7. Mean, minimum, and maximum lengths (fork length, inches) of male American shad measured from DMF fishery-independent sampling programs, 2000–2022.

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Total Number Measured
2000	16	13	19	173
2001	15	13	18	84
2002	15	12	18	135
2003	16	12	19	87
2004	17	12	19	14
2005	15	13	17	30
2006	15	13	18	14
2007	15	13	17	34
2008	14	12	17	33
2009	15	13	17	18
2010	15	12	16	40
2011	15	14	17	12
2012	15	13	17	23
2013	15	13	16	34
2014	15	14	16	11
2015	15	14	16	3
2016	15	15	16	7
2017	15	11	17	57
2018	15	12	18	80
2019	15	11	17	91
2020	15	12	16	32
2021	15	13	16	6
2022	14	12	16	36

Table 8. Modal age, minimum age, maximum age, and number aged for American shad (male and female combined) collected through DMF fishery-independent sampling programs, 2000–2021. Age data unavailable for 2022.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
2000	5	3	7	247
2001	5	3	7	282
2002	4	3	8	279
2003	6	3	8	248
2004	6	3	8	163
2005	5	3	7	136
2006	4	3	8	66
2007	4	4	7	69
2008	5	3	8	78
2009	6	4	8	40
2010	6	3	8	123
2011	6	3	8	26
2012	6	4	8	82
2013	5	3	8	107
2014	6	4	7	39
2015	6,7	3	7	21
2016	6	3	8	26
2017	6	3	8	122
2018	5	3	8	146
2019	5	3	7	152
2020	6	3	8	71
2021	5	4	7	15

**FIGURES**

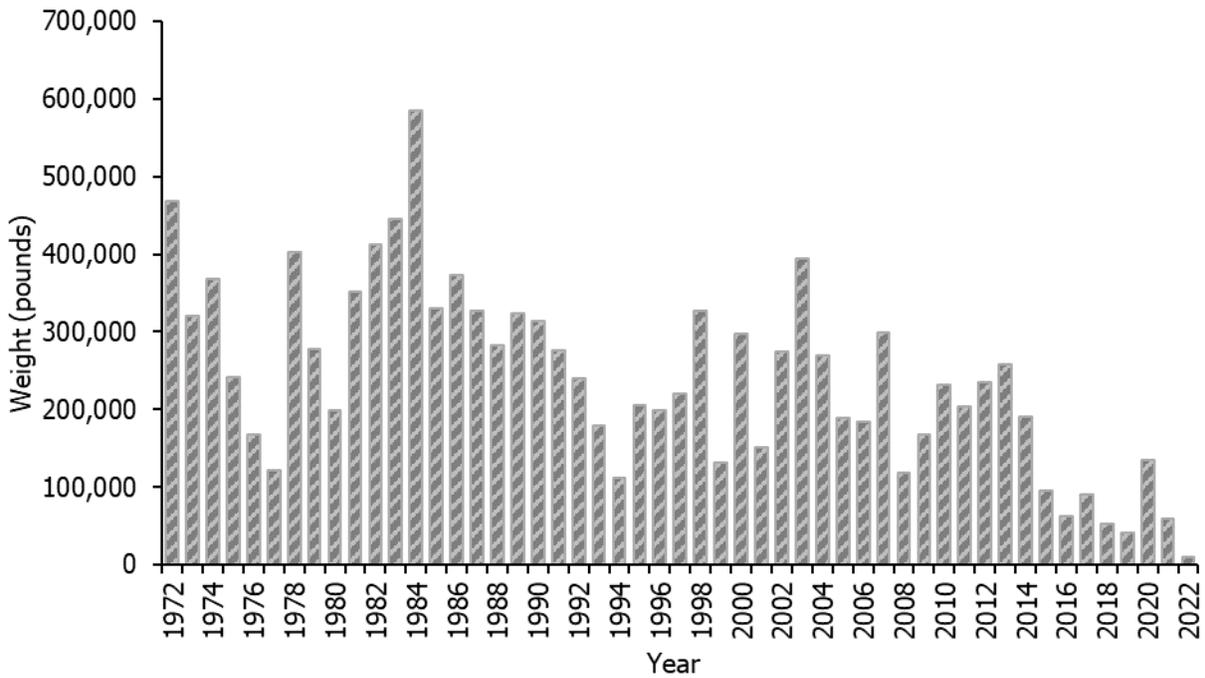


Figure 1. Commercial harvest (weight in pounds) of American shad from North Carolina, 1972–2022.

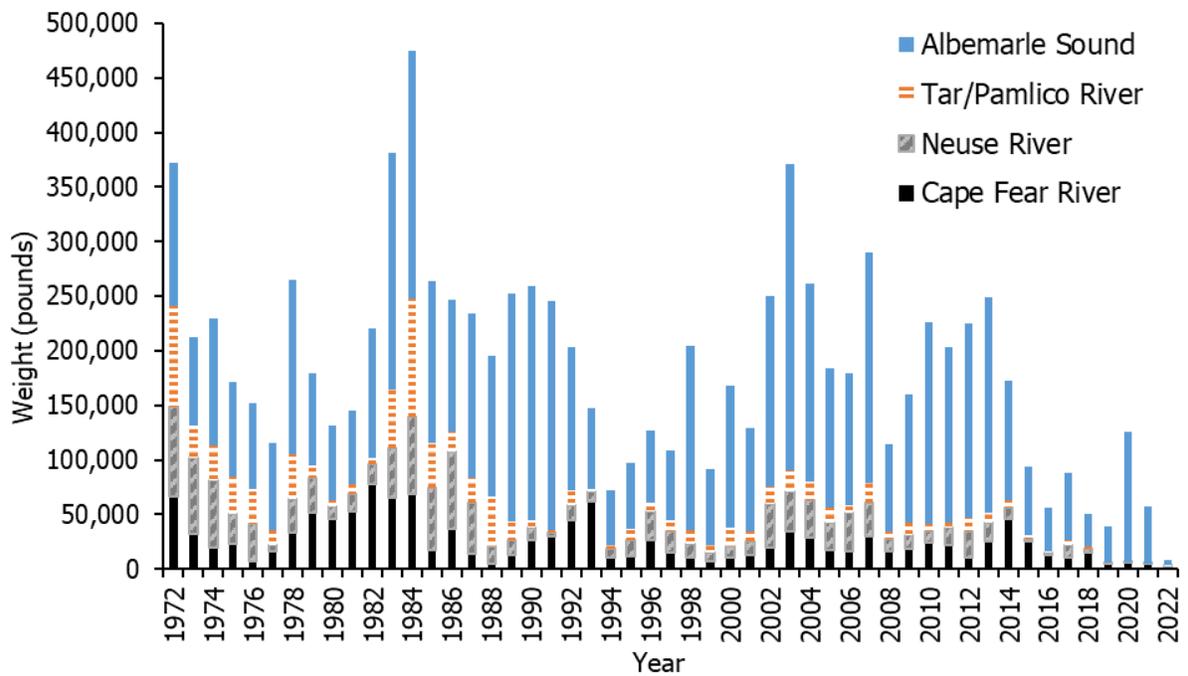


Figure 2. Commercial harvest (weight in pounds) of American shad from North Carolina by major waterbody, 1972–2022.

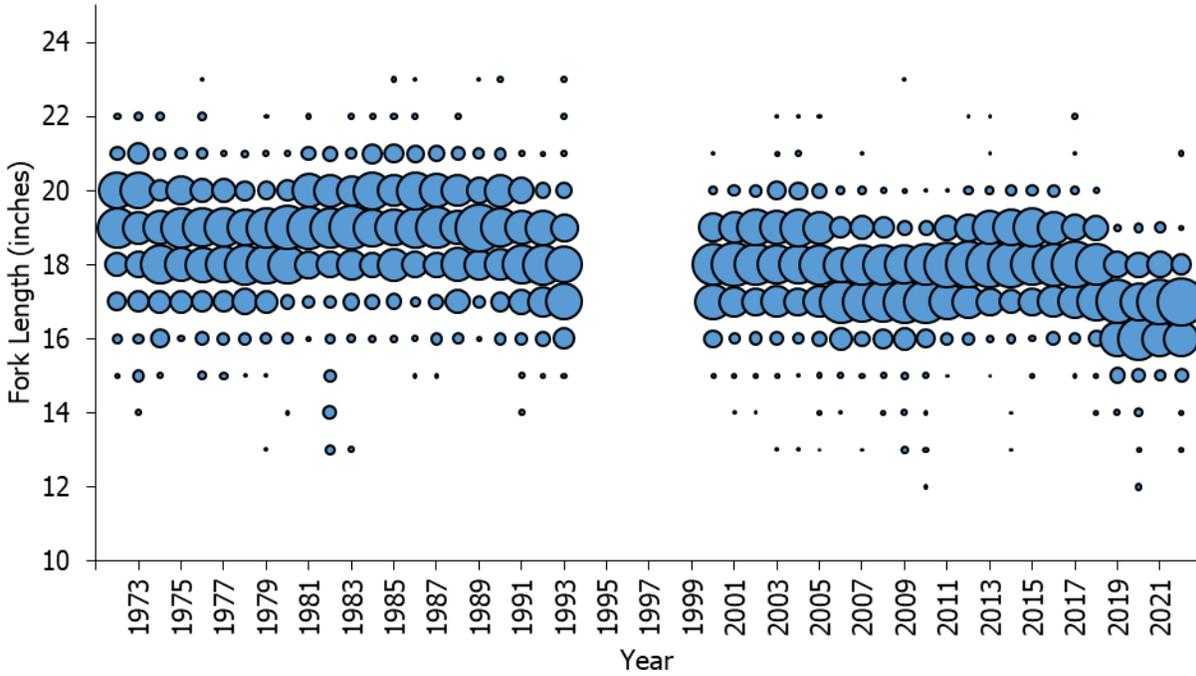


Figure 3. Commercial length frequency (fork length, inches) of female American shad harvested, 1972–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

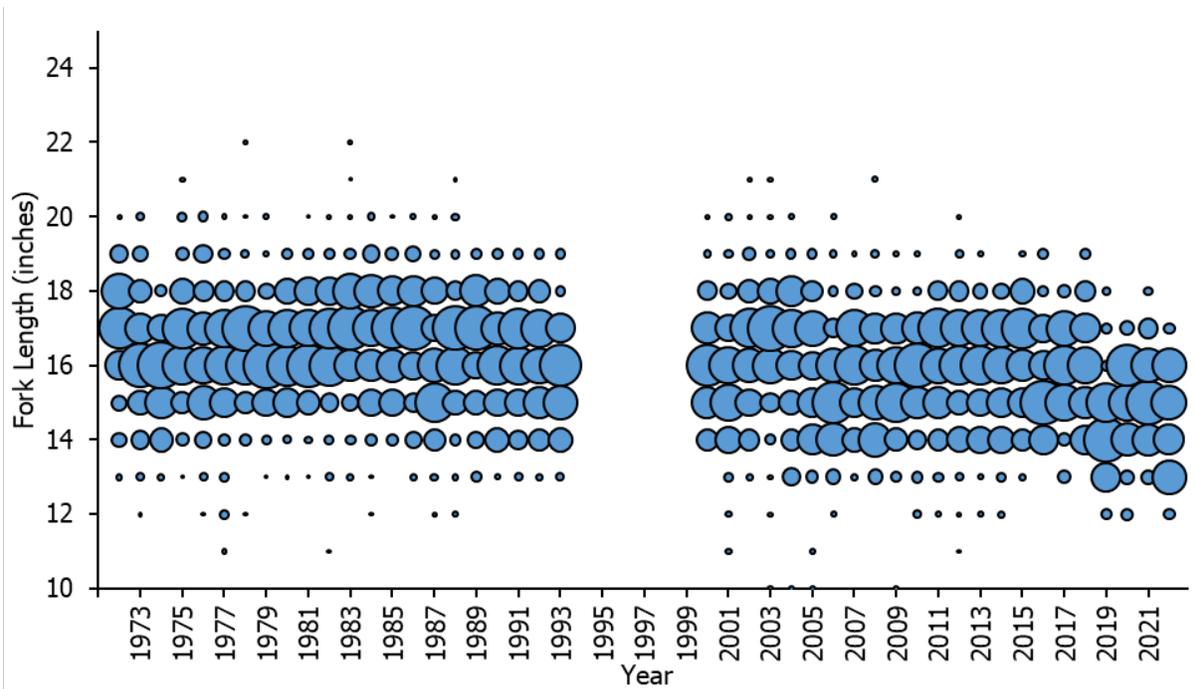


Figure 4. Commercial length frequency (fork length, inches) of male American shad, 1972–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

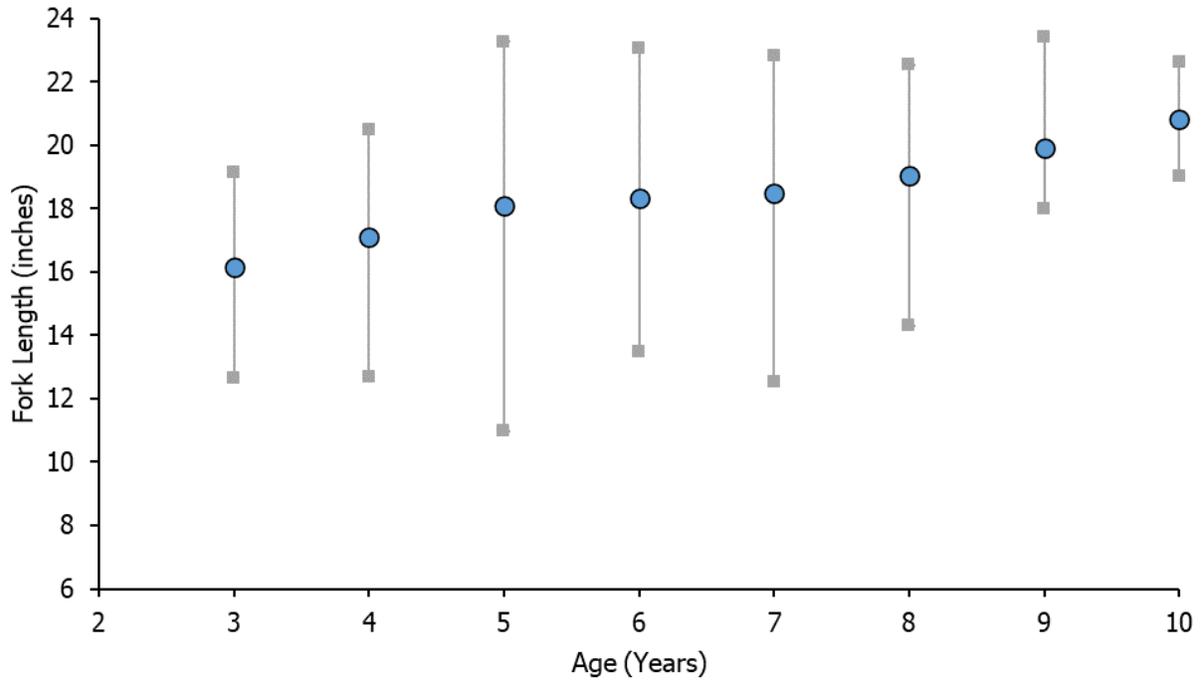


Figure 5. Female American shad length at age from all age samples collected from fishery-dependent monitoring, 1972–2021. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age. Age data unavailable for 2022.

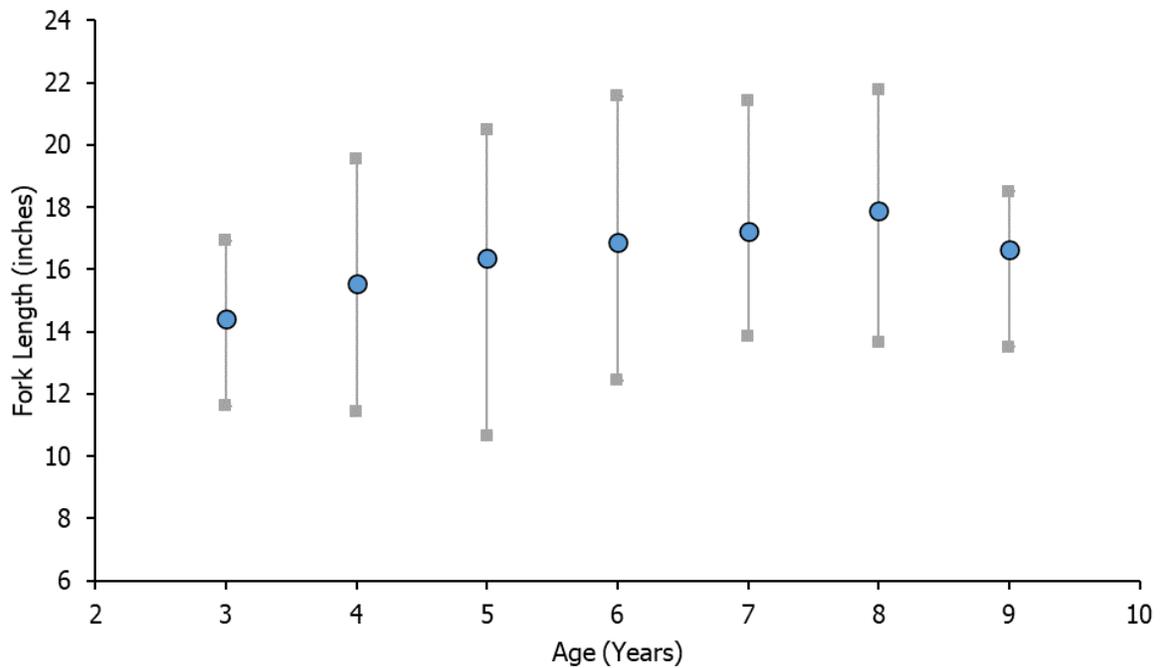


Figure 6. Male American shad length at age from all age samples collected from fishery-dependent monitoring, 1972–2021. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age. Age data unavailable for 2022.

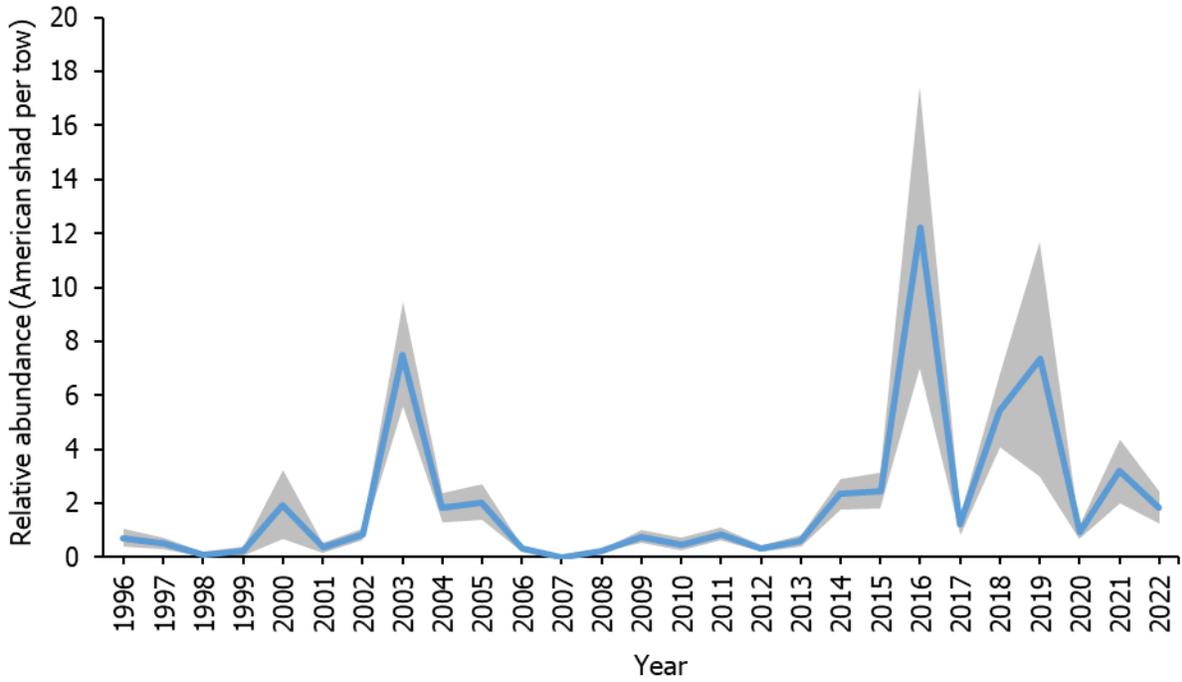


Figure 7. Relative abundance index (fish per tow) of American shad collected from Program 100 in Albemarle Sound during June through October 1996–2022. Error bars represent  $\pm 1$  standard error.

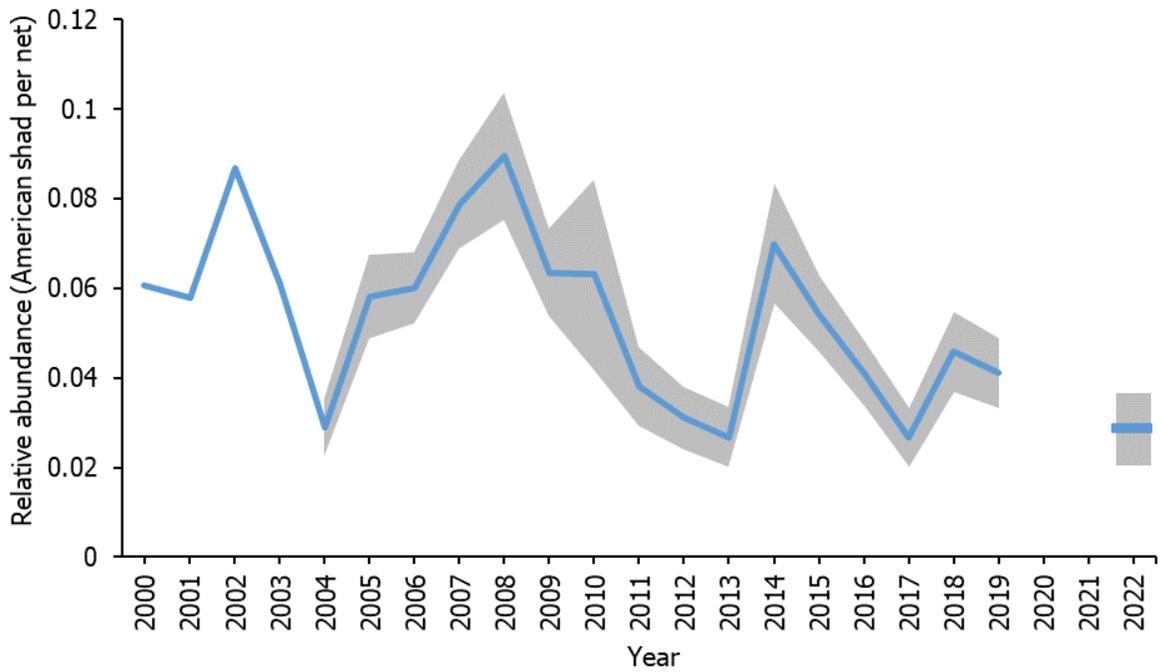


Figure 8. Relative abundance index of female American shad (fish per net, all float net mesh sizes) collected from Program 135 in Albemarle Sound during January through May 2000–2022. Error bars represent  $\pm 1$  standard error. \* Survey suspended February 20, 2020, and did not resume until fall 2021.

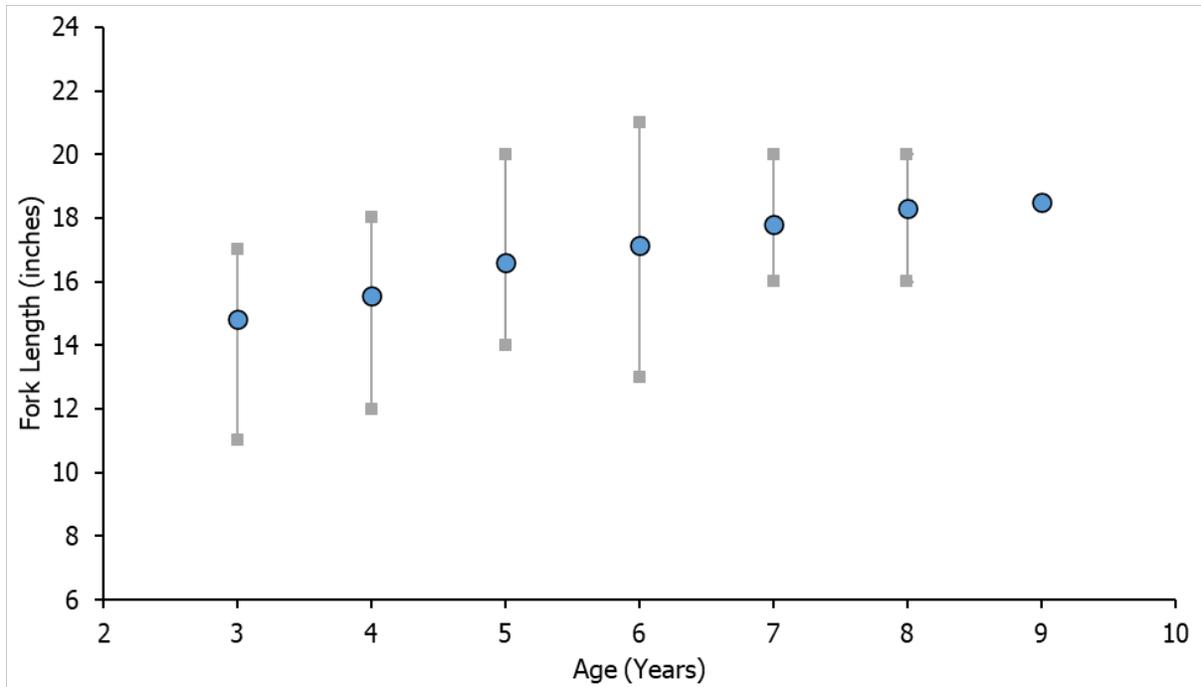


Figure 9. Female American shad length at age from all age samples collected through DMF fishery-independent sampling programs, 2000–2021. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age. Age data unavailable for 2022.

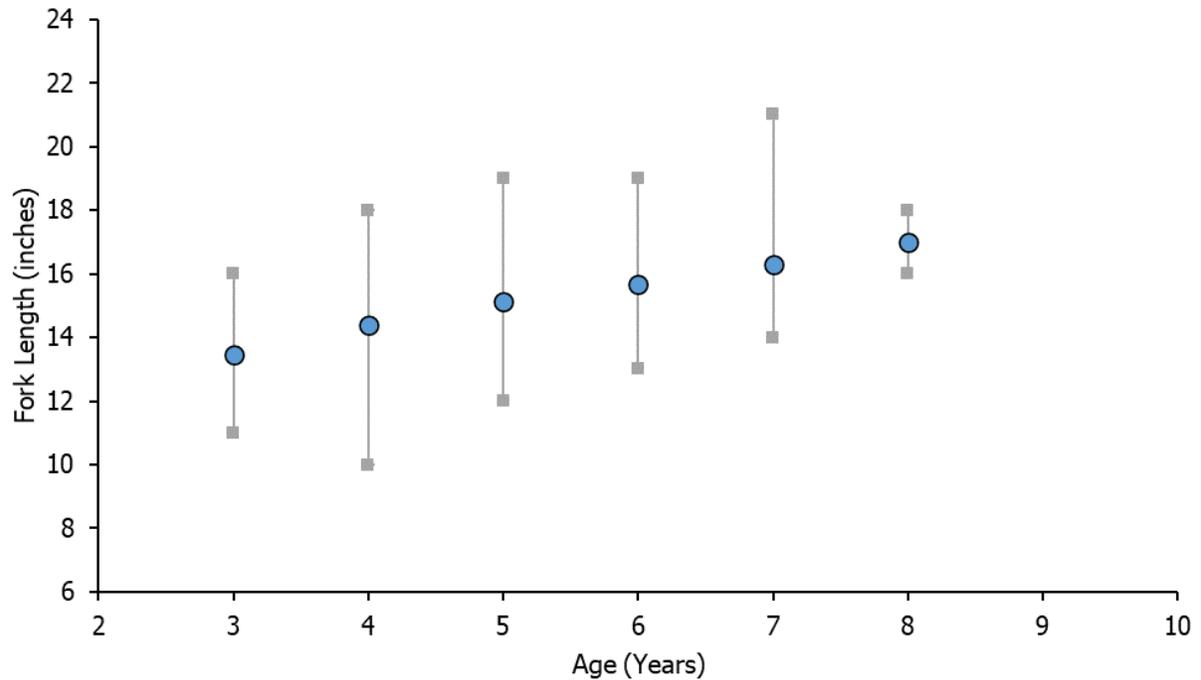


Figure 10. Male American shad length at age from all age samples collected through DMF fishery-independent sampling programs, 2000–2021. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age. Age data unavailable for 2022.

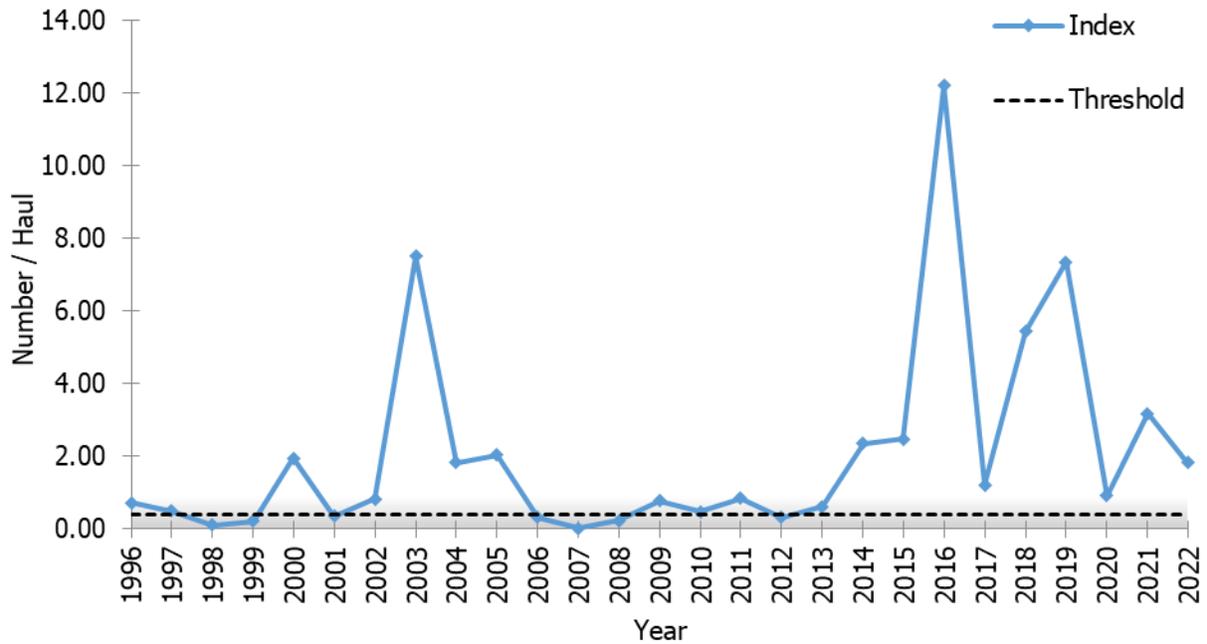


Figure 11 Juvenile abundance index from the DMF juvenile seine survey (Jun–Oct) for the Albemarle Sound, 1996-2022. Threshold represents 25th percentile (where 75% of all values are greater). Values in gray are below the threshold.

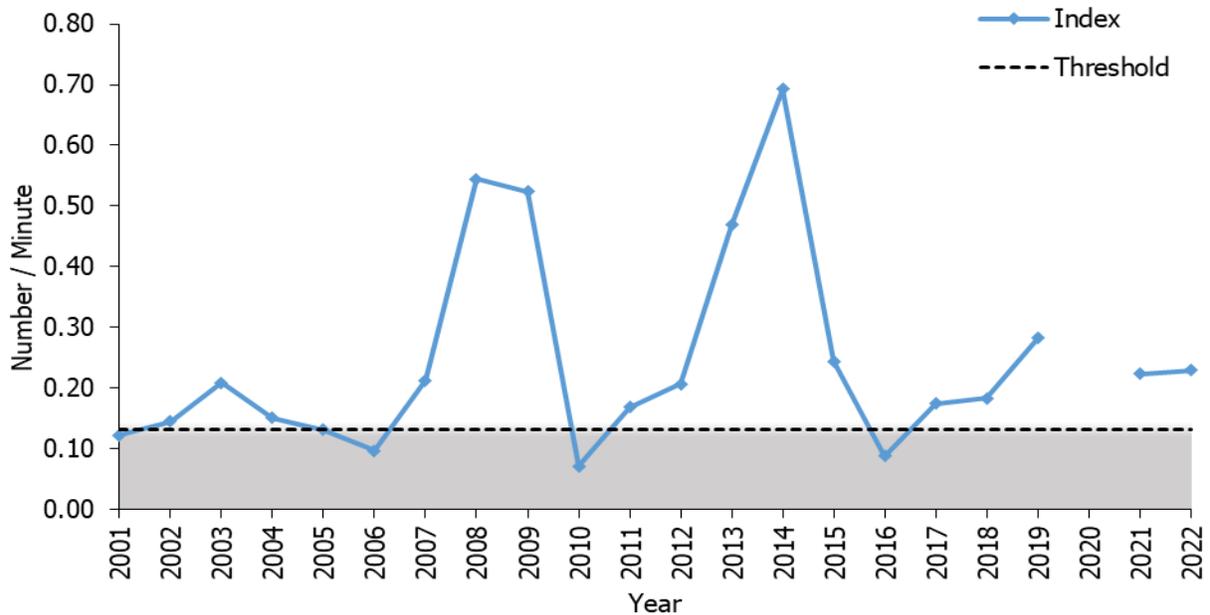


Figure 12. Female index from WRC electrofishing survey (March–May) for Roanoke River, 2001-2022. Threshold represents 25th percentile (where 75% of all values are greater). Values in gray are below the threshold. No survey data available for 2020.

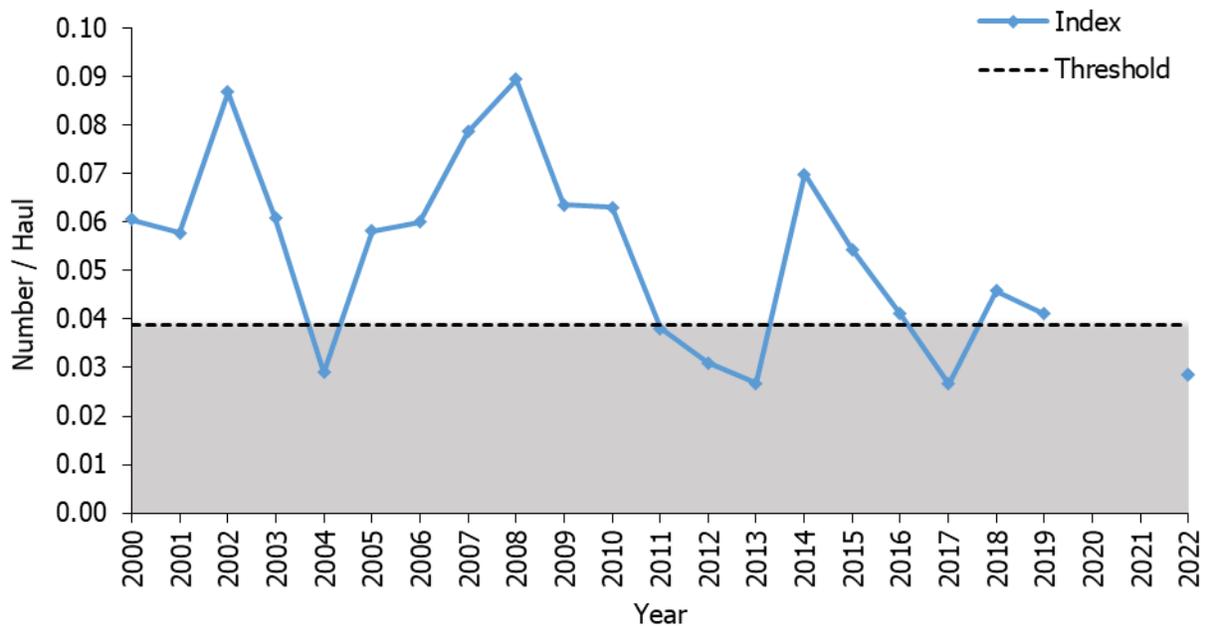


Figure 13. Female index from IGNS (January–May) for Albemarle Sound, 2000–2022. Threshold represents 25th percentile (where 75% of all values are greater). Values in gray are below the threshold. No survey data available for 2020–2021.

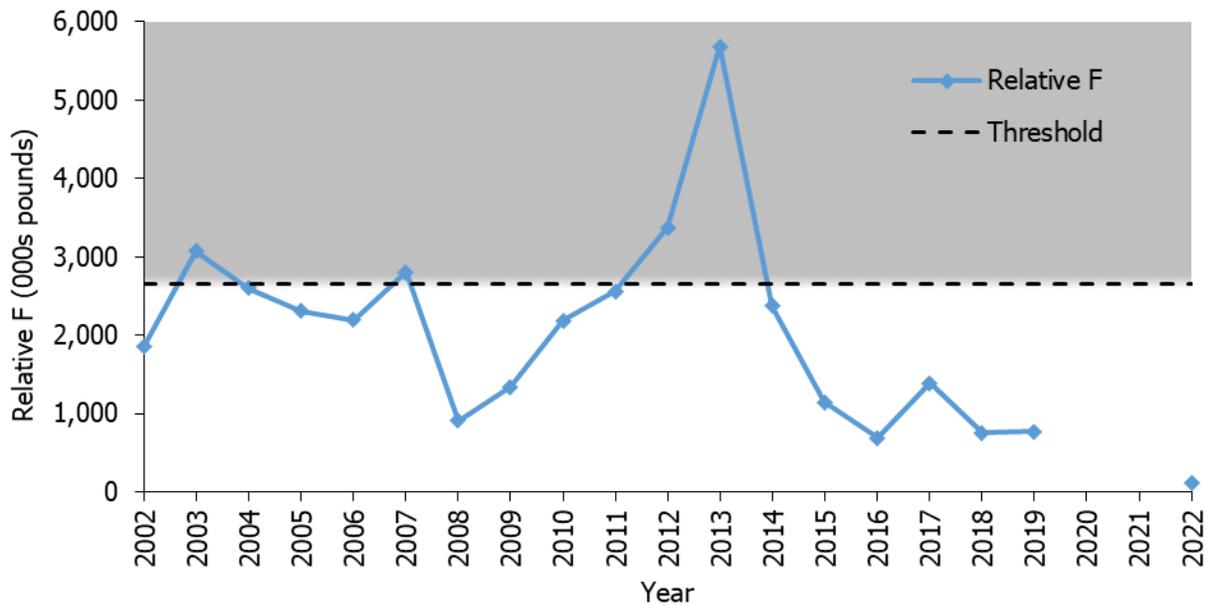


Figure 14. Albemarle Sound sustainability parameter for female relative  $F$  expressed in pounds of female fish, 2002–2022. The threshold represents the 75<sup>th</sup> percentile (where 25% of all values are greater), values in gray are exceeding the threshold. No survey data available for 2020 and 2021.

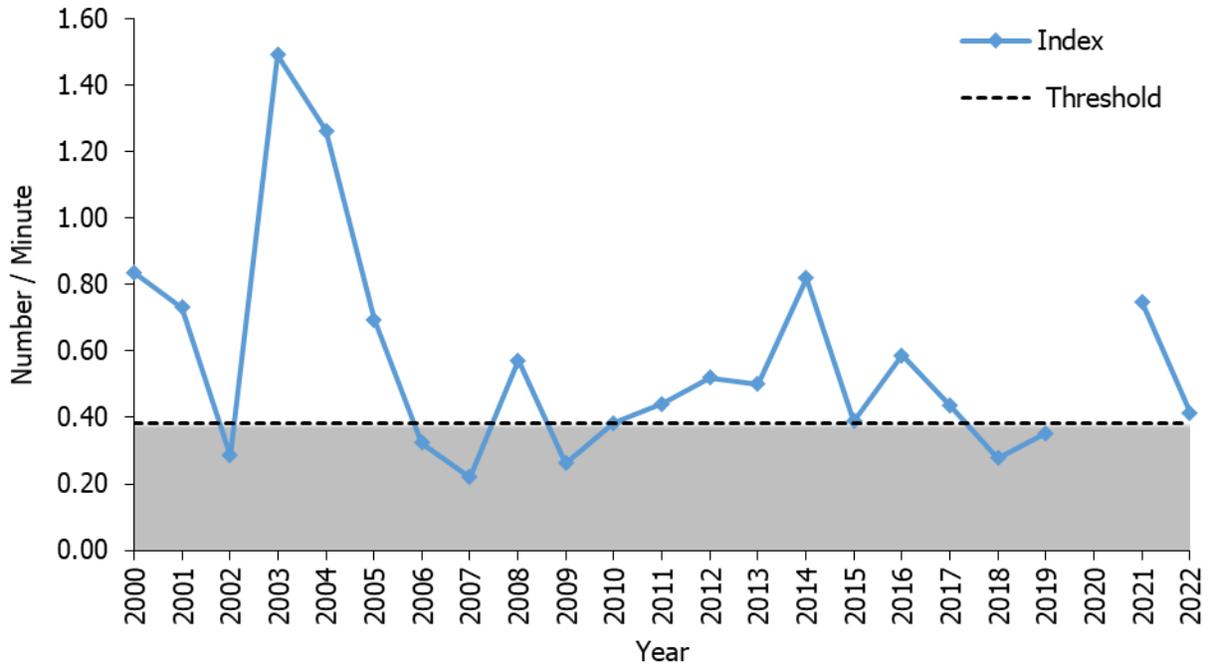


Figure 15. Female electrofishing index (March–May) for the Tar-Pamlico River, 2000–2022. The threshold represents the 25th percentile (where 75% of all values are greater). Values in gray are below the threshold. No survey data available for 2020.

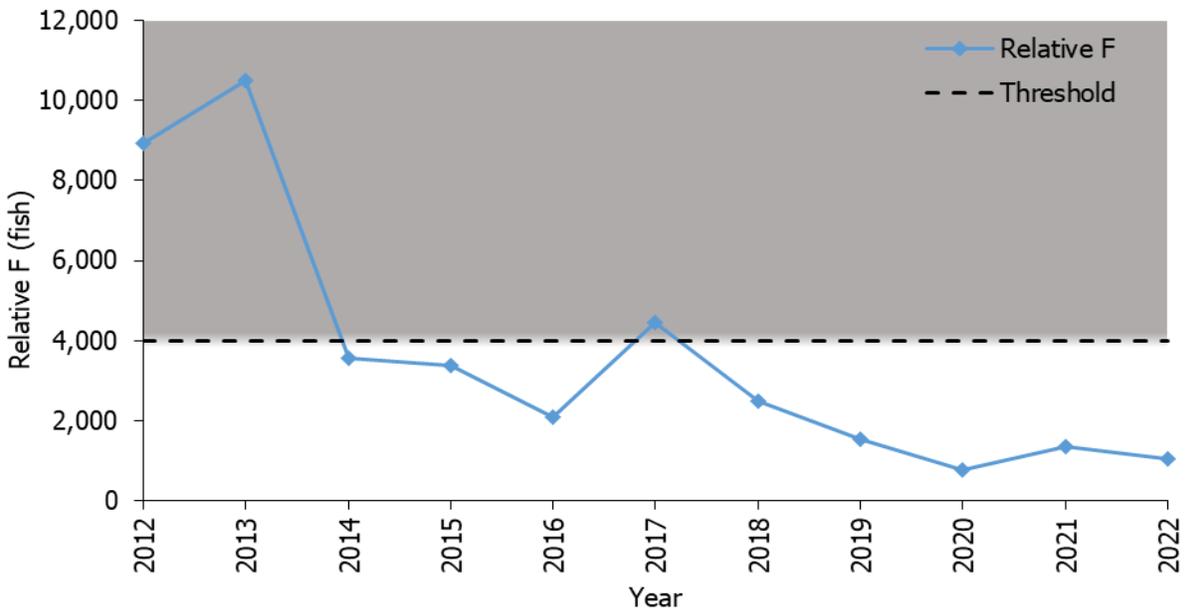


Figure 16. Tar-Pamlico River system sustainability parameter for female relative  $F$  in WRC electrofishing survey, 2012–2022. The threshold represents the 75th percentile (where 25% of all values are greater), values in gray are exceeding the threshold.

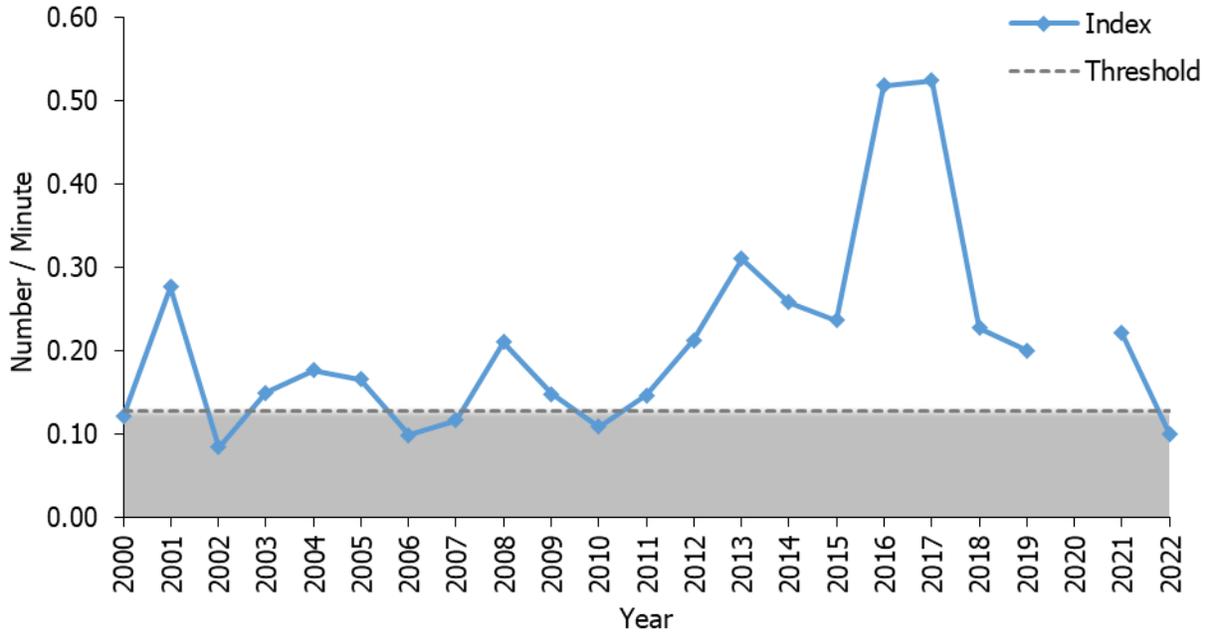


Figure 17. Female electrofishing index (March–May) for the Neuse River, 2000–2022. The threshold represents the 25th percentile (where 75% of all values are greater). Values in gray are below the threshold. No survey data available for 2020.

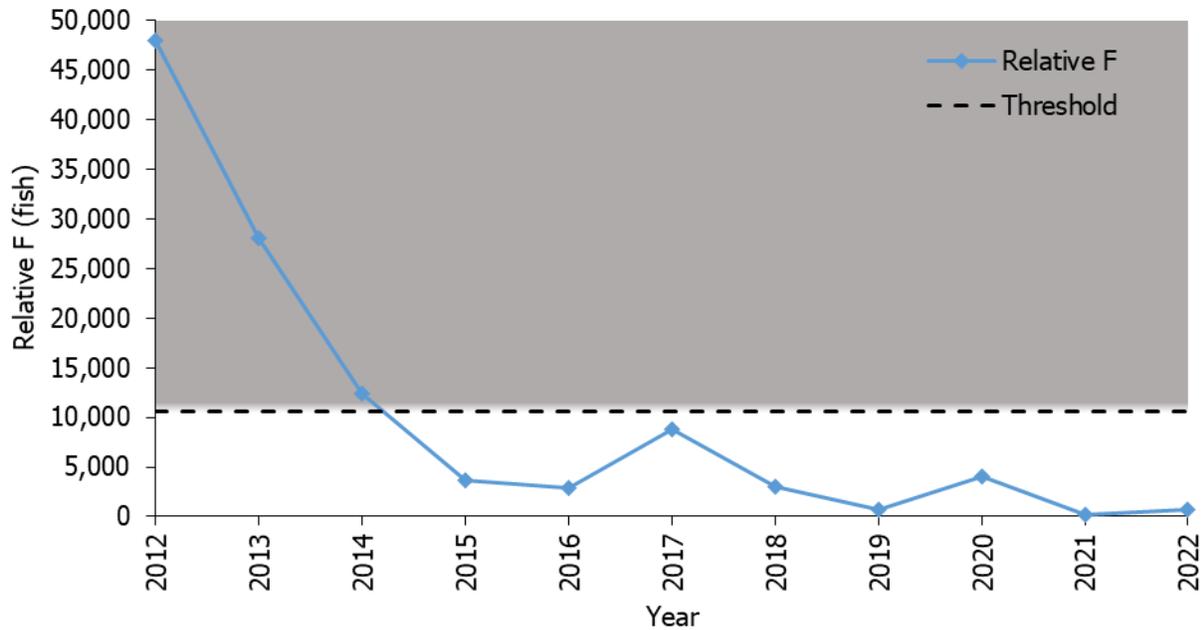


Figure 18. Neuse River system sustainability parameter for female relative F in WRC electrofishing survey, 2002–2022. The threshold represents the 75th percentile (where 25% of all values are greater), values in gray are exceeding the threshold.

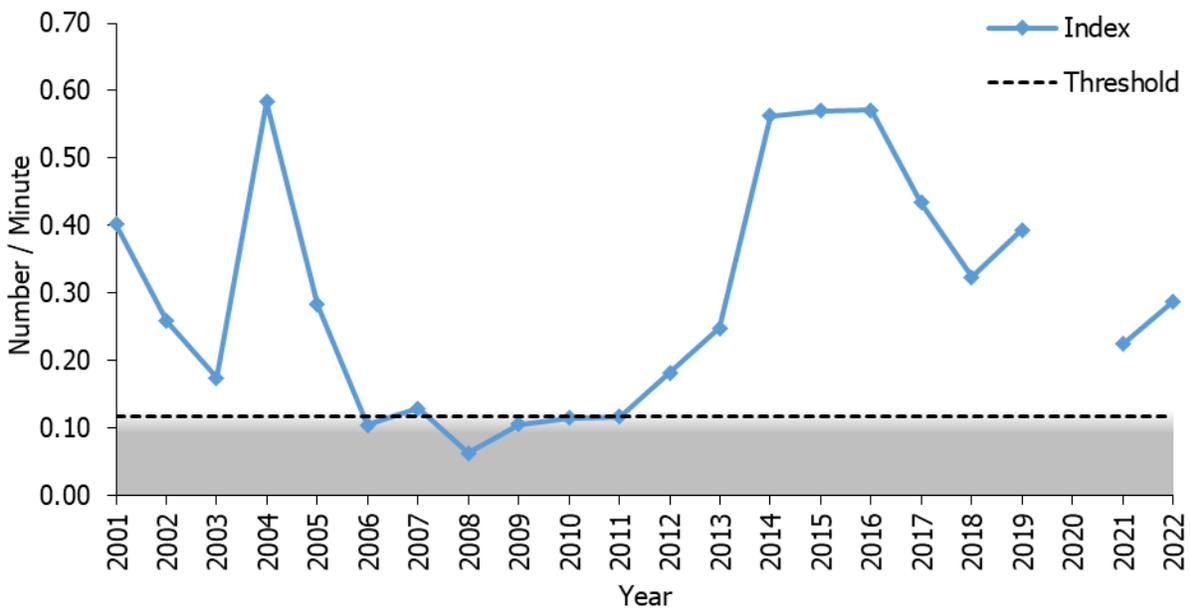


Figure 19. Female electrofishing index (March–May) for the Cape Fear River (LD-1 and LD-2, only), 2001–2022. The threshold represents the 25th percentile (where 75% of all values are greater). Values in gray are below the threshold. No survey data available for 2020.

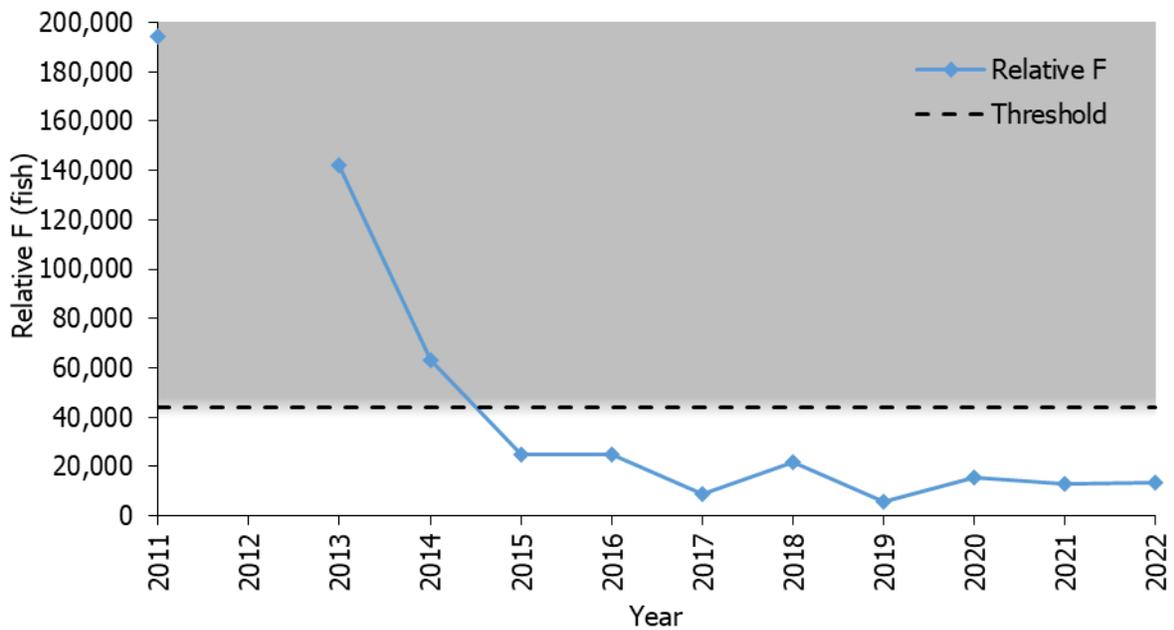


Figure 20. Cape Fear River system sustainability parameter for female relative F in WRC electrofishing survey, 2011–2022. The threshold represents the 75th percentile (where 25% of all values are greater), values in gray are exceeding the threshold.

**FISHERY MANAGEMENT PLAN UPDATE  
ATLANTIC CROAKER  
JUNE 2023**

**STATUS OF THE FISHERY MANAGEMENT PLAN**

**Fishery Management Plan History**

FMP Documentation:	ASMFC FMP	October 1987
	Amendment 1	November 2005
	Addendum I	March 2011
	Addendum II	March 2014
	Addendum III	February 2020
Comprehensive Review:	2024	

The original Fishery Management Plan (FMP) for Atlantic croaker was adopted in 1987 and included states from Maryland through Florida (ASMFC 1987). Upon review of the FMP, the South Atlantic State/Federal Fisheries Management Board (here after referred to as the Board) determined the management recommendations were vague and that an amendment was needed to better define the management measures necessary to achieve the FMP goals. The Interstate Fisheries Management Program Policy Board 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 in preparation for an amendment. The stock assessment was developed in 2003 and approved by a Southeast Data Assessment Review panel for management use in June 2004. Amendment 1 was approved in November 2005 and fully implemented by January 1, 2006 (ASMFC 2005).

Amendment 1 expanded the original management area to include the states of Delaware and New Jersey and defined two management regions: the mid-Atlantic region which included states from New Jersey through North Carolina and the south-Atlantic region, which included states from South Carolina through the east coast of Florida (ASMFC 2005).

Amendment 1 established biological reference points to define the overfished and overfishing stock statuses for the mid-Atlantic region only. Amendment 1 did not require specific measures to restrict recreational or commercial harvest, though states with more conservative measures in place were encouraged to maintain those regulations. Amendment 1 also specified that, through adaptive management, the Board may revise Amendment 1. 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 assessment of the stock in non-assessment years. However, if 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 included relative percent change in landings, biological data monitoring,

effort vs. landings, Marine Recreational Information Program catch per unit effort (CPUE), along with state and regional surveys.

Addendum I to Amendment 1 was initiated in August 2010 to modify the management area and biological reference points for Atlantic croaker, based on results from the 2010 stock assessment. The assessment evaluated the Atlantic croaker population as a single coast wide stock, whereas Amendment 1 divided the coast into two management regions. To fully utilize the stock assessment in managing the population, Addendum I consolidated the stock into one management unit and established a procedure by which the Board could 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 approved in August 2014. Addendum II established the use of the Traffic Light Approach (TLA) as a precautionary management framework (Caddy and Mahon 1995; Caddy 1998, 1999; Caddy 2002). The TLA is preferred for fast-growing, early maturing species like Atlantic croaker because it is more important to respond to multi-year trends rather than annual changes. The TLA more effectively illustrates long term trends than the triggers established by Addendum I. The management framework utilizing the TLA replaced the management triggers stipulated in Addendum I (ASMFC 2014). The harvest component of the TLA is a composite of commercial and recreational harvest data. The population, or adult abundance, component is a composite of fishery independent survey indices (e.g., Northeast Fishery Science Center (NEFSC) and Southeast Area Monitoring and Assessment Program (SEAMAP)). If thresholds for both population characteristics meet or exceed thresholds for a three-year period, management measures are triggered.

In February 2020, the Board approved Addendum III to Amendment 1, which revised the TLA's trigger mechanism and management response for the recreational and commercial fisheries (ASMFC 2020a). Addendum III incorporated the use of a regional approach (Mid-Atlantic NJ-VA and South Atlantic NC-FL) to better reflect localized fishery trends and changed the TLA to trigger management action if three of the four terminal years exceed threshold levels. State-specific management action is initiated when the proportion of red exceeds specified thresholds (30% or 60%) for both harvest and abundance. If management action is triggered, the coastwide response includes recreational bag limits and quantifiable measures to achieve percent reductions in commercial harvest. Response requirements vary depending on which threshold is exceeded. Addendum III also defines the mechanism by which triggered management actions may be removed, after abundance characteristics are no longer triggering management action. The TLA is reviewed annually in September. For additional information and links to the above-mentioned FMP, amendment, and addendums please refer to the ASMFC webpage for Atlantic croaker (<http://www.asmfc.org/species/atlantic-croaker>).

The North Carolina Wildlife Federation submitted a petition for rulemaking on November 2, 2016, and a modification to the petition on January 12, 2017. The petitioner put forth seven rules to designate nursery areas, restrict gear and seasonality in the shrimp trawl fishery to reduce bycatch of fish (including spot, Atlantic croaker and weakfish), and establish an eight-inch minimum size limit for spot and a 10-inch minimum size limit for Atlantic croaker. At its February 2017 business meeting, the North Carolina Marine Fisheries Commission passed a motion to approve the petitioned rules to begin the rulemaking process. Upon review by the Office of State Budget and Management it was determined that sufficient state funds are not available to implement the

proposed rule changes without undue detriment to the agency’s existing activities and the rules were never adopted.

To ensure compliance with interstate requirements, North Carolina also manages Atlantic croaker under the North Carolina Fishery Management Plan for Interjurisdictional Fisheries. The goal of the North Carolina FMP for Interjurisdictional Fisheries is to adopt FMPs, consistent with North Carolina Law, approved by the Mid-Atlantic Fishery Management Council (MAFMC), South Atlantic Fishery Management Council (SAFMC), or the Atlantic States Marine Fisheries Commission (ASMFC) by reference and implement corresponding fishery regulations in North Carolina to provide compliance or compatibility with approved FMPs and amendments, now and in the future. The goal of the councils and ASMFC plans, established under the Magnuson-Stevens Fishery Conservation Management Act (federal councils) 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 the 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 to:

- Manage the fishing mortality rate to provide adequate spawning potential to sustain long-term abundance of the population.
- Manage the stock to maintain the spawning stock biomass above the target biomass levels and restrict fishing mortality to rates below the threshold.
- Develop a management program for restoring and maintaining essential habitat.
- Develop research priorities that will further refine the management program to maximize the biological, social, and economic benefits derived from the population.

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

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. However, the center of Atlantic croaker distribution is forecast to shift northward due to climate change (Hare et al. 2010). Atlantic croaker feed on shrimp, crabs, worms, shellfish, and small fishes (Powers et al. 2005; Nye et al. 2011). Atlantic croaker has a protracted 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 juveniles is usually in the spring, with movement to offshore waters in the fall (Haven 1959; Norcross and Austin 1988). Higher overwinter survival of juvenile Atlantic croaker has been linked to increased winter water temperatures (Hare and Able 2007; Morley et al. 2016).

Atlantic croaker grow quickly, and can reach sizes 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), with length at 50 percent maturity generally falling between seven- and nine-inches total length (Barbieri et al. 1994; ASMFC 2010; NCDMF 2021a). 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 years.

### **Stock Status**

Because there is no currently approved stock assessment, the stock status for Atlantic Croaker with relation to overfishing or overfished is unknown.

To evaluate the status of the stock between stock assessments, the TLA established under Addendum II and revised under Addendum III, is reviewed annually in years when an assessment is not already being conducted.

Results of the 2022 TLA (2021 terminal year) indicated harvest indices for both regions were above 30% in three of the last four years. The harvest composite index triggered for the eighth year in a row in the Mid-Atlantic region and the seventh year in a row in the South Atlantic region (Figure 1; ASMFC 2022). For both regions, 2021 trends were consistent with recent years but cannot be used as trigger mechanisms because catch restrictions were in place in 2021. The adult abundance (age 2+) composite characteristic has exceeded the 30% threshold since 2010 in the Mid-Atlantic region (no 2019, 2020, 2021 data points as ChesMMAP indices were not available) but has not exceeded the 30% threshold in the South Atlantic region since 2010 (no 2020 data points; Figure 2; ASMFC 2022). The adult composite index in the South Atlantic has indicated an increasing or stable trend for several consecutive years. While not used for management decisions, the composite juvenile abundance index consisting of North Carolina Pamlico Sound Survey is reviewed annually. The index has been variable since 2002 with some indication of increases in abundance since 2010 except for 2018 with a unusually high red portion indicating low abundance (Figure 3; ASMFC 2022).

### **Stock Assessment**

The next Atlantic croaker Benchmark Stock Assessment is scheduled for 2024. The most recent 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 assumptions and model inputs (ASMFC 2017,

2019). The review panel noted that discard estimates 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 TLA.

For reference, the most recent stock assessment accepted for use in management was completed in 2010 (ASMFC 2010). Results of the 2010 stock assessment indicated the population was not experiencing overfishing and was likely not overfished. The assessment indicated biomass had been increasing and the age-structure of the population had been expanding since the late 1980s. Biological reference points in the 2010 stock assessment are ratio based. Overfishing is occurring if  $F/FMSY$  is greater than 1 and the stock is considered overfished if  $SSB/(SSBMSY(1-M))$  is less than 1.

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

The 2020 TLA update (2019 terminal year) for Atlantic croaker triggered at the 30% threshold and coastwide management action as outlined in Addendum III was enacted in March 2021. The management response outlined in Addendum III specifies, non de minimis states are required to implement a 50 fish bag limit for their recreational fishery and must reduce commercial harvest by 1% of the average state commercial harvest from the previous 10 years.

In North Carolina, the 50 fish per person per day recreational bag limit became effective April 15th, 2021 (FF-24-2021) and has remained in place. The commercial Atlantic croaker fishery closed December 16th, 2021, through December 31st, 2021, and 2022 to meet the required 1% reduction (FF-65-2021, FF-58-2022). The same commercial closure period will occur in December 2023. Management measures will remain in place for at least three years (until 2023) and future TLA updates will determine future management action after this time.

### **Commercial Fishery**

Data collected from the North Carolina Trip Ticket program indicates commercial harvest was at its greatest in the late 1990's to early 2000s' peaking at 14,429,197 pounds in 2003 (Table 1; Figure 4a). Landings in the past six years have been the lowest in the time series dropping to a time series minimum of 357,312 pounds harvested in 2022. Commercial harvest averaged 4,390,341 pounds from 2018 through 2022 and has generally been declining since 2003 with significant landings declines beginning in 2011. Commercial landings are currently supported almost entirely (98%) by the gill net fishery with 78% of landings reported from ocean gill nets and 20% of landings from estuarine gill nets in 2022 (Figure 5). 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 Fishery**

Atlantic croaker are targeted recreationally by shore-based anglers and those fishing from private vessels during the summer and fall. 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 to 2008, an average of 14,534 pounds were harvested per year (NCDMF 2021b). Recreational estimates across all years have been updated and are now based on the Marine Recreational Information Program (MRIP) Fishing Effort Survey-based calibrated estimates. For more information on MRIP see <https://www.fisheries.noaa.gov/topic/recreational-fishing-data>.

From 1989 through 2022 recreational harvest of Atlantic croaker in North Carolina ranged from 164,644 to 1,749,275 pounds or between 472,917 and 5,488,002 fish (Table 1, Figures 4b and 6). Harvest by weight declined between 2014 and 2018 with the lowest reported value occurring in 2018 before increasing again from 2019 to 2022. The four lowest annual harvest weights in the time series occurred from 2017 to 2020. The number of individuals harvested followed similar trends, declining between 2014 to the lowest value in the time series in 2018, then increasing over the proceeding years. In 2022, 1,110,382 fish and 481,721 pounds of Atlantic croaker were harvested, a 28% increase in number of fish and a 4% increase in weight from 2021.

The number of recreational releases has been variable over the time series with a noticeable peak in 2014 (Figure 6). The percentage of releases has steadily increased between 1989 and 2022 from 59% to 90%, declining slightly to 88% in 2022. In 2022, anglers released 7,914,042 fish, a 17% decrease from 2021.

The number of Atlantic croaker measured during MRIP sampling has generally declined, with 69 individuals measured in 2022, the lowest in the time series (Table 2). Mean total length (TL) in 2022 was 9.3 inches which is slightly less than preceding years. Mean TL has fluctuated little since 1989 ranging from 8.3 inches to 10.4 inches. Similarly, minimum and maximum TL have fluctuated little since 1989. Most of the recreational catch consists of fish from 6.0 to 10.0 inches TL (Figure 7). There was a wider range of lengths harvested during the 1990's and early 2000's relative to recent years. Length distribution from the 2022 recreational harvest ranged from 6.3 to 15.7 inches (Figure 8).

## **MONITORING PROGRAM DATA**

### **Fishery-Dependent Monitoring**

In 2022, 2,850 Atlantic croaker lengths were obtained from commercial fish house sampling with a mean TL of 9.7 inches, and lengths ranging from 7.1 to 13.9 inches (Table 3). Mean TL has varied little ranging from 9.3 inches to 12.1 inches and has generally declined since 2005. Minimum TL ranged from 3.9 inches to 7.4 inches and maximum TL ranged from 13.3 inches to 20.0 inches. Bait samples are included in calculations of mean, minimum and maximum length.

Modal length generally increased from 1994 to the early 2000's (Figure 9). There is a noticeable decline and contraction in size classes beginning in 2015, with most fish falling between 7.0 and 11.0 inches.

Size trends in 2022 commercial samples indicate a dominance of 8.5-inch and 9.0-inch fish with few over 10.0 inches or under 8.0 inches (Figure 8). When compared to the recreational fishery, the commercial fishery harvested a narrower range of sizes.

## **Fishery-Independent Monitoring**

The number of Atlantic croaker aged in North Carolina's comprehensive life history program (P930) from 1997 through 2022 has ranged from 237 in 2011 to 1,070 in 2014 (Table 4). Modal age was one or two in most years but has been zero in recent years including 2008, 2016, 2017, and 2020. Minimum age was zero in every year while maximum age ranged from six to 15 years. Maximum age was between 11 and 15 years from 2001-2010 and between six and ten from 2011-2022. A total of 580 fish were aged in 2022 with a modal age of two and a maximum age of nine. There is significant overlap in length at age for most observed ages, though mean length tends to plateau at age seven and length does not exceed 22 inches in any age class (Figure 10).

The Pamlico Sound Survey (P195) samples 54 stations (grids) annually 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) that are incorporated into ASMFC stock assessments and reported annually to ASMFC as part of compliance reports and for incorporation into the juvenile composite TLA. Length cutoffs for juvenile Atlantic croaker were updated in 2022 after analyzing length distribution of age-0 and age-1 Atlantic croaker in P930. Juvenile Atlantic croaker are defined as fish <160 mm TL (6.3 inches) in June, and fish <210 mm TL (8.3 inches) in September.

The COVID pandemic impacted sampling in 2020 and 2021. Executive Order (EO) 116, issued on March 10, 2020, declared North Carolina under a State of Emergency and was soon followed by EO 120 which implemented a statewide Stay at Home Order for all non-essential State employees. In 2020, sampling was limited to 28 stations sampled in June and 35 stations sampled in September. A total of 35 stations were sampled in June 2021 and 33 stations were sampled in September 2021. Limited sampling likely impacted abundance indices calculated from Sound Survey data. An initial analysis of this impact was conducted for the 2020 Atlantic croaker abundance indices and concluded the magnitude of abundance may be overestimated slightly but limited sampling was likely able to capture general abundance trends.

The Atlantic croaker weighted JAI from the Pamlico Sound Survey from 1987 through 2022 has been variable in both June and September. Annual fluctuations in the June JAI are most notable after 2009 when steep increases in abundance are followed by steep declines (Figure 11). The June JAI has ranged from 69 individuals per tow in 1996 to 1,297 individuals per tow in 2010 with a time series average of 417 individuals per tow. The time series average in September is slightly greater at 518 individuals per tow ranging from 96 individuals per tow in 1987 to 1,376 individuals per tow in 2020. The September JAI fluctuates around the time series average but the past ten years indicate an increasing trend. The JAI for September declined in 2021 but increased to 774.7 individuals per tow in 2022. The June JAI in 2022 was 312.3 individuals per tow, continuing the decline from June 2020.

Most Atlantic croaker captured in the Pamlico Sound Survey are juveniles (age 0), but because of the protracted spawning and recruitment period, the length composition of Atlantic croaker captured in the survey can be variable. There is more variability in length compositions of Atlantic croaker caught in the June portion of the survey compared to the September portion of the survey

(Figure 12). Modal length in June is generally 3.0 to 5.0 inches while modal length in September is around 5.0 to 5.5 inches with little fluctuation between years.

## **RESEARCH NEEDS**

There is 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. The high priority research recommendations are reported below. Additional research and monitoring recommendations can be found in the 2016 Atlantic Croaker Stock Assessment Peer Review Report here under Term of Reference 8 (ASMFC 2017).

- Describe the coast-wide distribution, behavior, and movement of croaker by age, length, and season, with emphasis on collecting larger, older fish.
- 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.
- Quantify effects of BRDs and TEDs implementation in the shrimp trawl fishery by examining their relative catch reduction rates on Atlantic croaker.
- 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.
- 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).

## **MANAGEMENT STRATEGY**

The TLA established under Addendum II and revised under Addendum III (approved February 2020) to Amendment 1 is used as a precautionary management framework for Atlantic croaker. The TLA provides guidance in lieu of a current stock assessment. Addendum III incorporated the use of a regional approach (Mid-Atlantic NJ-VA and South Atlantic NC-FL) to better reflect localized fishery trends. 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 any three of the four most recent years, then management action is required. The harvest composite index triggered at the 30% threshold in both regions in 2019. The adult abundance characteristics for the Mid-Atlantic exceeded the threshold in 2019 while the South Atlantic abundance composite characteristic did not exceed the trigger in 2019. Since both population characteristics were above the 30 percent threshold in at least three years from 2016-2019, management actions were implemented in March 2021. Management measures will remain in place for at least three years (until 2023) and future TLA updates will determine future management action after this time.

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## TABLES

Table 1. Atlantic croaker recreational harvest and number released (Marine Recreational Information Program) and commercial harvest (North Carolina Trip Ticket Program), 1989–2022. All weights are in pounds.

Year	Recreational			Commercial	Total Weight (lb)
	Numbers Landed	Numbers Released	Weight Landed (lb)	Weight Landed (lb)	
1989	5,448,002	2,289,602	1,749,275	6,824,088	8,573,363
1990	2,298,692	3,298,860	722,352	5,769,512	6,491,864
1991	1,335,923	2,031,277	488,193	3,436,960	3,925,153
1992	1,836,941	2,565,212	556,026	2,796,612	3,352,638
1993	1,590,195	2,594,149	590,338	3,267,652	3,857,990
1994	1,921,848	4,302,429	557,403	4,615,754	5,173,157
1995	1,632,366	2,024,031	602,628	6,021,304	6,623,932
1996	1,224,357	2,051,175	564,016	9,961,842	10,525,858
1997	1,142,169	2,367,265	550,949	10,711,667	11,262,616
1998	865,487	2,038,932	376,255	10,865,897	11,242,152
1999	1,042,224	2,848,626	525,970	10,185,507	10,711,477
2000	860,246	3,475,554	394,037	10,122,627	10,516,664
2001	1,285,029	2,387,491	647,119	12,017,424	12,664,543
2002	1,265,031	2,218,039	651,611	10,189,153	10,840,764
2003	1,127,298	2,765,303	708,487	14,429,197	15,137,684
2004	1,218,206	3,407,280	683,113	11,993,003	12,676,116
2005	672,437	3,038,472	323,380	11,903,292	12,226,672
2006	1,376,403	6,381,434	498,741	10,396,554	10,895,295
2007	1,058,663	3,933,603	336,486	7,271,163	7,607,649
2008	678,638	3,274,873	275,052	5,791,769	6,066,821
2009	958,128	5,623,278	359,703	6,135,452	6,495,155
2010	1,280,446	4,571,287	638,817	7,312,159	7,950,976
2011	873,659	7,005,152	360,390	5,054,186	5,414,576
2012	848,495	3,878,710	307,338	3,106,616	3,413,954
2013	1,300,804	6,729,556	453,881	1,927,938	2,381,819
2014	1,935,961	10,347,332	758,751	2,629,908	3,388,659
2015	1,437,019	9,632,560	557,735	1,819,020	2,376,755
2016	1,109,570	7,254,382	443,728	2,092,287	2,536,015
2017	666,930	4,631,445	237,160	1,008,015	1,245,175
2018	472,917	4,311,368	164,644	1,643,646	1,808,290
2019	651,268	3,634,211	224,337	1,278,340	1,502,677
2020	673,377	5,560,605	223,685	570,423	794,108
2021	1,066,533	9,539,047	376,121	540,620	916,741
2022	1,110,382	7,914,042	481,721	357,312	839,033
Mean	1,301,931	4,409,605	511,454	6,001,379	6,512,834

Table 2. Mean, minimum, maximum total length (inches), and total number of Atlantic croaker measured by Marine Recreational Information Program sampling in North Carolina, 1991–2022.

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Total Number Measured
1989	8.3	5.1	13.2	1,138
1990	8.3	4.3	15.5	1,066
1991	8.3	5.1	15.2	627
1992	8.5	4.6	13.2	535
1993	8.7	5.0	21.2	861
1994	8.6	4.8	15.6	2,065
1995	9.2	4.3	15.6	1,268
1996	10.0	5.3	16.7	1,169
1997	9.6	5.0	16.5	937
1998	9.3	6.0	16.7	599
1999	9.7	6.3	17.2	681
2000	9.6	6.7	17.6	360
2001	10.0	6.5	15.8	529
2002	9.7	6.0	15.0	255
2003	10.4	7.3	18.4	289
2004	10.1	7.0	17.4	263
2005	9.6	6.7	17.2	140
2006	8.8	4.8	14.9	198
2007	8.4	4.1	13.9	113
2008	9.4	4.3	15.4	188
2009	8.9	5.7	15.8	210
2010	9.8	6.2	16.8	330
2011	9.6	4.9	14.3	255
2012	9.2	4.9	14.1	230
2013	9.1	5.9	15.4	267
2014	9.1	4.1	14.1	215
2015	9.2	5.8	13.9	142
2016	9.3	6.3	13.2	219
2017	9.0	6.7	12.5	169
2018	8.9	6.5	19.1	119
2019	9.0	5.9	19.1	147
2020	8.9	5.9	19.1	127
2021	8.9	6.6	12.8	122
2022	9.3	6.3	15.7	76

Table 3. Mean, minimum, maximum total length (inches), and total number of Atlantic croaker measured from North Carolina commercial fish house samples, 1994–2022. Bait samples are included in calculations of mean, minimum and maximum length.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1994	9.3	4.6	15.2	20,162
1995	9.7	4.6	18.0	18,897
1996	11.0	4.3	18.3	32,310
1997	11.1	4.3	17.9	26,233
1998	11.7	3.9	19.7	22,815
1999	11.8	3.9	19.1	20,976
2000	11.6	4.0	19.8	29,022
2001	12.0	4.5	19.7	30,506
2002	12.0	5.1	19.7	21,990
2003	12.1	4.9	18.6	25,881
2004	12.0	3.9	20.0	23,330
2005	12.0	4.9	19.7	21,719
2006	11.3	4.7	19.2	20,533
2007	11.3	4.6	19.4	15,011
2008	11.1	4.6	19.5	15,032
2009	11.2	4.8	19.1	20,448
2010	11.3	5.0	17.8	21,511
2011	11.5	4.6	16.6	15,948
2012	11.2	5.7	17.9	10,923
2013	11.2	5.6	17.2	9,059
2014	10.3	4.4	16.7	11,523
2015	10.6	5.4	15.5	9,593
2016	10.7	7.4	15.2	6,959
2017	10.0	6.6	15.2	6,022
2018	10.3	6.2	15.2	3,771
2019	9.9	6.1	15.2	4,775
2020	9.4	5.4	13.3	1,807
2021	9.6	5.9	13.7	4,242
2022	9.7	7.1	13.9	2,850

Table 4. Modal, minimum, maximum age, and total number of Atlantic croaker aged in North Carolina from fishery dependent and fishery independent sampling, 1996–2022. Includes otolith ages only.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
1997	1	0	9	471
1998	1	0	9	1,030
1999	1	0	9	671
2000	1	0	9	815
2001	2	0	12	793
2002	1	0	11	605
2003	1	0	12	516
2004	2	0	13	681
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	451
2018	1	0	8	544
2019	2	0	10	537
2020	0	0	7	380
2021	1	0	9	486
2022	2	0	9	580

FIGURES

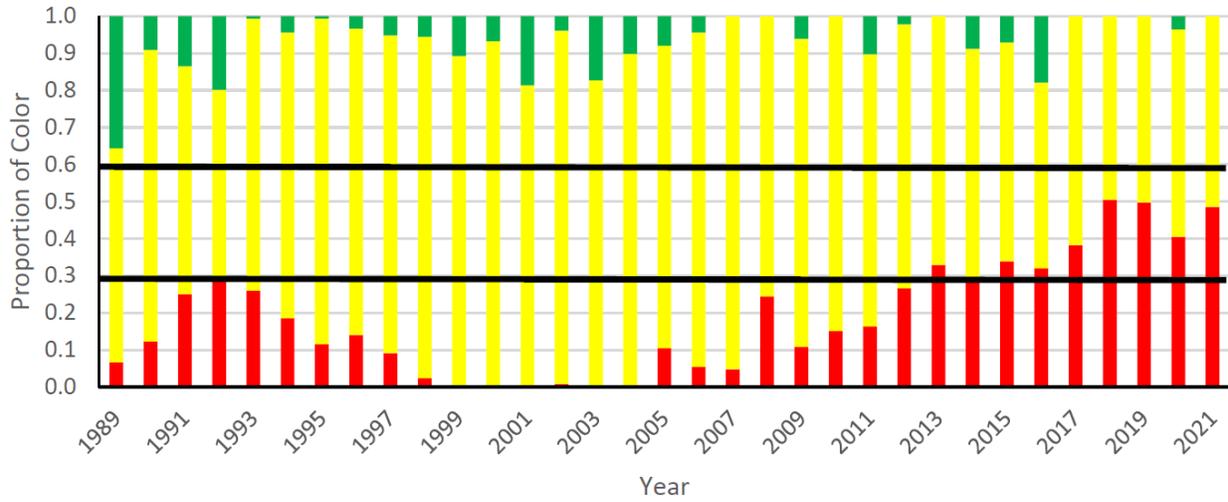


Figure 1. Annual color proportions for the harvest composite TLA of South Atlantic region (NC-FL) Atlantic croaker recreational and commercial landings, 1989–2021 (ASMFC 2022). The reference period is 2002–2012.

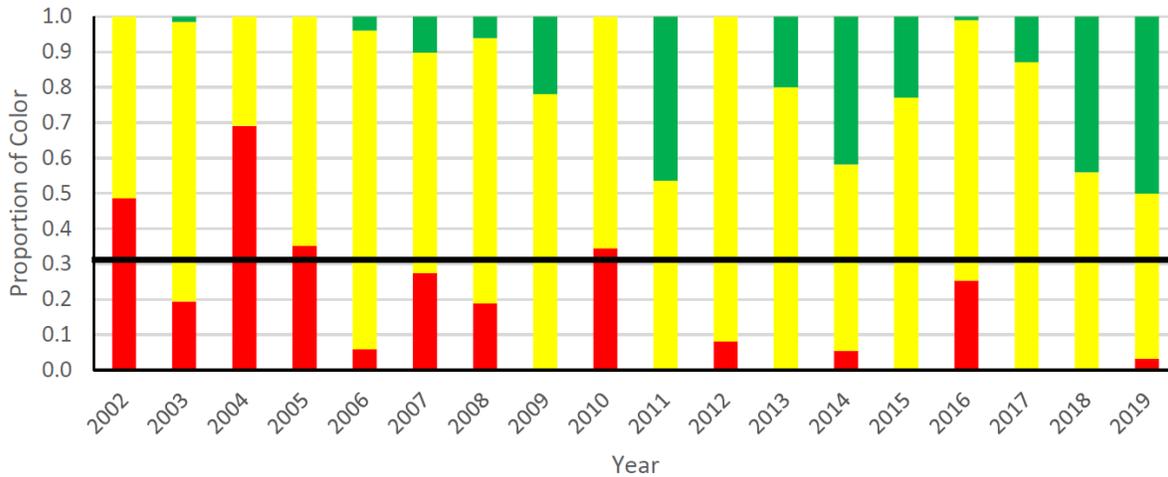


Figure 2. Annual color proportions for the abundance composite TLA of South Atlantic region (NC-FL) for adult (age 2+) Atlantic croaker fishery independent indices (SEAMAP and SCDNR trammel survey), 2002–2019 (no 2020 or 2021 data points due to limited sampling; ASMFC 2022). The reference period is 2002–2012.

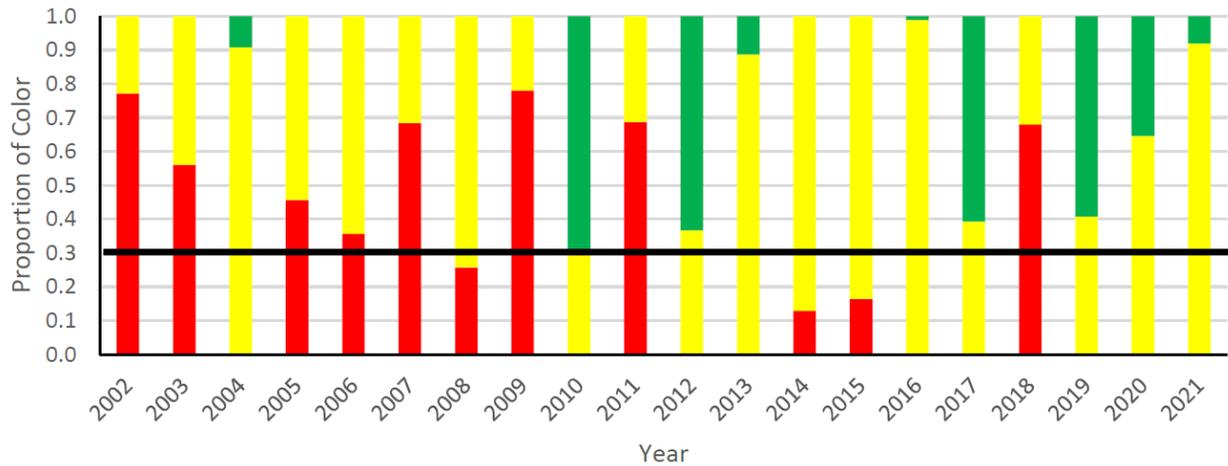


Figure 3. Annual color proportions for the abundance composite TLA of South Atlantic region (NC-FL) for juvenile (age 0-1) Atlantic croaker from the DMF Pamlico Sound Survey, 2002–2021 (ASMFC 2022). Reference period is 2002–2012. Juvenile index does not trigger management action

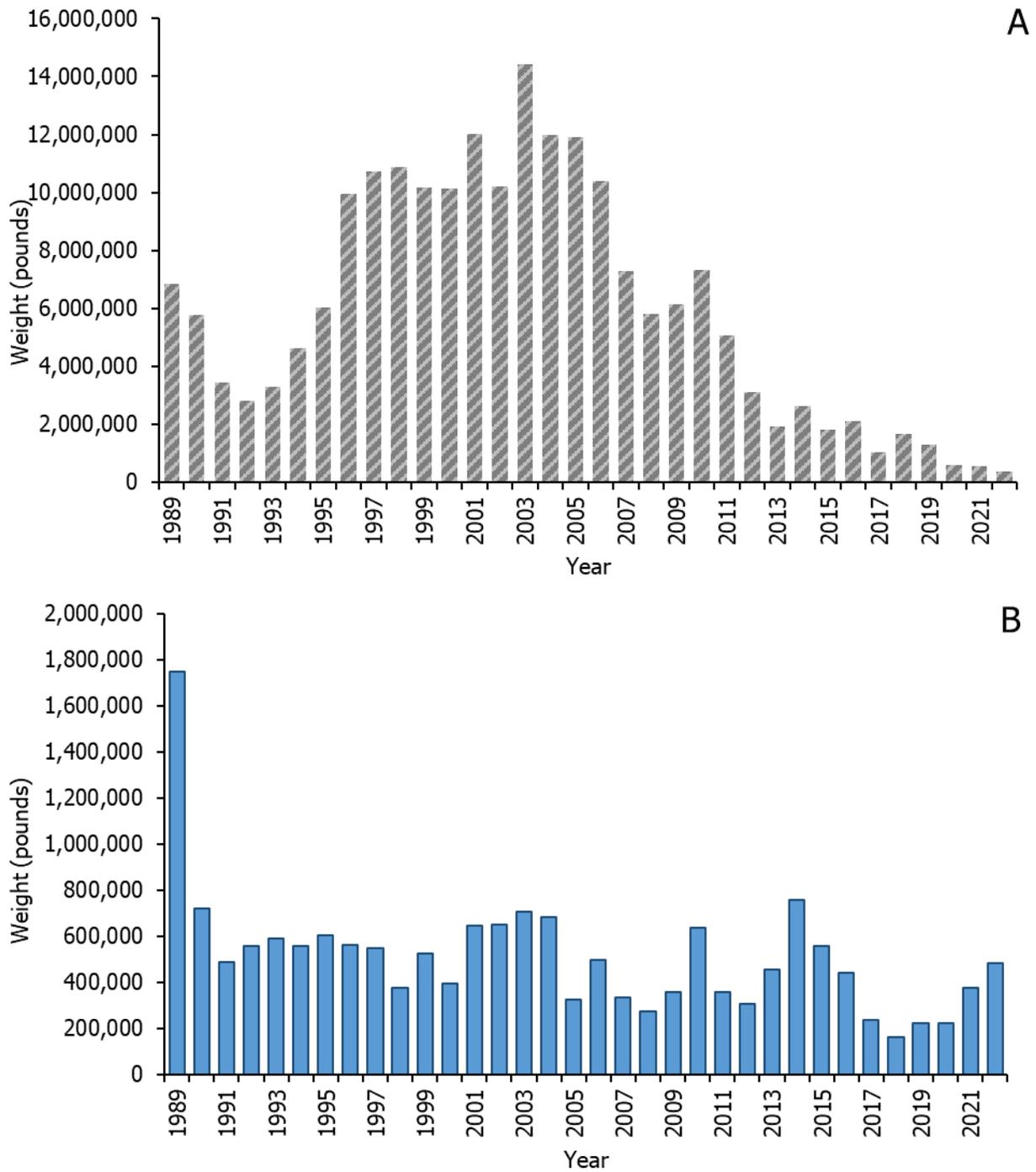


Figure 4. Annual A) commercial landings (North Carolina Trip Ticket Program) and B) recreational harvest (Marine Recreational Information Program) in pounds for Atlantic croaker in North Carolina, 1989–2022.

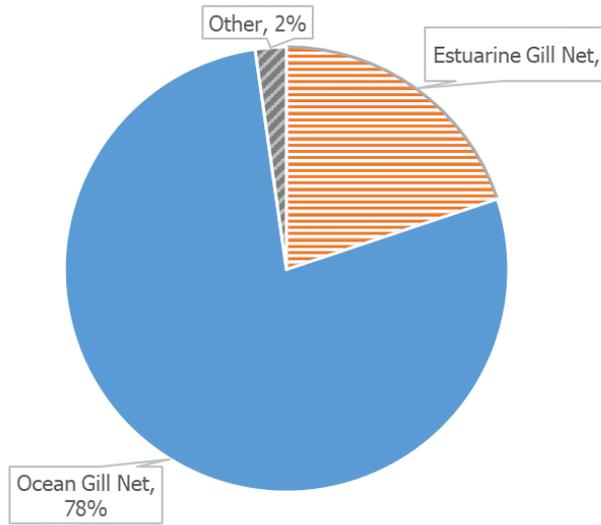


Figure 5. Commercial harvest of Atlantic croaker by gear, 2022. Other gears include swipe net, beach seine, crab pots, haul seines and pound nets.

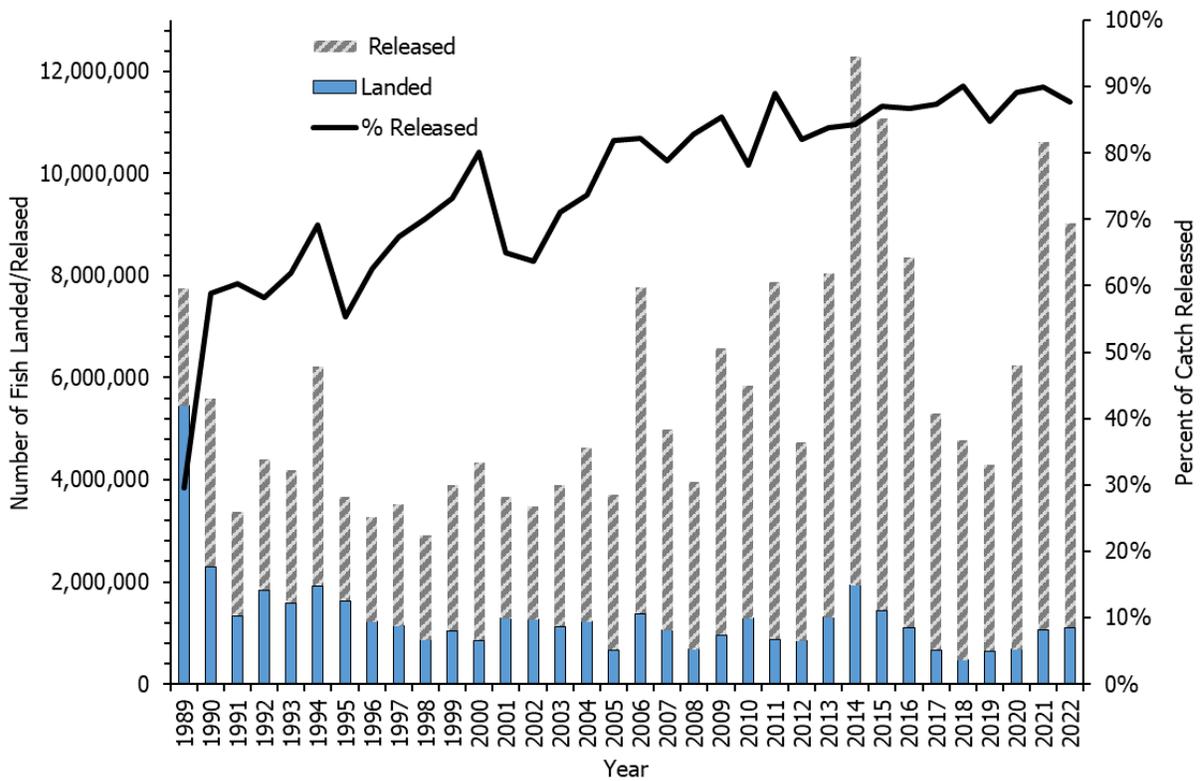


Figure 6. Recreational catch (landings and releases, in numbers) and the percent of catch that is released, 1989–2022 from the MRIP.

