FISHERY MANAGEMENT PLAN UPDATE
STRIPED MULLET
AUGUST 2019

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

Original FMP Adoption:	April 2006
Amendments:	Amendment 1 – November 2015
Revisions:	None
Supplements:	None
Information Updates:	None
Recommended Schedule Change:	None
Next MFC Scheduled 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 (NCDMF) would determine whether the decrease in landings is attributed to stock decline, decreased fishing effort, or both. If annual landings exceed the maximum trigger, NCDMF 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 1). As required by the FMP, the NCDMF initiated data analysis in July 2017 to determine whether the decrease was attributed to a stock decline, decreased fishing effort, or both. The NCDMF presented the findings from preliminary analysis and recommendations to the North Carolina Marine Fisheries Commission (NCMFC) during its November 2017 business meeting. It was determined by the NCDMF that no management

actions were necessary at that time, but a more comprehensive analysis with data through 2017 was needed.

The NCDMF presented results of their comprehensive analysis at the February 2018 NCMFC business meeting and concluded that the stock had likely declined since completion of the 2013 stock assessment which had a terminal year of 2011. The NCDMF recommended updating the 2013 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 configuration of the model that previously passed peer review was maintained. Results of the stock assessment indicated overfishing was not occurring through 2017.

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

Review of the 2018 commercial landings indicated neither the maximum or minimum triggers had been exceeded.

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:

1. Use a management strategy that provides for conservation of the striped mullet resource and promotes sustainable harvest while considering the needs of all user groups.
2. Promote the protection, enhancement, and restoration of habitats and water quality necessary for the striped mullet population.
3. Minimize conflict among user groups, including non-fishing user groups and activities.
4. Promote research to improve the understanding of striped mullet population dynamics and ecology to improve management of the striped mullet resource.
5. Initiate, enhance, and/or continue studies to collect and analyze the socio-economic data needed to properly monitor and manage the striped mullet fishery.
6. Promote public awareness regarding the status and management of the North Carolina striped mullet stock.

STATUS OF THE STOCK

Life History

Striped mullet are found in a wide range of depths and habitats, but primarily inhabit freshwater to estuarine environments until 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, in mud, silt, and sand and in decaying plant material (Odum 1968; Moore 1974; Collins 1985a; Larson and Shanks 1996; Torras et al. 2000). In turn, striped mullet are prey to top predators such as birds, fish, sharks and porpoises (Breuer 1957; Thomson 1963; Collins 1985a; Barros and Odell 1995; Fertl and Wilson 1997). Striped mullet are highly fecund (upwards of 4 million eggs for a large female; Bichy 2000) and spawn in large aggregations near inlets to offshore areas (Collins and Stender 1989). Length at 50% maturity for males occurs at 11.1 inches fork length and for females at 12.8 inches fork length (Bichy 2000). Spawning individuals have been reported from September to March; however, peak spawning activity occurs from October to early December (Bichy 2000).

Stock Status

The most recent assessment of the North Carolina striped mullet stock was completed in 2017 utilizing data from 1994-2017 (NCDMF 2018). The 2017 stock assessment is an update to the 2013 benchmark stock assessment (NCDMF 2013). Results of the stock assessment indicate spawning stock biomass increased from 2003 through 2007 but declined through 2017. Recruitment also declined in the latter portion of the time series, though a slight increase was observed in 2017. Fishing mortality (F) had little variation for most of the time series with a slight increase in 2017. Despite this increase, F in the terminal year ($F_{2017} = 0.13$) was below both the fishing mortality target ($F_{35\%} = 0.40$) and threshold ($F_{25\%} = 0.57$). Based on the assessment results, the stock was not undergoing overfishing in 2017. A poor stock-recruit relationship resulting in unreliable biomass based reference points prevented determining if the stock was overfished.

Stock Assessment

The striped mullet stock was modeled using Stock Synthesis text version 3.24f (Methot 2000, 2012; Methot and Wetzel 2013), which was also used to calculate reference points (NCDMF 2018). 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.

STATUS OF THE FISHERY

Current Regulations

There are no size restrictions, but as of July 1, 2006 there is a 200 mullet (white and striped aggregate) daily possession limit per person in the recreational fishery and the mutilated finfish rule was modified to exempt mullet used as bait.

Commercial Landings

Historically, 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 replaced seines as the dominant commercial gear type in 1979. Because the commercial fishery primarily targets striped mullet roe, the fishery is seasonal with the highest demand and landings occurring in the fall when large schools form during their spawning migration to the ocean. Striped mullet are targeted commercially using runaround gill nets in the estuarine waters of North Carolina with most landings occurring in the fall. 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). Stop nets are only permitted along Bogue Banks (Carteret County) in the Atlantic Ocean from October 1 to November 30. However, the stop net season was extended to include December 3 to December 17 in 2015 due to minimal landings of striped mullet (Proclamation M-28-2015). Due to the schooling nature of striped mullet the beach seine fishery has the potential to be, and historically has been, a high volume fishery with thousands of pounds landed during a single trip.

Since 1972, commercial landings have ranged from a low of 965,198 pounds in 2016 to a high of 3,063,853 pounds in 1993 (Table 1; Figure 1). From 2003 to 2009 landings were stable between 1,598,617 and 1,728,607 pounds before increasing to 2,082,832 pounds in 2010. Landings fluctuated annually between 1.5 and 2.0 million pounds from 2010-2014 before declining significantly in 2015 and again in 2016 dropping below the minimum commercial landings trigger established by Amendment 1. Commercial landings in 2018 were 1,312,117 pounds, which is 182,117 pounds above the minimum commercial landings trigger.

Recreational Landings

Recreational fishing activity is monitored through the Marine Recreational Information Program. In this report, 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 methodology changes see https://www.fisheries.noaa.gov/topic/recreational-fishing-data.

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). Because of imprecise estimates, MRIP data are not considered a reliable source for estimates of recreational striped mullet harvest and catch.

In October 2011, NCDMF began a mail survey to develop catch and effort estimates for recreational cast net and seine use. The mail survey was established as a direct response to a lack of precision in MRIP estimates for difficult to sample or overlooked recreational fisheries and activities. The survey does not distinguish between striped and white mullet and all data should be interpreted with caution because the ratio of striped mullet to white mullet in the recreational catch will differ between seasons and areas of the state. Recreational cast net effort directed toward mullet is generally highest from July through October and decreased significantly between 2017 and 2018 (Table 2). Mullet harvest and total catch is also highest from July through October and decreased significantly between 2017 and 2018. Number of releases decreased between 2017 and 2018. In addition to decreases, estimates in 2018 were also more uncertain (PSE >50) compared to previous years. Declines and increased uncertainty are likely the result of Hurricane Florence which caused major damage to much of the North Carolina coast in September 2018.

Striped mullet harvest data from the Recreational Commercial Gear License (RCGL) were collected from 2002 to 2008. The program was discontinued in 2009 due to lack of funding and the minimal contributions from RCGL to overall harvest. From 2002 through 2008 an average of 41,512 pounds of striped mullet were harvested per year using a RCGL (Table 3).

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

The total number of striped mullet measured in fishery dependent programs between 1994 and 2018 ranged from 123 to 13,212 annually, with the lowest number measured in 1996 (Table 4). Mean length varied little, generally falling between 12.0 and 14.5 inches fork length (FL), with the lowest mean length occurring in 1997 (12.8 inches FL). Minimum and maximum lengths generally fell within a small range, though in 1994 and 1996 maximum length was below 20.0 inches, while maximum length in other years ranged from 20.0 to 28.0 inches (Table 4).

From 1994 through 2018 the size range of striped mullet captured in the commercial fishery as determined from commercial fish house samples ranged from 5.0 to 28.0 inches FL (Figure 2). Modal length generally falls between 12.0 and 14.0 inches, and in recent years fewer small striped mullet have been present in the catch. In all years there are few striped mullet over 18.0 inches present in the catch.

Fishery-Independent Monitoring

Modal age was two in all years except 1996, 1999, 2001, and 2003 when the modal age was one, and in 2017 when modal age was 1-2 (Table 5). 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. From 2005 through 2008 the maximum age was 10, in 2009 the maximum age was 13, in 2011 the maximum age was 14 and in 2018 the maximum age was 10. There is significant overlap in length at age for striped mullet (Figure 3). Striped mullet grow quickly from age 0 to age 2 with growth slowing after age 3.

The striped mullet electrofishing survey also known as Program 146 (P146) was initiated in 2003 to produce a fisheries-independent index of relative abundance for striped mullet. Twelve sampling stations were established among four sites (three stations per site) in the Neuse River and its tributaries. Each station is sampled once per month from January through April and from October through December. To provide the most relevant index from the striped mullet electrofishing survey, data were limited to those collected during January through April when striped mullet are most abundant in the Neuse River. Since the survey primarily catches adults, juveniles were excluded from analysis. A sample represents all the fish collected over a 500 m transect. Striped mullet catch-per-unit-effort (CPUE) was stable at approximately 100 fish per sample from 2005 through 2009 before peaking in 2011 (Figure 4). Standard errors in 2010 and 2011 are large because most fish came from a few samples. CPUE dropped significantly in 2012, potentially due to hurricanes, before increasing to near the time series average in 2013 and 2014. CPUE declined in 2015 to approximately 45 fish per sample, declined again in 2016 to 20 fish per sample and remained low in 2017 at 26 fish per sample. CPUE increased to 91 fish per sample in 2018 which is above the time series average (80.5 fish per sample).

From 2004 through 2017, the size of striped mullet captured during the January to April portion of P146 sampling generally ranged from 4.0 to 21.0 inches FL (juveniles excluded; Figure 5). In most years modal length was between 10.0 to 12.0 inches FL. From 2014 through 2017 modal length increased but overall size distribution truncated. However, in 2018 there was some increase in the distribution of lengths.

The fishery-independent gill net survey, also known as Program 915 (P915), has sampled in Hyde and Dare Counties since 2001 and the Neuse, Pamlico, and Pungo rivers since 2003. Sampling in the Cape Fear and New rivers began in 2008 and sampling in Carteret County began in 2018. To provide the most relevant striped mullet index from the survey, data were limited to samples from shallow river areas (Pamlico, Pungo and Neuse rivers) during October-November where and when most striped mullet occur. The survey primarily catches adults, so juveniles were excluded from analysis. From 2004-2014 CPUE generally fluctuated between 7.0 and 16.0 striped mullet per sample (Figure 6). CPUE dropped significantly in 2015 to 3.7 and then again in 2016 to a time series low of 3.1 striped mullet per sample. CPUE remained low in 2017 at 3.4 fish per sample but increased to 5.8 striped mullet per sample in 2018.

From 2004 through 2018 the size of striped mullet captured during the October-November portion of P915 sampling in the Pamlico and Neuse rivers generally ranged from 8.0 to 25.0 inches FL (juveniles excluded; Figure 7). Modal length generally ranged from 12.0 to 14.0 inches but began to decline in 2011 and declined further in 2018. Few striped mullet less than 10.0 inches or greater than 15.0 inches are captured in this survey.

In October 1990, the NCDMF initiated the striped bass independent gill net survey, also known as Program 135 (P135). The survey was designed to monitor the striped bass population in the

Albemarle Sound and Roanoke River but also encounters striped mullet. To provide the most relevant striped mullet index from P135, data were limited to those collected from 2.5-inch to 5.5-inch mesh sizes during November through February (fall-winter) when and where the majority of striped mullet occur. Since the survey primarily catches adults, juveniles were excluded from analysis. Data were also limited to those collected in less than 10 feet of water because these samples covered most of the water column. CPUE averaged 2.0 fish per set from 1990-2008 (Figure 8). Standard errors in 2013, 2014 and 2015 are large because most fish came from a few samples. CPUE increased to 10.5 in 2010 and spiked at 15.2 and 12.9 fish per set in 2014 and 2015. CPUE dropped significantly in 2016 and no striped mullet were caught during the survey in 2017. In 2018, CPUE increased to 2.1 fish per set.

From 1990 through 2018 modal length of striped mullet captured in P135 sampling generally ranged from 10.0 to 15.0 inches FL with a range of sizes captured (juveniles excluded; Figure 9). Modal length has fluctuated, increasing in recent years while length distribution has truncated.

MANAGEMENT STRATEGY

The management strategy for the striped mullet fisheries in North Carolina is to: 1) optimize resource utilization over the long-term; 2) reduce user group conflicts; and 3) promote public education. The first strategy will be accomplished by protecting critical habitats and monitoring stock status. To address user group conflicts, a rule change was made to limit how much of a waterway may 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 bases 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 and 2) user group conflicts, and 3) updating the management framework for the N.C. striped mullet stock. See Table 6 for a summary of management strategies and outcomes.

Minimum and maximum landings triggers of 1.13 and 2.76 million pounds have been established to monitor the striped mullet fishery. If landings fall below the minimum landings trigger or exceed the maximum landings trigger the NCDMF will determine if a new stock assessment and/or interim management action is needed.

RESEARCH NEEDS

The following research needs were compiled from those listed in Amendment 1.

- Initiate a fishery independent adult striped mullet survey in the Core and Bogue sound areas where approximately 20% of the striped mullet harvest occurs – HIGH (independent gill net survey will began in 2018)
- Develop a reliable fisheries independent index of juvenile abundance – HIGH (Needed)
- Initiate a tagging study to provide estimates of stock size, fishing mortality, and natural mortality that are not dependent on assumptions about steepness – HIGH (Needed)

- Increase the number of age samples from both fisheries dependent and fisheries independent sources – MEDIUM (Ongoing)
- Investigate how catchability of striped mullet by NCDMF Program 146 is affected by variations in salinity and conductivity and expand survey to other coastal rivers and tributaries – MEDIUM (Needed)
- Initiate a study to estimate fecundity and update the current maturity schedule microscopically – MEDIUM (Ongoing)
- Initiate a survey to estimate RCGL landings of striped mullet to estimate recreational landings, as well as social and economic elements of the striped mullet fishery – MEDIUM (Ongoing through NCDMF)
- Increase sampling of the commercial bait mullet cast net fishery to improve estimates of striped mullet and white mullet harvest – LOW (Needed)
- Restart fishery independent cast net sampling to improve estimates of the proportion of striped mullet and white mullet in this fishery – LOW (Needed)
- Analyze the data from the CRFL recreational cast net and seine survey to better characterize the recreational striped mullet fishery, including the social and economic elements – LOW (Needed)
- Improve recreational fisheries statistics provided by the Marine Recreational Information Program (MRIP) or some other program to reliably characterize the magnitude and length and age structure of recreational fisheries losses – LOW (Ongoing)
- Initiate a plankton survey covering all inlets to determine inlet use by striped mullet – LOW (Needed)
- Explore the NOAA Bridge Net Survey as a possible larval/juvenile abundance index for striped mullet – LOW (Ongoing)
- Investigate the disappearance of males from the population after age three – LOW (Needed)
- Initiate an acoustic tagging study to determine spatial and temporal variations in habitat use throughout the state to help provide better indices for stock assessments – LOW (Needed)
- Implement public outreach on waste reduction of striped mullet in the commercial and recreational fisheries – LOW (Needed)
- Consider sex specific selectivity curves in future modeling work – LOW (Needed)

FISHERY MANAGEMENT PLAN SCHEDULE RECOMMENDATION

Striped mullet commercial landings in 2018 were 1,312,117 pounds, which is above the minimum and below the maximum commercial landings triggers established in Amendment 1. In addition, the 2018 striped mullet stock assessment update indicated overfishing was not occurring through 2017 (NCDMF 2018). Therefore, it is recommended to maintain the timing of the MFC scheduled review "as is" on the current FMP schedule, but continue to closely monitor trends in commercial landings and fishery independent indices.