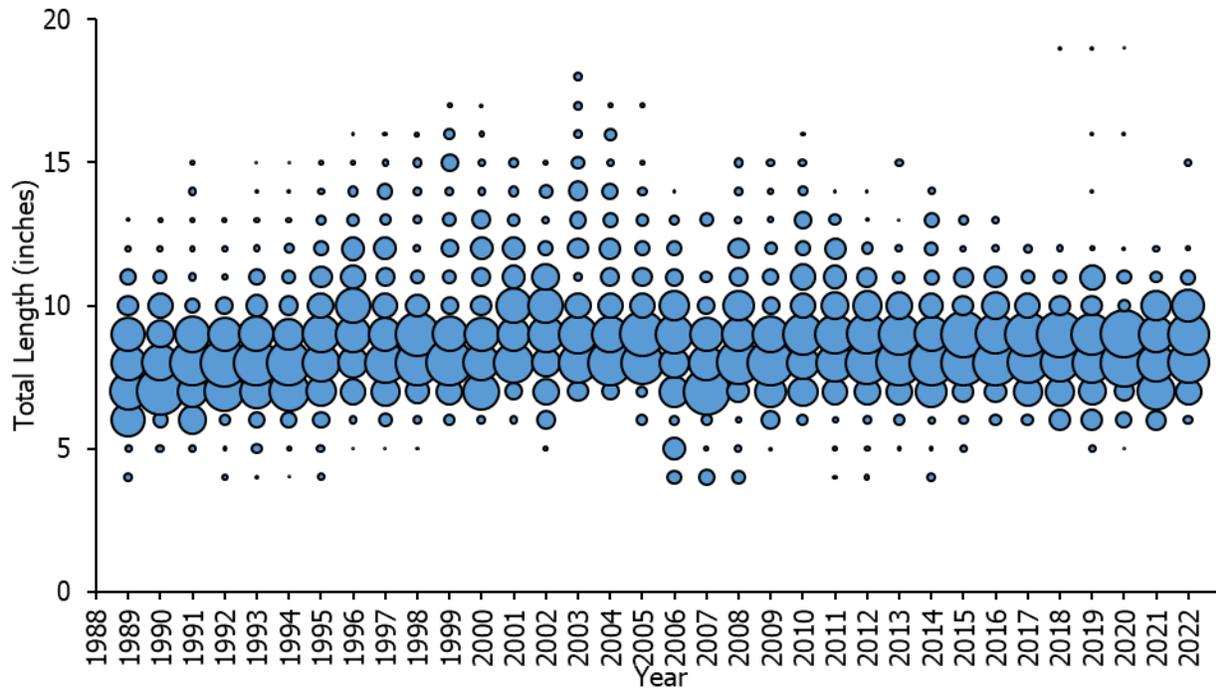


Figure 7. Recreational length frequency (total length, inches) of Atlantic croaker harvested, 1989–2022 (MRIP, n=44,263,763). Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

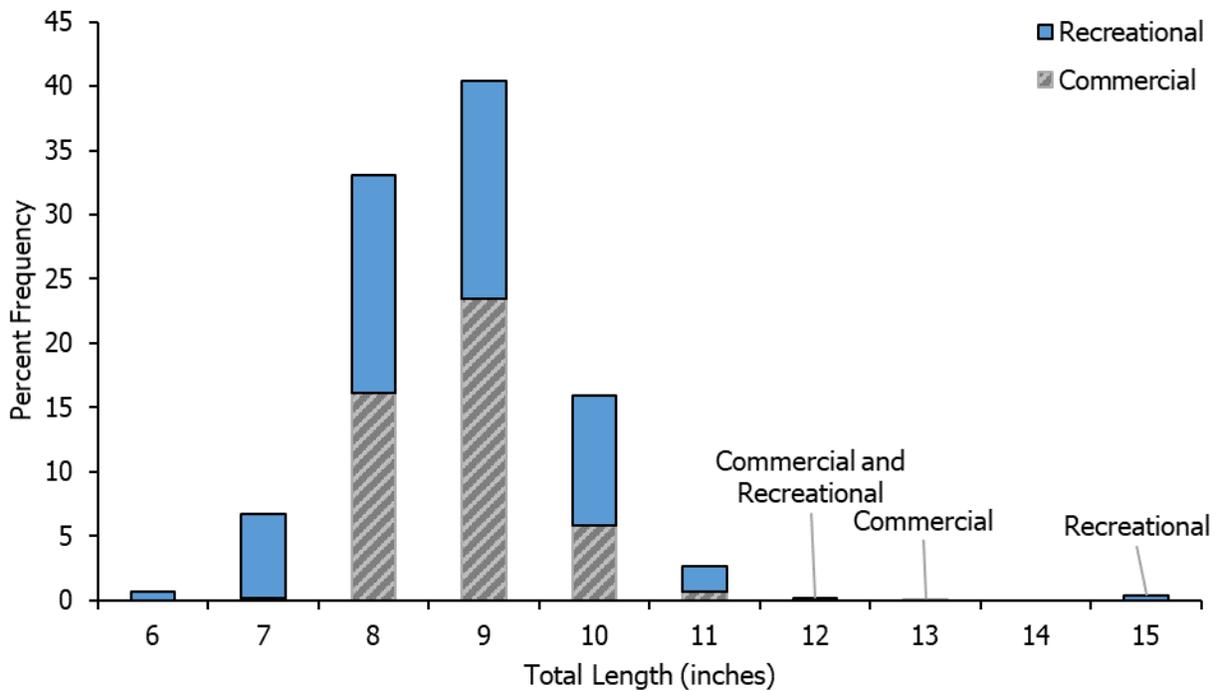


Figure 8. Commercial (n=955,084) and recreational (n=1,110,382) length frequency (TL, inches) distribution from Atlantic croaker harvested in 2022.

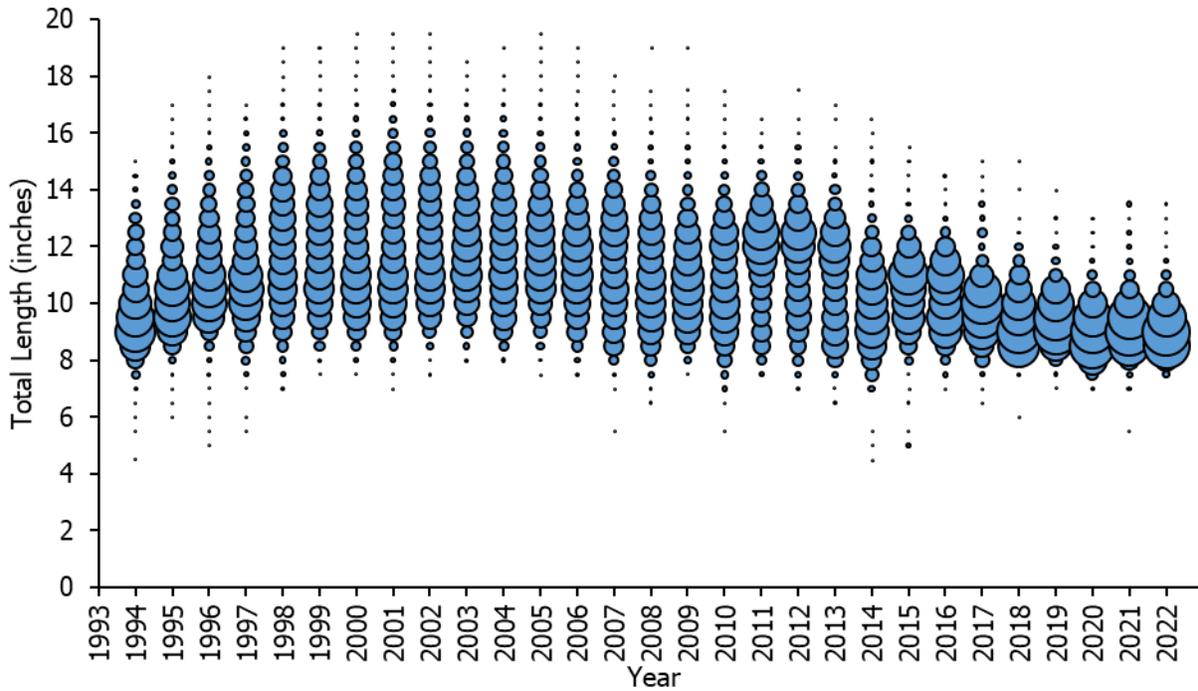


Figure 9. Commercial length frequency (total length, inches) of Atlantic croaker harvested from 1994–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length. Bait samples not included.

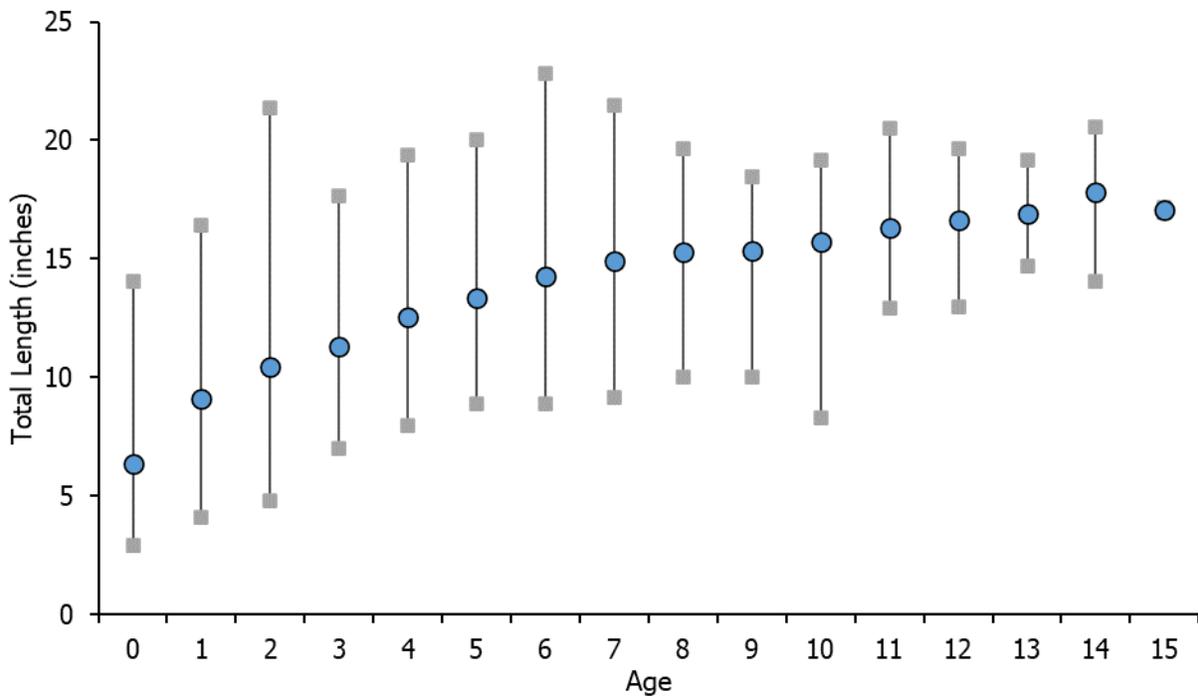


Figure 10. Atlantic croaker length at age based on age samples collected from 1994 to 2022 (n=15,987). Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age. Only ages derived from otoliths were used.

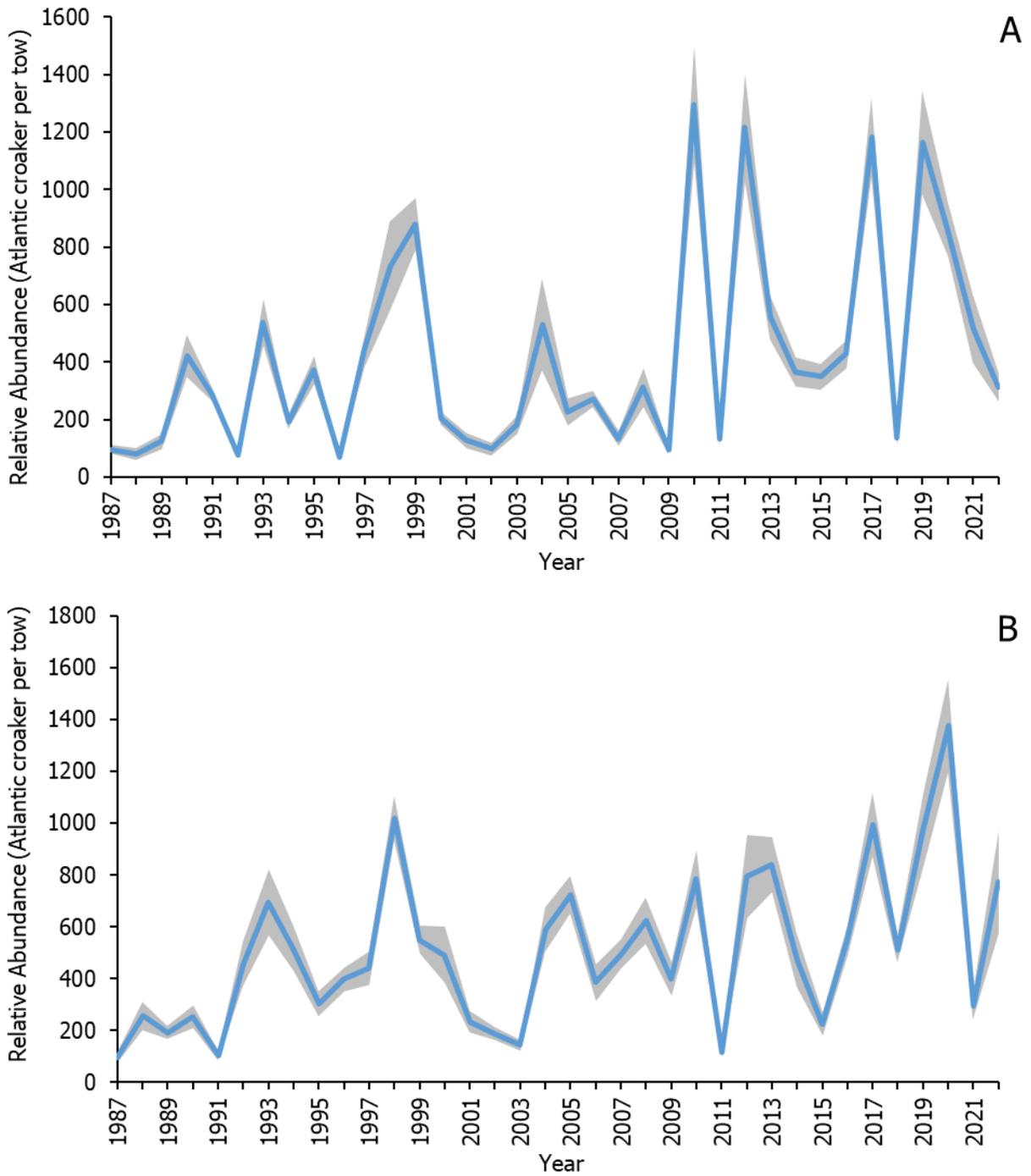


Figure 11. Atlantic croaker weighted juvenile relative abundance (number per tow) for A) June and B) September from the Pamlico Sound Survey, 1987–2022. Shaded area represents standard error. Length cutoffs are <160 mm TL (6.3 in) in June and <210 mm TL (8.3 in) in September.

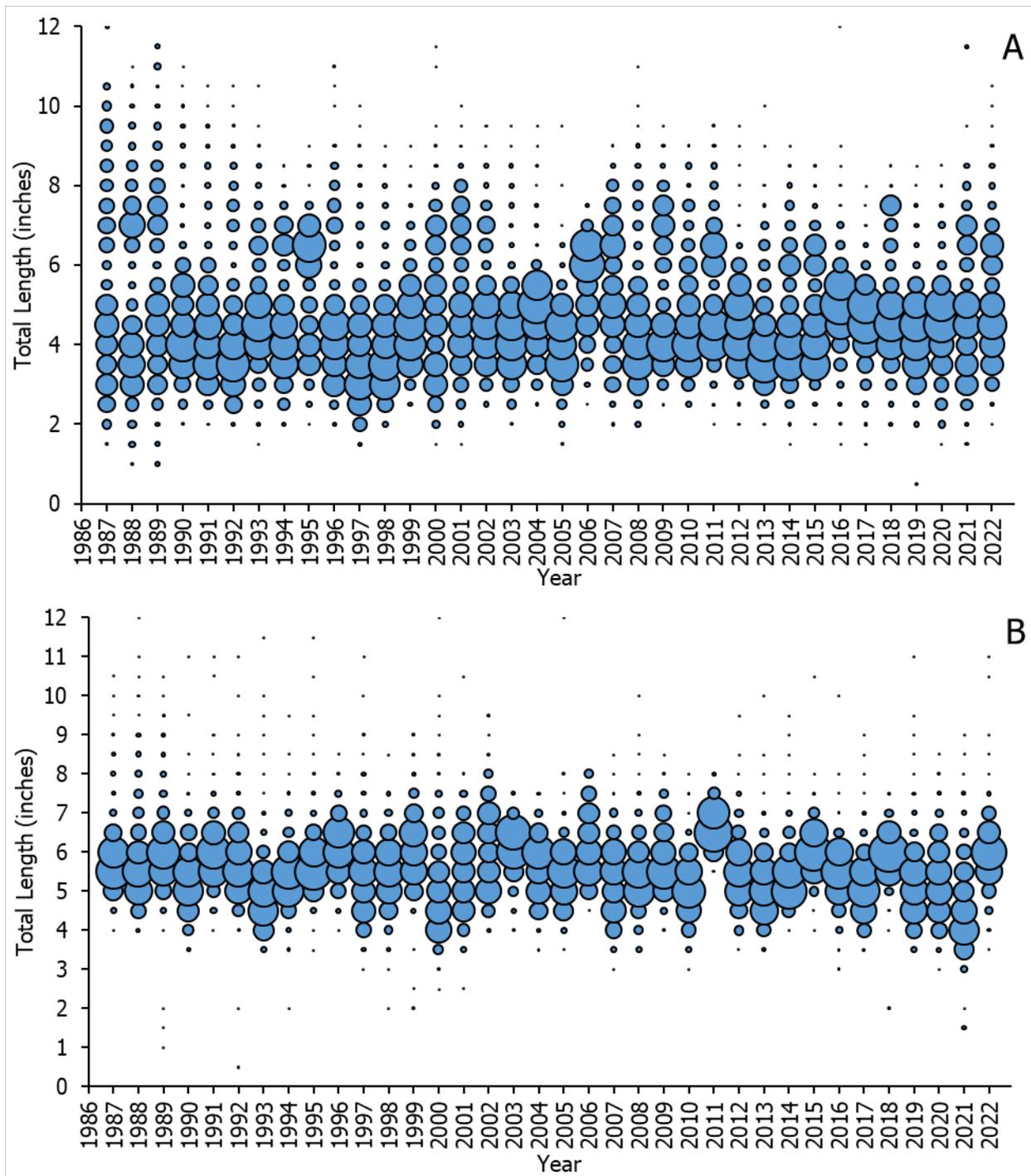


Figure 12. Length frequency (total length, inches) of all Atlantic croaker captured in Pamlico Sound Survey sampling during A) June and B) September 1987–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

**FISHERY MANAGEMENT PLAN UPDATE  
ATLANTIC MENHADEN  
AUGUST 2023**

**STATUS OF THE FISHERY MANAGEMENT PLAN**

**Fishery Management Plan History**

FMP Documentation:	August 1981	
	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 to the FMP	September 1992
Supplements:	Supplement to the FMP	October 1986
Comprehensive Review:	2026	

The first fishery management plan (FMP) for Atlantic menhaden (*Brevoortia tyrannus*) was approved by the Atlantic States Marine Fisheries Commission (ASMFC) 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. A Revision to the FMP was approved in 1992 and was the result of an updated stock assessment. The 1992 FMP also included a suite of objectives intended to improve data collection and increase awareness of the fishery and its research needs. 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 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 (2011–2013). In 2010, the Board tasked the Atlantic Menhaden Technical Committee (TC) to develop alternative reference points. In addition, the ASMFC 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 metric ton (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 the 2018 and 2019 fishing seasons was set at 216,000 MT (476,198,485 pounds) and maintained that TAC for 2020 with the expectation that it would be set in future years using ERPs. Subsequent years' TAC will be guided by menhaden-specific ERPs. Amendment 3 allocated a baseline quota of 0.5 % to each jurisdiction, and then additional TAC was allocated based on historic 2009–2011 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 % 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).

Atlantic menhaden are currently managed under Addendum I to Amendment 3. Addendum I addresses commercial allocations, the Episodic Event Set Aside (EESA) Program, and the Incidental Catch/Small-Scale Fishery (IC/SSF) Provision. Regarding allocations, the Addendum creates a three-tiered system for minimum allocations to the states, with Pennsylvania receiving

0.01%; South Carolina, Georgia, Connecticut, Delaware, North Carolina, and Florida receiving 0.25%; and the remaining states continuing to receive a minimum of 0.5%. Furthermore, the Addendum allocates the remainder of the TAC, excluding the 1% for episodic events in the states of New York through Maine under the EESA Program, on a state-by-state basis based on landings history of the fishery from 2018, 2019, and 2021. Under the IC/SSF provision, the Addendum codifies the ability for states to elect to divide their quotas into sectors, enabling individual sectors to enter into the provision at different times. Additionally, the Addendum removes purse seines as a permitted small-scale directed gear, thereby, prohibiting them from harvesting under the IC/SSF provision. Finally, the Addendum counts IC/SSF landings against the TAC and if IC/SSF landings cause the TAC to be exceeded, then the Board must take action to modify one or both of permitted gear types and trip limits under the provision. The Addendum also continues to prohibit the rollover of unused quota, maintains the 6,000 pounds trip limit for applicable gear types following the closure of a directed fishery, and keeps the current Chesapeake Bay Cap, which was first implemented in 2006 to limit the amount of reduction harvest within the Bay, at 51,000 mt. This recognizes the importance of the Chesapeake Bay as nursery grounds for many species by capping reduction landings from the Bay to current harvest levels.

The current TAC for the 2023 through 2025 fishing seasons is 233,550 mt, which is an approximate 20% increase from the 2021-2022 TAC based on the positive stock status of the resource under ecological reference point-based management. According to Technical Committee analysis, this increase has a less than 40% probability of exceeding the target set by the ecological reference points (ERPs) adopted in 2020. Given the positive results of the 2022 Stock Assessment Update, the Board approved this modest increase to provide additional fishing opportunities, while maintaining a conservative risk level of exceeding the ERP target.

To ensure compliance with the ASMFC Interstate FMP for Atlantic Menhaden, North Carolina also manages this species under the North Carolina FMP for Interjurisdictional Fisheries (IJ FMP). The goal of the IJ FMP is to adopt FMPs, 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) is like the goal 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 Addendum I to 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 2022).

## DESCRIPTION OF THE STOCK

### Biological Profile

Atlantic menhaden 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 distributed farther north. During fall and early winter, menhaden migrate south to the North Carolina capes 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 (plankton) while swimming in schools near the surface. Atlantic menhaden are important prey to many species including striped bass, bluefish, birds, dolphins, and whales.

### Stock Status

In February 2020, the ASMFC accepted the results of the Atlantic Menhaden Single-Species and Ecological Reference Point (ERP) Benchmark Stock Assessments and Peer Review Reports for management use. The Single-Species Assessment, acting as a traditional stock assessment, indicates the Atlantic menhaden stock is not overfished or experiencing overfishing relative to the current single-species reference points under Amendment 3 (SEDAR 2020). These reference points used historical performance of the population during the 1960–2012-time frame, representing a period where the population was fished sustainably. Fishing mortality rates have remained below the overfishing threshold (0.6) since the mid–1970s, and below the overfishing target (0.22) since the mid–1990s. Fishing mortality was estimated to be 0.11 in 2017 (terminal year of the assessment). The reference point used to determine the population fecundity is defined as the mature egg production one would expect when the population is being fished at the threshold fishing mortality rate. Population fecundity was highest in the early 1960s and from the 1990s to present. In 2017, fecundity was estimated at  $2.60 \times 10^{15}$  eggs, above the Single-Species Assessment threshold ( $1.46 \times 10^{15}$  eggs) and target ( $1.95 \times 10^{15}$  eggs).

The Ecological Reference Points Stock Assessment evaluates the health of the stock in an ecosystem context and indicates that the fishing mortality ( $F$ ) reference points for menhaden should be lower to account for menhaden's role as a forage fish (SEDAR 2020). The fishing mortality rate in 2017, terminal year of the assessment, was below both ERP target and threshold, indicating that the stock was not experiencing overfishing. Fecundity (a measure of reproductive capacity) in 2017 was above both the ERP target and threshold, indicating the stock was not overfished.

In August 2022, the ASMFC Board accepted the results of the Single-Species Update Assessment. Under the ERPs, Atlantic menhaden are neither overfished nor experiencing overfishing.

### **Stock Assessment**

The 2020 Atlantic Menhaden Benchmark Stock Assessments, which were endorsed by an independent panel of fisheries scientists, used the Northwest Atlantic Coastal Shelf Model of Intermediate Complexity for Ecosystems (NWACS-MICE) in combination with the single-species model (Beaufort Assessment Model or BAM) to develop Atlantic menhaden ERPs by evaluating trade-offs between menhaden harvest and predator biomass (SEDAR 2020). The SEDAR 2020 document is comprised of two reports: the 2019 Atlantic Menhaden Single-Species Benchmark Assessment and the Ecological Reference Points Stock Assessment. The Beaufort Assessment Model (BAM), which was used in the previous stock assessment, was used in the single-species assessment. The BAM again incorporated a “fleet as areas” based model configuration, such that the reduction and bait fisheries were divided into northern, mid-Atlantic, and southern regions, creating three fleets. The Single-Species Assessment, acting as a traditional stock assessment, indicates the Atlantic menhaden stock is not overfished or experiencing overfishing relative to the current single-species reference points. The Ecological Reference Points Stock Assessment uses the NWACS-MICE to develop Atlantic menhaden ERPs. NWACS-MICE is an ecosystem model that focuses on four key predator species (striped bass, bluefish, weakfish, and spiny dogfish) and three key prey species (Atlantic menhaden, Atlantic herring, and bay anchovy).

In August 2020, the ASMFC approved the use of ERPs in the management of Atlantic menhaden. Atlantic striped bass was the focal species for the ERP definitions because it was the most sensitive predator fish species to Atlantic menhaden harvest in the model, so an ERP target and threshold that sustained striped bass would likely provide sufficient forage for other predators under current ecosystem conditions. By adopting ERPs, the Board will be accounting for the species’ role as an important forage fish. The ERPs for Atlantic menhaden are:

- ERP target: the maximum fishing mortality rate ( $F$ ) on Atlantic menhaden that sustains Atlantic striped bass at their biomass target when striped bass are fished at their  $F$  target.
- ERP threshold: the maximum  $F$  on Atlantic menhaden that keeps Atlantic striped bass at their biomass threshold when striped bass are fished at their  $F$  target.
- ERP fecundity target and threshold: the long-term equilibrium fecundity that results when the population is fished at the ERP  $F$  target and threshold, respectively.

Since the stock assessment peer review process was adopted by the ASMFC in 1998, Atlantic menhaden have been assessed several times. Prior to the 2020 Atlantic Menhaden Benchmark Stock Assessments, the most recent peer reviewed benchmark stock assessment was SEDAR 40 (2015), which was updated in 2017 (ASMFC 2017b). The BAM was used to provide management advice during the 2015 benchmark stock assessment and the 2017 update. The 2015 benchmark stock assessment and 2017 update found that Atlantic menhaden were neither overfished nor experiencing overfishing. Stock status was evaluated against the assessment’s reference points, which used historical performance of the population during 1960–2012.

The ASMFC updated the 2019 Atlantic Menhaden Single Species Benchmark Stock Assessment in 2022. The stock assessment update added data through 2021, reran the peer reviewed BAM,

and determined stock status of Atlantic menhaden using the ERPs that were accepted for management use in 2020. The ERP assessment was not updated. The single species assessment update is the best information available on the status of the coastwide Atlantic menhaden stock for use in fisheries management. Both assessments are scheduled for benchmark assessments together in 2025. More information on the stock assessment update can be found [here](#).

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

No regulatory changes were made in 2022 that affected Atlantic menhaden. North Carolina's annual quota is currently 1,840 MT (4,056,588 pounds) or 0.96% of the coastwide allocation. Under Addendum 1 to Amendment 3, North Carolina's portion of the allocation will be dropping to 0.37% in 2023.

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 Fishery**

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, Figure 1). The average landings over the last 10 years is 624,547 pounds. Since 2013, landings have been regulated under the TAC initiated in Amendment 2. North Carolina has landed 10–14% of the state allocated portion of the TAC in the past three years, the majority of which is used for bait in the blue crab and recreational fisheries. The decline in commercial landings is due to the loss of North Carolina's last processing facility in 2005, which in turn led to the North Carolina General Assembly banning purse seines from near shore state waters in 2007 (15A N.C. Admin. Code 3J.0105). Gill nets are now the most common gear used to harvest menhaden throughout the state.

### **Recreational Fishery**

In October 2011, the North Carolina Division of Marine Fisheries (DMF) 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 during 2012–2022 recreational annual harvest averaged 183,139 fish harvested and 80,204 fish released (Table 1, Figure 1).

## **MONITORING PROGRAM DATA**

### **Fishery-Dependent Monitoring**

Commercial fishing activity is monitored in a variety of DMF fishery-dependent sampling programs for compliance with ASMFC. Monitoring includes the ocean sink net fishery, winter

trawl fishery, estuarine gill net fishery, long haul seine fishery, and sciaenid pound net fishery. Commercial landings of Atlantic menhaden are monitored through the DMF Trip Ticket Program. Table 2 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, with the exception of 2020 and 2021 where mean lengths increased (Figure 2).

### **Fishery-Independent Monitoring**

Atlantic menhaden are sampled in a variety of DMF independent surveys for compliance with ASMFC requirements. Atlantic menhaden are sampled in the North Carolina Estuarine Trawl Survey (Program 120), Pamlico Sound Survey (Program 195), the Juvenile Anadromous Survey (Program 100), the Albemarle Sound Independent Gill Net Survey (Program 135), and the Fishery Independent Gill Net Survey (Program 915). The Estuarine Trawl Survey (Figure 3) and Fishery Independent Gill Net Survey (Pamlico Sound only, Figure 4) were used as data sources in the 2019 Atlantic Menhaden Single-Species Benchmark Stock Assessment.

The Program 120 relative abundance index for Atlantic menhaden in 2021 was 2.78, which was a decrease from 2021 (3.39 Atlantic menhaden per tow). The 2022 relative abundance index was a below the ten-year average (2013–2022, 5.13 Atlantic menhaden per tow). Due to the suspension of the survey, the Program 915 relative abundance index was not calculated for Atlantic menhaden from February 20, 2020, through June 30, 2021. The 2022 relative abundance index was 11.02.

### **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.

## MANAGEMENT STRATEGY

In 2017, the ASMFC set the TAC at 216,000 MT (476,198,485 pounds) for 2018–2019 and maintained that TAC for 2020 with the expectation that it would be set in future years using ERPs. In October 2020, following the adoption of ERPs, the ASMFC approved a TAC of 194,400 MT (428,578,637 pounds) for 2021–2022, which represents a 10% reduction from the 2018–2020 TAC level. Based on projections, the TAC is estimated to have a 58.5% and 52.5% probability of exceeding the ERP *F* target in the first and second year, respectively. One percent of the TAC is set aside for episodic events. The remaining 192,456 MT (424,292,851 pounds) will be made available to the states based on the state-by-state allocation established by Amendment 3 of which North Carolina receives 0.96%. For 2021–2022, North Carolina’s annual quota will be set at 1,840 MT (4,056,588 pounds).

In November of 2022, the ASMFC set the 2023 TAC at 233,550 MT, which is an approximate 20% increase from the 2021–2022 TAC based on the positive stock status of the resource under ecological reference point-based management. According to ASMFC Technical Committee analysis, this increase has a less than 40% probability of exceeding the target set by the ERPs adopted in 2020.

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## TABLES

Table 1. Recreational harvest (number of fish landed and weight in pounds) and releases (number of fish) and commercial harvest (weight in pounds) of Atlantic menhaden from North Carolina, 1991–2022. Recreational weight landed for 2012 through 2022 are based on North Carolina recreational cast net and seine mail survey and an estimated individual fish weight of 0.35 pounds derived from Fishery-Independent sampling. Commercial landings based on North Carolina Trip Ticket Program, 1991–2022.

Year	Recreational			Commercial	Total Weight (lb)
	Numbers Landed	Numbers Released	Weight Landed (lb)	Weight Landed (lb)	
1991				110,528,754	110,528,754
1992				57,515,712	57,515,712
1993				64,711,384	64,711,384
1994				73,853,901	73,853,901
1995				58,374,046	58,374,046
1996				53,850,943	53,850,943
1997				97,727,057	97,727,057
1998				57,976,455	57,976,455
1999				42,799,080	42,799,080
2000				56,280,112	56,280,112
2001				56,012,396	56,012,396
2002				69,190,596	69,190,596
2003				48,936,502	48,936,502
2004				50,577,983	50,577,983
2005				13,387,423	13,387,423
2006				962,651	962,651
2007				1,134,208	1,134,208
2008				645,231	645,231
2009				2,124,734	2,124,734
2010				1,299,150	1,299,150
2011				3,530,003	3,530,003
2012	169,926	68,303	59,474	538,792	598,266
2013	221,014	96,004	77,355	454,206	531,561
2014	131,419	64,493	45,997	917,905	963,902
2015	271,824	162,539	95,138	898,322	993,460
2016	278,213	100,998	97,375	398,044	495,419
2017	261,203	96,573	91,421	752,799	844,220
2018	130,441	52,000	45,654	713,978	759,632
2019	152,247	83,285	53,286	551,849	605,135
2020	126,126	60,988	44,144	599,742	643,886
2021	152,722	37,343	53,453	419,127	472,580
2022	119,393	59,721	41,788	539,494	581,281
Mean	183,139	80,204	64,099	29,006,331	26,399,320

Table 2. Mean, minimum, and maximum lengths (fork length, inches) of Atlantic menhaden measured from the commercial fisheries, 1991–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1991	6.2	1.9	11.0	3,588
1992	7.0	4.1	17.5	1,832
1993	6.9	3.0	13.8	3,163
1994	7.0	4.3	11.4	1,077
1995	6.5	4.1	12.5	2,045
1996	7.7	3.7	12.9	2201
1997	8.8	3.8	15.6	1,623
1998	8.1	3.4	12.9	1,570
1999	7.4	3.3	14.9	1,702
2000	8.5	4.1	13.5	868
2001	9.6	2.6	15.9	1,266
2002	8.8	4.7	14.0	1,075
2003	9.3	4.4	14.4	621
2004	8.2	3.1	14.2	644
2005	8.5	4.0	13.4	1,197
2006	8.1	3.7	13.7	1,445
2007	8.3	4.3	15.7	1,424
2008	8.0	3.9	12.8	1,063
2009	8.9	3.9	13.5	1,124
2010	8.6	5.8	12.6	210
2011	9.2	3.7	13.7	1,346
2012	8.7	2.8	14.3	705
2013	9.3	5.6	15.2	845
2014	8.8	4.8	12.8	1,477
2015	9.1	4.8	13.7	1,165
2016	8.7	6.3	12.3	760
2017	9.4	5.6	12.4	891
2018	9.3	0.8	12.2	442
2019	8.5	5.6	11.3	179
2020	10.3	6.2	12.7	250
2021	9.9	5.4	12.5	416
2022	9.7	4.7	19.6	1,091

**FIGURES**

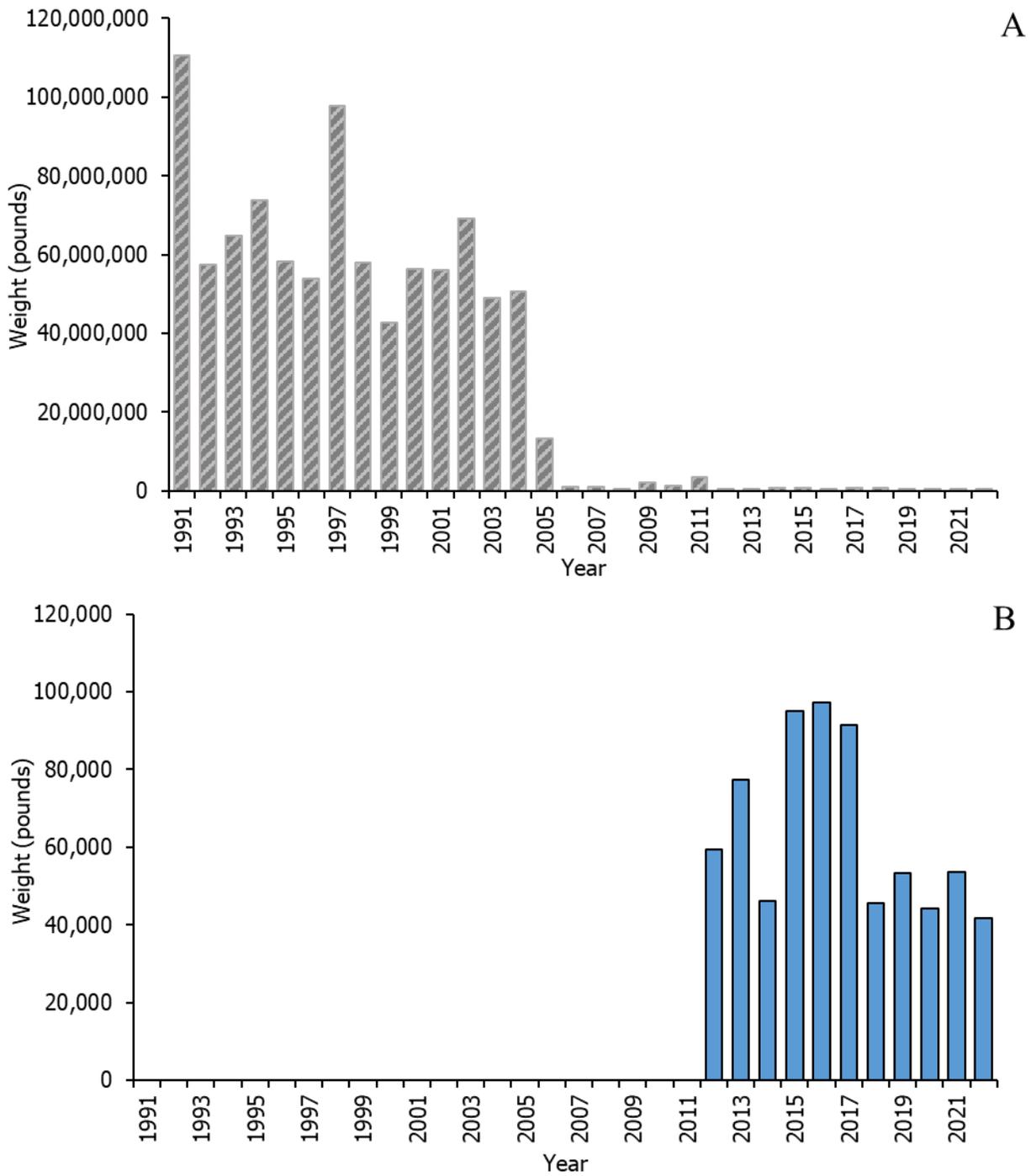


Figure 1. (A) Atlantic menhaden commercial landing (pounds) reported through the North Carolina Trip Ticket Program, 1991–2022, and (B) recreational landings (Type A + B1; pounds) estimated from the North Carolina recreational cast net and seine mail survey, 2012–2022.

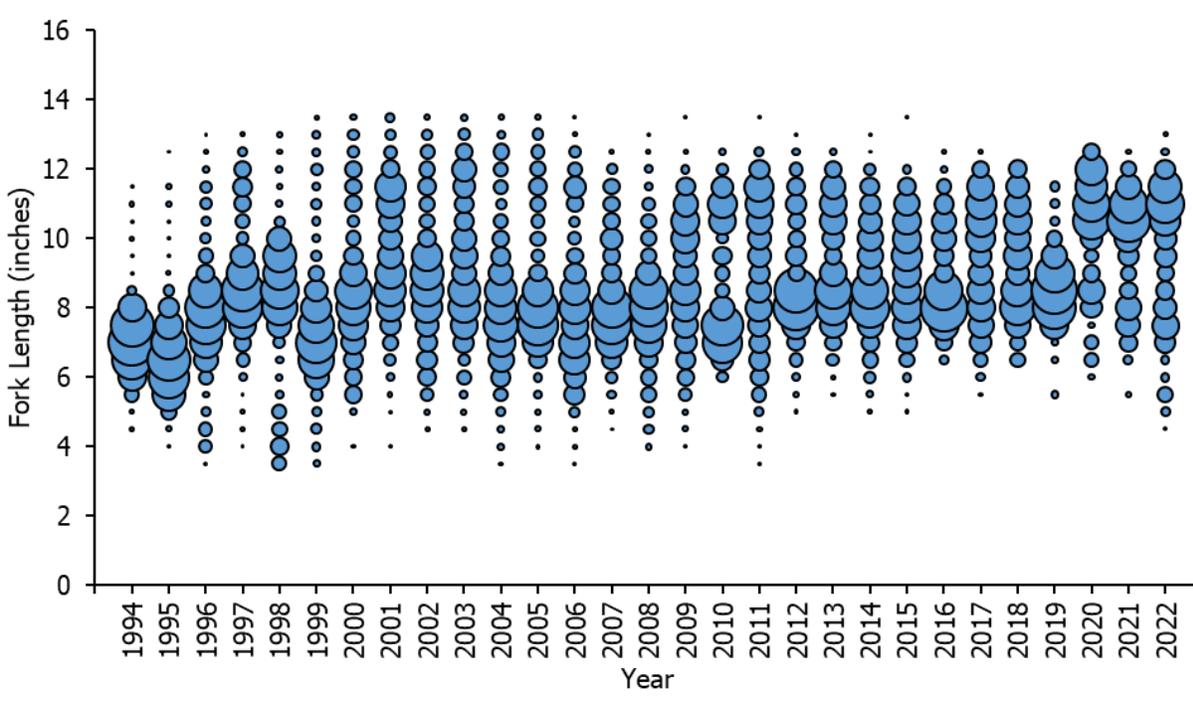


Figure 2. Commercial length frequency (fork length, inches) of Atlantic menhaden harvested from 1994 to 2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

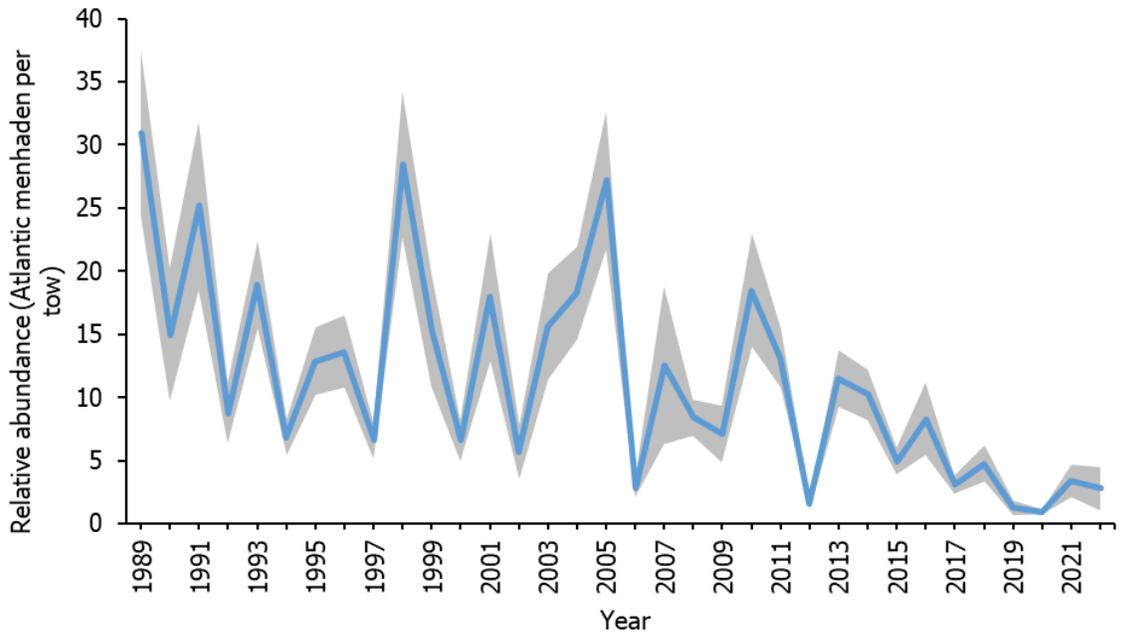


Figure 3. Relative abundance index (fish per tow) of Atlantic menhaden collected from the North Carolina Estuarine Trawl Survey (Program 120) during May and June 1989–2022. Error bars represent  $\pm 1$  standard error.

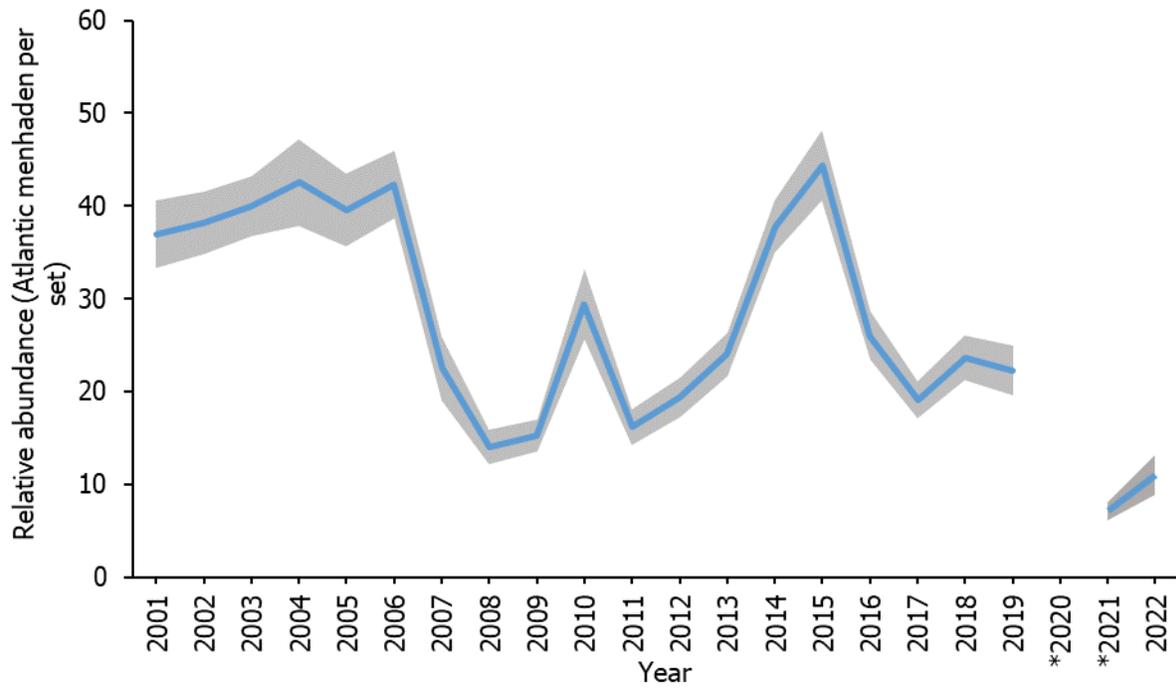


Figure 4. Relative abundance index (fish per set) of Atlantic menhaden collected from the Fishery-Independent Gill Net Survey (Program 915, Pamlico Sound only), 2001–2022. Error bars represent  $\pm 1$  standard error. \*Survey suspended February 20, 2020, through June 30, 2021.

**FISHERY MANAGEMENT PLAN UPDATE  
ATLANTIC STURGEON  
AUGUST 2022**

**STATUS OF THE FISHERY MANAGEMENT PLAN**

**Fishery Management Plan History**

FMP Documentation:	November 1990	
	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
Comprehensive 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 that 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 Atlantic sturgeon from Canada to North Carolina. Addendum III complements 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**

Atlantic sturgeon from Maine through Florida.

## Goal and Objectives

The goal is to restore Atlantic sturgeon spawning stocks to population levels that will provide for sustainable fisheries and ensure viable spawning populations (ASMFC 1998). In order to achieve this goal, the plan sets forth the following objectives:

- Establish 20 protected year classes of females in each spawning stock.
- Close the fishery for a sufficient time period to reestablish spawning stocks and increase numbers in current spawning stocks.
- Reduce or eliminate bycatch mortality of Atlantic sturgeon.
- Determine the spawning sites and provide protection of spawning habitats for each spawning stock.
- Where feasible, reestablish access to historical spawning habitats for Atlantic sturgeon.
- Conduct appropriate research as needed.

## DESCRIPTION OF THE STOCK

### Biological Profile

The Atlantic sturgeon (*Acipenser oxyrinchus*) is an anadromous species, which means they reside primarily in oceans as adults and migrate 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 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 migrations 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. In NC, adult fish that reproduce in the Roanoke River enter the Albemarle Sound basin during spring. They spend the summer in western Albemarle Sound and lower Roanoke River. Once temperatures begin to decrease around September, the fish ascend the Roanoke River to the rapids near Weldon to spawn. When spawning is complete and as water temperatures decrease further, sturgeon 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 other North Carolina rivers but collection of eggs has not been documented. Additionally, adult sturgeon fitted with radio-telemetry tags 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 Segments 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 limited data availability, 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  $Z_{50\%EPR}$  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'. The next stock assessment update will begin in 2023 and be finalized in 2024.

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

Coast-wide commercial and recreational moratorium.

### **Commercial Fishery**

No landings recorded since 1991.

### **Recreational Fishery**

No recreational fishery.

## **MONITORING PROGRAM DATA**

### **Fishery-Dependent Monitoring**

The North Carolina Division of Marine Fisheries (DMF) provides at-sea observer coverage for the estuarine anchored gill-net fisheries throughout North Carolina.

In July 2014, the DMF received an Incidental Take Permit (ITP) to address incidental takes of Atlantic sturgeon (*Acipenser oxyrinchus*) in anchored gill-net fisheries operating in estuarine waters across the state (NMFS 2014). The permit application included analyses using a zero-inflated Poisson general linear model that estimated bycatch in the 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 (Daniel 2014).

During 2003 through 2021, on-board and alternate platform observers documented 523 Atlantic sturgeon caught in anchored gill nets. These sturgeon ranged in size from 5- to 72-inches total length (TL) and averaged 27 inches TL (Table 1). Three-hundred seventy-two of the 523 sturgeon were observed in the Albemarle Sound Management Unit.

### **Fishery-Independent Monitoring**

The DMF 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 February 2020. Changes were incorporated beginning in November 2021 with the

objective of decreasing sturgeon interactions within the survey. Methods initially remained the same except nets were fished for a reduced 12-hours before retrieval. Beginning in March 2022, sinking nets were removed from the survey to further decrease sturgeon interactions. Lengths of sturgeon collected have ranged from 6 to 67 inches Fork Length (FL) and averaged 21 inches FL (Table 2). Twelve fish were collected with a fork length greater than 39 inches, and only seven of 2,563 fish collected were likely adults (>51 in fork length). The relative abundance index shows an increasing trend between 1991 and 2020, but annual values are variable (Figure 1). Following changes to reduce sturgeon interactions, CPUE decreased precipitously beginning in 2021. This result supports the success of sturgeon bycatch reduction methods although it could be confounded by annual abundance variation. Although these changes have correlated with reduced sturgeon interactions, the resulting survey is different enough that it should not be directly compared to previous years results for purposes of evaluating sturgeon abundance.

The Fishery Independent Assessment Survey (FIAS) is conducted in Pamlico Sound, Neuse, Pamlico and Pungo 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 surveys have been conducted since 2001 and the river surveys since 2003. A total of 64 sturgeon have been collected in Pamlico Sound and an additional 140 have been collected in the Neuse, Pamlico and Pungo, 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 surveys and three adults have been collected in the rivers surveys. A single juvenile (25 in. FL) was captured in Bogue Sound in 2022.

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. Effort has been ongoing since 2008. Additional sampling occurred in the coastal ocean waters off the New and Cape Fear rivers. Two-hundred and seventy yards were fished per sample in these ocean waters. However, sampling in the coastal ocean waters was discontinued on July 1, 2015. Eighteen fish have been collected in the Cape Fear River IGNS and they ranged from 21 to 37 inches FL (Table 5). No adult Atlantic sturgeon have been collected in this survey.

During 2010, the DMF 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 30 to 69 inches FL and averaged 37 inches FL (Table 6).

## 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.

Recommendations with asterisks (\*\*) indicate improvements that should be made before initiating another benchmark stock assessment.

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 DMF, potentially impacting the completion of research recommendations.

## 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 DMF to obtain a Section 10 Incidental Take Permit to allow the estuarine anchored 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.

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## TABLES

Table 1. Atlantic sturgeon length data (inches) collected from the North Carolina Division of Marine Fisheries Onboard Observer Program, 2001–2021, 2022 and Alternate Platform Observer Program (2013-2022).

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Sturgeon With Lengths	Total Sturgeon
2003	*	*	*	0	1
2004	23	13	32	24	25
2005	25	18	32	27	28
2006	24	13	45	38	39
2007				0	0
2008	25	19	33	18	18
2009				0	0
2010				0	0
2011	30	18	55	4	4
2012	26	18	35	8	10
2013	26	19	36	28	30
2014	28	16	65	51	59
2015	28	11	40	63	74
2016	26	15	62	77	82
2017	26	17	41	45	53
2018	28	19	40	22	24
2019	38	21	72	6	8
2020	31	18	47	17	18
2021**	33	20	38	7	11
2022	27	20	43	31	39

\*Length not recorded

\*\*Based on alternate platform trips only

Table 2. Atlantic sturgeon length data (inches) collected from the Albemarle Sound Independent Gill Net Survey, 1991–2022. Total sturgeon includes recaptures.

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Number of Sturgeon Measured	Total Sturgeon
1991	20	10	28	26	26
1992	18	8	23	17	17
1993	18	9	37	13	13
1994	18	10	29	40	41
1995	19	10	30	21	21
1996	17	8	22	27	27
1997	17	9	27	60	61
1998	19	6	29	92	92
1999	21	11	28	55	55
2000	15	7	30	139	139
2001	19	12	27	132	132
2002	21	9	29	29	29
2003	20	10	39	22	22
2004	19	10	31	30	30
2005	20	9	33	48	48
2006	22	9	58	62	63
2007	21	9	30	66	71
2008	21	10	33	124	128
2009	25	15	31	55	56
2010	23	16	32	32	32
2011	24	15	59	47	47
2012	23	12	42	64	65
2013	22	11	55	139	140
2014	24	14	46	70	72
2015	23	14	39	86	86
2016	21	10	37	124	124
2017	22	14	40	173	173
2018	23	15	67	152	155
2019	21	8	52	212	212
2020	22	15	43	148	148
2021	22	13	52	107	107
2022	25	15	39	53	53

Table 3. Atlantic sturgeon length data (inches) collected from the Pamlico Sound Independent Gill Net Survey, 2001–2022.

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Number of Sturgeon Measured	Total Sturgeon
2001				0	0
2002	26	26	26	1	1
2003				0	0
2004	20	18	21	5	5
2005	26	23	31	18	18
2006	27	21	31	12	13
2007	33	26	59	5	5
2008	31	25	37	2	2
2009	38	38	38	1	1
2010	24	20	27	2	2
2011				0	0
2012	56	56	56	1	1
2013				0	0
2014				0	0
2015	*	*	*	0	1
2016	30	29	30	2	2
2017	61	61	61	1	1
2018	24	21	27	3	3
2019	38	38	38	1	1
2020**				0	0
2021***				0	0
2022	30	19	42	7	8

\*Length not recorded

\*\*No sampling occurred

\*\*\*Limited sampling occurred (July–December)

Table 4. Atlantic sturgeon length data (inches) collected from the Pamlico, Pungo, and Neuse Rivers Independent Gill Net Survey, 2003–2022.

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Number of Sturgeon Measured	Total Sturgeon
2003				0	0
2004	24	19	32	9	9
2005	18	14	31	29	29
2006	25	19	29	4	4
2007	20	16	28	3	3
2008	21	21	21	1	1
2009	28	28	28	1	1
2010				0	0
2011				0	0
2012	25	25	25	1	1
2013				0	0
2014	*	*	*	0	1
2015	24	14	56	23	23
2016	28	18	38	8	8
2017	45	45	45	1	1
2018	34	22	56	5	5
2019	19	13	25	2	2
2020**					
2021***	22	14	38	43	44
2022	27	22	34	7	8

\*Length not recorded

\*\*No sampling occurred

\*\*\*Limited sampling occurred (July–December)

Table 5. Atlantic sturgeon length data (inches) collected from the Cape Fear and New Rivers Independent Gill Net Survey, 2008–2022.

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Number of Sturgeon Measured	Total Sturgeon
2008	28	28	28	1	1
2009	22	22	22	1	1
2010	34	34	34	1	1
2011	30	30	30	1	1
2012				0	0
2013				0	0
2014				0	0
2015	26	26	26	1	1
2016	29	25	37	5	5
2017	30	27	37	3	3
2018	25	21	28	3	3
2019	29	25	33	2	2
2020*				0	0
2021**				0	0
2022				0	0

\*No sampling occurred

\*\*Limited sampling occurred (July–December)

Table 6. Atlantic sturgeon length data (inches) 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	Collection Number
2011	38	25	64	45
2012	37	30	69	21
2013	34	24	46	28
Total	37	30	69	94

## FIGURES

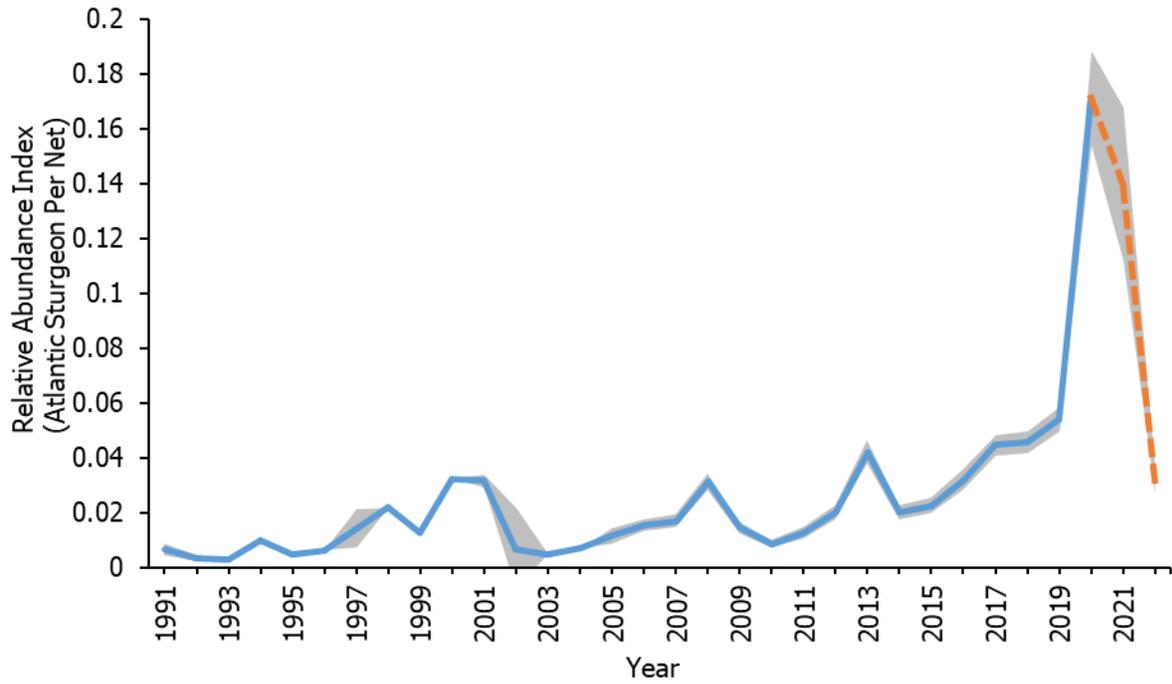


Figure 1. Annual nominal relative abundance index with standard error shaded in gray for Atlantic sturgeon collected from the Albemarle Sound Independent Gill Net Survey from 1991–2022. Survey methods changed in November 2021 to reduce sturgeon interactions.

**FISHERY MANAGEMENT PLAN UPDATE  
BLACK DRUM  
AUGUST 2023**

**STATUS OF THE FISHERY MANAGEMENT PLAN**

**Fishery Management Plan History**

FMP Documentation:	ASMFC FMP	June 2013
	Addendum I	May 2018
Information Updates:	October 2022	
Comprehensive Review:	2027	

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 (ASMFC 2013). 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 (MFC) 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 (Proclamation FF-73-2013). The FMP also includes an adaptive management framework to 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 which determined the stock was not overfished and overfishing was not occurring (ASMFC 2015). In May 2018, ASMFC approved Addendum I to the Black Drum FMP to allow Maryland to reopen its black drum commercial fishery in Chesapeake Bay with a daily vessel limit of up to 10 fish and a 28-inch minimum size (ASMFC 2018). The Black Drum Technical Committee noted 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 in the commercial fishery. In 2023, a benchmark stock assessment concluded the stock was not overfished and not experiencing overfishing (ASMFC 2023). The ASMFC Interstate FMP Policy Board determined no immediate management action was needed. However, due to relatively high level of uncertainty in qualitative estimates of stock status, stock indicators should be closely monitored between assessments.

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 2022).

## 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 (ASMFC 2015).

## Goal and Objectives

The goal of the Black Drum FMP is to provide an efficient management structure to implement coastwide management measures (ASMFC 2013). The objectives of the FMP include:

- Provide a flexible management system to address future changes in resource abundance, scientific information, and fishing patterns among user groups or area.
- 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.
- Manage the black drum fishery to protect both young individuals and established breeding stock.
- 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.

## DESCRIPTION OF THE STOCK

### Biological Profile

Black drum is the largest member of the drum family (Sciaenidae), reaching sizes of over 46 inches and 120 pounds (Jones and Wells 1998). 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 (Bigelow & Schroeder 1953; Simmons & Breuer 1962). Along the Atlantic Coast, black drum are thought to migrate northward and inshore each spring and southward and offshore by late fall (Jones & Wells 1998). Juvenile black drum can be found throughout the estuarine waters of North Carolina, while adults tend to congregate around structures including bridge and dock pilings. They are primarily bottom feeders; juvenile diets consist mainly amphipods, polychaetes, mollusks, crustaceans, and small fish, while the adult diet consists primarily of worms, bivalves, mollusks, crustaceans, and fish (Peters & McMichael 1990; Murphy and Muller 1995; Rubio et al. 2018). Spawning is thought to occur in the offshore waters of the mid-Atlantic during the winter and early spring (Richards 1973; Joseph et al. 1964; Wells & Jones 2002; Chesapeake Bay Program 2004). The number of juvenile fish entering the population annually (recruitment) is thought to be highly variable and dependent on natural environmental conditions (Murphey & Muller 1995). Females are sexually mature between the ages of 4 and 6 (25 to 28 inches) and spawn yearly through adulthood (Murphy & Taylor 1989). An average-sized female may spawn 32 million eggs each year (Fitzhugh et al. 1993). At ages 4 and 5 (22 to 25 inches) males are mature (Murphy & Taylor 1989). The species is long-lived, reaching up to 67 years of

age (Jones & Wells 1998; Campana & Jones 1998; ASMFC 2023). 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 (Murphy & Taylor 1989; Murphy & Muller 1995; Jones & Wells 1998).

### **Stock Status**

The 2023 ASMFC Black Drum Stock Assessment determined the stock is not overfished and not experiencing overfishing (ASMFC 2023).

### **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. In 2023, a benchmark stock assessment was completed and approved for use for management by the ASMFC (ASMFC 2023). The assessment model, JABBA-Select, was developed as an extension to the Just Another Bayesian Biomass Assessment (JABBA) surplus production modeling framework as a means of incorporating life history and fishery selectivity information into an age-structured production type model (Winker et al. 2020). The JABBA-Select model allowed the inclusion of the recalibrated Marine Recreational Information Program (MRIP) data as an index of abundance and catch history (Dettloff and Matter 2019). Annual spawning abundance (SB), annual exploitation (H), and biological reference points are estimated internally in the model, using an index of abundance (MRIP), total fishery removals, life history information, and selectivity information to describe black drum's vulnerability to fisheries. The stock is considered overfished when SB falls below the  $SB_{MSY}$  threshold ( $SB_y / SB_{MSY} < 1$ ). Overfishing is occurring when H exceeds the  $H_{MSY}$  threshold ( $H_y / H_{MSY} > 1$ ). In 2020, the median relative spawning biomass value was 2.92 and the median relative exploitation value was 0.29, indicating the stock was not overfished and not experiencing overfishing in the terminal year (ASMFC 2023; Figure 1). Results indicated greater certainty that the stock is not overfished; however, there was less certainty regarding the exploitation status. While overall stock indicators that monitor year class strength, sub-adult abundance, exploitable abundance, range expansion, and regional catch do not appear negative at this time, they will be closely monitored between assessments. The next benchmark stock assessment is scheduled to occur in 2027.

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

All harvest is limited to black drum between a 14-inch total length (TL) minimum size and 25-inch TL maximum size for both the recreational and commercial fisheries, except that one black drum over 25-inches TL may be retained. The recreational bag limit is ten fish per day. A daily commercial possession limit of no more than 500 pounds per trip is allowed for a commercial fishing operation, regardless of the number of persons, license holders, or vessels involved in the operation (Proclamation FF-73-2013).

## **Commercial Fishery**

Since 1994, the North Carolina Trip Ticket Program (NCTTP) has collected data on the commercial harvest of black drum. Black drum is primarily caught as bycatch in several North Carolina commercial fisheries; however, the majority are landed in the gill net (70%) and pound net (28%) fisheries (Figure 2). The annual commercial harvest of black drum has been highly variable (Table 1; Figure 3A). On average 119,406 pounds of black drum were landed annually from 1994 to 2022. Commercial landings have ranged from a low of 27,750 pounds in 1998 to a high of 497,479 pounds in 2002. Commercial landings increased 10% from 2021 to 2022. In 2022, 144,339 pounds of black drum were landed in the commercial fishery.

## **Recreational Fishery**

Recreational estimates across all years have been updated and are now based on the MRIP new Fishing Effort Survey-based calibrated estimates. For more information on MRIP see <https://www.fisheries.noaa.gov/topic/recreational-fishing-data>.

The recreational landings have been highly variable, ranging from a low of 164,280 pounds in 1998 to a high of 2,709,269 pounds in 2013 (Table 1; Figure 3B). In 2022, 1,710,528 pounds of black drum were harvested, above the time-series average of 801,327 pounds. The harvest (pounds of fish) increased 376% from 2021 to 2022. Recreational releases (number of fish) decreased 5% from 2021 to 2022.

The DMF offers award citations for exceptional catches of black drum. Prior to 2021, citations were awarded for black drum greater than 35 pounds or fish released greater than 40-inches TL. Released black drum greater than 40 inches TL are now only eligible for an award citation. In 2022, 47 citations were awarded (Figure 4).

## **MONITORING PROGRAM DATA**

### **Fishery-Dependent Monitoring**

Commercial fishing activity is monitored through fishery dependent sampling conducted under Title III of the Interjurisdictional Fisheries Act ongoing since 1982. Biological samples (lengths, aggregate weights) are obtained from several DMF 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-inch slot limit in 2014, as would be expected the mean total length (TL) of commercially harvested black drum has increased. The mean TL has ranged from 10-inches to 19-inches (Table 2). In 2022, the minimum TL was 12-inches, and the maximum TL was 29-inches (Table 2; Figure 5). Undersized black drum continue to be harvested since the implementation of the 14-inch TL minimum size limit established in 2014, likely due to fishermen confusing black drum with sheepshead (Figure 6). The minimum size limit of sheepshead is smaller than the minimum size limit for black drum at 10-inches fork length (FL).

The mean TL of recreational harvested black drum ranged from a 10-inches to 19-inches (Table 3). In 2022, the minimum TL was 13-inches, and the maximum TL was 37-inches (Table 3; Figure 5). Similar to the commercial fishery, undersized black drum continued to be harvested in the recreational fishery since the implementation of the 14-inch TL minimum size limit established in 2014 (Figure 7).

### **Fishery-Independent Monitoring**

A fishery-independent gill net survey (Program 915) was initiated by the DMF 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 and the Neuse, Pamlico, and Pungo rivers. By continuing a long-term database of age composition and developing a relative 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. Sampling in this program was suspended in February 2020 due to COVID-19 restrictions and protected species interactions but resumed July 2021.

The annual weighted black drum relative index of abundance from the independent gill net survey has ranged from a high of 1.12 in 2016 to a low of 0.32 in 2013 (Table 4; Figure 8). Proportional Standard Error (PSE) has ranged from 10 to 36. In 2022, the relative index of abundance was 0.54, below the time-series average (0.64 black drum per set). Survey data from the Pamlico Sound and Neuse, Pamlico, and Pungo river systems is used in the 2023 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 2022, 367 black drum were aged. Ages ranged from 0 to 4 years; however, a majority of the age structures were collected from independent sources and may not be representative of fish caught in North Carolina's recreational and commercial fisheries (Table 5). The oldest black drum harvested in North Carolina was age-60. Beyond age 3, there is significant overlap in the length at age for black drum (Figure 9).

## **RESEARCH NEEDS**

The 2023 Benchmark Stock Assessment Report (ASMFC 2023) recommends a new benchmark stock assessment be completed by 2027. However, if stock indicators identify any concerning trends an expedited assessment should be completed before 2027. The research recommendations identified in the 2023 assessment include:

### **High Priority**

- Develop fishery-independent adult surveys. Consider purse seine and long line surveys with bait and sampling areas appropriate to target black drum. Collect age samples, especially in states where maximum size regulations preclude the collection of adequate adult ages. long-term

- Conduct a high reward tagging program to obtain return rate estimates. Continue and expand current tagging programs to obtain total mortality, catch and release mortality, and growth information and movement-at-size data. long-term
- Increase biological sampling in commercial fisheries, particularly gill nets in Virginia, to better characterize size and age composition of commercial landings. These data would help improve data sets for selectivity estimates and eventual extensions to length/age-structured assessment approaches. long-term
- Increase biological sampling in recreational fisheries, particularly harvest in the Mid-Atlantic region and releases coastwide, to better characterize size and age composition of recreational catch. These data would help improve data sets for selectivity estimates and eventual extensions to length/age-structured assessment approaches. long-term
- Continue all current fishery-independent surveys recommended as stock indicators for black drum and collect biological samples for black drum on all surveys. long-term
- Evaluate use of MRIP site-use weighting factors to improve CPUE estimates. short-term
- Skate and Itarget with their current data inputs should be evaluated as annual indicators to show current relationships between stock and removals (Itarget) and the ongoing trend of relative F (Skate). short-term
- A process should be developed for appropriately combining MRIP and supplemental recreational sampling program data for characterizing the size structure of the recreational harvest. The process needs to consider spatial information, as there are likely spatial effects within states' supplemental sampling programs (e.g., VMRC Freezer Program representing Eastern Shore harvest). short-term

### Medium Priority

- Age otoliths that have been collected and archived ( $\approx$  500 sub-adults samples from GA). *short-term*
- Improve sampling of concentrated, targeted nighttime fisheries in the Mid-Atlantic region (e.g., Delaware Bay). Although the MRIP APAIS design changed to expand to nighttime sampling, data are too limited (e.g., only four potential nighttime black drum intercepts in Delaware's APAIS data) to evaluate whether this change was sufficient for black drum fisheries. *long-term*
- The recreation released alive trend and harvest trend provided a mixed signal. In order to identify which factor, a change in stock abundance vs. a change in fishing behavior, drove the mixed signal, we analyzed the released alive data by breaking them down by wave. However, such an analysis may provide limited information on fishing behavior change, therefore, we recommend to directly collect such information via a one-time pilot study ( $\approx$ three years) during existing creel surveys (e.g., MRIP APAIS). For example, anglers may report if they know where, when, and how to catch legal black drum (potentially increasing catch rate) meanwhile deliberately avoiding catching sublegal fish (potentially decreasing released alive quantity). Anglers don't need to share their specific skills during the creel survey by simply checking a box before "When", "Where", and "How" along with

targeted species data currently collected. Such information may potentially provide better information to understand drivers of these trends in the future stock assessment. *short-term*

- Conduct tagging study to determine survival, migration, and contribution of YOY fish spawned in the Mid-Atlantic to the overall sub-adult stock. *long-term*

### **Low Priority**

- Expand simulation-based power analysis to other index data sets used for stock indicators of black drum. *short-term*
- Conduct reproductive studies that provide updated estimates and an expanded spatial coverage, including: age and size-specific fecundity, spawning frequency, spawning behaviors by region, and movement and site fidelity of spawning adults. *long-term*
- There is uncertainty about selectivity between gill net types fished (anchor and drift) in Virginia and the appropriateness of combining these gears into a fleet. There are no composition data collected from drift gill nets, so this remains an uncertainty that should be researched in the future. *short-term*

### **Partially Addressed**

- 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.
- Obtain better estimates of harvest from the black drum recreational fishery (especially in states with short seasons). *MRIP changes were generally seen as improvements to catch estimates, though the exception remains nighttime fishery sampling identified as a moderate research recommendation above.*
- Collect information on the magnitude and sizes of commercial discards. Obtain better estimates of bycatch of black drum in other fisheries, especially juvenile fish in south Atlantic states. *An ongoing observer program now provides monitoring of the primary suspected commercial black drum discard fishery. Recent estimates have been small in comparison to total fishery removals, but this source of catch should continue to be monitored in future stock assessments for signs of increase. South Atlantic shrimp trawl fishery observer data were also reviewed during this assessment and do not indicate these fisheries are a significant source of black drum fishery removals.*

## **MANAGEMENT STRATEGY**

The management program currently in place for black drum has resulted in a stock that has met ongoing management targets. Each year the ASMFC Black Drum PRT monitors each states’ compliance with the FMP during its annual review. States must demonstrate the compliance criteria of the FMP are satisfied and submit an annual report concerning its fisheries and management programs. Following the review of the 2021 fishing year, the PRT determined all states were compliant with the FMP (ASMFC 2022).

See Table 6 for current management strategies and implementation status of the ASMFC Black Drum FMP.

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## TABLES

Table 1. Recreational harvest (number of fish landed and weight in pounds) and releases (number of fish) and commercial harvest (weight in pounds) of black drum from North Carolina for the period 1994–2022.

Year	Recreational			Commercial	Total Weight (lb)
	Numbers Landed	Numbers Released	Weight Landed (lb)	Weight Landed (lb)	
1994	132,517	9,122	272,820	33,536	306,356
1995	931,269	227,608	713,652	128,221	841,873
1996	468,766	176,061	608,460	122,837	731,297
1997	106,854	62,498	277,316	86,610	363,926
1998	105,349	95,834	164,280	27,750	192,030
1999	374,245	267,723	561,678	122,772	684,450
2000	293,983	112,470	685,687	98,784	784,471
2001	400,983	325,234	446,202	77,892	524,094
2002	846,855	215,810	1,791,703	497,479	2,289,182
2003	1,265,995	481,742	1,926,671	148,785	2,075,456
2004	296,531	255,753	566,484	62,445	628,929
2005	465,076	376,363	509,328	44,989	554,317
2006	276,257	265,369	431,212	125,214	556,426
2007	876,178	832,132	697,822	148,231	846,053
2008	925,963	548,931	1,232,589	301,998	1,534,587
2009	449,901	411,358	421,788	148,994	570,782
2010	650,010	427,577	812,699	69,194	881,893
2011	1,259,216	711,755	823,423	56,083	879,506
2012	556,482	397,155	879,401	94,352	973,753
2013	1,511,995	497,334	2,709,269	127,170	2,836,439
2014	109,307	1,964,749	230,834	51,217	282,051
2015	276,126	1,791,758	780,876	51,097	831,973
2016	459,078	2,530,596	1,322,547	90,055	1,412,602
2017	355,544	2,336,352	856,081	182,989	1,039,070
2018	134,624	1,450,855	428,273	109,781	538,054
2019	156,401	756,749	404,452	80,049	484,501
2020	213,320	704,357	612,932	98,143	711,075
2021	121,454	681,121	359,481	131,761	491,242
2022	264,634	647,304	1,710,528	144,339	1,854,867
Mean	492,583	674,540	801,327	119,406	920,733

Table 2. Mean, minimum, maximum total length (TL; inches), and total number of black drum measured from North Carolina commercial fish house samples, 1994–2022.

Year	Mean Total Length	Minimum Total Length	Maximum Total Length	Total Number Measured
1994	14	9	17	43
1995	10	8	42	209
1996	13	8	26	223
1997	15	8	23	102
1998	17	6	24	76
1999	14	7	47	673
2000	15	7	29	878
2001	15	7	36	432
2002	14	7	46	2,151
2003	16	7	49	609
2004	15	8	47	276
2005	14	4	44	314
2006	13	6	47	1,510
2007	13	7	50	2,086
2008	14	7	49	2,863
2009	15	7	47	1,072
2010	16	8	48	619
2011	12	7	32	1,467
2012	14	5	37	1,096
2013	15	5	35	806
2014	17	10	47	369
2015	18	9	43	299
2016	17	10	47	777
2017	17	10	29	494
2018	19	14	45	397
2019	17	12	43	421
2020	17	10	31	437
2021	16	8	27	579
2022	16	12	29	500

Table 3. Mean, minimum, maximum total length (TL; inches), and total number of black drum measured from Marine Recreational Information Program recreational samples, 1994–2022.

Year	Mean Total Length	Minimum Total Length	Maximum Total Length	Total Number Measured
1994	15	9	32	121
1995	11	7	30	390
1996	12	7	25	339
1997	15	9	33	144
1998	12	7	26	167
1999	13	8	31	248
2000	15	8	24	178
2001	11	8	25	173
2002	14	8	30	219
2003	11	7	52	198
2004	14	8	27	127
2005	11	7	34	89
2006	13	9	33	104
2007	11	7	20	191
2008	12	7	48	363
2009	11	8	25	191
2010	11	7	29	258
2011	10	7	24	567
2012	13	7	26	237
2013	13	7	26	154
2014	15	7	24	33
2015	17	11	25	75
2016	17	10	28	116
2017	16	9	27	162
2018	16	8	26	128
2019	16	10	44	106
2020	16	10	44	215
2021	16	9	46	155
2022	19	13	37	122

Table 4. Annual weighted black drum index of relative abundance (number per set, all ages combined) from the DMF Independent Gill Net Survey (Program 915) in the Pamlico Sound and Neuse, Pamlico, and Pungo river systems from 2003–2022. N=number of samples; Index=black drum per gill net set; SE=Standard Error; PSE=Proportional Standard Error. \*Sampling in this program was suspended in February 2020 due to COVID-19 restrictions and protected species interactions but resumed July 2021.

Year	N	Index	SE	PSE
2003	476	0.83	0.21	25
2004	640	0.35	0.07	19
2005	608	0.37	0.09	24
2006	640	0.71	0.07	10
2007	640	0.63	0.13	20
2008	640	1.02	0.14	13
2009	640	0.59	0.11	19
2010	640	0.40	0.13	32
2011	618	0.62	0.10	17
2012	628	0.39	0.06	14
2013	628	0.32	0.05	16
2014	628	0.59	0.12	20
2015	626	0.80	0.29	36
2016	628	1.12	0.15	14
2017	628	0.92	0.18	20
2018	628	0.37	0.05	14
2019	628	0.76	0.12	15
2020*				
2021*	344	0.83	0.17	20
2022	628	0.54	0.09	17

Table 5. Summary of black drum age samples collected from both dependent (commercial and recreational fisheries) and independent (surveys) sources from 2011–2022. Samples collected from partial carcasses were not included.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
2011	0	0	60	235
2012	1	0	3	324
2013	2	0	4	190
2014	1	0	31	407
2015	0	0	2	397
2016	1	0	13	667
2017	1	0	42	742
2018	1	0	46	429
2019	1	0	32	444
2020	1	1	4	104
2021	1	0	5	415
2022	1	0	4	367

Table 6. 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
Implement a 10 fish and 28-inch minimum size limit for Maryland's commercial fishery by February 25, 2019	Accomplished (Maryland)

## FIGURES

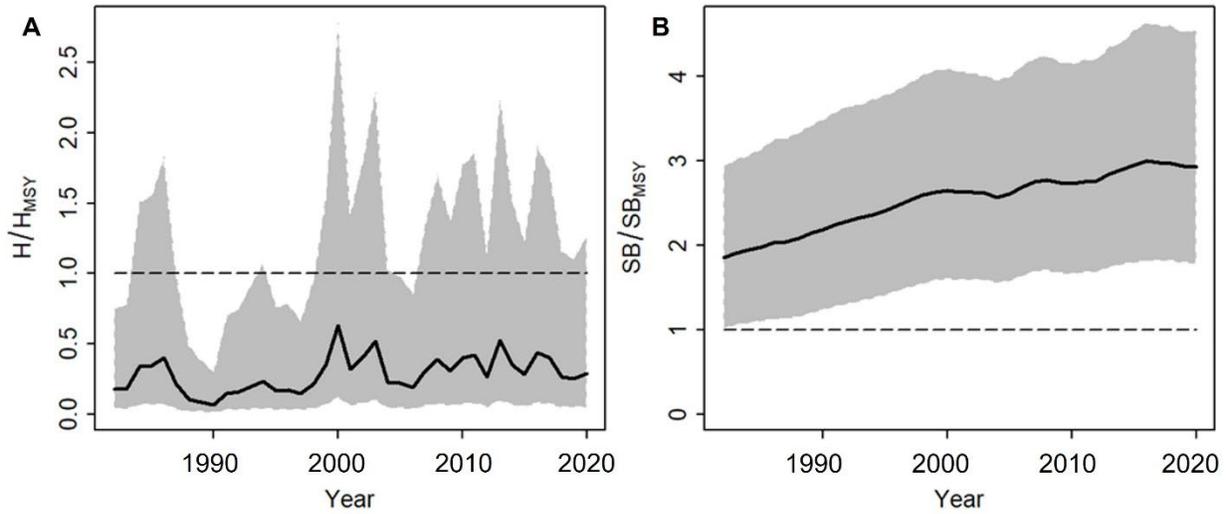


Figure 1. Black drum exploitation (A) and spawning biomass (B) relative to threshold reference points estimated in JABBA-Select. The solid line is the median and the shaded region is the 95% credible interval. The dashed line indicates the estimate at its respective threshold level. (Source: ASMFC 2023 Black Drum Stock Assessment and Peer Review Report).

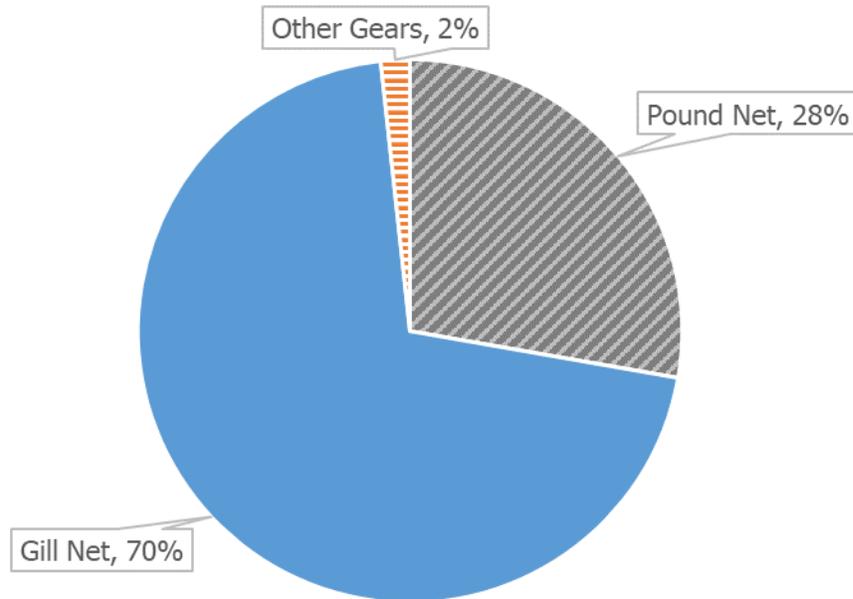


Figure 2. Black drum commercial harvest in 2022 by gear type. “Other Gears” includes haul seines, crab pots, channel nets, and fyke nets.

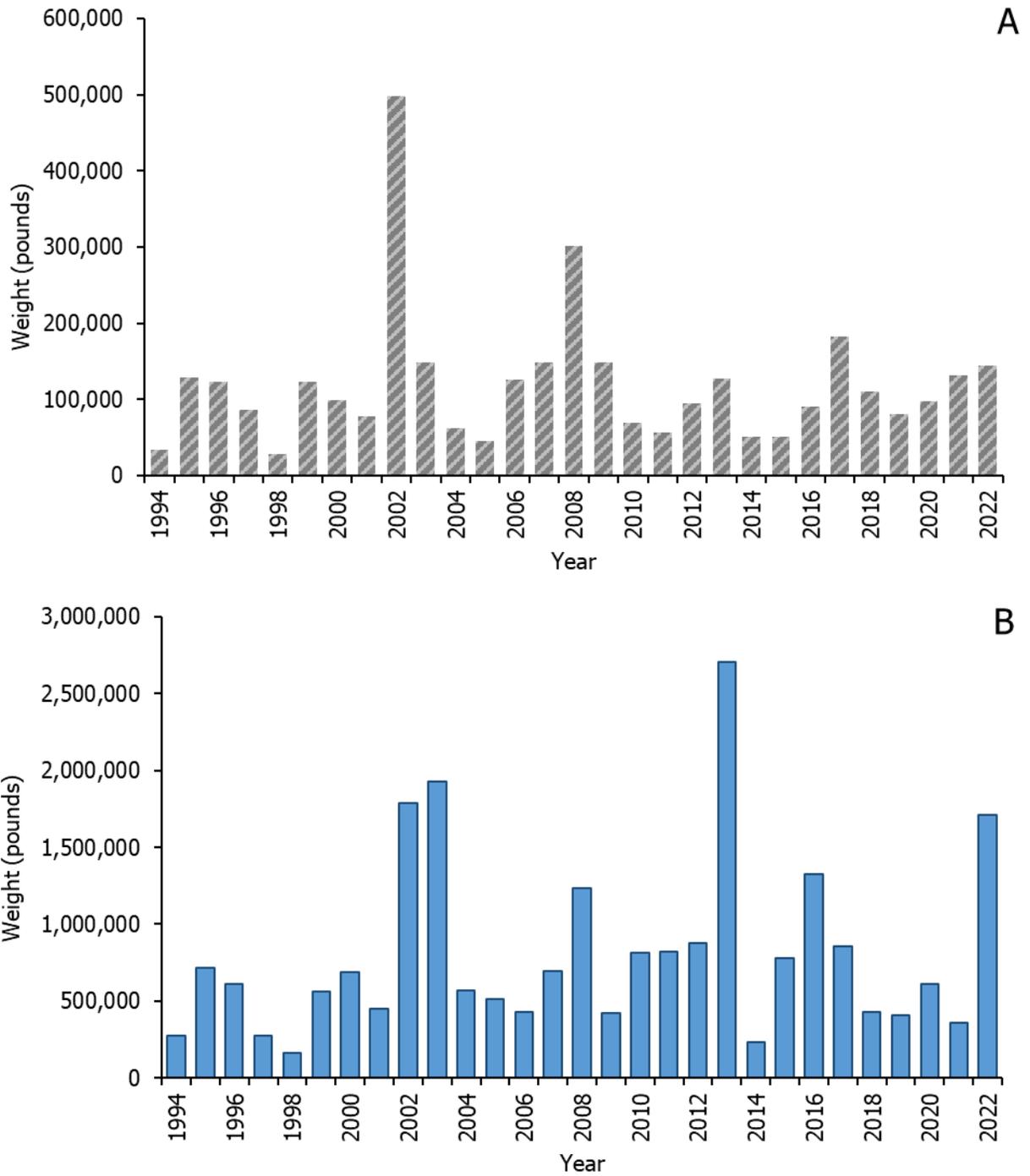


Figure 3. Annual commercial (A) and recreational (B) landings in pounds for black drum in North Carolina from 1994 to 2022.

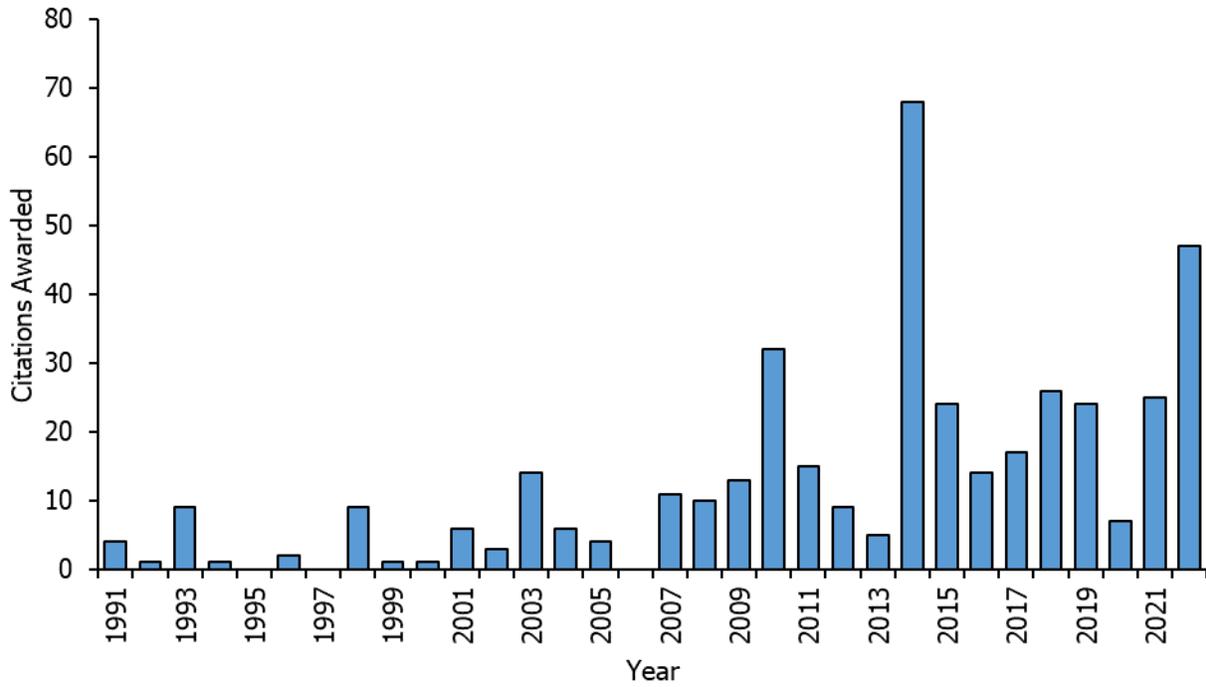


Figure 4. North Carolina Saltwater Fishing Tournament citations awarded for black drum from 1991 to 2022. Citations are awarded for released black drum greater than 40 inches total length.

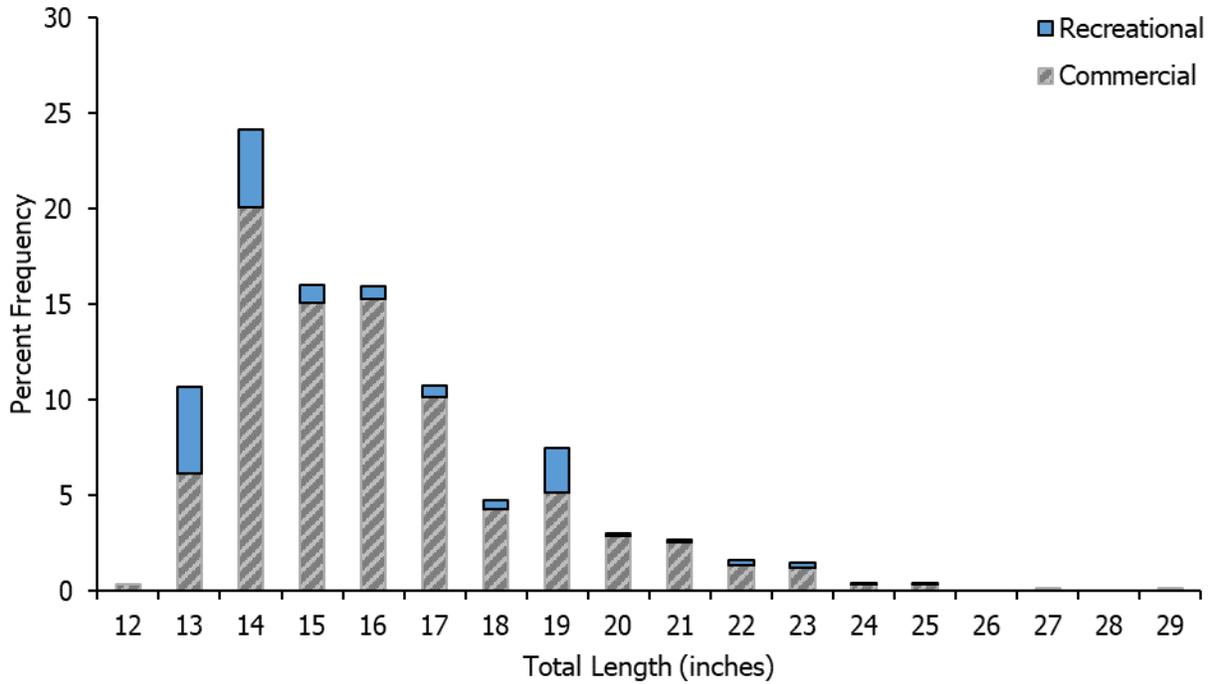


Figure 5. Commercial and recreational length frequency (total length, inches) of black drum harvested in 2022.