LITERATURE CITED

Able, K.W., and M.P. Fahay. 1998. The first year in the life of estuarine fishes in the Middle Atlantic Bight. Rutgers University Press, New Jersey.

Barros, N.B., and D.K. Odell. 1995. Bottlenose dolphin feeding and interactions with fisheries in the Indian River Lagoon system, Florida. Bulletin of Marine Science 57(1):278–279.

Bichy, J. 2000. Reproductive biology of striped mullet, *Mugil cephalus*, in North Carolina. Final Report to North Carolina Sea Grant. Fishery Resource Grant Project No. 97-FEG-09. 90 p.

Breuer, J.P. 1957. Ecological survey of Baffin and Alazan Bays, TX. Publications of the Institute of Marine Science, University of Texas 4(2):134–155.

Cardona, L. 2000. Effects of salinity on the habitat selection and growth performance of Mediterranean flathead grey mullet *Mugil cephalus* (Osteichthyes, Mugilidae). Estuarine, Coastal, and Shelf Science 50(5):727–737.

Collins, M.R. 1985a. Species profile: life histories and environmental requirements of coastal fishes and invertebrates (South Florida). Striped Mullet. U.S. Fish and Wildlife Service Biological Report 82 (11.34). U.S. Army Corps of Engineers, TR EL-82-4. 11 p.

Collins, M.R. 1985b. Species profile: life histories and environmental requirements of coastal fishes and invertebrates (South Florida). White Mullet. U.S. Fish and Wildlife Service Biological Report 82 (11.39). U.S. Army Corps of Engineers, TR EL-82-4. 7 p.

Collins, M.R., and B.W. Stender. 1989. Larval striped mullet (*Mugil cephalus*) and white mullet (*Mugil curema*) off the southeastern United States. Bulletin of Marine Science 45(3):580–589.

Fertl, D., and B. Wilson. 1997. Bubble use during prey capture by a lone bottlenose dolphin (*Tursiops truncatus*). Aquatic Mammals 23(2):113–114.

Larson, E.T., and A.L. Shanks. 1996. Consumption of marine snow by two species of juvenile mullet and its contribution to their growth. Marine Ecology Progress Series 130:19–28.

Methot, R.D. 2000. Technical description of the stock synthesis assessment program. NOAA Technical Memorandum NMFS-NWFSC-43. 46 p.

Methot Jr., R.D. 2012. User manual for stock synthesis: model version 3.23f. NOAA Fisheries, Seattle, WA. 150 p.

Methot Jr., R.D., and C.R. Wetzel. 2013. Stock synthesis: A biological and statistical framework for fish stock assessment and fishery management. Fisheries Research 142:86-99.

Moore, R.H. 1974. General ecology, distribution and relative abundance of *Mugil cephalus* and *Mugil curema* on the south Texas coast. Contributions in Marine Science 18:241–256.

NCDMF (North Carolina Division of Marine Fisheries). 2006. North Carolina Fishery Management Plan—Striped Mullet. NCDMF, Morehead City, North Carolina. 202 pp.

NCDMF. 2013. Stock assessment of striped mullet (*Mugil cephalus*) in North Carolina waters. NCDMF, Morehead City, North Carolina. 161 p.

NCDMF. 2015. North Carolina Striped Mullet Fishery Management Plan Amendment 1. NCDMF, Morehead City, North Carolina. 388 p.

NCDMF. 2018. Stock assessment of striped mullet (*Mugil cephalus*) in North Carolina waters. NCDMF, Morehead City, North Carolina. 129 p.

Odum, W.E. 1968. Mullet grazing on a dinoflagellate bloom. Chesapeake Science 9(3):202–204.

Pattillo, M.E., T.E. Czapla, D.M. Nelson, and H.E. Monaco. 1999. Distribution and abundance of fishes and invertebrates in Gulf of Mexico estuaries, Volume II: species life history summaries. ELMR Report No. 11. NOAA/NOS Strategic Environmental Assessments Division, Silver Spring, Maryland. 377 p.

Thomson, J.M. 1963. Synopsis of biological data on the grey mullet *Mugil cephalus* Linnaeus 1758. Fisheries Synopsis No. 1. Division of Fisheries and Oceanography, CSIRO, Australia. 66 p.

Torras, X., L. Cardona, and E. Gisbert. 2000. Cascading effects of the flathead grey mullet *Mugil cephalus* in freshwater eutrophic micorocosmos. Hydrobiologia 429(1-3):49–57.

Whitfield, A.K., J. Panfili, and J.-D. Durand. 2012. A global review of the cosmopolitan flathead mullet *Mugil cephalus* Linnaeus 1758 (Teleostei: Mugilidae), with emphasis on the biology, genetics, ecology and fisheries aspects of this apparent species complex. Reviews in Fish Biology and Fisheries 22(3):641–681.

TABLES

Table 1. Commercial landings of striped mullet in North Carolina, 1972-2018.

Year	Pounds	Year	Pounds
1972	1,176,918	1996	1,756,863
1973	1,092,620	1997	2,442,657
1974	2,137,502	1998	2,218,108
1975	1,952,748	1999	1,460,850
1976	2,071,741	2000	2,829,086
1977	1,834,935	2001	2,317,655
1978	1,752,233	2002	2,596,304
1979	1,767,955	2003	1,629,314
1980	2,215,532	2004	1,598,617
1981	1,293,902	2005	1,620,394
1982	1,492,179	2006	1,728,607
1983	1,068,014	2007	1,668,804
1984	1,688,522	2008	1,675,859
1985	1,486,583	2009	1,685,615
1986	1,932,190	2010	2,082,832
1987	2,590,360	2011	1,627,894
1988	3,060,829	2012	1,859,587
1989	2,062,147	2013	1,549,157
1990	2,994,604	2014	1,828,351
1991	1,467,448	2015	1,247,044
1992	1,820,494	2016	965,337
1993	3,063,853	2017	1,366,338
1994	1,726,242	2018	1,312,117
1995	2,298,446		

Table 2. Number of trips, number of mullet harvested, number of mullet released, and total number of mullet caught in the recreational cast net fishery estimated from the NCDMF mail survey with associated percent standard error (PSE) by wave, 2012-2018. Estimates with a PSE value greater than 50 are shaded in gray.