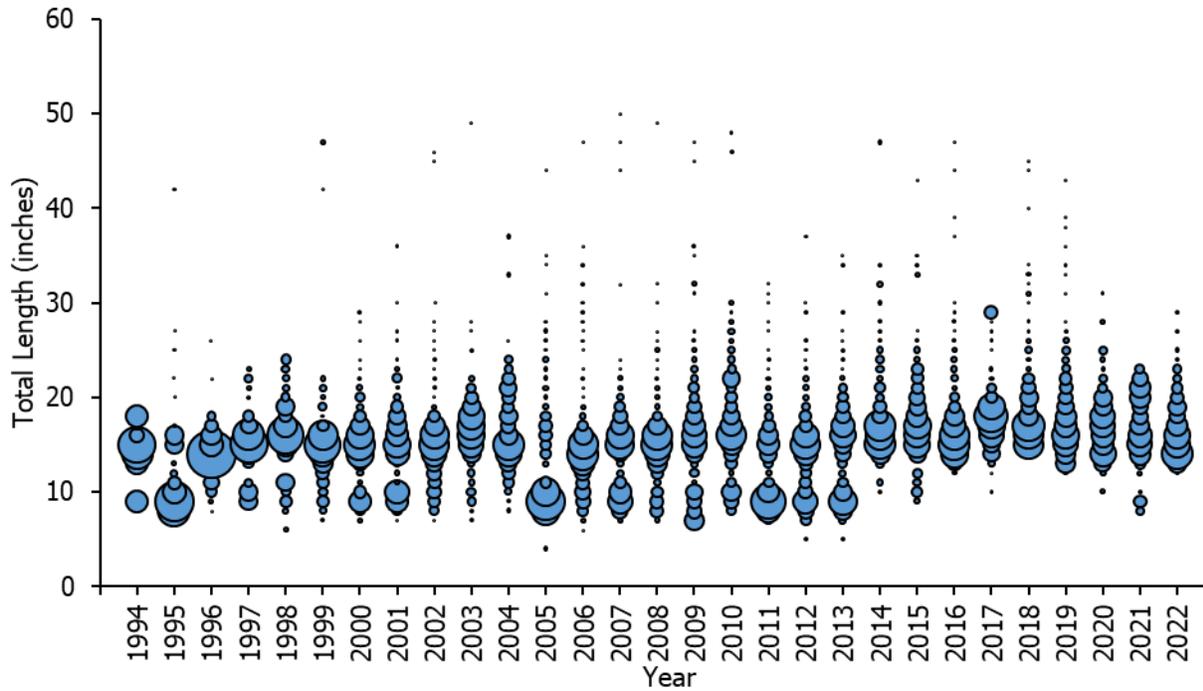


Figure 6. Commercial length frequency (total length, inches) of black drum harvested from 1994 to 2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

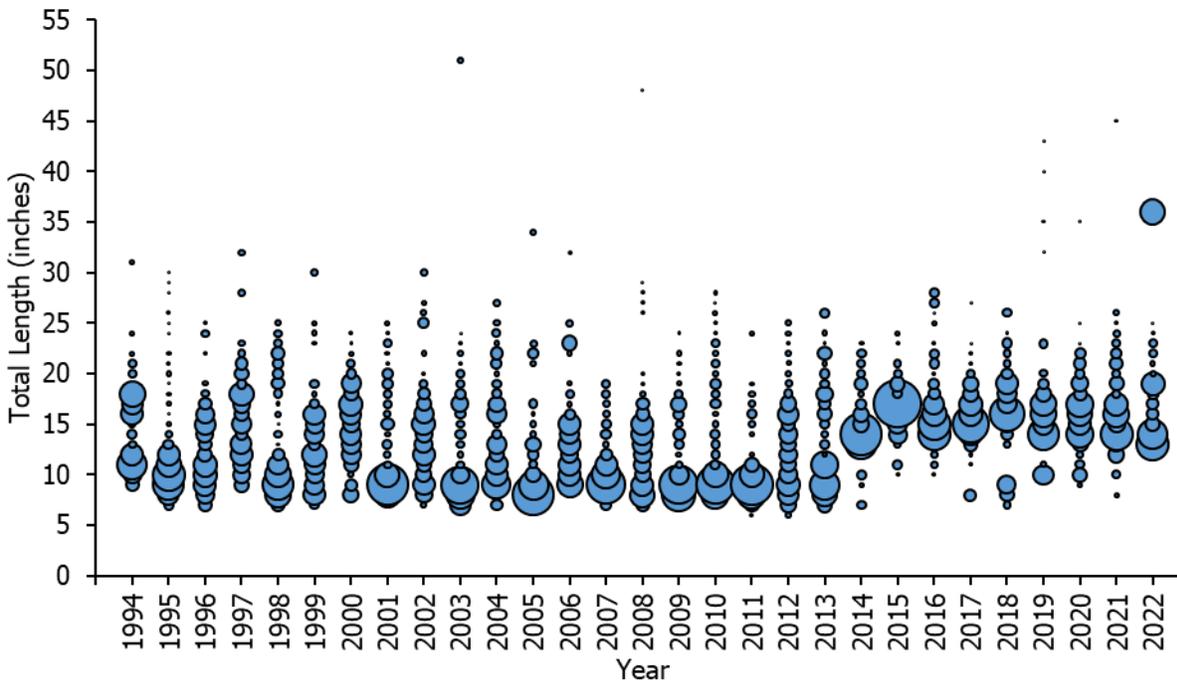


Figure 7. Recreational length frequency (total length, inches) of black drum harvested from 1994 to 2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

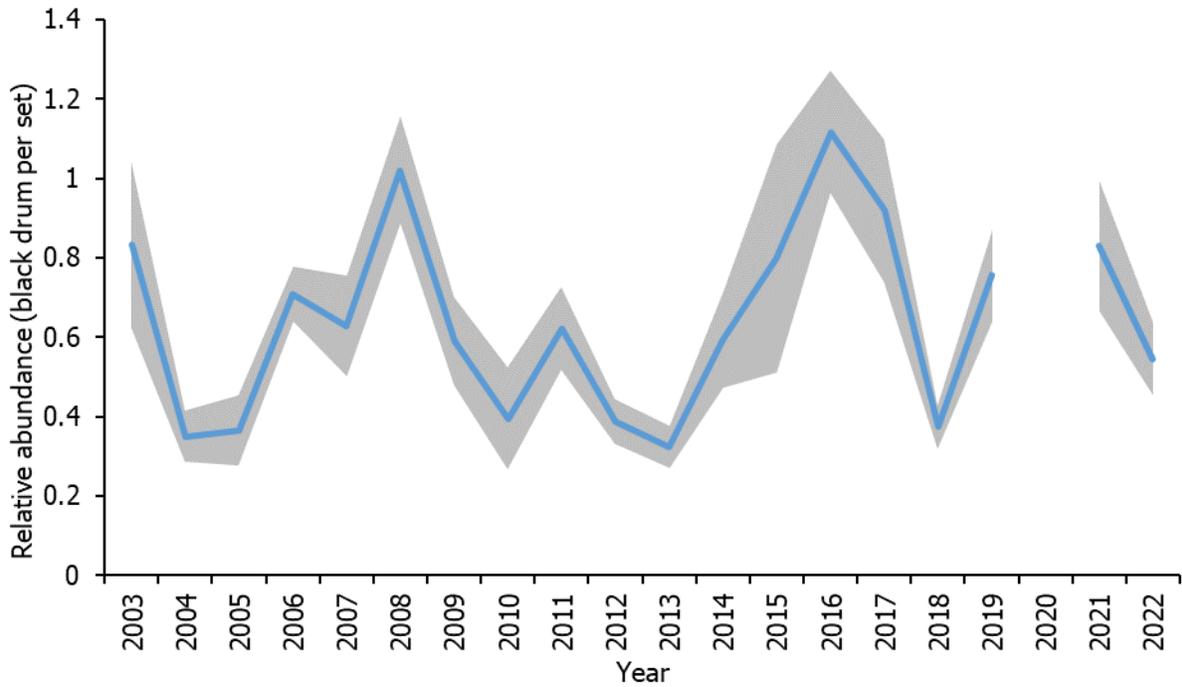


Figure 8. Annual weighted black drum index of relative abundance (number per set) from the DMF Independent Gill Net Survey (Program 915) in the Pamlico Sound and Neuse, Pamlico, and Pungo river systems from 2003–2022. Shaded area represents + one standard error. Sampling in this program was suspended in February 2020 due to COVID-19 restrictions and protected species interactions but resumed July 2021.

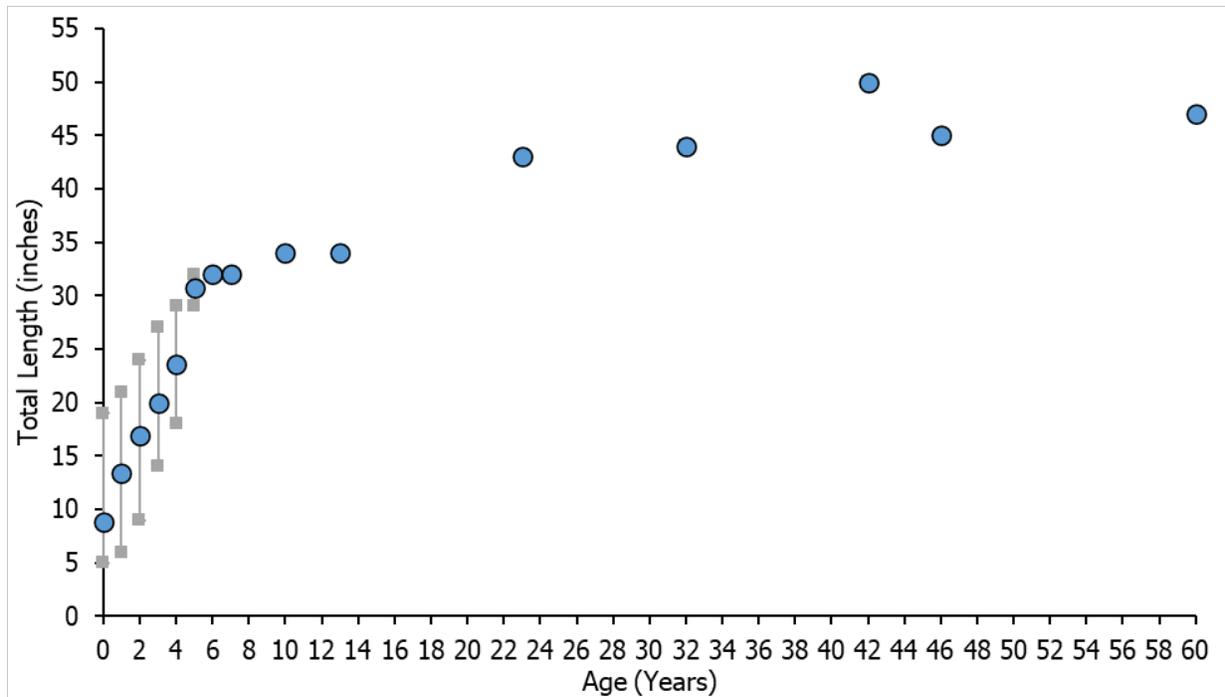


Figure 9. Black drum length (total length, inches) at age based on all age samples collected from 2011 to 2022. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age. Samples collected from partial carcasses were not included.

**FISHERY MANAGEMENT PLAN UPDATE  
BLUEFISH  
AUGUST 2023**

**STATUS OF THE FISHERY MANAGEMENT PLAN**

**Fishery Management Plan History**

FMP Documentation:	1990	
	Amendment 1	2000
	Framework 1	2001
	Amendment 2	2007
	Amendment 3	2011
	Addendum I	2012
	Amendment 4	2013
	Amendment 5	2015
	Amendment 6	2017
	Framework 2	2017
	Framework 3	2018
	Framework 4	2020
	Framework 5	2020
	Amendment 7	2021
	Framework 6	2023
Comprehensive Review:	2022	

The Fishery Management Plan (FMP) for bluefish was developed through a 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 the transfer of unused recreational quota to the commercial fishery. Framework 1 established annual harvest allocations specifically for biological monitoring programs. Amendments 2 and 5 were implemented to establish a strategy for monitoring bluefish bycatch. Amendment 3 added a formalizing process to incorporate scientific and management uncertainty when establishing catch limits. Addendum I established a coast-wide biological monitoring program to improve the quantity and quality of information available for use in bluefish stock assessments. Amendment 4 modified the accountability measures for the recreational bluefish fishery. 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-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. Framework 4 established a requirement for commercial vessels with federal permits for any species managed by the Mid-Atlantic and New England Councils to submit vessel trip reports electronically within 48 hours after entering port at

the conclusion of a trip. Framework 5 modified the Council’s acceptable biological catch (ABC) control rule and risk policy. The revised risk policy is intended to reduce the probability of overfishing as stock size falls below the target biomass while allowing for increased risk and greater economic benefit under higher stock biomass conditions. This action also removed the typical/atypical species distinction currently included in the risk policy. Amendment 7, the Bluefish Allocation and Rebuilding Amendment, revised the goals and objectives of the fishery management plan, reallocated quota between the commercial and recreational fisheries, reallocated commercial quota among the states, implemented a rebuilding plan, revised the sector quota transfer process, and revised how management uncertainty is applied during the specifications process. Amendment 7 took effect on January 1, 2022. Framework 6 established a new process for setting recreational bag, size, and season limits (i.e., recreational measures) for summer flounder, scup, black sea bass, and bluefish. This action also modified the recreational accountability measures for these species. Framework 6 took effect on March 9, 2023. The bluefish FMP, associated amendment documents, and framework information can be found at <https://www.mafmc.org/bluefish>.

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 and 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 2022a).

### **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 ASMFC bluefish FMP process except for Pennsylvania and the District of Columbia.

### **Goal and Objectives**

Amendment 7 revised the goals and objectives of the bluefish FMP to the following:

- Goal 1: Conserve the bluefish resource through stakeholder engagement to maintain sustainable recreational fishing and commercial harvest.
  - Objective 1.1: Achieve and maintain a sustainable spawning stock biomass and rate of fishing mortality.
  - Objective 1.2: Promote practices that reduce release mortality within the recreational and commercial fishery.
  - Objective 1.3: Maintain effective coordination between the National Marine Fisheries Service, Council, Commission, and member states by promoting compliance and to support the development and implementation of management measures.

- Objective 1.4: Promote compliance and effective enforcement of regulations.
- Objective 1.5: Promote science, monitoring, and data collection that support and enhance effective ecosystem-based management of the bluefish resource.
- Goal 2: Provide fair and equitable access to the fishery across all user groups throughout the management unit.
  - Objective 2.1: Ensure the implementation of management measures provides fair and equitable access to the resource across all user groups within the management unit.
  - Objective 2.2: Consider the economic and social needs and priorities of all groups that access the bluefish resource in the development of new management measures.
  - Objective 2.3: Maintain effective coordination with stakeholder groups to ensure optimization of economic and social benefits.

## DESCRIPTION OF THE STOCK

### Biological Profile

Bluefish (*Pomatomus saltatrix*) are a 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). 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. 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). Bluefish can exceed 39 inches and 31 pounds (NCDMF 2022b). Bluefish usually reach sexual maturity by age two around a length of 13 inches (Robillard et al. 2008). They spawn offshore from Massachusetts through Florida. Bluefish born each year typically fall into two distinct size classes, suggesting that there are two distinct spawning events, with one group spawning during the spring and a second spawning during the summer (Lassiter 1962). However, more recent research suggests that bluefish spawning is a single, continuous event that occurs as they migrate northward during the spring and summer, but that bluefish spawned in the middle of this time period do not have high survivability, resulting in two distinct size groups (Smith et al. 1994; Robillard et al. 2008).

### Stock Status

The 2021 management track stock assessment, which included data through 2019, determined that bluefish are overfished but are not experiencing overfishing (NMFS 2021).

## **Stock Assessment**

Estimates from the 2021 management track stock assessment show that spawning stock biomass (SSB) decreased from 2008 to 2018 but showed an increase from 2018 to 2019. SSB was below the SSB threshold in 2019 and has been below the SSB threshold since 2014 (Figure 1). SSB in 2019 was estimated to be 95,742 MT, which is 47.5% of the target reference point (NMFS 2021).

A bluefish research track stock assessment underwent peer review in December 2022 and will serve as the basis for the upcoming 2023 management track assessment. This management track assessment will use data through 2022 and be the basis for management in 2024-2025.

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

In North Carolina, the private recreational (all persons not fishing on a for-hire vessel) bag limit is three bluefish per person per day and the recreational for-hire (all persons fishing on a for-hire vessel) is five bluefish per person per day. These regulations have been in effect since 2020. Commercial fishery landings are monitored and if necessary, trip limits are implemented to prevent exceeding the annual quota. The commercial fishery was opened on January 1, 2022, with no possession limit and remained so through the end of 2022.

### **Commercial Fishery**

In North Carolina, bluefish have been harvested commercially using a variety of gears including estuarine long haul, ocean trawl, pound net, ocean beach seine, ocean gill net, and estuarine gill net. Capture methods have shifted primarily to gill nets over the last few decades. Gill nets, especially estuarine gill nets, have been the primary mode of harvest. Estuarine and ocean gill nets combined represent the largest commercial landings of bluefish, accounting for 98% of the harvest in 2022 (Figure 4). Bluefish commercial landings have fluctuated annually since 1972 (Table 1; Figure 2); however, landings in recent years have been lower than average. The commercial quota allocated to North Carolina for 2022 was 1,133,855 pounds. North Carolina did not receive any commercial quota transfers from other states in 2022. North Carolina's 2022 commercial bluefish landings totaled 872,041 pounds at a dockside value of \$513,425.

### **Recreational Fishery**

Bluefish are caught recreationally from shore, pier, and boat and can be targeted with lures as well as live and dead bait. Discards are a large part of the Bluefish fishery as they are not highly sought after for eating. In 2022, almost 86% of landed fish were released (Table 1). Overall, the size distribution of fish taken in the recreational fishery tends to be smaller than the distribution of fish harvested in the commercial fishery (Figure 5). Recreational landings for bluefish have been annually variable but relatively stable for the last few decades (Figure 2).

The DMF offers award citations for exceptional catches of bluefish. Bluefish exceeding 15 pounds are eligible for an award citation. The number of citations awarded was highest in 1991 (n=187), with fewer citations awarded in the last 20 years, compared to the 1990's (Figure 3). Since 2017,

the DMF has offered an additional citation for released bluefish that exceed 34 inches in length. Approximately 62% of the citations awarded since 2017 have been for released fish.

## **MONITORING PROGRAM DATA**

### **Fishery-Dependent Monitoring**

Commercial bluefish landings from a broad range of gears are sampled through the Division's fish house sampling programs. Information collected includes location, gear type and gear-specifics, soak time, and water depth. Commercial catches are also subsampled to collect biological information on bluefish including fork length (FL) and aggregate weight (kg) by market grade. Trip ticket information (total weight of catch) is also recorded and reported to DMF by licensed dealers. A total of 3,945 bluefish were measured from commercial landings in 2022 (Table 2). Mean fork length was 14 inches and ranged from 4 to 31 inches. Size ranges have varied minimally over the last few decades.

The number and size of fish harvested as well as number of fish released recreationally is characterized through NOAA Fisheries' Marine Recreational Information Program (MRIP). In 2022, approximately 1.6 million pounds of bluefish were recreationally harvested. The mean length of fish harvested and measured by MRIP in the recreational fishery in 2022 was 12 inches and ranged from 7 to 29 inches fork length (Table 3). Since 1985, the annual length distribution of harvest in both the commercial and recreational fisheries has varied little with most fish harvested ranging from 7 to 16 inches fork length (Figures 6 and 7). Larger bluefish (>20 inches) have been less common in recent years in both the commercial and recreational fisheries. See <https://www.fisheries.noaa.gov/topic/recreational-fishing-data> for more information on the collection of recreational fishing data.

### **Fishery-Independent Monitoring**

The Division's Pamlico Sound Independent Gill Net Survey was initiated in May of 2001 and has been sampled continuously through 2019. This survey provides fishery-independent indices of relative abundance along with associated length and age data. These estimates provide essential data for input into the coastwide bluefish stock assessment. The relative abundance index, defined as the number of bluefish per set, has ranged from 2.8 in 2015 to 8.6 in 2019 during the 22-year time-series (Figure 8). The relative abundance index in 2022 was 6.8, which is slightly below the time-series average (5.5). It should be noted that the index in 2021 is calculated from samples collected from Jul.-Dec while the index for all other years was calculated for Feb.-Dec. Sampling in this program was suspended in February 2020 due to COVID-19 restrictions and protected species interactions but resumed July 2021.

North Carolina is one of the states subject to compliance of the biological monitoring program implemented under Addendum I to Amendment 1. To comply with these monitoring requirements, DMF must collect at least 100 aging structures from bluefish each year. When possible, at least 50 fish are collected from January-June and 50 fish from July-December. In most years, the majority of bluefish age samples are obtained from the Pamlico Sound Independent Gill Net Survey as well as the commercial and recreational fisheries. In 2022, 1,210 age samples were collected (Table 4). The maximum age in 2022 was 8 years of age. The maximum age over the time-series is 12 years

of age. Bluefish length increases with age, although the size at a given age can be quite variable (Figure 9).

## **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.
- 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.

## **MANAGEMENT STRATEGY**

Bluefish in North Carolina are jointly managed by ASMFC and MAFMC under Amendment II of the FMP. Amendment II uses annual catch limits (ACLs) for both the recreational and commercial sectors. The recreational quota is a coast-wide quota while the commercial quota is further divided into state-specific quotas. Amendment II allows quota transfers between states and between sectors. Additionally, daily limits are used to manage recreational harvest and trip limits can be implemented for commercial fishermen if needed to prevent exceeding North Carolina's commercial quota.

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## TABLES

Table 1. Bluefish recreational harvest and number released (Marine Recreational Information Program) and commercial harvest (North Carolina Trip Ticket Program) in North Carolina, 1985–2022.

Year	Recreational			Commercial	Total Weight (lb)
	Number Landed	Number Released	Weight Landed (lb)	Weight Landed (lb)	
1985	3,706,930	1,281,466	7,001,181	3,604,445	10,605,626
1986	5,184,834	1,233,792	16,245,390	3,450,230	19,695,620
1987	3,248,002	1,402,327	8,542,577	4,561,101	13,103,678
1988	3,131,369	1,002,321	4,475,001	5,039,039	9,514,040
1989	4,843,723	2,314,161	7,123,822	3,291,468	10,415,290
1990	6,838,820	2,427,701	10,345,929	4,578,172	14,924,101
1991	2,423,772	1,478,829	4,627,434	3,919,786	8,547,220
1992	1,562,752	1,957,741	2,226,311	2,839,057	5,065,368
1993	1,620,184	1,825,095	1,991,395	2,705,278	4,696,673
1994	673,341	3,235,793	847,458	1,782,345	2,629,803
1995	660,979	2,345,163	770,490	3,010,742	3,781,232
1996	632,382	1,613,566	1,352,444	3,298,640	4,651,084
1997	1,476,271	2,286,439	2,366,435	4,003,160	6,369,595
1998	1,530,106	1,530,488	1,888,463	2,925,929	4,814,392
1999	1,774,946	2,749,327	1,232,827	2,761,084	3,993,911
2000	2,325,583	5,231,507	1,721,367	3,368,610	5,089,977
2001	3,410,135	6,756,435	3,048,743	4,066,000	7,114,743
2002	2,484,516	4,357,535	2,327,789	2,323,964	4,651,753
2003	2,161,780	3,432,547	1,843,018	3,470,100	5,313,118
2004	2,825,382	3,781,031	2,773,518	3,762,944	6,536,462
2005	3,004,921	4,417,822	2,938,814	2,837,661	5,776,475
2006	2,842,593	5,213,436	2,651,326	2,791,187	5,442,513
2007	3,749,514	6,740,155	3,616,359	2,329,718	5,946,077
2008	2,855,199	5,146,870	2,385,349	1,930,391	4,315,740
2009	3,190,313	6,447,822	3,566,768	2,360,081	5,926,849
2010	3,691,868	7,419,644	3,185,652	3,216,030	6,401,682
2011	3,613,883	7,150,476	3,158,287	1,897,471	5,055,758
2012	2,684,392	3,268,032	2,872,922	758,858	3,631,780
2013	4,287,526	7,050,725	3,517,233	1,159,580	4,676,813
2014	4,418,858	5,862,762	3,764,005	2,019,279	5,783,284
2015	4,123,461	6,356,252	3,754,577	804,094	4,558,671
2016	4,489,223	6,802,960	3,356,049	1,148,643	4,504,692
2017	3,173,218	8,255,510	3,634,502	1,544,053	5,178,555
2018	3,304,587	7,912,210	2,630,685	910,262	3,540,947
2019	2,752,589	7,162,431	3,011,480	1,108,205	4,119,685
2020	2,108,296	6,557,751	2,124,224	1,113,009	3,237,233
2021	982,389	3,539,333	1,031,760	1,051,026	2,082,786
2022	1,533,911	9,336,045	1,645,410	872,041	2,517,451
Mean	2,876,909	4,391,671	3,568,342	2,595,097	6,163,439

Table 2. Summary of fork length (inches) data sampled from all sources of length data (harvest and bait) from the bluefish commercial fishery in North Carolina, 1985–2022.

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Total Number Measured
1985	15	4	33	5,351
1986	14	4	33	4,220
1987	16	4	33	3,902
1988	16	3	32	4,243
1989	16	4	33	5,701
1990	16	4	33	8,090
1991	14	4	35	6,068
1992	13	4	32	6,771
1993	16	3	35	3,796
1994	15	5	33	2,096
1995	15	3	32	2,095
1996	16	5	33	2,428
1997	14	4	35	4,355
1998	16	5	33	4,693
1999	18	5	34	7,063
2000	18	6	35	8,369
2001	18	4	35	11,748
2002	18	5	35	8,288
2003	19	6	34	7,861
2004	19	6	33	9,608
2005	19	5	33	9,766
2006	18	5	33	10,255
2007	15	6	33	8,856
2008	16	5	33	8,035
2009	18	6	34	7,471
2010	17	6	35	6,721
2011	16	6	33	5,768
2012	14	5	34	7,030
2013	14	6	33	6,928
2014	15	8	34	6,459
2015	14	7	31	6,100
2016	14	3	33	7,616
2017	16	7	35	5,580
2018	15	7	34	3,778
2019	15	8	33	4,812
2020	16	7	35	3,396
2021	16	8	34	4,203
2022	14	4	31	3,945

Table 3. Summary of fork length (inches) data sampled from the bluefish recreational fishery in North Carolina, 1985–2022.

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Total Number Measured
1985	14	6	34	312
1986	18	6	38	420
1987	16	5	40	1,319
1988	7	0	38	1,117
1989	12	5	40	1,633
1990	13	5	34	2,413
1991	14	5	36	1,572
1992	13	7	33	1,044
1993	13	7	36	1,187
1994	14	7	36	1,174
1995	14	4	36	740
1996	15	6	38	1,177
1997	14	6	37	2,404
1998	13	6	40	1,624
1999	12	6	34	1,316
2000	12	6	34	1,356
2001	13	7	31	2,191
2002	13	7	34	999
2003	13	7	34	781
2004	13	6	40	1,149
2005	12	6	35	1,056
2006	12	6	36	1,028
2007	12	6	37	1,048
2008	12	5	35	894
2009	13	7	34	778
2010	12	6	38	1,323
2011	12	6	34	1,784
2012	12	7	35	1,190
2013	11	7	29	563
2014	12	7	29	660
2015	12	7	18	577
2016	11	8	23	732
2017	12	6	35	657
2018	11	6	30	846
2019	13	8	32	910
2020	12	8	32	713
2021	12	6	26	299
2022	12	7	29	433

Table 4. Summary of bluefish age samples collected in North Carolina from both dependent (commercial and recreational fisheries) and independent (surveys) sources, 1985–2022.

Year	Modal Age	Minimum Age	Maximum Age	Number of Samples
1985	1	0	11	548
1986	1	0	9	437
1987	1	0	9	380
1988	1	0	9	346
1989	1	0	9	320
1990	1	0	9	372
1991	1	0	8	289
1992	1	0	9	704
1993	1	0	10	722
1994	1	0	10	517
1995	1	0	9	634
1996	1	0	10	230
1997	1	0	10	446
1998	1	0	9	658
1999	1	0	10	442
2000	1	0	10	290
2006	3	0	10	89
2007	2	0	11	433
2008	1	0	10	656
2009	3	0	10	488
2010	3	0	8	527
2011	3	0	9	551
2012	1	0	9	818
2013	0	0	9	742
2014	1	0	9	803
2015	1	0	10	622
2016	1	0	11	678
2017	2	0	10	630
2018	1	0	10	669
2019	1	0	8	853
2020	2	0	12	244
2021	1	0	5	793
2022	1	0	8	1,210

## FIGURES

### Bluefish Spawning Stock Biomass (SSB) and Recruitment

Source: Northeast Fisheries Science Center, 2021

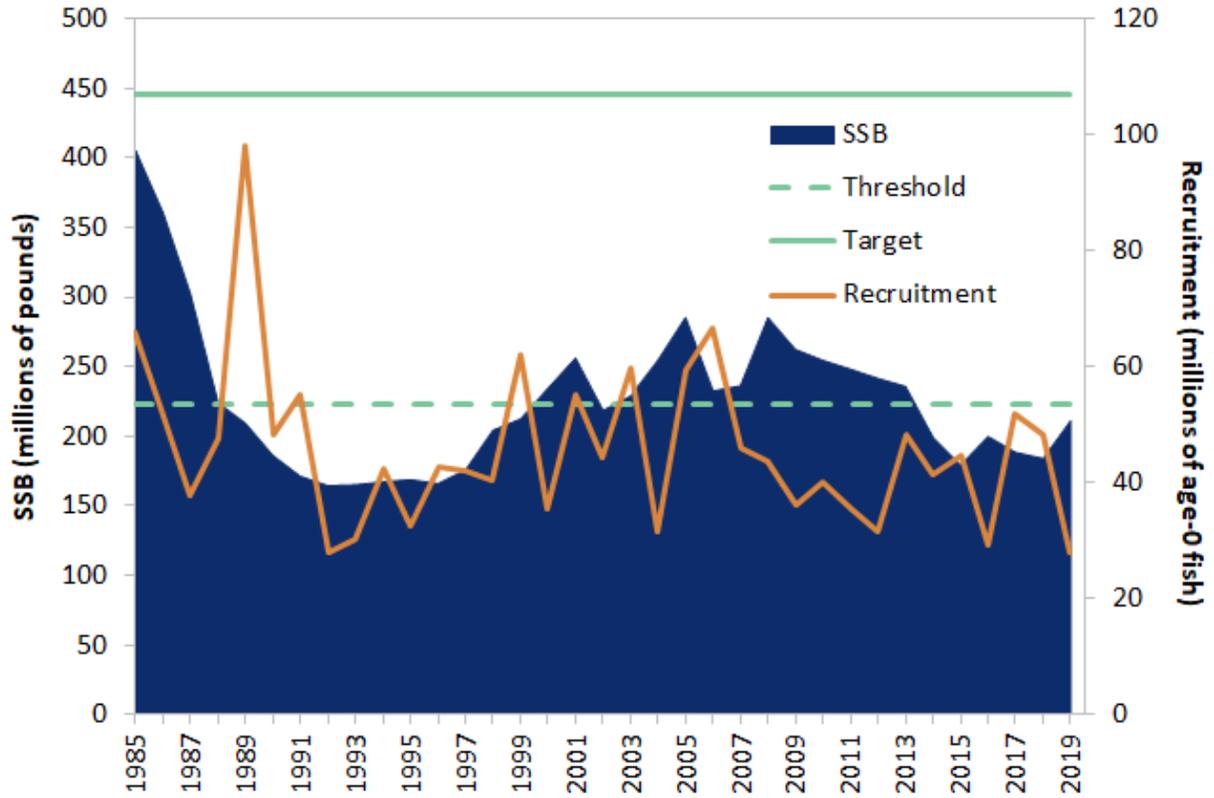


Figure 1. Bluefish spawning stock biomass and recruitment at age 0 by calendar year. The horizontal dashed green line is the SSB Threshold = 100,865 mt. Source: 2021 Bluefish Operational Stock Assessment, NEFSC (NMFS 2021).

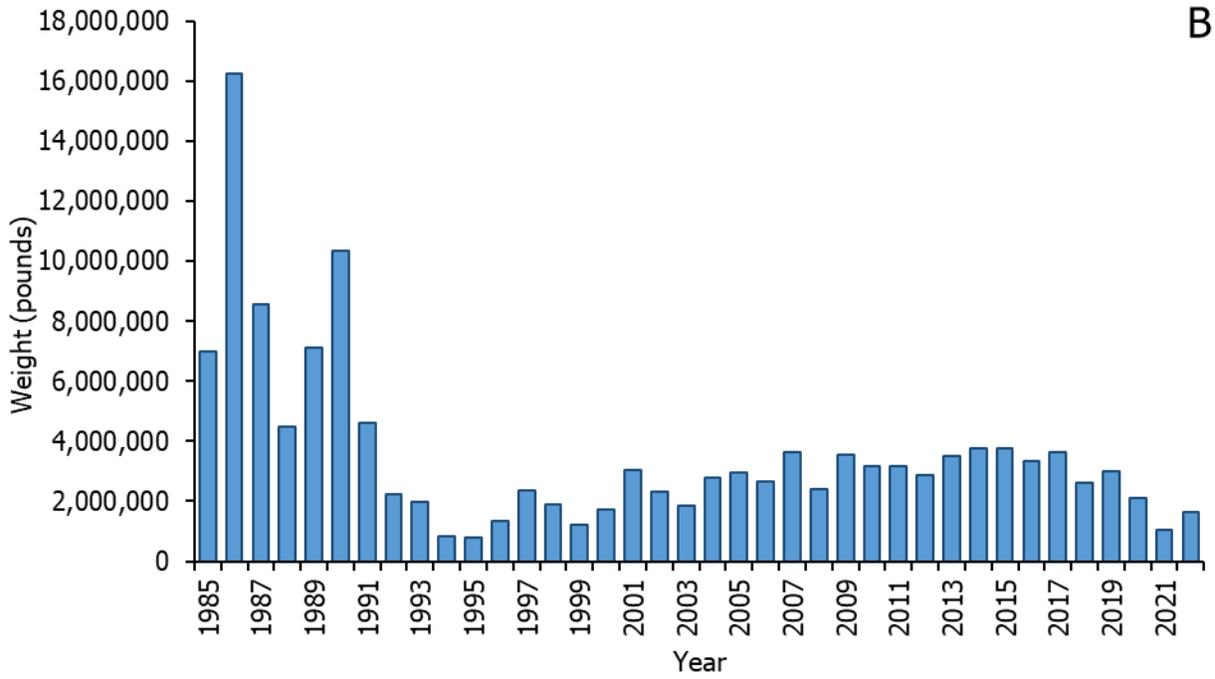
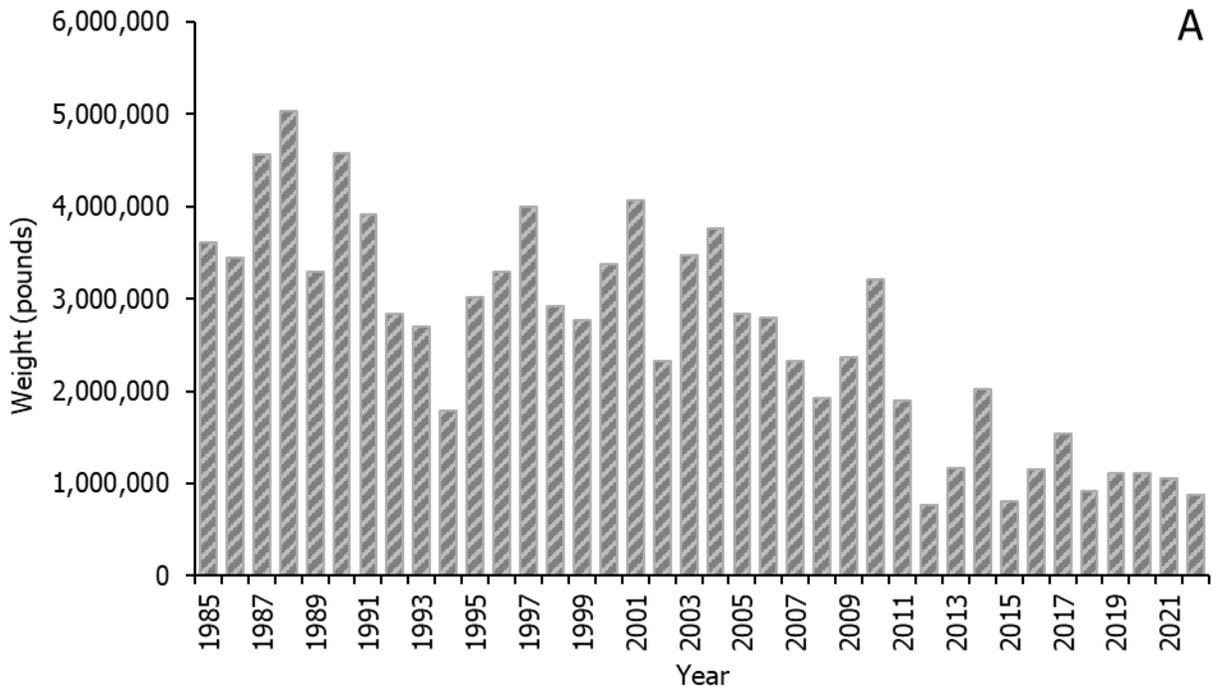


Figure 2. North Carolina commercial (A) and recreational (B) landings of bluefish, 1985–2022.

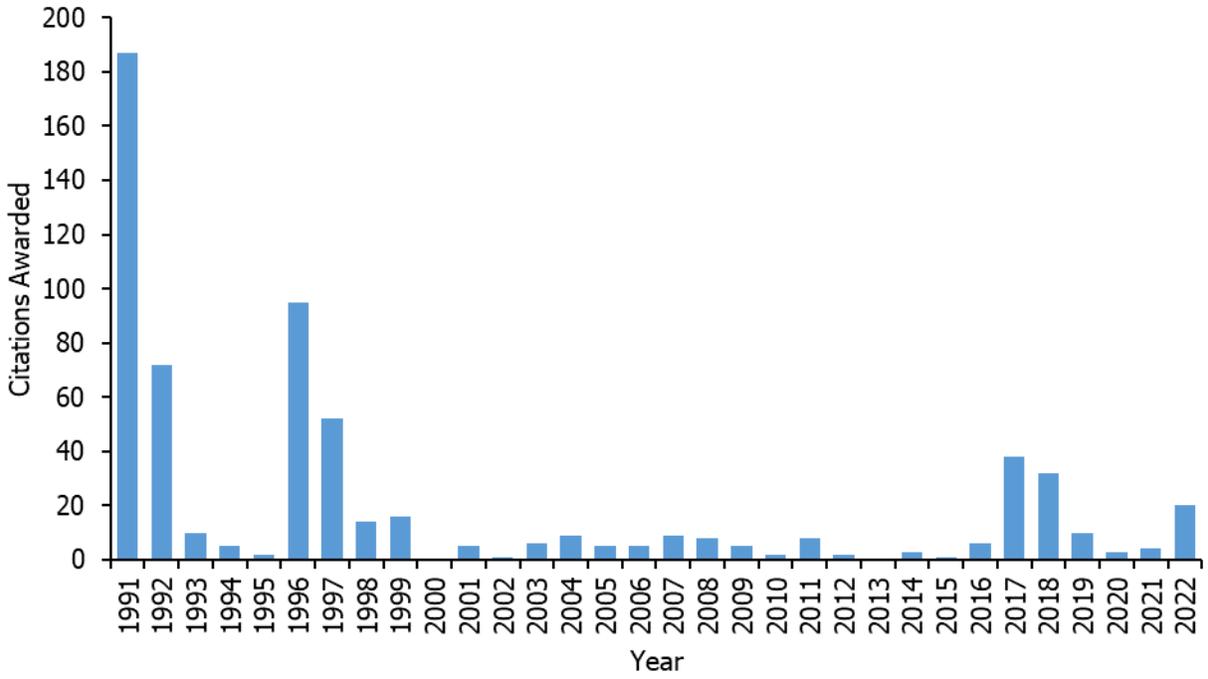


Figure 3. North Carolina recreational award citations for bluefish, 1991–2022.

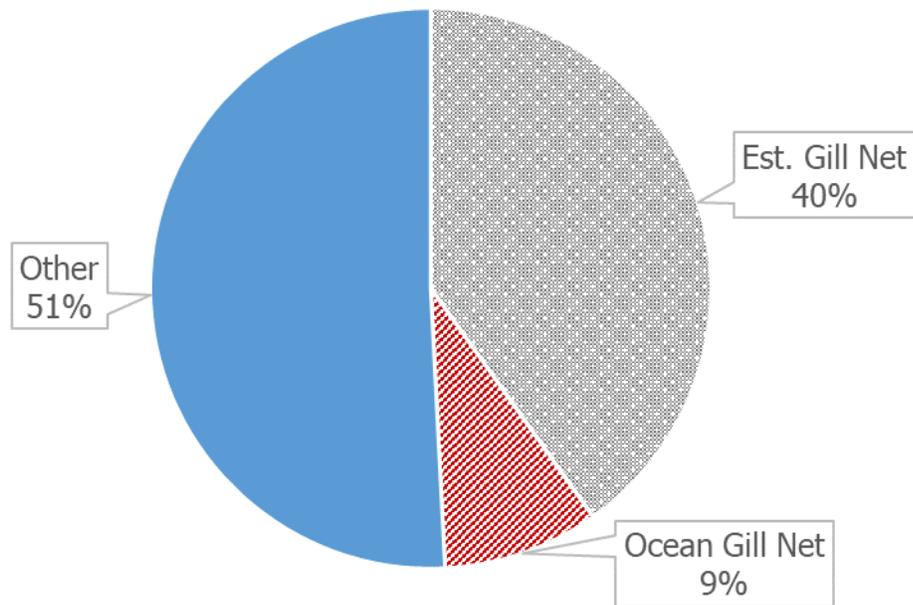


Figure 4. Commercial harvest of bluefish in North Carolina during 2022 by gear type.

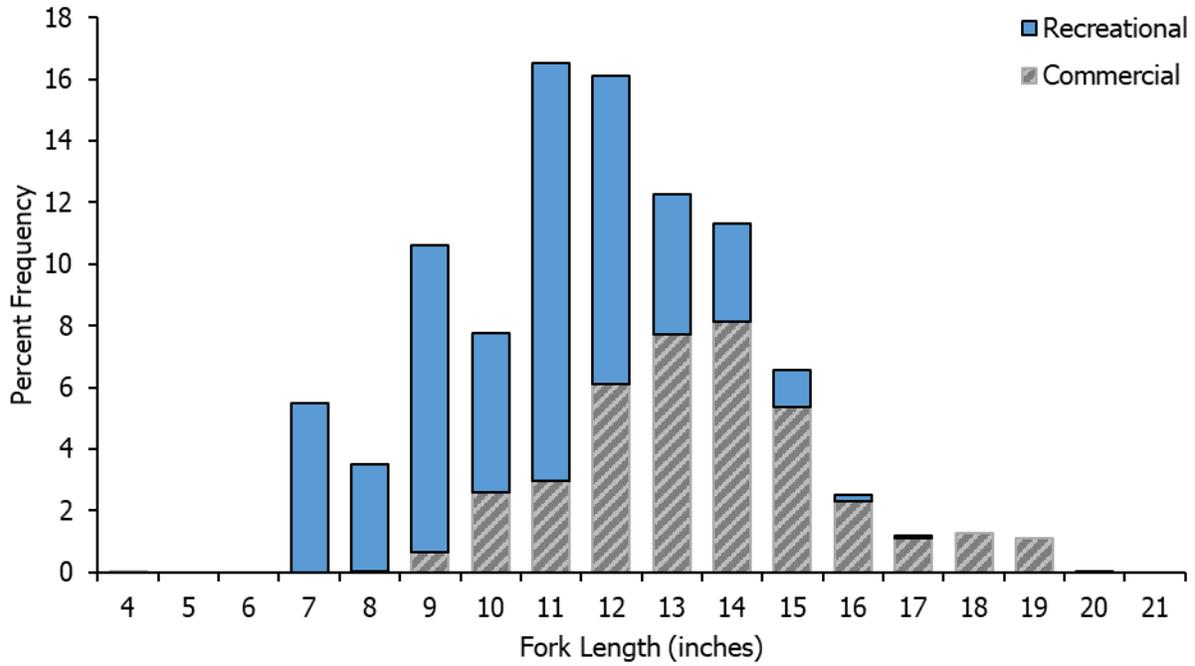


Figure 5. Commercial and recreational length frequency distribution from bluefish harvested in North Carolina, 2022.

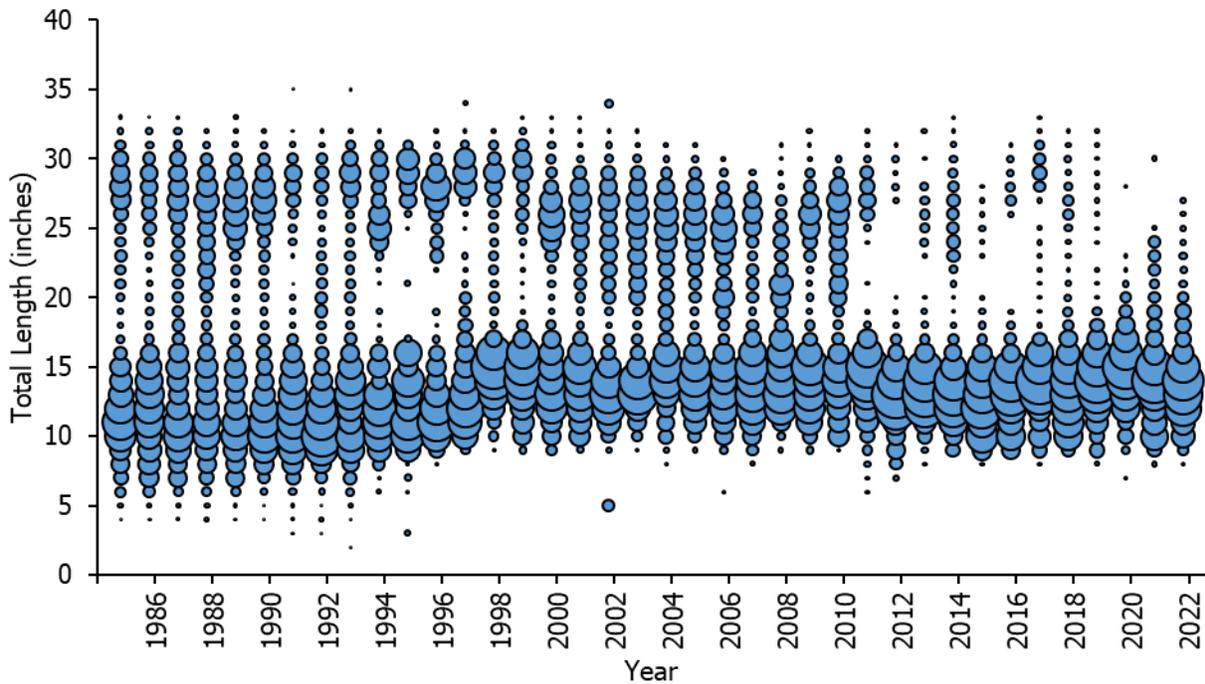


Figure 6. Commercial length frequency of bluefish harvested in North Carolina, 1985–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

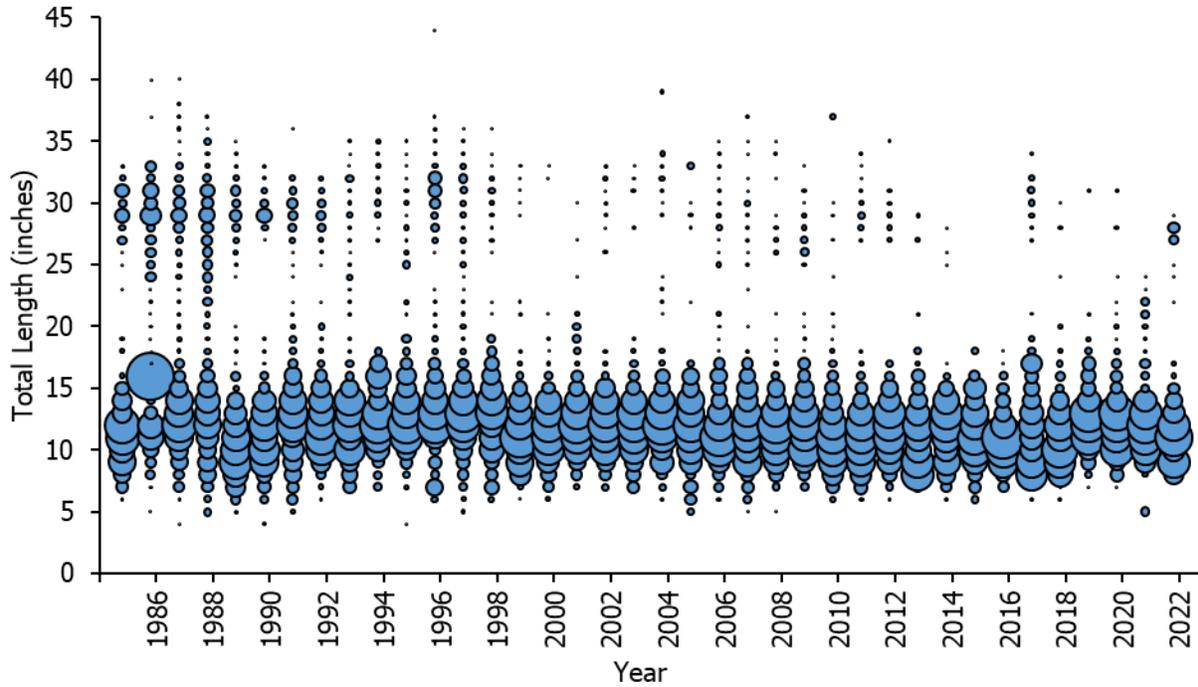


Figure 7. Recreational length frequency (fork length, inches) of bluefish harvested in North Carolina, 1985–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

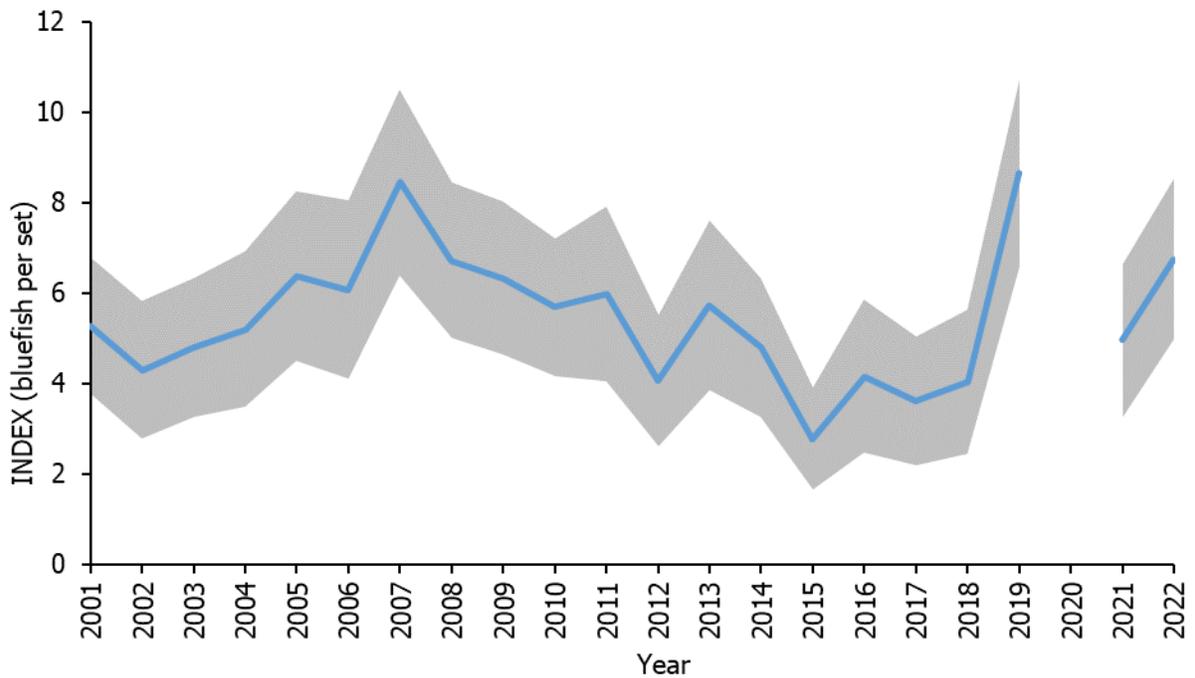


Figure 8. Relative abundance index of bluefish, from the North Carolina Pamlico Sound Independent Gill Net Survey, 2001–2022. Shading represents the standard error about the annual relative abundance index estimates. Pamlico Sound Independent Gill Net Survey sampling did not occur in 2020 and the first half of 2021.

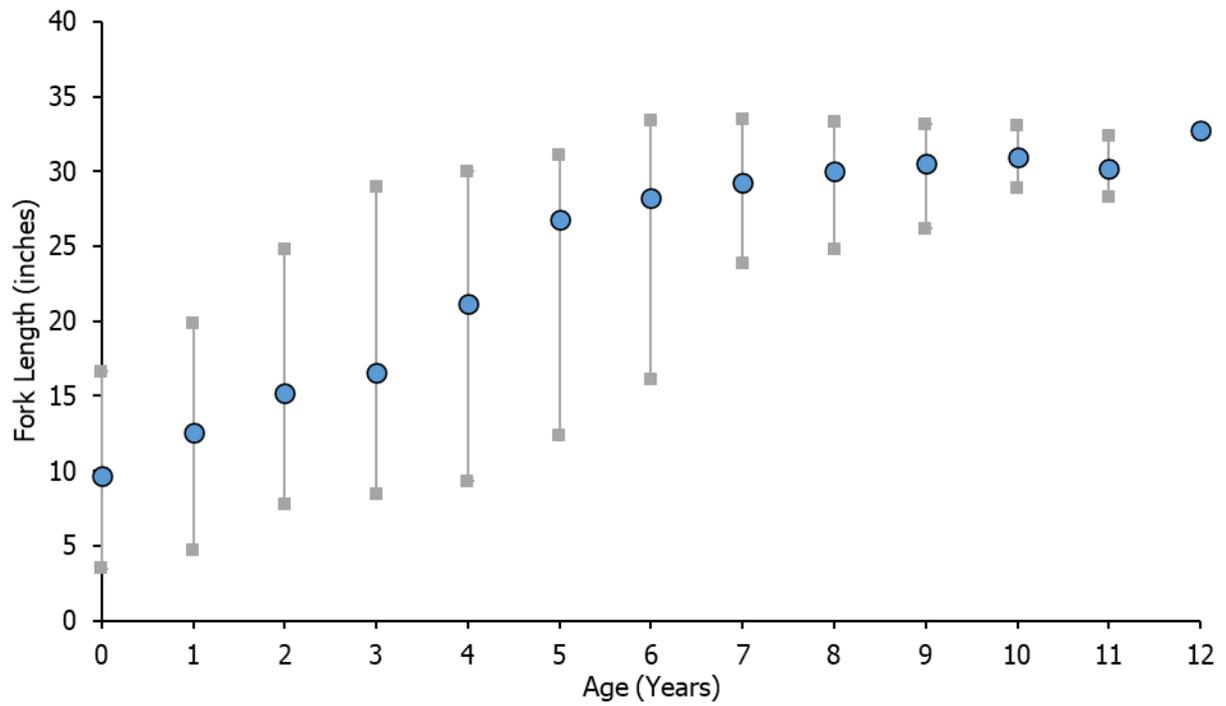


Figure 9. Bluefish length at age based on all age samples collected in North Carolina, 1985–2022. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age.

**FISHERY MANAGEMENT PLAN UPDATE**

**SPOT**

**JUNE 2023**

**STATUS OF THE FISHERY MANAGEMENT PLAN**

**Fishery Management Plan History**

Original FMP Adoption:	ASMFC FMP	October 1987
Amendments:	Omnibus Amendment	August 2012
	Addendum II	August 2014
	Addendum III	February 2020
Comprehensive Review:	2024	

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 was adopted prior to the 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 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.

In August 2011, the South Atlantic State/Federal Fisheries Management Board (hereafter referred to as the Board) approved the Omnibus Amendment for Spot, Spotted Seatrout, and Spanish Mackerel. The Omnibus Amendment updated the 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 results of the trigger exercise (ASMFC 2012). Without coast-wide minimum management measures, the trigger exercises did little to provide effective management between stock assessments.

In August 2014, the Board approved Addendum II to the Omnibus Amendment which established the use of the Traffic Light Approach (TLA; Caddy and Mahon 1995; Caddy 1998; Caddy 1999; Caddy 2002) as a precautionary management framework. The TLA is preferred for fast-growing, early maturing species like spot, where it is more important to respond to multi-year trends rather than annual changes. The TLA more effectively illustrates long term trends than the triggers established by the Omnibus Amendment. The management framework utilizing the TLA (ASMFC 2014) replaced the management triggers established in the Omnibus Amendment.

In February 2020, the Board approved Addendum III to the Omnibus Amendment, which revised the TLA’s trigger mechanism and management response for the recreational and commercial fisheries (ASMFC 2020a). Addendum III incorporated the use of a regional approach (Mid-Atlantic NJ-VA and South Atlantic NC-FL) to better reflect localized fishery trends and changed the TLA to trigger management action if two of the three terminal years exceed threshold levels. State-specific management action is initiated when the proportion of red exceeds specified thresholds (30% or 60%) for both harvest and abundance. If management action is triggered, the

coastwide response includes recreational bag limits and quantifiable measures to achieve percent reductions in commercial harvest. Response requirements vary depending on which threshold is exceeded. Addendum III also defines the mechanism by which triggered management actions may be removed, after abundance characteristics are no longer triggering management action. The TLA is reviewed annually in September. For additional information and links to the above-mentioned FMP, amendments, and addendums please refer to the ASMFC webpage for spot (<http://www.asmfc.org/species/spot>).

The North Carolina Wildlife Federation submitted a petition for rulemaking on November 2, 2016, and a modification to the petition on January 12, 2017. The petitioner put forth seven rules to designate nursery areas, restrict gear and seasonality in the shrimp trawl fishery to reduce bycatch of fish (including spot, Atlantic croaker, and weakfish), and establish an eight-inch minimum size limit for spot and a 10-inch minimum size limit for Atlantic croaker. At its February 2017 business meeting, the North Carolina Marine Fisheries Commission passed a motion to approve the petitioned rules and begin the rulemaking process. Upon review by the Office of State Budget and Management, it was determined that sufficient state funds are not available to implement the proposed rule changes without undue detriment to the agency's existing activities, and the rules were never adopted.

To ensure compliance with interstate requirements, North Carolina also manages spot under the North Carolina Fishery Management Plan for Interjurisdictional Fisheries. The goals of the North Carolina FMP for Interjurisdictional Fisheries is to adopt FMPs, consistent with North Carolina Law, approved by the Mid-Atlantic Fishery Management Council (MAFMC), South Atlantic Fishery Management Council (SAFMC), or the Atlantic States Marine Fisheries Commission (ASMFC) by reference and implement corresponding fishery regulations in North Carolina to provide compliance or compatibility with approved FMPs and amendments, now and in the future. The goal of the councils and ASMFC plans, established under the Magnuson-Stevens Fishery Conservation Management Act (federal councils) 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 the 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 are to:

- Increase the level of research and monitoring of spot bycatch in other fisheries, and to complete a coast-wide stock assessment.
- Manage the spot fishery to encourage reduced mortality on spot stocks until age-1.

- 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.

## DESCRIPTION OF THE STOCK

### Biological Profile

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 Chesapeake Bay to South Carolina. Spot generally reach maturity by age one or two, rarely living beyond six years. Length at 50 percent maturity is generally between seven- and 11-inches total length. Juvenile and adult spot are bottom feeders, eating mostly worms, small crustaceans, and mollusks. Post-larvae and young-of-the-year spot prey on planktonic organisms (ASMFC 2010).

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 move offshore to spawn during cooler months 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 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). Spot are most susceptible to commercial and recreational fishing activity during the fall when schools migrate from estuarine to oceanic waters (Pacheco 1962).

### Stock Status

Because there is no currently approved stock assessment, the stock status for spot with relation to overfishing or overfished is unknown.

To evaluate the status of the stock between stock assessments, the TLA established under Addendum II and revised under Addendum III, is reviewed annually in years when an assessment is not already being conducted.

Results of the 2022 TLA (2021 terminal year) indicated only the South Atlantic harvest composite characteristic index exceeded the 30% threshold in 2021 (ASMFC 2022). The Mid-Atlantic harvest composite index dropped below the 30% threshold in 2020 and 2021, to around 20% red in 2020 and 25% red in 2021 (ASMFC 2022). The South Atlantic harvest composite index has exceeded the 30% red threshold since 2016, with the 2021 index rising to around 55% red (ASMFC 2022; Figure 1). The TLA report cautioned that the harvest composite indices for 2021 should not be used to trigger management because catch restrictions were in place in 2021 (ASMFC 2022). The adult abundance composite index, which combines fishery independent surveys, has exceeded the 30% red threshold since 2011 in the Mid-Atlantic region (no 2020-2021 data points as ChesMMA indices were not available; ASMFC 2022). The South-Atlantic abundance composite index dropped below the 30% threshold in 2019, for the first time since 2015, to around 15% red (2020 and 2021 data were incomplete; Figure 2). While not used for management decisions, the composite juvenile abundance index consisting of North Carolina Program 195 trawl survey data

is reviewed annually. This index is highly variable and shows spikes in the red portion in 2020 and 2021 (Figure 3). Because both abundance composite indices were missing data for 2020 and 2021, a determination of whether the TLA triggered in 2021 or if management measures can be removed could not be made and management was maintained.

## **Stock Assessment**

The next Spot Benchmark Stock Assessment is scheduled for 2024. The most recent and first benchmark Stock Assessment, completed in 2017, did not pass peer review and will not be used for management (ASMFC 2017, 2020). The assessment was not recommended for management because of concern over uncertainty in assessment results due to disagreement between trends in harvest and abundance. Abundance in fishery-independent surveys has generally been increasing whereas commercial and recreational harvest has been declining. The review panel noted that discard estimates from the shrimp trawl fishery were an improvement, and recommended shrimp trawl discard estimates be incorporated into annual monitoring using the TLA.

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

The 2020 TLA review (2019 terminal year) for spot triggered at the 30% threshold and coastwide management action as outlined in Addendum III was enacted in March 2021 (ASMFC 2020b). The management response outlined in Addendum III specifies, non de minimis states are required to implement a 50 fish bag limit for their recreational fishery and must reduce commercial harvest by 1% of the average state commercial harvest from the previous 10 years.

In North Carolina, the 50 fish per person per day recreational bag limit was effective April 15th, 2021 (FF-23-2021) and has remained in place. The commercial spot fishery closed December 10<sup>th</sup>, 2021 through April 4<sup>th</sup>, 2022 and December 10<sup>th</sup>, 2022 through April 4<sup>th</sup>, 2022 to meet the required 1% reduction (FF-66-2021; FF-57-2022). The same commercial closure period will occur from December 2023 into April 2024. Management measures will remain in place for at least two years and future TLA updates will determine future management action after this time.

### **Commercial Fishery**

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, beach seines, swipe nets, and crab pots contribute minimally to commercial landings. Commercial landings have fluctuated with higher catches reported in the 1990's and have generally declined since 2001, averaging 434,666 pounds since 2018 (Table 1; Figure 4a). The lowest landings in the time series have occurred over the past seven years. In 2022, commercial landings were 543,096 pounds, which is a slight increase from 2021. Commercial spot landings exceeded recreational harvest in 2020, 2021, and 2022. 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 Fishery**

Spot are targeted recreationally by shore-based anglers and those fishing from private vessels during the fall. Harvest data from the Recreational Commercial Gear License (RCGL) were collected from 2002 to 2008. The program was discontinued in 2009 due to a lack of funding. From 2002 to 2008, an average of 203,383 pounds was harvested per year, ranging from 97,753 to 339,077 pounds (NCDMF 2021). Recreational estimates across all years have been updated and are now based on the Marine Recreational Information Program (MRIP) Fishing Effort Survey-based calibrated estimates. For more information on MRIP see <https://www.fisheries.noaa.gov/topic/recreational-fishing-data>.

From 1989 through 2022 recreational harvest of spot in North Carolina ranged from 297,813 to 4,596,119 pounds or between 920,512 and 11,797,824 fish, with the lowest landings in both count and weight occurring in 2020 (Table 1, Figure 4b and 5). Harvest by weight was generally stable prior to 2008 when there was a notable decline in the time series. Harvest in the last eight years has been consistently low. The three lowest values in the time series occurred in the last three years. Recreational harvest in 2022 was 1,197,145 fish and 375,168 pounds, a 0.16% decrease in number of fish and a 16% decrease in weight from 2021.

The number of recreational releases were relatively low in the first ten years of the time series remaining below 4 million fish. In 2006, there was a noticeable increase in releases to 8,196,592 fish and releases remained relatively high until dropping in 2016 remaining consistently lower into 2022 (Figure 5). The percentage of released recreational catch has steadily increased over the time series from 14% to 66%. In 2022, anglers released 2,331,484 fish or 66% of all catches.

The number of spot measured during MRIP sampling has generally declined since 2011, only 69 individuals were measured in 2022 which is the second lowest in the time series (Table 2). Mean fork length (FL) in 2022 was 8.4 inches and there has been little fluctuation since 1989 ranging from 7.9 to 9.5 inches. Maximum FL in 2022 was 12.2 inches which is the highest since 2015, and minimum FL increased in 2022 to 6.7 inches, the highest in the time series. Most of the recreational catch consists of spot from 6.0 to 9.0 inches FL with little change in length composition since 1989 (Figure 6). However, in the '90s and early 2000s, a wider range of lengths were harvested in the recreational fishery. Primarily, spot over 12 inches FL have not been observed in the recreational fishery for the past 10 years, though at least one was landed in 2022. Length distribution from 2022 recreational catches ranged from 6.4 to 11.8 inches and when compared to commercial catches had greater representation of smaller size classes (Figure 7). The modal length in the recreational harvest for 2022 was 8.0 inches with 41 percent of the recreational catch within this size class.

## **MONITORING PROGRAM DATA**

### **Fishery-Dependent Monitoring**

In 2022, 2,587 spot lengths were obtained from commercial fish house sampling with a mean FL of 8.0 inches, and lengths ranging from 4.4 to 11.7 inches. Mean FL has been consistent since 2020 and relatively stable across the time series ranging from 6.7 to 8.9 inches. The number of spot lengths obtained from commercial fish house sampling has generally decreased since 2005 ranging

from 2,242 in 2018 to 15,538 in 2005 (Table 3). Bait samples are included in minimum, maximum, and mean length calculations.

Modal length generally increased from 1994 to the early 2000's (Figure 8). The range of lengths harvested narrowed in the late 2000s with little change since. Size composition in 2022 commercial samples indicate a dominance of spot from the 7.0- and 8.0-inch size classes (Figure 7). When compared to the recreational fishery, the commercial fishery harvested a narrower range of sizes.

### **Fishery-Independent Monitoring**

The number of spot aged in North Carolina's comprehensive life history program (P930) using otoliths from 1997 through 2022 has ranged from 230 to 776 (Table 4). In 2022, 392 spot were aged with a modal age of one and maximum age of three. The maximum age observed has been three since 2013. Modal age was one in every year except 2004 when modal age was two and 2016 when modal age was zero. Minimum age was zero in every year, while maximum age ranged from two to six and is most frequently three. There is substantial overlap in length at age for ages zero through three with length at age becoming less variable after age four (Figure 9).

The Pamlico Sound Survey (Program 195) samples 54 randomly selected stations (grids) annually 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 (JAI) that are incorporated into ASMFC stock assessments and reported annually to ASMFC as part of compliance reports and for incorporation into the juvenile composite TLA. Length cutoffs for juvenile spot were updated in 2022 after analyzing length distribution of age-0 and age-1 spot in P930. Juvenile spot are defined as fish <140 mm TL (5.5 inches) in June, and fish <190 mm TL (7.5 inches) in September.

The COVID pandemic impacted sampling in 2020 and 2021. Executive Order (EO) 116, issued on March 10, 2020, declared North Carolina under a State of Emergency and was soon followed by EO 120 which implemented a statewide Stay at Home Order for all non-essential State employees. In 2020, sampling was limited to 28 stations sampled in June and 35 stations sampled in September. A total of 35 stations were sampled in June 2021 and 33 stations were sampled in September 2021. Limited sampling likely impacted abundance indices calculated from Sound Survey data. An initial analysis of this impact was conducted for the 2020 spot abundance indices, and concluded the magnitude of abundance may be overestimated slightly but limited sampling was likely able to capture general abundance trends.

The spot weighted JAI from the Pamlico Sound Survey is highly variable in both June and September with a time series average of 460 and 398 respectively (Figure 10). Throughout the time series, large peaks tend to be followed by large declines. JAI reached a peak of 1,285 individuals per tow in June 2008 and 774 individuals per tow in September 2005. The June JAI declined from 2018 to 2021, dropping below the time series average in 2020 at 254 individuals per tow and in 2021 at 255 individuals per tow before increasing to 632 individuals per tow in 2022. The September JAI also declined from 2018 to 2021, dropping below the time series average in 2021 at 244 individuals per tow before increasing to 582 individuals per tow in 2022.

Most spot captured in the Pamlico Sound Survey are juveniles (age-0), but a number of age one or greater fish are captured in some years producing two distinct length modes, particularly in June. One mode is around 3.5 inches FL (age-0), and the other is around 6.0 inches FL (age-1 or greater; Figure 11). Modal length from the September portion of the Pamlico Sound Survey is more variable than June ranging from 3.0 to 5.5 inches FL with a wider range of lengths captured.

## **RESEARCH NEEDS**

There are no research or monitoring programs required of the states except for the submission of an annual compliance report. The top three recommendations are reported below (ASMFC 2023). Additional research and monitoring recommendations can be found in the 2017 Spot Stock Assessment Peer Review Report (ASMFC 2017).

- Expand collection of life history data (age, growth, and reproduction data) from fishery dependent sources while maintaining these collections from ongoing state level fishery independent sources as well as multistate monitoring surveys. In addition, investigate identification of coastal stocks and their movement through tagging and genetic studies.
- Increase efforts to characterize commercial discards through expanded observer coverage, particularly within the shrimp trawl fishery, and develop a standardized bycatch protocol with collection of lengths and ages of discards and by-catch. Other sources for discard mortality studies include scrap and bait fisheries, commercial gears and recreational gear, and direct research and engagement of commercial harvesters.
- Investigate environmental impacts of temperature shifts, climate change and large-scale oceanic cycles (e.g., Atlantic Multi-Decadal Oscillation, AMO, and El Nino Southern Oscillation, El Nino) on recruitment SSB, stock distribution and maturity schedules for incorporation into stock assessment models.

## **MANAGEMENT STRATEGY**

The TLA established under Addendum II and revised under Addendum III (approved February 2020) to the Omnibus Amendment is used as a precautionary management framework for spot. The TLA provides guidance in lieu of a current stock assessment. Addendum III incorporated the use of a regional approach (Mid-Atlantic NJ-VA and South Atlantic NC-FL) to better reflect localized fishery trends. 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 any two of the three most recent years, then management action is required. The harvest composite triggered at the 30% threshold in both regions in 2019. The adult abundance composite exceeded the 30% threshold in the Mid-Atlantic region but not in the South Atlantic region. Since both population characteristics were above the 30 percent threshold in at least two years (2017-2019), management actions were implemented in March 2021. Because both abundance composite indices were missing data for 2020 and 2021, a determination of whether the TLA triggered in 2021 or if management measures can be removed could not be made.

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## TABLES

Table 1. Spot recreational harvest and number released (Marine Recreational Information Program), commercial harvest (North Carolina Trip Ticket Program), and total harvest, 1989–2022. All weights are in pounds.

Year	Recreational			Commercial	
	Numbers Landed	Numbers Released	Weight Landed (lb)	Weight Landed (lb)	Total Weight (lb)
1989	10,246,429	1,995,653	3,566,280	3,254,473	6,820,753
1990	7,920,697	2,868,842	2,453,645	3,455,460	5,909,105
1991	9,894,562	3,454,466	3,066,857	3,047,305	6,114,162
1992	5,043,969	2,908,974	1,431,733	2,826,138	4,257,871
1993	6,877,688	1,445,961	2,879,162	2,672,164	5,551,326
1994	14,032,650	2,365,031	4,571,386	2,937,311	7,508,697
1995	8,199,743	2,214,819	3,214,061	3,006,845	6,220,906
1996	6,729,366	2,234,354	2,461,892	2,290,000	4,751,892
1997	4,529,620	1,110,650	2,129,481	2,627,925	4,757,406
1998	11,797,824	2,379,578	4,596,119	2,396,979	6,993,098
1999	5,736,185	2,343,795	2,565,546	2,262,175	4,827,721
2000	6,121,384	1,366,746	2,598,813	2,829,818	5,428,631
2001	10,043,845	2,804,349	4,519,545	3,093,872	7,613,417
2002	8,456,981	1,569,579	3,017,466	2,184,032	5,201,498
2003	9,717,824	2,970,990	4,220,534	2,043,387	6,263,921
2004	7,845,322	2,899,319	3,682,623	2,317,169	5,999,792
2005	10,105,205	4,407,100	3,652,186	1,714,597	5,366,783
2006	11,109,551	8,196,592	3,995,432	1,364,743	5,360,175
2007	8,728,295	4,049,250	2,737,144	879,091	3,616,235
2008	3,970,431	3,817,529	1,382,428	736,484	2,118,912
2009	4,197,640	4,847,202	1,427,956	1,006,500	2,434,456
2010	3,830,384	3,615,808	1,173,173	572,315	1,745,488
2011	6,480,714	4,993,544	2,201,947	936,970	3,138,917
2012	2,677,082	2,995,879	760,276	489,678	1,249,954
2013	6,120,985	5,513,732	1,789,251	768,943	2,558,194
2014	8,343,467	4,043,710	2,877,483	766,224	3,643,707
2015	2,572,738	2,984,629	833,390	377,028	1,210,418
2016	1,928,716	1,831,415	558,799	241,044	799,843
2017	2,418,331	1,902,281	909,796	415,465	1,325,261
2018	2,068,865	2,062,163	597,511	167,696	765,207
2019	2,822,884	2,356,120	851,998	392,206	1,244,204
2020	920,512	1,673,676	297,813	542,870	840,683
2021	1,199,080	2,357,567	435,231	527,464	962,695
2022	1,197,145	2,331,484	375,168	543,096	918,264
Mean	6,290,768	2,968,023	2,289,180	1,637,867	3,927,047

Table 2. Mean, minimum, maximum fork length (inches), and total number of spot measured by Marine Recreational Information Program (MRIP) sampling in North Carolina, 1989–2022.

Year	Mean Length	Minimum Length	Maximum Length	Number Measured
1989	7.9	4.5	13.6	1,513
1990	7.6	4.3	12.6	1,167
1991	7.6	4.0	13.3	3,022
1992	7.6	3.2	11.7	1,193
1993	8.4	4.9	13.5	1,385
1994	8.0	5.7	14.9	2,633
1995	8.5	4.3	19.4	2,040
1996	8.5	4.9	11.6	2,376
1997	8.7	5.7	15.6	1,762
1998	8.6	6.3	12.4	1,632
1999	9.1	5.5	11.5	1,159
2000	8.6	5.5	20.5	1,223
2001	8.8	5.4	13.9	1,627
2002	8.3	6.3	12.0	860
2003	8.7	4.6	14.2	1,403
2004	9.2	4.8	12.8	2,034
2005	8.4	5.2	16.2	1,286
2006	8.9	4.8	13.5	1,216
2007	9.1	5.7	12.0	1,243
2008	8.3	5.0	12.2	1,344
2009	8.4	5.0	10.8	682
2010	8.1	5.8	12.0	1,096
2011	8.2	5.9	11.1	1,534
2012	7.9	5.6	11.7	611
2013	7.9	4.5	11.5	484
2014	8.2	4.8	11.9	344
2015	8.1	6.1	11.9	214
2016	8.0	6.3	11.0	107
2017	8.1	6.3	10.6	98
2018	8.4	5.7	10.9	125
2019	7.7	5.0	10.1	276
2020	8.1	5.0	10.1	131
2021	8.0	4.7	10.1	67
2022	8.1	6.4	11.8	69

Table 3. Mean, minimum, maximum fork length (inches), and total number of spot measured from North Carolina commercial fish house samples, 1994–2022. Bait samples are included in calculation of mean, minimum and maximum length.

Year	Mean Length	Minimum Length	Maximum Length	Number Measured
1994	6.7	3.3	11.9	9,226
1995	6.7	0.6	11.4	11,178
1996	7.2	3.2	11.8	14,241
1997	7.3	1.3	13.3	15,622
1998	7.4	0.8	12.2	11,850
1999	7.6	3.1	11.7	9,268
2000	7.9	3.3	17.6	15,653
2001	8.5	3.3	12.4	15,603
2002	8.4	2.5	17.8	13,035
2003	8.6	2.5	13.9	12,920
2004	8.8	0.8	15.0	12,391
2005	8.9	3.1	13.1	15,538
2006	8.3	4.1	13.2	13,517
2007	7.9	3.9	12.0	13,889
2008	7.9	3.1	13.3	10,768
2009	8.1	3.9	11.7	9,087
2010	8.1	3.6	11.6	7,494
2011	8.1	4.3	13.1	8,906
2012	8.0	4.1	19.1	4,459
2013	8.3	4.2	13.3	4,699
2014	8.2	4.1	13.1	6,650
2015	8.3	4.3	11.6	4,543
2016	8.0	4.9	12.8	2,250
2017	8.3	4.4	11.7	2,648
2018	7.9	1.7	10.9	2,242
2019	7.9	3.7	12.9	3,720
2020	8.0	0.8	12.5	3,201
2021	8.0	4.9	12.0	3,085
2022	8.0	4.4	11.7	2,587

Table 4. Modal, minimum, maximum age, and total number of spot aged in North Carolina from fishery dependent and fishery independent sampling, 1997–2022. Includes otolith ages only.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
1997	1	0	3	263
1998	1	0	3	603
1999	1	0	2	522
2000	1	0	3	551
2001	1	0	4	555
2002	1	0	5	603
2003	1	0	4	354
2004	2	0	6	455
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	687
2015	1	0	3	505
2016	0	0	3	373
2017	1	0	3	528
2018	1	0	3	516
2019	1	0	3	440
2020	1	0	3	452
2021	1	0	3	776
2022	1	0	3	392

## FIGURES

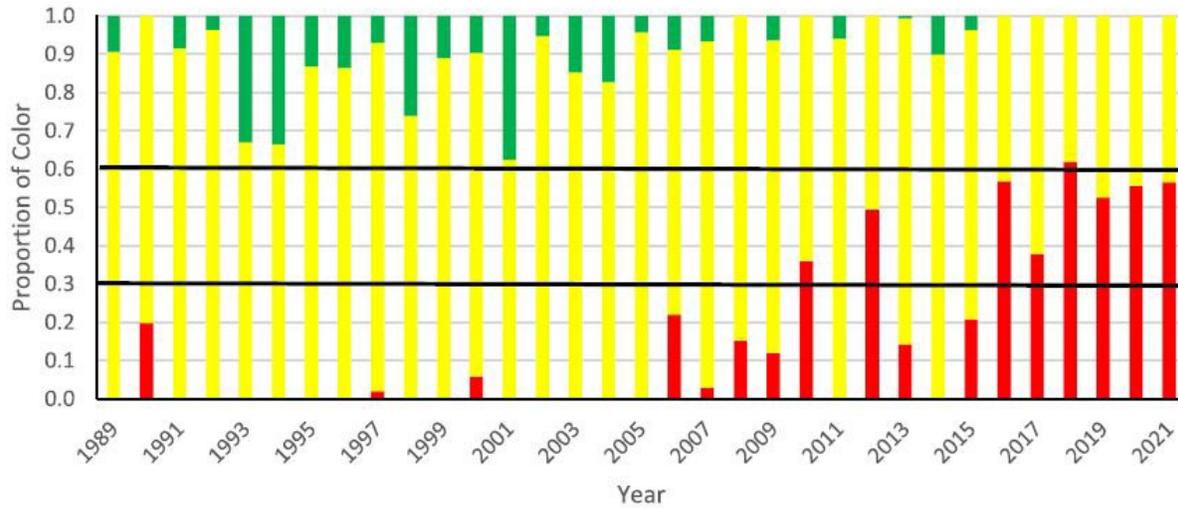


Figure 1. Annual harvest composite TLA color proportions for South Atlantic region (NC-FL) spot recreational and commercial landings, 1989 – 2021 (ASMFC 2022). The reference period is 2002-2012.

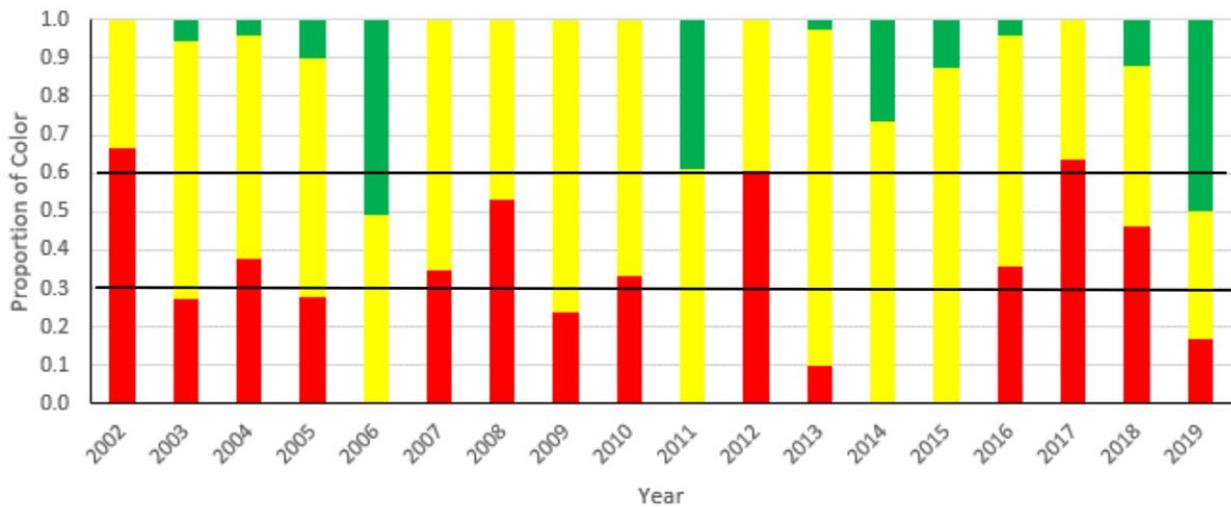


Figure 2. Annual abundance composite TLA color proportions for the South Atlantic region (NC-FL) adult spot (age 1+) from fishery-independent indices (SEAMAP and NCDMF Program 195), 2002-2019 (no 2020 or 2021 data due to limited sampling; ASMFC 2022). The reference period is 2002-2012.

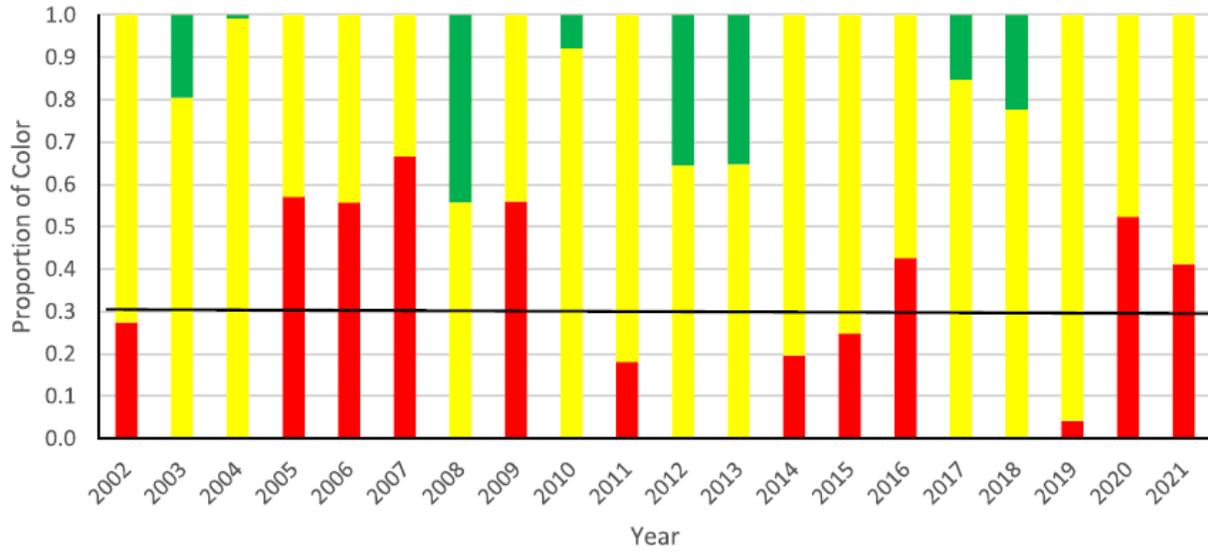


Figure 3. Annual TLA color proportions for the South Atlantic region abundance composite for juvenile spot (age 0) from the DMF Pamlico Sound Survey, 2002-2021 (ASMFC 2022). Juvenile index does not trigger management action. Reference period is 2002-2012.

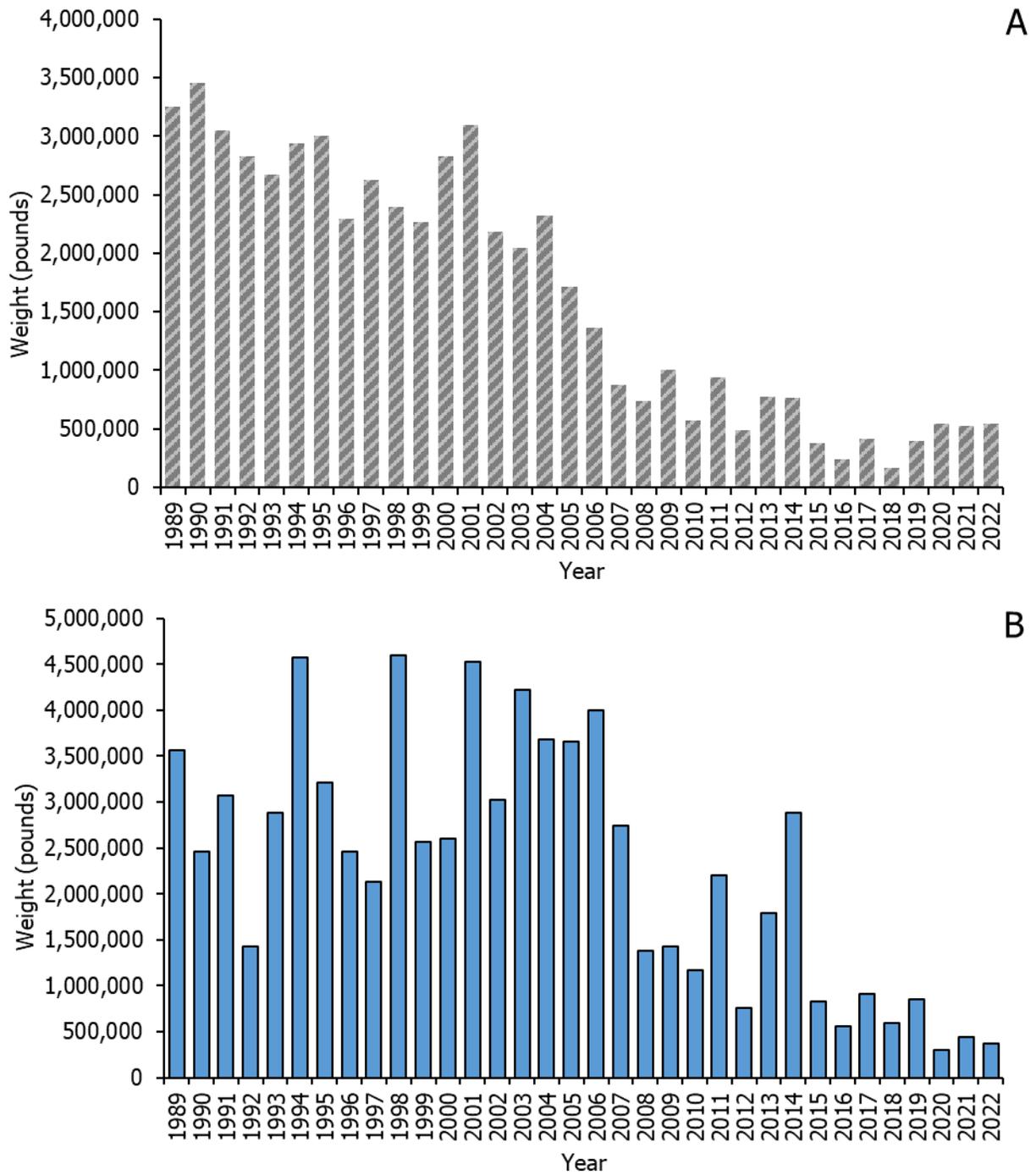


Figure 4. Annual A) commercial landings (North Carolina Trip Ticket Program) and B) recreational harvest (Marine Recreational Information Program) in pounds for spot in North Carolina, 1989–2022.

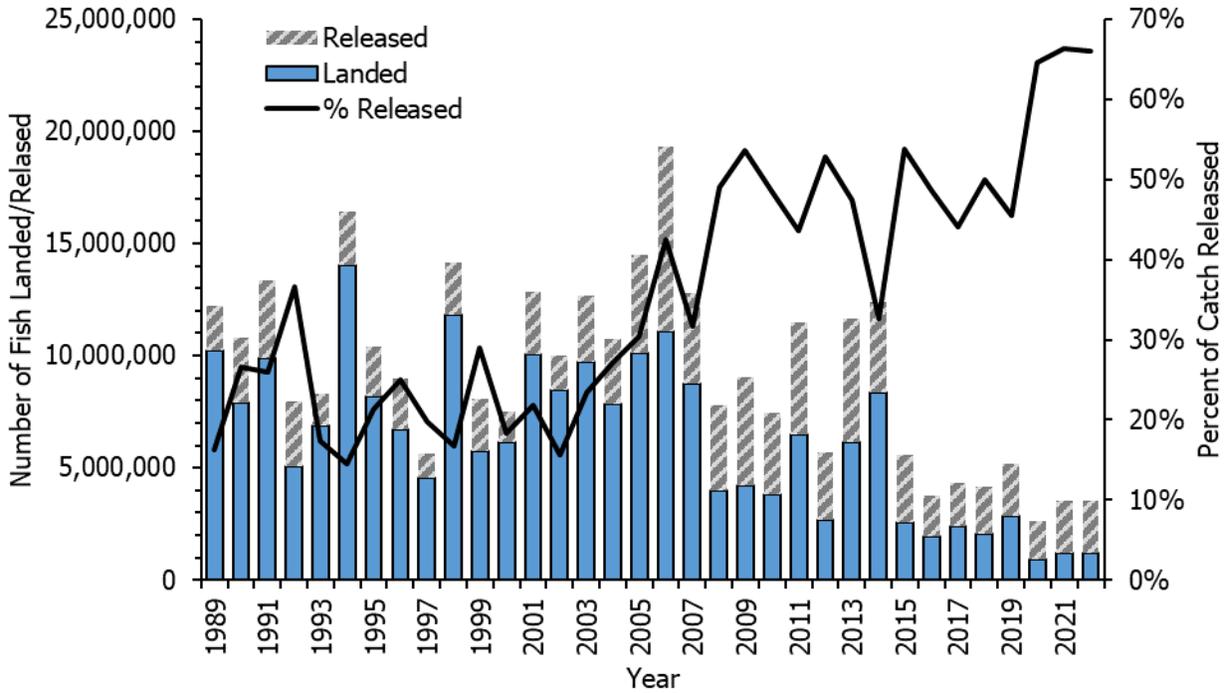


Figure 5. Recreational catch (landings and releases, in numbers) and the percent of catch that is released, 1989–2022 from the MRIP.

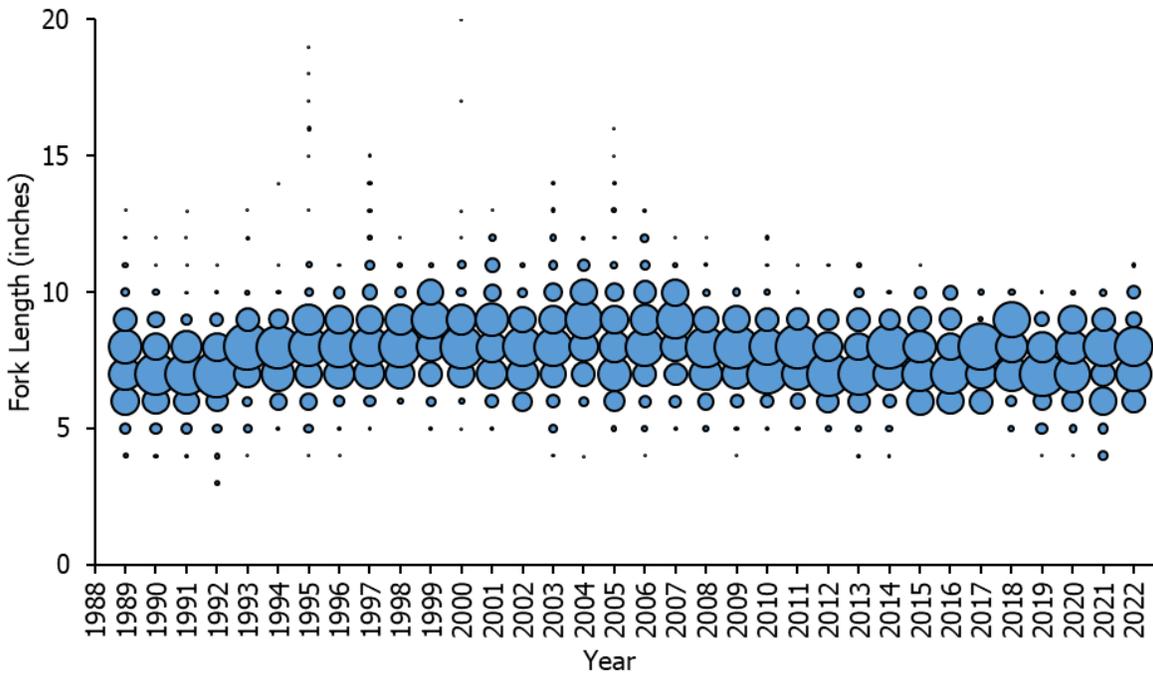


Figure 6. Recreational length frequency (fork length, inches) of spot harvested in North Carolina, 1989–2022 (MRIP,  $n = 213,886,116$ ). Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

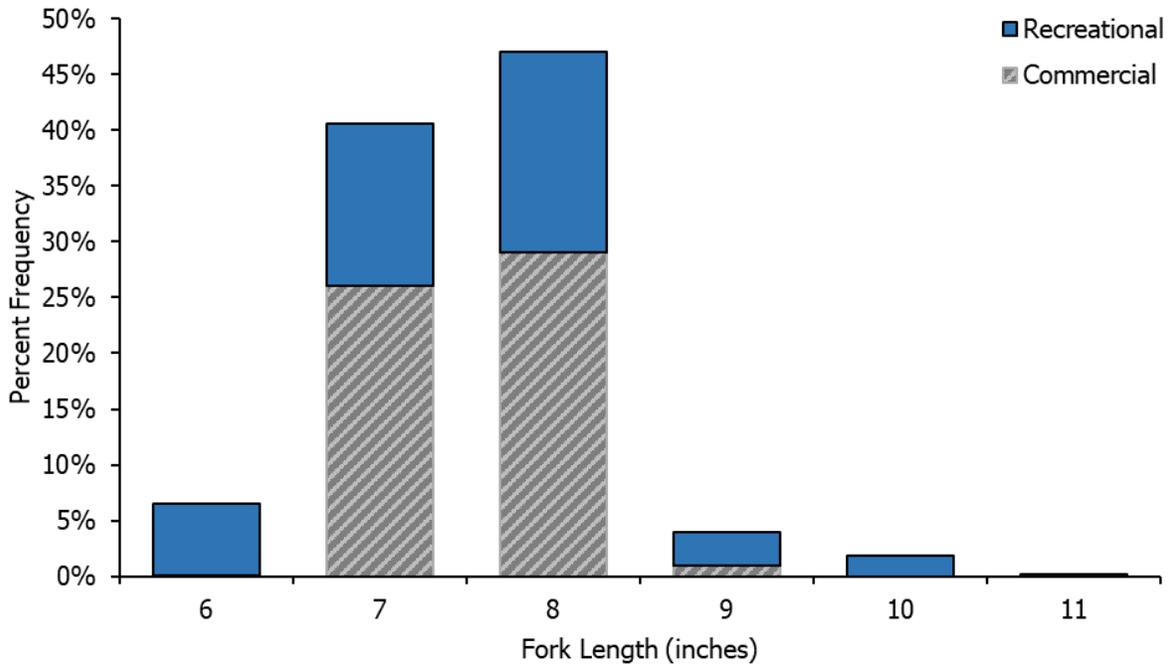


Figure 7. Commercial (n=1,534,206) and recreational (n=1,197,145) length frequency distribution for spot harvested in North Carolina, 2022.