Year	Wave	Total Effort	PSE Effort	Total Harvest	PSE Harvest	Total Releases	PSE Releases	Total Catch	PSE Catch
2012	Jan/Feb	10,484	22.1	23,346	32.8	9,050	42.3	32,395	32.4
	Mar/Apr	9,734	19.8	17,055	32	3,931	57.2	20,986	31.8
	May/Jun	20,903	12.5	84,180	25.7	26,845	32.9	111,025	23.9
	Jul/Aug	29,725	13.8	107,409	23.7	64,453	29.6	171,862	21.3
	Sep/Oct	29,810	11.3	135,318	19.9	72,941	16	208,259	15.5
	Nov/Dec	21,094	15.9	24,484	38	31,774	26.5	56,258	26
	Total	121,751	6.2	391,792	11.6	208,993	12.5	600,785	9.9
2013	Jan/Feb	12,635	18.6	26,244	51.4	6,668	39.1	32,911	46.4
	Mar/Apr	8,642	24.1	6,915	69.5	2,741	56.4	9,656	52.2
	May/Jun	24,541	11.8	25,409	40.4	21,957	30.5	47,366	29.9
	Jul/Aug	41,197	11.3	210,888	23.4	121,012	21.7	331,900	20.1
	Sep/Oct	25,277	16.6	33,918	46	39,065	26.1	72,983	31
	Nov/Dec	25,666	15.3	37,667	27.3	34,740	30.9	72,407	23.8
	Total	137,959	6.4	341,039	16.7	226,183	14.1	567,223	13.7
2014	Jan/Feb	5,036	25.7	4,886	82.2	744	70.9	5,631	73.7
	Mar/Apr	15,247	19.7	11,284	53.1	1,563	69.2	12,847	50.7
	May/Jun	28,343	13.1	39,438	33.2	22,465	23.6	61,903	24.4
	Jul/Aug	42,572	12	37,774	36.9	56,604	20.4	94,378	22.2
	Sep/Oct	63,250	12.7	82,343	23.2	146,886	17.3	229,229	16
	Nov/Dec	24,174	14.6	29,518	29.6	24,946	25.6	54,464	21.2
	Total	178,623	6.6	205,243	14.5	253,209	11.9	458,453	10.6
2015	Jan/Feb	6,554	26	11,172	52.5	2,884	54.8	14,056	48.2
	Mar/Apr	13,338	18.8	9,870	40.8	5,880	33.6	15,751	35.3
	May/Jun	49,792	12.2	103,793	22.9	48,774	26.3	152,567	19.5
	Jul/Aug	63,706	10.6	149,016	20	133,629	20.5	282,645	16.1
	Sep/Oct	37,938	11	32,683	30	39,298	19.8	71,981	18.2
	Nov/Dec	24,264	17.7	34,817	36.7	34,672	25.5	69,489	25.2
	Total	195,592	6.1	341,350	12.5	265,137	12.6	606,488	10.1
2016	Jan/Feb	11,400	28.3	.	.	73	100	73	100
	Mar/Apr	13,803	20.5	15,411	49.5	1,238	63.5	16,649	46.2
	May/Jun	35,478	14.4	28,748	37	40,159	31.4	68,907	26.6
	Jul/Aug	51,299	11.8	140,659	29.5	112,351	22	253,010	19.8
	Sep/Oct	41,928	11.9	42,855	26.5	29,109	20.7	71,964	19.7
	Nov/Dec	33,813	16.7	43,571	46.4	33,017	32.2	76,588	37.9
	Total	187,721	6.5	271,245	18.4	215,947	14.3	487,192	13.2
2017	Jan/Feb	6,178	25.3	5,722	65.1	994	70.9	6,716	63.1

Year	Wave	Total Effort	PSE Effort	Total Harvest	PSE Harvest	Total Releases	PSE Releases	Total Catch	PSE Catch
	Mar/Apr	17,512	15.9	20,607	35.7	13,568	30.5	34,175	30.9
	May/Jun	36,167	13.4	64,209	35.4	54,339	22.3	118,548	24.6
	Jul/Aug	55,330	13.7	92,670	23.6	95,611	18.8	188,281	17.5
	Sep/Oct	40,032	13.8	93,323	21.7	54,989	25.8	148,312	19.6
	Nov/Dec	27,478	14.4	44,132	29.9	28,040	27.3	72,172	24.3
	Total	182,697	6.7	320,662	12.8	247,543	11.3	568,205	10.2
2018	Jan/Feb	4,121	30.4	1,124	100.0	450	70.5	1,574	86.8
	Mar/Apr	10,108	22.4	645	77.2	4,560	43.1	5,205	39.0
	May/Jun	32,380	14.2	19,922	39.8	13,295	29.4	33,217	32.2
	Jul/Aug	13,097	19.0	.	.	15,913	30.4	15,913	30.4
	Sep/Oct	11,832	71.1	17,170	100.0	56,912	85.8	74,082	70.4
	Nov/Dec	20,890	16.3	34,353	31.6	20,987	23.6	55,340	22.7
	Total	92,428	11.78	73,215	29.83	112,117	44.15	185,331	29.72

Table 3. North Carolina RCGL survey estimates of the number of striped mullet harvested, pounds harvested, number released, and total number caught. The RCGL survey was conducted from 2002-2008, funding was discontinued in 2009.

Year	Number Harvested	Pounds Harvested	Number Released	Total Number
2002	66,305	64,213	6,549	72,854
2003	28,757	24,774	3,514	32,270
2004	34,736	35,947	2,875	37,611
2005	35,888	36,314	3,492	39,380
2006	38,175	37,385	5,352	43,527
2007	35,472	40,168	7,449	42,921
2008	51,465	51,785	9,207	60,672

Table 4. Mean length, minimum length, maximum length (fork length, inches), and total number of striped mullet measured from North Carolina commercial fish house samples, 1994-2018.

Year	Mean Length	Minimum Length	Maximum Length	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

Table 5. Modal age, minimum age, maximum age and total number of striped mullet aged from fishery independent and fishery dependent sampling, 2004-2018. Age data from 2018 is considered preliminary.

Year	Modal Age	Minimum Age	Maximum Age	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	2	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	770
2016	2	0	8	956
2017	1-2	0	15	695
2018*	2	0	10	763

Table 6. Summary of management strategies.

MANAGEMENT STRATEGY	Implementation Status
Establish minimum and maximum commercial landings triggers of 1.13 and 2.76 million pounds.	Amendment 1, 2015.
Establish minimum and maximum commercial landings triggers of 1.3 and 3.1 million pounds.	Striped Mullet Fishery Management Plan, 2006.
Implement a recreational harvest limit of 200 mullet per person, per day – currently there are no bag restrictions for mullet.	Striped Mullet Fishery Management Plan, 2006. MFC Rule April 2006 adoption 15ANCAC 03M.0502 (a), (b)
Modify mutilated finfish rule to exempt mullet when used as bait.	Striped Mullet Fishery Management Plan, 2006. 15ANCAC 03M.0101