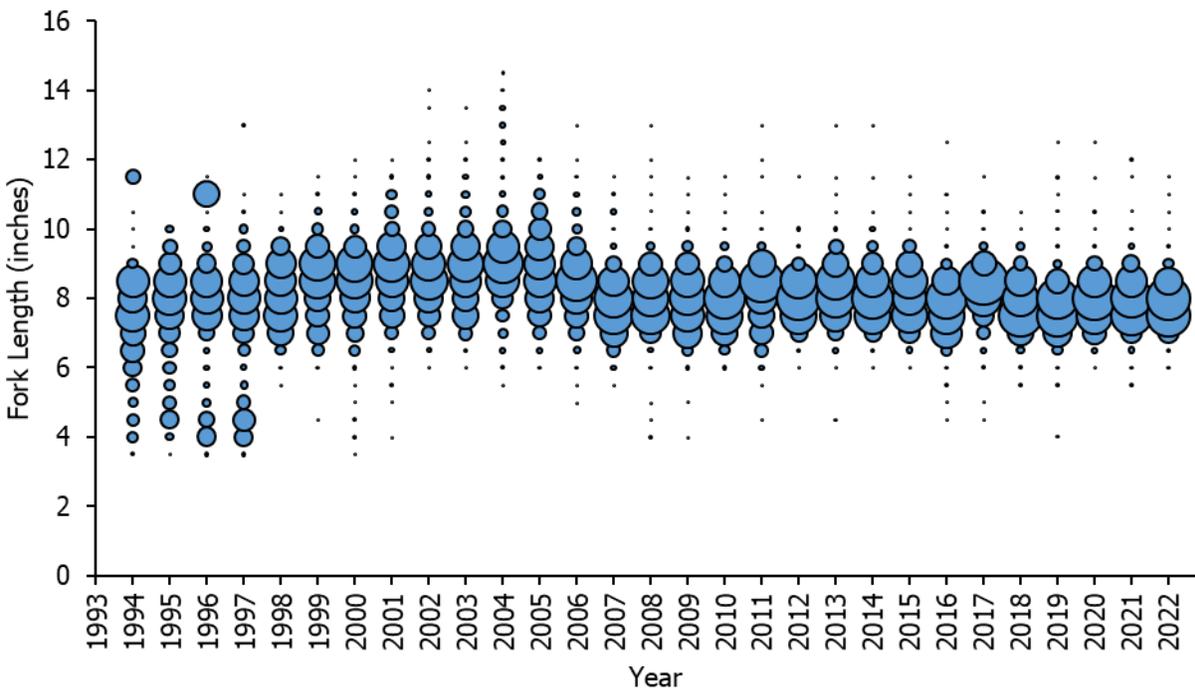


Figure 8. Commercial length frequency (fork length, inches) of spot harvested from 1994 to 2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length. Bait samples not included.

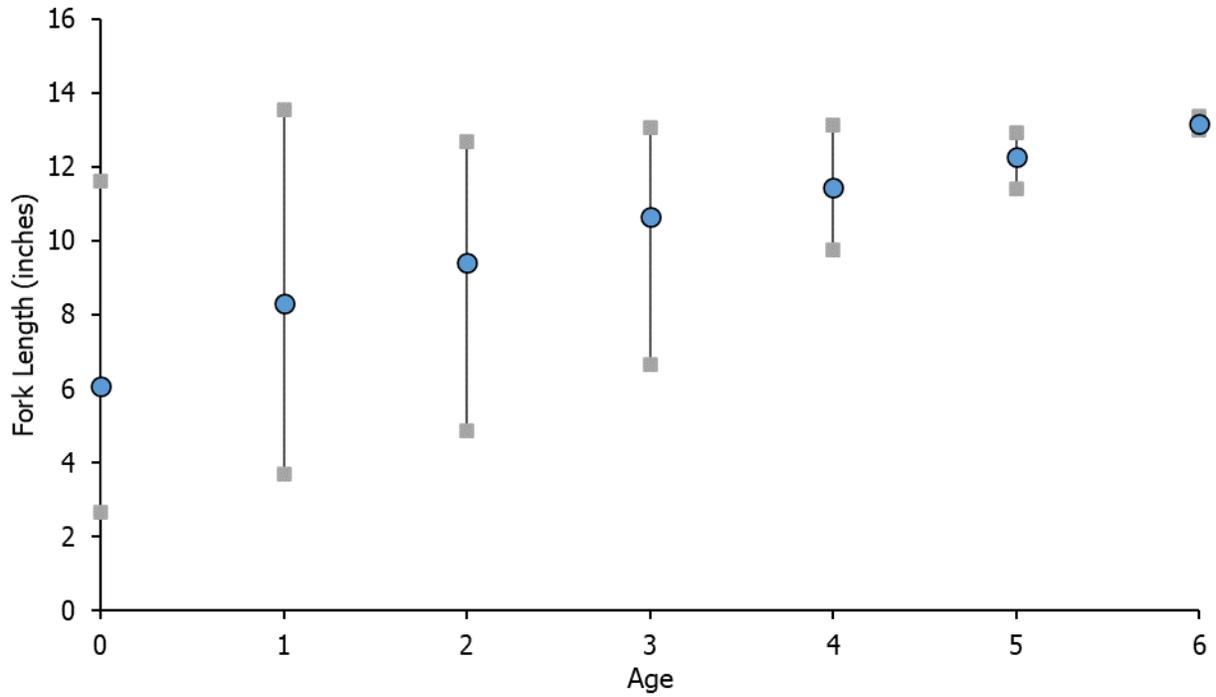


Figure 9. Spot length at age based on age samples collected from 1997 to 2022 (n=11,933). Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size at age. Only ages derived from otoliths were used.

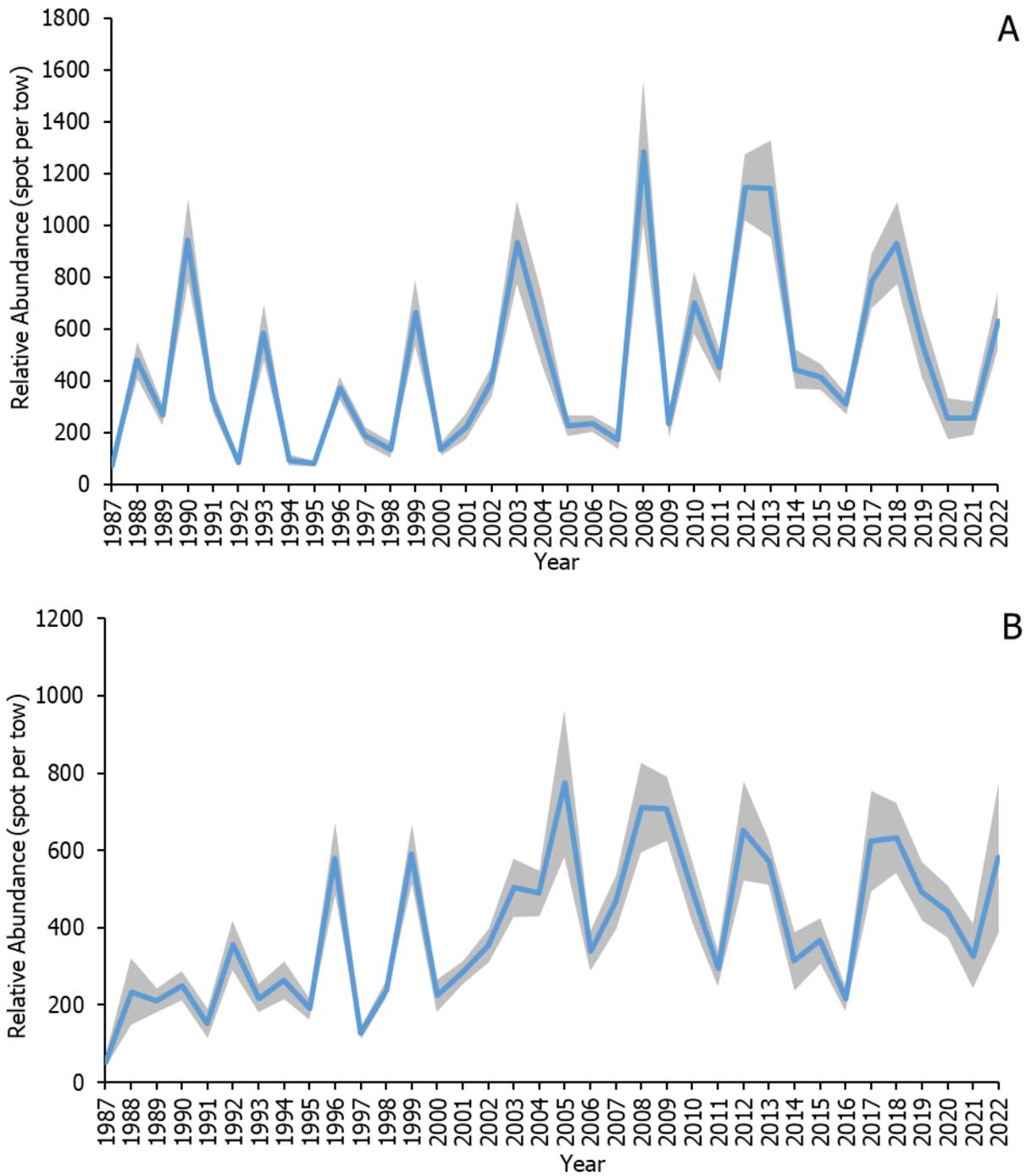


Figure 10. Spot juvenile weighted abundance index (number per tow) for A) June and B) September from the Pamlico Sound Survey, 1987–2022. Shaded area represents standard error. Length cutoffs are <140 mm FL (5.5 in) in June and <190 mm TL (7.5 in) in September.

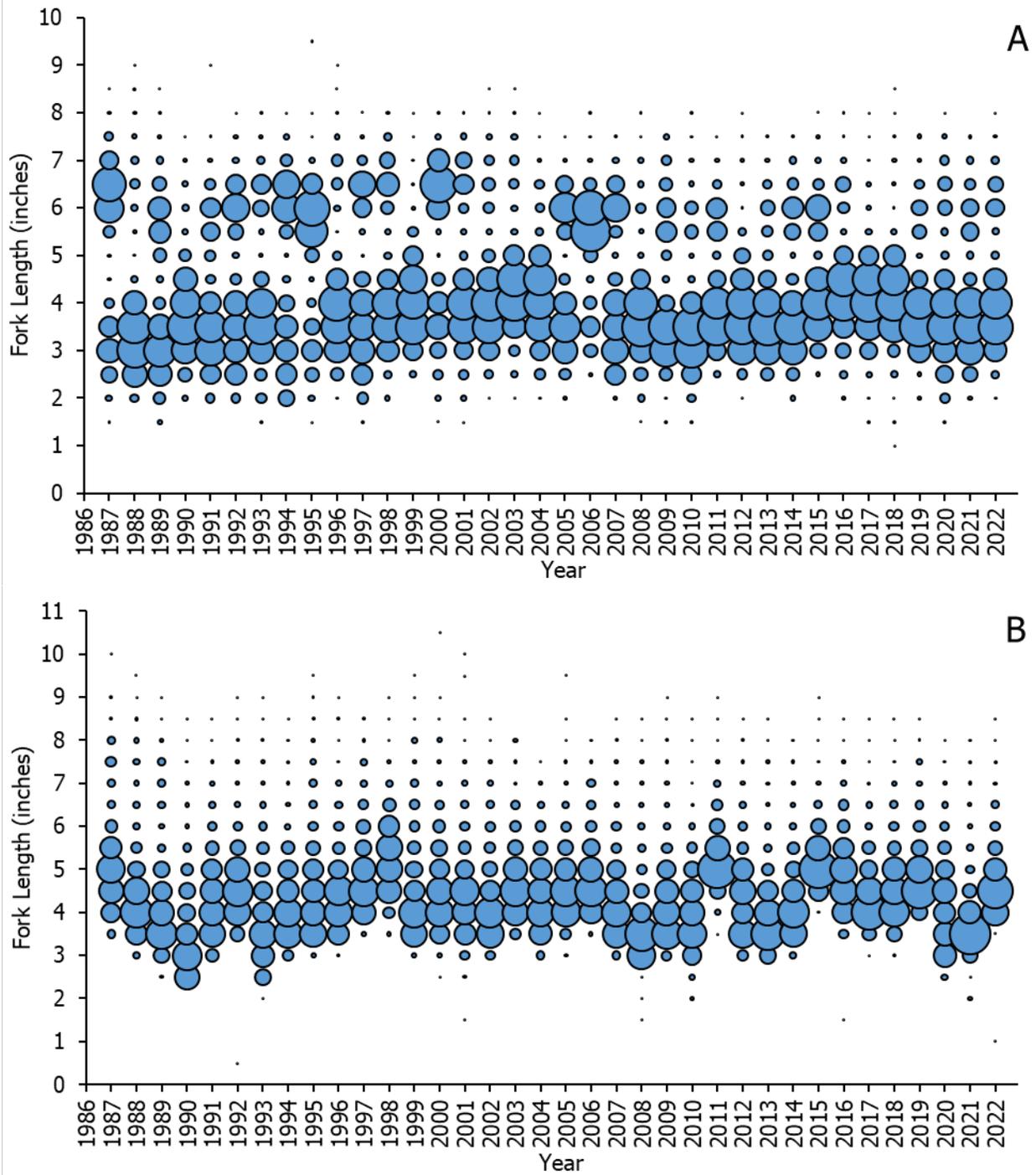


Figure 11. Length frequency (Fork Length, inches) of all spot captured in Pamlico Sound Survey sampling during A) June and B) September, 1987–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

**FISHERY MANAGEMENT PLAN UPDATE  
SUMMER FLOUNDER  
AUGUST 2023**

**STATUS OF THE FISHERY MANAGEMENT PLAN**

**Fishery Management Plan History**

Original FMP Adoption:	1982 – ASMFC	
	1988 – MAFMC	
Amendments:	Amendment 1	1991
	Amendment 2	1993
	Amendment 3	1993
	Amendment 4	1993
	Amendment 5	1993
	Amendment 6	1994
	Amendment 7	1995
	Amendment 10	1997
	Amendment 11	1998
	Amendment 12	1999
	Framework 1	2001
	Framework 2	2001
	Addendum III	2001
	Addendum IV	2001
	Framework 5	2004
	Addendum VIII	2004
	Addendum XIV	2004
	Addendum XV	2004
	Addendum XVI	2005
	Addendum XVII	2005
	Framework 6	2006
	Addendum XVIII	2006
	Framework 7	2007
	Addendum XIX	2007
	Amendment 16	2007
	Amendment 15	2011
	Amendment 19	2013
	(Recreational Accountability Amendment)	
	Addendum XXV	2014
	Amendment 17	2015
	Addendum XXVI	2015
	Amendment 18	2015
	Addendum XXVII	2016
	Addendum XXVIII	2017
	Amendment 20	2017

Framework 10	2017
Framework 11	2018
Framework 13	2018
Addendum XXXI	2018
Addendum XXXII	2018
Framework 14	2019
Framework 15	2020
Amendment 21	2020
Framework 16	2020
Amendment 22	2022
Framework 17 & Addendum XXXIV	2022/2023

Comprehensive Review: 2023

Because of their presence in, and movement between state waters (0-3 miles) and federal waters (3-200 miles), the Mid-Atlantic Fishery 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.

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.

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 permit; 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 equivalence 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 ASMFC's Summer Flounder, Scup, and Black Sea Bass 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 ASMFC's Summer Flounder, Scup, and Black Sea Bass Management Boards decisions on regulations.

Framework 5 established multi-year specification setting of the quotas 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 meets 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 coast-wide 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 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 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 initiated an addendum to consider adaptive management, including regional approaches, for the 2017 summer flounder recreational fishery.

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.

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 13 modified the accountability measures required for overages not caused by directed landings (i.e., discards) in the summer flounder, scup, and black sea bass fisheries.

Addendum XXXI established conservation equivalency for black sea bass and transit provisions in federal waters around Block Island, Rhode Island for recreational and commercial fishermen which allows permitted fishermen to pass through federal waters legally.

Addendum XXXII established a specifications process instead of an addendum process to implement recreational management measures more quickly for summer flounder and black sea bass.

Framework 14 gives the Council the option to waive the federal recreational black sea bass measures in favor of state measures through conservation equivalency; implements a transit zone for commercial and recreational summer flounder, scup, and black sea bass fisheries in Block Island Sound; and allows for the use of a maximum size limit in the recreational summer flounder and black sea bass fisheries.

Framework 15 established a requirement for commercial vessels with federal permits for all species managed by the Mid-Atlantic and New England Councils to submit vessel trip reports electronically within 48 hours after entering port at the conclusion of a trip.

Amendment 21 modified the summer flounder commercial state quota allocation system and FMP goals and objectives.

Framework 16 modified MAFMC's ABC control rule and risk policy. The revised risk policy is intended to reduce the probability of overfishing as stock size falls below the target biomass while allowing for increased risk and greater economic benefit under stock biomass conditions. This action also removed the typical/atypical species distinction currently included in the risk policy.

Amendment 22 revised the commercial and recreational sector allocations for all three species.

Framework 17/Addendum XXXIV Recreational Harvest Control Rule established a new process for setting recreational bag, size, and season limits (i.e., recreational measures) for summer flounder, scup, black sea bass, and bluefish. This action also modified the recreational accountability measures for these species.

Specific details for each amendment under development include:

Summer Flounder, Scup, and Black Sea Bass Commercial/Recreational Allocation Amendment was jointly approved in December 2021 and selected preferred alternatives for each species. In 2022 the amendment was sent for submission to NMFS. For summer flounder, this amendment allocates 55% of the acceptable biological catch (ABC) to the commercial annual catch limit and 45% to the recreational annual catch limit.

The Recreational Harvest Control Rule Framework/Addenda has been submitted to NOAA for review, approval, and implementation. The Addenda proposed different approaches for setting recreational measures. These differences have implications for how often measures would change and the magnitude of those changes. This Addenda will not implement any specific bag, size, or season limits but will modify the specification process for setting specific measures. The Council and Policy Board approved a range of alternatives, the selected management option is referred as the “Percent Change Approach”. This management option will be in place with an agreement to continue development of several other options for possible implementation by 2026. Under this selected approach, it will be determined whether recreational measures should be restricted, liberalized, or remain unchanged for the next two years. For further information on the Harvest Control Rule, refer to [asmfc.org](http://asmfc.org).

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. These plans were established under the Magnuson-Stevens Fishery Conservation and Management Act (federal council plans) and the Atlantic Coastal Fisheries Cooperative Management Act (ASMFC plans) with the goal, like the Fisheries Reform Act of 1997 to “ensure long-term viability” of these fisheries (NCDMF 2022).

### **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**

Amendment 21 in 2020 approved the proposed revised FMP Goals and Objectives for Summer Flounder and are as follows:

- Goal 1: Ensure the biological sustainability of the summer flounder resource in order to maintain a sustainable summer flounder fishery.
  - Objective 1.1: Prevent overfishing and achieve and maintain sustainable spawning stock biomass levels that promote optimum yield in the fishery.
- Goal 2: Support and enhance the development and implementation of effective management measures.
  - Objective 2.1: Maintain and enhance effective partnership and coordination among the Council, Commission, Federal partners, and member states.
  - Objective 2.2: Promote understanding, compliance, and the effective enforcement of regulations.

- Objective 2.3: Promote monitoring, data collection, and the development of ecosystem-based science that support and enhance effective management of the summer flounder resource.
- Goal 3: Optimize economic and social benefits from the utilization of the summer flounder resource, balancing the needs and priorities of different user groups to achieve the greatest overall benefit to the nation.
  - Objective 3.1: Provide reasonable access to the fishery throughout the management unit. Fishery allocations and other management measures should balance responsiveness to changing social, economic, and ecological conditions with historic and current importance to various user groups and communities.

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

Summer flounder are estuarine-dependent members of the left eyed flounder family (*Paralichthyidae*) that also 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 total length and males maturing at 10 inches 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 2021 management track stock assessment indicates that summer flounder is not overfished nor experiencing overfishing.

### **Stock Assessment**

The 2018 summer flounder benchmark stock assessment estimated fishing mortality rates and stock sizes using a statistical catch-at-age model calculated by using the Age Structured Assessment Program. It also included revised National Oceanic and Atmospheric Administration (NOAA) Marine Recreational Information Program estimates of recreational landings and discards that contributed to increased biomass estimates. The benchmark stock assessment indicated that the stock was not overfished, and that overfishing was not occurring in 2017 relative to the new biological reference points established in the 2018 benchmark stock assessment. Fishing mortality estimates increased since 2007 and below average recruitment persisted from 2011 to 2017. Spawning stock biomass was above the new threshold biomass reference point in 2017. Higher biomass projections resulted in a 49% increase in the commercial quota and recreational harvest limit beginning in 2019. The 2021 management track assessment was an update of the 2018 benchmark assessment and indicated that the spawning stock biomass (SSB) was at approximately

86% of the SSB target, fishing mortality was below the threshold, and recruitment still remains below average. The stock assessment report can be found on the summer flounder page on the ASMFC website for further information.

## **DESCRIPTION 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 replaced harvest limits to provide additional opportunities to land the quota, which are established by proclamation [see most recent North Carolina Division of Marine Fisheries (DMF) proclamation on commercial summer flounder fishery]. A bycatch trip limit of 100 pounds is in place for shrimp trawls during closed flounder trawl harvest periods. A license to land flounder from the Atlantic Ocean is required to land more than 100 pounds per trip.

Recreational: Season closures are currently in effect for North Carolina. The recreational closure affects all flounder species in North Carolina and was implemented in accordance with Amendment 3 to the North Carolina Southern Flounder Fishery Management Plan. The 2023 season is currently tentative and will likely occur in September for two weeks for internal and ocean waters of the state. During the open season, a 15-inch total length minimum size limit and 1-fish creel limit will be in effect.

### **Commercial Fishery**

All landings reported as caught in the Atlantic Ocean are considered to be summer flounder by the North Carolina Trip Ticket Program. Since 2019, summer flounder have only been allowed to be harvested by trawls from the Atlantic Ocean (Figure 1). Although in history's past other gears were also comparable in summer flounder landings coming from the Atlantic Ocean. Commercial state allocations were modified via Amendment 21, which became effective on January 1, 2021. The revised allocation system modifies the state-by-state commercial quota allocations in years when the annual coastwide commercial quota exceeds the specified trigger of 9.55 million pounds. North Carolina has an allocation of 27.4% (baseline quota) and an additional allocation of 12.37% if the 9.55 million pounds of coastwide commercial quota is triggered. In recent years, landings peaked in 2004 and have been generally stable since 2007, aside from 2012 and 2013, when landings were lower than average (Table 1, Figure 2). 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. Since 2014, more ocean trawl vessels returned to North Carolina to land catches, mainly in the Beaufort and Engelhard ports.

### **Recreational Fishery**

Summer flounder harvest is reported through the NOAA Marine Recreational Information Program (MRIP). Recreational estimates across all years have been updated and are now based on the new MRIP Fishing Effort Survey-based calibrated estimates. For more information on MRIP,

see <https://www.fisheries.noaa.gov/topic/recreational-fishing-data>. Recreational harvest of summer flounder has varied annually but has seen a decline over the years (Table 1, Figure 2). Some of this decline in landings is likely the result of increases in size limits and the lack of these larger summer flounder being prevalent in this area. The limited harvest opportunities and closed and shortened seasons in accordance with Amendment 2 and 3 to the North Carolina Southern Flounder FMP have also contributed to the decline in landings.

## **MONITORING PROGRAM DATA**

### **Fishery-Dependent Monitoring**

Several DMF sampling programs collect biological data on commercial and recreational fisheries that catch summer flounder. Program 433 (ocean trawl fishery) is the primary program that collects commercial length and age data for harvested summer flounder. Other programs that collect information include: 432 (flounder pound net), 434 (ocean gill net), 435 (beach seine), 461 (estuarine gill net), and 437 (long haul seine). 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 NOAA Marine Recreational Information Program. Age data from the recreational fishery are collected through the North Carolina Carcass Collection Program.

From 1991 to 2022, annual mean length in the commercial fishery increased from 17 to 20 inches total length (TL) (varying through the years) and the mean number of fish measured from 1991 to 2022 was 18,902 (Table 2). Summer flounder harvested commercially during 2022 ranged from 12 to 32 inches TL with 27% being the mode at 15 inches TL (Figure 3). From 1991 to 2022, summer flounder harvested commercially ranged from 12 to 35 inches TL (Table 2, Figure 4).

As for recreational fishery length data from 1982 to 2022, annual mean lengths increased over time as size limits have been implemented. The number of fish measured from 1982 to 2022 were variable (Table 3). Summer flounder harvested recreationally during 2022 ranged from 14 to 20 inches TL with the mode being 18 inches TL (Figure 3). From 1982 to 2022, summer flounder harvested recreationally ranged from 5 to 29 inches TL (Table 3, Figure 5).

### **Fishery-Independent Monitoring**

Several DMF independent sampling programs collect biological data on summer flounder. 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 and use 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. Annual mean lengths ranged from 5 to 8 inches TL during 1987 through 2022 (Table 4). During 2020 and 2021,

sampling was impacted during scheduled sampling months due to staffing issues and the COVID pandemic. During this time, sampling did not occur in 2020 and incomplete sampling in 2021. Data from 1999 is also excluded from the average due to sampling occurring in July instead of June (Figure 6). The summer flounder JAI from the Pamlico Sound Survey is one of the recruitment indices provided for the annual coast-wide stock assessment of summer flounder and was used in the 2018 summer flounder benchmark stock assessment.

To characterize age structure, summer flounder otoliths are primarily collected from the commercial ocean trawl fishery but are also collected from other dependent (recreational) and various independent (scientific surveys) sources throughout the year. While scales were used to determine the age of summer flounder historically, otoliths are now preferred and have been collected exclusively since 2016. In 2022, 468 summer flounder otoliths were aged yielding a range in age from 0 to 16 years. Maximum ages since 2010 were higher than previous years, suggesting expansion of the stock age structure. Modal age ranged from 2 to 7 during 1991 through 2022 (Table 5). The age data suggests that summer flounder grow very quickly during their first year of life with an average TL of 13 inches at age 1. They continue to grow to an average TL of 28 inches by age 14 (Figure 7).

## **RESEARCH NEEDS**

Updated research needs from the 2018 summer flounder benchmark 66th Stock Assessment Workshop are provided below. The research needs listed below start with the most recent. Text in parenthesis indicates known progress made to address these needs.

- Continue to explore changes in the distribution of recruitment. Develop studies, sampling programs, or analyses to better understand how and why these changes are occurring, and the implications to stock productivity (progress unknown at this time).
- The reference points are internally consistent with the current assessment. It may be useful to carry uncertainty estimates through all the components of the assessment, biological reference points, and projections (progress unknown at this time).
- Explore the potential mechanisms for recent slower growth that is observed in both sexes (progress unknown at this time).
- Evaluate uncertainties in biomass to determine potential modifications to OFL CV employed (research is ongoing)
- Evaluate fully the sex- and size distribution of landed and discarded fish, by sex, in the summer flounder fisheries (research is ongoing).
- Incorporate sex-specific differences in size at age into the stock assessment (progress has been made and research is ongoing)
- Determine and evaluate the sources of the over-optimistic stock projections (progress has been made)
- Evaluate the causes of decreased recruitment and changes in recruitment per spawner in recent years (progress has been made)

- 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. This could include: (a) 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. (b) Development of models incorporating these factors that would create greater realism. (c) 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. (d) The modeling infrastructure should be simultaneously developed to support these types of modeling approaches (flexibility in model framework, MCMC/bootstrap framework, projection framework) (some progress has been made and research is 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 (research is needed).
- Apply standardization techniques to all of the state and academic-run surveys, to be evaluated for potential inclusion in the assessment (progress has been made and research is ongoing).
- 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 (research is ongoing).

## MANAGEMENT STRATEGY

An update of the summer flounder stock assessment is completed every two years 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 coast-wide quota each year. Amendments to the FMP are undertaken as issues arise that require action. 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. Beginning in 2023, revised allocations will be implemented and transitioning to catch-based allocations with 55 percent being commercial and 45 percent being recreational. 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. North Carolina has several specific management strategies for summer flounder (Table 6).

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## TABLES

Table 1. Recreational harvest (number of fish landed and weight in pounds) and releases (number of fish) and commercial harvest (weight in pounds) of summer flounder from North Carolina for the period 1982–2022.

Year	Recreational			Commercial	Total Weight (lb)
	Numbers Landed	Numbers Released	Weight Landed (lb)	Weight Landed (lb)	
1982	2,263,184	1,240,516	2,028,678	6,499,785	8,528,463
1983	1,522,625	601,360	986,346	7,279,379	8,265,725
1984	1,695,404	736,472	2,025,350	12,792,430	14,817,780
1985	2,012,982	476,231	2,153,031	8,968,385	11,121,416
1986	3,228,832	688,243	3,753,337	6,231,310	9,984,647
1987	530,793	1,096,193	403,096	5,362,322	5,765,418
1988	1,469,995	1,895,950	138,242	6,951,749	7,089,991
1989	559,131	509,719	792,196	4,329,403	5,121,599
1990	1,112,750	2,293,475	1,236,371	2,829,105	4,065,476
1991	567,660	1,398,056	622,637	3,630,629	4,253,266
1992	458,311	1,868,903	562,855	2,613,003	3,175,858
1993	593,005	2,457,437	716,004	3,120,901	3,836,905
1994	767,804	2,094,265	947,445	3,592,781	4,540,226
1995	241,409	955,117	344,315	4,582,176	4,926,491
1996	486,480	1,243,934	582,987	4,227,052	4,810,039
1997	463,367	1,560,563	597,973	1,501,171	2,099,144
1998	599,776	2,942,394	780,861	2,983,107	3,763,968
1999	357,645	1,097,385	466,028	2,869,055	3,335,083
2000	611,081	2,007,411	780,211	3,386,578	4,166,789
2001	424,615	1,836,338	577,139	2,784,741	3,361,880
2002	366,467	1,376,069	435,113	4,129,119	4,564,232
2003	177,360	763,794	273,895	3,572,448	3,846,343
2004	318,632	1,283,788	467,869	4,844,118	5,311,987
2005	202,797	734,860	289,495	4,064,464	4,353,959
2006	254,653	977,039	326,684	3,981,413	4,308,097
2007	251,068	1,299,735	379,387	2,670,110	3,049,497
2008	88,501	939,708	132,743	2,406,603	2,539,346
2009	219,321	1,894,409	307,692	2,859,039	3,166,731
2010	245,839	1,486,980	341,310	3,310,992	3,652,302
2011	186,877	1,009,389	311,573	2,854,122	3,165,695
2012	176,553	1,452,828	287,522	1,090,218	1,377,740
2013	123,742	1,359,319	196,002	541,542	737,544
2014	150,201	1,478,527	215,294	2,911,750	3,127,044
2015	99,263	856,849	157,437	2,878,743	3,036,180
2016	65,494	664,388	110,392	2,071,100	2,181,492
2017	91,193	977,285	147,426	1,572,707	1,720,133
2018	57,913	440,676	92,032	1,654,569	1,746,601
2019	34,895	467,942	52,872	2,025,401	2,078,273
2020	24,699	705,247	37,935	1,779,861	1,817,796
2021	13,863	1,187,109	27,492	2,093,366	2,120,858
2022	10,591	314,007	22,151	2,190,368	2,212,519
Mean	564,068	1,235,851	612,376	3,708,222	4,320,598

Table 2. Summer flounder length (total length, inches) data from commercial fish house samples in North Carolina, 1990–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1990	17	12	29	16,275
1991	17	12	31	24,855
1992	17	12	30	14,714
1993	17	12	32	21,317
1994	18	12	32	21,837
1995	17	12	30	18,805
1996	17	12	30	18,004
1997	17	12	30	13,074
1998	18	12	29	21,538
1999	19	12	31	11,976
2000	19	12	30	24,360
2001	19	12	30	19,994
2002	18	12	31	21,790
2003	19	12	32	17,558
2004	19	12	33	20,469
2005	19	13	32	20,660
2006	20	12	33	20,946
2007	19	12	30	26,280
2008	20	12	31	27,914
2009	20	13	31	19,801
2010	20	12	33	23,381
2011	19	12	31	17,202
2012	20	13	33	7,682
2013	21	13	31	6,452
2014	20	13	35	20,982
2015	20	13	35	28,145
2016	20	12	32	24,268
2017	20	12	33	14,281
2018	20	13	32	13,844
2019	20	13	33	18,964
2020	20	12	35	14,768
2021	19	13	32	17,884
2022	19	13	32	13,742

Table 3. Summer flounder length (total length, inches) data from NOAA Marine Recreational Information Program recreational samples in North Carolina, 1982–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1982	13	8	22	562
1983	12	6	19	150
1984	14	5	19	244
1985	14	5	20	274
1986	14	8	23	281
1987	13	7	29	400
1988	13	8	25	717
1989	15	9	22	338
1990	14	6	25	1,285
1991	14	5	20	810
1992	14	8	22	556
1993	14	8	25	979
1994	15	9	39	1,454
1995	15	10	28	484
1996	15	8	23	1,155
1997	15	9	22	998
1998	15	11	23	1,239
1999	15	12	25	544
2000	15	11	25	703
2001	15	12	23	915
2002	15	9	25	566
2003	15	13	21	121
2004	16	11	23	244
2005	16	13	23	193
2006	15	12	21	217
2007	16	13	21	286
2008	16	13	19	88
2009	16	13	20	136
2010	16	12	22	259
2011	16	13	24	213
2012	16	11	24	228
2013	16	14	23	114
2014	16	13	19	137
2015	16	13	20	116
2016	16	13	21	59
2017	16	13	24	129
2018	16	13	20	91
2019	16	13	19	65
2020	16	8	24	38
2021	17	15	19	13
2022	17	15	21	34

Table 4. Summer flounder length (total length, inches) data from Program 195 (Pamlico Sound Survey) samples in North Carolina, 1987–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1987	6	1	19	1,711
1988	7	2	15	493
1989	6	2	14	662
1990	6	3	15	763
1991	6	3	14	359
1992	6	3	16	874
1993	6	3	13	619
1994	7	3	13	842
1995	7	3	13	607
1996	5	3	15	1,378
1997	6	3	17	1,044
1998	6	3	16	794
1999	7	2	14	408
2000	7	3	18	401
2001	6	3	17	1,225
2002	6	3	16	985
2003	6	3	16	592
2004	6	2	16	536
2005	5	3	13	710
2006	7	3	15	310
2007	6	3	13	397
2008	6	3	16	1,096
2009	7	3	19	596
2010	6	2	15	685
2011	6	3	17	695
2012	7	3	16	644
2013	6	3	14	1,169
2014	6	2	17	596
2015	7	3	17	477
2016	6	3	12	272
2017	6	3	14	559
2018	6	3	12	618
2019	6	3	15	400
2020*	7	4	13	56
2021*	8	3	14	30
2022	8	2	17	319

\*Note: Data for 2020 and 2021 not usable due to staffing issues and insufficient sampling during COVID-19.

Table 5. Summer flounder age samples collected from both dependent (commercial and recreational fisheries) and independent (surveys) sources in North Carolina from 1991–2022.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
1991	2	0	8	635
1992	2	0	7	359
1993	2	0	6	401
1994	2	0	7	552
1995	2	0	7	535
1996	2	1	9	476
1997	2	0	6	444
1998	2	0	6	476
1999	3	1	8	412
2000	3	1	8	569
2001	4	1	8	499
2002	3	1	8	609
2003	3	1	8	610
2004	3	1	10	553
2005	3	1	11	620
2006	4	1	11	682
2007	3	1	11	697
2008	4	1	11	751
2009	5	1	11	723
2010	3	1	14	783
2011	4	2	12	417
2012	3	1	13	541
2013	4	0	13	610
2014	5	1	16	1,128
2015	6	0	17	890
2016	7	0	18	998
2017	4	0	19	1,179
2018	5	0	19	882
2019	5	0	19	925
2020	4	0	17	761
2021	4	1	12	628
2022	5	0	16	468

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 $\geq 6$ -inches (square) throughout the body, extensions and tailbag required to possess more than 100 pounds of flounder May 1 through October 31 or more than 200 pounds of flounder November 1 through 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)
Owner of a vessel required to possess a Licenses to Land flounder from the Atlantic Ocean and in order for a dealer to purchase or offload $\geq 100$ pounds of flounder from the Atlantic Ocean.	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**

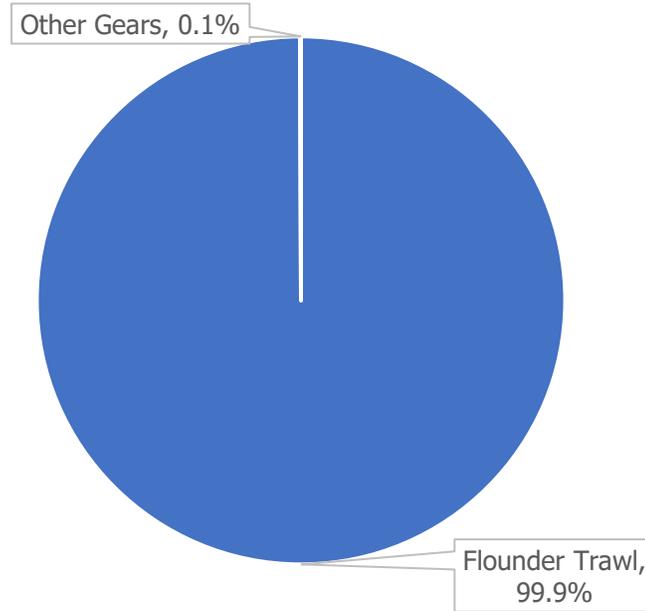


Figure 1. Commercial harvest of summer flounder in North Carolina by gear type in 2022.

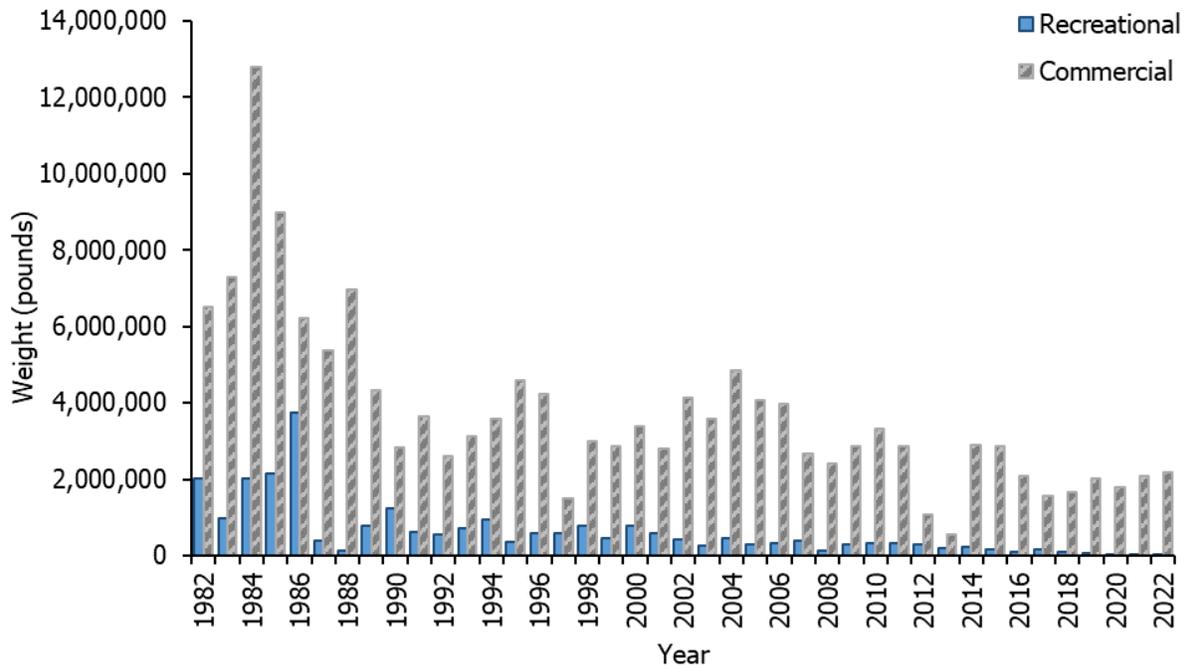


Figure 2. Annual commercial and recreational landings in pounds for summer flounder in North Carolina from 1982–2022.

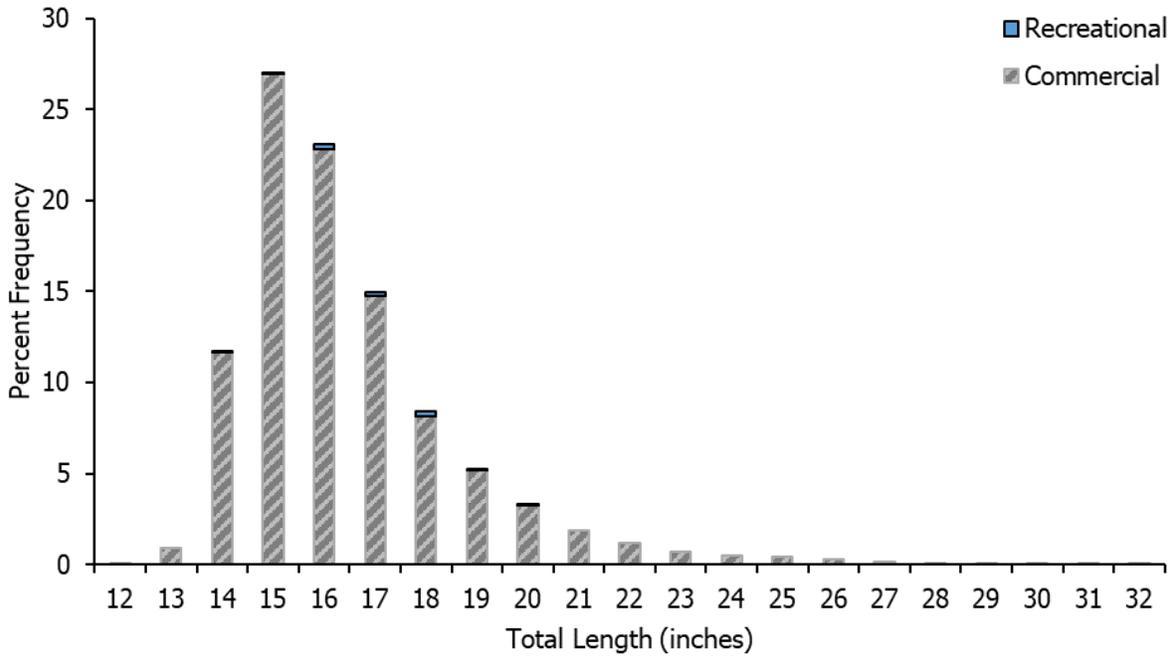


Figure 3. Commercial and recreational length frequency distribution from summer flounder harvested in North Carolina in 2022.

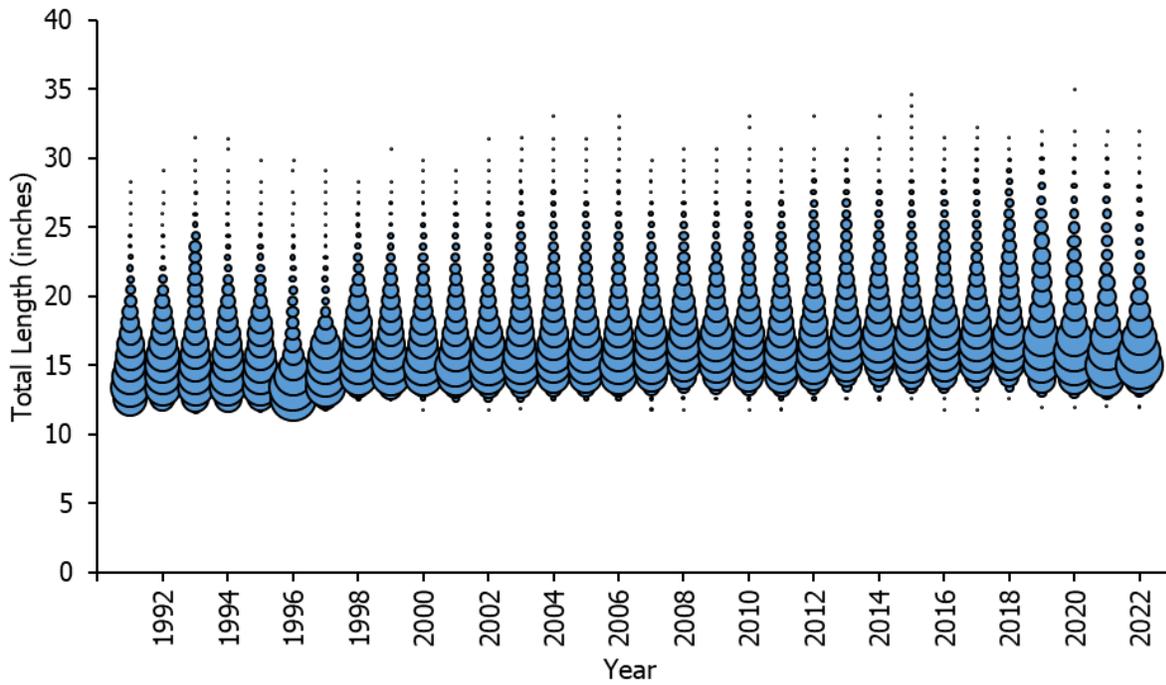


Figure 4. Commercial length frequency (total length, inches), of summer flounder harvested in North Carolina from 1991–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

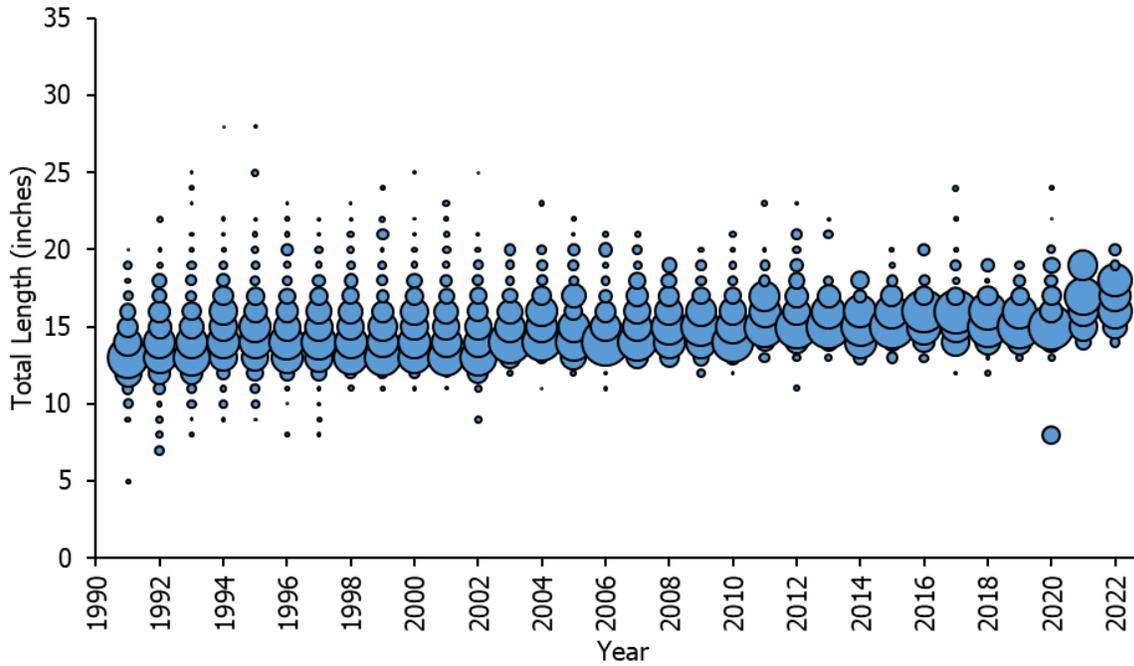


Figure 5. Recreational length frequency (total length, inches), of summer flounder harvested in North Carolina from 1991–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

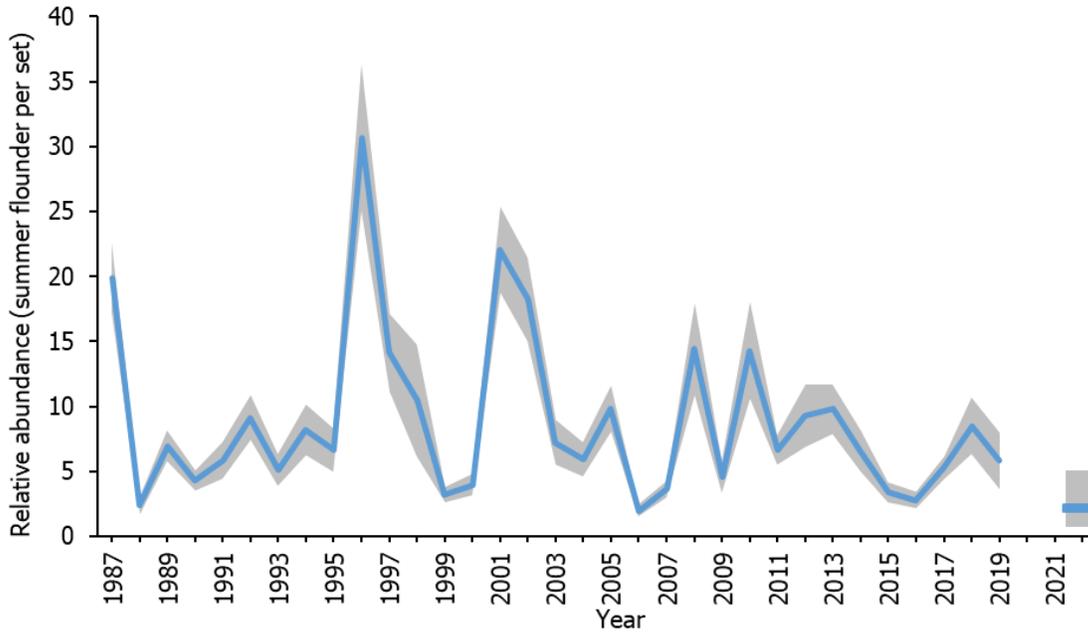


Figure 6. The annual summer flounder juvenile abundance index with standard error shaded in the gray from the North Carolina Program 195 (Pamlico Sound Survey) Survey for the period of 1987–2022. Data from 2020 and 2021 will not be used due to staffing issues and incomplete sampling corresponding with the COVID-19 pandemic.

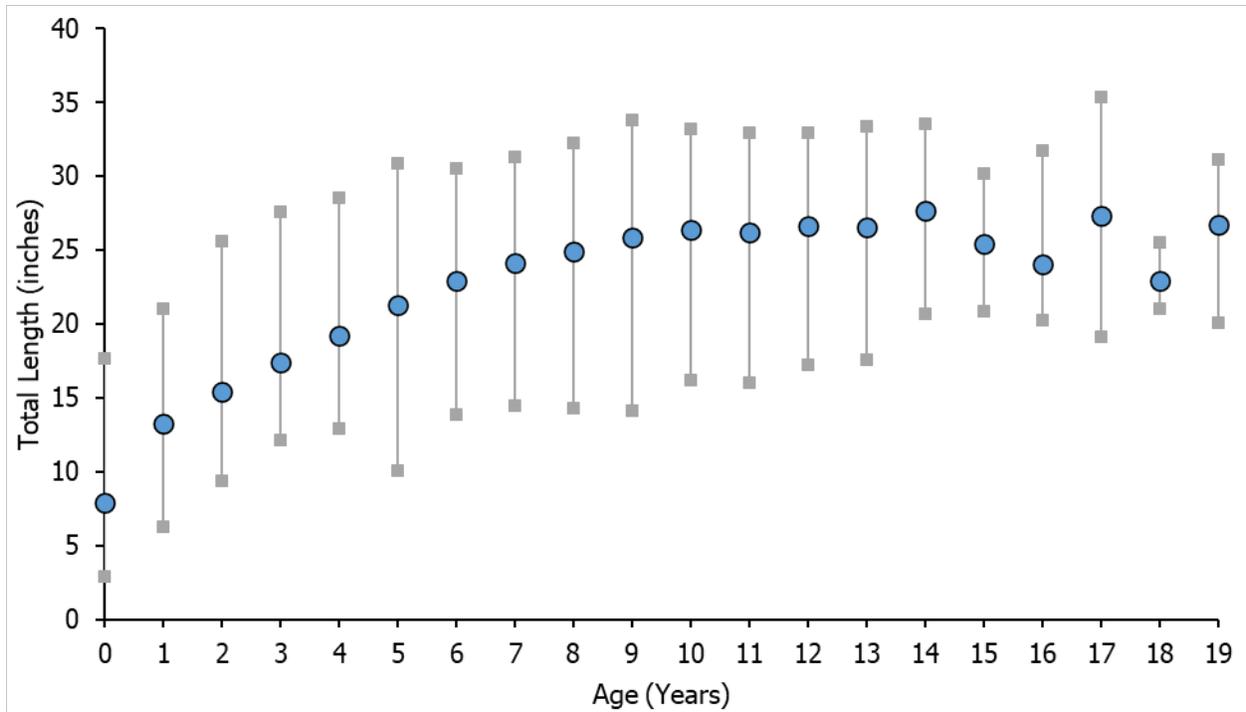


Figure 7. Summer flounder length at age based on age samples collected in North Carolina from 1991–2022. Blue circles represent the mean size at a given age while the gray squares represent the minimum and maximum observed size for each age.

**FISHERY MANAGEMENT PLAN UPDATE  
WEAKFISH  
JUNE 2023**

**STATUS OF THE FISHERY MANAGEMENT PLAN**

**Fishery Management Plan History**

FMP Documentation:	ASMFC	October 1985
	Amendment 1	March 1992
	Amendment 2	October 1994
	Amendment 3	May 1996
	Addendum I	October 2000
	Amendment 4	November 2002
	Technical Addendum 1	March 2003
	Addendum I	December 2005
	Addendum II	February 2007
	Addendum III	May 2007
	Addendum IV	November 2009
 Comprehensive Review:	No comprehensive review scheduled. ASMFC Stock Assessment Update Scheduled for 2025	

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 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 to extend the existing management program until the Weakfish Management Board could approve Amendment 4 (ASMFC 2000).

Weakfish are currently managed under the management program contained in Amendment 4 (ASMFC 2002, 2003) 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.

The findings of the 2009 weakfish stock assessment indicated weakfish were in a severely depleted state (NEFSC 2009a and 2009b) 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% 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% of the weight of all finfish landed up to 1,000 pounds per trip or day, whichever is larger. In November of 2012, based on the recommendation of the North Carolina Marine Fisheries Commission (MFC), 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 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 assessment indicate weakfish are depleted and 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 no new management action was warranted.

An update to the peer-reviewed 2016 assessment was completed in 2019 (ASMFC 2019) and presented at the 2019 ASMFC Fall Meeting. Results of the assessment update show the weakfish stock is depleted and has been since 2003. Estimates of recruitment, spawning stock biomass, and total abundance remain low in recent years. Estimates of fishing mortality were moderately high in recent years, although not as high as the time-series highs of the mid- to late-2000's or the earliest years, and natural mortality remained high. The Board reviewed the results of the assessment update at their October 2019 meeting and decided no new management action was warranted. The management program implemented under Addendum IV remains in effect. An additional update to the 2016 assessment is expected in early 2025 with the bulk of the work completed in 2024.

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 2022).

## **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 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 Subcommittee, 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:

- 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.
- Restore the weakfish age and size structure to that necessary for the restoration of the fishery.
- Return weakfish to their previous geographic range.
- Achieve compatible and equitable management measures among jurisdictions throughout the fishery management unit, including states' waters and the federal EEZ.
- Promote cooperative interstate research, monitoring and law enforcement necessary to support management of weakfish.
- Promote identification and conservation of habitat essential for the long-term stability in the population of weakfish.
- Establish standards and procedures for both the implementation of Amendment 4 and for determination of states' compliance with provisions of the management plan

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

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 (Wilk 1979). 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 (Bigelow and Schroeder 1953; Wilk 1979). Spawning occurs during this time in higher salinity environments around the coastal inlets (Luczkovich et al. 1999; Luczkovich et al. 2008). 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 (Wilk 1979). Peak spawning in North Carolina is typically around April or May but females are batch spawners and will spawn multiple times throughout the spring and summer months (Lowerre-Barbieri et al. 1996; Merriner 1976). Most weakfish are sexually mature by age 1 and at 11 to 12 inches in length (Lowerre-Barbieri et al. 1996; Nye et al. 2008). 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 (Merriner 1975).

### **Stock Status**

According to the 2019 stock assessment update, spawning stock biomass (SSB) in 2017 was 4.24 million pounds, well below the SSB threshold of 30% (13.6 million pounds), indicating the stock is depleted (Figure 1; ASMFC 2019). The weakfish Technical Committee recommended total mortality (Z) benchmarks, which includes fishing and natural mortality. Total mortality in 2017 was 1.45, which was above both the 20% target (1.03) and the 30% threshold (1.43), indicating total mortality was too high (Figure 2). However, fishing mortality in 2017 (0.62) was above the 20% target but below the 30% threshold (0.97), indicating the stock is not overfished.

### **Stock Assessment**

The assessment completed in 2016 and updated in 2019 employed a spatially structured forward projecting statistical catch at age model with time-varying natural mortality, with a terminal year of 2017. This model accounts for varying population spatial distribution and changing natural mortality through time. Results of the assessment show the weakfish stock is depleted and has been for the past 15 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 13.6 million pounds that is equivalent to 30% of the projected SSB under average natural mortality and no fishing (SSB30%). When SSB is below the threshold, the stock is considered depleted. Despite SSB showing a slight increasing trend in recent years, SSB was 4.24 million pounds in 2017 (Figure 1), which is well below the threshold. The model indicated natural mortality has been increasing since the mid-1990s, from approximately 0.17 at the beginning of the time-series to an average of 0.92 from 2007-2017 (Figure 2). The weakfish population has been experiencing very high levels of total mortality which has prevented the stock from recovering. Fishing mortality has increased in recent years but was below the threshold in 2017.

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

The DMF allows the recreational harvest of weakfish year-round 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 pound daily limit and 12-inches total length minimum size 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 Fishery**

Commercial landings of weakfish peaked in 1988 at 15,091,878 pounds. Landings have since steadily dropped, and in 2009 Addendum IV reduced commercial harvest to 100 pounds per trip achieving an estimated reduction of 61% from the 2005-2008 harvest levels. Recent years have shown little increase due to low abundance and commercial harvest restrictions. Landings increased in 2022 to 62,196 pounds from the previous year (59,534 pounds) but were lower than 2019 (115,665 pounds) and 2020 (87,645 pounds; Table 1; Figure 3).

### **Recreational Fishery**

Recreational landings of weakfish are estimated from the Marine Recreational Information Program (MRIP). Recreational estimates across all years have been updated and are now based on the MRIP's new Fishing Effort Survey-based calibrated estimates. For more information on MRIP see <https://www.fisheries.noaa.gov/topic/recreational-fishing-data>.

Estimated recreational harvest has been variable since 1982 with a peak in 1987 at 3,442,746 pounds. Harvest since 2009 has 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% for North Carolina. Average harvest since 2010 is 83,418 pounds and has varied from a high of 157,269 pounds in 2015 to a low of 29,924 in 2018 but has increased each year since 2018. Recreational harvest increased in 2019 to 43,252 pounds (or 39,061 fish), increased again in 2020 to 105,729 pounds (82,124 fish) – the highest observed since 2015 (157,269 pounds; Table 1; Figure 3) – and remained similar in 2021 at 103,449 pounds (or 91,032 fish). Harvest in 2022 was consistent with 2020 and 2021 with 105,060 pounds (or 113,095 fish) harvested. The number of weakfish released has remained relatively stable since 2017, varying between 300,195 fish in 2017 and 386,364 fish in 2020 but increased dramatically in 2021 to 1,030,829 fish and increased again in 2022 to 1,921,985 fish, the highest since 2001 (2,831,044 fish).

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. A total of 59 citations were issued for weakfish in 2022 including 37 release citations (greater than 24 inches total length released) and 22 harvest citations (greater than five pounds landed) (Table 2; Figure 4). This is the highest number of weakfish citations since 2003 and the second highest number of citations in the time series (1991-2022).

## **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 from commercial fish houses has generally declined since 2000, following a similar trend to commercial landings (Tables 1 and 3).

Samples are collected from ocean fisheries as well as estuarine fisheries. The ocean sink net fishery and estuarine gill net fishery land the majority of weakfish accounting for 66% of the overall commercial catch in 2022. However, the percentage of landings from the ocean sink net and estuarine gill net fisheries decreased nearly 20% from 2021 largely due to a greater than 7% increase in pound net landings in 2022 the highest since 2012.

Mean and minimum lengths of fish harvested in the commercial fishery have remained relatively consistent throughout the time series (Table 3; Figure 6). Since 2012, the mean length has been approximately 14 inches fork length. However, since 2010, there has been a noticeable decline in maximum lengths, from an average of 32 inches (1982-2010) to an average of 26 inches (2011-2022).

Recreational lengths and weights are collected as part of the MRIP by recreational port agents. While the mean lengths of weakfish sampled from the recreational fishery are similar to those sampled from the commercial fishery in recent years, the average maximum observed length is smaller in the recreational fishery by approximately 9 inches (Table 3; Figure 7). The maximum observed length in the recreational fishery in 2022 (20 inches) was smaller than the previous year (23 inches).

The recreational modal length decreased to 11 inches in 2022 (Figure 5). The commercial modal length increased from 12 inches in 2021 to 14 inches in 2022. In addition, in 2021, 70% of both commercial fishery harvest and recreational fishery harvest was between 12 and 16 inches (Figure 5).

### **Fishery-Independent Monitoring**

Fishery independent data are collected through both the Program 195 Pamlico Sound Survey and Program 915 Independent Gill Net Survey. The Pamlico Sound Survey provides an age-0 relative abundance index calculated from the September stations and an age-1+ index calculated from the June stations. Although the ASMFC stock assessment only uses the age-0 index, both are provided here to assess overall trends in both groups. The Pamlico Sound Survey indices show a variable trend over the years (Figures 8 and 9). During 2021, sampling was impacted during June and September due to the COVID pandemic. Not all stations were able to be sampled as only day trips were permitted. In June, only 35 of the 54 stations were sampled, and in September, only 33 of the 54 stations were sampled. Thus, the relative abundance indices from 2021 should be viewed with caution. The 2022 age-0 relative abundance index (14.71 fish per tow) increased from 2021 (1.0 fish per tow) which was the lowest in the time series (1990-2022). The 2022 age-1+ relative abundance index (12.35 fish per tow) decreased from the previous year (41.47 fish per tow). Both the 2022 age-0 and age-1+ relative abundance indices were approximately half of the mean relative abundance from 2010-2022 (30.05 and 33.47 fish per tow). The period from 2010-2022 represents the timeframe of current weakfish management in North Carolina.

The Independent Gill Net Survey collects size, age, and abundance data for commercially and recreationally important species in the Pamlico Sound, Pamlico, Pungo, and Neuse rivers, and the Cape Fear and New rivers using multi-mesh gill nets. The relative abundance index from the Pamlico Sound portion is used in the ASMFC stock assessment and had been showing a declining trend since the beginning of the time series, but it has remained relatively stable since 2015 (Figure

10). The data from the Pamlico, Pungo, and Neuse rivers and the Cape Fear and New rivers are not used in the assessment as these regions have minimal catches of weakfish. During 2020 no index of relative abundance was available for weakfish from the Independent Gill Net Survey. Sampling in this program was suspended in February 2020 due to COVID-19 restrictions and protected species interactions but resumed July 2021. The 2021 relative abundance index should be used with caution as just over 50% of the samples were completed for the year. The relative abundance index for 2022 was 0.43 fish per set and was a slight increase from 2021 but remained similar to indices for 2015 through 2019.

Weakfish age samples (otoliths) are collected through both fishery dependent and independent sampling. Sampling for weakfish has been ongoing since 1995. Age samples are collected from all possible gears and during all months. The number of samples collected yearly has ranged from 170 to 1,319, with a total of 16,859 otoliths aged to date. Ages have ranged from 0 to 15 years with a mean modal age of two years (Table 4; Figure 11). Based on average age-at-lengths, weakfish growth does not plateau until age-10 (Figure 11). The maximum age of the weakfish sampled in 2022 was age 5 (Table 4). Since 2007, the maximum age of weakfish has fluctuated between four and six with the exception of 2009 (age 15).

## **RESEARCH NEEDS**

### **High**

- Increase observer coverage to identify the magnitude of discards for all commercial gear types from both directed and non-directed fisheries.
- Continue studies on temperature, size, and depth specific recreational hook and release mortality rates, particularly catches from warm, deep waters. Investigate methods to increase survival of released fish.
- Continue studies on mesh size selectivity, particularly trawl fisheries.
- Improve methods to estimate commercial bycatch. Refine estimates of discard mortality based on factors such as distance from shore and other geographical differences for all sizes including below minimum size.
- Evaluate predation of weakfish with a more advanced multispecies model (e.g., the ASMFC MSVPA or Ecopath with Ecosim).
- Develop a bioenergetics model that encompasses a broader range of ages than Hartman and Brandt (1995) and use it to evaluate diet and growth data.
- Analyze the spawner-recruit relationship and examine the effects of the relationship between adult stock size and environmental factors on year class strength.
- Develop a coast-wide tagging program to identify stocks and determine migration, stock mixing, and characteristics of stocks in over wintering grounds. Determine the relationship between migratory aspects and the observed trend in weight-at-age.
- Monitor weakfish diets over a broad regional and spatial scale, with emphasis on new studies within estuaries.

- Continue to investigate the geographical extent of weakfish hybridization.
- Estimate weakfish mortality through independent approaches (e.g., alternative models, tagging) to corroborate trends in mortality from the assessment model.
- Conduct a meta-analysis of all factors likely to influence changes in natural mortality to see if the aggregate effect shows stronger statistical likelihood of occurrence than the significance shown by each individual driver effect on its own.
- Improve implementation of the process for organizing and collecting data from different agencies and sources to assure timely and high-quality data input into the model.

### **Moderate**

- Identify and delineate weakfish spawning habitat locations and environmental preferences to quantify spawning habitat.
- Compile data on larval and juvenile distribution from existing databases to obtain preliminary indications of spawning and nursery habitat location and extent.
- Examine geographical and temporal differences in growth rate (length and weight-at-age).
- Determine the impact of power plants and other water intakes on larval, post larval, and juvenile weakfish mortality in spawning and nursery areas. Calculate the resulting impact on adult stock size.
- Monitor predation on weakfish from both fish and marine mammal species.
- Determine the impact of scientific monitoring surveys on juvenile weakfish mortality. Calculate the resulting impact on adult stock size.
- Assemble socioeconomic data as it becomes available from ACCSP.

### **Low**

- Determine the onshore versus offshore components of the weakfish fishery.
- 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 and further north.
- Develop latitudinal, seasonal, and gear specific age length keys coast wide. Increase sample sizes for gear specific keys.
- Define restrictions necessary for implementation of projects in spawning and over wintering areas and develop policies on limiting development projects seasonally or spatially.

## **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 on results from the 2016 assessment, the Weakfish TC recommended a 30% SSB threshold be used as a reference point to determine if the stock is depleted. The TC also noted there is no long-term stable equilibrium population of weakfish due to time varying natural mortality, so they recommended managing the stock using Z-based (total mortality) targets and thresholds of 20% and 30%. In addition, total mortality (Z) benchmarks are used to prevent an increase in fishing pressure when F is low, but M is high. Although the total mortality of the stock in the terminal year of the assessment update (2017) was above both the Z target and threshold, the TC recommended, and the board approved no new management measures at this time given how highly restrictive the weakfish management program already is.

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## TABLES

Table 1. Recreational harvest (number of fish landed and weight in pounds) and releases (number of fish) and commercial harvest (weight in pounds) of weakfish from North Carolina for the period 1982–2022.

Year	Recreational			Commercial	Total Weight (lb)
	Number Landed	Number Released	Weight Landed (lb)	Weight Landed (lb)	
1982	255,080	61,048	348,645	12,052,232	12,400,877
1983	596,354	16,387	749,910	10,233,734	10,983,644
1984	555,640	35,101	252,873	12,990,726	13,243,599
1985	1,010,772	2,638	796,974	9,797,734	10,594,708
1986	2,049,746	694,759	1,455,912	14,309,372	15,765,284
1987	2,403,361	250,581	3,442,746	11,508,389	14,951,135
1988	650,224	175,284	175,178	15,091,878	15,267,056
1989	456,191	65,500	331,840	10,115,747	10,447,587
1990	149,508	30,295	104,761	5,802,159	5,906,920
1991	358,273	32,083	286,349	5,308,574	5,594,923
1992	72,064	69,585	53,214	4,862,551	4,915,765
1993	293,966	157,478	230,010	4,017,265	4,247,275
1994	336,188	477,521	276,435	3,489,929	3,766,364
1995	103,190	225,976	118,177	4,113,260	4,231,437
1996	138,577	361,153	121,291	3,977,633	4,098,924
1997	333,852	506,509	313,767	3,561,060	3,874,827
1998	450,645	669,125	487,884	3,354,008	3,841,892
1999	313,427	687,884	420,706	2,617,580	3,038,286
2000	147,397	852,262	179,599	1,869,042	2,048,641
2001	317,974	2,831,044	325,447	1,960,324	2,285,771
2002	214,040	917,803	215,402	1,828,150	2,043,552
2003	291,168	422,294	309,412	848,822	1,158,234
2004	395,268	614,762	428,627	685,463	1,114,090
2005	297,605	702,685	281,710	421,984	703,694
2006	343,092	1,047,135	302,775	363,086	665,861
2007	191,192	600,987	202,583	175,593	378,176
2008	203,779	470,805	209,470	162,516	371,986
2009	204,814	626,742	245,358	163,148	408,506
2010	110,770	914,004	103,903	106,328	210,231
2011	48,727	380,366	62,543	65,998	128,541
2012	96,947	396,620	95,952	91,384	187,336
2013	63,090	257,367	66,720	120,191	186,911
2014	71,912	1,067,344	70,988	105,247	176,235
2015	143,543	1,652,582	157,269	80,242	237,511
2016	77,341	1,097,615	83,702	79,667	163,369
2017	51,795	351,613	55,944	85,462	141,406
2018	30,935	300,195	29,924	35,134	65,058
2019	39,061	366,518	43,252	115,665	158,917
2020	82,124	386,364	105,729	91,374	197,103
2021	91,032	1,030,829	103,449	59,534	162,983
2022	112,095	1,921,985	105,060	62,196	167,256
Mean+	78,413	788,723	84,318	84,494	167,912

+ Mean value is from 2010-2022 reflecting the current weakfish management period.

Table 2. Total number of awarded citations for weakfish (>24-inches total length for release or > 5 pounds landed) from the North Carolina Saltwater Fishing Tournament from 1991–2022.

Year	Total Citations	Release Citations <sup>+</sup>	% Release
1991	1		0
1992	2		0
1993	10		0
1994	2		0
1995	3		0
1996	2		0
1997	0		0
1998	6		0
1999	6		0
2000	8		0
2001	8		0
2002	0		0
2003	124		0
2004	9		0
2005	3		0
2006	1		0
2007	2		0
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	16	100
2018	3	0	0
2019	8	3	38
2020	10	3	30
2021	49	30	61
2022	59	37	63

<sup>+</sup> Weakfish release citations (fish released greater than 24 inches total length) began in 2008

Table 3. Mean, minimum, and maximum lengths (fork length, inches) of weakfish sampled from the commercial and recreational fisheries of North Carolina from 1982–2022. Commercial lengths include both marketable and scrap finfish.

Year	Commercial				Recreational			
	Mean Length	Minimum Length	Maximum Length	Total Number Measured	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1982	13.8	4.4	34.1	4,485	13.9	7.8	22.8	55
1983	13.8	4.6	33.7	10,357	13.9	7.7	25.6	29
1984	14.2	5.1	36.6	14,952	10.9	4.7	18.9	90
1985	12.9	4.7	34.4	15,310	12.0	7.7	22.4	34
1986	13.9	5.4	34.9	17,446	13.0	8.7	20.1	164
1987	12.9	4.4	34.2	22,943	15.1	7.9	22.4	253
1988	13.8	5.3	33.7	18,116	12.7	8.3	20.5	208
1989	14.8	4.8	35.2	14,853	12.0	7.5	23.2	182
1990	12.2	4.1	35.4	18,613	12.2	7.1	21.7	181
1991	11.1	4.2	26.1	24,772	12.0	7.3	18.6	136
1992	12.1	5.2	29.8	21,050	12.3	7.6	17.2	64
1993	11.9	4.0	29.2	23,679	12.6	8.6	16.0	196
1994	13.2	4.6	28.0	15,011	13.2	6.2	20.8	573
1995	12.7	4.4	29.5	18,526	15.2	10.0	20.2	231
1996	13.1	4.6	28.1	18,906	14.0	9.9	19.2	336
1997	13.1	4.1	29.7	20,583	13.7	8.3	20.7	602
1998	13.5	6.5	27.4	13,963	14.3	9.9	27.0	518
1999	13.2	5.1	29.1	16,490	15.4	10.6	26.0	258
2000	13.2	4.1	29.8	19,382	14.8	9.8	22.4	122
2001	14.0	6.5	31.5	15,182	14.1	10.6	19.9	180
2002	13.7	6.1	31.5	13,531	13.9	9.4	19.1	106
2003	12.7	4.2	33.3	9,721	14.1	8.6	27.5	131
2004	13.2	5.8	33.5	10,500	14.4	11.1	25.5	164
2005	13.2	5.6	34.4	9,893	14.0	11.7	19.8	104
2006	12.7	5.6	32.5	11,649	13.6	9.8	20.1	240
2007	12.3	4.8	26.1	6,817	14.2	10.5	20.7	76
2008	12.3	5.0	26.3	3,851	13.8	11.7	20.4	145
2009	12.8	6.3	33.7	3,318	14.8	9.7	21.9	132
2010	12.3	5.1	34.6	2,568	13.6	9.3	17.3	96
2011	12.7	7.8	25.1	2,044	14.6	11.6	30.7	41
2012	13.5	5.0	23.3	2,754	13.8	10.2	20.8	81
2013	14.0	8.0	28.3	3,466	14.2	7.6	22.8	74
2014	14.0	5.0	24.4	3,348	13.8	10.9	20.3	72
2015	14.0	5.4	27.7	2,212	14.0	12.2	19.0	34
2016	14.1	8.7	23.6	2,743	14.0	10.3	18.0	76
2017	14.3	8.5	28.2	1,240	14.2	8.7	17.0	51
2018	13.7	7.0	26.9	770	13.4	8.6	18.5	34
2019	14.1	8.7	26.3	1,923	14.5	9.8	18.1	62
2020	14.0	9.0	26.0	1,004	15.0	9.8	22.9	65
2021	13.9	10.2	24.3	870	14.4	8.7	22.7	70
2022	13.6	8.0	23.7	850	13.3	9.3	19.8	73

Table 4. Modal age, minimum age, maximum age, and number aged for weakfish collected through DMF sampling programs from 1995 through 2022.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
1995	1	0	5	898
1996	4	0	6	1,319
1997	3	0	7	1,059
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	3	0	4	425
2016	1	0	5	570
2017	1	0	5	353
2018	2	0	4	170
2019	2	0	6	551
2020	2	0	4	724
2021	1	0	6	1,016
2022	2	0	5	522

FIGURES

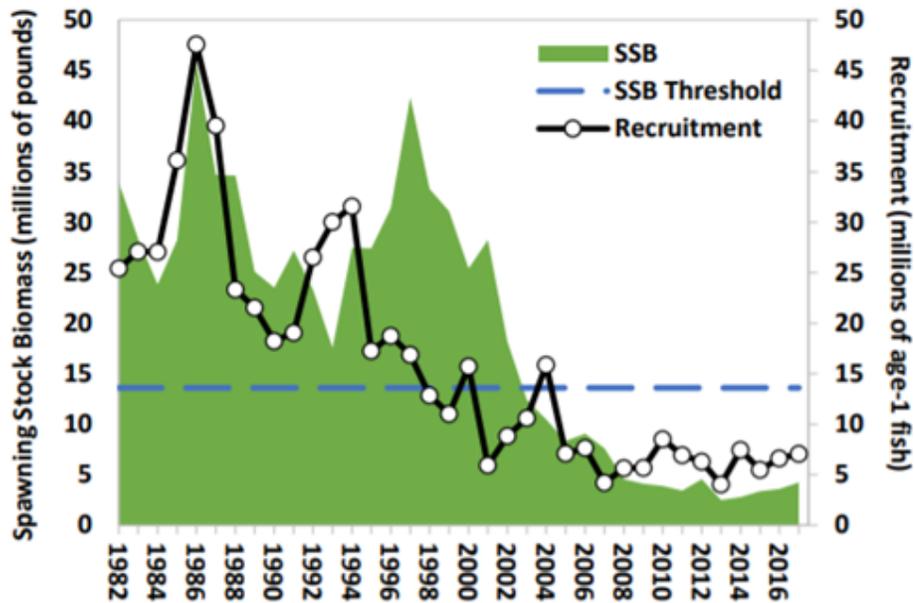


Figure 1: Spawning stock biomass (SSB) and recruitment of age-1 weakfish estimated along the U.S. Atlantic coast from 1982 to 2017 (ASMFC 2019). Dashed line represents the 30% spawning stock biomass (SSB) threshold of 13.6 million pounds.

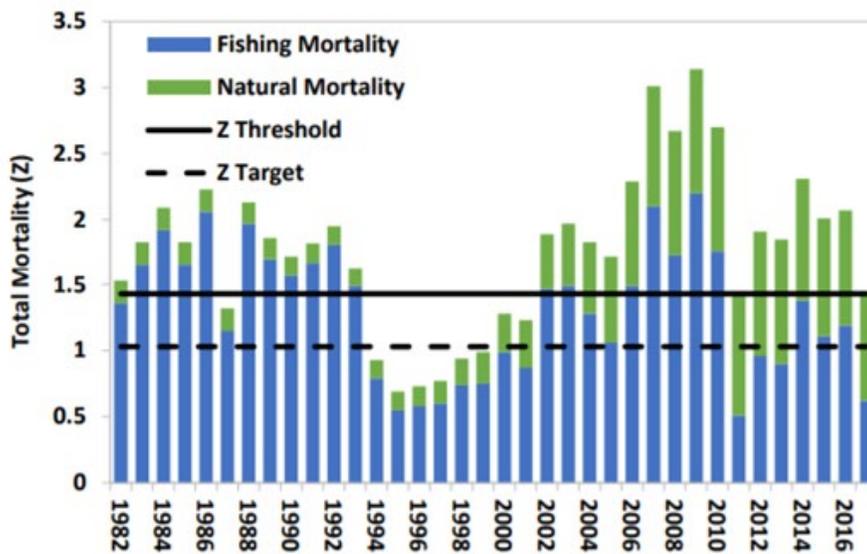


Figure 2. Natural mortality (M) and fishing mortality (F) estimated for all weakfish along the U.S. Atlantic east coast, 1982 to 2017 (ASMFC 2019). Solid and dashed lines represent total mortality target ( $Z_{30\%} = 1.03$ ) and threshold ( $Z_{20\%} = 1.43$ ) used to determine if the stock is being overfished.

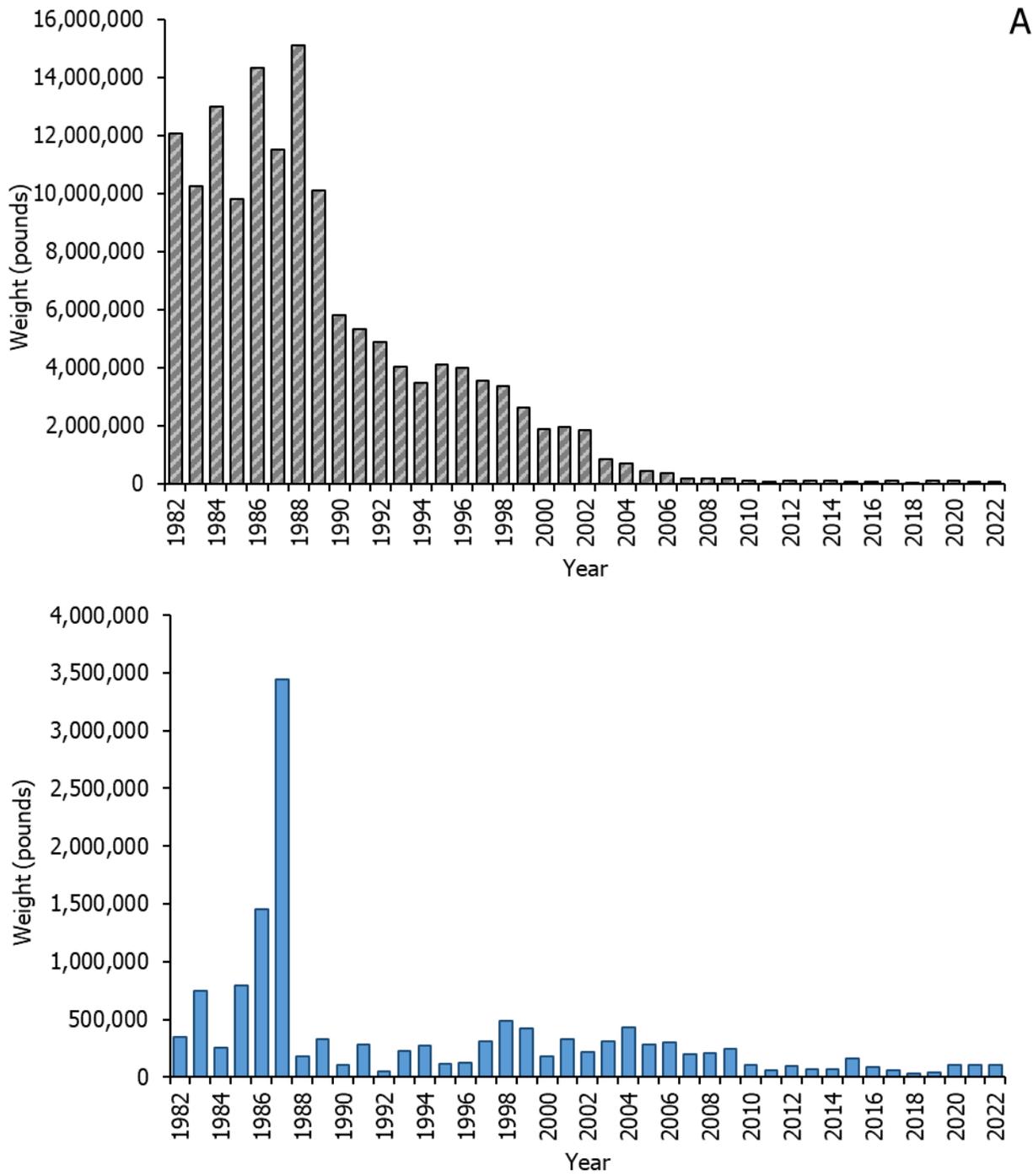


Figure 3. Annual commercial (A) and recreational (B) landings in pounds for weakfish in North Carolina from 1982 to 2022.

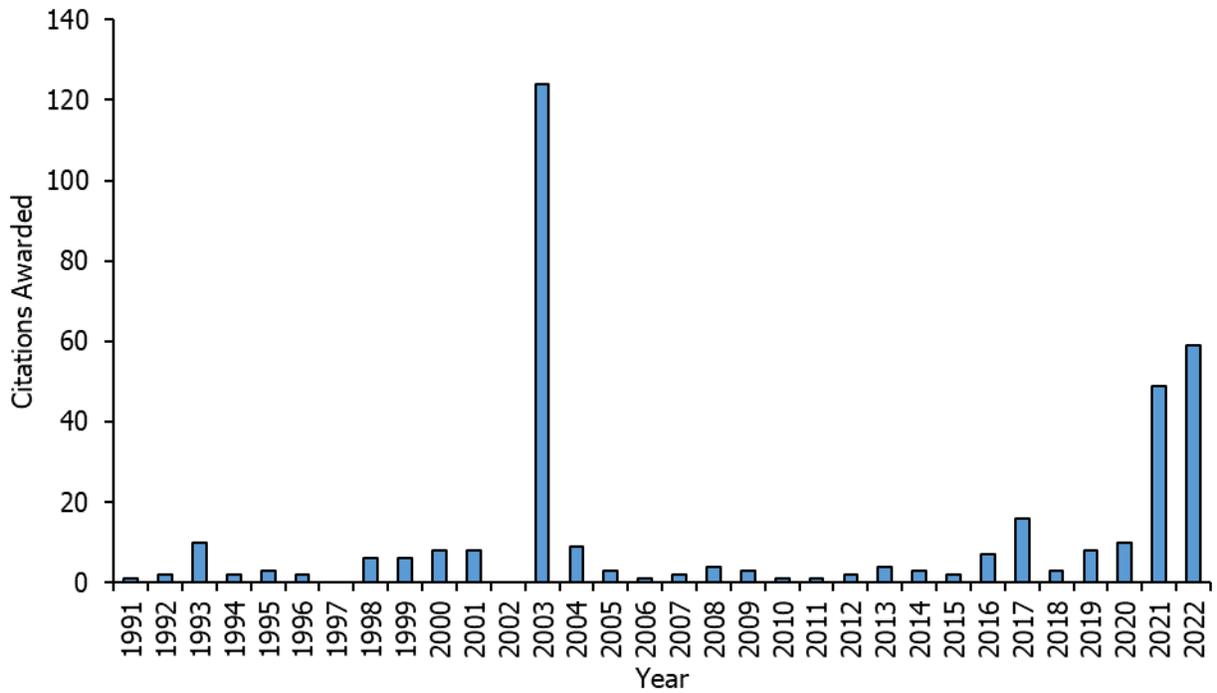


Figure 4. North Carolina Saltwater Fishing Tournament citations awarded for weakfish from 1991 to 2022. Citations are awarded for weakfish greater than 24 inches total length released or greater than 5 pounds landed.

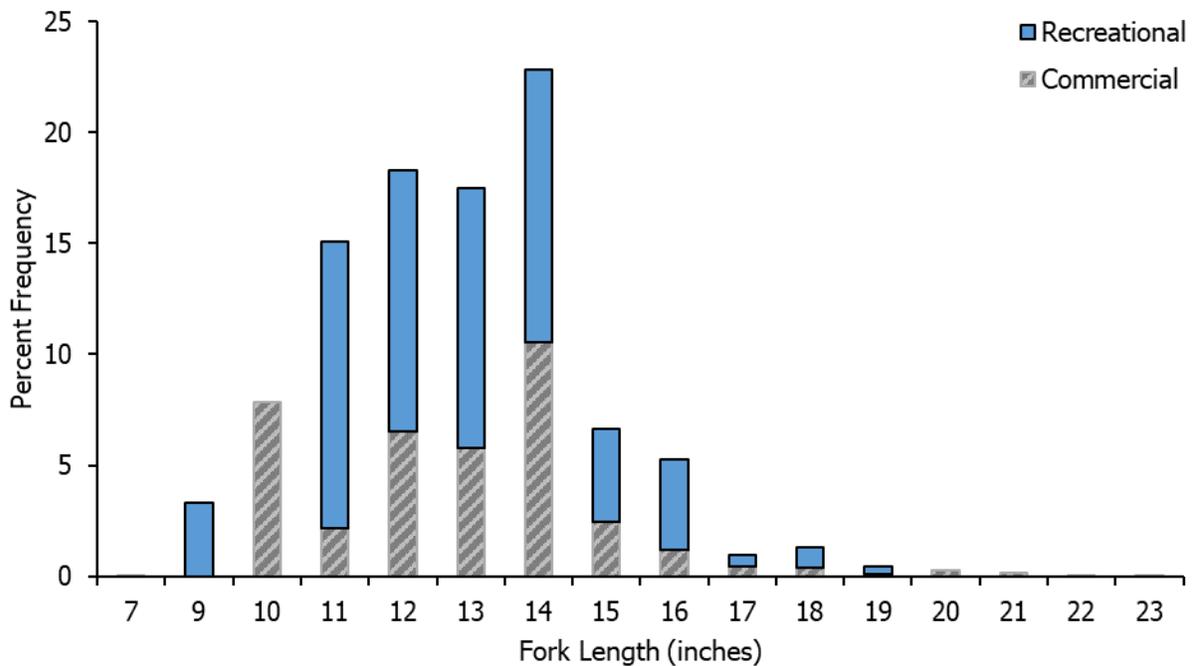


Figure 5. Commercial and recreational length frequency distribution from weakfish harvested in 2022.

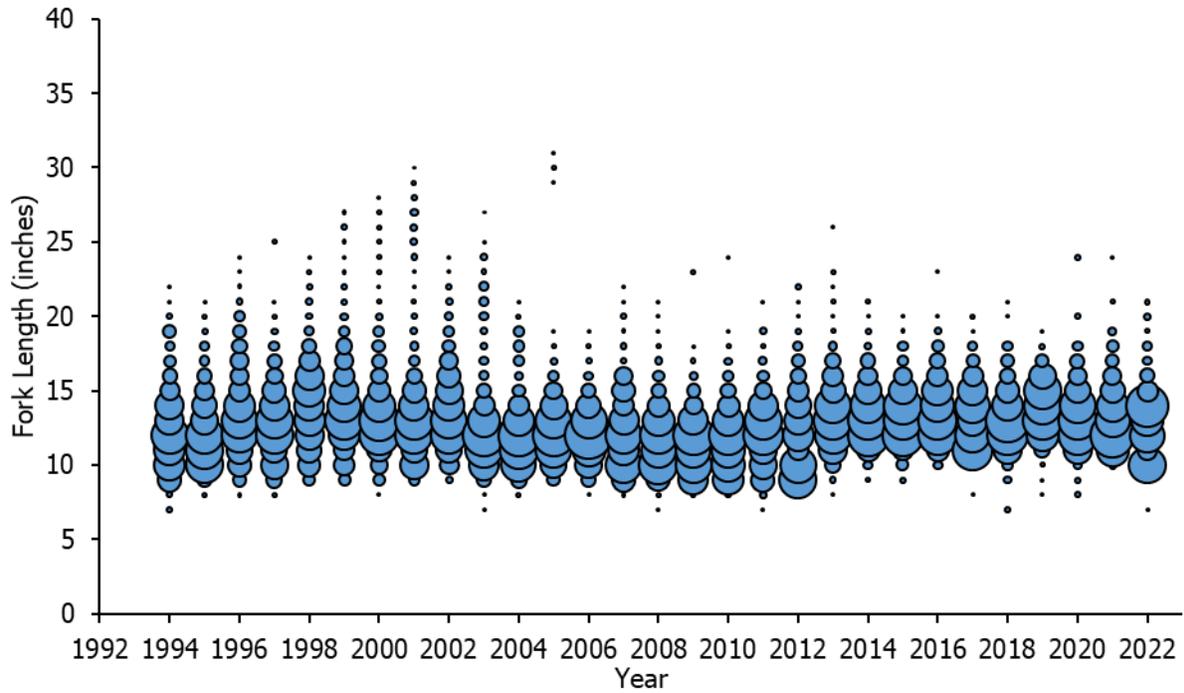


Figure 6. Commercial length frequency (fork length, inches) of weakfish harvested from 1994-2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

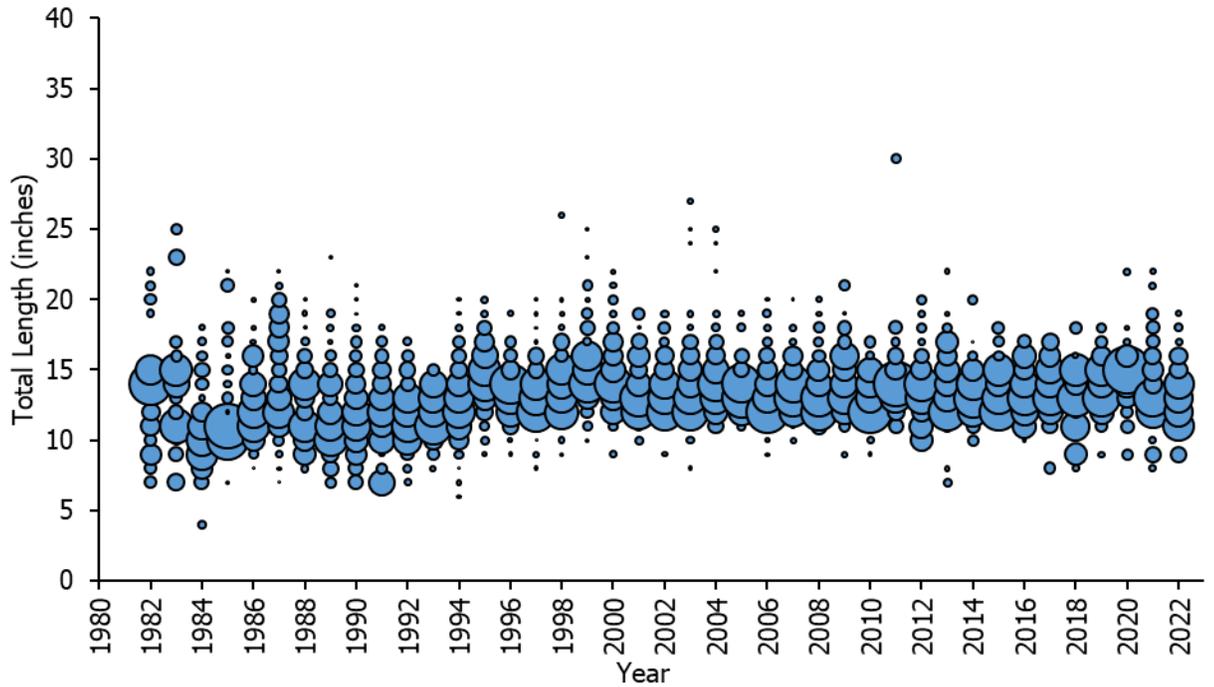


Figure 7. Recreational length frequency (fork length, inches) of weakfish harvested from 1982-2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

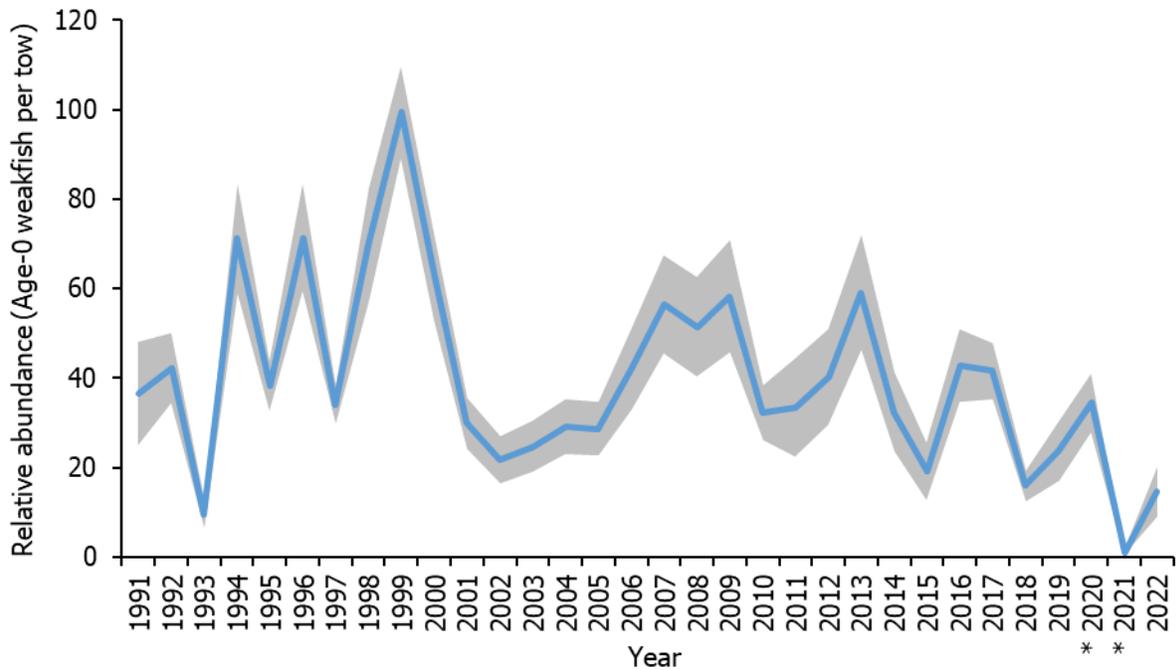


Figure 8. Relative abundance index (fish per tow) from the Pamlico Sound Survey (Program 195) in North Carolina of Age-0 weakfish collected during September with a total length less than 200 mm from 1990 through 2022. Error bars represent  $\pm$  one standard error (SE). \*Not all samples were completed in 2020 and 2021.

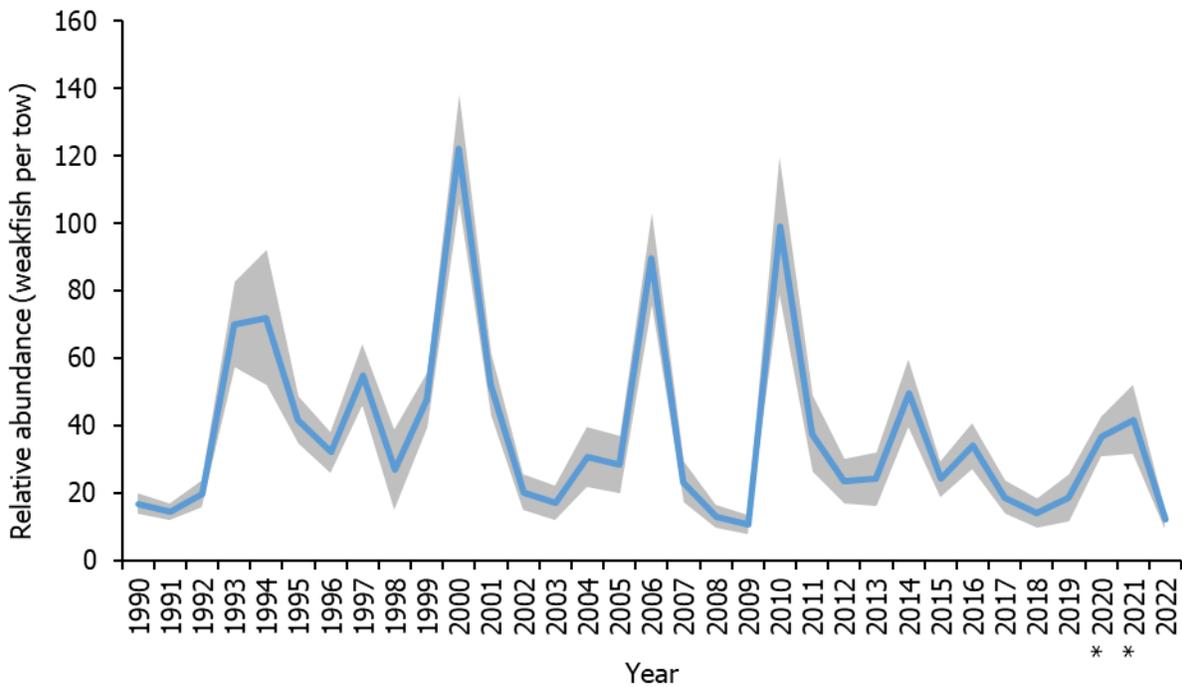


Figure 9. Relative abundance index (fish per tow) from the Pamlico Sound Survey (Program 195) in North Carolina of Age-1+ weakfish collected during June with a total length of 140 mm and greater from 1990 through 2022. Error bars represent  $\pm$  one standard error (SE). \*Not all samples were completed in 2020 and 2021.

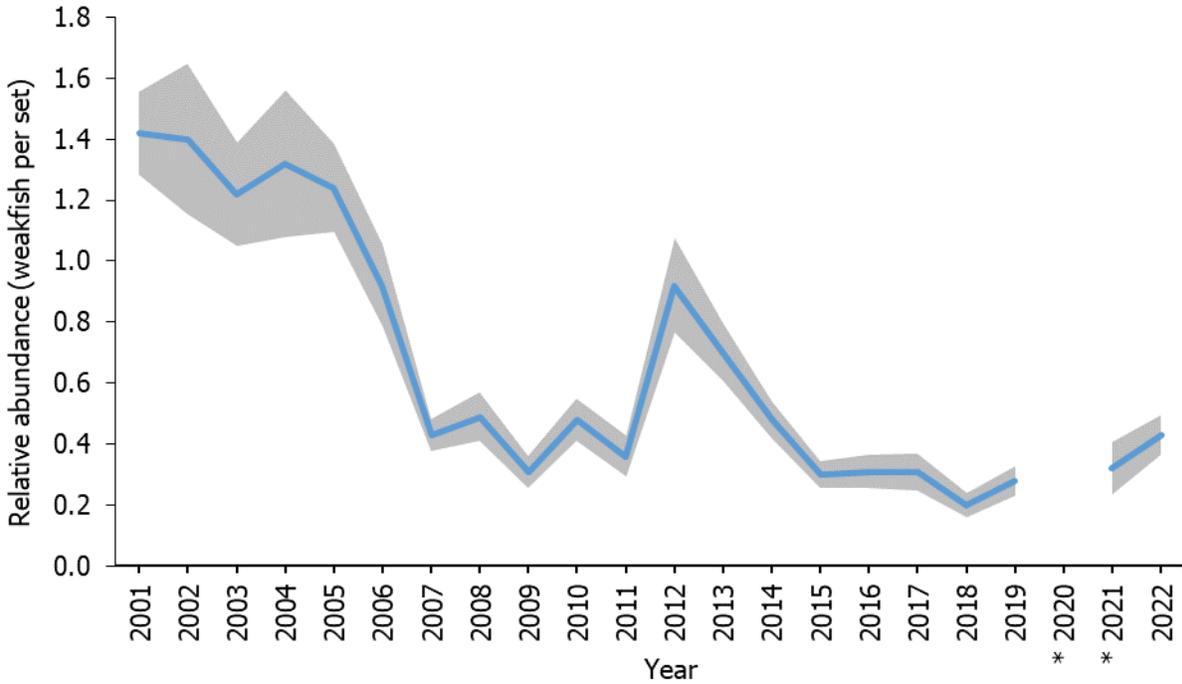


Figure 10. Relative abundance index (fish per station set) from the Pamlico Sound portion of the Independent Gill Net Survey (Program 915) in North Carolina, 2001 - 2022. Error bars represent  $\pm$  one standard error (SE). \*Sampling not conducted in 2020 and not all samples completed in 2021.

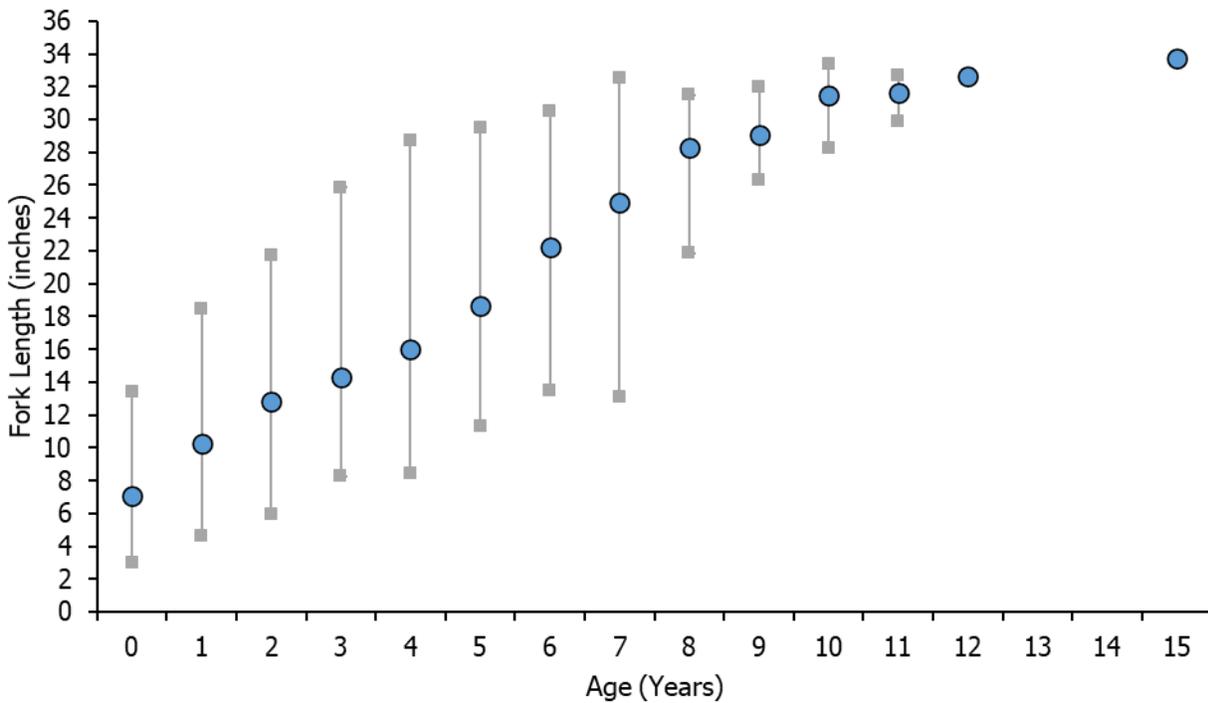


Figure 11. Weakfish length at age based on all age samples collected from 1995 to 2022. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age.

**FISHERY MANAGEMENT PLAN UPDATE  
BLACK SEA BASS NORTH OF CAPE HATTERAS  
AUGUST 2023**

**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	1996
	Amendment 10	1997
	Amendment 11	1998
	Amendment 12	1999
	Framework 1	2001
	Addendum IV	2001
	Addendum VI	2002
	Amendment 13	2003
	Framework 5	2004
	Addendum XII	2004
	Addendum XIII	2004
	Addendum XVI	2005
	Amendment 16	2007
	Framework 7	2007
	Addendum XIX	2007
	Addendum XX	2009
	Amendment 15	2011
	Addendum XXI	2011
	Addendum XXII	2012
	Amendment 19	2013
	Addendum XXIII	2013
	Addendum XXV	2014
	Amendment 17	2015
	Framework 8	2015
	Amendment 18	2015
	Addendum XXVII	2016
	Amendment 20	2017
	Framework 10	2017
	Addendum XXX	2018
	Framework 11	2018
	Framework 13	2018
	Addendum XXXI	2018
	Addendum XXXII	2018
	Framework 14	2019
	Framework 15	2020

Framework 16	2020
Addendum XXXIII	2021
Amendment 22	2022
Framework 17 & Addendum XXXIV	2022/2023

Comprehensive Review: 2023

Because of their presence in, and movement between, state waters (0-3 miles) and federal waters (3-200 miles), the Mid-Atlantic Fishery 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. Black sea bass went through preliminary FMP development from 1978-1993 by the MAFMC. In 1996 NMFS requested that black sea bass regulations be incorporated into another FMP to reduce the number of separate fisheries regulations. As a result, the black sea bass FMP was incorporated into the summer flounder FMP as Amendment 9.

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 permit; 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 ASMFC's Summer Flounder, Scup, and Black Sea Bass 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 ASMFC's Summer Flounder, Scup, and Black Sea Bass 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 year's 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 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 Council 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 13 modified the accountability measures required for overages not caused by directed landings (i.e., discards) in the summer flounder, scup, and black sea bass fisheries.

Addendum XXXI established conservation equivalency for black sea bass and transit provisions in federal waters around Block Island, Rhode Island for recreational and commercial fishermen which allows permitted fishermen to pass through federal waters legally.

Addendum XXXII established a specifications process instead of an addendum process to implement recreational management measures more quickly for summer flounder and black sea bass.

Framework 14 gives the Council the option to waive the federal recreational black sea bass measures in favor of state measures through conservation equivalency; implements a transit zone for commercial and recreational summer flounder, scup, and black sea bass fisheries in Block Island Sound; and allows for the use of a maximum size limit in the recreational summer flounder and black sea bass fisheries.

Framework 15 established a requirement for commercial vessels with federal permits for all species managed by the Mid-Atlantic and New England Councils to submit vessel trip reports electronically within 48 hours after entering port at the conclusion of a trip.

Framework 16 modified MAFMC's ABC control rule and risk policy. The revised risk policy is intended to reduce the probability of overfishing as stock size falls below the target biomass while allowing for increased risk and greater economic benefit under stock biomass conditions. This action also removed the typical/atypical species distinction currently included in the risk policy.

Addendum XXXIII modifies the allocation of the coastwide black sea bass commercial quota among the states, which were originally implemented in 2003 through Amendment 13 and extended indefinitely through Addendum XIX. The revised allocation addresses the significant change in the distribution of black sea bass that have occurred since the original allocations were implemented in 2003.

Amendment 22 revised the commercial and recreational sector allocations for all three species.

Framework 17/Addendum XXXIV Recreational Harvest Control Rule established a new process for setting recreational bag, size, and season limits (i.e., recreational measures) for summer flounder, scup, black sea bass, and bluefish. This action also modified the recreational accountability measures for these species.

Specific details for each amendment and addendum under development include:

Summer Flounder, Scup, and Black Sea Bass Commercial/Recreational Allocation Amendment was jointly approved in December 2021 and selected preferred alternatives for each species. In 2022 the amendment was sent for submission to NMFS. For black sea bass, this amendment allocates 45% of the acceptable biological catch (ABC) to the commercial annual catch limit and 55% to the recreational annual catch limit.

The Recreational Harvest Control Rule Framework/Addenda has been submitted to NOAA for review, approval, and implementation. The Addenda proposed different approaches for setting recreational measures. These differences have implications for how often measures would change and the magnitude of those changes. This Addenda will not implement any specific bag, size, or

season limits but will modify the specification process for setting specific measures. The Council and Policy Board approved a range of alternatives, the selected management option is referred to as the “Percent Change Approach”. This management option will be in place with an agreement to continue development of several other options for possible implementation by 2026. Under this selected approach, it will be determined whether recreational measures should be restricted, liberalized, or remain unchanged for the next two years. For further information on the Harvest Control Rule, refer to [asmfc.org](http://asmfc.org).

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. These plans were established under the Magnuson-Stevens Fishery Conservation and Management Act (federal council plans) and the Atlantic Coastal Fisheries Cooperative Management Act (ASMFC plans) with the goal, like the Fisheries Reform Act of 1997, to “ensure long-term viability” of these fisheries (NCDMF 2022).

### **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 for the Black Sea Bass FMP are to:

- Reduce fishing mortality in the black sea bass fisheries to assure that overfishing does not occur.
- Reduce fishing mortality on immature black sea bass to increase spawning stock biomass.
- Improve the yield from these fisheries.
- Promote compatible management regulations between state and federal jurisdictions.
- Promote uniform and effective enforcement of regulations.
- 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 above objectives (1-5) in the future.

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

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**

An operational assessment that incorporated new recreational harvest estimates was peer reviewed in 2021. The assessment found that the black sea bass stock status has not changed and was not overfished and overfishing was not occurring in 2019 relative to revised reference points.

### **Stock Assessment**

A black sea bass management track stock assessment was peer reviewed and accepted in June 2021. This assessment retained the model structure of the 2016 benchmark stock assessment and incorporated fishery data and fishery-independent survey data through 2019. Data from 2020 were not incorporated due to significant gaps in some data sets due to the COVID-19 pandemic and the time required to consider how to best address those gaps. Based on the assessment spawning stock biomass was estimated at two times the target level and fishing mortality was 15% below the threshold level. Comparisons between assessments indicated that the trends in spawning stock biomass, recruitment and fishing mortality have been consistent between the 2016 benchmark assessment and 2021 update. Stock assessment reports can be found on the black sea bass page on the ASMFC website for further information.

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

Commercial: 11-inch total length minimum size limit in Atlantic Ocean and internal coastal waters north of Cape Hatteras. Harvest periods 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 (DMF) proclamation].

Recreational: 13-inch total length minimum size limit and a 15-fish creel limit in Atlantic Ocean and internal coastal waters north of Cape Hatteras. The season for the recreational fishery was May 15 to December 11. Beginning in 2023 the minimum size will remain at 13-inches, 15-fish creel limit, and two harvest periods that are May 15 – September 30 and October 10 – December 31.

### **Commercial Fishery**

All black sea bass landings are reported through the North Carolina Trip Ticket Program. In 2022 the majority of black sea bass landings from north of Cape Hatteras were from fish pots and flynets. Flounder trawls usually land the majority of black sea bass but caught much smaller numbers in 2022 (Figure 1). Landings generally declined from 1994 through 2012 but have increased notably since 2013, with the exception of 2022 being another low year (Table 1; Figure 2). The low landings in 2012 and 2013 were partly due to shoaling at Oregon Inlet making passage by large vessels (such as trawlers) unsafe and the consequent transfer of large portions of North Carolina’s black sea bass quota allocation to Virginia and other states. During 2014 through 2022, more ocean trawl vessels returned to North Carolina (mainly Beaufort and Washington areas) to land catches rather than transferring quota to Virginia and other states.

### **Recreational Fishery**

Recreational estimates across all years have been updated and are now based on the new National Ocean and Atmospheric Administration (NOAA) Marine Recreational Information Program (MRIP) Fishing Effort Survey-based calibrated estimates. For more information on MRIP, see <https://www.fisheries.noaa.gov/topic/recreational-fishing-data>. All black sea bass harvest is reported through the NOAA Marine Recreational Information Program. Recreational harvest of black sea bass from north of Cape Hatteras was variable from 1994 through 2019, above average harvest occurred in 2020 and 2022 (Table 1; Figure 2).

## **MONITORING PROGRAM DATA**

### **Fishery-Dependent Monitoring**

Two DMF sampling programs collect biological data on commercial and recreational fisheries that catch black sea bass north of Cape Hatteras. Program 433 (Ocean Trawl Fishery) is the primary program that collects harvest length data. Additionally, Program 438 (Offshore Live Bottom Fishery) collects some harvest length data but is not as active as Program 433. Other commercial sampling programs focusing on fisheries that do not target black sea bass rarely collect biological data. DMF sampling of the recreational fishery occurs through the NOAA Marine Recreational Information Program which collects harvest and length data.

There were no clear trends in commercial length data from 1994 through 2022. Annual mean lengths were fairly consistent for the time-series. The number of measurements collected totaled 1,529 in 2022 (Table 2). Otoliths have been collected from commercial fisheries since 2013 and

are currently in the process of being aged, although these data are not currently used in the coastwide stock assessments.

Length data in the recreational fishery was variable and sample size was low from 1994 through 2022. Mean lengths have gradually increased over the time-series but tend to be variable given low sample size (Table 3). Age data were not collected for black sea bass north of Cape Hatteras from recreational fisheries.

### **Fishery-Independent Monitoring**

DMF independent sampling programs rarely encounter black sea bass north of Cape Hatteras and the few fish that are encountered are mostly from Program 120 (Estuarine Trawl Survey) and from Program 195 (Pamlico Sound Survey), which collect samples of black sea bass juveniles from inshore estuarine waters. However, it is not clear that samples collected inshore north of Cape Hatteras are from the northern or southern stock of black sea bass; this combined with the small sample numbers means that these data cannot be used in an abundance index. DMF currently does not have independent sampling programs in Atlantic Ocean waters north of Cape Hatteras.

### **RESEARCH NEEDS**

- Expand on previous genetic studies with smaller spatial increments in sampling. — Progress unknown at this time
- Consider the impact of climate change on black sea bass, particularly in the Gulf of Maine. — Progress unknown at this time
- Evaluate population sex change and sex ratio, particularly comparing dynamics among communities. — Progress unknown at this time
- Study black sea bass catchability in a variety of survey gear types. — Progress unknown at this time
- Investigate and document social and spawning dynamics of black sea bass. — Progress unknown at this time
- Increase work to understand habitat use in sea bass and seasonal changes. — Progress unknown at this time
- Evaluate use of samples collected by industry study fleets. — Progress unknown at this time
- The panel recommended multiple age-structured models be evaluated for use in future models. Examples include a simple separable model with smoothing on F among years, a more complex, spatially structured model with 6-month time step within independent stock areas in spring and mixing in winter with natal homing, and tag return data in an age-structured assessment model. — Some progress has been made
- Continue and expand the tagging program to provide increased age information and increased resolution on mixing rates among putative populations. — Some progress has been made
- Continue and expand genetic studies to evaluate the potential of population structure north of Cape Hatteras. — Some progress has been made

- 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. — Research is ongoing
- 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. — Some progress has been made

## 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 2021 operational stock assessment are being used to guide management. 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. Beginning in 2023, revised allocations will be implemented and transitioning to catch-based allocations with 45 percent being commercial and 55 percent being recreational. 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 and regional basis in state waters and coastwide basis in federal waters. The commercial quota is divided into state-by-state quotas. 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.

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## TABLES

Table 1. Recreational harvest (number of fish landed and weight in pounds) and releases (number of fish) and commercial harvest (weight in pounds) of black sea bass north of Cape Hatteras from North Carolina for the period 1994 – 2022.

Year	Recreational			Commercial	Total Weight (lb)
	Numbers Landed	Numbers Released	Weight Landed (lb)	Weight Landed (lb)	
1994	13,464	127,309	14,746	244,767	259,513
1995	52,181	279,414	25,298	142,508	167,806
1996	17,373	53,235	14,948	287,347	302,295
1997	17,249	102,069	22,482	247,603	270,085
1998	19,229	315,269	25,353	218,655	244,008
1999	44,785	386,011	48,213	121,199	169,412
2000	11,875	179,458	13,828	152,668	166,496
2001	5,706	201,487	8,872	167,171	176,043
2002	11,638	267,317	18,862	159,507	178,369
2003	27,468	51,566	20,195	373,807	394,002
2004	2,521	124,332	2,531	374,880	377,411
2005	1,710	220,159	5,203	368,400	373,603
2006	23,781	388,422	26,459	334,080	360,539
2007	18,147	329,655	55,565	195,460	251,025
2008	12,636	407,420	14,948	208,726	223,674
2009	3,984	543,285	8,283	176,748	185,031
2010	17,183	211,057	24,471	107,996	132,467
2011	73,207	266,289	111,538	98,505	210,043
2012	3,625	413,879	8,231	61,187	69,418
2013	16,119	136,016	21,617	88,242	109,859
2014	768	111,327	1,269	212,488	213,757
2015	2,955	149,347	6,224	241,538	247,762
2016	1,188	117,664	1,591	225,405	226,996
2017	23,720	152,491	33,421	388,865	422,286
2018	6,762	96,604	9,494	315,983	325,477
2019	6,268	159,129	11,638	279,008	290,646
2020	44,475	104,177	74,149	218,756	292,905
2021	4,171	252,992	6,564	200,565	207,129
2022	32,117	1,158,816	57,252	108,991	166,243
Mean	17,804	251,938	23,905	217,967	241,872

Table 2. Black sea bass (north of Cape Hatteras) length (total length, inches) data from commercial fish house ocean trawl samples in North Carolina, 1994-2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1994	11	8	22	3,018
1995	12	8	20	2,070
1996	13	8	23	1,213
1997	12	8	19	727
1998	13	8	24	593
1999	14	10	21	27
2000	14	8	28	1,414
2001	13	9	22	826
2002	14	8	23	2,169
2003	15	9	24	7,416
2004	15	8	24	6,810
2005	16	9	26	6,899
2006	15	9	24	5,323
2007	15	9	26	3,213
2008	15	9	26	6,378
2009	15	9	26	3,936
2010	15	9	25	5,254
2011	15	9	25	2,946
2012	15	11	21	725
2013	15	9	24	1,452
2014	15	8	24	3,740
2015	15	9	24	7,192
2016	16	9	28	6,526
2017	16	10	24	5,372
2018	16	10	29	6,247
2019	15	9	24	4,124
2020	15	9	23	3,244
2021	16	10	24	3,542
2022	15	11	23	1,529

Table 3. Black sea bass (north of Cape Hatteras) length, (total length, inches) data from NOAA Marine Recreational Information Program recreational samples in North Carolina, 1994-2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1994	11	5	28	74
1995	9	6	21	80
1996	12	7	20	80
1997	13	8	20	61
1998	13	7	19	75
1999	13	8	19	126
2000	13	9	23	59
2001	14	10	17	34
2002	14	11	23	128
2003	11	9	21	110
2004	14	11	19	7
2005	20	11	24	42
2006	13	8	23	64
2007	18	13	22	26
2008	14	11	20	48
2009	15	12	24	48
2010	14	12	21	29
2011	14	11	22	36
2012	17	13	20	14
2013	14	9	20	14
2014	14	13	18	4
2015	17	13	17	5
2016	14	12	21	16
2017	13	12	17	11
2018	14	13	21	23
2019	17	12	21	32
2020	15	9	21	52
2021	16	13	20	22
2022	15	12	20	35

**FIGURES**

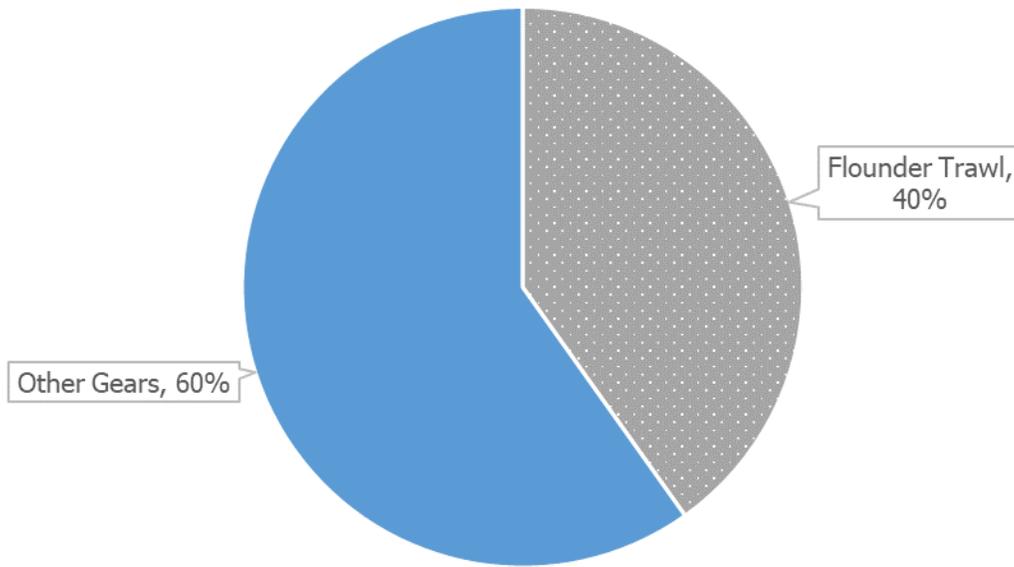


Figure 1. Commercial harvest of black sea bass (north of Cape Hatteras) in North Carolina by gear type in 2022. Note: data for Other Gears are confidential data.

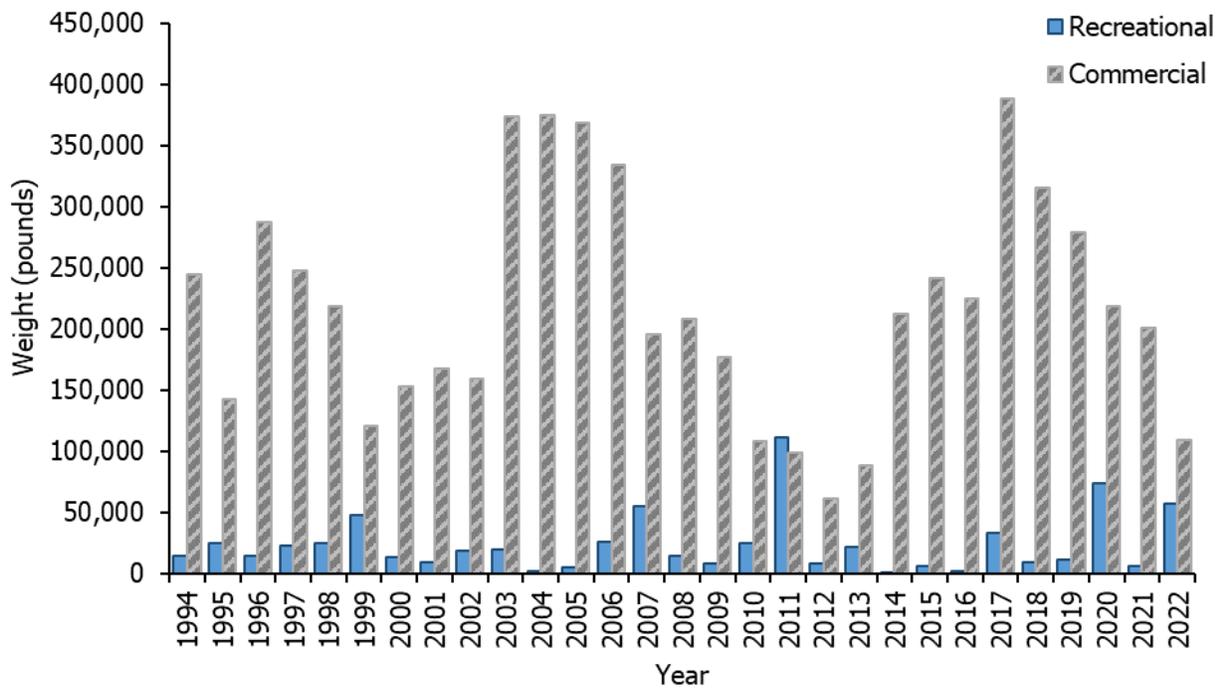


Figure 2. Annual commercial and recreational landings in pounds for black sea bass (north of Cape Hatteras) in North Carolina from 1994-2022.

**FISHERY MANAGEMENT PLAN UPDATE  
COBIA  
AUGUST 2023**

**STATUS OF THE FISHERY MANAGEMENT PLAN**

**Fishery Management Plan History**

FMP Documentation:	SAFMC FMP	February 1983
	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
	Amendment 31	March 2019
	ASMFC FMP	November 2017
	Amendment 1	August 2019
	Addendum 1	October 2020
Comprehensive Review:	2025	

The Gulf of Mexico Fishery Management Council (GMFMC) and the South Atlantic Fishery Management Council (SAFMC) approved and implemented the Fishery Management Plan (FMP), Final Environmental Impact Statement, Regulatory Impact Review and Final Regulations for the Coastal Migratory Pelagic (CMP) 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 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 was established for the Fishery Conservation Zone (FSC), which is analogous to the Exclusive Economic Zone (EEZ) of today, locally referred to as ‘federal waters’. The FMP was 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 (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 prohibited drift gill nets as a gear that could be used to harvest coastal pelagic species (GMFMC/SAFMC 1987b).

Amendment 5 addressed the issue of average annual catches from 1981-1986 exceeding the established MSY level and defined the overfishing limit for the cobia stock, as well as set the procedure for rebuilding if the stock was found to be overfished (GMFMC/SAFMC 1990). Cobia were added to the annual stock assessment procedures for the councils, and a bag and possession limit was established for both commercial and recreational sectors in an effort to control harvest. Amendment 6 (GMFMC/SAFMC 1992) removed the total length minimum size limit, specifying that the only minimum size for cobia was fork length (FL) and increased Maximum Sustainable Yield (MSY) based on results stock assessment analyses done for, and at the recommendation of, the Mackerel Stock Assessment Panel (Isely 1992; MSAP 1992).

In 1998, Amendment 8 extended the management area for cobia through the Mid-Atlantic Fishery Management Council's (MAFMC) jurisdiction which also extended the bag limit and 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% 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% of a static SPR. It also redefined the overfishing level as a fishing mortality rate ( $F$ ) in excess of the  $F$  at 30% of a static SPR and established a threshold level for all the species in the coastal migratory pelagic unit as 10% of the static SPR.

Amendment 18 separated cobia into two stocks at the jurisdiction boundary between the GSFMC and the SAFMC (GMFMC/SAFMC 2011). 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% recreational and 8% commercial sector allocation. Amendment 20B (GMFMC/SAFMC 2014) modified the stock boundary based on the results of the 2013 stock assessment (SEDAR 2013) to the Florida-Georgia state line. A new ACL was set at 690,000 pounds for the 2015 fishing season and 670,000 pounds for every year after, with sector allocations shifting appropriately. Accountability Measures (AM) required under the 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 was met or projected to be met rather, measures were 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 was 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 required an in-season closure if the commercial ACL was met or projected to be met. If the stock was 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 increased the recreational minimum size limit of cobia to 36 inches FL, reduced the bag limit to one fish per person per day and implemented a vessel limit. The recreational AM were modified to allow for a reduction in vessel limit before a season reduction was implemented. The framework amendment also maintained the existing commercial minimum size limit and

established a two fish per person per day or six fish per vessel per day (whichever is more restrictive) commercial trip limit.

Amendment 31 (SAFMC 2018) to the CMP FMP was approved by the council in June of 2018 and the final rule went into effect March of 2019. The amendment removed the Atlantic migratory group cobia (Georgia through New York) from federal management under the Magnuson-Stevens Act and transferred sole management of Atlantic cobia to the Atlantic States Marine Fisheries Commission (ASMFC). The amendment also implemented comparable regulations to the CMP FMP in the federal waters under the Atlantic Coastal Act in order to ensure that Atlantic cobia continues to be managed in federal waters and that there was no lapse in the management of the stock.

The ASMFC approved the Interstate FMP for Atlantic Migratory Group Cobia in November of 2017 (ASFMC 2017). The interstate plan complements 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 (SAFMC 2016). 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 accommodate the removal of Atlantic cobia from federal management, ASMFC approved Amendment 1 in August 2019. Amendment 1 changes several portions of the Commission's FMP that were previously dependent on the CMP FMP and institutes a long-term strategy for managing in the absence of a federal plan (ASMFC 2019). Several of these changes establish processes for the Commission to carry out management responsibilities previously performed by the South Atlantic Council, including setting of harvest quotas and sector allocations, and defining stock status criteria. Amendment 1 recommends to NOAA Fisheries that fishing in federal waters be regulated according to the state of landing. Amendment 1 changes the units used to measure and evaluate the recreational fishery from pounds to numbers of fish. Additionally, Amendment 1 transitions responsibilities of monitoring and closing commercial harvest to the Commission and establishes *de minimis* criteria for the commercial fishery (ASMFC 2019).

When SEDAR 58 was accepted for management, the ASMFC South Atlantic Board approved an increase in the annual total harvest based on the assessment results and harvest projections (SEDAR 2020). Addendum 1 to Amendment 1 was initiated after approval of the assessment. The Board approved the Addendum in October 2020. Addendum 1 modifies the sector allocations from a 92% recreational:8% commercial split to 96% recreational:4% commercial, respectively (ASMFC 2020). The change was primarily based on new recreational catch estimates that resulted from changes in survey methodology by the Marine Recreational Information Program; estimates were, on average, two times higher than previously estimated. The new commercial allocation allows the fishery to operate at the current level with some room for landings to increase as the stock range expands further north. Additionally, Addendum 1 modifies the calculation of the commercial trigger to determine when an in-season coastwide commercial closure occurs and

modified *de minimis* measures including an adjustment to the commercial allocation set aside and the recreational regulations (ASMFC 2020).

To ensure compliance with interstate requirements, North Carolina also manages this species under the North Carolina Interjurisdictional Fisheries Management Plan (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 (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 2022).

### **Management Unit**

The management unit for Atlantic cobia is defined as all waters north of the Florida-Georgia line through New York from coastal estuarine waters eastward to the offshore boundaries of the EEZ (ASMFC 2019; Figure 1).

### **Goal and Objectives**

The goal of Amendment 1 to the Interstate FMP (ASMFC 2019) is to provide for an efficient management structure that implements coastwide management measures, providing equitable and sustainable access to the Atlantic cobia resource throughout the management unit in a timely manner.

The following objectives are intended to support the goal of Amendment 1.

- Provide a flexible management system to address future changes in resource abundance, scientific information, and fishing patterns among user groups or area.
- Implement management measures that allow stable, sustainable harvest of Atlantic cobia in both state and federal waters.
- Establish a harvest specification procedure that will allow flexibility to respond quickly to stock assessment results or problems in the fishery, while also providing opportunities for public input on potential significant changes to management.
- Promote continued, cooperative collection of biological, economic, and social data required to effectively monitor and assess the status of the Atlantic cobia resource and evaluate management efforts.
- Manage the Atlantic cobia fishery to protect both young individuals and established breeding stock.
- Develop research priorities that will further refine the Atlantic cobia management program to maximize the biological, social, and economic benefits derived from the Atlantic cobia population.

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

Cobia is the sole member of the family Rachycentridae. It is a fast growing and moderately long-lived species with a maximum reported age of 16 years with a worldwide distribution in tropical, subtropical, and warm-temperature waters (SEDAR 2018). In the western Atlantic, cobia occur from Nova Scotia, Canada south to Argentina including the Caribbean Sea. Off the coast of the United States, they are most abundant in nearshore coastal waters from Virginia south through the Gulf of Mexico. They migrate in the spring and fall from inshore and offshore habitats, as well as up and down the Atlantic coast (Perkinson et al. 2019; Crear et al. 2020; Gallagher 2020). Recent tagging and genetics studies have shown there is the potential for a resident sub-stock off Virginia and northern North Carolina (Darden et al. 2014; Perkinson et al. 2019; Gallagher 2020)

Spawning along the Atlantic coast occurs from April through July, peaking during May and June around inlets and in high salinity estuarine waters (Brown-Peterson et al. 2001). In North Carolina, spawning peaks in June, coinciding with water temperatures of 20 – 25°C (Smith 1995; Lefebvre and Denson 2012; Perkinson et al. 2019). 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 FL 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 FL (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 structures such as channel markers, sea walls and jetties, or floating objects like larger marine animals such as leatherback sea turtles and rays.

### **Stock Status**

Results of the 2020 benchmark assessment indicate that cobia are not overfished, and overfishing is not occurring (SEDAR 2020; Figures 2 and 3). An operational assessment updating the benchmark assessment is scheduled for 2025.

### **Stock Assessment**

Cobia were assessed during South East Data, Assessment, and Review (SEDAR) 58 using data through 2017 (SEDAR 2020); this was a benchmark assessment. SEDAR 58 began with a stock identification workshop in April 2018. The workshop maintained the Florida-Georgia state line as the stock boundary since this border is within a transition zone that occurs from the southern boundary of Brevard County, FL to Brunswick, GA (SEDAR 2018).

SEDAR 58 assessed the Atlantic stock of cobia using data from 1986 – 2017 (SEDAR 2020). This assessment included several modifications from the previous assessment (SEDAR 2013). Though more years of data were added to the end of the assessment, overall, the time series was shorted such that the model was started in the year when the best data became available.

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 the headboat logbook index. 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 ( $SSB_{2017}/SSB_{40\%} = 1.41$ ; Figure 2) and overfishing was not occurring ( $F_{2015-2017}/F_{40\%} = 0.29$ ; 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 the sole index used in the model was from a fishery-dependent source. Because the fishery operates in such a way that a trip consists of very few fish, the reliability of fishery-dependent indices as a true indicator of the stock should be approached with caution since they may not track actual abundance well and issues can be exacerbated by management measures. For SEDAR 58, the fishery-dependent index was not extended past 2015 due to seasonal closures. The spawner-recruit relationship was also not well defined and annual recruitment was based on a fixed value. MSY-based management quantities rely heavily on this value, so results should be considered with this uncertainty in mind.

Overall, the model estimated little trend in SSB, though the terminal year was the lowest of the time series (Figure 2). The last strong year class in the model was predicted to have occurred around 2010. Predicted recruitment in the last four years (2014-2017) was below the time series average. If recruitment remains low, the decline in the stock as seen in the last several years of the assessment will continue.

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

Under the Interstate Plan, North Carolina must implement seasons and/or vessel limits that constrain harvest to the RHL. State landings will be evaluated against the RHL by averaging landings over a three-year period. The acceptance of SEDAR 58 in 2020 for management meant an increase in the amount of fish available for harvest, and the shift of harvest allocation to the recreational sector through Addendum 1. North Carolina's RHL increased to 29,302 fish with a shared coastwide commercial quota of 73,116 pounds.

For the 2020 – 2022 fishing years, North Carolina implemented a 36-inch FL minimum 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 were set to two fish per vessel from May 1 to 31 and one fish per vessel from June 1 to December 31. Due to the increase in the RHL through Addendum 1, North Carolina re-submitted the cobia implementation plan to ASMFC, and was approved to extend the two fish vessel limit for private vessels through June 30 each year starting in 2021. Charter and for-hire vessels may harvest up to four fish per vessel from May 1 to December 31. The commercial fishery is managed under a 36-inch FL minimum size limit and two fish per person per day possession limit, not to exceed six fish per vessel.

North Carolina was not the only state to implement new management measures in 2021. Based on a recommendation from the Technical Committee to the Coastal Pelagics Board at the spring 2022 meeting, the Board changed the current specification period for harvest quotas to include fishing years 2021 – 2023 to better align with management. New specifications for the 2024 – 2026 fishing years will be set by the ASMFC Coastal Pelagics Board later in 2023.

## **Commercial Fishery**

Commercial landings of cobia in North Carolina are available from 1950 to the present. However, monthly landings were not available until 1972. 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. Since 1986, landings have ranged from 14,898 pounds (1989) to 52,684 pounds (2015), averaging 34,155 pounds over the last 10 years (Table 1; Figure 4A). In 2022, 32,686 pounds were landed commercially in North Carolina.

The primary fisheries associated with cobia in North Carolina are the snapper-grouper, coastal pelagic troll, and the 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 primarily landed out of the haul seine fishery. Most landings that occurred during the 1980s came from the pelagic troll and hook-and-line fisheries with modest landings from the haul seine and anchored gill net fisheries. From 1994 – 2020, most landings have occurred from the gill net, pelagic troll, and hook-and-line fisheries with gill nets being the top gear during most of those years. In 2022, gill nets accounted for 70% of the landings, while 25% of the landings were from the hook-and-line and pelagic troll fisheries combined (Table 2; Figure 5). From 2017-2019 gill-net landings decreased as the cobia season closed in early September. As the result of an increase in quota in 2020 due to SEDAR 58, gill-net landings have increased the last couple of years as fishermen have been able to land cobia incidentally caught during the fall king mackerel fishery. From 2012- 2017, landings in the pound net fishery increased, accounting for up to 12% of the total landings dependent on the year; however, since 2017, pound nets landings have contributed less than 5% to the overall landings (Table 2).

## **Recreational Fishery**

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 estimates are available from 1981 to the present. Recreational estimates across all years have been updated and are now based on the MRIP new Fishing Effort Survey-based calibrated estimates. For more information on recreational estimates and the survey see: <https://www.fisheries.noaa.gov/topic/recreational-fishing-data>.

Cobia is enthusiastically pursued by recreational anglers in North Carolina, and recreational harvest can be up to 98% of the total harvest. Over the last 10 years, recreational harvest has averaged 96% of the total harvest. Recreational harvest of cobia in North Carolina has ranged from a low of 81,833 pounds (1987) to a high of 1,925,762 pounds (2015) with average landings of 374,499 pounds over the 37-year time series. Recently, landings have ranged from 102,077 pounds (2012) to 1,925,762 pounds (2015), averaging 727,451 pounds over the last 10-year period (Table 1; Figure 4B). In 2022, North Carolina landed 306,411 pounds of cobia in the recreational fishery. 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. Cobia are landed mostly in the spring and summer months corresponding with their spring spawning migration (Smith 1995; Brown-Peterson et al. 2001). Peak landings occur during the latter part of May into June and quickly diminish thereafter. However, recreational landings of cobia can occur through October.

The North Carolina Division of Marine Fisheries (DMF) offers award citations for exceptional catches of cobia. Harvested cobia that weigh greater than 40 pounds, and cobia captured and released that measure greater than 33 inches FL (prior to May 1, 2021) or 36 inches FL (currently), are eligible for an award citation. Since 1991, just over 10,600 citations have been awarded for cobia. On average, 10% of citations have been from released fish; in 2022, 11% were from releases. From 1991 through 2017 the number of award citations for cobia was variable but steadily increased. The last few years have seen fewer citations (Figure 6).

## **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, the majority of which come DMF Program 438 (Offshore Live Bottom Fishery), as well as Program 431 (Sciaenid Pound Nets) and Program 434 (Ocean Gill Net Fishery). Length-frequency information for the recreational cobia fishery is collected through the DMF Carcass Collection Program and MRIP. Twelve cobia were measured from the commercial fishery in 2022 with an average FL of 37 inches (Table 3). Mean FL has ranged from 37 to 43 inches since 1986. Cobia landed in the commercial fishery have ranged from 15 to 61 inches FL (Table 3; Figure 7).

Nine cobia were measured by MRIP in 2022 with an average FL of 42 inches (Table 4). Mean size has ranged from 27 to 48 inches FL over the time series. Cobia harvested in the recreational fishery have ranged from 9 to 68 inches FL (Table 4; Figure 8). Additionally, a total of 26 cobia were measured through the carcass collection program in 2022, with an average FL of 41 inches. Donated carcass lengths tend to be similar to what is measured by MRIP (Table 4). The number of commercial and recreational fish sampled is low and is most likely affected by low possession limits and seasonal nature of the fishery. Size trends in commercially landed fish for most years appear to correspond with sizes observed in the recreational fishery though at lower frequencies (Tables 3 and 4). However, the length distribution of the recreational fishery was larger than that of the commercial fishery in 2022 (Figure 9). This is possibly due to the timing of the fisheries, and differences in gear selectivity between these sectors; differences may also be impacted by the low frequency of sample sizes for both sectors in 2022.

In order to describe the age structure of harvest and indices, cobia age structures are collected from various fishery-independent (scientific surveys) and dependent (fisheries) sources throughout the year. Through 2018, aging structures are provided to the NOAA Beaufort Age Lab for analysis. In 2017, 50 cobia were collected ranging in age from 0 to 13 years (Table 5). In 2022, 45 cobia were collected for aging, but have not yet been aged. The modal age of cobia collected each year is hard to determine due to low sample size. The age-length relationship is less predictable beyond age-3, as there is overlap in age for a given length (Figure 10).

### **Fishery-Independent Monitoring**

Currently, the DMF does not have many fishery-independent sampling programs that target or catch cobia in great numbers.

In 2001, the DMF initiated a fisheries-independent gill net survey in Pamlico Sound (Program 915). The objective of this project is to provide annual, independent, relative-abundance indices for key estuarine species in the nearshore 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 half-inch increments). A total of 156 cobia have been captured in the Pamlico Sound Independent Gill Net Survey from 2001 – 2022. Cobia ranged from 6 to 38 inches FL and had a mean size of 19 inches FL. Due to the low number of positive trips (ranging from <1% to 5% of all sets), this survey cannot be used to create an index.

Additionally, cobia have been caught by the independent gill net survey sampling south of Pamlico Sound. The ‘Rivers’ portion of the survey (Neuse, Pamlico, Tar, and Pungo rivers) was initiated in 2003, the ‘Southern’ portion (Cape Fear and New rivers) in 2008, and the ‘Central’ portion (White Oak River through Back Sound) in 2018. Ninety cobia have been caught in this sampling, ranging in size from 8 to 25 inches FL, with a mean size of 15 inches FL.

While this data cannot be used to create an index of abundance, this sampling program is one of the few programs on the Atlantic coast that catches smaller cobia, providing important life history information that may not otherwise be obtained.

### **Tagging Program**

Cobia were added to the North Carolina multi-species tagging program in May of 2017. Cobia have been tagged each year since using both volunteer anglers and DMF staff throughout the coastal waters of the state along with some tags released in Chesapeake Bay. All cobia have been tagged with red high reward tags (\$100 reward) to maximize returns. Tagging of cobia will allow for information to be gathered on migration patterns and exploitation rates. Tagging of cobia has occurred along the coast ranging from Wilmington to the Chesapeake Bay. The total number tagged from 2017 to 2022 is 547 cobia and has resulted in 97 recaptures (Table 6; Figures 11-12). The time series average was 406 days at large with an average distance travelled of 123 miles (Table 6). Most recaptures occur within the state of NC and VA as cobia tend to migrate north in the spring along the NC coast with movement into the Chesapeake Bay common during the summer months. The maximum distance travelled was 696 miles for a cobia tagged north of the Chesapeake Bay bridge in August of 2019 and recaptured 564 days later in February of 2021 off

Fort Pierce, Florida (Figure 12). The maximum days between release and recapture was 1,558 days or just over 4 years (Table 6).

## RESEARCH NEEDS

Current research needs for cobia can be found in the most recent SEDAR 58 stock assessment report (SEDAR 2020) and Amendment 1 to the Interstate FMP (ASMFC 2019). Below is a list of state prioritized research needs based off the recommendations from SEDAR 58, Amendment 1 to the Interstate Plan, and input from DMF lead staff.

- Institute fisheries 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.
- Obtain more precise and timely estimates of harvest from the Atlantic cobia recreational fishery.
- Investigate release mortality and fishing mortality within the commercial and recreational fisheries.
- Increase reporting of recreational harvest and better characterize the recreational and for-hire fisheries.

## MANAGEMENT STRATEGY

As of March 2019, cobia is managed solely under the ASMFC Interstate Plan requirements. The interstate plan, including Amendment 1 and Addendum 1 to the FMP, aim to maintain SSB above a threshold which allows for surplus recruitment to the stock.

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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; Atlantic Coastal Cooperative Statistic Program and N.C. Trip Ticket Program) of cobia from North Carolina, 1986–2022. All weights are in pounds.

Year	Recreational			Commercial	Total Weight (lb)
	Number Landed	Number Released	Weight Landed (lb)	Weight Landed (lb)	
1986	17,956	9,112	533,982	18,303	552,285
1987	6,959	592	81,833	32,672	114,505
1988	5,716	3,257	103,975	15,690	119,665
1989	9,872	2,262	208,259	14,898	223,157
1990	10,054	6,089	188,539	21,938	210,477
1991	11,524	22,522	266,633	23,217	289,850
1992	10,711	9,777	317,628	18,534	336,162
1993	6,346	2,778	168,142	20,431	188,573
1994	6,908	4,543	169,168	30,586	199,754
1995	9,530	4,817	302,745	35,134	337,879
1996	4,744	2,000	102,899	33,404	136,303
1997	4,115	13,723	129,299	42,063	171,362
1998	3,132	9,859	117,754	22,197	139,951
1999	2,399	18,498	101,465	15,463	116,928
2000	2,473	4,734	91,143	28,754	119,897
2001	3,548	18,500	121,751	24,718	146,469
2002	7,196	14,036	319,178	21,058	340,236
2003	6,948	21,722	223,508	21,313	244,821
2004	12,522	11,079	420,684	20,162	440,846
2005	18,491	19,083	401,557	17,886	419,443
2006	5,154	11,425	196,330	20,270	216,600
2007	6,262	12,695	218,447	19,005	237,452
2008	3,972	24,028	167,463	22,047	189,510
2009	12,823	55,374	320,075	31,898	351,973
2010	24,030	48,590	808,227	43,715	851,942
2011	10,711	47,151	399,192	19,924	419,116
2012	3,805	66,567	102,077	31,972	134,049
2013	37,617	35,398	980,541	35,456	1,015,997
2014	24,601	32,184	645,427	41,798	687,225
2015	47,110	44,254	1,925,762	52,684	1,978,446
2016	26,421	39,237	838,363	48,252	886,615
2017	25,025	125,251	872,861	20,842	893,703
2018	25,331	68,219	685,962	20,629	706,591
2019	10,090	38,285	254,963	21,553	276,516
2020*	15,067	51,158	407,883	38,344	446,227
2021	10,970	40,136	356,340	29,301	385,641
2022	12,330	46,777	306,411	32,686	339,097
Mean	12,499	26,641	374,499	27,265	401,764

\*2020 recreational data contains imputed data as a result of impacts from COVID on sampling during this year.

Table 2. Commercial harvest (weight in pounds) by gear, 2013–2022. (Source: North Carolina Trip Ticket Program)

Year	Gear					Total
	Gill Nets	Hook & Line	Trolling	Pound Nets	Other*	
2013	11,744	15,530	4,453	2,506	1,223	35,456
2014	21,288	9,670	6,163	3,538	1,140	41,798
2015	32,904	10,624	3,560	4,541	1,055	52,684
2016	32,809	9,041	2,314	3,434	656	48,252
2017	11,768	4,765	1,056	2,541	712	20,842
2018	8,965	7,040	2,552	1,636	436	20,629
2019	9,417	7,752	3,221	473	690	21,553
2020	29,202	3,175	3,780	1,294	894	38,344
2021	21,451	4,146	2,078	1,060	567	29,301
2022	23,028	4,267	3,909	941	541	32,686

\*Other can include beach seines, trawls, crab and fish pots, flynets, fyke nets, spears, longlines, and haul seines.

Table 3. Mean, minimum, and maximum lengths (fork length, inches) of cobia sampled from the commercial fisheries (DMF fish house sampling programs) from North Carolina, 1986–2022.

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Total Number Measured
1986	38	24	52	21
1987	39	28	50	42
1988	40	21	57	52
1989	38	24	48	28
1990	38	15	53	108
1991	39	31	46	19
1992	39	32	47	19
1993	37	32	46	10
1994	38	31	45	4
1995	40	33	48	14
1996	35	17	42	5
1997	38	33	43	4
1998				0
1999	37	25	45	8
2000	41	33	61	7
2001	37	30	42	8
2002	38	33	41	5
2003	40	30	46	13
2004	38	26	49	24
2005	40	31	54	18
2006	39	32	49	23
2007	40	31	52	24
2008	39	18	57	29
2009	39	30	44	15
2010	43	35	52	19
2011	38	34	46	13
2012	38	29	50	34
2013	38	33	46	16
2014	36	30	53	32
2015	39	32	48	34
2016	39	33	51	13
2017	42	36	46	9
2018	40	33	48	11
2019	39	34	49	12
2020	39	33	47	14
2021	39	34	47	10
2022	37	32	42	12

Table 4. Mean, minimum, and maximum lengths (fork length, inches) of cobia sampled from the recreational fisheries (MRIP) and the DMF Carcass Collection Program from North Carolina, 1986–2022. It should be noted that the DMF Carcass Collection Program started in 2016.

Year	MRIP				NCDMF Carcass Collection			
	Mean Length	Minimum Length	Maximum Length	Total Number Measured	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1986	43	20	50	7				
1987	27	9	48	13				
1988	37	16	50	9				
1989	34	11	55	16				
1990	34	11	53	28				
1991	35	11	60	20				
1992	41	22	52	19				
1993	41	31	51	16				
1994	39	18	52	18				
1995	43	31	54	25				
1996	36	17	61	37				
1997	42	35	51	17				
1998	45	35	55	28				
1999	47	41	55	5				
2000	41	26	58	8				
2001	43	33	59	11				
2002	48	34	59	16				
2003	42	33	56	19				
2004	43	32	58	26				
2005	37	20	61	30				
2006	43	34	57	12				
2007	44	34	49	8				
2008	45	33	55	5				
2009	38	23	51	8				
2010	43	23	59	58				
2011	42	14	68	21				
2012	39	30	62	11				
2013	39	12	50	34				
2014	39	33	58	41				
2015	44	32	58	65				
2016	43	35	59	54	44	36	63	12
2017	43	36	58	27	41	33	48	38
2018	41	33	57	60	37	23	47	39
2019	40	34	57	30	45	35	57	42
2020	41	33	57	67	41	34	49	9
2021	43	31	50	9	41	35	49	28
2022	42	32	48	17	39	33	46	26

Table 5. Summary of cobia age samples collected from both dependent (commercial and recreational fisheries) and independent (surveys) sources, 2008–2022.

Year	Minimum Age	Maximum Age	Total Number Aged
2008	0	1	7
2009	1	1	4
2010	0	12	13
2011	0	1	6
2012	1	4	5
2013	1	1	1
2014*			0
2015	1	1	1
2016	0	11	20
2017	0	13	50
2018**			94
2019**			80
2020**			34
2021**			47
2022**			45

\*Cobia was not added to the priority species list for sampling until 2016; as a result, no species were collected this year.

\*\*Age samples not yet read.

Table 6. Summary of cobia tagged as part of the DMF multi-species tagging program, 2017–2022.

Year Tagged	Total Fish Tagged (#)	Total Fish Recaptured (#)	Average Days Out	Max Days Out	Average Distance Traveled (miles)	Max Distance Traveled (miles)
2017	81	24	501	1,198	157	681
2018	214	49	434	1,558	109	370
2019	134	19	279	777	140	696
2020	29	1	357	357	3	3
2021	48	4	119	353	40	157
2022	41	0				

## FIGURES

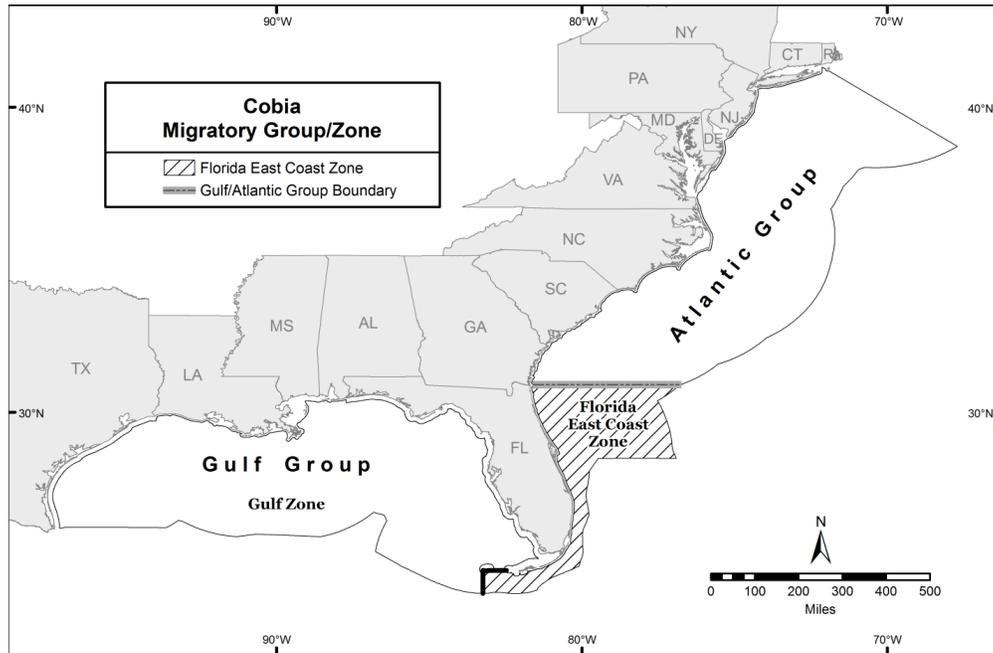


Figure 1. Zone splits for Gulf and Atlantic Migratory Group cobia established in Coastal Migratory Pelagics Fishery Management Plan Amendment 20b (Source: GMFMC/SAFMC 2014).

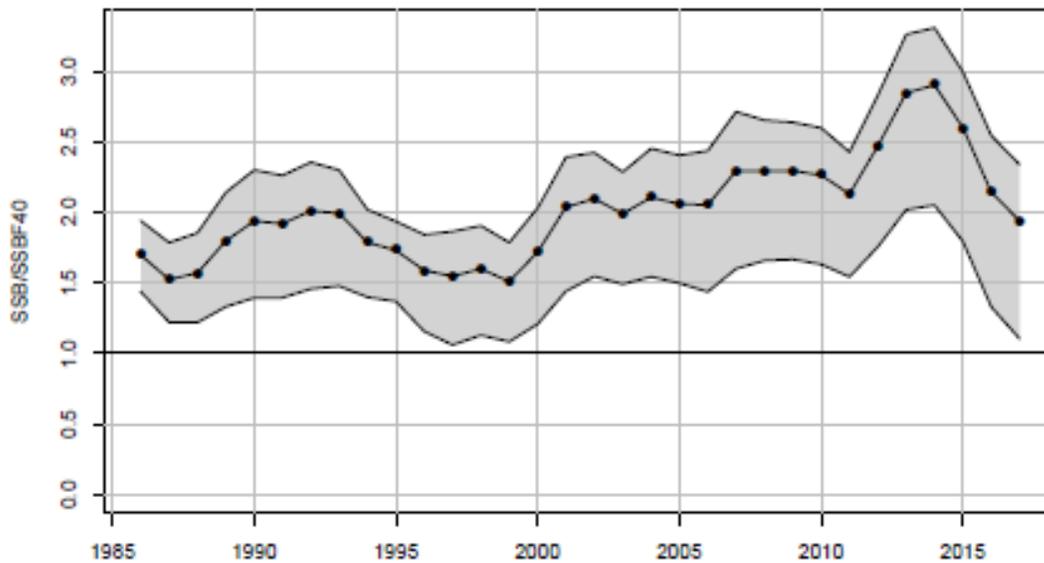


Figure 2. Spawning Stock Biomass (SSB) relative to established reference point SSBF40% for cobia from SEDAR 58 (SEDAR 2020). The shaded gray error bands indicate 5th and 95th percentiles of the Monte Carlo Bootstrap trials.

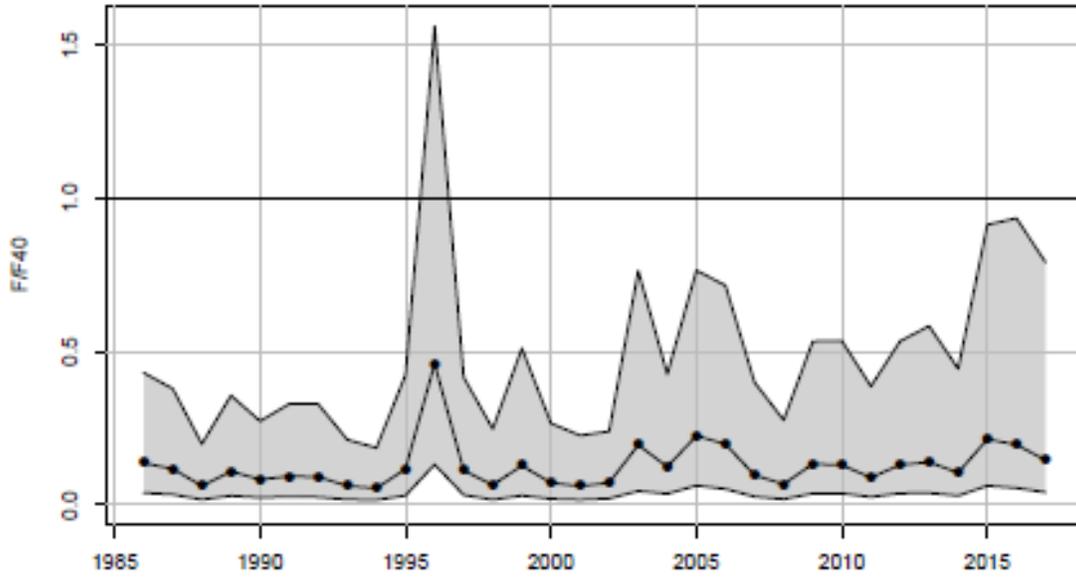


Figure 3. Fishing mortality ( $F$ ) relative to established reference point  $F_{40\%}$  for cobia from SEDAR 58 (SEDAR 2020). The shaded gray error bands indicate 5<sup>th</sup> and 95<sup>th</sup> percentiles of the Monte Carlo Bootstrap trials.

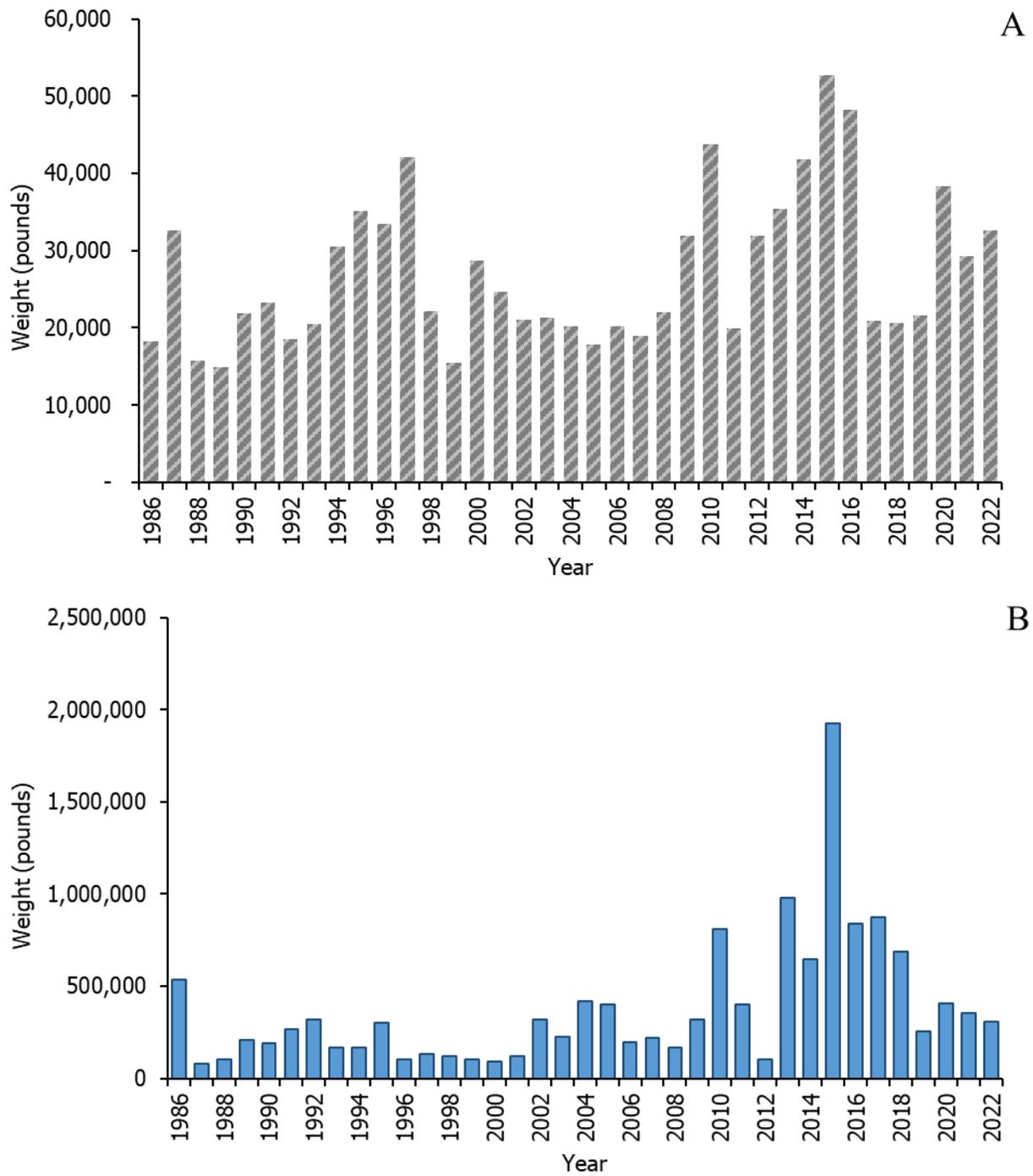


Figure 4. Annual (A) commercial (Atlantic Coastal Cooperative Statistics Program and N.C. Trip Ticket Program) and (B) recreational (MRIP) landings in pounds for cobia in North Carolina from 1986–2022.

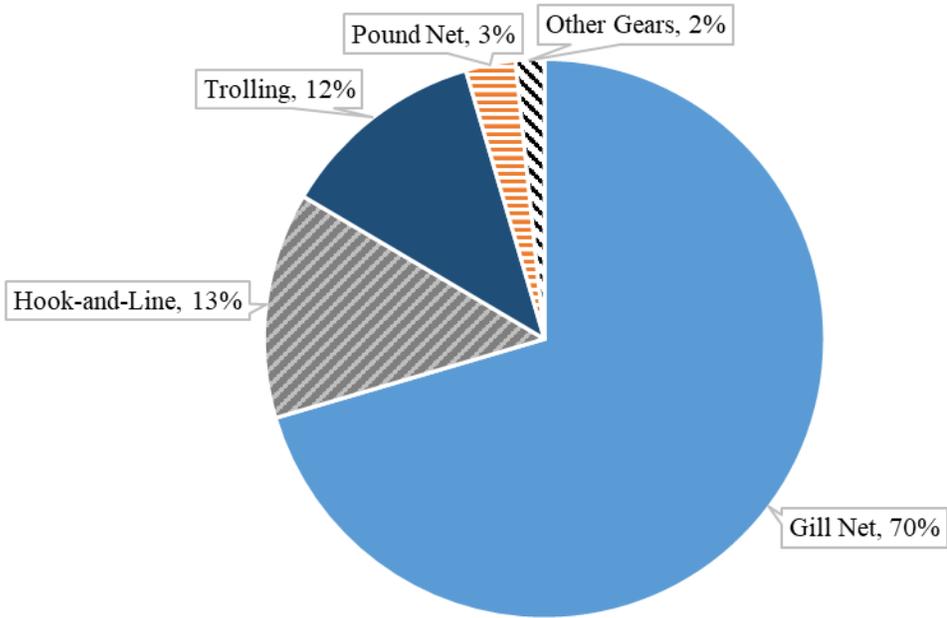


Figure 5. Commercial harvest in 2022 by gear type. Other gears can include beach seines, trawls, crab and fish pots, flynets, fyke nets, spears, longlines, and haul seines.

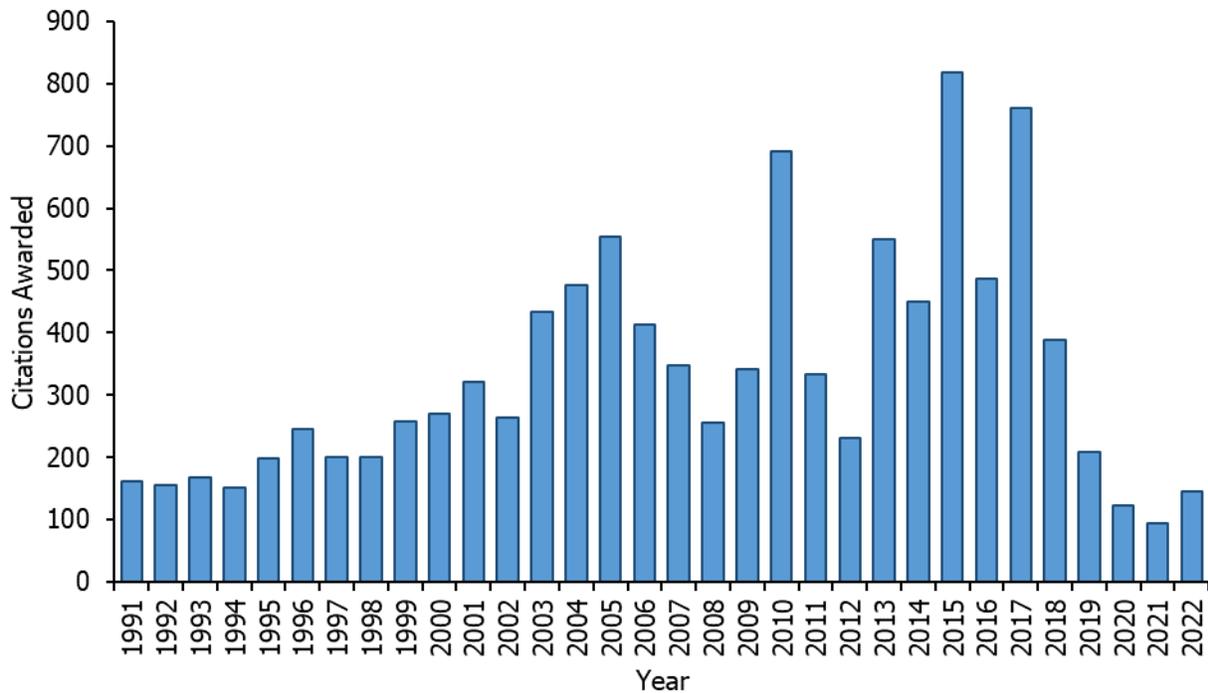


Figure 6. North Carolina Saltwater Fishing Tournament citations awarded for cobia from 1991–2022.

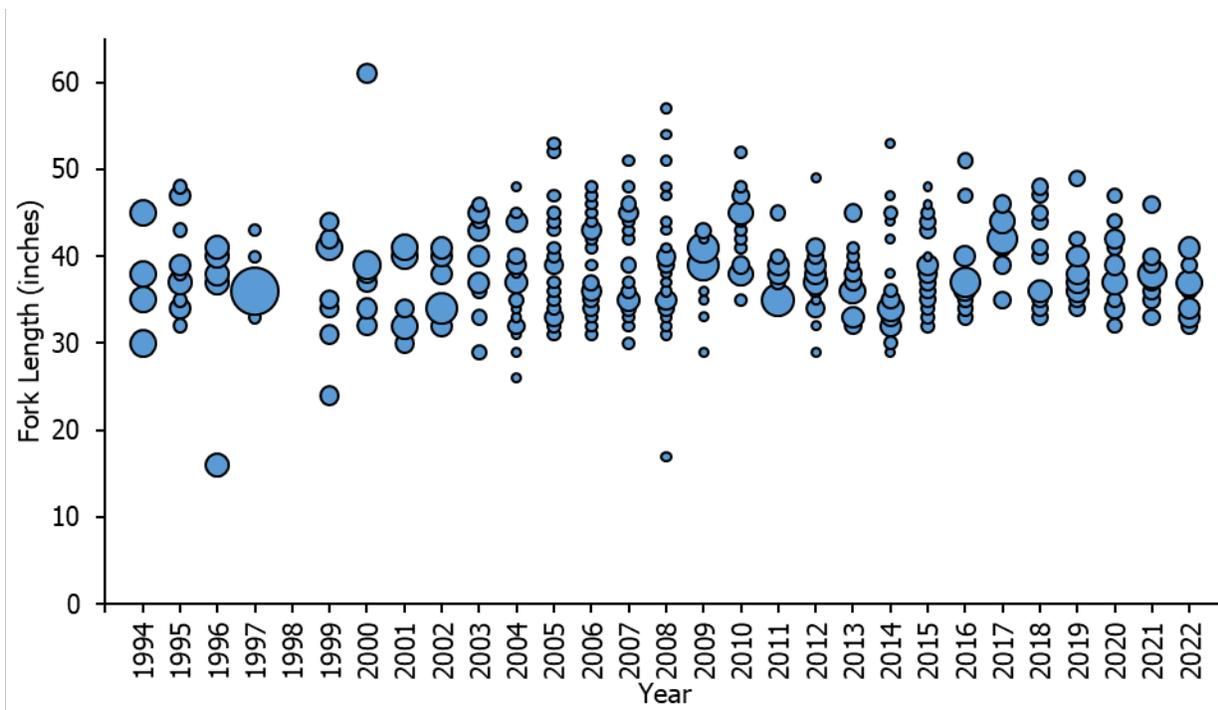


Figure 7. Commercial length frequency (fork length, inches) of cobia harvested from 1994–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

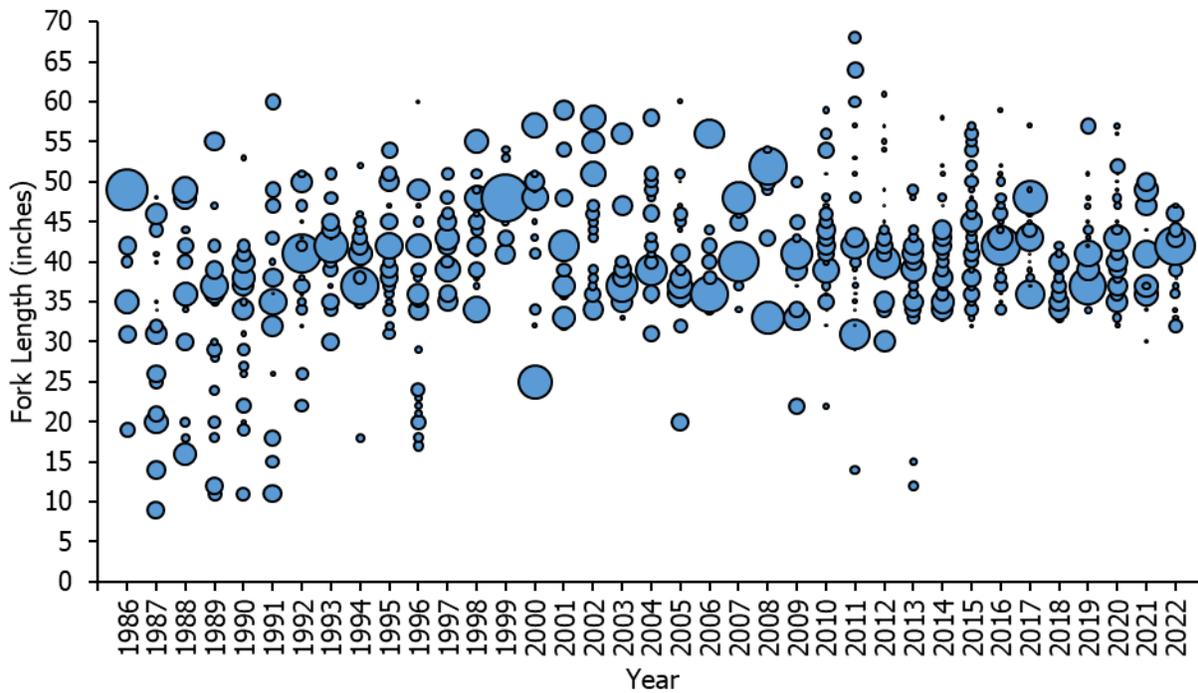


Figure 8. Recreational length frequency (fork length, inches) of cobia harvested from 1986–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

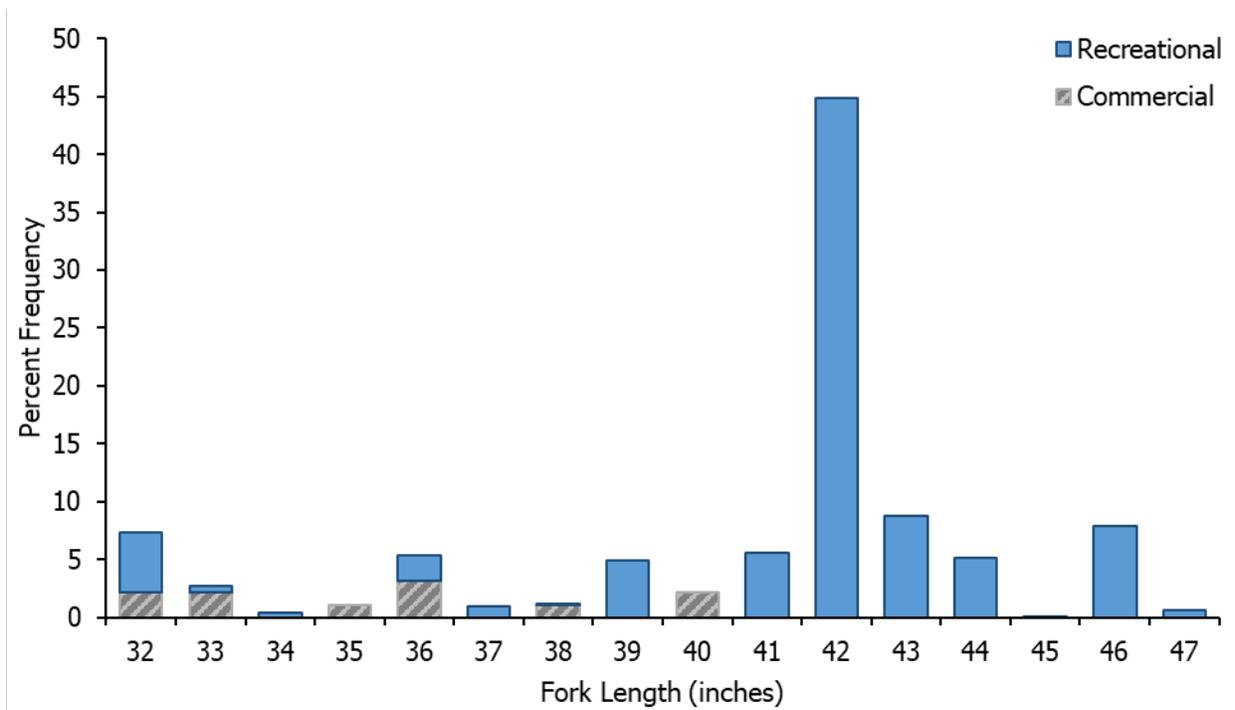


Figure 9 Commercial and recreational length frequency distribution from cobia harvested in 2022.

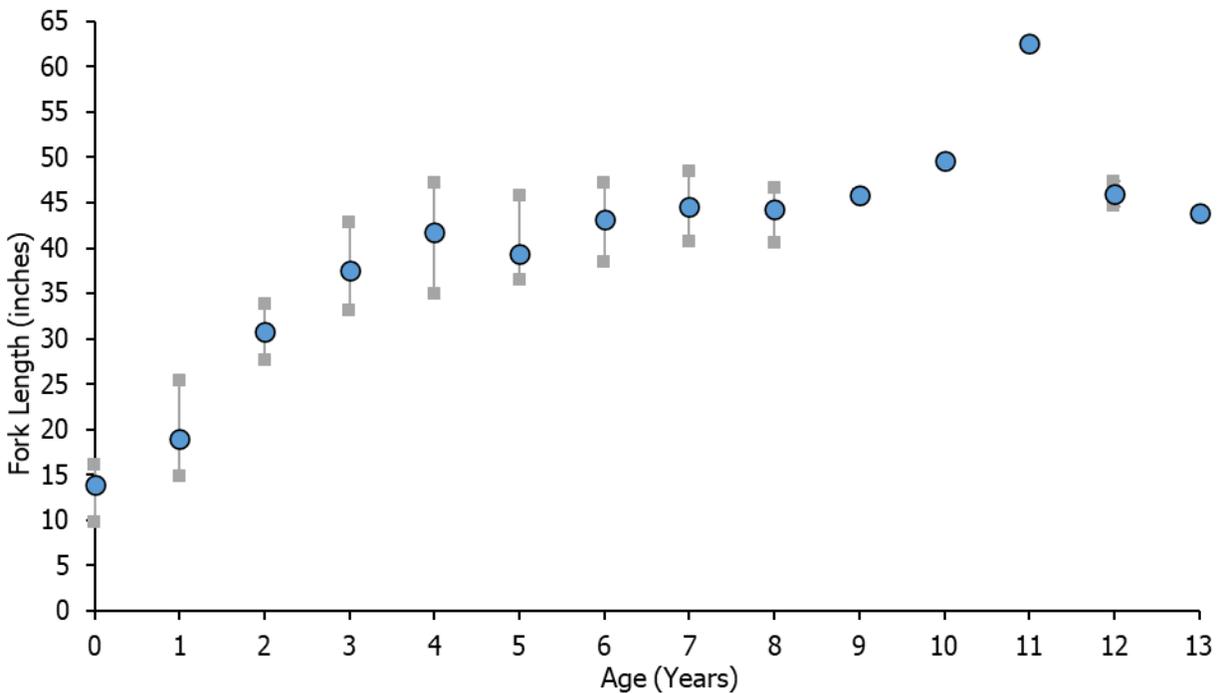


Figure 10. Cobia length at age based on all age samples collected from 2008–2017. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age. Otoliths from 2018–2022 are not included in this figure as they have not yet been aged.

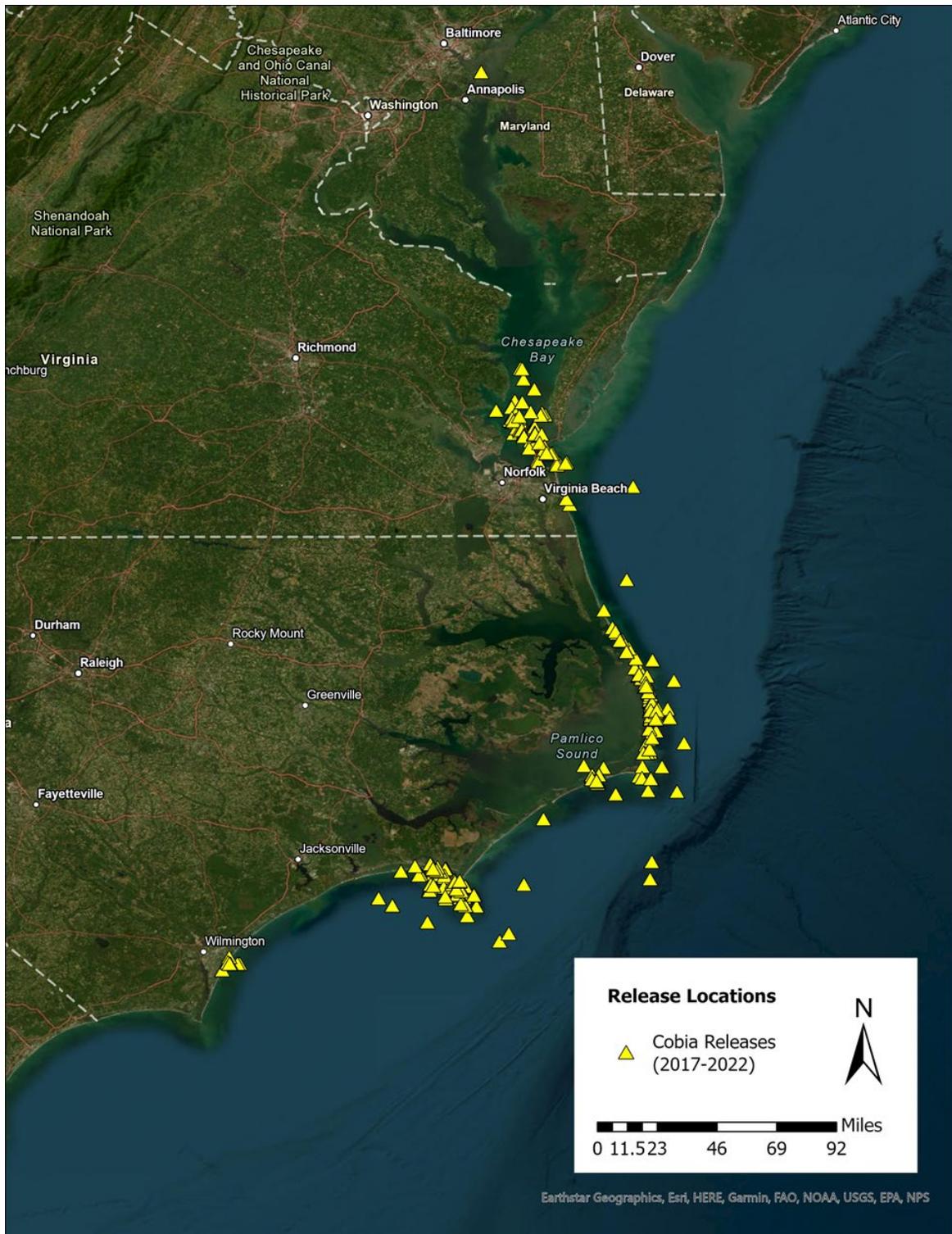


Figure 11. Red drum tagging release locations 2017-2022.

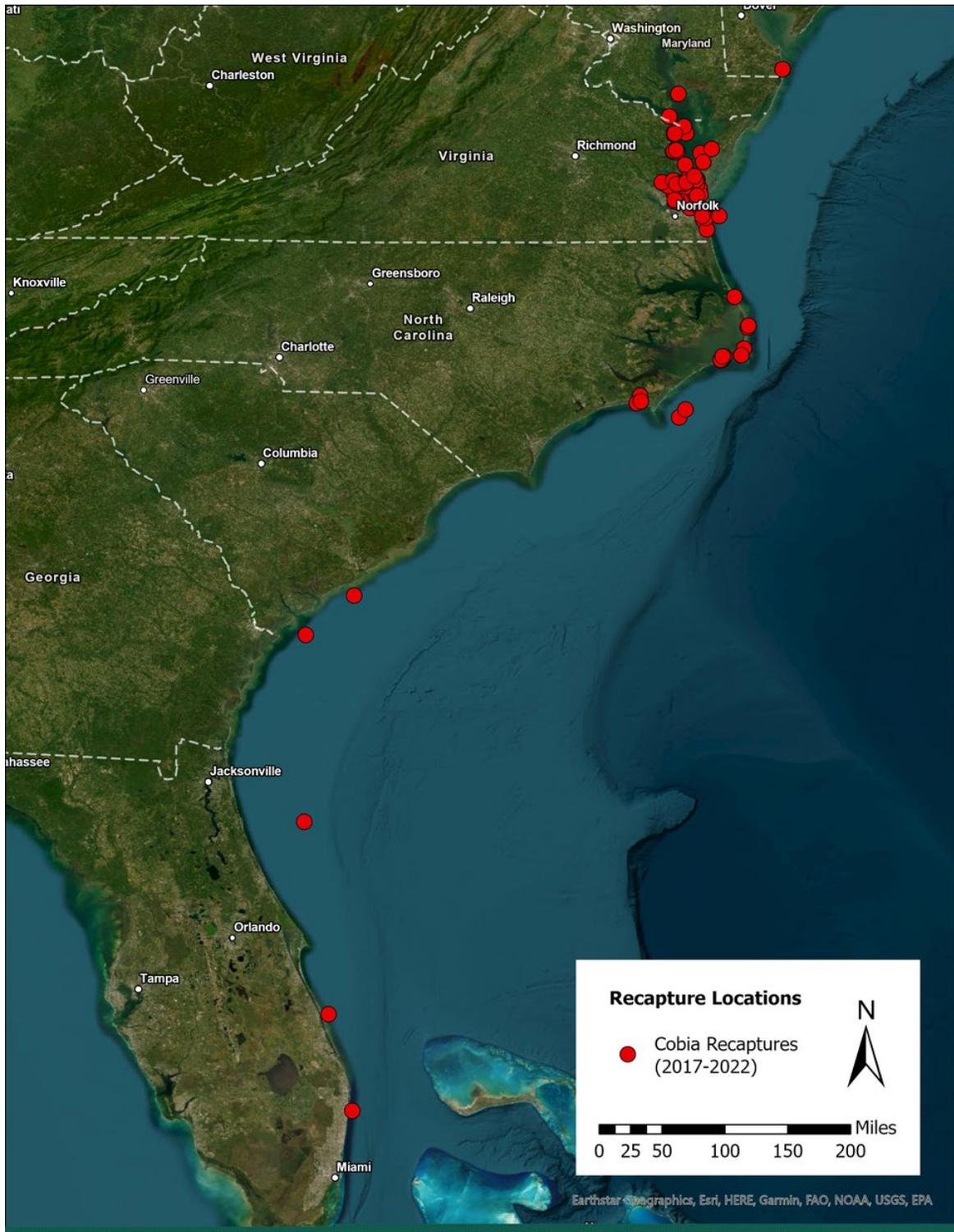


Figure 12. Cobia tagging recapture locations 2017-2022.

**FISHERY MANAGEMENT PLAN UPDATE  
DOLPHIN  
AUGUST 2023**

**STATUS OF THE FISHERY MANAGEMENT PLAN**

**Fishery Management Plan History**

FMP Documentation:	June 2004	
	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
	Amendment 12	June 2021
	Amendment 10	May 2022
Comprehensive 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 (FL) 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), 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 20-inch FL minimum size limit 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. 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 (MRIP). 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

filets 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% of the total ACL. Regulatory Amendment 1 (SAFMC 2016), effective March 2017, established a commercial trip limit for vessels with an Atlantic dolphin/wahoo permit of 4,000 pounds for the dolphin commercial sector once 75% 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.

Amendment 12 was approved by the Council at its September 2020 meeting and became effective June 6, 2021 (SAFMC 2020). Amendment 12 adds bullet mackerel and frigate mackerel to the Dolphin Wahoo Fishery Management Plan and designates them as ecosystem component species. Amendment 10 was approved by the Council at its September 2021 meeting and became effective May 2, 2022 (SAFMC 2020). Amendment 10 includes actions that accommodate updated recreational data from the MRIP by revising the annual catch limits and sector allocations for dolphin and wahoo. The amendment also contains actions that implement other management changes in the fishery including revising accountability measures, accommodating possession of dolphin and wahoo on vessels with certain unauthorized gears onboard, removing the operator card requirement, and reducing the recreational vessel limit for dolphin and wahoo.