FIGURES

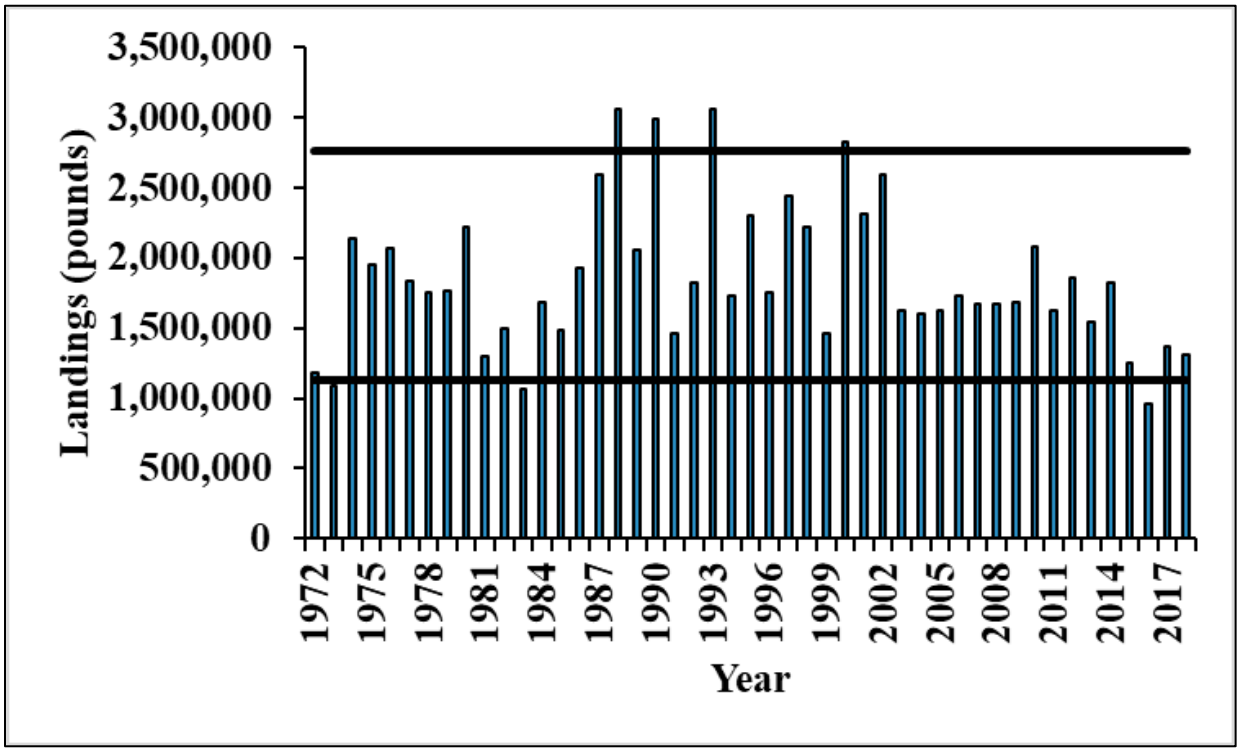

Figure 1. Commercial landings of striped mullet, 1972-2018. Solid lines represent upper (2.76 million lb.) and lower (1.13 million lb.) landings limits that would trigger a closer examination of data. Landings limits were changed from upper and lower limits of 3.1 million and 1.3 million pounds by Amendment 1 in November 2016 (NCDMF 2014).

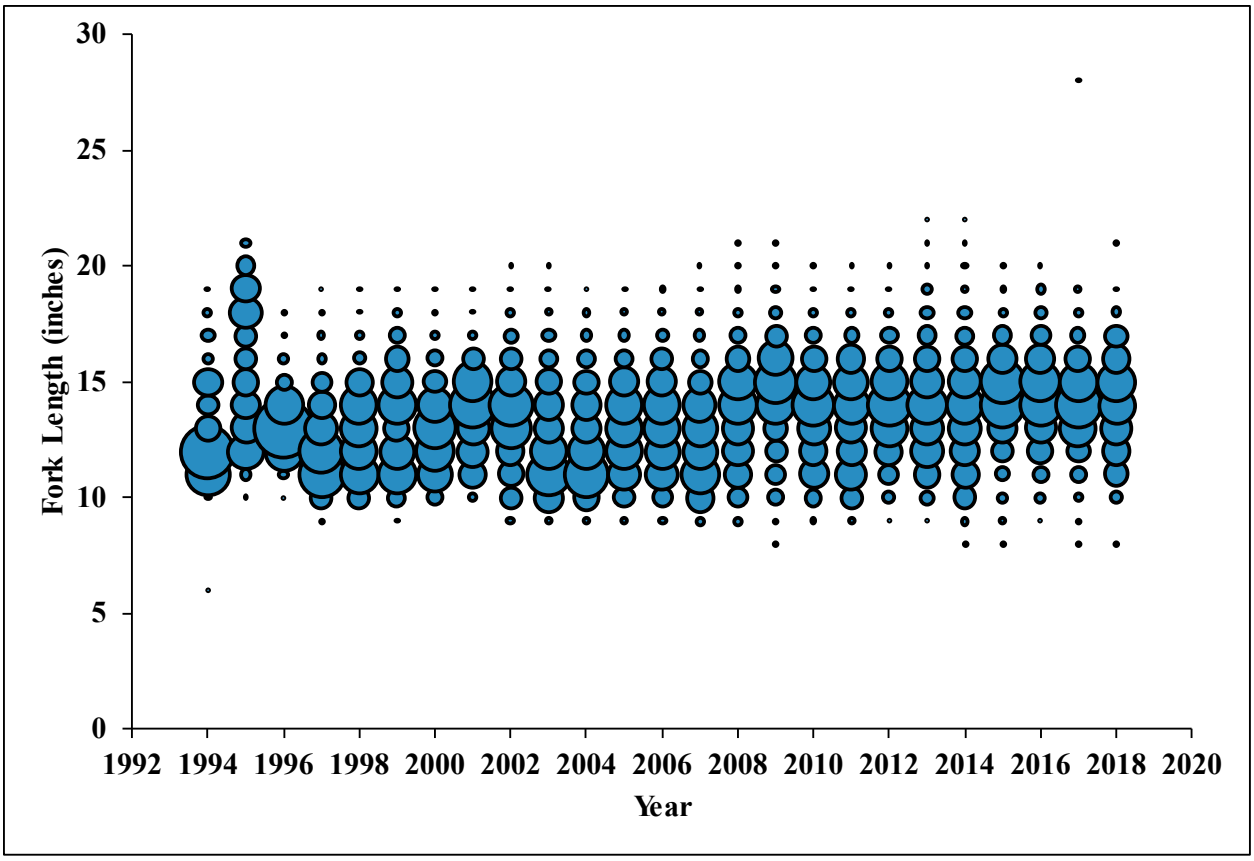

Figure 2. Commercial length-frequency (fork length, inches) of striped mullet harvested in the commercial fishery based on NCDMF fish house sampling, 1994-2018. Bubble represents the proportion of fish at length.