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(a)). 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:

- 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.
- 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.
- 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.
- 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.
- 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.
- Direct research to evaluate the role of dolphin and wahoo as predator and prey in the pelagic ecosystem.
- Direct research to enhance collection of biological, habitat, social, and economic data on dolphin and wahoo stocks and fisheries.

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

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 FL with most fish maturing by 24 inches FL (Schwenke et al. 2008). They are considered batch spawners, meaning 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, dolphin have been known to spawn year-round.

### **Stock Status**

The stock status of wahoo in the western Atlantic is unknown.

### **Stock Assessment**

A stock assessment is not available for this species.

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

The North Carolina Division of Marine Fisheries (DMF) 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 dolphin per person per day or more than 54 dolphin per vessel per day. Headboats are excluded from the vessel limit requirement. It is also unlawful to sell a recreational bag limit of dolphin harvested by a person on a vessel while it is operating as a charter vessel or headboat or to sell dolphin without a Federal Commercial Dolphin/Wahoo Vessel Permit. Commercially harvested dolphin must be at least 20 inches fork length. 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 weight trip limit is implemented. Commercial vessels federally permitted in another fishery are allowed to land up to 200 pounds of dolphin and wahoo combined.

### **Commercial Fishery**

Commercial landings of dolphin are reported through the mandatory DMF Trip Ticket program. Landings since 1986 have fluctuated with a low of 26,112 pounds in 2021 and a high of 611,962 pounds in 2009 (Table 1; Figure 1). Commercial landings in 2022 (28,379 pounds) were much lower than the time series average (189,428 pounds), and the second lowest landings of the time series.

### **Recreational Fishery**

Recreational landings of dolphin are estimated from the MRIP. Recreational estimates across all years have been updated and are now based on the MRIP's new Fishing Effort Survey-based calibrated estimates. For more information on MRIP see <https://www.fisheries.noaa.gov/topic/recreational-fishing-data>.

From 1986 to 2009, recreational dolphin landings had been steadily increasing. Subsequently, from 2010 to present, dolphin landings have slowly declined. After peaking in 2009 (6,380,552 pounds), landings of dolphin fluctuated between highs in 2015 (5,610,008 pounds) and 2016 (5,099,647 pounds) and lows in 2020 (2,149,038 pounds), 2021 (1,971,454 pounds), and 2022 (962,267

pounds; Table 1; Figure 2). The recreational landings in 2022 (962,267 pounds) were the lowest since 1992 (927,165 pounds), and fifth lowest in the time series (1986-2022).

The DMF offers award citations for recreational fishermen who land dolphin greater than 35 pounds. The number of citations awarded annually since the program started for dolphin has been variable, with a declining trend observed from 2013-2018 (Table 2; Figure 2). Although the total number of citations awarded through the North Carolina Saltwater Fishing Tournament increased in 2019 (181 citations), citations declined in 2020 (94 citations), 2021 (68 citations), and 2022 (61 citations) to the lowest number recorded in the time series (1991-2022).

## **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 DMF programs 438 (Offshore Live Bottom Fishery) and 439 (Coastal Pelagic). The number of commercial dolphin lengths collected in 2022 (195 samples) was above time series average of 183 samples (Table 3; Figure 3). The average size of dolphin sampled from the commercial fishery decreased in 2022 (28.7 inches fork length) from the previous year (32.1 inches fork length) but was above the time series average (27.8 inches fork length; Table 3; Figure 4). The maximum size of dolphin sampled from the commercial fishery also decreased in 2022 (43.3 inches fork length) from 2021 (59.8 inches fork length; Table 3; Figure 4).

Length and weight information for the recreational fishery are collected through the MRIP dockside sampling. The average size of dolphin sampled from the recreational fishery increased from 26.1 inches fork length in 2021 to 27.9 inches fork length in 2022, but overall has remained relatively constant throughout the time series (Table 3; Figure 5). The minimum size of dolphin sampled from the recreational fishery in 2022 (11.9 inches fork length) was below the time series average from 1986-2022 (13.1 inches fork length), and the maximum size sampled in 2022 (48.1 inches fork length) was below the previous year (55.1 inches fork length) and the time series average of 53.3 inches fork length.

The modal length for the commercial fishery (31 inches fork length) was larger than the recreational fishery (24 inches fork length) in 2022 (Figure 3; Figure 5). However, the recreational fishery harvests larger dolphin than the commercial fishery (Figure 3; Figure 5); the maximum length of dolphin sampled from the recreational fishery was 67.9 inches fork length in 2010, compared to a maximum length of 59.8 inches fork length by the commercial fishery in 2021 (Table 3; Figure 5).

### **Fishery-Independent Monitoring**

Currently, DMF does not have any fishery-independent sampling programs that target or catch dolphin in great numbers.

## RESEARCH NEEDS

The following are research and management needs as determined by the SAFMC and outlined in the FMPs for pelagic Sargassum habitat and the dolphin/wahoo fishery (SAFMC 2002; SAFMC 2003(b)).

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?
- Are there differences in dolphin 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.

- 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. 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 bio profile data (size, sex, hard parts for aging, etc.).
- 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.

## **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 Amendment 5 (SAFMC 2013), Amendment 7 (SAFMC 2015a), Amendment 8 (SAFMC 2015b), Amendment 12 (SAFMC 2020), Amendment 10 (SAFMC 2021) and Regulatory Amendment 1 (SAFMC 2016).

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## TABLES

Table 1: Recreational harvest (number of fish landed and weight in pounds) and releases (number of fish) and commercial harvest (weight in pounds) of dolphin from North Carolina, 1986–2022.

Year	Recreational			Commercial	Total Weight (lb)
	Number Landed	Number Released	Weight Landed (lb)	Weight Landed (lb)	
1986	49,810	589	478,136	35,923	514,059
1987	92,582	79	489,338	70,516	559,854
1988	81,487	31,103	205,599	56,098	261,697
1989	231,953	1,696	1,653,574	98,899	1,752,473
1990	209,476	1,452	986,307	96,207	1,082,514
1991	254,975	6,565	1,298,933	140,837	1,439,770
1992	167,690	6,936	927,165	72,119	999,284
1993	291,297	3,190	1,527,078	149,043	1,676,121
1994	268,417	9,402	1,791,880	160,742	1,952,622
1995	294,100	9,620	2,324,560	354,188	2,678,748
1996	213,861	2,154	1,514,866	128,586	1,643,452
1997	372,989	6,320	3,400,820	229,791	3,630,611
1998	241,733	9,249	1,792,198	149,990	1,942,188
1999	395,167	10,406	3,280,273	209,488	3,489,761
2000	516,491	17,396	4,631,849	197,259	4,829,108
2001	344,865	4,781	4,669,172	160,546	4,829,718
2002	400,736	3,699	4,853,768	168,429	5,022,197
2003	245,651	13,985	3,029,205	186,262	3,215,467
2004	323,140	6,905	2,445,482	255,805	2,701,287
2005	634,260	3,264	5,664,028	139,761	5,803,789
2006	551,924	32,911	4,300,459	159,452	4,459,911
2007	591,835	6,908	5,729,879	369,472	6,099,351
2008	362,023	2,393	3,227,899	289,548	3,517,447
2009	595,967	4,480	6,380,552	611,962	6,992,514
2010	615,081	5,759	3,754,430	239,551	3,993,981
2011	638,543	16,217	4,950,235	94,210	5,044,445
2012	426,877	4,800	3,335,644	249,020	3,584,664
2013	322,769	5,315	2,277,519	178,035	2,455,554
2014	403,203	6,731	2,933,166	422,496	3,355,662
2015	740,023	73,872	5,610,008	320,961	5,930,969
2016	480,860	2,520	5,099,647	356,061	5,455,708
2017	279,932	3,035	2,223,509	198,038	2,421,547
2018	495,435	27,959	3,318,532	144,660	3,463,192
2019	458,086	35,286	3,147,384	208,385	3,355,769
2020	262,372	26,902	2,149,038	51,994	2,201,032
2021	268,012	25,108	1,945,342	26,112	1,971,454
2022	117,803	521	962,267	28,379	990,646
Mean	357,876	11,608	2,927,290	189,428	3,116,718

Table 2. Total number of awarded citations for dolphin (>35 pounds landed) annually from the North Carolina Saltwater Fishing Tournament, 1991–2022.

Year	Total Citations
1991	191
1992	266
1993	221
1994	334
1995	354
1996	248
1997	262
1998	412
1999	249
2000	315
2001	457
2002	409
2003	409
2004	155
2005	164
2006	202
2007	218
2008	426
2009	209
2010	157
2011	113
2012	147
2013	284
2014	273
2015	171
2016	124
2017	115
2018	125
2019	181
2020	94
2021	68
2022	61

Table 3. Mean, minimum, and maximum lengths (fork length, inches) of dolphin collected from the commercial and recreational fisheries, 1986–2022.

Year	Commercial				Recreational			
	Mean Length	Minimum Length	Maximum Length	Total Number Measured	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1986	26.9	16.1	45.3	46	28.7	13.8	47.8	101
1987	23.4	5.9	50.4	113	22.8	7.1	50.4	1,038
1988	24.4	14.8	43.3	104	23.8	12.4	52.0	691
1989	25.4	16.1	47.2	229	25.3	13.4	65.7	1,581
1990	23.9	13.0	49.6	201	23.1	13.8	60.0	1,956
1991	28.9	16.1	47.2	99	23.0	8.7	49.2	2,468
1992	32.6	18.1	47.6	30	22.7	7.5	55.9	1,721
1993	24.9	15.7	43.9	154	22.9	12.5	57.0	2,796
1994	27.7	16.1	50.6	136	25.5	11.0	59.1	4,469
1995	28.5	17.5	48.4	156	27.4	11.0	62.0	3,929
1996	26.1	17.5	42.1	57	26.3	12.6	59.0	2,873
1997	29.1	16.1	48.0	30	28.8	13.8	65.7	3,250
1998	23.6	15.0	46.5	143	27.0	9.4	60.0	3,287
1999	33.0	13.6	53.1	454	28.3	7.9	51.3	2,886
2000	26.4	14.6	48.8	208	28.3	15.9	58.0	3,740
2001	26.5	14.6	45.7	93	31.9	10.9	58.2	2,617
2002	25.8	15.7	52.8	100	30.5	15.7	58.0	3,538
2003	27.5	15.7	48.8	190	31.9	13.9	58.0	1,185
2004	25.2	15.6	47.2	146	27.6	18.2	48.6	1,341
2005	25.7	16.5	44.9	229	29.2	16.9	49.0	1,834
2006	27.9	16.8	52.8	172	27.8	11.8	47.8	1,659
2007	29.9	13.7	43.2	232	30.4	17.0	55.3	1,662
2008	26.2	16.3	44.7	231	29.2	12.2	55.3	1,759
2009	32.1	5.5	51.0	555	32.0	15.4	50.8	1,963
2010	24.7	13.6	43.9	451	25.2	15.2	67.9	1,532
2011	26.2	16.1	44.1	269	27.7	11.1	51.0	2,022
2012	29.8	16.9	49.0	579	28.3	15.0	53.5	1,918
2013	27.6	18.8	56.7	176	26.5	11.8	57.8	601
2014	31.0	15.4	53.2	339	27.0	10.6	51.7	896
2015	32.3	19.6	53.5	78	27.0	11.3	52.1	956
2016	33.1	18.2	40.7	125	31.1	7.5	52.2	1,152
2017	25.0	16.9	37.3	161	28.0	12.8	47.4	722
2018	28.8	12.0	47.2	117	25.6	13.1	57.2	1,313
2019	29.3	14.1	45.3	143	25.7	10.3	58.1	877
2020	26.0	17.6	43.5	64	28.0	13.1	55.3	1,092
2021	32.1	15.7	59.8	194	26.1	13.7	55.1	396
2022	28.7	17.8	43.3	195	27.9	11.9	48.1	359

## FIGURES

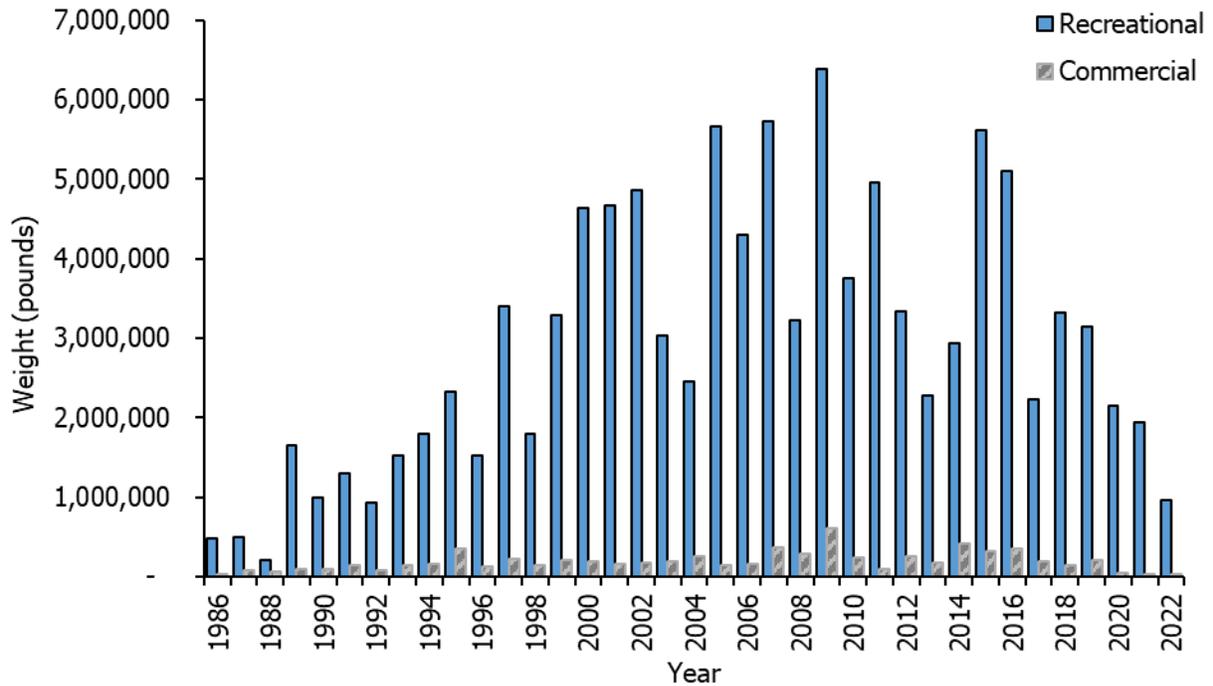


Figure 1. Annual commercial and recreational landings in pounds of dolphin in North Carolina, 1986–2022.

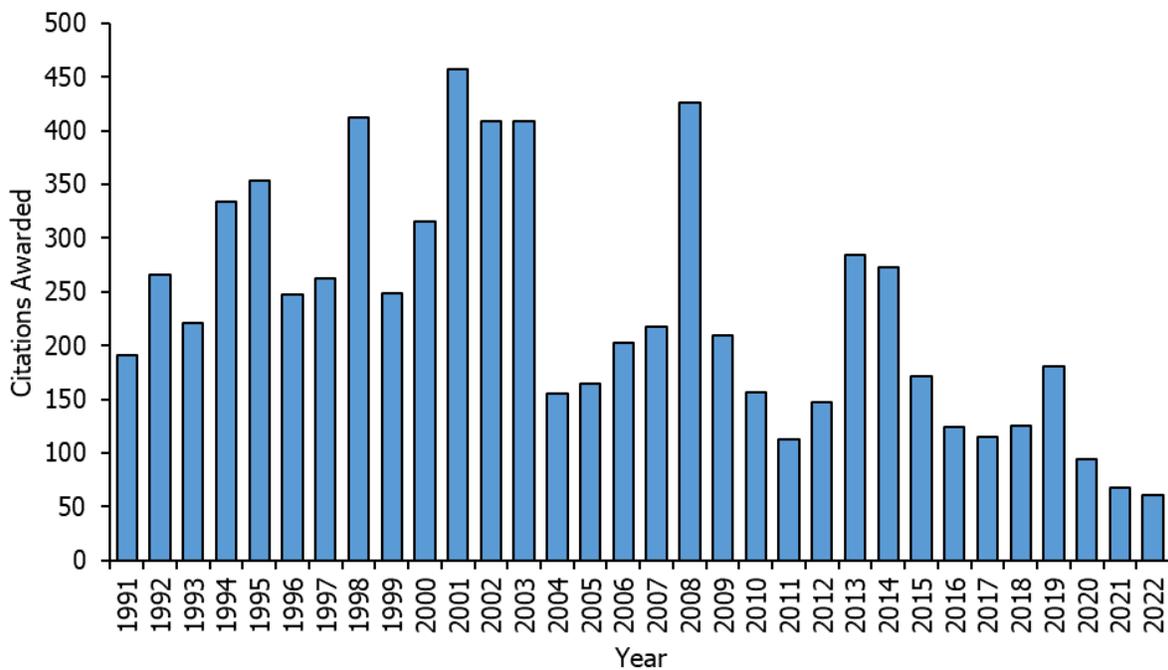


Figure 2. Total number of awarded citations for dolphin (>35 pounds landed) annual from the North Carolina Saltwater Fishing Tournament, 1991–2022.

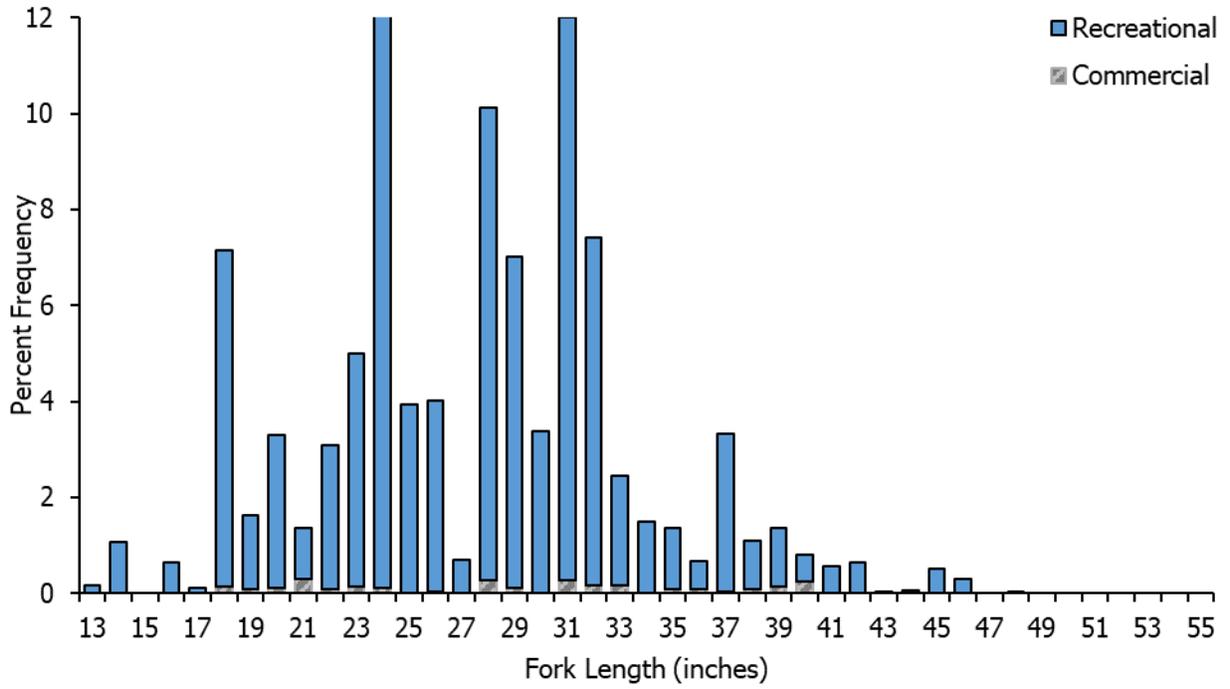


Figure 3. Commercial and recreational length frequency distribution for dolphin harvested in 2022.

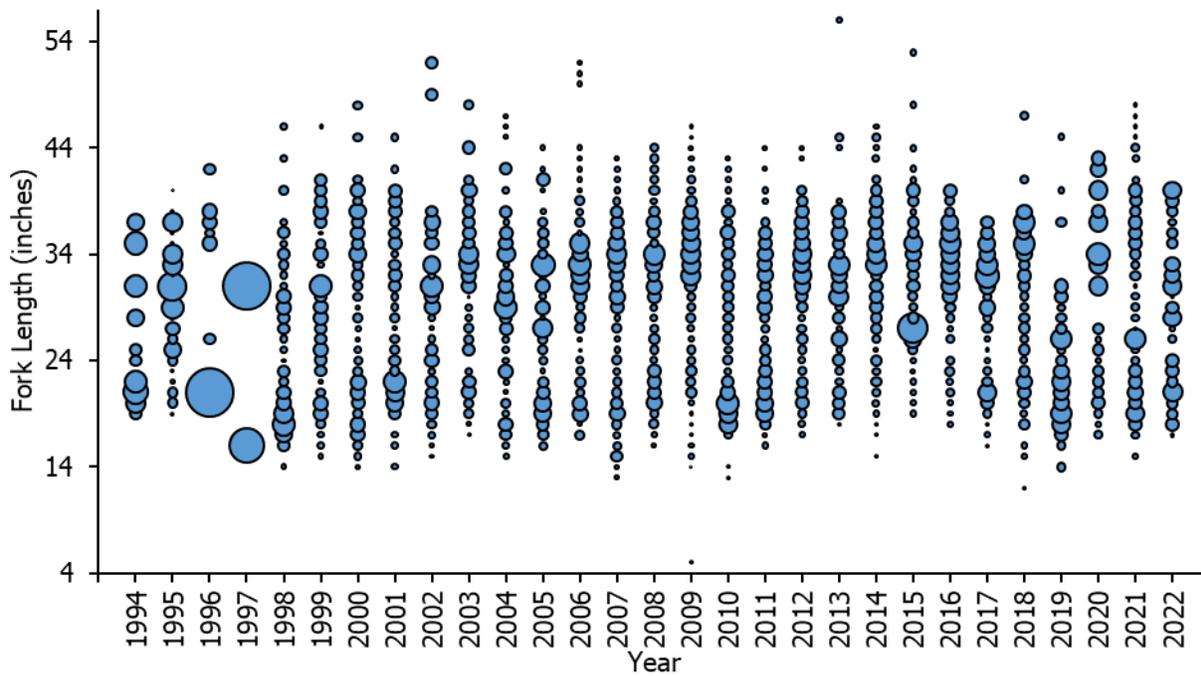


Figure 4. Commercial length frequency (fork length, inches) of dolphin harvested, 1994-2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

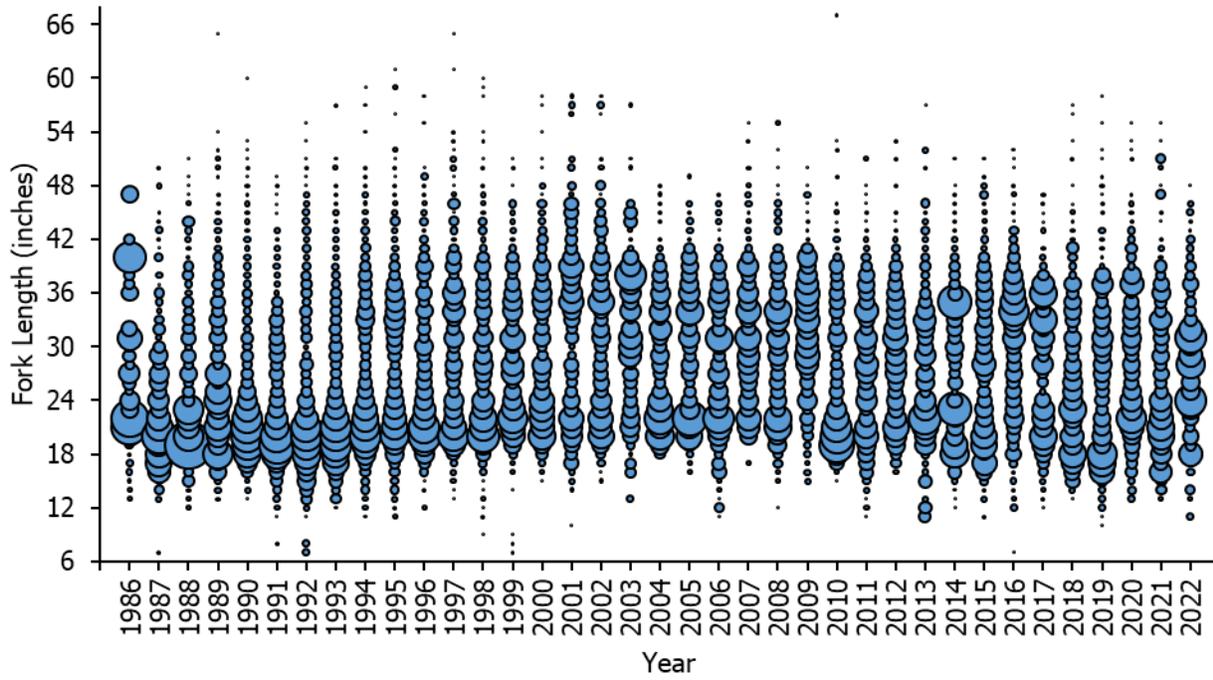


Figure 5. Recreational length frequency (fork length, inches) of dolphin harvested, 1986-2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

**FISHERY MANAGEMENT PLAN UPDATE  
KING MACKEREL  
AUGUST 2023**

**STATUS OF THE FISHERY MANAGEMENT PLAN**

**Fishery Management Plan History**

FMP Documentation:	February 1983	
	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

Comprehensive Review: 2020

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 (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 1989). 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 the bag limit catch of mackerel may be sold, provided guidelines for corporate commercial vessel permits, established a minimum size of 12 inches fork length (FL) or 14 inches total length (TL) for king mackerel and included a definition of "conflict".

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 FL (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 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, (e) allow setting zero bag limits, and (f) 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% North and 53.85% South/West (previously, this allocation was split 50% to each zone); and allowed possession of cut-off (damaged) king 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 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 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 1998b).

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 exclusive economic zone (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 2002a). 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 2002b). 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 2004). This amendment also changed the fishing year to March 1 through February 28 (29 on leap year) 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 head boat) permits, building on the moratorium established under Amendment 14 (SAFMC 2002b).

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 (SAFMC 2011).

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 2010).

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 2013a). 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% 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 2014a). 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 head boat reporting regulations to require weekly electronic reporting of all South Atlantic Council managed species (SAFMC 2013b).

Amendment 23 (SAFMC 2013c) 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 (SAFMAC 2014b).

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.

Framework Amendment 6 (effective 2018) modifies the commercial trip limit for Atlantic migratory group king mackerel in the exclusive economic zone from the North Carolina/South Carolina line to the Miami-Dade/Monroe County line (Atlantic Southern Zone) (SAFMC 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 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 2022).

## **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:

- 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.
- 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.
- To provide necessary information for effective management and establish a mandatory reporting system.
- To minimize gear and user group conflicts.
- 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.
- To minimize waste and bycatch in the fishery.
- To provide appropriate management to address specific migratory groups of king mackerel.
- To optimize the social and economic benefits of the coastal migratory pelagic fisheries.

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

King mackerel (*Scomberomorus cavalla*) 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 FL, but most recreational catches are between 35- and 45-inches FL. They feed on menhaden, mullet, thread herring, sardines and squid and may be seen leaping out of the water in pursuit of prey (Manooch 1984).

### **Stock Status**

In 2020, the Atlantic king mackerel stock was assessed and peer reviewed through the Southeast Data, Assessment and Review (SEDAR 2020). The results of the assessment indicated 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 assessment approach, Stock Synthesis 3, was used to assess the stock (SEDAR 2014) in a benchmark assessment (SEDAR 2014). The SEDAR 38 assessment was updated in 2020 (SEDAR 2020). 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 (DMF) 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 (CPUE) indices. Total biomass and spawning stock biomass estimates increased steadily since 2013. All fishery indicators (fleet CPUEs and scientific survey) showed positive trends since SEDAR 38. Stock Synthesis estimated a recent period (2013 to 2016) of above average age-0 recruitments, contrasting the period prior (2008 to 2012) of below average recruitments first detected during SEDAR 38. Two particularly high recruitment years were estimated for 2015 and 2016, supported by the juvenile survey observations in 2016 (SEAMAP trawl survey), as well as fleet length compositions. Observations by stakeholders may help validate the model predictions, given the distinct change in signal from five years of low recruitment up to SEDAR 38 to four years of recent high recruitment. The fish would have entered the fisheries beginning in the 2015 fishing year, with relatively high abundance beginning in 2017 fishing year, particularly of fish between 24- and 36-inches FL.

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

The DMF complements the management measures of the Coastal Migratory Pelagic FMP through rule (NCMFC Rule 15A NCAC 03M .0512) and proclamation authority (NCMFC Rule 15A NCAC 03M .0512). Current regulations include a recreational bag limit of fish per person per day and 24-inch FL minimum size limit (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 recreational 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 Fishery**

In 2022, commercial landings were 409,941 pounds (Table 1; Figure 1A) and 84% of the king mackerel harvest was taken by hook and line while the remaining 16% was harvested in gill nets (Table 2; Figure 2). The commercial fishery has declined since 2008 and the 2022 landings were lower than the 499,376 pound 10-year average (2013-2022).

### **Recreational Fishery**

Recreational landings of king mackerel are estimated from the Marine Recreational Information Program (MRIP). Recreational estimates across all years have been updated and are now based on

the MRIP new Fishing Effort Survey-based calibrated estimates. For more information on MRIP see: <https://www.fisheries.noaa.gov/topic/recreational-fishing-data>. 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 375,164 pounds of king mackerel in 2022, which is 33% lower than 2021 harvest and 62% lower than the 10-year average of 990,729 pounds (Table 1 and Figure 1B).

The DMF offers award citations for exceptional catches of king mackerel. King mackerel greater than 30 pounds or 45 inches FL are eligible for an award citation. In 2022, 184 citations were awarded, 36 of which were released alive (Figure 6).

## **MONITORING PROGRAM DATA**

### **Fishery-Dependent Monitoring**

Length-frequency information for the commercial king mackerel fishery in North Carolina is collected through the division's Program 434 (Ocean Gill Net Fishery), Program 437 (Long Haul Seine Fishery), Program 438 (Offshore Live Bottom Fishery), Program 439 (Coastal Pelagic), and Program 461 (Estuarine Gill Net and Seine Sampling)]. Through these programs, 550 king mackerel were measured with a mean length of 32.9 inches FL (Table 4; Figures 3 and 5). 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 5). Length and weight information for the recreational fishery are collected through the MRIP dockside sampling (Figures 4 and 5).

### **Fishery-Independent Monitoring**

Currently, the division does not have any fishery-independent sampling programs that target or catch king mackerel in great numbers.

## **RESEARCH NEEDS**

From SEDAR 38 (2014) and SEDAR 38 Update (2020):

- 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 age-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 Stock Synthesis 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.
- Research aimed at improving the documentation of data series formatting, including index standardization, for Stock Synthesis 3 would improve modeling efficiency. This includes statistical coding for consistent database querying and data processing.
- Evaluation of alternative age references, or age-specific time series, for the Southeast Area Monitoring and Assessment Program (SEAMAP) fishery-independent survey was recommended by the data providers and noted by the analyst for future assessments. An analysis of the effect of excluding sublegal fish size observations on the assessment should be undertaken. Information on the age-composition of discarded fish from all fleets is needed to validate the assumption of exclusively age-0 discards. The conditional age-at-length data had a significant influence on recent recruitment estimates.

## **MANAGEMENT STRATEGY**

King mackerel is included in the North Carolina IJ FMP, which defers to SAFMC's management plan compliance requirements. Current management measures were established under recent Amendments 20A (SAMFC 2013a), 20B (SMAFC 2014b), and 26 (SAMFC 2016) to the Coastal Migratory Pelagics FMP. Amendment 20A prohibits the sale of all recreational 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 SAFMC completed Amendment 26 (SAFMC 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 6.

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## TABLES

Table 1. Recreational harvest (number of fish landed and weight in pounds) and releases (number of fish) and commercial harvest (weight in pounds) of king mackerel from North Carolina, 1994–2021.

Year	Recreational			Commercial	Total Weight (lb)
	Number Harvested	Number Released	Weight Landed (lb)	Weight Landed (lb)	
1994	177,608	5,792	1,709,740	849,909	2,559,649
1995	135,796	7,544	1,240,901	1,013,319	2,254,220
1996	119,418	15,465	1,097,226	793,467	1,890,693
1997	206,601	57,739	1,797,936	1,558,439	3,356,375
1998	112,383	9,155	1,163,739	1,143,342	2,307,081
1999	104,483	120,296	1,034,465	1,082,693	2,117,158
2000	196,979	26,009	2,250,512	1,045,554	3,296,066
2001	145,290	12,381	2,046,022	839,107	2,885,129
2002	104,631	20,811	1,242,058	778,427	2,020,485
2003	153,339	33,774	1,388,145	764,831	2,152,976
2004	191,584	184,384	2,276,035	955,002	3,231,037
2005	175,070	101,507	1,349,536	1,246,088	2,595,624
2006	177,369	45,568	1,805,814	1,185,534	2,991,348
2007	339,278	53,549	3,099,801	1,059,107	4,158,908
2008	164,719	41,283	1,379,450	1,036,852	2,416,302
2009	168,558	23,639	1,822,673	777,585	2,600,258
2010	58,311	9,734	580,505	328,806	909,311
2011	31,589	851	367,896	408,162	776,058
2012	55,529	6,385	613,903	297,423	911,326
2013	48,000	8,868	521,153	345,177	866,330
2014	72,288	35,075	1,213,096	549,981	1,763,077
2015	95,705	16,877	1,168,255	391,315	1,559,570
2016	108,151	43,909	963,139	420,869	1,384,008
2017	110,339	94,655	1,261,775	629,703	1,891,478
2018	102,675	75,614	1,018,459	506,933	1,525,392
2019	184,962	115,350	1,446,939	698,252	2,145,191
2020	146,423	70,879	1,376,229	610,718	1,986,947
2021	58,174	24,069	563,082	430,868	993,950
2022	38,512	12,996	375,164	409,941	785,105
Mean	130,475	43,936	1,316,333	764,090	2,080,422

Table 2. North Carolina commercial harvest of king mackerel with landings in pounds by gear type, 1994–2022.

Year	Gear Type			Total
	Hook and Line	Gill Net	Other	
1994	782,796	61,648	5,465	849,909
1995	954,958	58,104	257	1,013,319
1996	738,562	53,211	1,761	793,534
1997	1,388,933	167,973	1,533	1,558,439
1998	1,076,494	65,460	1,388	1,143,342
1999	1,042,517	40,148	28	1,082,693
2000	939,435	105,504	616	1,045,554
2001	790,925	47,517	665	839,107
2002	696,160	81,933	334	778,427
2003	738,129	26,168	534	764,831
2004	829,056	125,826	120	955,002
2005	1,012,598	232,681	810	1,246,089
2006	1,010,909	174,573	52	1,185,534
2007	883,514	175,570	24	1,059,107
2008	821,059	215,793	0	1,036,852
2009	668,150	109,347	88	777,585
2010	235,965	92,739	102	328,806
2011	357,375	50,748	38	408,162
2012	248,979	48,444	0	297,423
2013	311,321	33,856	0	345,177
2014	461,424	88,557	0	549,981
2015	323,686	67,629	0	391,315
2016	337,016	83,794	59	420,869
2017	557,374	72,284	38	629,696
2018	444,047	62,814	72	506,933
2019	616,273	81,944	13	698,229
2020	518,010	92,509	199	610,718
2021	368,767	61,987	113	430,868
2022	344,501	64,344	1,096	409,941

Table 3. Total number measured, mean, minimum, and maximum length (inches) of king mackerel measured by MRIP sampling in North Carolina, 1981–2022.

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Total Number Measured
1981	38.5	25.0	46.0	47
1982	33.9	15.7	44.1	90
1983	30.1	5.7	36.0	33
1984	31.1	12.2	44.3	71
1985	32.9	22.0	42.5	67
1986	33.1	19.7	48.9	257
1987	31.4	12.6	55.9	1,041
1988	13.5	14.2	58.5	646
1989	33.8	12.2	53.9	765
1990	31.3	12.2	59.5	1,169
1991	31.8	10.1	57.9	1,057
1992	31.1	14.6	57.9	1,037
1993	32.3	12.8	58.3	772
1994	32.2	20.1	65.4	829
1995	31.2	14.6	53.5	959
1996	31.3	20.1	56.0	670
1997	30.5	12.6	54.6	1,814
1998	32.4	13.9	57.8	1,062
1999	32.9	18.3	50.2	452
2000	33.7	19.3	69.6	831
2001	37.0	22.4	59.1	800
2002	34.6	22.7	54.2	218
2003	32.8	20.2	55.0	268
2004	32.2	13.2	55.5	247
2005	29.6	21.7	53.3	277
2006	32.0	19.2	59.2	269
2007	31.1	21.3	49.3	320
2008	30.1	20.6	47.9	317
2009	32.7	21.0	46.9	168
2010	32.5	25.0	50.0	83
2011	34.1	28.0	51.0	36
2012	32.9	23.5	51.0	74
2013	32.6	23.5	54.8	38
2014	38.7	23.9	53.1	106
2015	33.3	22.2	52.9	93
2016	30.4	12.2	60.0	213
2017	31.9	13.4	48.9	278
2018	30.3	14.6	60.4	365
2019	29.7	10.2	49.8	369
2020	31.6	10.4	54.4	363
2021	31.7	17.8	48.4	306
2022	31.8	17.1	50.6	128

Table 4. King mackerel length (fork length, inches) data from commercial fish house samples, 1997–2022.

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Total Number Measured
1997	30.3	21.9	47.2	152
1998	30.0	20.9	42.3	240
1999	30.1	16.3	50.4	722
2000	30.4	16.7	48.8	872
2001	31.8	20.3	51.2	729
2002	33.0	24.0	46.5	217
2003	29.2	21.3	44.1	204
2004	31.5	22.0	45.3	448
2005	29.5	19.7	47.2	397
2006	31.0	21.5	49.4	277
2007	29.3	13.6	48.0	331
2008	27.6	22.2	49.8	1,676
2009	28.4	15.1	55.1	1,005
2010	33.8	23.2	52.6	193
2011	33.1	23.4	48.8	643
2012	32.4	23.1	53.0	313
2013	34.1	24.1	45.5	89
2014	29.8	18.1	47.6	420
2015	32.8	14.7	46.9	229
2016	29.4	20.3	54.3	360
2017	28.4	13.6	53.3	994
2018	28.8	22.6	43.3	459
2019	29.5	16.0	49.8	1,136
2020	30.2	15.7	46.9	439
2021	29.1	17.2	47.2	917
2022	32.9	25.0	60.2	550

Table 5. King mackerel length (fork length, inches) fishery-dependent data collected by DMF for ageing by the NOAA Southeast Fisheries Science Center, 1997–2022.

Year	Mean Fork Length	Minimum Fork Length	Maximum Fork Length	Total Number Measured
1997	35.4	12.6	54.1	363
1998	37.6	21.7	60.2	458
1999	37.4	14.8	57.1	477
2000	38.7	24.3	56.1	541
2001	38.0	25.8	55.7	547
2002	38.2	23.8	54.9	477
2003	37.0	23.3	57.3	488
2004	38.0	13.5	56.7	467
2005	37.3	19.6	55.1	444
2006	37.7	17.0	54.1	435
2007	37.9	19.2	54.7	507
2008	34.3	23.4	53.7	450
2009	36.0	24.2	55.1	415
2010	37.9	23.2	57.2	386
2011	37.4	23.4	57.0	429
2012	37.6	23.1	55.9	597
2013	40.2	24.1	56.3	413
2014	40.0	4.6	59.1	388
2015	39.1	4.4	54.4	446
2016	35.2	13.3	54.3	482
2017	35.8	15.4	56.3	663
2018	36.3	11.0	54.3	568
2019	35.5	17.5	56.3	695
2020	36.2	19.5	56.5	520
2021	36.9	15.9	57.1	549
2022	39.1	21.7	57.3	483

Table 6. Summary of N.C. Marine Fisheries Commission management strategies for king mackerel.

Management Strategy	Implementation Status
Prohibits Purse Gill Nets when taking king or Spanish mackerel	Rule 15A NCAC 03M .0512
24-inch fork length minimum size limit. Three fish recreational creel limit. Commercial Vessel Permit requirements. Commercial trip limit of 3,500 pounds of king, Spanish, or aggregate. Charter vessels or head boats with Commercial Vessel Permit must comply with possession limits when fishing with more than three persons 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-238-2022

**FIGURES**

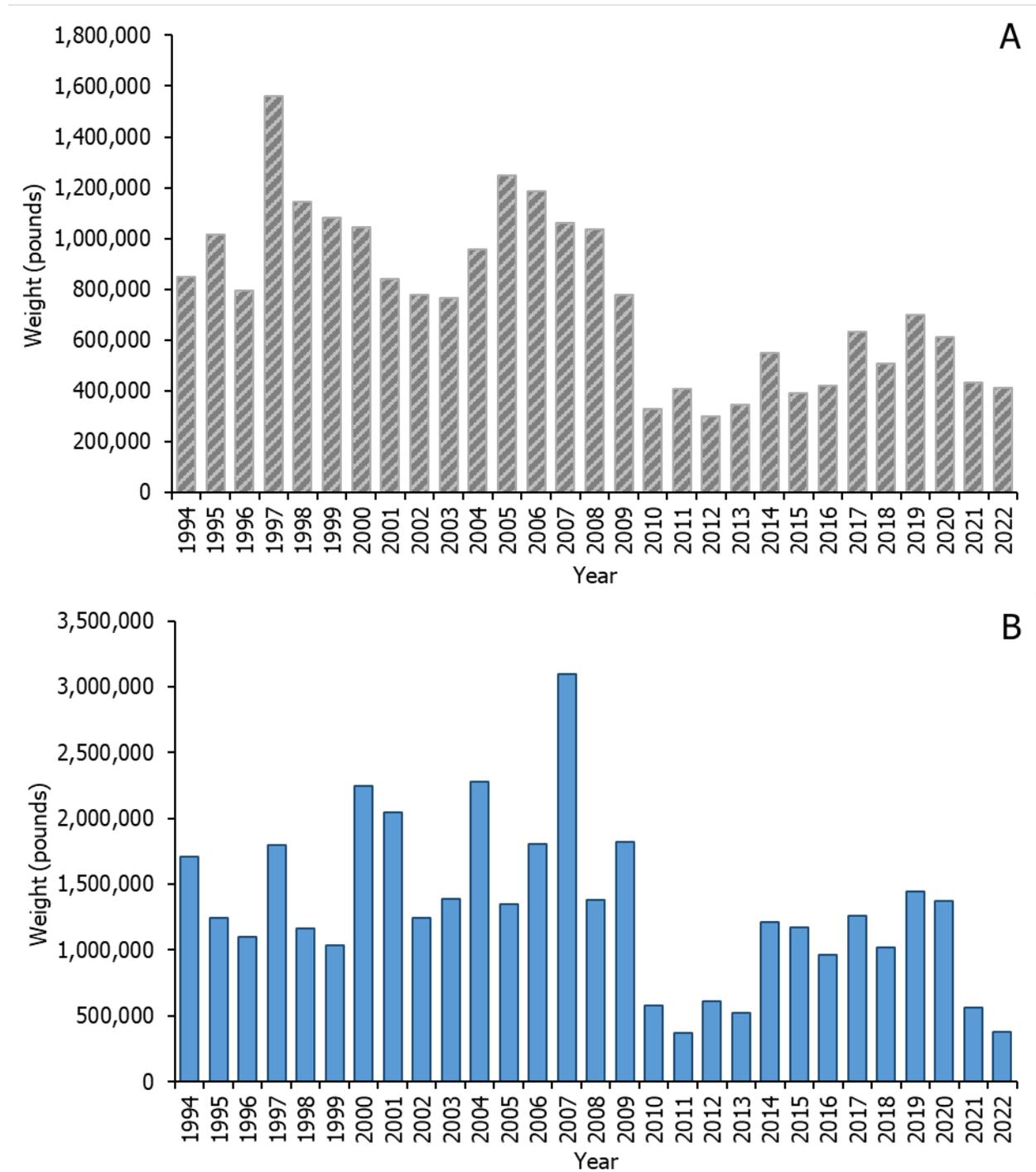


Figure 1. Annual commercial (A) and recreational (B) landings in pounds for king mackerel in North Carolina, 1994–2022.

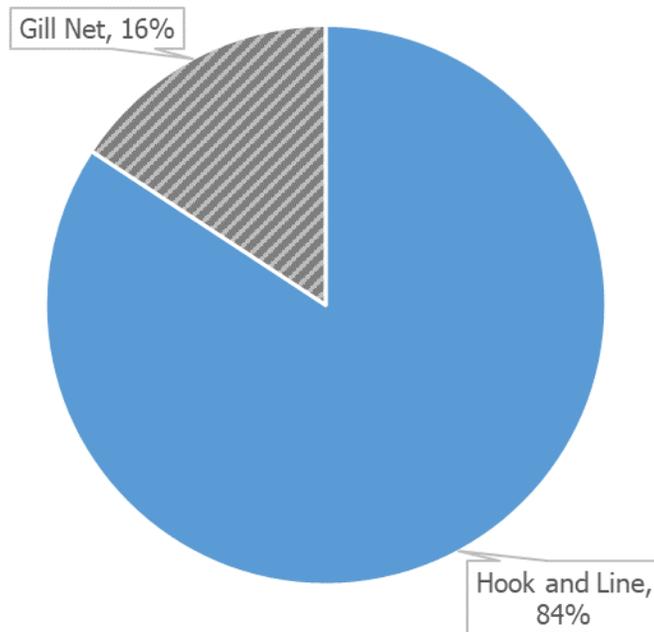


Figure 2. Commercial harvest of king mackerel by gear, 2022.

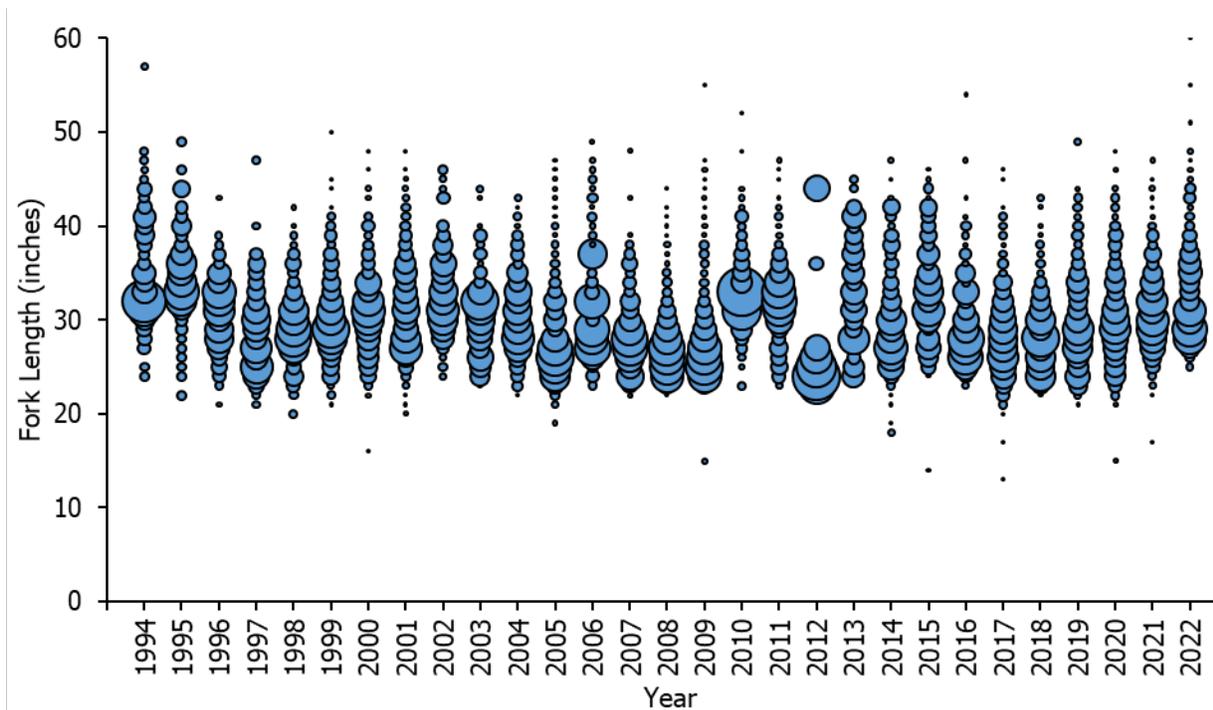


Figure 3. Commercial length frequency (fork length, inches) of king mackerel, 1994–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

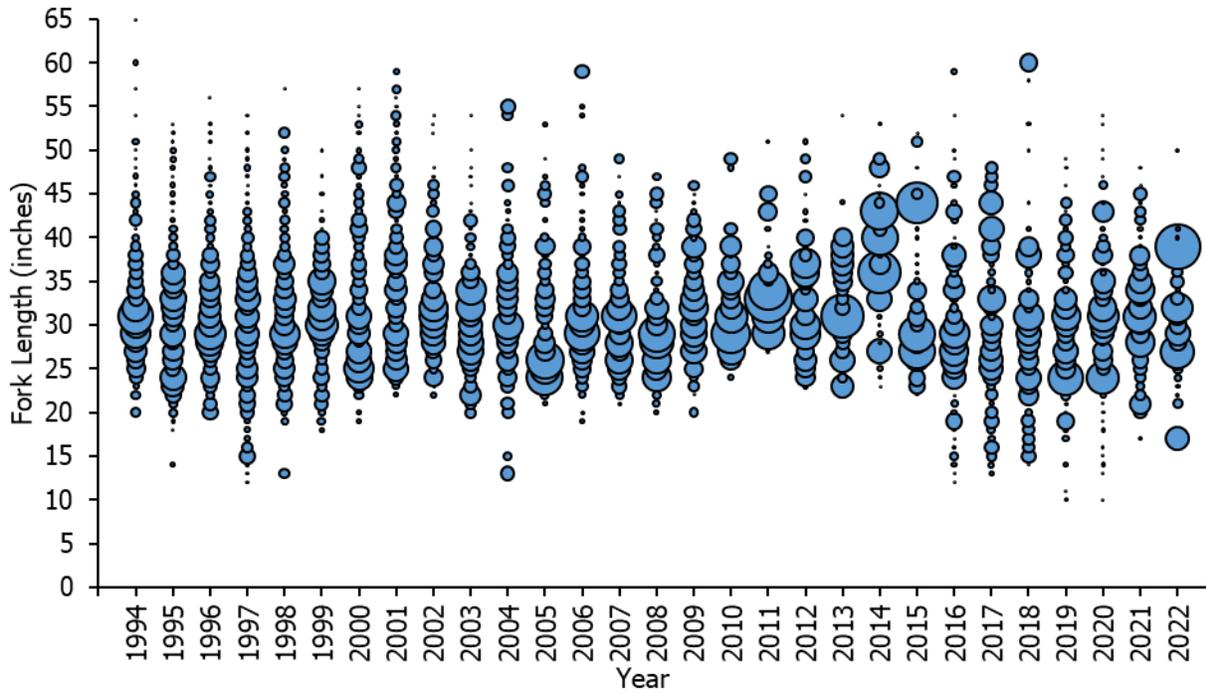


Figure 4. Recreational length frequency (fork length, inches) of king mackerel, 1994–2022 Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

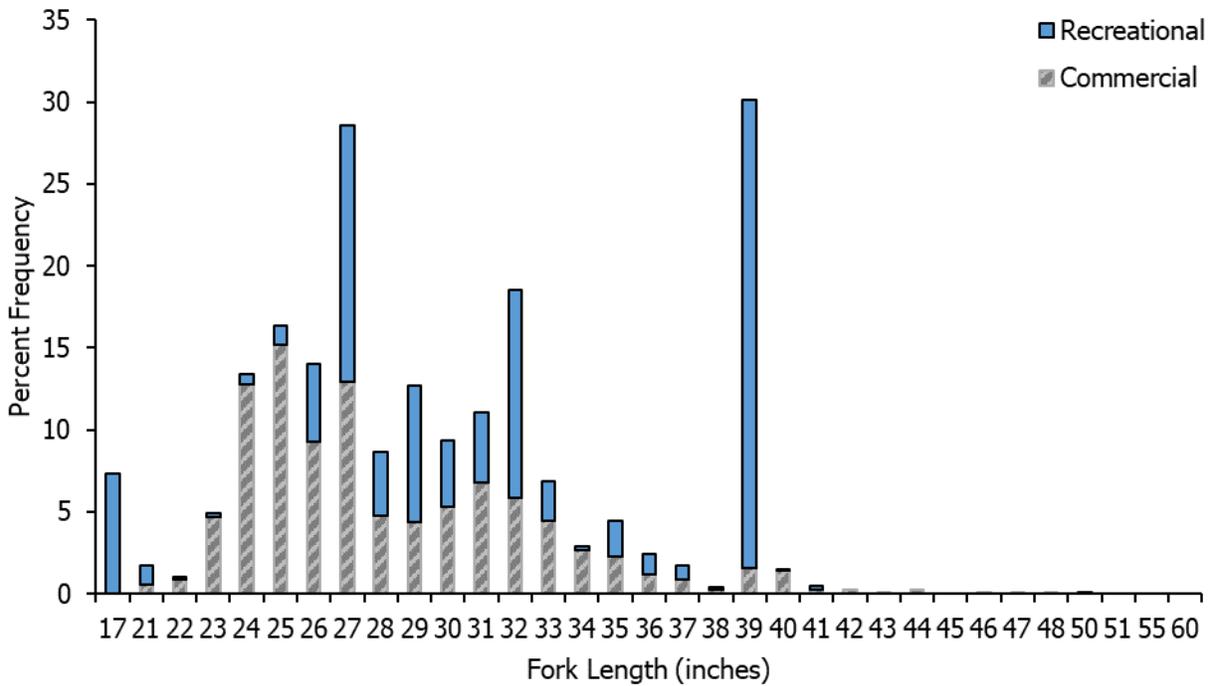


Figure 5. Commercial and recreational length frequency distribution from king mackerel harvested in 2022.

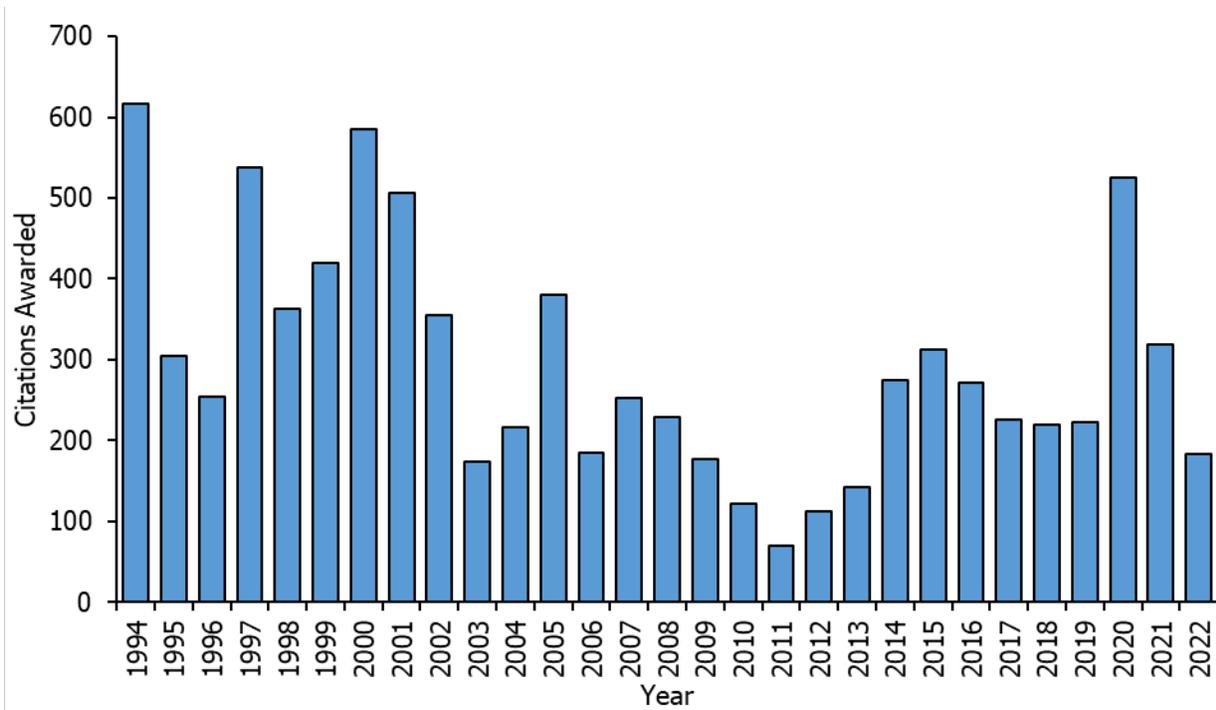


Figure 6. North Carolina Saltwater Fishing Tournament citations awarded for king mackerel, 1994–2022. Citations are awarded for king mackerel greater than 30 pounds or 45 inches fork length.

**FISHERY MANAGEMENT PLAN UPDATE  
SCUP NORTH OF CAPE HATTERAS  
AUGUST 2023**

**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	1996
	Regulatory Amendment	1996
	Amendment 10	1997
	Amendment 11	1998
	Amendment 12	1999
	Framework 1	2001
	Addendum III	2001
	Addendum IV	2001
	Addendum V	2002
	Addendum VII	2002
	Framework 3	2003
	Framework 4	2003
	Addendum IX	2003
	Addendum X	2003
	Amendment 13	2003
	Framework 5	2004
	Addendum XI	2004
	Addendum XIII	2004
	Addendum XVI	2005
	Framework 7	2007
	Addendum XIX	2007
	Amendment 14	2007
	Amendment 16	2007
	Addendum XX	2009
	Amendment 15	2011
	Amendment 19	2013
	Amendment 17	2015
	Amendment 18	2015
	Framework 9	2016
	Amendment 20	2017
	Addendum XXIX	2017
	Framework 10	2017
	Framework 11	2018
	Framework 12	2018
	Framework 13	2018

Framework 14	2019
Framework 15	2020
Framework 16	2020
Amendment 22	2022
Framework 17 & Addendum XXXIV	2022/2023

Comprehensive Review: 2023

Because of their presence in, and movement between, state waters (0-3 miles) and federal waters (3-200 miles), the Mid-Atlantic Fishery 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. Scup went through preliminary FMP development from 1978-1993 by the MAFMC. In 1995 MAFMC and ASMFC adopted the scup FMP but sequentially NMFS requested that the scup regulations be incorporated into another FMP to reduce the number of separate fisheries regulations. As a result, the scup FMP was incorporated into the summer flounder FMP as Amendment 8.

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 permit; 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.

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 ASMFC's Summer

Flounder, Scup, and Black Sea Bass 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 ASMFC's Summer Flounder, Scup, and Black Sea Bass Management Boards decisions on regulations.

Addendum V created state-specific shares of the summer period quota that will remain in place until the ASMFC's Summer Flounder, Scup, and Black Sea Bass 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 quotas 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.

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 the 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 year's end.

Amendment 15 established annual catch limits and accountability measures.

Amendment 19 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.

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 Council 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.

Framework 13 modified the accountability measures required for overages not caused by directed landings (i.e., discards) in the summer flounder, scup, and black sea bass fisheries.

Framework 14 gives the Mid-Atlantic Council the option to waive the federal recreational black sea bass measures in favor of state measures through conservation equivalency; implements a transit zone for commercial and recreational summer flounder, scup, and black sea bass fisheries in Block Island Sound; and allows for the use of a maximum size limit in the recreational summer flounder and black sea bass fisheries.

Framework 15 established a requirement for commercial vessels with federal permits for all species managed by the Mid-Atlantic and New England Councils to submit vessel trip reports electronically within 48 hours after entering port at the conclusion of a trip.

Framework 16 modified MAFMC's ABC control rule and risk policy. The revised risk policy is intended to reduce the probability of overfishing as stock size falls below the target biomass while allowing for increased risk and greater economic benefit under stock biomass conditions. This action also removed the typical/atypical species distinction currently included in the risk policy.

Amendment 22 revised the commercial and recreational sector allocations for all three species.

Framework 17/Addendum XXXIV Recreational Harvest Control Rule established a new process for setting recreational bag, size, and season limits (i.e., recreational measures) for summer flounder, scup, black sea bass, and bluefish. This action also modified the recreational accountability measures for these species.

Specific details for each Amendment under development include:

Summer Flounder, Scup, and Black Sea Bass Commercial/Recreational Allocation Amendment was jointly approved in December 2021 and selected preferred alternatives for each species. In 2022 the amendment was sent for submission to NMFS. For scup, this amendment allocates 65% of the acceptable biological catch (ABC) to the commercial annual catch limit and 35% to the recreational annual catch limit.

The Recreational Harvest Control Rule Framework/Addenda has been submitted to NOAA for review, approval, and implementation. The Addenda proposed different approaches for setting recreational measures. These differences have implications for how often measures would change and the magnitude of those changes. This Addenda will not implement any specific bag, size, or season limits but will modify the specification process for setting specific measures. The Council and Policy Board approved a range of alternatives, the selected management option is referred to as the "Percent Change Approach". This management option will be in place with an agreement to continue development of several other options for possible implementation by 2026. Under this selected approach, it will be determined whether recreational measures should be restricted, liberalized, or remain unchanged for the next two years. For further information on the Harvest Control Rule, refer to [asmfc.org](http://asmfc.org).

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. These plans were established under the Magnuson-Stevens Fishery Conservation and Management Act (federal council plans) and the Atlantic Coastal Fisheries Cooperative Management Act (ASMFC plans) with the goal, like the Fisheries Reform Act of 1997, to “ensure long-term viability” of these fisheries (NCDMF 2022).

## **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 Scup FMP are to:

- Reduce fishing mortality in the scup fisheries to assure that overfishing does not occur.
- Reduce fishing mortality on immature scup to increase spawning stock biomass.
- Improve the yield from these fisheries.
- Promote compatible management regulations between state and federal jurisdictions.
- Promote uniform and effective enforcement of regulations.
- 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 that 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 above objectives (1-5) in the future.

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

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 2020 scup operational stock assessment included data through 2018 and indicated that the stock was not overfished, and overfishing was not occurring in 2018. The 2021 management track stock assessment indicated that the scup stock status has not changed using data through 2019.

### **Stock Assessment**

The 2020 scup operational stock assessment and the 2021 scup management track assessment both estimated fishing mortality and stock sizes using a statistical catch-at-age model calculated by using the Age Structured Assessment Program. Both assessments 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. Spawning stock biomass was estimated to be 2 times above biomass reference points. The 2020 and 2021 stock assessment reports can be found on the scup page on the ASMFC website for further information.

## **DESCRIPTION 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 (DMF) proclamation].

Recreational: 9-inch fork length minimum size, 50-fish creel limit in state Atlantic Ocean and internal coastal waters north of Cape Hatteras, season is year-round. Beginning in April 2023 the minimum size remains 9-inches and a lower creel limit of 40-fish. In Federal waters north of Cape Hatteras the minimum size is 10-inches fork length, 40-fish creel limit, and a season shortened to May 1 – Dec 31.

### **Commercial Fishery**

All scup landings are reported through the North Carolina Trip Ticket Program. Flounder trawl is the main gear landing scup from north of Cape Hatteras (Figure 1). Annual landings were variable from 1994 through 2022 with very low landings during 2012, 2013, 2020, and 2022 (Table 1, Figure 2). Landings in 2022 were lower in 2021 but there were also half as many trips in 2022.

Low landings in 2012 to 2013 were partly due to shoaling at Oregon Inlet limiting access to large vessels (such as trawlers) and the consequent landing of most of North Carolina's scup in Virginia and other states. During 2014 through 2022, ocean trawl vessels returned to North Carolina (mainly Beaufort and Washington areas) to land catches rather than landing in Virginia and other states.

### **Recreational Fishery**

All scup harvest is reported through the National Oceanic and Atmospheric Administration (NOAA) Marine Recreational Information Program. Recreational estimates across all years have been updated and are now based on the new Marine Recreational Information Program (MRIP) Fishing Effort Survey-based calibrated estimates. For more information on MRIP see <https://www.fisheries.noaa.gov/topic/recreational-fishing-data>. Recreational harvest of scup north of Cape Hatteras was only reported in 1994, 2000, 2011, 2012 and 2015 (Table 1, Figure 2).

## **MONITORING PROGRAM DATA**

### **Fishery-Dependent Monitoring**

Two DMF sampling programs collect biological data on commercial and recreational fisheries that catch scup north of Cape Hatteras. Program 433 (Ocean 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. DMF sampling of the recreational fishery through the NOAA marine recreational information program collects harvest length data. There were no clear trends in commercial length data during 1994 through 2022. Annual mean lengths have been consistent since 2001 and 2022 was consistent with past years. The number of scup measured in 2022 decreased significantly than in prior years, which could be contributed to the low number of trips. (Table 2). Recreational harvest length data were only collected in 1994, 2000 and 2015 for scup north of Cape Hatteras. Only two fish in 1994, two fish in 2000, and one fish in 2015 were measured, very few scup are encountered in this fishery (Table 3). Age data have not been collected by DMF for scup north of Cape Hatteras as ASMFC has not requested it.

### **Fishery-Independent Monitoring**

DMF currently does not have independent sampling programs in the Atlantic Ocean or internal estuarine waters north of Cape Hatteras that encounter scup.

## **RESEARCH NEEDS**

Updated research needs from the 2015 60th Stock Assessment Workshop are provided below. The research needs listed below start with the most recent. Text in parentheses indicates known progress made to address needs.

- A standardized fishery dependent catch per unit effort for tows targeting scup, 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 at this time

- 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 at this time
- 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 at this time
- 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 at this time
- Explore study fleet data in general for information that could provide additional context and/or input for the assessment. — Progress unknown at this time
- 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 at this time
- Improve estimates of discards and discard mortality for commercial and recreational fisheries. — Some progress has been made
- Evaluate indices of stock abundance from new surveys. — Some progress has been made
- Quantify the pattern of predation on scup. — Some progress has been made
- Conduct biological studies to investigate maturity schedules and factors affecting annual availability of scup to research surveys. — Some progress has been made
- 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. — Some progress has been made
- Evaluate alternate forms of survey selectivity in the assessment to inform indices of abundance at higher ages. — Some progress has been made
- Evaluation of indicators of potential changes in stock status that could provide signs to managers of potential reductions of stock productivity in the future would be helpful. — Some progress has been made
- A management strategy for evaluation of alternative approaches to setting quotas would be helpful. — Progress unknown at this time
- 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. — Some progress has been made
- 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. — Progress has been made and research is ongoing

- Quantification of the biases in sampling of 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 at this time
- 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 different commercial gear types should be conducted to more accurately quantify the magnitude of scup discard mortality. — Progress unknown at this time

## MANAGEMENT STRATEGY

Scup stock assessments are completed by the NMFS Northeast Fisheries Science Center (NEFSC). Results from the 2020 stock assessment update are used to guide management. Data are analyzed from the previous year based on decisions made for the benchmark assessment. 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. Beginning in 2023, catch-based allocations will continue, and revised allocations will be implemented with 65 percent being commercial and 35 percent being recreational. 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 during the winter seasons (January-April; October-December) and state specific during the summer season (May-September).

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## TABLES

Table 1. Recreational harvest (number of fish landed and weight in pounds) and releases (number of fish) and commercial harvest (weight in pounds) of scup (north of Cape Hatteras) from North Carolina for the period 1994 – 2022. Note: \* represents confidential data.

Year	Recreational			Commercial	Total Weight (lb)
	Numbers Landed	Numbers Released	Weight Landed (lb)	Weight Landed (lb)	
1994	827	1,231	365	304,350	304,715
1995	0	0	0	23,872	23,872
1996	0	1,267	0	58,559	58,559
1997	0	0	0	1,292	1,292
1998	0	0	0	14,718	14,718
1999	0	0	0	0	0
2000	165	0	169	0	169
2001	0	0	0	0	0
2002	0	0	0	*	*
2003	0	0	0	142,996	142,996
2004	0	0	0	523,554	523,554
2005	0	0	0	351,609	351,609
2006	0	0	0	139,420	139,420
2007	0	0	0	66,856	66,856
2008	0	0	0	205,703	205,703
2009	0	0	0	244,020	244,020
2010	0	0	0	102,745	102,745
2011	181	0	200	308,883	309,083
2012	521	0	516	3,903	4,419
2013	0	0	0	28,394	28,394
2014	0	0	0	160,399	160,399
2015	3,446	0	380	229,664	230,044
2016	0	0	0	111,901	111,901
2017	0	0	0	199,711	199,711
2018	0	0	0	78,944	78,944
2019	0	0	0	216,632	216,632
2020	0	0	0	38,719	38,719
2021	0	0	0	54,118	54,118
2022	0	0	0	18,275	18,275
Mean	177	86	56	125,859	125,915

Table 2. Scup (north of Cape Hatteras) length (fork length, inches) data from commercial fish house samples in North Carolina, 1994-2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1994	9	4	15	3,342
1995	9	7	12	169
1996	10	8	14	76
1997	5	4	16	176
1998	9	7	13	66
1999	6	5	7	3
2000	7	5	12	25
2001	10	8	14	35
2002	10	9	13	393
2003	11	4	16	1,210
2004	10	6	16	2,584
2005	11	4	15	1,817
2006	11	6	15	1,568
2007	11	7	16	1,659
2008	11	7	16	3,493
2009	11	6	16	1,740
2010	11	8	15	1,450
2011	11	8	16	1,076
2012	13	11	16	7
2013	10	8	15	261
2014	11	8	17	2,725
2015	11	5	17	2,998
2016	11	6	15	1,175
2017	11	8	16	2,879
2018	11	7	17	1,940
2019	11	6	17	3,037
2020	11	8	15	891
2021	11	7	16	1,628
2022	10	8	14	291

Table 3. Scup (north of Cape Hatteras) length (fork length, inches) data from NOAA Marine Recreational Information Program recreational samples in North Carolina, 1994-2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1994	7	7	9	2
1995	0	0	0	0
1996	0	0	0	0
1997	0	0	0	0
1998	0	0	0	0
1999	0	0	0	0
2000	11	11	11	2
2001	0	0	0	0
2002	0	0	0	0
2003	0	0	0	0
2004	0	0	0	0
2005	0	0	0	0
2006	0	0	0	0
2007	0	0	0	0
2008	0	0	0	0
2009	0	0	0	0
2010	0	0	0	0
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
2014	0	0	0	0
2015	4	4	4	1
2016	0	0	0	0
2017	0	0	0	0
2018	0	0	0	0
2019	0	0	0	0
2020	0	0	0	0
2021	0	0	0	0
2022	0	0	0	0

## FIGURES

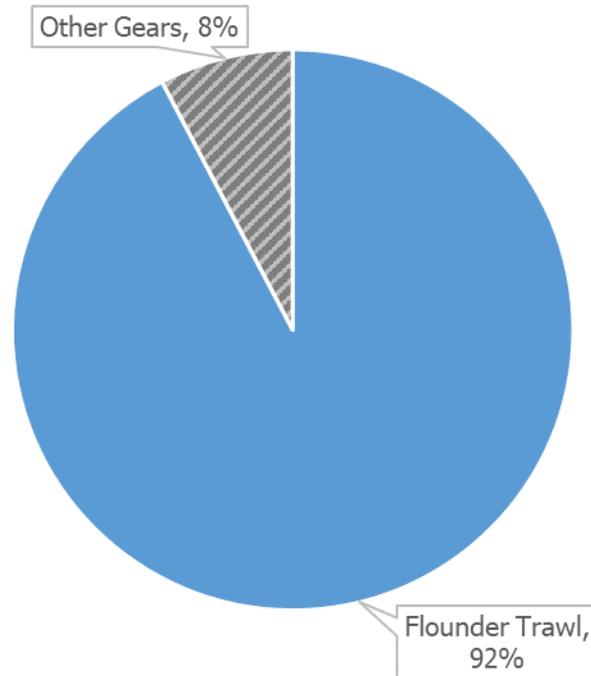


Figure 1. Commercial harvest of scup (north of Cape Hatteras) in North Carolina by gear type in 2022. Note: data for Other Gears are confidential data.

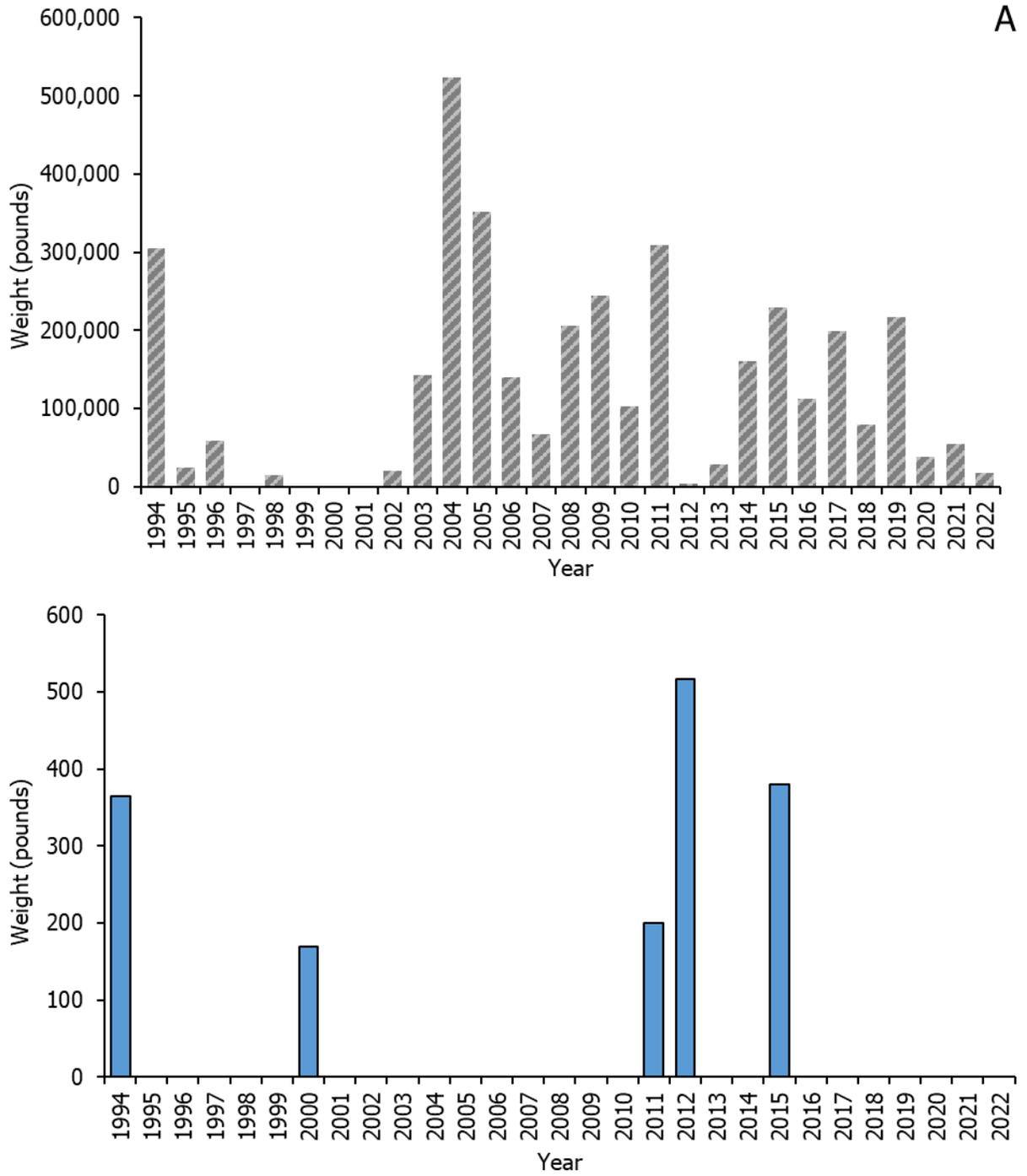


Figure 2. Annual commercial (A) and recreational (B) landings in pounds for scup (north of Cape Hatteras) in North Carolina from 1994-2022.

**FISHERY MANAGEMENT PLAN UPDATE  
COASTAL SHARKS  
AUGUST 2022**

**STATUS OF THE FISHERY MANAGEMENT PLAN**

**Fishery Management Plan History**

FMP Documentation:	August 2008	
	Addendum I	September 2009
	Addendum II	May 2013
	Addendum III	October 2013
	Addendum IV	August 2016
	Addendum V	October 2018
Comprehensive Review:	2023: Blue shark (ICCAT)	
	2023: Hammerhead sharks Complex (SEDAR 77)	

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. Prior to the ASMFC FMP, sharks were domestically managed exclusively under National Marine Fisheries Service (NMFS) FMPs (NOAA Fisheries 1993; NOAA Fisheries 1999; NOAA Fisheries 2006). Atlantic highly migratory species (HMS), which includes sharks, are also managed internationally by the International Commission for the Conservation of Atlantic Tunas (ICCAT). The ASMFC 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 NMFS openings and closures for all shark species and management groups.

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.

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 weight 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 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% smooth dogfish, consistent with federal management measures.

Addendum V (ASMFC 2018a) allows the ASMFC to streamline the process of state implementation of federal shark regulations so that complementary measures are seamlessly and concurrently implemented at the state and federal level whenever possible. Previously, any changes, with the exception of those related to commercial quotas, possession limits and season dates, had to be accomplished through an addendum.

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 North Carolina 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 2022).

### **Management Unit**

The management unit includes the entire coast-wide 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. The management units for pelagic sharks and sandbar sharks (Shark Research Fishery) are not split by region; the respective management units are the Atlantic and Gulf of Mexico combined.

### **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:

- Reduce fishing mortality to rebuild stock biomass, prevent stock collapse, and support a sustainable fishery.
- Protect essential habitat areas such as nurseries and pupping grounds to protect sharks during particularly vulnerable stages in their life cycle.
- Coordinate management activities between state and federal waters to promote complementary regulations throughout the species’ range.

- Obtain biological and improved fishery related data to increase understanding of state water shark fisheries.
- Minimize endangered species bycatch in shark fisheries.

## DESCRIPTION OF THE STOCK

### Biological Profile

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 rates are 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 (2–25) of 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 individual species when sufficient data is available (Table 1). For species that are data-limited, they are either assessed at the species complex level or have not been assessed. 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; NOAA Fisheries 2022). These reports are required under the Magnuson-Stevens Fishery Conservation and Management Act and provide the public with information on the latest updates in Atlantic HMS management.

## Stock Assessment

Stock status varies between species and species group (Table 1). In 2015 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 Coastal Shark Management Board of ASMFC (the Board) approved the blacknose shark assessment for management use in February 2012 and NOAA Fisheries' Highly Migratory Species Division incorporated the results of the assessment as part of Amendment 5a to its FMP (NOAA Fisheries 2013). The dusky shark stock assessment was updated in 2016 and resulted in a determination of the population being overfished with overfishing occurring (SEDAR 2016). In 2017, a new sandbar shark stock assessment was conducted through SEDAR and the same status as the 2011 assessment was determined that the population was overfished but overfishing was not occurring (SEDAR 2017).

The 2007 SEDAR 13 assessed the SCS complex, finetooth (*Carcharhinus isodon*), Atlantic sharpnose (*Rhizoprionodon terraenovae*), and bonnethead (*Sphyrna tiburo*) sharks (SEDAR 2007). 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 (SEDAR 2013). Atlantic sharpnose status remained as not overfished or undergoing overfishing. Based on SEDAR 34, bonnethead were not overfished or undergoing overfishing. However, the assessment combined the Gulf of Mexico stock and the Atlantic stock for the assessment. Because data shows that they are in fact two separate stocks, the results of the assessment were rejected and the status of the Atlantic stock is officially considered unknown.

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. A new stock assessment for Atlantic blacktip sharks was completed in December 2020 (SEDAR 65) and the stock assessment concluded that the stock is not overfished and overfishing is not occurring.

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 (ICCAT 2017). The next stock assessment is scheduled for 2024.

Porbeagle sharks (*Lamna nasus*) were assessed by ICCAT in 2009 (ICCAT 2009). 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 most recent porbeagle shark stock assessment, which was completed in 2020, came to the same determination as the 2009 stock assessment; the northwest Atlantic stock is overfished but overfishing is not occurring (ICCAT 2020; NOAA Fisheries 2021).

The most recent blue shark stock assessment was completed in 2015 ICCAT (ICCAT 2015). The assessment found that domestically, the north Atlantic stock is not overfished and overfishing is not occurring. The international north Atlantic stock is not likely overfished and overfishing is not likely occurring. The next stock assessment is scheduled for 2023.

A 2009 stock assessment for the Northwest Atlantic and Gulf of Mexico populations of scalloped hammerhead sharks (*Sphyrna lewini*) indicated the stock is overfished and experiencing overfishing (Hayes et al. 2009). This assessment was reviewed by NOAA Fisheries and deemed appropriate to serve as the basis for U.S. management decisions (SEFSC 2010). In response to the assessment findings, NOAA Fisheries established a scalloped hammerhead rebuilding plan that will end in 2023. Since the assessment, research has determined that a portion of animals considered scalloped hammerheads in the US Atlantic are actually a cryptic species, recently named the Carolina hammerhead (*Sphyrna gilberti*; Quattro et al. 2013). Little to no species-specific information exists regarding the distribution, abundance, and life history of the two species. Therefore, both species are currently managed under the name scalloped hammerhead. The stocks of the species in the hammerhead complex (scalloped, Carolina, great, smooth) will be assessed through SEDAR 77. Completion is scheduled for spring 2023 (SEDAR 2021).

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

All non-prohibited shark management groups opened in North Carolina on January 1, 2022 (Table 2) reflecting NOAA Fisheries openings. Commercial fishing shark management groups are outlined in Table 3. NOAA Fisheries closes the management groups' fisheries when 80% 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 for LCS, but there is a retention limit that is set and changed by NOAA fisheries based on available quota. 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% smooth dogfish. If fins are removed, the total wet weight of the shark fins may not exceed 12% of the total dressed weight (dw) of smooth dogfish carcasses landed or found onboard a vessel. It is unlawful for a vessel to retain, transport, 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 inches) gill net more than 2,734 yards in length to capture sharks. It is unlawful to sell sharks 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 available quotas (Table 2). In March 2019, NOAA HMS implemented final measures to address the overfishing and overfished condition of Atlantic shortfin mako under Amendment 11 to the HMS FMP (NOAA Fisheries 2019). The rules respond to the determination by ICCAT that all member countries need to reduce shortfin mako landings by 72-79% to prevent further population decline. The final commercial rule as implemented allows for Atlantic shortfin mako commercial retention only by properly permitted operations using pelagic longline and gillnet gear and only if the shark is dead at haul back. Additionally, retention by pelagic longline gear is only allowed if a functional electronic monitoring system is on board the vessel. Recreational measures included an increase in the minimum size limit from 54 inches FL to 71 inches FL for males and to 83 inches FL for females. In April of 2019, the ASMFC Coastal Shark Board adopted complementary size limit measures for the recreational fishery in state waters to provide consistency with size limits in federal waters. In May 2022, the Board approved a zero-retention limit in state waters for Atlantic shortfin mako sharks for both recreational and commercial fisheries. These measures are consistent with those implemented by NOAA Fisheries for federal highly migratory species (HMS) permit holders based on the International Commission for the Conservation of Atlantic Tunas (ICCAT) recommendation. This action was taken in response to the 2019 Atlantic shortfin mako stock assessment data update that indicates the resource is overfished and experiencing overfishing, with a rebuild date of 2070. This rule took effect federally on July 5, 2022, and at the state level on July 11, 2022. Additionally, in 2019 the Board moved to require non-offset circle hooks for the recreational shark fishery in state waters with an implementation date of July 1, 2020. The Board chose to do so after NOAA Fisheries requested that the states implement a circle hook requirement for the recreational fishery consistent with the measures approved in HMS Amendment 11. Species authorized for recreational harvest are listed in Table 4 based on management group and recreational size and bag limits are described in Table 5.

### **Commercial Fishery**

Table 2 summarizes preliminary coast-wide Atlantic commercial landings data from 2022. Shark management groups with Atlantic region quotas are LCS, hammerhead, non-blacknose SCS, blacknose, and smoothhound. Commercial landings of LCS totaled 54,063 pounds, dressed weight (lb, dw) in 2022, which was a decrease from 176,753 lb, dw from 2021. Total commercial landings of hammerhead sharks were 34,856 lb, dw in 2022, which was a decrease from 42,933 lb, dw reported in 2021. Commercial landings of non-blacknose SCS shark species in 2022 totaled 35,608 lb, dw, a large decrease from 231,876 lb, dw landed in 2021. The commercial landings total of blacknose sharks south of 34° N latitude (Kure Beach, North Carolina) in 2022 was <4,408 lb, dw. Commercial retention of blacknose sharks is prohibited

north of 34° N latitude. Commercial landings of smoothhound sharks in 2022 were 26,199 lb, dw, which was a decrease from the 825,432 lb dw landed in 2021. Shark management groups with no regional quotas are sandbar (shark research fishery), blue, porbeagle, and other pelagics. There are no reported landings for porbeagle sharks in 2022. Commercial landings of blue sharks was <2,204 lb, dw. Other pelagic shark landings were 16,795 lb, dw. The shark research fishery landed 13,200 lb, dw of sandbar sharks and <2,204 lb, dw of LCS.

In North Carolina, total shark commercial landings steadily decreased since 2014 (Figure 1; Table 6). Smoothhound shark landings have steadily decreased from 783,052 lb, dw in 2013 to 27,686 lb, dw in 2021. Peak harvest of pelagic sharks was highest in 2014 (424,531 lb, dw) and there has been an overall decreasing trend. Similarly, peak harvest of SCS was in 2019 (479,484 lb, dw) and has decreased since. In 2022, 44,298 lb, dw of pelagic sharks were landed. While total shark landings have decreased, landings of hammerheads have generally increased. LCS (non-hammerhead) harvest has fluctuated annually but has been consistent over the last ten years. In 2022, LCS landings totaled 213,172 lb, dw.

### **Recreational Fishery**

Recreational harvest estimates for SCS in North Carolina has fluctuated in the past 10 years from a low of 2,545 pounds in 2017 to a peak in harvest of 106,765 pounds in 2019 (Table 7). The 2022 landings (16,909 pounds) were less than the 10-year average (27,596 pounds). Recreational harvest for LCS in North Carolina tends to be smaller than for SCS. In 2022, there were no estimated harvests of LCS. From 2013 to 2023, average annual harvest was 5,491 lb, dw (Table 8). Recreational harvest of pelagic sharks in North Carolina is highly variable. Harvest was 0 pounds in 2022 and has ranged from 0 to 479,443 pounds from 2013 to 2023 (Table 9). Recreational harvest of smooth dogfish in North Carolina is variable and often low, although releases are common. Harvest for smoothhound ranged from 0 to 186,261 from 2013 to 2023 (Table 10). Recreational landing estimates for all shark species across all years have been updated and are now based on the Marine Recreational Information Program (MRIP) new Fishing Effort Survey-based calibrated estimates. Due to small sample sizes and the relatively rare occurrence of landings, the percent standard errors (PSE) is high for many years of recreational shark landings. For more information on MRIP methodology and changes see <https://www.fisheries.noaa.gov/topic/recreational-fishing-data>.

## **MONITORING PROGRAM DATA**

### **Fishery-Dependent Monitoring**

North Carolina does not collect individual lengths for sharks other than spiny dogfish; sharks arrive at the dock dressed (i.e., gutted with head and tail removed). Landings in pounds dw are recorded by the Trip Ticket Program.

### **Fishery-Independent Monitoring**

The North Carolina Division of Marine Fisheries (DMF) established a fishery-independent adult red drum longline survey in 2007 (P365) that operates in Pamlico Sound from July to October. Atlantic coastal shark species captured in the survey are measured, tagged, and released. In total,

seven coastal sharks were captured in P365 in 2022. DMF has conducted a fishery-independent gill net survey (P915) which has been conducted in Pamlico Sound since 2001. Sampling was expanded to the Pamlico, Pungo, and Neuse Rivers in 2003 and to the Cape Fear and New Rivers in 2008. Coverage was further expanded to Bogue, Back, and Core Sounds in 2018. The objective of this project is to provide annual indices of relative abundance for key estuarine species in North Carolina estuaries 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 DMF 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 DMF to assess the status of these stocks without relying solely on commercial and recreational fishery dependent data. The survey employs a stratified random sampling design and utilizes multiple mesh gill nets (3.0 inch to 6.5 inch stretched mesh, by 0.5-inch increments). In 2022, a total of 641 individual coastal sharks were captured in P915 (Table 11), which is more than the project's annual average of 286 individual sharks.

## **RESEARCH NEEDS**

The review of the ASMFC FMP (ASMFC 2022) directs to research needs from the 2018 ASMFC Research Priorities (ASMFC 2018):

### **Fishery-Dependent Priorities**

- Initiate or expand dockside sampling for sharks to verify landings information and species composition.
- The Atlantic menhaden fishery data should be examined to determine shark bycatch estimates, if available.
- Conduct additional length sampling and age composition collection to improve information for developing selectivities.
- Shrimp trawl observer coverage should be expanded to 2 to 5% of total effort, particularly during periods of regulatory or gear changes. The observer coverage program should strive for even spatial coverage (particularly adding more south Atlantic coverage), randomness in vessel selection and full identification of elasmobranch species (continuing on from the 2009 Bycatch Characterization Protocol).
- Increase research on post-release survivorship of all shark species by gear type.
- Continue to acquire better species-specific landings information on number of species, by weight, from dealers.

### **Fishery-Independent 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 a fishery-independent porbeagle shark survey to provide additional size composition and catch rate data to calculate an index of abundance.
- All dealers must report landings by species.
- Recent bomb radiocarbon research has indicated that past age estimates based on tagging data for sandbar sharks may be correct and that vertebral ageing may not be the most reliable method for mature individuals.
- Develop a stock wide fishery-independent monitoring program in state coastal waters for
- Dusky sharks that include annual samples of length and age frequencies.

### **Life History, Biological, and Habitat Priorities**

- Re-evaluate finetooth life history in the Atlantic Ocean in order to validate fecundity and reproductive periodicity.
- 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.
- Examine female sharks during the spawning periods to determine the proportion of
- spawning female
- Continue life history studies for all species of the shark complex to allow for additional species specific assessments. Particularly, natural mortality, age, fecundity, and reproductive frequency. Update age, growth, and reproductive studies of blacknose sharks with emphasis on smaller individuals in the Atlantic and larger individuals in the Gulf of Mexico.
- Coordinate a biological study for Atlantic sharpnose so that samples are made at least monthly, and, within each month, samples would be made consistently at distinct geographic locations. For example, sampling locations would be defined in the northern Gulf, west coast of Florida, the Florida Keys (where temperature is expected to be fairly constant over all seasons), and several locations in the South Atlantic, including the east coast of Florida, Georgia, South Carolina, and North Carolina. This same sampling design could be applied to all small coastal sharks.
- Population level genetic studies are needed that could lend support to arguments for stock discriminations using new loci and/or methodology that has increased levels of sensitivity.
- Determine what is missing in terms of experimental design and/or data analysis to arrive at incontrovertible (to the extent that it may be scientifically possible) conclusions on the reproductive periodicity of the sandbar shark stock.

### **Management, Law Enforcement, and Socioeconomic Priorities**

- Conduct species specific assessments for all shark species, with a priority for smooth dogfish.

## 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 and management groups. The ASMFC adopts NOAA Fisheries regulations in state waters.

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## TABLES

Table 1. 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	2020: Rebuilding ends in 2108
Blue	No	No	2015
Shortfin Mako	Yes	Yes	2017
All other pelagic species	Unknown	Unknown	
<i>Large Coastal Sharks</i>			
Blacktip	No	No	2020
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	Unknown	Unknown	2013
Finetooth	No	No	2007
<i>Hammerhead</i>			
Scalloped	Yes	Yes	2009: Rebuilding ends in 2023
<i>Blacknose</i>			
Blacknose	Yes	Yes	2011: Rebuilding ends in 2043
<i>Smoothhound</i>			
Smooth Dogfish	No	No	2015
<i>Research</i>			
Sandbar	Yes	No	2017: Rebuilding ends 2070
<i>Prohibited</i>			
Dusky	Yes	Yes	2016: Rebuilding ends in 2107
All other prohibited species	Unknown	Unknown	

Table 2. Preliminary 2022 (through May 31, 2022) coast-wide Atlantic coastal shark commercial fishery landings (Atlantic Coastal Cooperative Statistics Program, ACCSP) and annual quota.

Management Group	Region	2023 Quota (lb dw)	Season	2022 Landings (lb dw)
Aggregated LCS	Atlantic	372,552	1/1/2022 – 12/31/2022	54,063
Hammerhead		59,736		34,856
Non-Blacknose SCS		582,333		35,608
Blacknose (South of 34° N. latitude only)		37,921		<4,408
Smoothhound		3,973,902		26,199
Sandbar (shark research fishery)	No Regional Quotas	199,943		<13,200
Blue		601,856		<2,204
Porbeagle		3,748		0
Other pelagics <sup>1</sup>		1,075,856		16,795

<sup>1</sup> As of July 5, 2022, the shortfin mako shark retention limit in all commercial and recreational Atlantic HMS fisheries is zero ([87 FR 39373, July 1, 2022](https://www.federalregister.gov/documents/2022/07/01/2022-13111)).

Table 3. List of commercial shark management groups.

Management Group	Species Within Group
Prohibited	Sand tiger, bigeye sand tiger, whale, basking, white, dusky, bignose, Galapagos, night, reef, narrowtooth, Caribbean sharpnose, smalltail, Atlantic angel, longfin mako, bigeye thresher, sharpnose sevengill, bluntnose sixgill, and bigeye sixgill
Research	Sandbar
Non-Blacknose Small Coastal	Atlantic sharpnose, finetooth, and bonnethead
Blacknose	Blacknose
Aggregated Large Coastal	Silky, tiger, blacktip, spinner, bull, lemon, and nurse
Hammerhead	Scalloped hammerhead, great hammerhead, and smooth hammerhead
Pelagic	Shortfin mako <sup>1</sup> , common thresher, oceanic whitetip <sup>3</sup> , porbeagle <sup>2</sup> , and blue <sup>2</sup>
Smoothhound	Smooth dogfish (referred to as smoothhound throughout this report)

<sup>1</sup>As of July 5, 2022, the shortfin mako shark retention limit in all commercial and recreational Atlantic HMS fisheries is zero ([87 FR 39373, July 1, 2022](#)).

<sup>2</sup>Although porbeagle and blue sharks are in the Pelagic Management Group, they each have their own quota.

<sup>3</sup>A rule proposed in March 2023 would prohibit the commercial and recreational retention of oceanic whitetip

Table 4. 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 <sup>1</sup> Porbeagle Thresher	Smoothhound shark (Smooth dogfish) Spiny dogfish

<sup>1</sup>A rule proposed in March 2023 would prohibit the commercial and recreational retention of oceanic whitetip

Table 5. Recreational size and bag limits (as of January 1, 2023). Non-listed species are prohibited.

RECREATIONAL SIZE / BAG LIMITS and SEASONS			
Species*	Minimum Size (FL, inches)	Trip Bag Limit/Calendar Day	Season
Atlantic sharpnose	None	1 per person of each species	Jan. 1 – Dec. 31
Bonnethead	None		
Smooth dogfish	None	None	
Spiny dogfish	None	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"		

\*Check [DMF proclamations](#) for most current regulations

Table 6. Summary of North Carolina commercial landings (pounds) for large coastal sharks (LCS), small coastal sharks (SCS), hammerheads, smoothhound, and pelagics, 2013–2022. In this table, sandbar shark landings are included with the LCS and SCS includes blacknose landings.

Year	LCS (non-hammerhead)	SCS	Hammerhead	Smoothhound	Pelagics	Total
2013	157,340	140,798	14,428	783,053	220,872	1,316,491
2014	340,708	204,572	28,264	498,904	424,531	1,496,978
2015	197,948	375,026	41,768	268,429	176,882	1,060,053
2016	288,081	371,140	62,135	178,694	224,746	1,124,796
2017	216,142	359,486	40,743	154,440	240,128	1,010,939
2018	201,146	430,382	55,004	209,760	125,993	1,022,285
2019	263,269	479,484	65,104	102,592	69,182	979,631
2020	209,939	318,268	75,339	49,286	99,468	752,300
2021	165,005	297,193	85,966	42,147	44,648	634,959
2022	213,172	160,464	114,848	27,686	44,298	561,008

Table 7. North Carolina small coastal sharks recreational harvest, discards, and percent standard error (PSE) (including blacknose), 2013–2022.

Year	Number Harvested	PSE	Weight (lb)	PSE	Number Released	PSE
2013	2,171	45.9	13,474	48.0	16,772	42.1
2014	7,420	56.7	24,060	43.9	2,043	57.5
2015	6,656	41.3	38,499	44.3	15,866	70.4
2016	514	66.6	2,545	63.4	133,214	57.0
2017	5,768	56.5	19,256	42.3	58,440	60.5
2018	1,678	38.9	9,097	40.9	4,496	39.5
2019	13,736	70.8	106,765	75.8	34,952	36.1
2020	5,074	70.2	21,114	56.0	16,563	50.9
2021	3,556	57.7	24,241	53.9	21,045	44.9
2022	1,698	49.1	16,909	51.1	30,202	57.1

\*PSE higher than 50 indicates a very imprecise estimate

Table 8. North Carolina large coastal sharks recreational harvest, discards, and percent standard error (PSE), 2013–2022. Blank indicates years with estimated harvest of zero.

Year	Number Harvested	PSE	Weight (lb)	PSE	Number Released	PSE
2013	59	113.4	11,128	113.4	7,963	39.8
2014	556	89.4	10,194	91.4	20,647	39.2
2015	10	99.9			139,486	66.1
2016	12	101.0	1,100	101.0	27,885	54.3
2017	910	79.6	27,367	83.4	43,041	43.7
2018	39	84.5	235	95.8	4,916	59.3
2019	60	72.1	3,745	72.1	30,032	40.5
2020	26	74.6	551	100.8	8,567	36.0
2021	6	100.8	594	100.8	22,576	97.5
2022					18,735	98.4

\*PSE higher than 50 indicates a very imprecise estimate

Table 9. North Carolina pelagic sharks recreational harvest, discards, and percent standard error (PSE), 2013–2022. Blank indicates years with estimated harvest of zero.

Year	Number Harvested	PSE	Weight (lb)	PSE	Number Released	PSE
2013	28	100.8	1,219	100.8	1,865	97.1
2014	26	54.6	2,082	51.5	296	110.5
2015	5,097	76.1	479,443	75.9	987	91.8
2016					3,512	79.0
2017	66	64.1	4,917	62.2	33	86.2
2018	2,043	73.1	160,155	73.1	38	63.0
2019					888	65.7
2020						
2021	111	98.1			20	96.9
2022						

\*PSE higher than 50 indicates a very imprecise estimate

Table 10. North Carolina smoothhound recreational harvest, discards, and percent standard error (PSE), 2013–2022. Blank indicates years with estimated harvest of zero.

Year	Number Harvested	PSE	Weight (lb)	PSE	Number Released	PSE
2013	3,423	100.0	8,679	100.0	93,216	49.4
2014					110,938	35.6
2015	1,013	71.2	1,964	71.4	119,678	63.7
2016	10,879	92.6	186,261	97.0	97,256	44.9
2017					34,722	36.2
2018					29,524	49.3
2019	2,856	95.6	6,926	95.6	15,301	73.6
2020	1,289	98.9	3,125	98.9	479,933	49.4
2021					10,815	89.9
2022					9,156	81.5

\*PSE higher than 50 indicates a very imprecise estimate

Table 11. Shark species captured in the DMF 2022 statewide Independent Gill Net Survey (P915).

Species	Total Number Measured	Mean Total Length (inches)	Minimum Total Length (inches)	Maximum Total Length (inches)
Atlantic sharpnose	220	17	10	44
Sandbar	146	28	16	65
Bonnethead	83	32	16	47
Blacktip	63	33	13	54
Bignose	56	28	18	51
Smoothhound	35	23	17	49
Bull	24	27	23	45
Finetooth	9	39	32	52
Blacknose	3	38	34	48
Scalloped hammerhead	1	24	24	30
Spinner	1	33	33	42

**FIGURES**

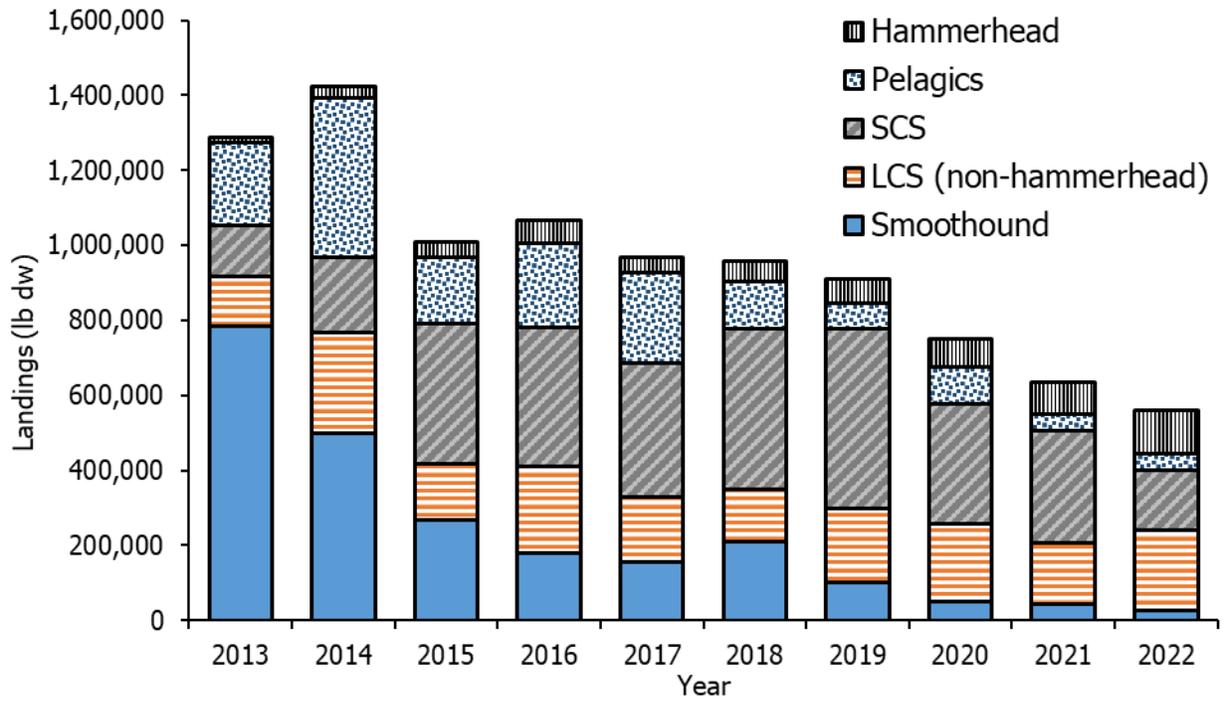


Figure 1. North Carolina commercial shark landings by management group, 2013–2022. In this figure, sandbar shark landings are included with the LCS and SCS includes blacknose landings.

**FISHERY MANAGEMENT PLAN UPDATE  
SNAPPER GROUPER COMPLEX  
AUGUST 2023**

**STATUS OF THE FISHERY MANAGEMENT PLAN**

**Fishery Management Plan History**

FMP Documentation:	August 1983 (SAFMC 1983a, b; 48 FR 39463)
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
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 43	July 2018
Amendment 41	February 2018
Regulatory Amendment 28	January 2019
Abbreviated Framework Amendment 1	August 2018
Abbreviated Framework Amendment 2	May 2019
Amendment 42	January 2020
Regulatory Amendment 27	February 2020
Regulatory Amendment 30	March 2020
Regulatory Amendment 26	March 2020
Regulatory Amendment 29	July 2020
Abbreviated Framework Amendment 3	August 2020
Regulatory Amendment 33	November 2020
Amendment 39	January 2021
Regulatory Amendment 34	May 2021
Amendment 50	January 2023

Comprehensive Review: None

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 1990s 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 degrees and 30 degrees 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.

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 (TL) or larger off Florida; and protect gray triggerfish by implementing a minimum size limit of 12-inches 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 deep-water 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 deep-water closure (240 feet seaward) for deep-water 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 deep-water 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 (MRIP), 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 porgy 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 porgy, 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 porgy, 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 were 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 2017n; 83 FR 1305) updated the ABC, ACL, MSY, MSST, OY, and revised management measures for mutton snapper.

Amendment 43 (SAFMC 2017k; 83 FR 35428) revised the commercial and recreational ACLs and allowed for limited harvest of red snapper in federal waters of the South Atlantic.

Abbreviated Framework Amendment 1 (SAFMC 2017i; FR 83 35435) reduced the commercial and recreational ACLs for red grouper to address overfishing.

Regulatory Amendment 28 (SAFMC 2018a; FR 83 62508) revised the commercial and recreational ACLs for golden tilefish. The purpose of this final rule is to end overfishing of golden tilefish while minimizing, to the extent practicable, adverse socio-economic effects and achieve OY on a continuing basis.

Abbreviated Framework Amendment 2 (SAFMC 2018b; FR 84 14021) increased the commercial and recreational ACLs for vermilion snapper and decreased the commercial and recreational ACLs for black sea bass in response to the latest stock assessments.

Amendment 42 (SAFMC 2019a; FR 84 67236) modified the sea turtle handling and release gear requirements for the snapper grouper fishery, clarified the requirements for other release gears, and modified the FMP framework procedure to implement newly approved devices and handling requirements for sea turtles and other protected resources.

Regulatory Amendment 27 (SAFMC 2019b; FR 85 4588) modified the commercial trip limits for blueline tilefish, greater amberjack, red porgy, and vermilion snapper; established commercial split seasons for snowy grouper, greater amberjack, and red porgy; established a commercial trip limit for the “other” jacks complex; established a minimum size limit for almaco jack; and removed the minimum size limits for silk, queen, and blackfin snappers; and reduced the minimum size limit for gray triggerfish in the EEZ off the east coast of Florida.

Regulatory Amendment 30 (SAFMC 2019c; FR 85 6825) revised the rebuilding schedule for red grouper based on the most recent stock assessment and modified the spawning season closure for the commercial and recreational sectors in the EEZ off North Carolina and South Carolina, and established a 200 pound commercial trip limit.

Regulatory Amendment 26 (SAFMC 2019d; FR 85 11307) removed the recreational minimum size limits for silk snapper, queen snapper, and blackfin snapper, reduced the recreational minimum size limit for gray triggerfish in the EEZ off the east coast of Florida, and modified the snapper grouper aggregate bag limit for the 20-fish aggregate.

Regulatory Amendment 29 (SAFMC 2020c; FR 85 36166) modified gear requirements for South Atlantic snapper grouper species. Actions include requirements for descending and venting devices, and modifications to requirements for circle hooks and powerheads.

Abbreviated Framework Amendment 3 (SAFMC 2020d; FR 85 43145) increased the commercial and recreational ACLs and increased the recreational ACT for blueline tilefish in the South Atlantic EEZ based on updated information from a SouthEast Data, Assessment, and Review (SEDAR) benchmark assessment that was completed for the Atlantic stock of blueline tilefish, using data through 2015 (SEDAR 50).

Regulatory Amendment 33 (SAFMC 2020b; FR 85 64978) removed the four-day minimum season length requirement for South Atlantic red snapper (commercial or recreational) to improve access to South Atlantic red snapper, particularly for the recreational sector.

Amendment 39 (SAFMC 2020e; FR 85 10331) established new, and revised existing, electronic reporting requirements for federally permitted charter vessels and headboats, in certain Atlantic fisheries to increase and improve fisheries information collected from federally permitted for-hire vessels in the Atlantic.

Regulatory Amendment 34 (SAFMC 2020a; FR 86 17318) created 34 special management zones (SMZs) around artificial reefs in the EEZ off North Carolina and South Carolina to designate new SMZs and to restrict fishing gear with greater potential to result in high exploitation rates.

Amendment 50 (SAFMC 2023a; FR 87 77742) responded to the overfished and overfishing status of red porgy by establishing a rebuilding plan, revising sector annual catch limits, sector allocations, management measures and accountability measures.

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 Interjurisdictional Fisheries Fishery Management Plan (IJ FMP). The goal of the IJ FMP is to adopt FMPs, consistent with North Carolina law, approved by the Mid-Atlantic Fishery Management Council (MAFMC), SAFMC, or the Atlantic States Marine Fisheries Commission (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 2022).

## **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 porgy, 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).

## **Goal and Objectives**

The following are the FMP 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).

- Prevent overfishing.
- Collect necessary data.
- Promote orderly utilization of the resource.

- Provide for a flexible management system.
- Minimize habitat damage.
- Promote public compliance and enforcement.
- Mechanism to vest participants.
- Promote stability and facilitate long-run planning.
- Create market-driven harvest pace and increase product continuity.
- Minimize gear and area conflicts among fishermen.
- Decrease incentives for overcapitalization.
- Prevent continual dissipation of returns from fishing through open access.
- Evaluate and minimize localized depletion.

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

Fifty-five species make up the snapper grouper complex, which is managed by the SAFMC. 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 ontogenetic (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: <https://safmc.net/fishery-management-plans/snapper-grouper/>.

### **Stock Status**

Of the 55 species in the SAFMC management unit, several species are either overfished or experiencing some degree of overfishing. The overfished stocks include gag grouper, red grouper, red porgy, red snapper, hogfish (east Florida), and snowy grouper. Stocks experiencing overfishing are gag grouper, red snapper, and snowy grouper.

### **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 the North Carolina Division of Marine Fisheries (DMF) (Table 2).

Since 2002, stock assessments have been conducted through the SEDAR which is the cooperative process by which stock assessment projects are conducted in National Oceanic and Atmospheric Administration (NOAA) Fisheries' Southeast Region. Currently, stock assessments are available for 16 of the complex species.

Some of the other species have status updates provided by 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 at: <https://www.fisheries.noaa.gov/national/population-assessments/fishery-stock-status-updates>.

## DESCRIPTION OF THE FISHERY

### Current Regulations

The following species have state and federal regulations for minimum lengths:

- Greater amberjack: 28-inch fork length (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 TL (commercial)
- Red pogy: 14-inch TL
- Vermilion, gray, cubera and yellowtail 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
- Almaco jack: 20-inch FL (commercial)

All species have sector ACLs and recreational bag limits and/or commercial trip limits. See the SAFMC (<https://safmc.net/regulations/>) or DMF (<https://www.deq.nc.gov/about/divisions/marine-fisheries/rules-proclamations-and-size-and-bag-limits/fisheries-management-proclamations#currentprocs>) 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' landings and/or catch data
- January-April shallow water grouper spawning closure (commercial and recreational); red grouper remains closed through May in North and South Carolina

- 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 recreational fishery open May 1- August 31
- Blueline tilefish recreational fishery open May 1 – July 26

Temporary closures may result for a species if the ACL is met or projected to be met. NOAA Fisheries monitors the landings for species managed by the SAFMC, and this information is available online for both the commercial and recreational sectors (<https://www.fisheries.noaa.gov/southeast/southeast-region-annual-catch-limit-acl-monitoring>).

See also the SAFMC or DMF websites for more details, and the most current information.

### **Commercial Fishery**

Commercial gear used in the snapper grouper fishery includes bandit reels, electric reels, manual hook and line, long lines, fish pots, spear, and trolling. Bandit reels, followed by electric rods and reels are the two most prevalent gear types used, especially south of Cape Hatteras (NCDMF 2015b). Spear fishing appears 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 deep-water 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 1994-2022 was 1,927,038 pounds with a dockside value of \$4,005,917 (Table 3). In 2022, 918,618 pounds of snapper grouper species were caught commercially in North Carolina. The highest landings in the past 28 years were in 2008, after which landings dropped; landings have been under two million pounds for the last ten years (Figure 1A). The decline in landings over the past ten years is most likely due to the removal of species from the complex, as well as the changes to ACLs and trip limits as well as implementation of a seasonal spawning closure by the SAFMC.

Over the last five years, landings have been dominated by six main aggregates; black 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 Fishery**

Recreational fishing uses many of the same gear types as the commercial fishery, with the exception of fish pots and longlines. Recreational estimates across all years have been updated and are now based on the MRIP new Fishing Effort Survey-based calibrated estimates. For more information on MRIP see <https://www.fisheries.noaa.gov/topic/recreational-fishing-data>.

The average recreational catch of snapper grouper species was 1,867,591 pounds for 1994-2022. Since 2008, the total amount of fish landed declined steadily until 2013 (Table 5; Figure 1B). The

number of fish harvested declined roughly 60% from 2017 to 2018 and harvest weight decreased 48%. As no major management changes in the recreational sector contributed to this decrease in landings, it is likely due to the impacts of Hurricane Florence on coastal North Carolina. The number of fish harvested increased 3% from 2021 to 2022 and harvest weight decreased 31%. Recreational landings (by weight) have dropped roughly 85% since a 29-year high (4,773,359 pounds) in 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 around 50% 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).

In 2022, the dominant species (by pounds) landed were groupers, snappers, jacks, triggerfish, tilefish, and black sea bass (Table 6). This pattern mainly holds true for the last five years; however, other species are occasionally more dominant.

## **MONITORING PROGRAM DATA**

Fishery-dependent and fishery-independent data collected by DMF from the snapper grouper fishery is provided to NOAA Fisheries. In 2006, the division received a Marine Fisheries Initiative Program (MARFIN) grant to collect ageing structures of the snapper grouper species, determine the age structure of the black sea bass stock south of Cape Hatteras, and estimate release mortality of the of the commercial snapper grouper fishery. Funding for the grant ended in 2014. Data collected for this grant is summarized in the final 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 dependent length-frequency information for the commercial snapper grouper fishery in North Carolina is collected by fish house samplers, the majority of which come from DMF Program 438 (Offshore Live Bottom Fishery). Length-frequency information for the recreational snapper grouper fishery is collected through the DMF Carcass Collection Program and MRIP. In 2022, DMF recorded 6,334 lengths from individual fish from the commercial and recreational snapper grouper fishery of which 625 were black sea bass south of Cape Hatteras (Table 7). In 2022, 74 black sea bass were measured from MRIP recreational samples with an average TL of 14 inches (Table 8; Figure 2). TL has ranged from 4 inches to 21 inches since 1994 (Table 8; Figure 4). In 2022, 625 black sea bass south of Cape Hatteras were measured from the commercial fishery with an average TL of 14 inches (Table 7; Figure 2). Black sea bass landed in the commercial fishery have ranged from 7 to 19 inches TL since 1994 (Figure 3). Differences in the commercial and recreational length frequency distribution of black sea bass south of Cape Hatteras in 2022 can

be attributed to the different size limits (13 inches TL for recreational and 11 inches TL for commercial), as well differences in the size selectivity of the gears used (Figure 2).

In order to describe the age structure of the harvest and indices, age structures are collected from various fishery-independent (scientific surveys) and dependent (fisheries) sources throughout the year. Aging structures are provided to the NOAA Beaufort Age Lab for analysis except for black sea bass caught south of Cape Hatteras, NC which are analyzed by DMF. In 2022, DMF collected 4,320 age structures from the snapper grouper fishery of which 402 came from black sea bass (Table 7). Since 2004, the modal age of black sea bass collected each year is 4 with the exception of 2011, 2018, 2019 and 2021 where the modal age was 3, 5, 6 and 5, respectively (Table 9). The maximum age recorded for black sea bass south of Cape Hatteras is 10. Black sea bass ages for 2022 have not been assessed yet. The age-length relationship for black sea bass is fairly unpredictable, as there is overlap in age for a given length (Figure 5).

### **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.

### **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. — Ongoing
- Collect otoliths and spines for ageing. — Ongoing
- Estimate mortality rates. — Ongoing
- Determine if stock structure exists for many of the species. — Ongoing
- Note seasonal and spawning migrations. — Ongoing

- Identify and map essential/critical fish habitat. — Ongoing
- Determine spawning locations and seasons. — Ongoing
- Continue life history studies. — Ongoing
- Estimate reproductive parameters including fecundity, age and size of maturity, age and size of sexual transition, and sex ratio. — Ongoing
- Determine reliability of historical landings. — Ongoing
- Expand diet studies. — Ongoing
- Develop juvenile and adult indexes. — Ongoing

## **MANAGEMENT STRATEGY**

The snapper grouper complex is managed under the various amendments of the SAFMC FMP. 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.

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- SAFMC. 2015d. Amendment 35 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 4055 Faber Place Drive, Ste 201, Charleston, S.C. 29405.
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- SAFMC. 2016c. Amendment 36 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region: Actions to Implement Special Management Zones in the South Atlantic. South Atlantic Fishery Management Council, 4055 Faber Place Drive, Ste 201, Charleston, S.C. 29405.
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- SAFMC. 2017n. Amendment 41 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 4055 Faber Place Drive, Ste 201, Charleston, S.C. 29405.
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- SAFMC. 2018b. Abbreviated Framework Amendment 2 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 4055 Faber Place Drive, Ste 201, Charleston, S.C. 29405.
- SAFMC. 2019a. Amendment 42 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 4055 Faber Place Drive, Ste 201, Charleston, S.C. 29405.
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- SAFMC. 2019e. Regulatory Amendment 31 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 4055 Faber Place Drive, Ste 201, Charleston, S.C. 29405.
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- SAFMC. 2021a. Amendment 50 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 4055 Faber Place Drive, Ste 201, Charleston, S.C. 29405.
- SAFMC. 2021b. Amendment 49 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 4055 Faber Place Drive, Ste 201, Charleston, S.C. 29405.
- SAFMC. 2022a. Amendment 35 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 4055 Faber Place Drive, Ste 201, Charleston, S.C. 29405.
- SAFMC. 2022b. Amendment 53 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 4055 Faber Place Drive, Ste 201, Charleston, S.C. 29405.
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- SAFMC. 2022e. Amendment 44 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 4055 Faber Place Drive, Ste 201, Charleston, S.C. 29405.
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- SAFMC. 2022g. Amendment 45 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region. South Atlantic Fishery Management Council, 4055 Faber Place Drive, Ste 201, Charleston, S.C. 29405.
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## TABLES

Table 1. Amendments under consideration/review by the South Atlantic Fishery Management Council (SAFMC). Summaries of the issues the amendment addresses are included; documentation is provided as available.

Amendment	Issue addressed	Where in process	Documentation
Amendment 49	Greater amberjack catch levels and allocations	Secretarial Review	SAFMC 2021b
Amendment 35	Release mortality issues in the snapper grouper fishery and modifications to red snapper catch levels	Final Approval	SAFMC 2022a
Amendment 53	Gag grouper rebuilding, catch levels, and allocations	Final Approval	SAFMC 2022b
Amendment 52	Golden tilefish allocations and blueline tilefish bag limit and accountability measures	Final Approval	SAFMC 2022c
Amendment 51	Snowy grouper catch levels, sector allocations, management measures, and accountability measures	Secretarial Review	SAFMC 2022d
Amendment 44	Yellowtail snapper catch levels	Scoping	SAFMC 2022e
Amendment 46	Private recreational reporting and permitting	Scoping	SAFMC 2022f
Amendment 45	Modifies the Acceptable Biological Catch (ABC) Control Rule to address scientific uncertainty, management risk, and rebuilding stocks. Specifies criteria and procedures for phase-in of ABC changes and carry-over of unused portions of annual catch limits	Final Approval	SAFMC 2022g
Amendment 55	Respond to the latest scamp/yellowmouth stock assessment (SEDAR 68).	Pre-scoping	SAFMC 2023b
Amendment 54	Reporting requirements for commercial logbooks in the snapper grouper, coastal migratory pelagics, and dolphin-wahoo fisheries.	Public Hearing	SAFMC 2022h

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 North Carolina Division of Marine Fisheries due to the nature of the fishery.

Family (species aggregate)	Species	Overfishing?	Overfished?	Documentation
Serranidae (Sea basses and groupers)	Gag ( <i>Mycteroperca microlepis</i> )	Yes	Yes	SEDAR 71 (SEDAR 2021a); NMFS 2022
	Red grouper ( <i>Epinephelus morio</i> )	No	Yes	SEDAR 53 (SEDAR 2017a); NMFS 2022
	Scamp ( <i>Mycteroperca phenax</i> )	No	Unknown	NMFS 2022
	Black grouper ( <i>Mycteroperca bonaci</i> )	No	No	SEDAR 19 (SEDAR 2010); NMFS 2022
	Rock hind ( <i>Epinephelus adcaensionis</i> )	Unknown	Unknown	NMFS 2022
	Red hind ( <i>Epinephelus guttatus</i> )	Unknown	Unknown	NMFS 2022
	Graysby ( <i>Cephalopholis cruentata</i> )	Unknown	Unknown	NMFS 2022
	Yellowfin grouper ( <i>Mycteroperca venenosa</i> )	Unknown	Unknown	NMFS 2022
	Coney ( <i>Cephalopholis fulva</i> )	Unknown	Unknown	NMFS 2022
	Yellowmouth grouper ( <i>Mycteroperca interstitialis</i> )	Unknown	Unknown	NMFS 2022
	Goliath grouper ( <i>Epinephelus itajara</i> )	No (Permanent closure)	Unknown	SEDAR 47 (SEDAR 2016d); NMFS 2022
	Nassau grouper ( <i>Epinephelus striatus</i> )	No (Permanent closure)	Unknown	NMFS 2022
	Snowy grouper ( <i>Epinephelus niveatus</i> )	Yes	Yes	SEDAR 36 Update (SEDAR 2020c); NMFS 2022
	Yellowedge grouper ( <i>Epinephelus flavolimbatus</i> )	Unknown	Unknown	NMFS 2022
	Warsaw grouper ( <i>Epinephelus nigritus</i> )	Unknown	Unknown	SG Amendment 17b (SAFMC 2010b); NMFS 2022
	Speckled hind ( <i>Epinephelus drummondhayi</i> )	Unknown	Unknown	SG Amendment 17b (SAFMC 2010b); NMFS 2022
	Misty grouper ( <i>Epinephelus mystacinus</i> )	Unknown	Unknown	NMFS 2022
	Black sea bass ( <i>Centropristis striata</i> )	No	No	SEDAR 56 (SEDAR 2018b); NMFS 2022
	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	Rademeyer and Butterworth 2014; NMFS 2022

\* Indicates ecosystem component species which do not have management measures in place and are not assessed.

Table 2. (continued).

Family (species aggregate)	Species	Overfishing?	Overfished?	Documentation
Lutjanidae (Snappers)	Queen snapper ( <i>Etelis oculatus</i> )	Unknown	Unknown	NMFS 2022
	Yellowtail snapper ( <i>Ocyurus chrysurus</i> )	No	No	SEDAR 27A (SEDAR 2012b); NMFS 2022
	Gray snapper ( <i>Lutjanus griseus</i> )	Unknown	Unknown	NMFS 2022
	Mutton snapper ( <i>Lutjanus analis</i> )	No	No	SEDAR 15A Update (SEDAR 2015); NMFS 2022
	Lane snapper ( <i>Lutjanus synagris</i> )	Unknown	Unknown	NMFS 2022
	Cubera snapper ( <i>Lutjanus cyanopterus</i> )	Unknown	Unknown	NMFS 2022
	Vermilion snapper ( <i>Rhomboplites aurorubens</i> )	No	No	SEDAR 55 (SEDAR 2018a); NMFS 2022
	Red snapper ( <i>Lutjanus campechanus</i> )	Yes	Yes	SEDAR 73 (SEDAR 2021b); NMFS 2022
	Silk snapper ( <i>Lutjanus vivanus</i> )	Unknown	Unknown	NMFS 2022
	Blackfin snapper ( <i>Lutjanus buccanella</i> )	Unknown	Unknown	NMFS 2022
	Sparidae (Porgies)	Red Porgy ( <i>Pagrus pagrus</i> )	No	Yes
Knobbed porgy ( <i>Calamus nodosus</i> )		Unknown	Unknown	NMFS 2022
Jolthead porgy ( <i>Calamus bajonado</i> )		Unknown	Unknown	NMFS 2022
Scup ( <i>Stenotomus chrysops</i> )		Unknown	Unknown	NMFS 2022
Whitebone porgy ( <i>Calamus leucosteus</i> )		Unknown	Unknown	NMFS 2022
Saucereye porgy ( <i>Calamus calamus</i> )		Unknown	Unknown	NMFS 2022
Longspine porgy ( <i>Stenotomus caprinus</i> )*		N/A	N/A	N/A
Haemulidae (Grunts)	White grunt ( <i>Haemulon plumieri</i> )	Unknown	Unknown	NMFS 2022
	Margate ( <i>Haemulon album</i> )	Unknown	Unknown	NMFS 2022
	Tomtate ( <i>Haemulon aurolineatum</i> )	Unknown	Unknown	NMFS 2022
	Sailor's choice ( <i>Haemulon parra</i> )	Unknown	Unknown	NMFS 2022
	Cottonwick ( <i>Haemulon melanurum</i> )*	N/A	N/A	N/A

\* Indicates ecosystem component species which do not have management measures in place and are not assessed.

Table 2. (continued).

Family (species aggregate)	Species	Overfishing?	Overfished?	Documentation
Carangidae (Jacks)	Greater Amberjack ( <i>Seriola dumerili</i> )	No	No	SEDAR 59 (SEDAR 2020b); NMFS 2022
	Almaco jack ( <i>Seriola rivoliana</i> )	Unknown	Unknown	NMFS 2022
	Banded rudderfish ( <i>Seriola zonanta</i> )	Unknown	Unknown	NMFS 2022
	Bar jack ( <i>Caranx ruber</i> )	Unknown	Unknown	NMFS 2022
	Lesser Amberjack ( <i>Seriola fasciata</i> )	Unknown	Unknown	NMFS 2022
Malacanthidae (Tilefishes)	Golden tilefish ( <i>Lopholatilus chamaeleonticeps</i> )	No	No	SEDAR 66 (SEDAR 2021c); NMFS 2022
	Blueline (or gray) tilefish ( <i>Caulolatilus microps</i> )	No	No	SEDAR 50 (SEDAR 2017b); NMFS 2022
	Sand tilefish ( <i>Malacanthus plumier</i> )	Unknown	Unknown	NMFS 2021
Balistidae (Triggerfishes)	Gray triggerfish ( <i>Balistes capriscus</i> )	No	Unknown	SEDAR Assessment 41 (SEDAR 2016c); NMFS 2022
	Ocean triggerfish ( <i>Canthidermis sufflamen</i> )*	N/A	N/A	N/A
Labridae (Wrasses)	Hogfish ( <i>Lachnolaimus maximus</i> )	Unknown (Carolinas); No (Florida)	Unknown (Carolinas); Yes (Florida)	SEDAR 37 (SEDAR 2013b); NFMS 2022
Eppiphidae (Spadefishes)	Atlantic spadefish ( <i>Chaetodipterus faber</i> )	Unknown	Unknown	NMFS 2022

\* Indicates ecosystem component species which do not have management measures in place and are not assessed.

Table 3. Landings of all snapper grouper species for the commercial fishery, 1994–2022. Sheepshead were removed from the fishery in 2012 and therefore not included past 2011.

Year	Weight of harvested fish (lb)	Value of Landings (USD)
1994	2,933,539	\$4,086,083
1995	2,785,341	\$3,844,101
1996	2,587,420	\$3,601,653
1997	2,748,108	\$4,053,605
1998	2,501,675	\$3,931,486
1999	2,372,628	\$3,981,018
2000	2,151,794	\$3,762,289
2001	2,178,180	\$3,652,941
2002	2,356,054	\$3,930,576
2003	1,953,932	\$3,375,178
2004	2,014,492	\$3,522,424
2005	1,889,092	\$3,567,878
2006	2,140,637	\$4,332,982
2007	2,324,604	\$5,247,795
2008	2,748,623	\$5,990,469
2009	2,625,263	\$5,262,980
2010	2,281,867	\$4,877,050
2011	1,613,928	\$3,911,719
2012	1,651,545	\$4,169,682
2013	1,445,346	\$3,918,164
2014	1,427,568	\$3,845,196
2015	1,161,861	\$3,324,493
2016	1,246,432	\$3,715,347
2017	1,259,683	\$3,825,047
2018	1,250,722	\$3,887,748
2019	1,315,444	\$4,452,724
2020	1,022,430	\$3,397,185
2021	977,290	\$3,278,421
2022	918,618	\$3,425,362
Mean	1,927,038	\$4,005,917

Table 4. Landings (in pounds) of snapper grouper, by aggregate groups, for the commercial fishery, 1994–2022. Aggregate groups are those used by the South Atlantic Fishery Management Council 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 and the Mid-Atlantic Fisheries Management Council. Wreckfish landings are confidential and are excluded.

Year	Black sea bass	Grouper	Snapper	Porgies	Grunts	Jacks	Tilefish	Triggerfish	Hogfish	Spadefish	Unclassified
1994	456,284	775,414	450,221	344,117	202,940	151,984	231,584	271,503	19,133	23,347	7,011
1995	348,030	773,372	403,499	355,210	184,799	171,510	160,860	304,540	33,507	40,873	9,142
1996	489,845	651,105	350,206	338,242	106,851	139,669	158,586	277,741	13,841	55,890	5,445
1997	518,223	719,513	366,482	264,012	131,974	178,310	149,402	342,123	14,010	57,384	6,676
1998	523,253	745,591	352,020	269,092	108,162	101,739	67,770	274,641	12,037	38,994	8,375
1999	491,401	758,059	441,783	178,690	95,008	129,245	76,697	150,387	12,405	34,320	4,634
2000	414,281	636,942	510,897	143,212	81,338	127,116	85,467	88,277	7,727	46,235	10,303
2001	477,123	558,626	523,742	148,513	94,422	121,966	106,674	87,628	8,203	41,994	9,290
2002	432,321	699,579	490,591	145,394	102,158	120,644	220,331	90,934	10,637	38,400	5,067
2003	476,511	651,941	269,230	108,931	65,379	135,991	87,102	117,396	9,135	28,519	3,797
2004	506,376	584,722	339,453	127,543	81,075	106,507	78,126	136,211	8,902	44,521	1,055
2005	321,858	579,194	432,829	101,936	90,364	122,361	44,014	145,636	7,877	35,445	7,578
2006	443,565	708,823	345,071	130,363	118,234	101,722	138,090	126,354	7,296	19,623	1,496
2007	277,453	827,622	550,617	175,215	118,545	133,519	58,218	155,261	7,112	19,567	1,476
2008	275,761	785,429	602,838	204,349	91,292	160,769	404,295	198,724	13,035	11,694	438
2009	437,954	637,438	374,081	231,478	74,054	153,099	469,293	215,757	10,839	20,636	635
2010	292,879	561,753	320,260	242,520	47,219	128,466	430,394	225,682	13,046	18,827	821
2011	173,681	408,332	326,371	211,792	33,451	72,797	133,824	220,204	10,793	21,535	1,149
2012	194,778	381,929	279,368	83,969	49,734	124,325	361,094	143,114	8,256	24,238	739
2013	241,367	311,056	276,533	72,966	44,718	90,122	217,079	160,861	7,847	20,369	2,429
2014	316,421	299,555	251,087	82,918	39,333	193,049	91,074	116,782	9,767	22,761	4,822
2015	226,337	261,031	232,030	54,496	32,702	146,584	45,354	131,536	8,238	15,997	7,556
2016	198,595	257,743	280,043	47,326	39,953	139,061	111,788	135,545	9,195	15,231	11,952
2017	243,356	223,383	286,861	54,531	42,392	128,125	88,754	152,958	15,776	18,834	4,713
2018	180,623	239,135	323,276	59,007	37,269	142,459	68,509	174,047	13,755	9,838	2,803
2019	106,249	302,728	422,970	49,135	44,752	104,756	90,118	165,126	14,486	12,262	2,862
2020	53,562	199,012	277,175	31,842	35,002	152,977	115,363	126,655	11,640	15,007	4,194
2021	53,226	186,870	224,168	28,462	25,051	230,049	119,269	67,353	13,147	27,489	2,207
2022	62,868	152,912	246,279	23,634	19,555	183,902	106,413	88,167	11,987	21,494	1,405

Table 5. Landings of all snapper grouper species for the recreational fishery, 1994–2022. Sheepshead were removed from the fishery in 2012 and therefore not included past 2011.

Year	Number Harvested	Weight Harvested (lb)	Number Released	Percent Released
1994	1,122,704	1,536,118	2,085,119	36
1995	760,710	1,272,346	1,017,649	34
1996	520,600	1,035,700	516,966	39
1997	758,210	1,275,604	982,893	39
1998	462,922	638,255	1,180,941	37
1999	512,259	1,115,025	1,279,859	40
2000	814,533	1,875,322	2,070,305	40
2001	885,512	1,951,012	1,793,595	35
2002	763,191	2,119,881	1,385,078	31
2003	1,120,047	2,335,324	1,327,321	29
2004	1,153,460	2,731,095	2,578,785	33
2005	1,157,612	2,736,693	2,562,520	35
2006	885,567	3,378,064	3,380,922	34
2007	1,230,325	4,245,321	3,463,009	49
2008	1,328,295	4,773,359	2,778,672	49
2009	1,179,139	3,986,022	2,519,259	40
2010	933,735	2,803,945	2,763,289	47
2011	611,220	1,361,512	3,132,003	50
2012	592,316	1,375,815	4,942,686	45
2013	383,259	1,004,917	3,413,860	43
2014	527,044	1,119,307	5,665,011	55
2015	585,640	1,236,957	5,585,899	43
2016	629,119	1,354,061	7,792,792	57
2017	851,774	1,659,890	6,795,091	47
2018	342,750	859,989	2,485,376	44
2019	434,400	885,120	3,346,307	63
2020	551,571	1,767,713	3,096,666	44
2021	320,255	1,019,528	3,034,845	59
2022	331,328	706,250	4,224,225	50

Table 6. Recreational landings (in pounds), by aggregate groups, 1994–2022. Aggregate groups are those used by the South Atlantic Fishery Management Council 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 Atlantic States Marine Fisheries Council and Mid-Atlantic Fishery Management Council.

Year	Black sea bass	Groupers	Snappers	Porgies	Grunts	Jacks	Tilefish	Triggerfish	Hogfish	Spadefish	Wreckfish
1994	255,936	192,300	86,864	348,920	405,116	142,011	-	96,569	256	8,146	-
1995	192,882	120,308	55,390	484,602	112,911	147,991	27,907	25,071	83,710	21,574	-
1996	222,898	44,050	31,717	289,437	77,503	276,636	540	77,012	-	15,907	-
1997	225,333	175,595	48,080	396,527	77,153	186,042	71,038	72,236	1,146	22,454	-
1998	154,986	60,962	9,577	250,646	37,113	89,045	-	25,188	-	10,738	-
1999	59,202	83,222	14,977	773,977	31,670	71,471	2,332	26,159	-	52,015	-
2000	373,028	52,463	23,294	820,377	9,520	548,623	3,724	26,184	-	18,109	-
2001	401,777	193,874	53,284	722,015	162,741	242,933	22,253	81,602	-	70,533	-
2002	183,634	348,809	143,786	865,924	337,495	159,670	7,290	54,879	11,499	6,895	-
2003	300,241	309,336	54,508	1,055,668	237,379	220,407	20,207	62,147	1,719	73,712	-
2004	507,359	1,022,259	170,615	558,545	266,540	94,406	29,313	64,317	1,300	16,441	-
2005	447,869	883,330	213,954	431,621	345,702	119,282	132,444	56,314	19,319	86,858	-
2006	175,048	1,671,117	54,160	476,295	235,456	316,341	330,140	64,556	19,365	35,586	-
2007	246,920	1,348,151	37,518	1,542,134	277,955	194,892	361,745	127,338	-	108,668	-
2008	104,582	1,946,062	114,550	1,139,132	302,233	468,560	404,734	269,507	1,813	22,186	-
2009	158,882	1,435,703	125,579	678,816	182,410	699,654	161,626	450,795	5,043	87,514	-
2010	206,765	325,422	50,327	1,016,739	84,349	567,382	51,649	257,445	8,658	235,209	-
2011	151,366	190,108	21,234	541,299	67,802	237,212	31,528	107,820	2,431	10,712	-
2012	219,859	215,213	78,050	42,963	171,618	262,534	65,879	221,703	24,243	73,281	472
2013	101,797	98,178	17,303	29,682	44,549	470,545	42,557	146,636	7,116	46,554	-
2014	562,393	28,173	25,717	21,247	86,365	154,373	45,541	102,145	-	93,353	-
2015	448,876	102,038	60,137	26,547	76,945	402,160	8,128	76,733	-	35,393	-
2016	301,334	79,379	46,391	19,455	86,926	356,481	282,035	165,279	466	16,315	-
2017	506,489	55,465	42,040	52,667	60,245	234,338	125,497	397,002	45,064	141,083	-
2018	107,331	9,227	29,406	8,012	16,762	357,661	116,891	178,928	383	35,388	-
2019	208,739	109,848	50,678	11,947	91,273	136,613	121,689	134,476	433	19,424	-
2020	120,950	28,013	83,330	12,831	83,906	361,133	833,910	230,521	305	12,814	-
2021	72,631	107,991	117,205	21,748	34,696	306,312	190,012	130,101	141	38,691	-
2022	196,050	59,021	135,665	11,842	20,702	103,882	13,496	153,763	310	11,519	-

Table 7. Number of lengths and aging structures collected by DMF Program 438 (Offshore Live Bottom Fishery dependent sampling) for all species landed by the commercial and recreational sectors combined of the snapper grouper fishery in 2022. Many species included in this table are not part of the South Atlantic Snapper Grouper Management Complex but are landed as incidental catch during the prosecution of the fishery.

Species	Number Measured	Number of Aging Structures
African Pompano	26	12
Almaco Jack	532	0
Atlantic Bearded Brotula	1	0
Atlantic Bonito	10	0
Atlantic Spadefish	1	0
Balistes Triggerfishes	10	10
Banded Rudderfish	32	6
Bank Sea Bass	42	0
Bigeye	10	0
Black Grouper	1	0
Black Jack	2	0
Black Sea Bass	625	402
Blackbar Drum	4	0
Blackbar Soldierfish	4	0
Blackbelly Rosefish	20	0
Blackfin Snapper	143	143
Blackfin Tuna	2	0
Blackline Tilefish	1	1
Blue Runner	1	0
Blue Tang	1	0
Bluefish	9	0
Blueline Tilefish	70	70
Bluespotted Cornetfish	1	0
Bluestriped Grunt	5	0
Carribbean Red Snapper	2	2
Carribbean Spiny Lobster	1	0
Cobia	9	1
Coney	1	1
Conger Eels	1	0
Cottonwick	63	0
Creole-fish	11	11
Cubbyu	2	0
Cubera Snapper	4	4
Dolphinfish	58	0
Gag	336	335
Goldface Tilefish	7	7
Gray Snapper	9	9
Gray Triggerfish	525	498
Graysby	66	64
Great Barracuda	4	0
Greater Amberjack	240	1
Greater Soapfish	9	0
Gulf Flounder	1	1
Hogfish	61	12
Jolthead Porgy	1	0
King Mackerel	15	0

Table 7. (continued)

Knobbed Porgy	76	0
Lesser Amberjack	10	0
Little Tunny	15	0
Marbled Grouper	3	3
Mutton Snapper	11	11
Ocean Triggerfish	1	1
Pigfish	5	0
Pinfish	1	0
Queen Triggerfish	4	4
Rainbow Runner	2	1
Red Grouper	17	17
Red Hake	1	0
Red Hind	4	4
Red Hogfish	1	0
Red Lionfish	4	0
Red Porgy	284	284
Red Snapper	122	122
Reticulate Moray	3	0
Rock Hind	25	24
Rock Sea Bass	3	0
Saddle Bass	22	0
Sand Perch	6	0
Sand Tilefish	96	0
Scamp	133	132
Scup	16	0
Sheepshead	11	9
Short Bigeye	17	0
Silk Snapper	586	580
Snowy Grouper	224	224
Southern Flounder	3	3
Spanish Flag	1	0
Spanish Mackerel	1	0
Spinycheek Scorpionfish	13	0
Spotfin Hogfish	6	0
Spottail Pinfish	85	0
Spotted Moray	1	0
Squirrelfish	109	0
Striped Bass	6	6
Striped Grunt	2	0
Tilefish	7	7
Tomtate	94	4
Unicorn Filefish	1	0
Vermilion Snapper	1144	1143
Wahoo	1	0
White Grunt	154	142
Whitebone Porgy	13	0
Whitespotted Soapfish	1	0
Yellowcheek Wrasse	1	0
Yellowedge Grouper	2	2
Yellowfin Grouper	3	3
Yellowmouth Grouper	3	3
Yellowtail Snapper	1	1
Grand Total	6,334	4,320

Table 8. Black sea bass south of Cape Hatteras length (total length, inches) data from Marine Recreational Information Program recreational samples, 1994–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1994	10	4	21	211
1995	11	6	20	173
1996	11	7	19	177
1997	11	6	18	175
1998	10	6	21	173
1999	10	7	19	139
2000	11	8	15	102
2001	12	8	19	219
2002	12	9	20	46
2003	12	9	18	75
2004	12	9	18	125
2005	13	9	18	90
2006	12	10	19	85
2007	14	11	20	51
2008	14	9	18	72
2009	13	11	20	172
2010	13	6	19	297
2011	14	8	21	206
2012	14	9	19	217
2013	13	7	19	244
2014	13	5	17	135
2015	14	11	20	111
2016	15	12	18	115
2017	15	10	19	139
2018	14	10	17	152
2019	14	12	18	117
2020	14	11	18	152
2021	14	11	18	90
2022	14	9	18	74

Table 9. Summary of black sea bass south of Cape Hatteras age samples collected from both fishery-dependent (commercial and recreational fisheries) and fishery-independent (surveys) sources, 2004–2021. The 2022 otoliths have not been read.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
2004	4	2	8	316
2005	4	2	9	767
2006	4	2	8	699
2007	4	1	10	1837
2008	4	2	10	1452
2009	4	2	8	1473
2010	4	1	8	900
2011	3	1	8	798
2012	4	2	10	1116
2013	4	1	7	1251
2014	4	1	8	1546
2015	4	2	9	1039
2016	4	1	8	708
2017	4	1	7	1025
2018	5	2	7	964
2019	6	2	7	592
2020	4	2	7	314
2021	5	2	9	490

**FIGURES**

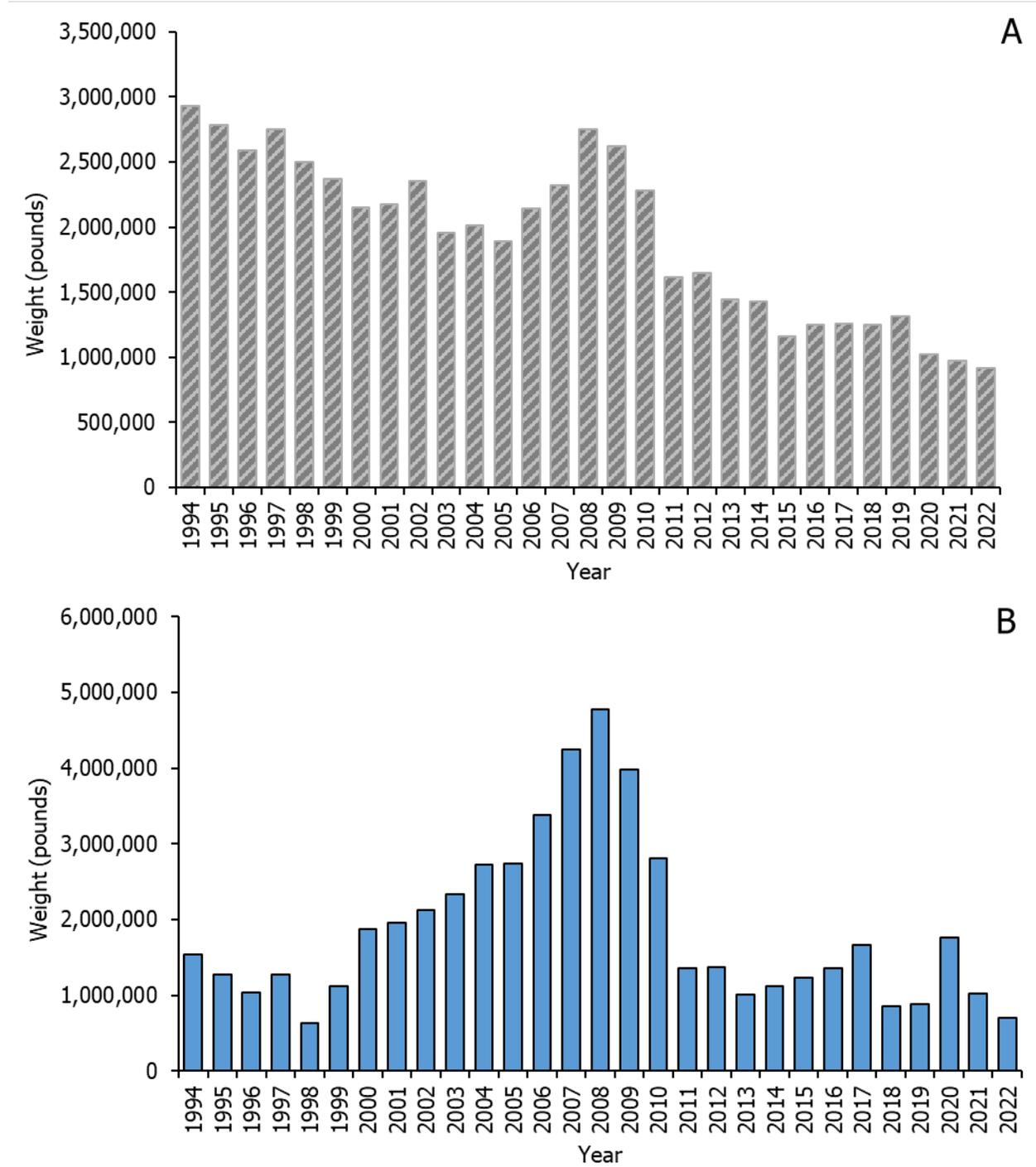


Figure 1. Annual commercial (A) and recreational (B) landings in pounds for snapper grouper species in North Carolina, 1994–2022.

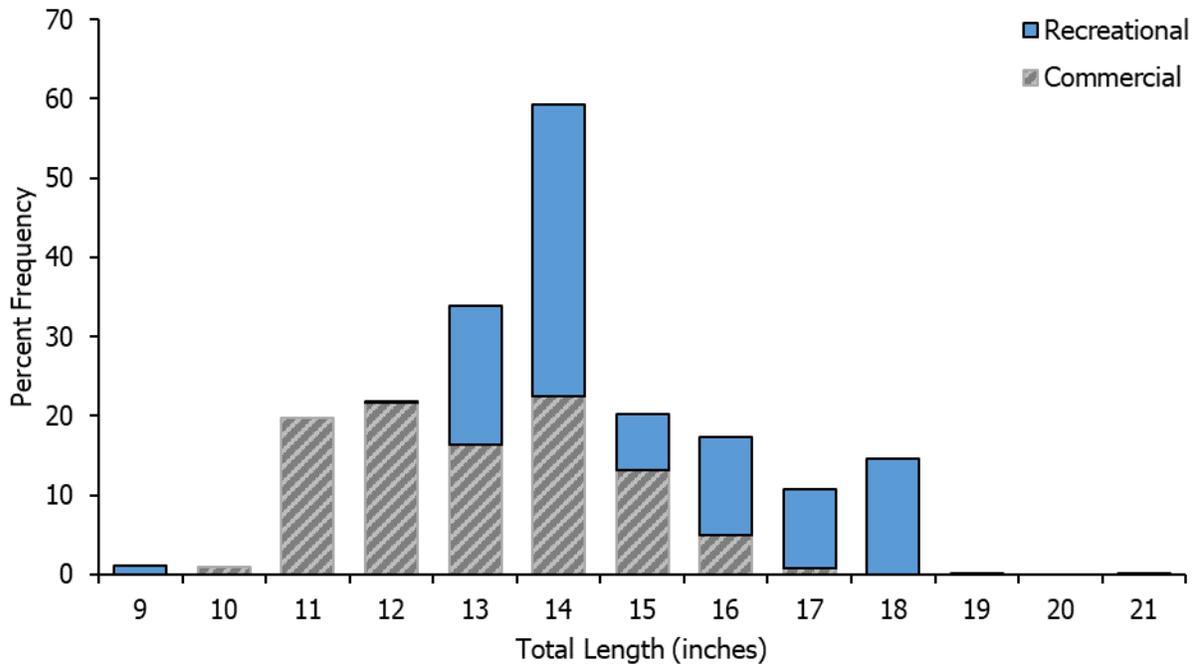


Figure 2. Commercial and recreational length frequency distribution from black sea bass south of Cape Hatteras, North Carolina harvested in 2022.

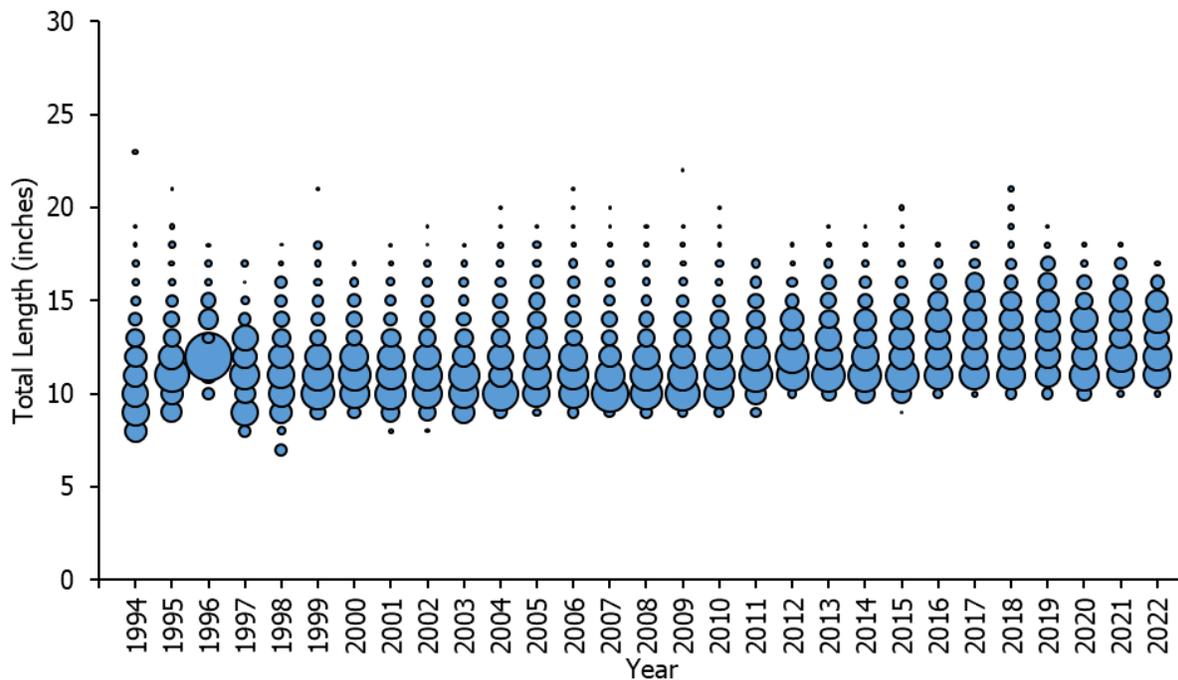


Figure 3. Commercial length frequency (total length, inches) of black sea bass south of Cape Hatteras, North Carolina harvested, 1994–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

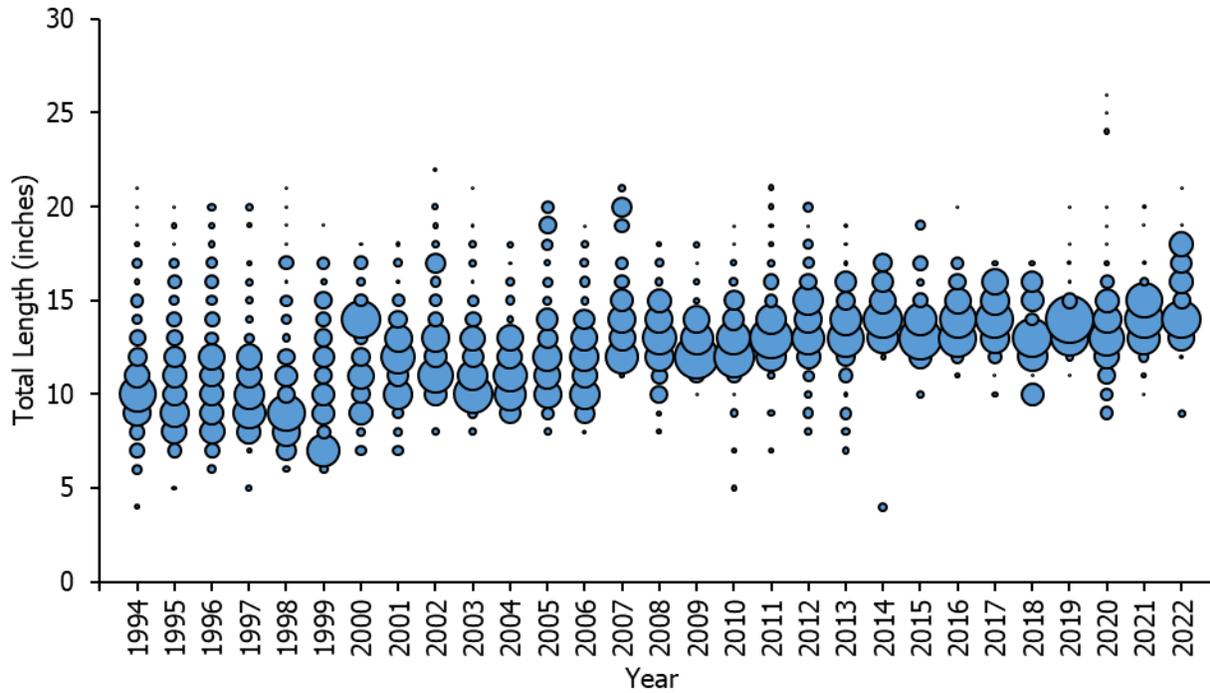


Figure 4. Recreational length frequency (total length, inches) of black sea bass south of Cape Hatteras, North Carolina harvested, 1994–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

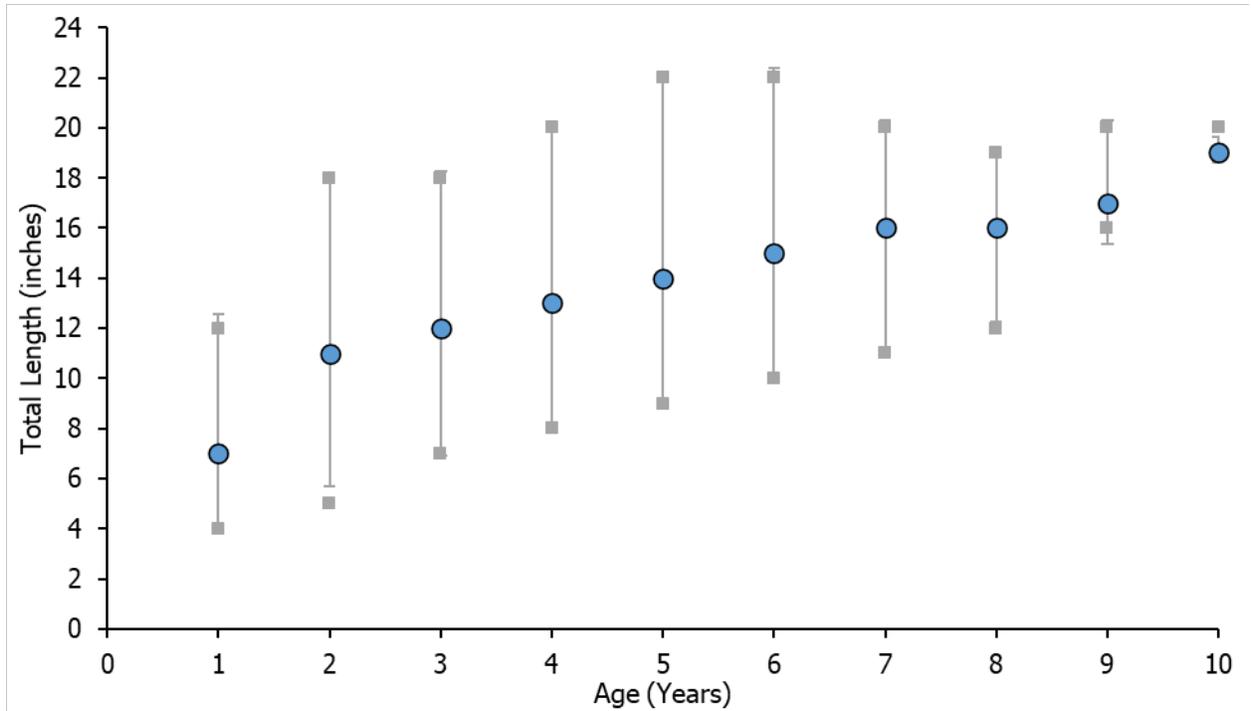


Figure 5. Black sea bass south of Cape Hatteras length at age based on all age samples collected, 2004–2021. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age. The 2022 otoliths have not been read.

**FISHERY MANAGEMENT PLAN UPDATE  
SPANISH MACKEREL  
AUGUST 2023**

**STATUS OF THE FISHERY MANAGEMENT PLAN**

**Fishery Management Plan History**

FMP Documentation:	February 1983	
	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	August 2013

Comprehensive Review: 2022

Spanish mackerel is managed under the Atlantic States Marine Fisheries Commission (ASMFC) Fishery Management Plan (FMP) for Spanish Mackerel and the South Atlantic Fishery Management Council (SAFMC) Coastal Migratory Pelagics FMP (SAFMC 1982; ASMFC 2011). 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 (FL) 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 1998a).

Amendment 14 established a three-year moratorium on the issuance of for-hire (charter vessel and headboat) 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 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 (ACL), annual catch targets (ACT) and accountability measures (AM) 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 2010).

Amendment 20A prohibits the sale of Spanish mackerel caught under the recreational 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 2014a).

Amendment 22 2013 included in the Generic Headboat Reporting Amendment: Requires weekly electronic reporting for headboats in the South Atlantic (SAFMC 2013a).

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 2014c) updated the ACL and ACT for Gulf and Atlantic migratory groups of Spanish mackerel based on the results of the 2012 stock assessment.

Amendment 22. modified headboat reporting regulations to require weekly electronic reporting of all SAFMC managed species (SAFMC 2013b).

Amendment 23 (SAFMC 2014b) 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 2017) 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 FMP 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 FL 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 FMPs, 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 2022).

## **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:

- 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.
- 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.

- To provide necessary information for effective management and establish a mandatory reporting system.
- To minimize gear and user group conflicts.
- 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.
- To minimize waste and bycatch in the fishery.
- To provide appropriate management to address specific migratory groups of king mackerel.
- 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:

- 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.
- Manage the Spanish mackerel stock to maintain the spawning stock biomass above the target biomass levels.
- Minimize endangered species bycatch in the Spanish mackerel fishery.
- 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.
- 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.

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

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 eight years old. Spanish mackerel in North Carolina grow as large as 30 inches FL, but most recreational catches

are between 12- and 15-inches FL. Both sexes are capable of reproduction by age 2. Spanish mackerel feed primarily on small, schooling pelagic fish such as anchovies and herring (Manooch 1984).

### **Stock Status**

In 2022, the Atlantic Spanish mackerel stock was assessed and peer reviewed through the Southeast Data, Assessment and Review (SEDAR 2022). The results of the assessment (SEDAR 78) indicate Atlantic Spanish mackerel are not overfished and overfishing is not occurring.

### **Stock Assessment**

The SEDAR 78 South Atlantic Spanish Mackerel assessment took place over a series of webinars held from May 2021 to March 2022 (SEDAR 2022). This SEDAR was an operational assessment using data from 1986-2020. The assessment estimated that spawning stock has fluctuated near or above the minimum stock size threshold (MSST) level. The base-run estimate of terminal (2020) spawning stock was above the MSST ( $SSB_{2020}/MSST = 1.40$ ). The estimated fishing rate has been at or below the maximum fishing mortality threshold (MFMT), represented by  $F_{MSY}$  with the exception of the terminal year (2020). The terminal estimate, which is based on a three-year geometric mean, was below  $F_{MSY}$  in the base run ( $F_{2018-2020}/F_{MSY} = 0.77$ ) and in the median of the Monte Carlo/Bootstrap Ensemble ( $F_{2018-2020}/F_{MSY} = 0.74$ ), indicating that the stock is not experiencing overfishing. However, if the overfishing rate of 2020 continued in 2021, the geometric mean would indicate overfishing.

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

The North Carolina Division of Marine Fisheries (DMF) currently complements the management measures of the Coastal Migratory Pelagic FMP through rules MFC Rule 15A NCAC 03M .0512 and proclamation authority (NCMFC Rule 15A NCAC 03M .0512). Current regulations include a recreational bag limit of 15 Spanish mackerel per person per day and 12-inch FL minimum size. Commercial regulations also include a 12-inch FL minimum size and a trip limit of 3,500 pounds. Federal vessel permits are required for commercial, charter and headboats fishing in the exclusive economic zone (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 Fishery**

In 2022, commercial landings were 926,026 pounds (Table 1; Figure 1) and 96% of the Spanish mackerel harvest was taken in estuarine and ocean gill nets (Figure 2). Landings for 2022 are higher than the 10-year average of 790,828 pounds, with most landings occurring between May and October. Predominant commercial fisheries for Spanish mackerel include gill nets and estuarine pound nets (Table 2). The North Carolina commercial fishery is responsible for landing approximately 20% of the South Atlantic landings annually. Atlantic Spanish mackerel catches are divided into a Northern zone (NC through the Mid-Atlantic) and a Southern zone (SC, GA, and

FL east coast to Dade-Monroe County line). On June 21, 2022, the harvest of Spanish mackerel in federal waters was closed when NOAA Fisheries estimated the Northern zone quota had been reached. On June 21, 2022, a harvest period for the commercial Spanish mackerel fishery in North Carolina Coastal Fishing Waters was opened with a 500-pound daily trip limit. The fishery remained closed in federal waters. The state water harvest period closed on November 11, 2022.

## **Recreational Fishery**

Recreational landings of Spanish mackerel are estimated from the Marine Recreational Information Program (MRIP). For more information on MRIP see <https://www.fisheries.noaa.gov/topic/recreational-fishing-data>. 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 degrees Fahrenheit. Recreational anglers harvested 1,841,527 pounds of Spanish mackerel in 2022 (Table 1; Figure 1B).

The DMF offers award citations for exceptional catches of Spanish mackerel. Spanish mackerel greater than six pounds are eligible for an award citation. In 2022, 118 citations were awarded (Figure 6).

## **MONITORING PROGRAM DATA**

### **Fishery-Dependent Monitoring**

Length-frequency information for the commercial Spanish mackerel fishery in North Carolina is collected through DMF's Program 431 (sciaenid pound net), Program 434 (ocean gill net), Program 461 (estuarine gill net), and Program 466 (Onboard Observer Program) (Table 4; Figures 3 and 5). 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 (Table 5). Length and weight information for the recreational fishery are collected through the MRIP dockside sampling (Table 3).

### **Fishery-Independent Monitoring**

Length-frequency information for Spanish mackerel is collected in the division's statewide Independent Gill Net Survey (Program 915) and the Pamlico Sound Trawl Survey (Program 195) (Table 6). Ageing structures, otoliths, are collected from both fishery-independent sampling programs and sent to the Southeast Fisheries Science Center in Panama City, Florida for processing and ageing (Table 5).

## **RESEARCH NEEDS**

From Omnibus Amendment (ASMFC 2011):

- Increase collection of fishery-dependent length, sex, age, and Catch Per Unit Effort (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 theoretical age when size is zero ( $t^0$ ), 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).

## MANAGEMENT STRATEGY

In North Carolina, Spanish mackerel are included in the North Carolina IJ FMP (NCDMF 2022), which defers, to the SAFMC's Coastal Migratory Pelagics FMP (SAFMC 2015) and the ASMFC's Spanish Mackerel FMP (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 FMP. Amendment 20A prohibits the sale of all recreational 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 NC-SC state line) and Southern Zone (south of NC-SC 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 FL 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 2015-2018 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 FL 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 did not implement the Addendum in 2019. Current management strategies for Spanish mackerel in South Atlantic waters are summarized in Table 7.

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## TABLES

Table 1. Recreational harvest (number of fish landed and weight in pounds) and releases (number of fish) and commercial harvest (weight in pounds) of Spanish mackerel from North Carolina, 1994– 2022.

Year	Recreational			Commercial	Total Weight (lb)
	Number Landed	Number Released	Weight Landed (lb)	Weight Landed (lb)	
1994	641,980	292,919	724,589	531,371	1,255,960
1995	397,190	239,972	492,096	402,392	894,488
1996	533,333	184,518	709,589	401,830	1,111,419
1997	956,589	304,629	1,444,907	766,958	2,211,865
1998	374,804	145,746	488,951	372,415	861,366
1999	891,001	253,317	1,035,943	459,100	1,495,043
2000	1,102,777	451,910	1,175,351	659,426	1,834,777
2001	942,500	338,918	1,155,788	653,673	1,809,461
2002	787,125	309,546	987,238	698,448	1,685,686
2003	540,399	266,887	641,024	456,784	1,097,808
2004	534,720	317,189	819,978	456,242	1,276,220
2005	561,073	303,641	526,054	446,001	972,055
2006	439,736	165,098	624,488	470,662	1,095,150
2007	604,518	340,027	799,263	487,879	1,287,142
2008	1,013,980	806,280	1,234,030	415,405	1,649,435
2009	1,480,931	752,806	2,155,692	961,811	3,117,503
2010	927,116	701,634	1,116,099	911,866	2,027,965
2011	854,554	479,586	1,100,110	871,217	1,971,327
2012	995,852	591,792	1,327,350	916,439	2,243,789
2013	994,599	685,692	1,242,029	620,752	1,862,781
2014	1,028,925	814,064	1,193,442	673,974	1,867,416
2015	835,011	514,714	981,867	561,714	1,543,581
2016	918,352	546,950	907,400	601,623	1,509,023
2017	995,706	688,062	1,094,778	816,089	1,910,867
2018	1,012,889	1,019,418	1,156,702	796,890	1,953,592
2019	1,478,890	1,340,366	1,694,247	722,398	2,416,645
2020	1,286,131	1,267,210	1,843,314	1,033,526	2,876,840
2021	1,312,929	1,294,525	1,894,535	1,155,289	3,049,824
2022	1,898,755	2,268,283	1,841,527	926,026	2,767,553
Mean	908,357	609,852	1,117,530	663,731	1,781,261

Table 2. North Carolina commercial harvest of Spanish mackerel with landings in pounds by gear type, 1994–2022.

Year	Gear				Total
	Ocean Gill Net	Estuarine Gill Net	Pound Net	Other	
1994	327,155	138,452	29,708	36,057	531,371
1995	233,296	104,827	49,077	15,192	402,392
1996	215,536	124,013	45,221	17,060	401,830
1997	502,463	174,141	60,898	29,457	766,958
1998	234,547	97,472	26,962	13,435	372,415
1999	297,435	98,855	49,485	13,326	459,100
2000	462,459	162,291	21,792	12,884	659,426
2001	411,974	186,628	33,163	21,909	653,673
2002	463,430	205,865	24,118	5,035	698,448
2003	368,171	80,219	5,218	3,176	456,784
2004	359,467	90,317	3,524	2,934	456,242
2005	257,074	180,874	2,184	5,869	446,001
2006	358,614	100,114	2,783	9,152	470,662
2007	420,680	57,144	3,440	6,615	487,879
2008	268,435	93,579	49,534	3,857	415,405
2009	454,081	266,621	228,201	12,908	961,811
2010	177,091	631,218	96,490	7,068	911,866
2011	287,908	524,967	53,704	4,638	871,217
2012	501,369	372,759	38,644	3,667	916,439
2013	346,810	250,524	18,764	4,654	620,752
2014	422,528	221,799	25,772	3,875	673,974
2015	289,489	229,114	40,032	3,080	561,714
2016	328,635	242,291	27,806	2,891	601,623
2017	507,905	287,434	17,314	3,436	816,089
2018	486,707	280,689	19,931	9,563	796,890
2019	354,891	322,101	39,118	6,288	722,398
2020	601,095	369,436	53,384	9,611	1,033,526
2021	711,685	404,168	31,767	7,669	1,155,289
2022	457,503	432,678	29,953	5,893	926,026

Table 3. Spanish mackerel length (fork length, inches) data from Marine Recreational Information Program samples, 1981–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1981	21.2	8.9	27.0	62
1982	18.0	8.0	31.9	69
1983	20.3	16.9	20.1	4
1984	14.7	13.0	23.8	28
1985	19.7	9.8	27.4	45
1986	15.4	8.1	27.2	110
1987	15.5	9.1	34.1	950
1988	5.0	7.9	32.9	1,118
1989	15.3	7.9	33.5	1,799
1990	15.9	8.3	35.5	2,160
1991	15.2	6.3	37.0	2,135
1992	15.4	7.5	33.1	1,354
1993	16.1	9.0	28.5	1,056
1994	15.2	6.4	29.4	2,255
1995	15.1	8.2	31.9	799
1996	16.0	9.8	70.2	1,107
1997	16.2	8.9	33.3	1,846
1998	15.5	9.2	31.1	895
1999	15.3	8.5	28.9	1,286
2000	15.7	9.0	27.2	1,242
2001	16.1	11.4	28.7	858
2002	16.3	9.5	28.0	827
2003	15.9	10.8	28.0	476
2004	16.7	11.1	27.5	298
2005	14.6	11.9	29.2	289
2006	16.0	11.1	39.4	236
2007	15.4	10.6	28.6	240
2008	15.2	8.9	26.2	596
2009	15.8	11.4	26.9	788
2010	15.2	10.7	26.5	763
2011	15.0	11.1	28.1	543
2012	15.1	10.6	28.0	776
2013	15.1	10.1	27.1	454
2014	14.8	9.0	29.9	754
2015	14.8	9.2	27.4	644
2016	14.3	11.0	26.3	1,030
2017	14.8	10.3	26.4	1,023
2018	15.0	9.9	27.2	1,691
2019	15.0	9.3	28.2	1,486
2020	15.6	9.0	68.0	1,914
2021	15.8	9.6	32.3	1,313
2022	14.1	9.7	26.6	1,070

Table 4. Spanish mackerel length (fork length, inches) data from commercial fish house samples, 1997–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1997	14.5	7.8	23.7	769
1998	15.0	8.2	26.0	778
1999	14.6	6.8	25.0	968
2000	16.4	8.3	25.4	1,616
2001	15.6	9.6	26.0	861
2002	15.6	11.0	25.4	880
2003	16.3	9.8	26.5	473
2004	17.1	8.6	27.0	989
2005	16.2	9.3	27.4	1,841
2006	16.9	7.0	27.7	2,187
2007	15.8	7.1	31.9	2,072
2008	16.0	7.3	26.3	2,127
2009	15.6	7.5	38.2	3,509
2010	16.2	6.8	26.7	4,759
2011	16.6	10.1	42.5	5,507
2012	16.5	8.2	27.7	5,409
2013	16.6	7.9	28.5	3,902
2014	16.3	8.6	27.7	4,462
2015	16.1	10.0	26.8	5,402
2016	16.3	5.8	28.8	6,888
2017	16.4	10.7	28.0	4,522
2018	16.5	10.8	28.0	3,772
2019	16.5	9.6	28.4	4,427
2020	16.1	8.6	27.9	4,947
2021	16.6	9.9	28.8	5,077
2022	16.7	10.4	26.8	2,778

Table 5. Mean, minimum and maximum fork lengths (inches) and total number sampled of Spanish mackerel collected by DMF from both dependent (commercial and recreational) and independent (survey) sources for ageing by the NOAA Southeast Fisheries Science Center, 1997–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1997	14.0	5.6	24.3	403
1998	15.5	7.9	28.3	430
1999	14.7	7.4	30.5	294
2000	17.4	8.9	27.2	466
2001	16.3	8.0	26.2	488
2002	16.2	5.7	28.0	337
2003	14.5	9.8	26.0	330
2004	14.9	10.0	26.4	282
2005	14.7	8.7	25.4	303
2006	14.9	10.0	26.9	291
2007	14.9	10.4	31.7	297
2008	14.3	7.7	26.9	328
2009	15.3	9.3	25.1	317
2010	14.9	6.9	25.4	411
2011	15.1	6.1	28.0	430
2012	14.5	6.3	26.4	557
2013	15.2	7.4	27.5	370
2014	14.7	7.6	25.8	515
2015	14.8	7.2	27.6	412
2016	15.1	8.5	29.1	579
2017	18.6	7.0	28.1	451
2018	16.0	7.8	29.0	463
2019	14.3	5.0	28.0	640
2020	16.4	4.8	27.3	337
2021	15.0	5.8	25.7	778
2022	15.4	8.7	24.4	664

Table 6. Mean, minimum and maximum fork lengths (inches) and total number sampled of Spanish mackerel from fishery independent sampling programs, 1997–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1997	8.1	2.8	13.9	52
1998	8.1	5.6	19.9	77
1999	9.1	3.1	19.3	31
2000	15.8	2.8	23.9	155
2001	15.6	4.1	24.4	158
2002	16.5	8.1	23.4	45
2003	16.6	9.7	22.4	35
2004	14.0	4.8	22.5	17
2005	15.0	3.8	24.1	61
2006	14.1	6.9	21.3	47
2007	11.4	2.2	21.8	163
2008	12.8	5.4	26.8	335
2009	13.9	4.3	22.4	474
2010	13.5	3.0	21.7	361
2011	14.2	2.8	20.5	103
2012	11.5	4.9	22.8	47
2013	10.3	4.6	17.9	46
2014	8.9	2.9	19.0	29
2015	12.3	3.9	21.7	49
2016	15.0	6.9	22.4	47
2017	19.8	2.8	24.6	130
2018	13.6	3.8	21.5	76
2019	12.7	1.9	22.6	517
2020	6.2	2.1	13.4	336
2021	14.1	5.0	22.8	360
2022	15.5	4.8	25.3	612

**FIGURES**

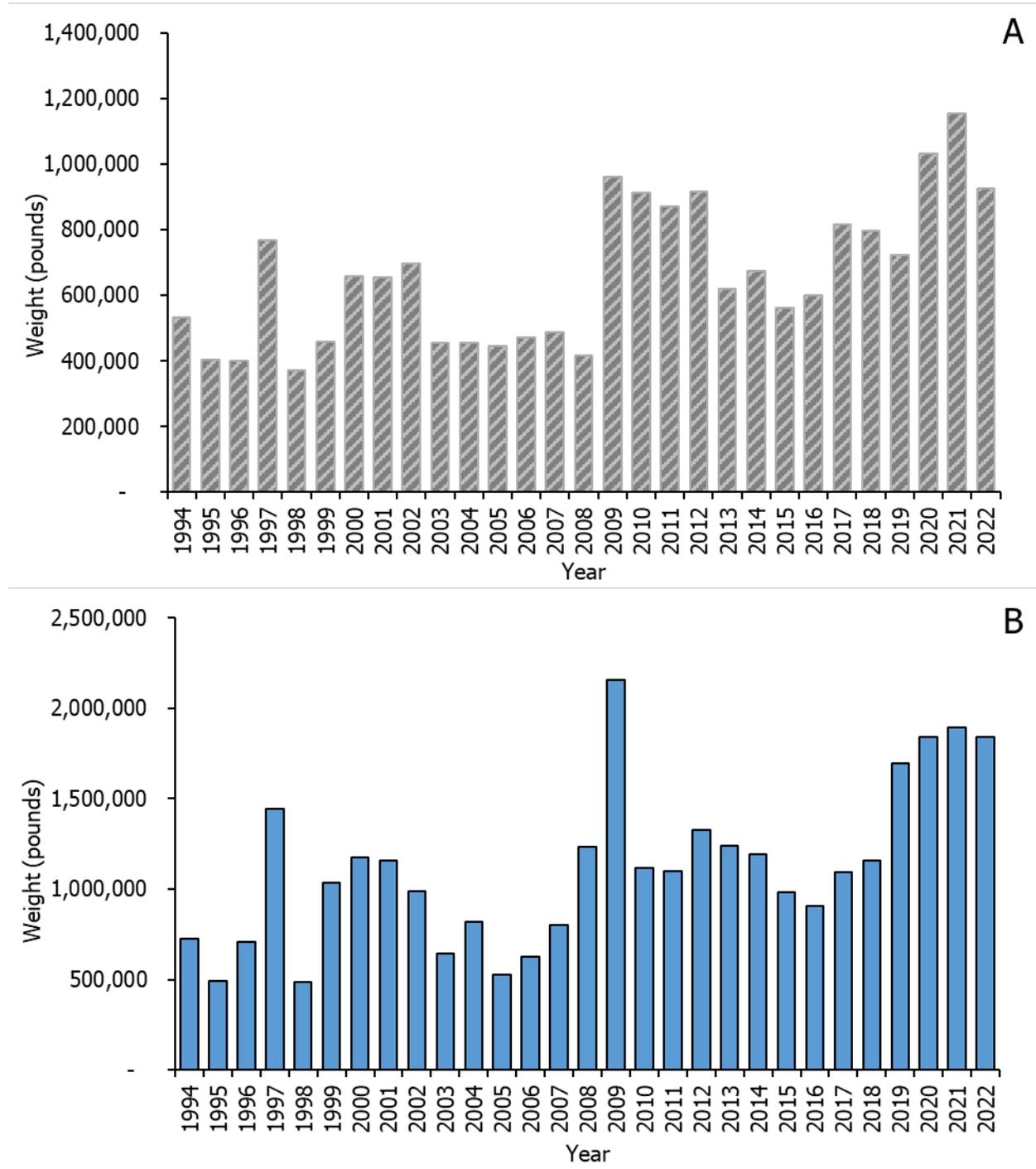


Figure 1. Annual commercial (A) and recreational (B) landings in pounds for Spanish mackerel in North Carolina, 1994–2022.

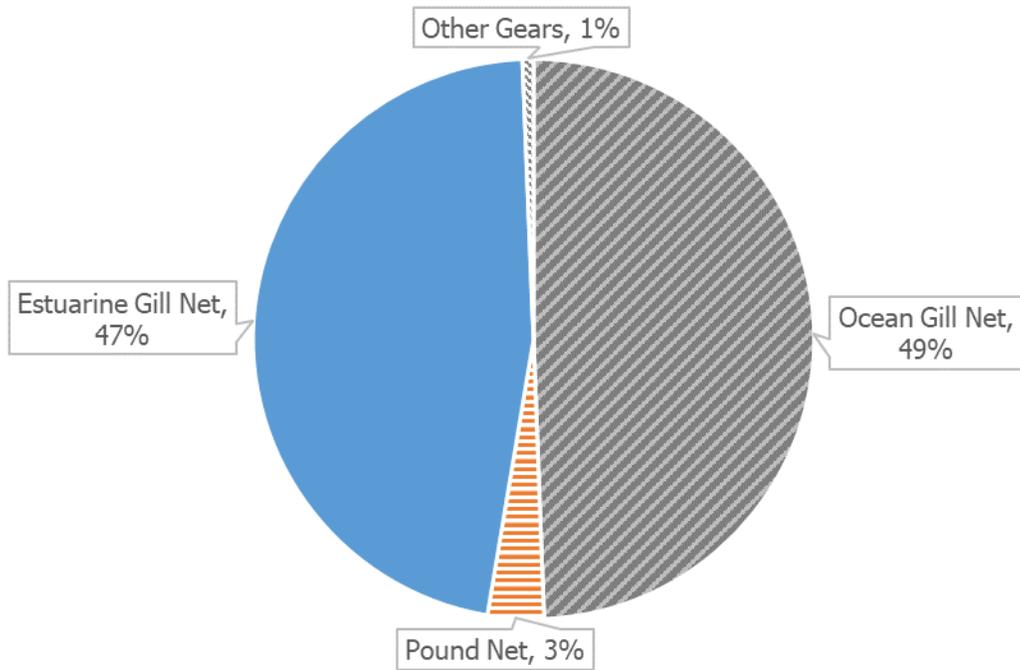


Figure 2. Commercial harvest of Spanish mackerel by gear, 2022.

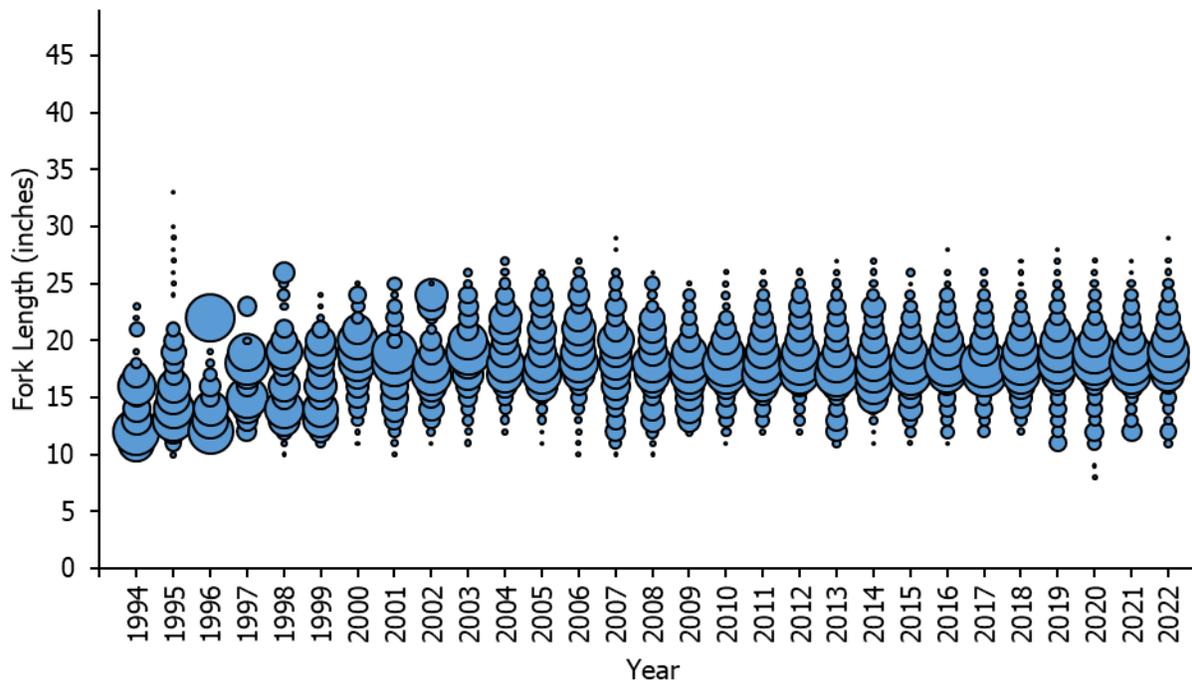


Figure 3. Commercial length frequency (fork length, inches) for Spanish mackerel harvested, 1994–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

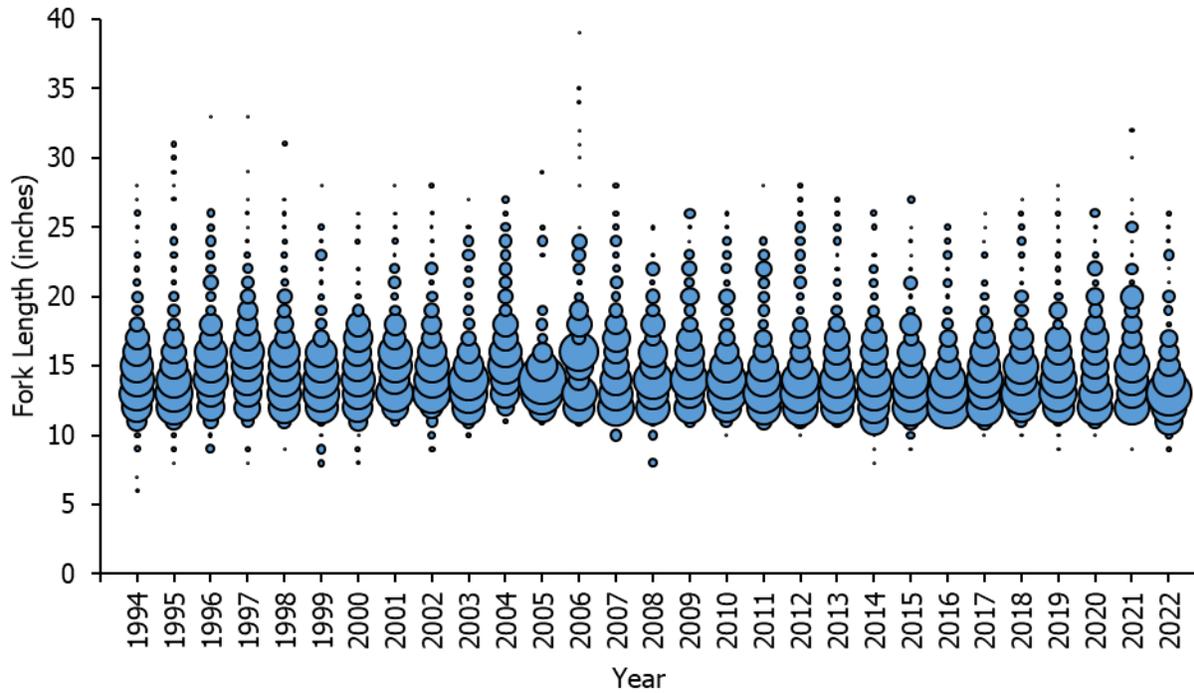


Figure 4. Recreational length frequency (fork length, inches) for Spanish mackerel harvested, 1994–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

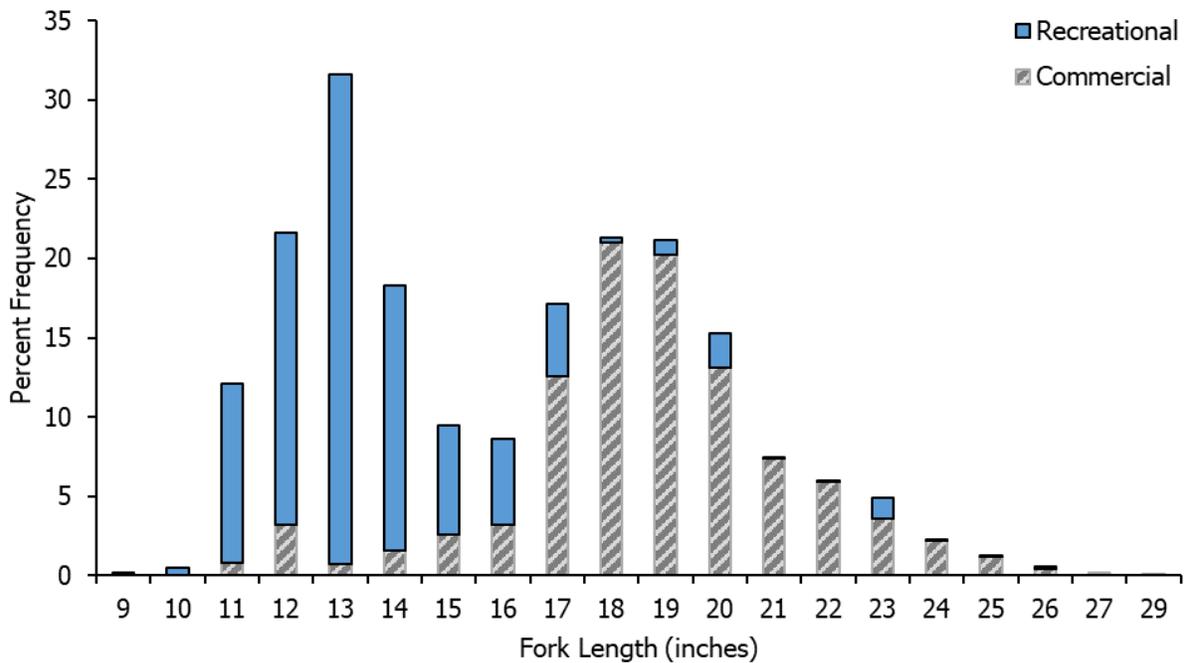


Figure 5. Commercial and recreational length frequency distribution from Spanish mackerel harvested in 2022.