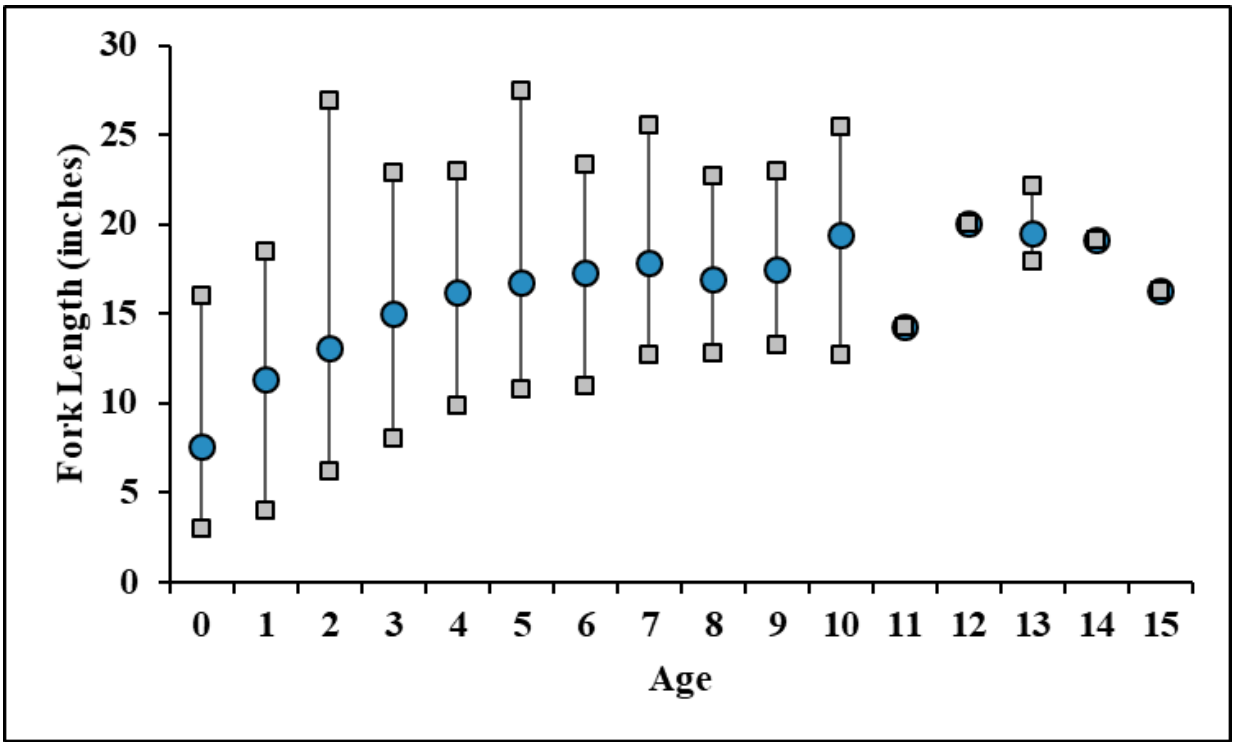

Figure 3. Striped mullet length at age based on all age samples collected from 1996 to 2018. Blue circles represent mean size at a given age and the grey squares represent the minimum and maximum observed size for each age. Data from 2018 is considered preliminary.

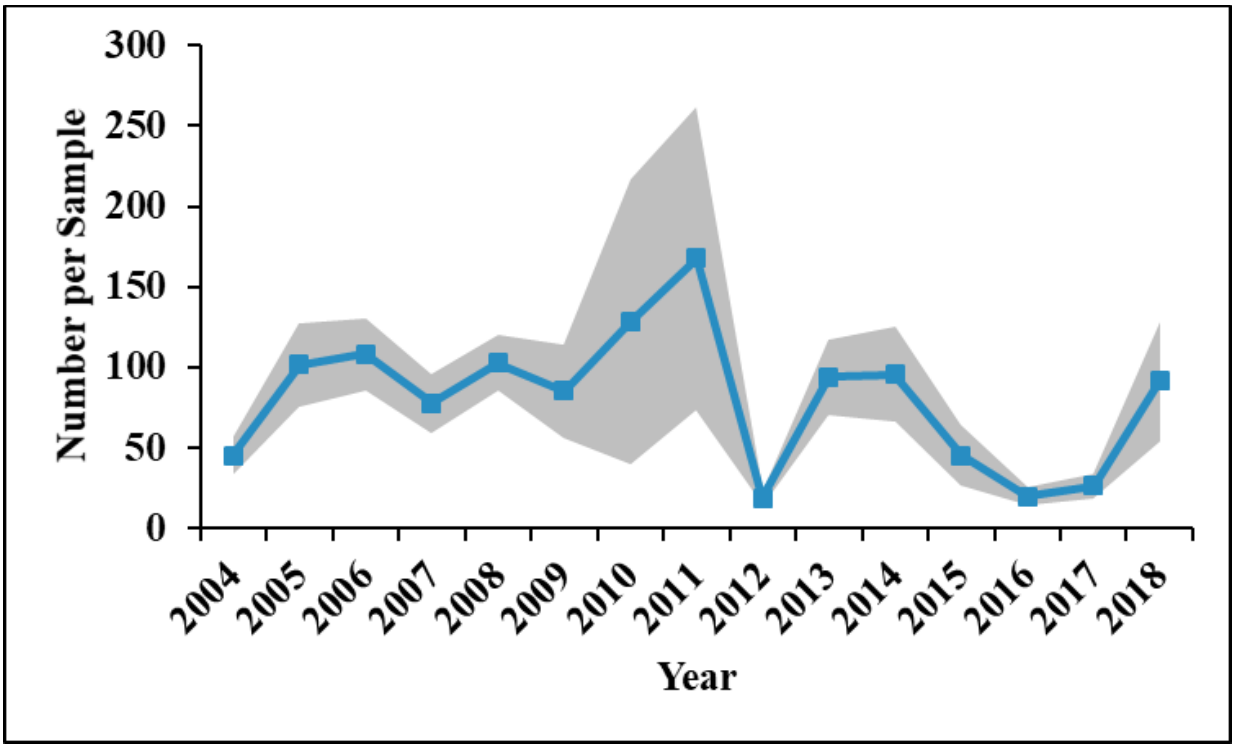

Figure 4. Number of striped mullet per sample (500 m sampling session) from the striped mullet electrofishing survey (P146), 2004-2018. To provide the most relevant index, data were limited to those collected during January through April. The shaded area represents standard error.