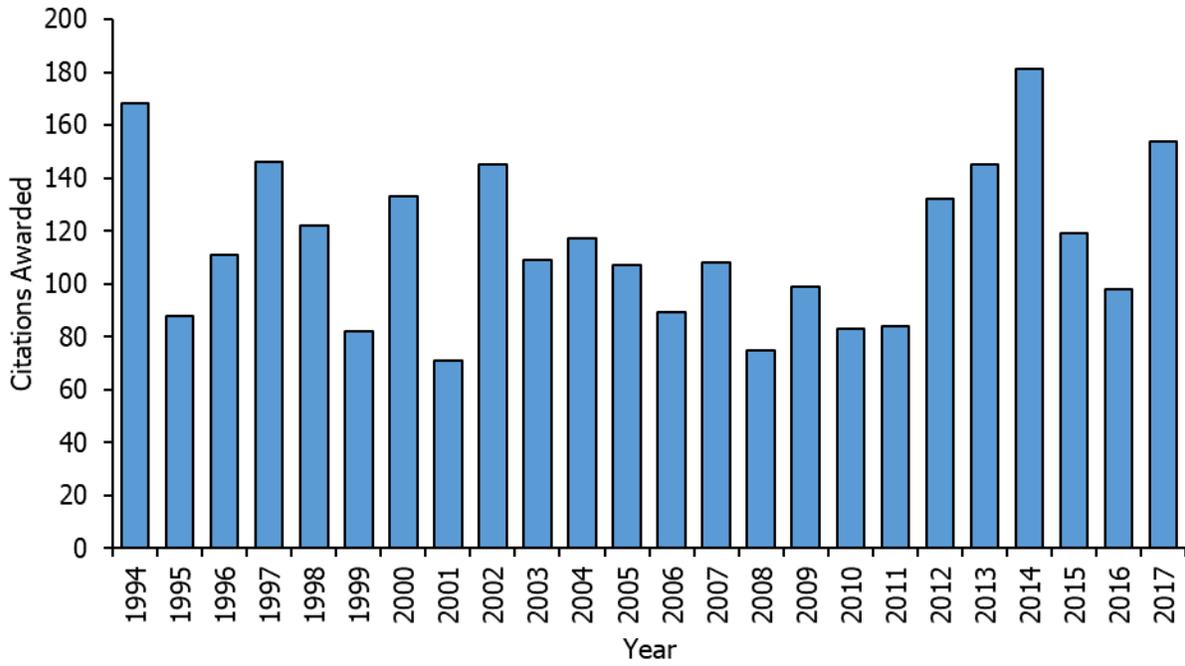


Figure 6. North Carolina Saltwater Fishing Tournament citations awarded for Spanish mackerel from 1994–2022. Citations are awarded for Spanish mackerel greater than six pounds.

**FISHERY MANAGEMENT PLAN UPDATE  
SPINY DOGFISH  
AUGUST 2022**

**STATUS OF THE FISHERY MANAGEMENT PLAN**

**Fishery Management Plan History**

FMP Documentation:	MAFMC/NEFMC FMP	January 2000
	Framework 1	2006
	Amendment 1	2007
	Framework 2	2009
	Amendment 2	2011
	Amendment 3	2014
	Amendment 4	2015
	Amendment 5	2017
	Framework 3	2018
	Framework 4	2020
	Framework 5	2020
	ASMFC FMP	November 2002
	Addendum I	November 2005
	Addendum II	October 2008
	Addendum III	April 2011
	Addendum IV	August 2012
	Addendum V	October 2014
	Addendum VI	October 2019
Comprehensive Review:	2022	

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 fishery management plan (FMP) was created for the stock in 2000 (MAFMC and NEFMC 2000). The FMP includes an annual commercial quota allocated for each fishing year (May 1–April 30).

The MAFMC/NEFMC spiny dogfish FMP has had five amendments since initiated in 2000. Amendment 1 required a standardized method to report by-catch, Amendment 2 established annual catch limits (ACLs) and Accountability Measures (AMs), Amendment 3 allowed for updates to essential habitat definitions, established provisions to maintain existing management measures (including quotas) in the event of delayed rulemaking, and eliminated the seasonal allocation of the coast-wide commercial quota, Amendment 4 implemented a standardized bycatch reporting methodology, and Amendment 5 implemented management measures to prevent the development of new, and the expansion of existing, commercial fisheries of certain forage species in the Mid-Atlantic. All amendments were approved by the National Oceanic and Atmospheric Association (NOAA). The MAFMC/NEFMC spiny dogfish FMP, associated

amendment documents, and framework information can be found at <https://www.mafmc.org/dogfish>.

In state waters, the ASMFC 2002 Interstate FMP for spiny dogfish establishes the annual quota and possession limits (ASMFC 2002). The Spiny Dogfish Coast Wide 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 six addenda. Addendum I allows the Spiny Dogfish Management Board to set multi-year specifications and Addendum II establishes regional allocation of the annual quota (58%) 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 5%, state-specified possession limits, and includes a three-year reevaluation of the measures. North Carolina is allocated 14.04% of the 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. Addendum VI allows quota to be transferred between all regions and states to enable full utilization of the coast-wide commercial quota and avoid quota overages. The ASMFC spiny dogfish FMP and associated addendum documents can be found at <http://www.asmfc.org/species/spiny-dogfish>.

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 2022).

### **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 coast-wide quota and allowed to specify possession limits in state waters.

## Goal 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 following objectives were adopted:

- Reduce fishing mortality to ensure that overfishing does not occur.
- Promote compatible management regulations between state and council jurisdictions and the US and Canada.
- Promote uniform and effective enforcement of regulations.
- Minimize regulations while achieving the management objectives stated above.
- Manage the spiny dogfish fishery to minimize the influences of the regulations on the prosecution of other fisheries, to the extent practicable.
- 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:

- Reduce fishing mortality and rebuild the female portion of the spawning stock biomass (SSB) to prevent recruitment failure and support a more sustainable fishery.
- Coordinate management activities between state, federal, and Canadian agencies to ensure complementary regulations throughout the species range.
- Minimize the regulatory discards and bycatch of spiny dogfish within state waters.
- Allocate the available resource in biologically sustainable manner that is equitable to all the fishers.
- 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.

## DESCRIPTION OF THE STOCK

### Biological Profile

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). Spiny dogfish 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 length of approximately 4 feet. Males are mature at approximately 23.6 inches (6 years old), while females mature at between 29.5 and 31.5 inches (12 years old; Nammack et al. 1985). The maximum recorded age is 35 years for males and 40 years for females (Campana et al. 2006). Spiny dogfish give 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 during the fall and winter offshore in the mid-Atlantic and pups are born during the winter in the offshore wintering grounds (Campana et al. 2009).

### **Stock Status**

The 2018 stock assessment update indicates that spiny dogfish are not overfished and overfishing is not occurring (Sosebee et al. 2018).

### **Stock Assessment**

The 2018 stock assessment update determined that the spiny dogfish SSB of 235 million pounds was slightly above the SSB threshold of 175 million pounds as of 2017. The 2018 stock assessment update used a fishing mortality (F) target of  $F_{40\%}$  spawning potential ratio (SPR) of 0.202 and determined that the observed F was below this target ( $F=0.2439$ ). However, results from the assessment indicated a decreasing trend in female spawning stock biomass from 2013 to 2018, the terminal year of the assessment. To address this trend, the federal quota for 2019 was set at 20.5 million pounds, a 46% reduction from the 2018 quota (38.2 million pounds). The quota was set at 23.2 million pounds in 2020 and 29.9 million pounds in 2021. A research track stock assessment was completed in late 2022, and future management advice will be provided through the Northeast Fisheries Science Center's management track assessment that is scheduled for June of 2023.

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

The fishery is typically opened via proclamation from November through April, as the quota allows; this time period corresponds to the time when spiny dogfish are available in North Carolina waters [see most recent [North Carolina Division of Marine Fisheries \(DMF\) proclamation](#)]. 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. There are no recreational harvest restrictions for spiny dogfish.

### **Commercial Fishery**

In North Carolina, spiny dogfish commercial landings peaked in 1996 and declined sharply through 2001. Landings remained low through 2008 and then steadily increased from 2009 through 2014. Landings have declined since 2014 (Table 1; Figure 1A). Most of the spiny dogfish were 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. In 2022, 91% of spiny dogfish were caught in ocean gill nets.

### **Recreational Fishery**

Recreational estimates across all years have been updated and are now based on the NOAA Marine Recreational Information Program (MRIP) new Fishing Effort Survey-based calibrated estimates. For more information on MRIP, please see <https://www.fisheries.noaa.gov/topic/recreational-fishing-data>. Total annual North Carolina

recreational landings, obtained from the NOAA Marine Recreational Information Program, have been minimal since 1994 (Table 1; Table 2; Figure 1).

## **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 1994 to 2023. Prior to 1999, sampling was minimal, and sex was not recorded. Therefore, length data presented in this report includes the years 1999 through 2022. Samples were collected 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 sample collected, total length (TL) and fork length (FL), aggregate weight (nearest kg), and sex were recorded. From 1999 through 2022, sampled spiny dogfish TL has averaged 33 inches and ranged from 19 to 43 inches (Table 3). The total number of spiny dogfish measured in 2022 was 114. Female spiny dogfish are typically encountered more often during sampling events due to their relatively higher abundance in nearshore areas where fishing occurs (Table 4). Like many elasmobranch species, spiny dogfish exhibit sexual dimorphism; males are generally smaller than females.

### **Fishery-Independent Monitoring**

The DMF initiated a fishery-independent gill net survey of Pamlico Sound in 2001 (P915). DMF has conducted a fishery-independent gill net survey (P915) which has been conducted in Pamlico Sound since 2001. Sampling was expanded to the Pamlico, Pungo, and Neuse Rivers in 2003 and to the Cape Fear and New Rivers in 2008. Coverage was further expanded to Bogue, Back, and Core Sounds in 2018. The objective of this project is to provide annual indices of relative abundance for key estuarine species in North Carolina estuaries 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 DMF 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 DMF to assess the status of these stocks without relying solely on commercial and recreational fishery dependent data. The survey employs a stratified random sampling design and utilizes multiple mesh gill nets (3.0 inch to 6.5 inch stretched mesh, by 0.5-inch increments). A total of 936 spiny dogfish were measured in the Pamlico Sound Independent Gill Net Survey from 2001 to 2021. Total length ranged from 20 to 40 inches and averaged 32 inches during the survey period.

## **RESEARCH NEEDS**

Research needs from the ASMFC's 2021 FMP review are provided below:

### **Fishery-Dependent Priorities**

- Determine area, season, and gear specific discard mortality estimates coast-wide in the recreational, commercial, and non-directed (bycatch) fisheries.

- Characterize and quantify bycatch of spiny dogfish in other fisheries.
- Increase the biological sampling of dogfish in the commercial fishery and on research trawl surveys.
- Further analyses of the commercial fishery are also warranted, especially with respect to the effects of gear types, mesh sizes, and market acceptability on the mean size of landed spiny dogfish.

### **Fishery-Independent Priorities**

- Conduct experimental work on NEFSC trawl survey gear performance, with focus on video work to study the fish herding properties of the gear for species like dogfish and other demersal groundfish.
- Investigate the distribution of spiny dogfish beyond the depth range of current NEFSC trawl surveys, possibly using experimental research or supplemental surveys.
- Continue to analyze the effects of environmental conditions on survey catch rates.

### **Modeling / Quantitative Priorities**

- Continue work on the change-in-ratio estimators for mortality rates and suggest several options for analyses.
- Examine observer data to calculate a weighted average discard mortality rate based on an assumption that the rate increased with catch size.

### **Life History, Biological, and Habitat Priorities**

- 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, DMF, Canada DFO, other interested agencies, academia, and other international investigators with an interest in dogfish ageing.
- Identify how spiny dogfish abundance and movement affect other organisms.

### **Management, Law Enforcement, and Socioeconomic Priorities**

- Monitor the changes to the foreign export markets for spiny dogfish and evaluate the potential to recover lost markets or expand existing ones.
- Update on a regular basis the characterization of fishing communities involved in the spiny dogfish fishery, including the processing and harvesting sectors, based upon Hall-Arber et al. (2001) and McCay and Cieri (2000).
- Characterize the value and demand for spiny dogfish in the biomedical industry on a state-by-state basis.
- Characterize the spiny dogfish processing sector.

## 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 formed using fisheries data collected from the previous fishing season. These quota recommendations are then communicated to the Spiny Dogfish Management Board and MAFMC for approval. The 2023/2024 quota (12 million pounds) was reduced 59.4% from the 2022/2023 quota (29,559,580 pounds). Current management targets and thresholds are below:

- $F_{msy} = 0.2439$
- $SSB_{target} = 351.2$  million pounds (159,288 metric tons); level of biomass that would maximize recruitment to the population (100%  $SSB_{max}$ ).
- $SSB_{threshold} = 175.6$  million pounds (79,644 metric tons); 50% of  $SSB_{target}$

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## TABLES

Table 1: Spiny dogfish recreational harvest and number released (NOAA Marine Recreational Information Program) and commercial harvest (North Carolina Trip Ticket Program), 1994–2022.

Year	Recreational			Commercial	Total Weight (lb)
	Number Landed	Number Released	Weight Landed (lb)	Weight Landed (lb)	
1994	0	1,842	0	1,234,931	1,234,931
1995	107	1,911	1,071	7,174,803	7,175,874
1996	0	2,453	0	13,210,735	13,210,735
1997	0	0	0	7,608,426	7,608,426
1998	1,645	3,229	11,308	4,961,379	4,972,687
1999	0	51,303	0	3,718,622	3,718,622
2000	0	0	0	3,549,939	3,549,939
2001	0	7,866	0	*	*
2002	0	12,167	0	*	*
2003	2,701	1,429	0	*	*
2004	0	40,336	0	522,576	522,576
2005	0	3,928	0	18,865	18,865
2006	1,402	72,255	5,718	11,574	17,292
2007	0	78,188	0	149,543	149,543
2008	0	40,842	0	158,727	158,727
2009	0	94,509	0	1,416,362	1,416,362
2010	3,613	167,231	16,556	1,708,437	1,724,993
2011	11,422	175,993	83,637	2,557,923	2,641,560
2012	1,365	176,126	9,538	2,728,882	2,738,420
2013	48,603	2,006,275	79,537	3,010,958	3,090,495
2014	1,992	598,268	11,978	5,650,285	5,662,263
2015	7,302	657,373	36,376	4,247,213	4,283,589
2016	22,611	52,562	173,584	2,271,201	2,472,840
2017	683	44,038	5,616	393,085	398,701
2018	7,514	157,394	43,732	1,168,247	1,211,979
2019	6,106	261,322	43,551	1,124,291	1,167,842
2020	1,785	31,195	13,638	1,501,331	1,514,969
2021	21,587	400,905	117,447	131,501	248,948
2022	3,903	70,502	12,295	70,392	82,687
Average**	4,977	179,705	22,951	2,703,855	2,730,533

\* Confidential data

\*\* Average does not include confidential data

Table 2. Spiny dogfish length (total length, inches) data from NOAA Marine Recreational Information Program recreational samples, 1994–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1994	0	0	0	0
1995	33	33	33	1
1996	0	0	0	0
1997	0	0	0	0
1998	31	21	32	4
1999	0	0	0	0
2000	0	0	0	0
2001	0	0	0	0
2002	0	0	0	0
2003	0	0	0	0
2004	0	0	0	0
2005	0	0	0	0
2006	33	30	35	4
2007	0	0	0	0
2008	0	0	0	0
2009	0	0	0	0
2010	28	25	31	2
2011	31	30	33	3
2012	33	31	33	1
2013	22	21	31	1
2014	35	12	40	1
2015	27	16	40	2
2016	35	31	38	2
2017	33	31	34	5
2018	30	25	38	11
2019	35	32	38	3
2020	32	27	38	11
2021	29	24	35	10
2022	24	18	27	10

Table 3. Spiny dogfish length (total length, inches) data from commercial fish house samples, 1999–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1999	33	22	41	255
2000	33	25	41	2,636
2001	32	29	35	12
2002	30	26	32	10
2003	0	0	0	0
2004	34	27	41	1,323
2005	30	27	32	7
2006	35	30	41	92
2007	34	27	40	1,201
2008	34	29	39	545
2009	34	28	43	1,048
2010	34	28	40	843
2011	33	28	40	686
2012	34	26	42	2,461
2013	35	27	41	2,373
2014	35	26	42	2,168
2015	34	19	40	1,365
2016	34	25	40	795
2017	33	24	39	67
2018	34	27	40	380
2019	34	24	39	580
2020	31	23	41	454
2021	34	28	38	76
2022	33	26	38	114

Table 4. Female spiny dogfish length (total length, inches) data from commercial fish house samples, 1999–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1999	33	22	41	235
2000	33	25	41	2,464
2001	33	31	35	7
2002	31	28	32	8
2003	0	0	0	0
2004	34	27	41	1,295
2005	30	27	32	4
2006	35	30	41	91
2007	34	29	40	1,017
2008	34	29	39	527
2009	34	28	43	994
2010	34	28	40	794
2011	34	26	39	647
2012	35	27	42	2,373
2013	35	26	41	2,285
2014	35	19	42	2,094
2015	35	25	40	1,281
2016	35	24	40	727
2017	34	29	39	53
2018	35	27	40	343
2019	34	25	39	523
2020	32	23	41	362
2021	31	31	31	1
2022	33	27	38	98

Table 5. Male spiny dogfish length (total length, inches) data from commercial fish house samples, 1999–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1999	30	23	32	20
2000	30	27	38	172
2001	31	29	33	5
2002	27	26	28	2
2003	0	0	0	0
2004	31	28	36	28
2005	30	29	31	3
2006	30	30	30	1
2007	30	27	37	184
2008	31	29	37	18
2009	31	28	37	54
2010	31	28	35	49
2011	30	28	33	34
2012	30	28	35	87
2013	31	26	35	88
2014	31	25	33	74
2015	31	25	38	84
2016	30	26	35	68
2017	30	27	32	14
2018	30	27	35	37
2019	30	24	35	57
2020	29	25	37	88
2021	34	28	38	75
2022	30	26	32	16

**FIGURES**

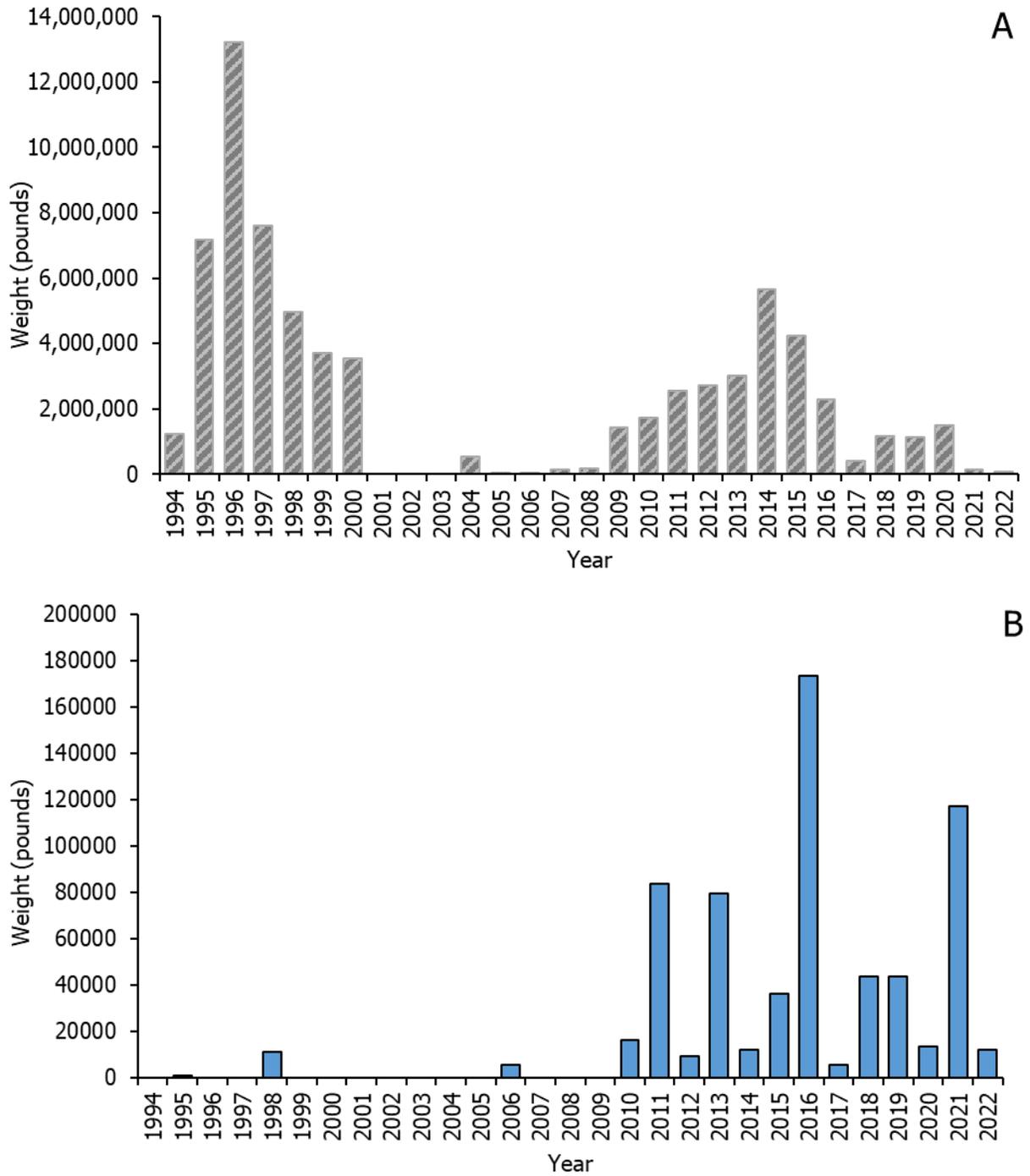


Figure 1. Annual commercial (A) and recreational (B) landings in pounds for spiny dogfish in North Carolina, 1994–2022.

**FISHERY MANAGEMENT PLAN UPDATE  
ATLANTIC STRIPED BASS  
AUGUST 2022**

**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 October 1989
	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 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 2019
	Revised April 2021
	Addendum VI October 2019
	Amendment 7 May 2022
	Addendum I May 2023
Comprehensive Review:	2024

Increased fishing pressure in the 1970s, coupled with degradation and loss of habitat, led to stock collapse and promoted the development of a cooperative interstate fisheries management plan (FMP). While a notable first step, the first FMP (1981) and Amendments 1 and 2 to the plan (1984) only provided recommendations on how to manage the resource. States could take voluntary actions under these management plans but there was no statutory requirement that ensured unified management actions by all the involved states. The passage of the Atlantic Striped Bass Conservation Act in 1984 (Striped Bass Act) changed this by requiring the states, through the Commission, to develop and implement management plans that included mandatory conservation measures. Amendment 3 (1985) was the first plan under the Striped Bass Act with such measures,

including regulations to protect the 1982-year class, the first modestly sized cohort for nearly a decade. Some states elected for an even more conservative approach and imposed a total moratorium to protect the 1982-year class. The Amendment contained a mechanism to relax fishery regulations based on a juvenile abundance index. The mechanism was triggered with the recruitment of the 1989-year class and led to the implementation of Amendment 4 (1989), which aimed to rebuild the resource rather than maximize yield. In 1995, with adoption of Amendment 5, the Commission declared Atlantic coastal striped bass stocks fully recovered.

Amendment 6 (2003) introduced a new set of biological reference points based on female spawning stock biomass (SSB), and a suite of management triggers based on the reference points. It also restored the commercial quota for the ocean fishery to 100% of average landings during the 1972-1979 historical period, and recreational fisheries were constrained by a 2-fish bag limit and a minimum size limit of 28 inches, except for the Chesapeake Bay fisheries, Albemarle-Roanoke (A-R) fisheries, and fisheries with approved conservation equivalency proposals. From 2007 to 2014, a series of four Addenda (I-IV) to Amendment 6 were implemented. These addenda addressed a range of issues, including implementation of a bycatch monitoring program, modifying the definition of recruitment failure, implementation of a mandatory commercial harvest tagging program, and establishing one set of F reference points for the coastal migratory population in all management areas. Addendum IV (2014) also formally deferred management of the A-R stock to the State of North Carolina, under the auspices of the Commission, since the A-R stock was deemed to contribute minimally to the coastal migratory population.

In 2019, a new benchmark assessment which used updated recreational catch estimates, changed our understanding of stock status. The benchmark assessment found the stock to be overfished and experiencing overfishing. As a result, Addendum VI to Amendment 6 was initiated to end overfishing, and bring F to the target level in 2020. Specifically, the Addendum reduced all state commercial quotas by 18%, and implemented a 1-fish bag limit and a 28" to less than 35" recreational slot limit for ocean fisheries and a 1-fish bag limit and an 18" minimum size limit for Chesapeake Bay recreational fisheries. These measures were implemented in 2020 and designed to achieve at least an 18% reduction in total removals at the coastwide level.

In November 2022, the Board reviewed the results of the 2022 Atlantic Striped Bass Stock Assessment Update. The 2022 assessment indicated the resource is still overfished but no longer experiencing overfishing relative to the updated reference points. The updated fishing mortality reference points took into account the period of low recruitment the stock has experienced in recent years.

As it considered its actions under Addendum VI, the Management Board also discussed the development of a new Amendment to the FMP, one that reflected our understanding of the resource and the fisheries that depend on it. This led to the development and approval of Amendment 7 in 2022.

Currently, Atlantic striped bass is managed under Amendment 7 to the Interstate Fishery Management Plan, which consolidates Amendment 6 and its associated addenda into a single document. Amendment 7 establishes new requirements for the following components of the FMP: management triggers, conservation equivalency, additional measures to address recreational release mortality, and the stock rebuilding plan. This Amendment builds upon the Addendum VI

to Amendment 6 action to address overfishing and initiate rebuilding in response to the overfished finding from the last stock assessment, requiring the Board to rebuild the stock by 2029. Amendment 7 strengthens the Commission's ability to reach the rebuilding goal by implementing a more conservative recruitment trigger, providing more formal guidance around uncertainty in the conservation equivalency process, and implementing measures intended to increase the chance of survival after a striped bass is released alive in the recreational fishery. All provisions of Amendment 7 are effective May 5, 2022, except for gear restrictions. States must implement new gear restrictions by January 1, 2023.

Amendment 7 also maintains the same recreational and commercial measures specified in Addendum VI to Amendment 6, which were implemented in 2020. As such, all approved Addendum VI conservation equivalency programs and state implementation plans are maintained until such measures are changed in the future.

In May 2023, the Board approved an emergency action to change the recreational size limit, effective immediately for 180 days from May 2, 2023, through October 28, 2023. This action responds to the unprecedented magnitude of 2022 recreational harvest, which was nearly double that of 2021, and new stock rebuilding projections, which estimate the probability of the spawning stock rebuilding to its biomass target by 2029 drops from 97% under the lower 2021 fishing mortality rate to less than 15% if the higher 2022 fishing mortality rate continues each year.

The Board implemented the emergency 31-inch total length (TL) maximum size limit for 2023 to reduce harvest of the strong 2015-year class. The 31-inch TL maximum size limit applies to all existing recreational fishery regulations where a higher (or no) maximum size applies, excluding the May Chesapeake Bay trophy fisheries which already prohibit harvest of fish less than 35 inches. All bag limits, seasons, and gear restrictions will remain the same. Jurisdictions are required to implement the required measure as soon as possible but no later than July 2, 2023. If it deems necessary, the Board may extend the emergency action for two additional periods of up to one year each at a future Board meeting. The Commission is conducting four virtual public hearings between May 17 and May 31, 2023, to inform the public about the emergency action and identify next steps for management.

Addendum I to Amendment 7 was approved in May 2023 to allow for voluntary ocean commercial quota transfers contingent on stock status. When the stock is overfished, no quota transfers will be allowed. When the stock is not overfished, the Board can decide every one-to-two years whether it will allow voluntary transfers of ocean commercial quota. The Board can also set criteria for allowable transfers, including a limit on how much and when quota can be transferred in a given year, and the eligibility of state to request a transfer based on its landings.

The Board also initiated Addendum II to Amendment 7 in May 2023 to address the concerns about increased removals and stock rebuilding beyond 2023. The Draft Addendum is intended to follow the 2023 emergency action and will consider 2024 management measures designed to reduce fishing mortality to the target. Specifically, the Draft Addendum will propose options for the ocean recreational fishery, including modifications to the slot limit with harvest season closures as a secondary non-preferred option. It will also propose options for the Chesapeake Bay recreational fisheries, as well all commercial fisheries, including maximum size limits. Board members

emphasized the importance of soliciting public input through the addendum process for 2024 measures following the 2023 emergency action.

For measures beyond 2024, the Board intends to consider the results of the upcoming 2024 stock assessment update to inform subsequent management action. To enable an expedited management response to the 2024 stock assessment update, the Draft Addendum will propose a provision that would enable the Board to respond to the results of the stock assessment updates via Board action if the stock is projected to not rebuild by 2029.

The Board will consider the Draft Addendum at the 2023 Summer Meeting, when it will either approve the document for public comment or provide feedback for further development of the document.

To ensure compliance with interstate requirements, North Carolina also includes striped bass in the North Carolina FMP for Interjurisdictional Fisheries (IJ FMP). The goal of the IJ FMP is to adopt FMPs, 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 all coastal migratory striped bass stocks on the East Coast of the United States, excluding the Exclusive Economic Zone (3–200 nautical miles offshore), which is managed separately by NMFS. The coastal migratory striped bass stocks occur in the coastal and estuarine areas of all states and jurisdictions from Maine through the Albemarle-Roanoke striped bass stock in North Carolina. Inclusion of these states in the management unit is also congressionally mandated in the Atlantic Striped Bass Conservation Act (PL 98-613). In North Carolina the striped bass stocks in the Tar-Pamlico, Neuse, and Cape Fear rivers are considered estuarine and non-migratory, and are not managed through the ASMFC FMP, rather they are managed under the N.C. Estuarine Striped Bass FMP.

### **Goal and Objectives**

The Goal of Amendment 7 is to perpetuate, through cooperative interstate fishery management, migratory stocks of striped bass (*Morone saxatilis*); to allow commercial and recreational fisheries consistent with the long-term maintenance of a broad age structure, a self-sustaining spawning stock; and to provide for the restoration and maintenance of their essential habitat.

In support of this goal, the following objectives are specified:

- 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.

- Manage fishing mortality to maintain an age structure that provides adequate spawning potential to sustain long-term abundance of striped bass populations.
- 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.
- Foster quality and economically viable recreational, for-hire, and commercial fisheries.
- Maximize cost effectiveness of current information gathering and prioritize state obligations in order to minimize costs of monitoring and management.
- Adopt a long-term management regime that minimizes or eliminates the need to make annual changes or modifications to management measures.
- 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.

## DESCRIPTION OF THE STOCK

### Biological Profile

Striped bass are the largest member of the Moronidae family, the temperate basses, which also includes white perch, white bass and yellow bass. Striped bass are a riverine and estuarine dependent species native from the St. Lawrence River in Canada down to the St. Johns River in Florida, and through the Gulf of Mexico, although some taxonomists suggest the striped bass found in the Gulf of Mexico warrant description as a subspecies (GSMFC 2006). The migratory striped bass stocks from Maine through the A-R stock in North Carolina are managed under the jurisdiction of the ASMFC. Striped bass stocks south of the Albemarle Sound are considered estuarine and non-migratory and are not under ASMFC jurisdiction.

Atlantic striped bass under ASMFC jurisdiction are anadromous, meaning they spend most of their adult life in ocean waters, but return to their natal rivers to spawn in the spring. The rivers that feed the Chesapeake Bay, and the Delaware and Hudson rivers are the major spawning grounds for the coastal migratory population. Female striped bass typically grow larger and heavier than males. There are two, distinct life history strategies for striped bass from the Chesapeake Bay, Delaware, Hudson, and A-R stocks. One group consists of mostly females and participate in extensive coastal migrations. Fish travel north as far as Maine and Canada in the spring after spawning takes place, then as water temperatures drop they move south in the winter where they overwinter off the VA/NC coast before going to their natal rivers to spawn again in the spring. The other group is mostly resident fish and the majority are males, inhabiting the estuaries and near-shore ocean within their natal systems.

Based on sampling efforts from the Chesapeake Bay, 45% of female striped bass mature at age 6 and 100% mature by age 9. The latest maturity study for the A-R stock determined 29% of female striped bass are mature at age 3, 97% are mature at age 4, and 100% are mature at age 5 (Boyd 2011). The oldest striped bass on record is 31 years old, but they would likely live longer than that in the absence of fishing pressure. The oldest fish observed in the Albemarle-Roanoke stock is also 31 years old.

## **Stock Status**

The stock is currently overfished but no longer experiencing overfishing.

## **Stock Assessment**

In November 2022, the Board reviewed the results of the 2022 Atlantic Striped Bass Stock Assessment Update, which uses the same model from the approved, peer-reviewed 2018 Benchmark Stock Assessment. The 2022 assessment indicated the resource is still overfished but no longer experiencing overfishing relative to the updated reference points. Female SSB in the terminal year (2021) was estimated at 143 million pounds, which is below the SSB threshold of 188 million pounds and below the SSB target of 235 million pounds. Fishing mortality ( $F$ ) in 2021 was estimated at 0.14, which is below the  $F$  threshold of 0.20 and below the  $F$  target of 0.17. The updated fishing mortality reference points took into account the period of low recruitment the stock has experienced in recent years.

The assessment also indicated a period of strong recruitment (numbers of age-1 fish entering the population) from 1994–2004, followed by a period of lower recruitment from 2005–2011 (although not as low as the early 1980s, which likely contributed to the decline in SSB in recent years. Recruitment of age-1 fish was high in 2012, 2015, 2016, and 2019 (corresponding to strong 2011, 2014, 2015, and 2018 year classes), but estimates of age-1 striped bass were below the long-term average in 2018, 2020, and 2021. Recruitment in 2021 was estimated at 116 million age-1 fish, below the time series average of 135.7 million fish.

## **DESCRIPTION OF THE FISHERY**

### **Current Regulations**

Striped bass regulations in the North Carolina coastal waters (0–3 miles) of the Atlantic Ocean are under the jurisdiction of ASMFC, while striped bass regulations in North Carolina’s 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 3–200 miles offshore. Striped bass cannot even be targeted for recreational catch-and-release fishing in the EEZ.

In North Carolina, commercial harvest is currently constrained by a 294,495-pound annual quota and a 28-inch TL 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. It is also illegal to harvest striped bass less than 28 inches TL or greater than 31 inches TL. It is also unlawful to fish for or possess striped bass from the Atlantic Ocean for recreational purposes using hook and line gear with natural bait unless using a non-stainless steel, non-offset (inline) circle hook,

regardless of tackle or lure configuration. Natural bait is defined as any living or dead organism (animal or plant) or parts thereof. Non-offset circle hook is defined as a hook with the point pointed perpendicularly back towards the shank and the point and barb are in the same plane as the shank. Striped bass may be taken seven days a week and the season is open year-round.

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 in prior years. 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.

### **Commercial Fishery**

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 Virginia waters while overwintering (Tables 1 and 2, Figure 3).

### **Recreational Fishery**

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 6.6 million pounds in 2004 (Table 1; Figure 3). 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 2001 to 2011 landings averaged about 2.3 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 3.).

The DMF offers award citations for exceptional catches of striped bass. Most citations are from fish caught in the Atlantic Ocean. Striped bass that measure greater than 45 inches total length or 35 pounds are eligible for an award citation. Citations peaked in 2004 at over 700 but have declined to near zero since 2011 due to shifting overwintering patterns (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 (Table 2). Because of the 28-inch total length minimum size limit and gear regulations, most fish harvested average about 38-inches total length (Table 3; Figure 5). North Carolina also augments NOAA Fisheries Marine Recreational Information Program (MRIP) by providing additional funding for increased samplers, which estimates the annual harvest and releases of marine recreational fisheries. Mean total 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; Figure 6).

### **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). Tagging takes place in January and/or February on their overwintering grounds, usually in the vicinity of the VA/NC border. Although in recent years some trips have had to move to Ocean City MD because the striped bass did not move that far south. 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. This means that fish from all producer areas, including Chesapeake Bay, Delaware River, Hudson River, and A-R 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.

In order to describe the age structure of harvest and indices, striped bass age structures are collected from various fishery independent (scientific surveys) and dependent (fisheries) sources throughout the year. The length at age data for striped bass display an increasing length at age for striped bass up to about 40 inches in length, although the length at age overlaps between similar ages (Table 6; Figure 7).

### **RESEARCH NEEDS**

The following research recommendations were developed by the 2018 Benchmark Stock Assessment Subcommittee and the 66th SARC (NEFSC 2019).

- Continue collection of paired scale and otolith samples, particularly from larger striped bass, to facilitate development of otolith-based age-length keys and scale-otolith conversion matrices.
- Develop studies to provide information on gear specific (including recreational fishery) discard mortality rates and to determine the magnitude of bycatch mortality.
- Conduct study to directly estimate commercial discards in the Chesapeake Bay.

- Collect sex ratio information on the catch and improve methods for determining population sex ratio for use in estimates of female SSB and biological reference points.
- Develop an index of relative abundance from the Hudson River Spawning Stock Biomass survey to better characterize the Delaware Bay/Hudson River stock.
- Improve the design of existing spawning stock surveys for Chesapeake Bay and Delaware Bay.
- Develop better estimates of tag reporting rates; for example, through a coastwide tagging study.
- Investigate changes in tag quality and potential impacts on reporting rate.
- Explore methods for combining tag results from programs releasing fish from different areas on different dates.
- Develop field or modeling studies to aid in estimation of natural mortality and other factors affecting the tag return rate.
- Compare M and F estimates from acoustic tagging programs to conventional tagging programs.
- Continue in-depth analysis of migrations, stock compositions, sex ratio, etc. using mark-recapture data.
- Continue evaluation of striped bass dietary needs and relation to health condition.
- Continue analysis to determine linkages between the Mycobacteriosis outbreak in Chesapeake Bay and sex ratio of Chesapeake spawning stock, Chesapeake juvenile production, and recruitment success into coastal fisheries.
- See Section 4.4 of Amendment 7 [asmfc.org/species/atlantic-stripped-bass](http://asmfc.org/species/atlantic-stripped-bass) for habitat conservation and restoration recommendations, which include reviewing striped bass habitat use and data (e.g., water quality criteria) to inform habitat conservation and restoration.

## MANAGEMENT STRATEGY

Amendment 7 establishes new requirements for the following components of the FMP: management triggers, conservation equivalency, measures to address recreational release mortality, and the stock rebuilding plan. Amendment 7 strengthens the Commission's ability to reach the rebuilding goal by implementing a more conservative recruitment trigger, providing more formal guidance around uncertainty in the management process, and implementing measures designed to reduce recreational release mortality. This Amendment builds upon the Addendum VI action to address overfishing and initiate rebuilding in response to the assessment findings.

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## TABLES

Table 1. Recreational harvest (number of fish landed and weight in pounds) and releases (number of fish) and commercial harvest (weight in pounds) of striped bass from the Atlantic Ocean, North Carolina, 1982–2022. Recreational data presented from MRIP are for waves 1 (Jan–Feb) and 6 (Nov–Dec).

Year	Recreational			Commercial	
	Number Landed	Number Released	Weight Landed (lb)	Number Landed	Weight Landed (lb)
1982	0	0	0	3,200	92,462
1983	0	0	0	1,405	52,796
1984	0	0	0	532	14,501
1985	0	0	0	0	0
1986	0	0	0	0	0
1987	0	0	0	0	0
1988	510	0	0	0	0
1989	0	0	0	0	0
1990	0	0	0	803	9,797
1991	1,032	0	10,240	413	6,186
1992	2,680	928	0	1,745	27,702
1993	531	2,115	6,084	3,414	36,463
1994	6,543	6,340	89,819	7,956	139,672
1995	16,479	28,169	232,043	23,387	344,627
1996	31,709	98,285	391,588	3,289	58,217
1997	60,074	102,395	865,306	25,820	463,144
1998	41,236	130,531	636,090	14,213	272,969
1999	26,388	50,032	339,092	21,119	391,482
2000	18,108	41,812	276,814	6,465	162,369
2001	60,700	23,264	1,081,940	24,955	381,115
2002	56,330	47,328	997,649	23,242	441,018
2003	50,418	19,006	965,671	5,769	201,199
2004	323,239	246,671	6,655,565	31,041	605,356
2005	194,854	179,323	3,947,042	27,288	604,464
2006	134,184	37,204	2,975,348	2,718	74,189
2007	81,777	22,486	1,965,111	16,798	379,467
2008	36,877	26,405	749,673	13,369	288,410
2009	6,548	1,001	186,729	9,030	189,963
2010	67,144	51,400	1,197,988	13,664	276,435
2011	207,610	245,287	4,467,159	10,867	246,366
2012	0	0	0	333	7,281
2013	0	0	0	0	0
2014	0	0	0	0	0
2015	0	0	0	0	0
2016	0	39,248	0	0	0
2017	0	5,149	0	0	0
2018	0	3,490	0	0	0
2019	0	0	0	0	0
2020	0	0	0	0	0
2021	0	0	0	0	0
2022	0	34,518	0	0	0
Mean	36,538	36,099	718,896	7,509	147,888

Table 2. Striped bass commercial harvest (pounds) by gear (North Carolina Trip Ticket Program) from the Atlantic Ocean, North Carolina, based on a fishing year beginning December 1 and ending November 30. The fishing year management strategy began with the implementation of a coastwide (states from Maine to North Carolina) commercial quota in 1991.

Fishing Year	Gear			Total Landings	Quota
	Beach Seine	Gill Net	Trawl		
1991/1992				6,186	96,000
1992/1993				27,702	96,000
1993/1994				75,671	96,000
1994/1995	64,077	54,576	4,531	123,184	96,000
1995/1996	163,519	130,280	36,250	330,049	334,000
1996/1997	76,558	95,337	184,192	356,187	334,000
1997/1998	155,633	104,551	92,316	352,500	*312,827
1998/1999	68,920	330,784	0	399,727	*299,954
1999/2000	61,149	2,055	100,910	164,114	*218,000
2000/2001	62,969	117,457	168,456	348,882	336,000
2001/2002	100,718	113,515	84,795	299,028	*326,787
2002/2003	226,023	93,346	108,141	427,510	480,480
2003/2004	0	201,025	220,166	421,191	480,480
2004/2005	181,552	233,772	37,598	452,922	480,480
2005/2006	330,429	981	17,797	349,207	480,480
2006/2007	0	326,328	98,373	424,701	480,480
2007/2008	86,150	138,894	74,118	299,162	480,480
2008/2009	4,888	51,677	133,430	189,995	480,480
2009/2010	4,097	71,664	196,657	272,418	480,480
2010/2011	6,646	139,377	104,360	250,383	480,480
2011/2012	0	4,045	2,181	6,226	480,480
2012/2013	0	0	0	0	480,480
2013/2014	0	0	0	0	480,480
2014/2015	0	0	0	0	360,360
2015/2016	0	0	0	0	360,360
2016/2017	0	0	0	0	360,360
2017/2018	0	0	0	0	360,360
2018/2019	0	0	0	0	360,360
2019/2020	0	0	0	0	295,495
2020/2021	0	0	0	0	295,495
2021/2022	0	0	0	0	295,495

\*Fishing year quotas adjusted for previous year's overage.

Table 3. Summary of striped bass total length (inches) samples collected from commercial fisheries from the Atlantic Ocean, North Carolina, 1981/1982–2021/2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1981/1982	43	38	48	53
1982/1983	43	35	50	221
1983/1984	44	29	52	7
1990/1991	31	27	38	203
1991/1992	33	28	51	241
1992/1993	31	24	46	135
1993/1994	33	26	51	351
1994/1995	35	30	39	51
1995/1996	35	22	43	211
1996/1997	35	28	45	358
1997/1998	33	28	40	183
1998/1999	36	29	42	191
1999/2000	37	30	44	290
2000/2001	35	28	43	256
2001/2002	38	29	47	249
2002/2003	36	23	43	573
2003/2004	37	29	47	400
2004/2005	38	29	46	717
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
2016/2017				0
2017/2018				0
2018/2019				0
2019/2020				0
2020/2021				0
2021/2022				0

Table 4. Striped bass total length (inches) data from Marine Recreational Information Program recreational fishery samples, Atlantic Ocean, North Carolina, 1991–2022.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1991	685	685	685	1
1992	848	848	848	1
1993	802	802	802	1
1994	733	501	892	19
1995	817	720	1,058	69
1996	782	293	990	135
1997	788	483	1,018	229
1998	807	458	1,083	272
1999	770	488	1,076	182
2000	792	482	1,091	113
2001	830	471	1,091	267
2002	828	473	1,098	318
2003	905	584	1,152	614
2004	907	536	1,279	1,800
2005	914	706	1,168	1,106
2006	920	708	1,145	372
2007	965	722	1,178	375
2008	902	722	1,204	303
2009	1,005	725	1,253	67
2010	858	708	1,302	95
2011	913	683	1,244	609
2012				0
2013				0
2014				0
2015				0
2016				0
2017				0
2018				0
2019				0
2020				0
2021				0
2022				0

Table 5. Striped bass total length (inches) and tagging data from the Cooperative Winter Tagging Program, trawl and hook-and-line gear, 1988–2022.

Year	Number Tagged		Mean Length		Minimum Length		Maximum Length	
	H&L	Trawl	H&L	Trawl	H&L	Trawl	H&L	Trawl
1988		1,338		25		17		53
1989		1,156		27		20		46
1990		2,010		25		14		48
1991		1,780		28		20		40
1992		1,016		28		17		39
1993		530		26		17		39
1994		4,631		23		14		49
1995		644		29		15		42
1996		698		30		11		44
1997		1,356		29		16		45
1998		462		25		18		49
1999		277		30		3		43
2000		6,236		20		13		42
2001		2,447		25		15		44
2002		4,087		23		15		47
2003		1,908		31		11		48
2004		2,708		25		14		47
2005		4,263		23		12		44
2006		4,462		28		12		48
2007		370		32		19		48
2008		1,033		34		21		47
2009		146		32		22		45
2010		567		30		12		43
2011	*108	**	32		26		43	
2012	*6	**	36		25		46	
2013	1,114	893	37	33	26	24	49	47
2014	921	**	37		27		53	
2015	1,042	333	38	35	29	22	52	42
2016	1,241	110	39	38	23	24	48	43
2017	881	**	40		21		50	
2018	667	**	41		29		52	
2019	44	**	40		31		45	
2020	202	**	41		37		56	
2021	1,020	**	38		26		48	
2022	726		43		30		52	

\* Only one hook-and-line sampling trip was taken due to a lack of funding. 2011 was the first year charter boats were used as the sampling platform and hook-and-line was used as the sampling gear.

\*\* No trips using the traditional research vessel sampling platform and trawl gear were taken due to a lack of funding.

Table 6. Summary of striped bass age samples collected from the Atlantic Ocean from both dependent (commercial and recreational fisheries) and independent (surveys) sources 1982–2022.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
1981	10	4	17	43
1982	12	5	18	98
1983	11	9	18	214
1984	6, 12	4	17	197
1985				0
1986				0
1987				0
1988				0
1989				0
1990	7	5	11	133
1991	9	6	13	90
1992	8	4	19	320
1993	8	3	17	638
1994	8	3	23	367
1995	7	3	13	475
1996	8	2	14	467
1997	9	3	15	787
1998	5	4	16	623
1999	9	5	12	449
2000	9	3	13	807
2001	8	2	14	536
2002	10	3	16	782
2003	8	4	18	401
2004	9	3	17	589
2005	10	2	17	614
2006	11	2	17	552
2007	9	4	16	627
2008	10	4	17	411
2009	11	7	17	179
2010	9	6	18	292
2011	8	6	17	226
2012	9	8	15	21
2013				0
2014				0
2015				0
2016				0
2017				0
2018				0
2019				0
2020				0
2021				0
2022				0

**FIGURES**

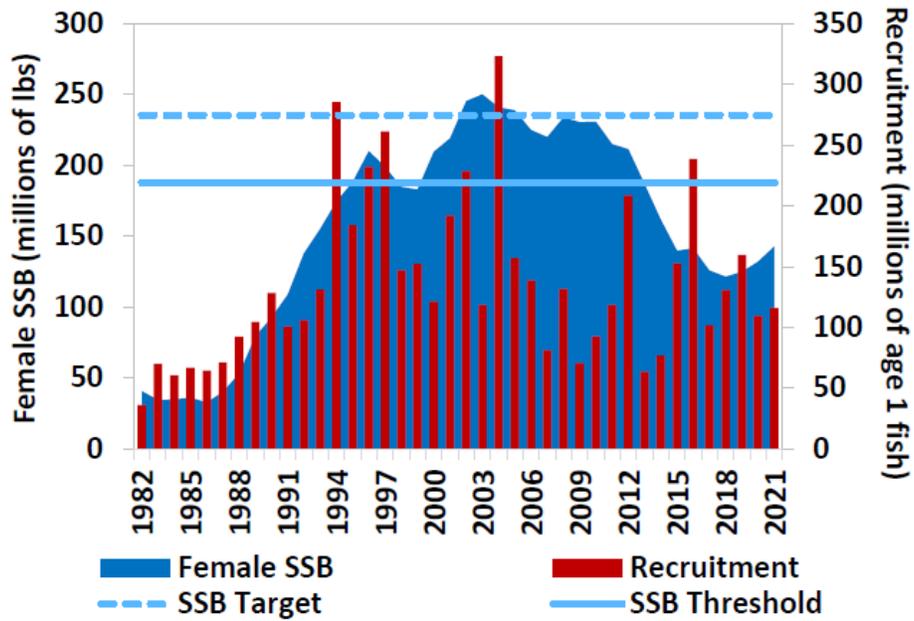


Figure 1. Atlantic striped bass female spawning stock biomass and recruitment (abundance of age-1). Source: ASMFC Atlantic Striped Bass Stock Assessment 2022.

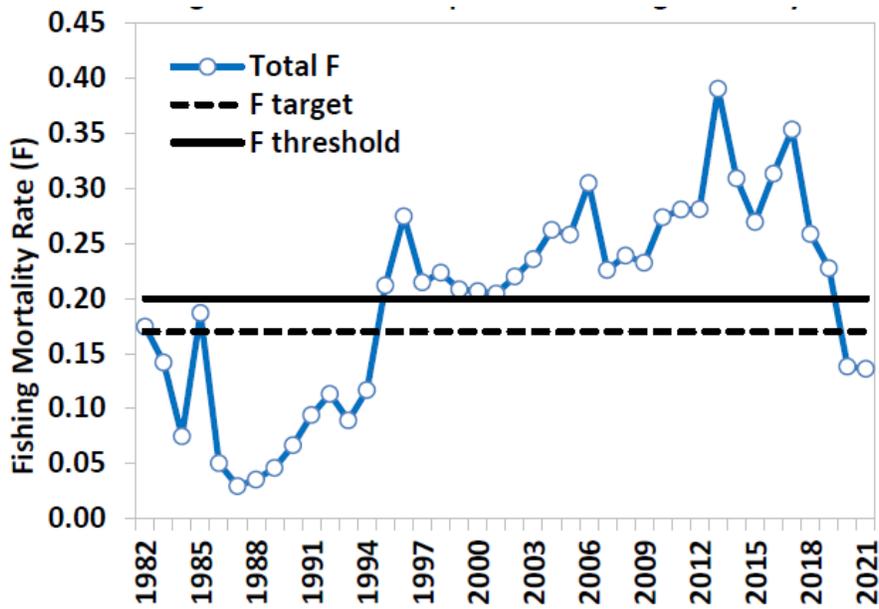


Figure 2. Atlantic striped bass estimates of fishing mortality and the fishing mortality target and threshold reference points. Source: ASMFC Atlantic Striped Bass Stock Assessment 2022.

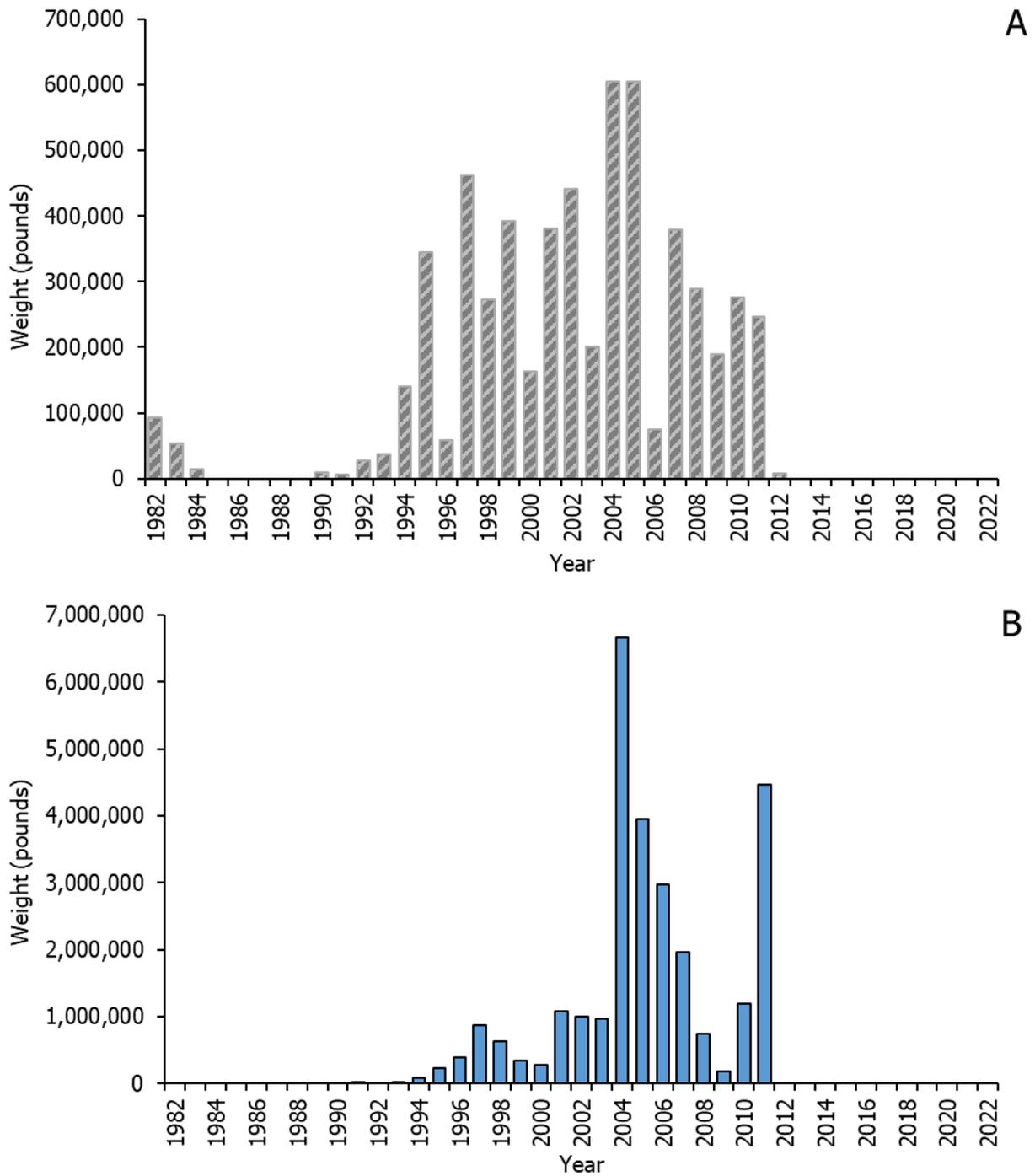


Figure 3. (A) Atlantic striped bass commercial landing (pounds) reported through the North Carolina Trip Ticket Program and (B) recreational landings (Type A + B1; pounds) estimated from the Marine Recreational Information Program survey for North Carolina, 1982–2022.

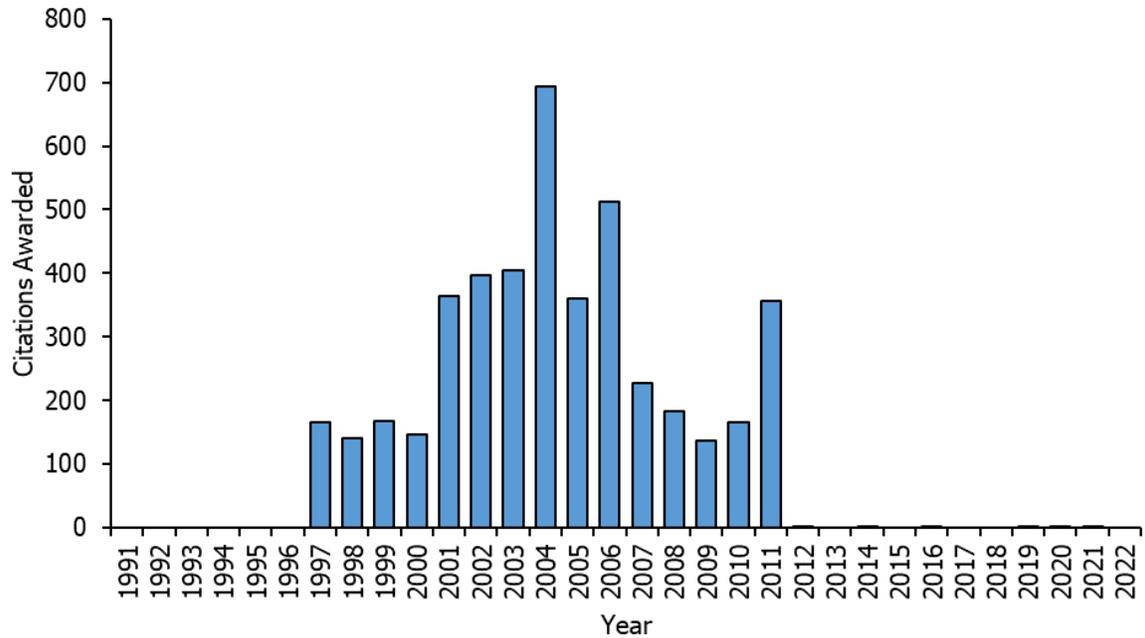


Figure 4. North Carolina Saltwater Fishing Tournament citations awarded for striped bass from the Atlantic Ocean, 1991–2022. Citations are awarded for striped bass greater than 35 pounds or 45 inches total length. Striped bass were removed from the citation program May 1, 2022.

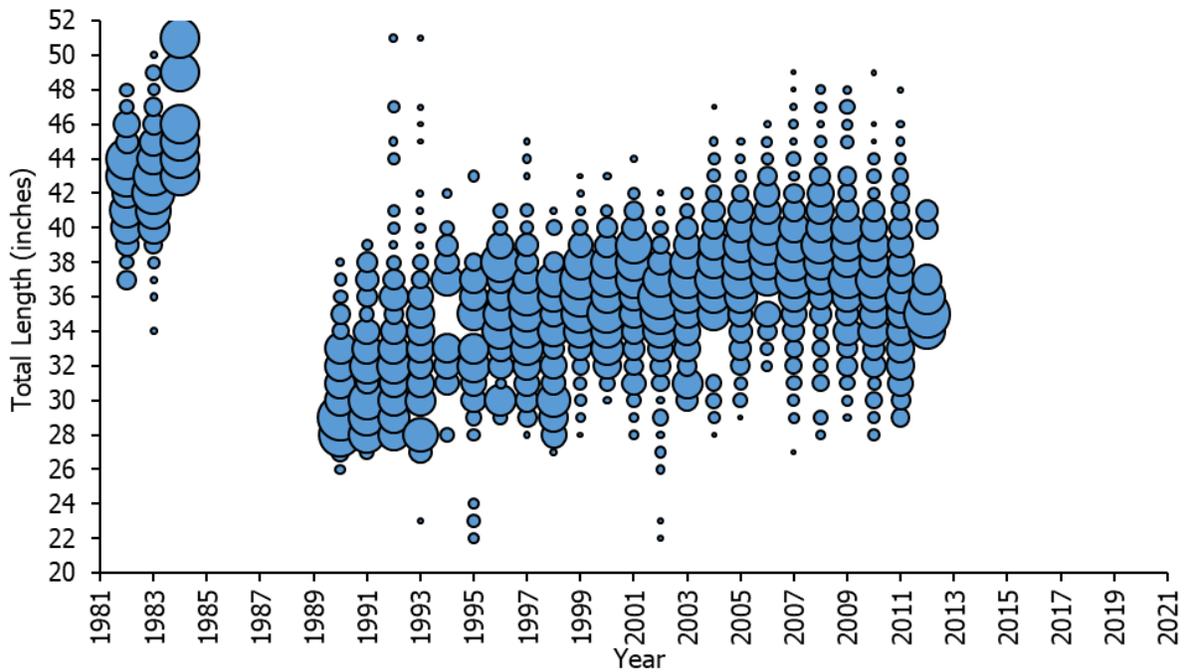


Figure 5. Commercial length frequency (total length, inches) of striped bass harvested from the Atlantic Ocean, 1982–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length..

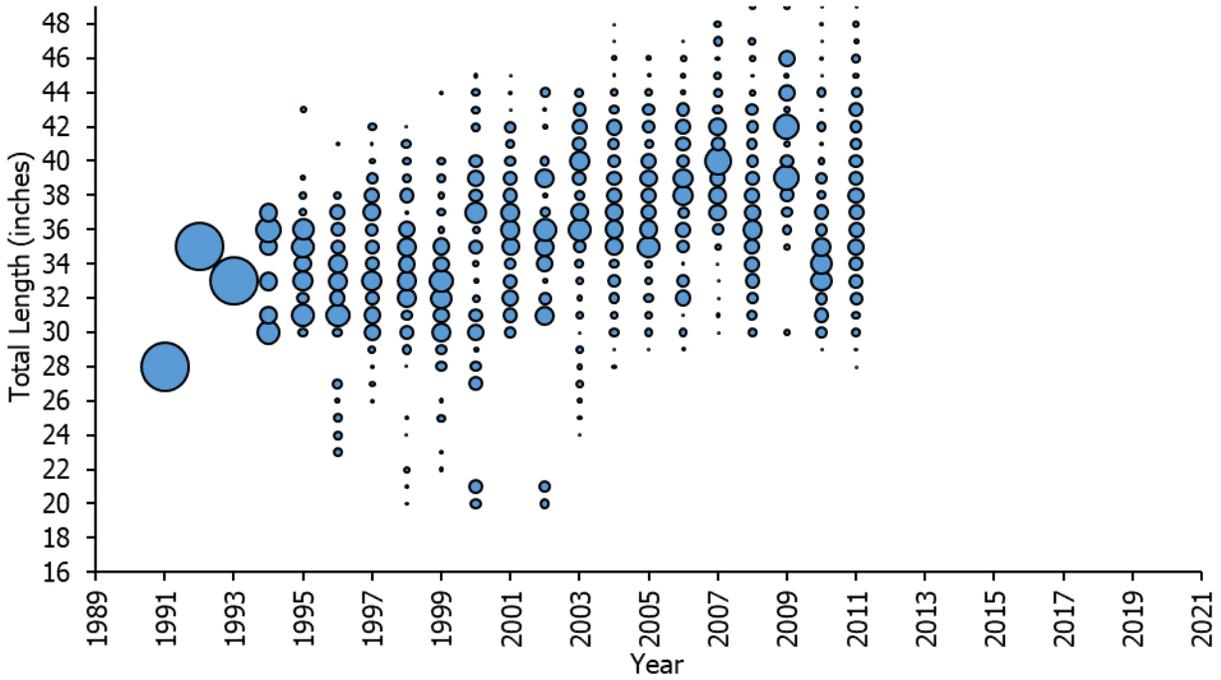


Figure 6. Recreational length frequency (total length, inches) of striped bass harvested from the Atlantic Ocean, 1988–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

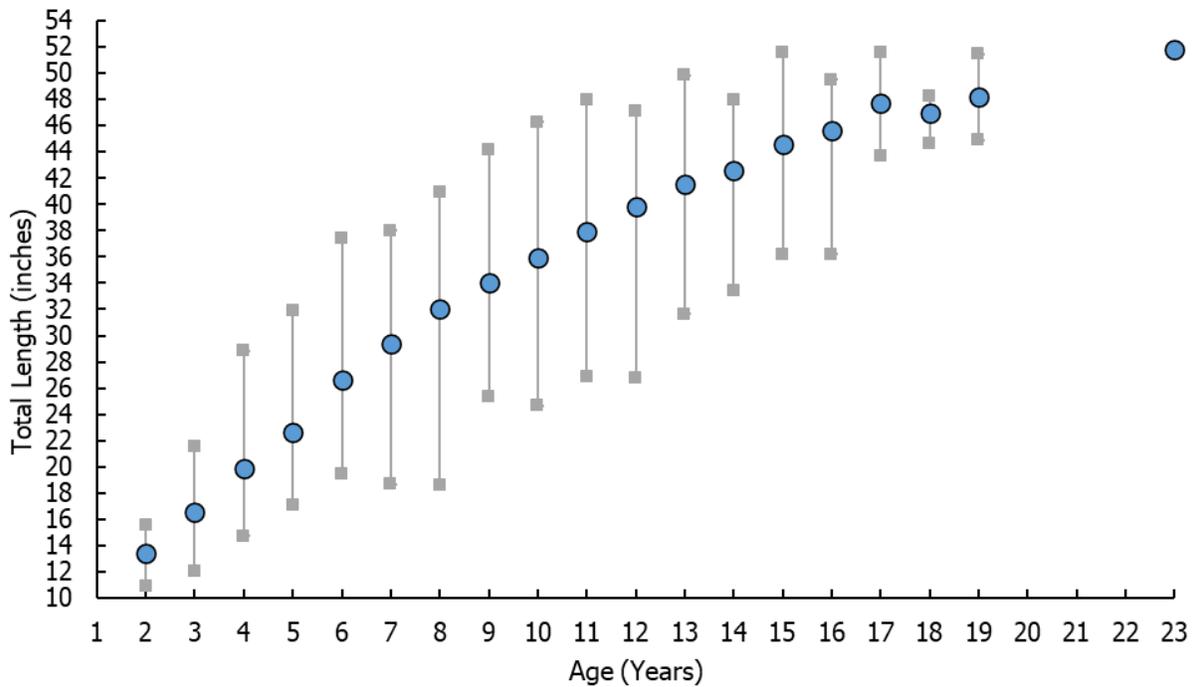


Figure 7. Striped bass length at age samples collected from both dependent (commercial and recreational fisheries) and independent (surveys) sources from the Atlantic Ocean, 1982–2022. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age.

**FISHERY MANAGEMENT PLAN UPDATE  
WAHOO  
AUGUST 2023**

**STATUS OF THE FISHERY MANAGEMENT PLAN**

**Fishery Management Plan History**

FMP Documentation:	June 2004	
	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 12	June 2021
	Amendment 10	May 2022

Comprehensive 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. The Council adopted a precautionary and risk-averse approach to management for the wahoo fishery to maintain the status quo. The original FMP established no minimum size limit for wahoo in the Atlantic EEZ; established a commercial trip limit of 500 pounds; identified allowable gears in the fishery; and prohibited the use of longline gear to harvest wahoo 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), modified the allocations for both commercial and recreational sectors, and established Annual Catch Targets (ACT) for the recreational sector. 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 wahoo through the existing logbook program and is included under the Joint Generic Commercial Logbook Reporting Amendment. 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 (MRIP). 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 12 was approved by the Council at its September 2020 meeting and became effective June 6, 2021 (SAFMC 2020). Amendment 12 adds bullet mackerel and frigate mackerel to the Dolphin/Wahoo Fishery Management Plan and designates them as ecosystem component species. Amendment 10 was approved by the Council at its September 2021 meeting and became effective May 2, 2022 (SAFMC 2020). Amendment 10 includes actions that accommodate updated recreational data from the MRIP by revising the annual catch limits and sector allocations for dolphin and wahoo. The amendment also contains actions that implement other management changes in the fishery including revising accountability measures, accommodating possession of dolphin and wahoo on vessels with certain unauthorized gears onboard, removing the operator card requirement, and reducing the bag limit/recreational vessel limit for dolphin.

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 wahoo (*Acanthocybium solandri*) 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 wahoo and ensure that no new fisheries develop (SAFMC 2003 (a)). To achieve these goals, the following management objectives were identified:

- 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.
- 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.
- 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.

- Optimize the social and economic benefits of the dolphin and wahoo fishery. Given the significant importance of dolphin and wahoo to the recreational sector throughout the range of these species and management unit, manage the resources to achieve optimum yield on a continuing basis.
- 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.
- Direct research to evaluate the role of dolphin and wahoo as predator and prey in the pelagic ecosystem.
- Direct research to enhance collection of biological, habitat, social, and economic data on dolphin and wahoo stocks and fisheries.

## **DESCRIPTION OF THE STOCK**

### **Biological Profile**

Wahoo are an epipelagic marine species and can be found worldwide in tropical and subtropical waters and extend seasonally into temperate waters. Wahoo are typically solitary but may form small loose aggregations (Collette and Nausen 1983). They gather around floating debris and flotsam, including sargassum, spending most of their time in water less than 200m depth, and prefer water temperatures ranging from 17.5 to 27.5 degrees Celsius (63.5 – 81.5 degrees Fahrenheit; Theisen and Baldwin 2012). The species is presumed to be short lived (with a possible lifespan of up to or more than 5-6 years; Oxenford et al. 2003); there is much uncertainty in aging wahoo, and there has been no successful validation of presumed annuli or daily growth checks in otoliths to date. In addition, wahoo grows rapidly, with fish captured off North Carolina reaching a mean length of 44 inches by approximately age-1 (Hogarth 1976). The state record for wahoo was caught off Ocracoke in 1994 and weighed 150 pounds; however, fish landed in North Carolina weigh on average approximately 27 pounds. Wahoo become sexually mature during their first year, at around 34 inches for males and 40 inches for females (Hogarth 1976). They are considered batch spawners, meaning they will spawn many times throughout the spawning season, maximizing the survival of larval fish. Spawning occurs offshore of North Carolina around open-ocean currents from June to August, with a peak in June and July (Hogarth 1976).

### **Stock Status**

The stock status of wahoo in the western Atlantic is unknown.

### **Stock Assessment**

A stock assessment is not available for this species.

## **DESCRIPTION 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 .0517). It is unlawful to possess for recreational purposes more than two wahoo per person per day taken by hook and line. For commercial fishing, there is a 500-pound trip limit (landed head and tail intact). It is unlawful for a commercial fishing operation to take or possess or sell a commercial trip limit of wahoo without a Federal Commercial Dolphin/Wahoo Vessel Permit. Commercial vessels federally permitted in another fishery are allowed to land up to 200 pounds of dolphin and wahoo combined.

### **Commercial Fishery**

Commercial landings of wahoo are reported through the mandatory DMF Trip Ticket program. Landings since 1986 have fluctuated with a low of 6,014 pounds in 1986 and a high of 40,731 pounds in 1995 (Table 1; Figure 1). In the past 10 years, landings have averaged approximately 20,036 pounds; commercial landings in 2022 (7,924 pounds) were much lower than the average.

### **Recreational Fishery**

Recreational landings of wahoo are estimated from the MRIP. Recreational estimates across all years have been updated and are now based on the MRIP new Fishing Effort Survey-based calibrated estimates. For more information on MRIP see <https://www.fisheries.noaa.gov/topic/recreational-fishing-data>.

Landings of wahoo, on average, have decreased in the last 10 years (2013-2022 average of 568,163 pounds compared to the 2002-2011 average of 1,058,188 pounds). After peaking in 2004 (2,220,765 pounds), wahoo landings have fluctuated, declining to low of 232,436 pounds in 2022 (Table 1; Figure 2). Landings remained similar to 2021 (244,078 pounds) in 2022 at 232,436.

The DMF offers award citations for recreational fishermen who land wahoo greater than 40 pounds. After a period of high, stable number of citations from 2012-2019 (750 citations per year average), the total number of citations awarded through the North Carolina Saltwater Fishing Tournament decreased in 2020 (527 citations), and 2021 (310 citations) before increasing in 2022 (462 citations; Table 2; Figure 2).

## **MONITORING PROGRAM DATA**

### **Fishery-Dependent Monitoring**

Fishery dependent length-frequency information for the commercial wahoo fishery in North Carolina is collected by fish house samplers, specifically through DMF programs 438 (Offshore Live Bottom Fishery) and 439 (Coastal Pelagic). The number of wahoo samples obtained by fish house samplers is generally low, ranging from 1 to 101 samples each year from 1986 to 2021; this is due to it being an incidental catch in other fisheries. In 2022, five wahoo lengths were obtained,

an increase from the previous year (4 samples in 2021) and below the average number of samples (11 samples; Table 3; Figure 3). The average size of wahoo sampled from the commercial fishery decreased in 2022 (46.3 inches fork length) from the previous year (48.3 inches fork length) and was below the time series average (49.3 inches fork length; Table 3; Figure 4). The maximum size of wahoo sampled from the commercial fishery increased in 2022 (53.4 inches fork length) from the previous year (52.6 inches fork length) and was below the time series average (59.7 inches fork length; Table 3; Figure 4).

Length and weight information for the recreational fishery are collected through the MRIP dockside sampling. The average size of wahoo sampled from the recreational fishery was slightly larger in 2022 (47.4 inches fork length) compared to the previous year (46.0 inches fork length), and overall has remained relatively constant throughout the time series (Table 3; Figure 5). The minimum size of wahoo sampled from the recreational fishery was much smaller in 2022 (5.6 inches fork length) from the previous year (26.0 inches fork length). The maximum size of wahoo sampled from the recreational fishery decreased in 2022 (68.0 inches fork length) from the previous year (71.9 inches fork length in 2021).

Due to so few commercial samples, there was no modal length for the commercial fishery in 2021; however, in 2019, the commercial modal length was 44 inches fork length. The modal length for the wahoo recreational fishery in 2022 was 50 inches fork length (Figure 5). On average, the recreational fishery harvests larger maximum sizes of wahoo than the commercial fishery (Table 3; Figure 5); the average maximum length of wahoo sampled from the recreational fishery is 67.3, compared to an average of 59.7 inches fork length by the commercial fishery. However, on average, the commercial fishery harvests similar size fish (49.3 inches fork length) to the recreational fishery (47.9 inches fork length; Table 3; Figure 5).

### **Fishery-Independent Monitoring**

Currently, DMF does not have any fishery-independent sampling programs that target or catch wahoo in great numbers.

### **RESEARCH NEEDS**

The following 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 (b)).

Essential Fish Habitat research needs for wahoo 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 wahoo?
- Are there differences in wahoo 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 wahoo in order of priority from highest to lowest:

- Additional data are needed to develop and/or improve estimates of growth, fecundity, etc.
- 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. In addition, existing tagging databases should be examined.
- Establish a list serve for dolphin and wahoo which would facilitate research and the exchange of information.

## **MANAGEMENT STRATEGY**

In North Carolina, wahoo 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 wahoo in 2004 and it is currently

managed under Amendment 5 (SAFMC 2013), Amendment 7 (SAFMC 2015a), Amendment 12 (SAFMC 2020), Amendment 10 (SAFMC 2021).

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## TABLES

Table 1. Recreational harvest (number of fish landed and weight in pounds) and releases (number of fish) and commercial harvest (weight in pounds) of wahoo from North Carolina, 1986–2022. The (-) denotes years where there were no observations of released wahoo.

Year	Recreational			Commercial	Total Weight (lb)
	Number Landed	Number Released	Weight Landed (lb)	Weight Landed (lb)	
1986	11,085		21,298	6,014	480,416
1987	6,400	42	172,708	15,827	188,535
1988	2,043	-	14,342	19,783	34,125
1989	6,674	-	194,287	9,921	204,208
1990	5,290	-	114,060	16,653	130,713
1991	5,068	17	121,382	18,620	140,002
1992	6,326	1,061	1,726,842	14,383	1,741,225
1993	7,673	-	208,325	24,121	232,446
1994	12,182	1,286	308,986	20,319	329,305
1995	21,726	14	476,289	40,731	517,020
1996	15,259	1,300	397,335	26,675	424,010
1997	19,587	152	464,335	20,628	484,963
1998	11,195	51	253,128	22,600	275,728
1999	17,341	-	387,342	28,963	416,305
2000	18,183	1,126	412,824	19,905	432,729
2001	17,889	-	473,926	20,503	494,429
2002	32,783	398	1,056,010	19,952	1,075,962
2003	21,274	-	662,567	17,222	679,789
2004	61,153	-	2,220,765	22,006	2,242,771
2005	41,364	-	1,249,160	14,980	1,264,140
2006	21,834	594	490,904	16,426	507,330
2007	47,890	-	1,495,127	24,306	1,519,433
2008	21,777	-	527,736	11,643	539,379
2009	42,129	48	1,696,717	16,397	1,713,114
2010	19,703	2,532	571,575	12,626	584,201
2011	21,501	40	611,319	15,870	627,189
2012	37,423	12	994,195	23,521	1,017,716
2013	11,951	337	319,866	23,380	343,246
2014	29,362	22	804,473	22,783	827,256
2015	36,920	608	983,232	18,380	1,001,612
2016	39,565	5	1,056,969	25,393	1,082,362
2017	30,305	-	842,604	28,963	871,567
2018	10,690	182	280,644	22,619	303,263
2019	17,098	23	454,391	31,494	485,885
2020	19,055	87	462,937	12,079	475,016
2021	9,760	-	244,078	7,343	251,421
2022	9,657	-	232,436	7,924	240,360
Mean	20,733	452	634,006	19,485	653,491

Table 2. Total number of awarded citations for wahoo (>40 pounds landed) annually from the North Carolina Saltwater Fishing Tournament, 1991–2022.

<u>Year</u>	<u>Citations</u>
1991	247
1992	349
1993	390
1994	422
1995	400
1996	378
1997	391
1998	474
1999	493
2000	706
2001	501
2002	537
2003	448
2004	827
2005	680
2006	614
2007	913
2008	327
2009	377
2010	419
2011	358
2012	673
2013	737
2014	718
2015	697
2016	694
2017	978
2018	719
2019	786
2020	527
2021	310
2022	462

Table 3. Mean, minimum, and maximum lengths (fork length, inches) of wahoo collected from the commercial and recreational fisheries, 1986–2022.

Year	Commercial				Recreational			
	Mean Length	Minimum Length	Maximum Length	Total Number Measured	Mean Length	Minimum Length	Maximum Length	Total Number Measured
1986	51.2	47.6	55.9	3	53.2	31.0	64.0	28
1987	36.2	36.2	36.2	1	46.6	24.0	72.4	72
1988	53.2	39.8	65.4	15	47.9	28.9	72.8	96
1989	53.3	41.9	72.0	20	46.8	28.3	59.8	91
1990	54.6	41.7	68.3	7	44.5	16.9	59.6	143
1991	47.9	41.3	53.5	5	45.6	21.1	64.2	105
1992	55.0	42.9	70.3	11	47.3	29.5	66.0	139
1993	45.3	38.4	57.1	15	46.9	21.9	71.0	154
1994	53.5	40.9	63.4	4	47.0	4.3	66.5	320
1995	51.7	39.4	60.4	6	45.4	3.9	72.1	391
1996	56.5	46.5	63.0	4	48.0	25.6	67.5	253
1997	-	-	-	0	45.6	23.2	70.6	302
1998	-	-	-	0	45.5	28.2	61.0	327
1999	51.9	32.3	65.0	11	44.7	31.7	68.5	275
2000	49.8	40.9	57.1	5	44.9	33.1	83.5	247
2001	45.5	41.7	50.0	3	46.1	36.0	77.1	249
2002	41.3	41.3	41.3	1	48.0	33.0	68.0	260
2003	52.9	44.5	61.8	4	48.2	37.3	68.0	58
2004	41.7	31.9	50.0	4	52.3	35.6	66.1	151
2005	55.1	48.8	62.6	8	48.1	34.4	67.2	75
2006	61.4	61.0	61.8	2	45.0	28.2	67.3	87
2007	26.7	24.6	29.4	4	50.4	24.3	62.0	110
2008	44.8	40.9	52.2	3	46.1	30.3	68.0	113
2009	45.4	39.5	52.0	10	53.6	34.0	68.2	145
2010	50.4	38.1	87.3	6	49.0	28.0	67.6	184
2011	47.9	41.1	63.4	16	49.0	31.0	68.1	227
2012	49.3	35.4	70.0	101	48.2	32.0	70.6	393
2013	45.5	41.3	49.6	2	48.4	39.8	65.6	97
2014	46.2	39.7	54.3	30	48.2	26.0	59.0	133
2015	53.2	50.3	56.5	8	47.9	31.7	78.0	135
2016	49.8	39.5	68.3	18	48.1	30.9	62.6	211
2017	54.4	50.0	60.0	4	48.8	36.3	68.0	163
2018	53.0	35.9	69.5	14	47.7	28.1	68.5	126
2019	55.5	41.7	71.1	50	47.1	32.1	78.4	104
2020	46.9	35.0	65.7	5	46.9	26.0	70.5	93
2021	48.3	43.6	52.6	4	46.0	26.0	71.9	39
2022	46.3	41.0	53.4	5	47.4	5.6	68.0	59

**FIGURES**

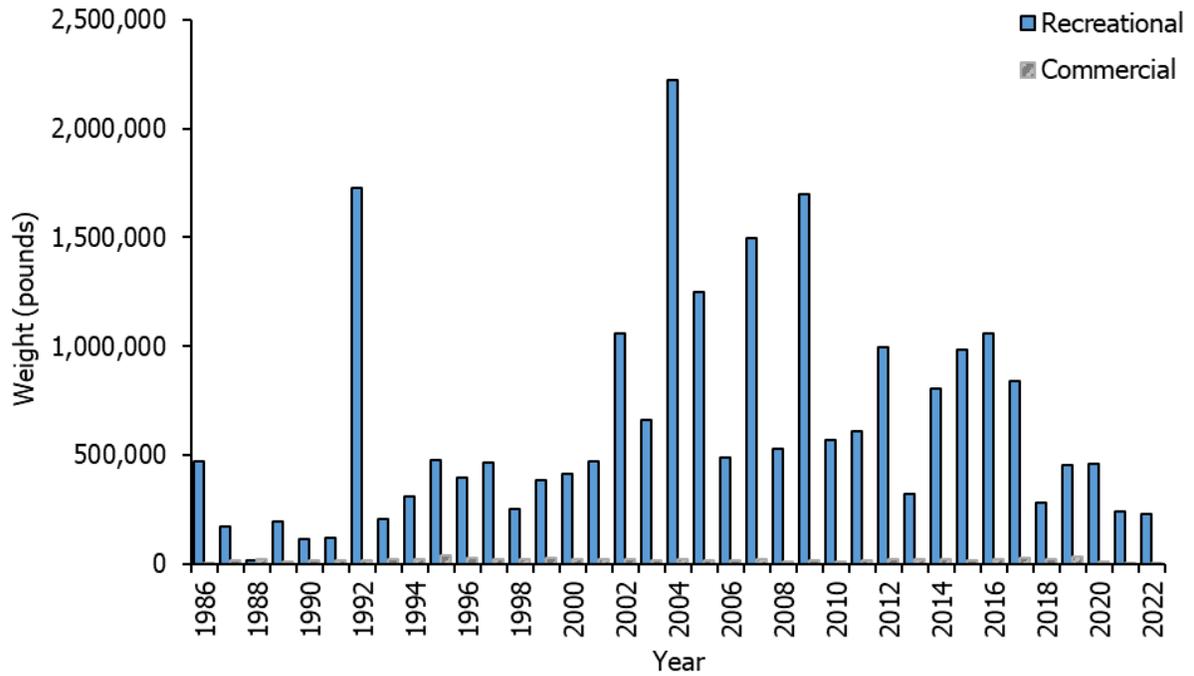


Figure 1. Annual commercial and recreational landings in pounds of wahoo in North Carolina, 1986–2022.

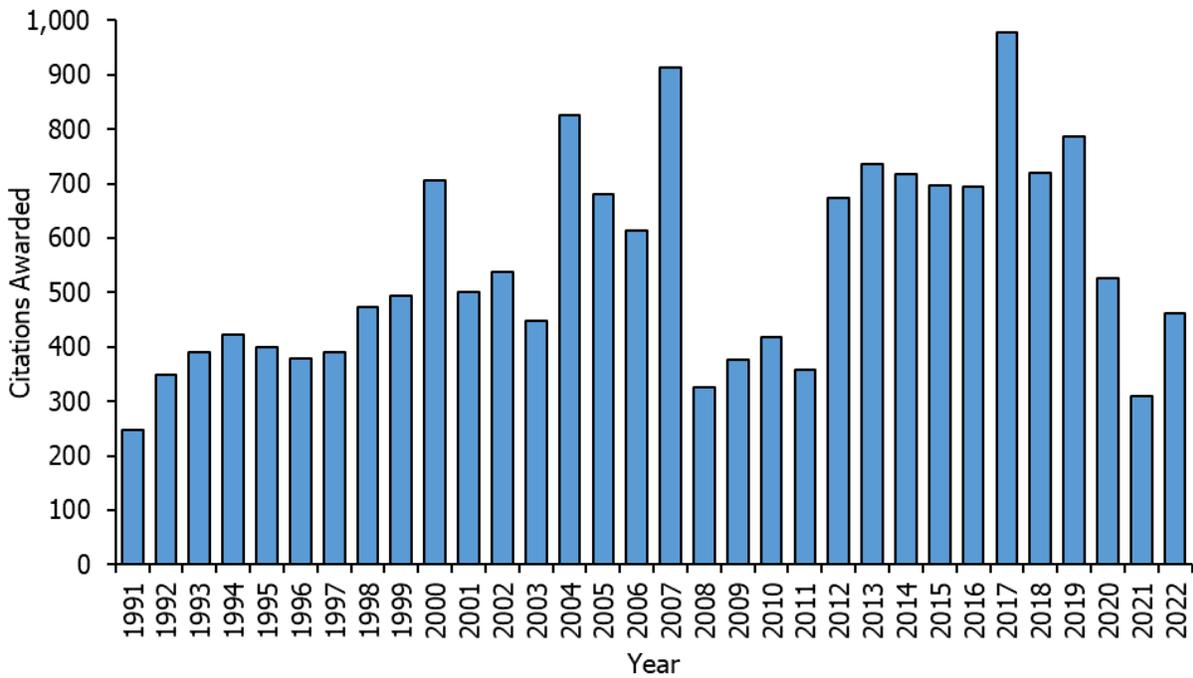


Figure 2. Total number of awarded citations for wahoo (>40 pounds landed) annual from the North Carolina Saltwater Fishing Tournament, 1991–2022.

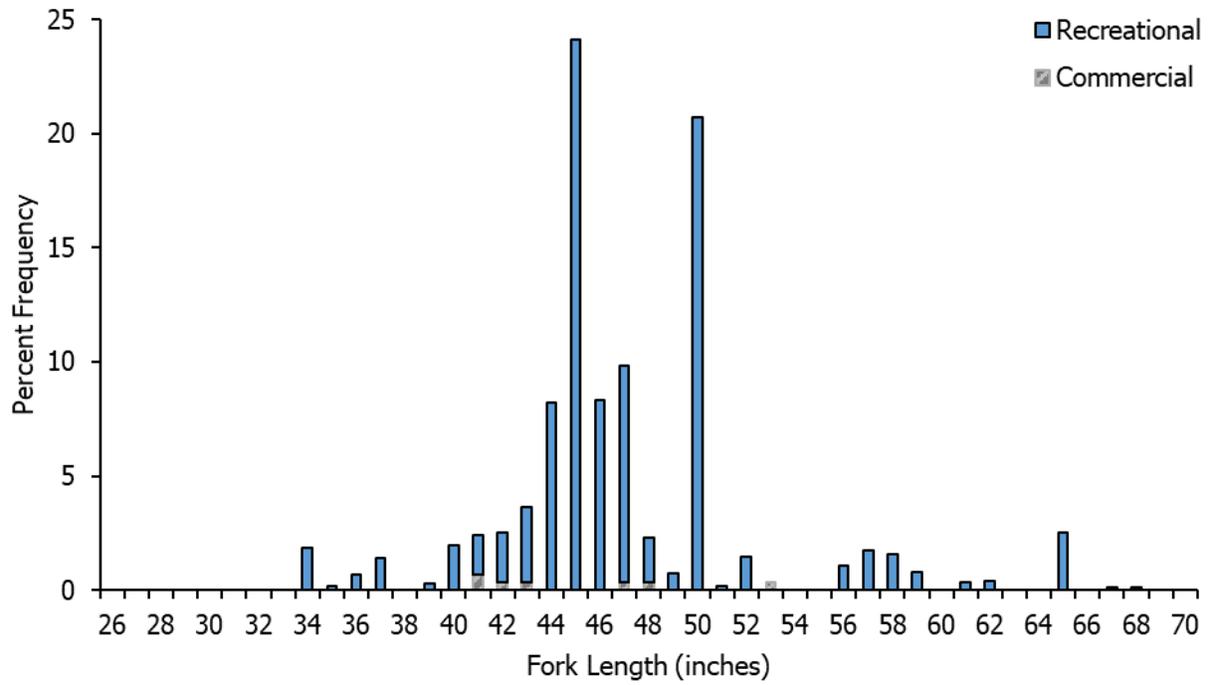


Figure 3. Commercial and recreational length frequency distribution for wahoo harvested in 2022.

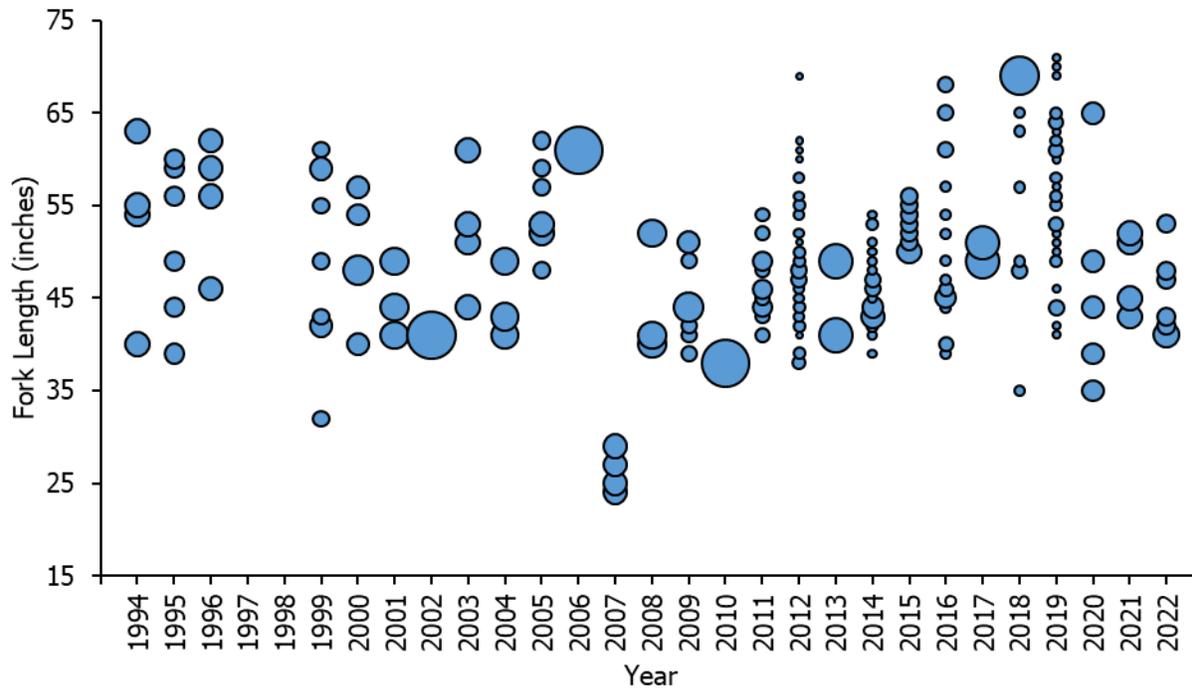


Figure 4. Commercial length frequency (fork length, inches) of wahoo harvested, 1994–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.

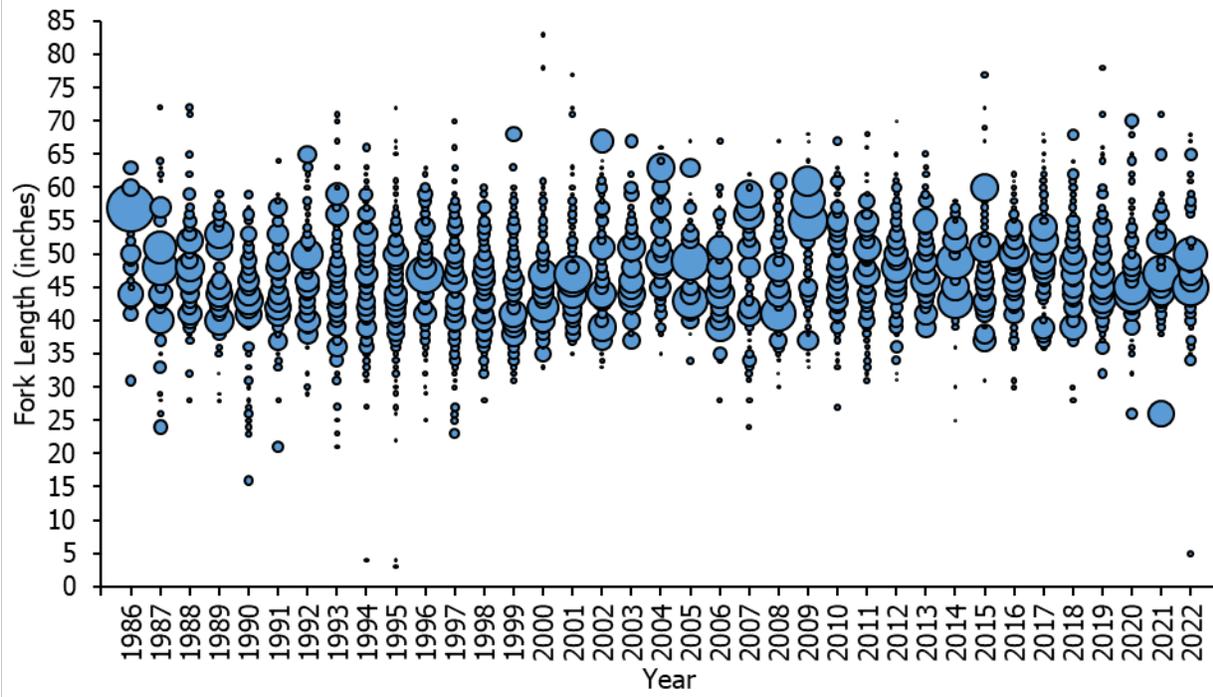


Figure 5. Recreational length frequency (fork length, inches) of wahoo harvested, 1986–2022. Bubbles represent fish at length and the bubble size is proportional to the number of fish at that length.