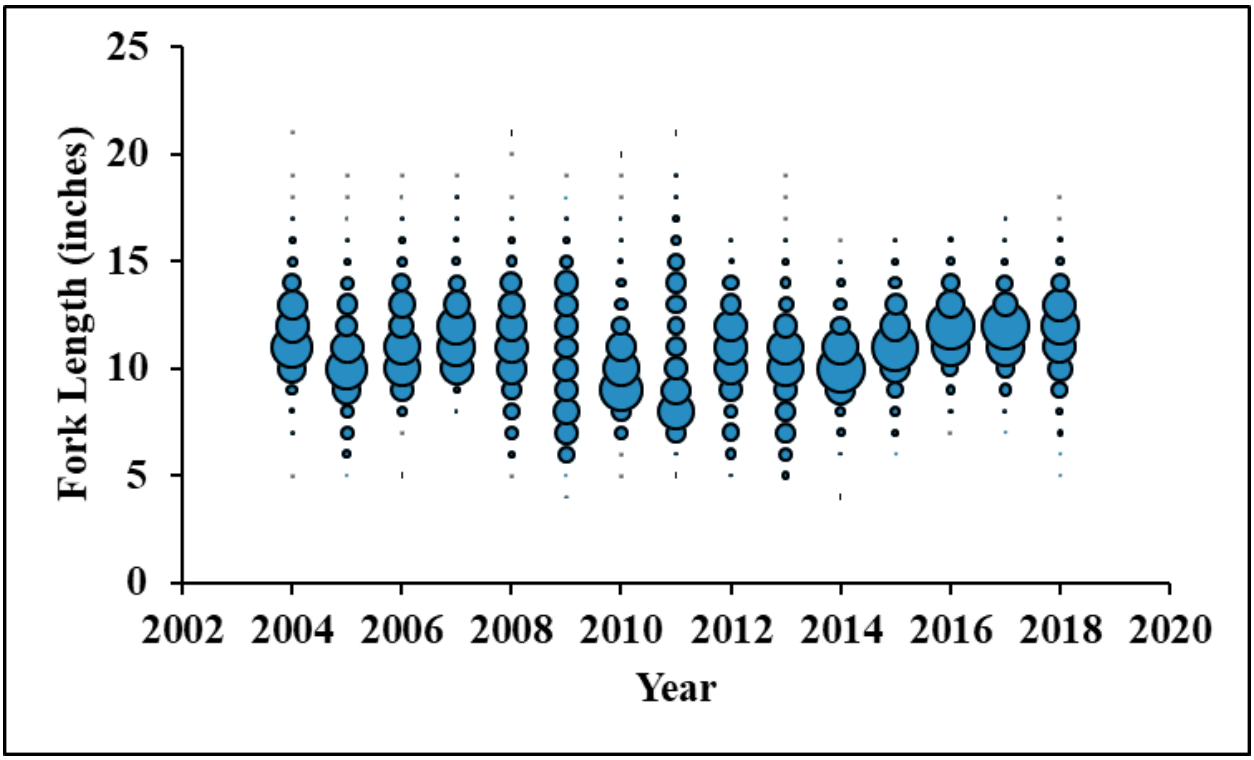

Figure 5. Length frequency (fork length, inches) of striped mullet from the striped mullet electrofishing survey (P146), 2004-2018. Lengths include striped mullet collected during January-April.

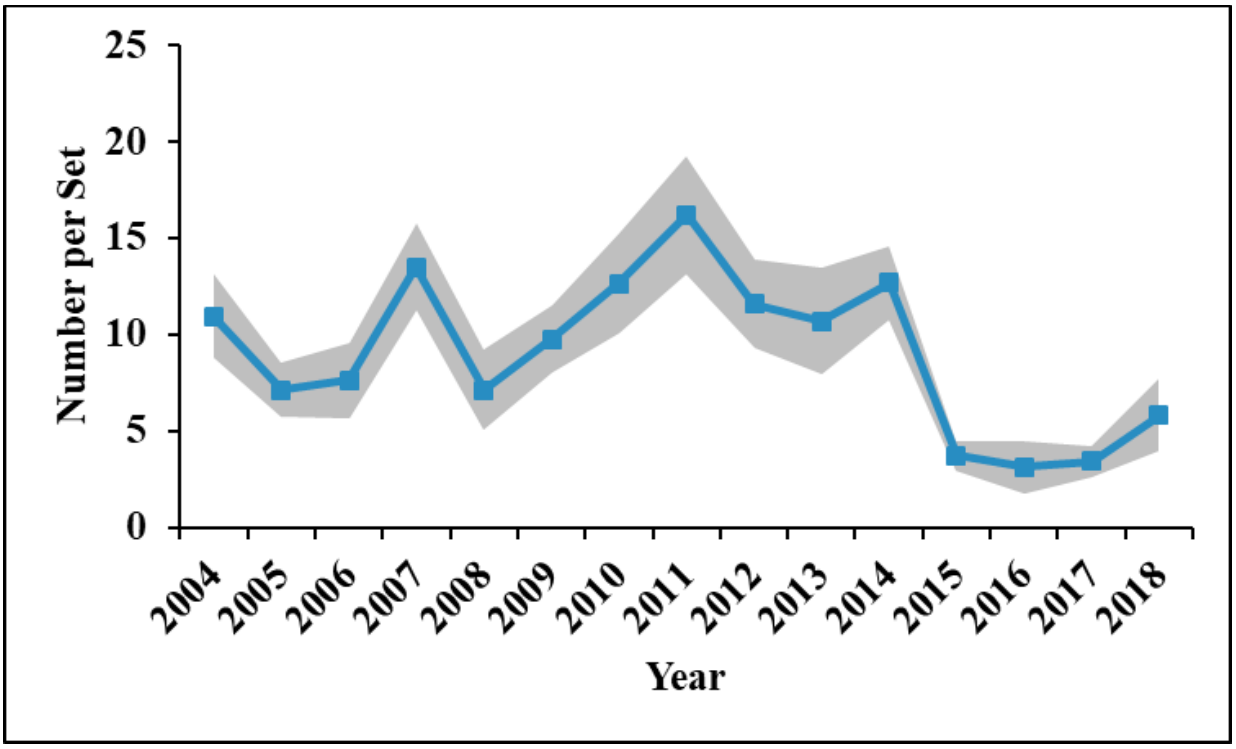

Figure 6. CPUE (number/set) of striped mullet from the independent gill net survey (P915), 2004-2018. To provide the most relevant index, only shallow river (Neuse, Pamlico, Pungo) samples collected during October-November were included. The shaded area represents standard error.

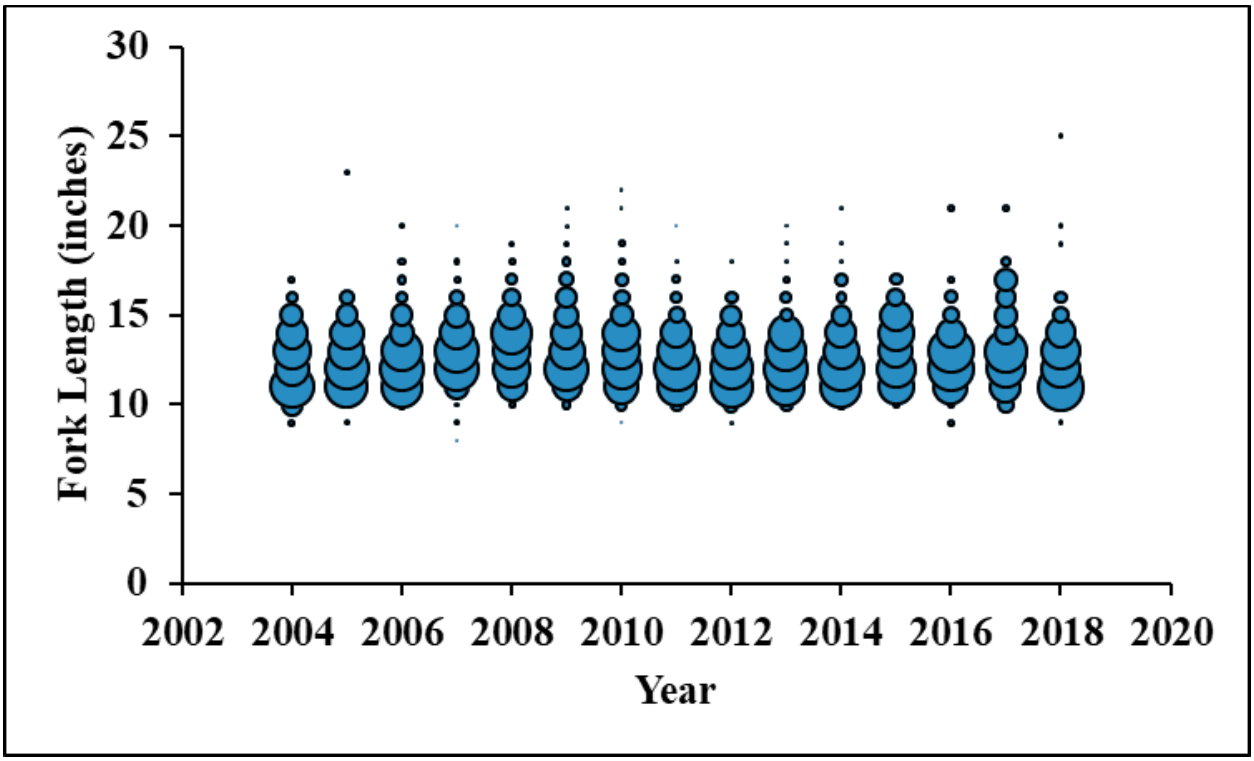

Figure 7. Length-frequency (fork length, inches) of striped mullet from the independent gill net survey (P915), 2004-2018. Lengths include striped mullet from shallow river (Neuse, Pamlico, Pungo) samples collected during October-November.

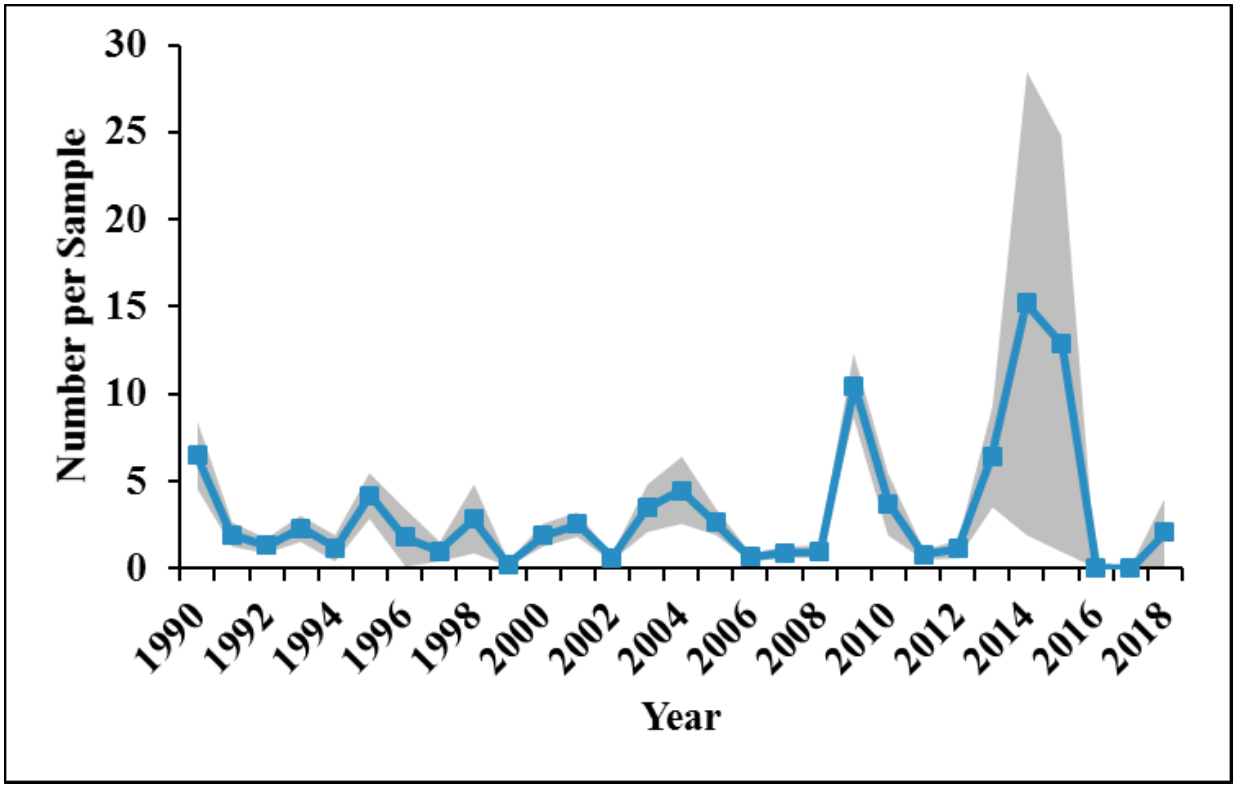

Figure 8. CPUE (number/set) of striped mullet from the striped bass independent gill net survey (P135), 1990-2018. To provide the most relevant striped mullet index data were limited to those collected from 2.5-inch to 5.5-inch mesh sizes during November through February (fall-winter) in less than 10 feet of water.

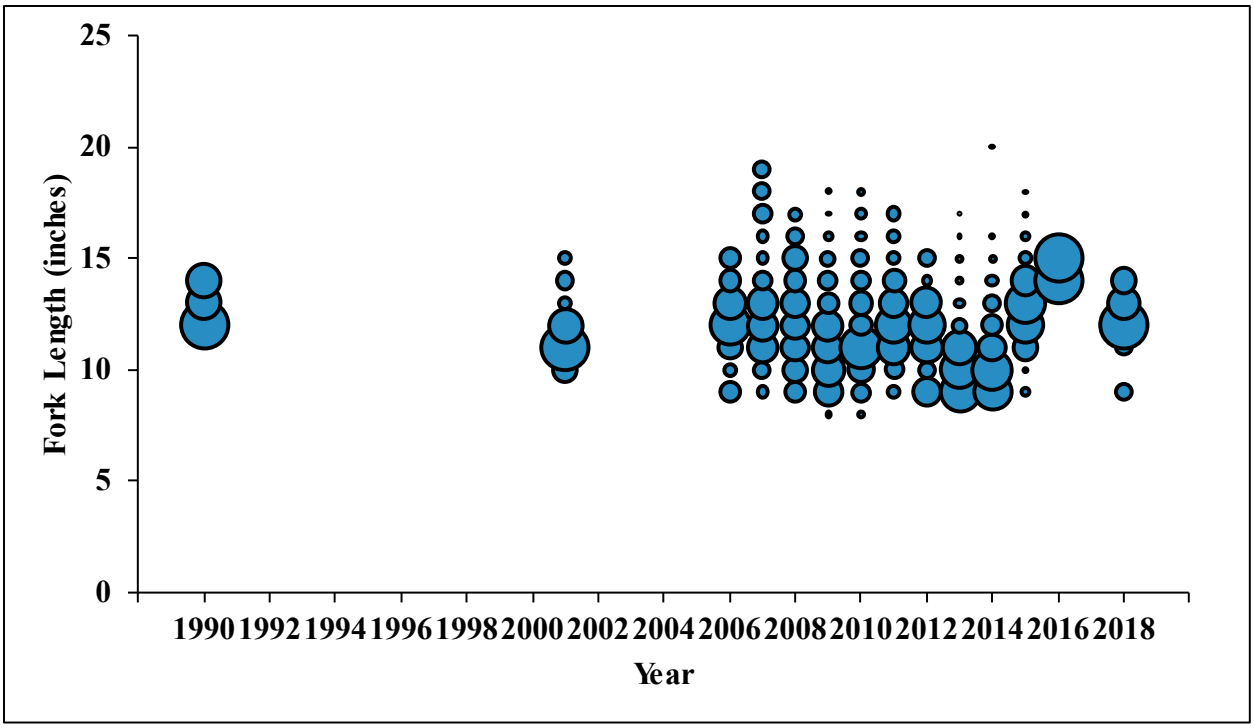

Figure 9. Length-frequency (fork length, inches) of striped mullet from the fall-winter portion of the striped bass independent gill net survey (P135), 1990-2018. In some years no striped mullet were captured or no lengths were recorded.