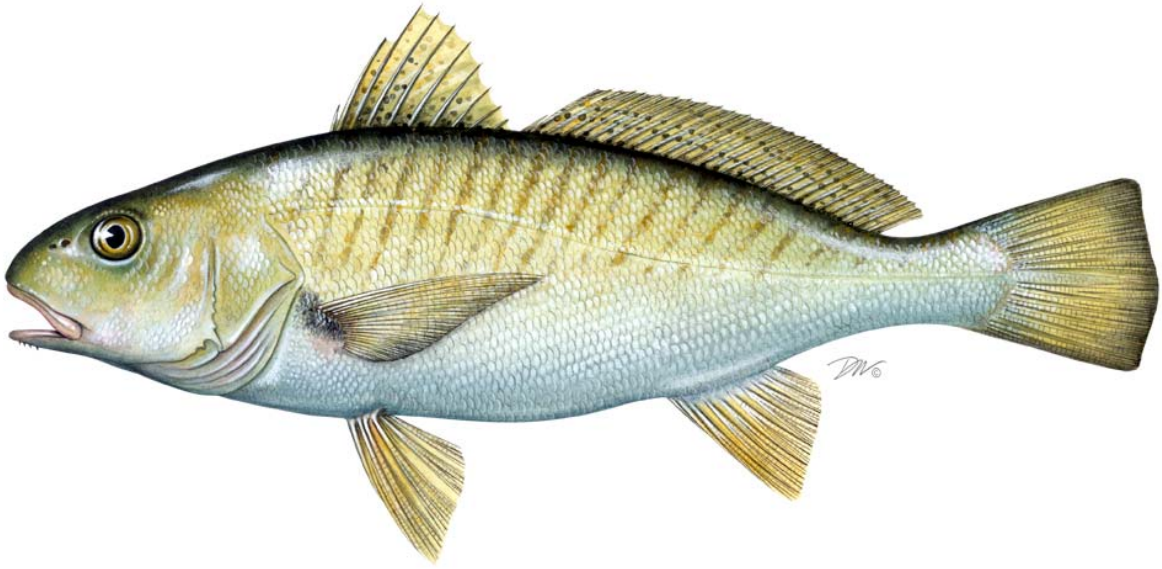
2017 REVIEW OF THE
ATLANTIC STATES MARINE FISHERIES COMMISSION
FISHERY MANAGEMENT PLAN FOR

ATLANTIC CROAKER
(Micropogonias undulatus)

2016 FISHING YEAR



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I. Status of the Fishery Management Plan

Date of FMP Approval:	Original FMP – October 1987
Amendments:	Amendment 1 – November 2005 (implemented January 2006) Addendum I – March 2011 Addendum II – August 2014
Management Areas:	The Atlantic coast distribution of the resource from New Jersey through Florida
Active Boards/Committees:	South Atlantic State/Federal Fisheries Management Board; Atlantic Croaker Technical Committee, Stock Assessment Subcommittee, and Plan Review Team; South Atlantic Species Advisory Panel

The Fishery Management Plan (FMP) for Atlantic Croaker was adopted in 1987 and included the states from Maryland through Florida (ASMFC 1987). In 2004, the South Atlantic State/Federal Fisheries Management Board (Board) found the recommendations in the FMP to be vague, and recommended that an amendment be prepared to define management measures necessary to achieve the goals of the FMP. The Interstate Fisheries Management Program Policy Board also adopted the finding that the original FMP did not contain any management measures that states were required to implement.

In 2002, the Board directed the Atlantic Croaker Technical Committee to conduct the first coastwide stock assessment of the species to prepare for developing an amendment. The Atlantic Croaker Stock Assessment Subcommittee developed a stock assessment in 2003, which was approved by a Southeast Data Assessment Review (SEDAR) panel for use in management in June 2004 (ASMFC 2005a). The Board quickly initiated development of an amendment and, in November 2005, approved Amendment 1 to the Atlantic Croaker FMP (ASMFC 2005b). The amendment was fully implemented by January 1, 2006.

The goal of Amendment 1 is to utilize interstate management to perpetuate the self-sustainable Atlantic croaker resource throughout its range and generate the greatest economic and social benefits from its commercial and recreational harvest and utilization over time. Amendment 1 contains four objectives:

1) Manage the fishing mortality rate for Atlantic croaker to provide adequate spawning potential to sustain long-term abundance of the Atlantic croaker population.
2) Manage the Atlantic croaker stock to maintain the spawning stock biomass above the target biomass levels and restrict fishing mortality to rates below the threshold.
3) Develop a management program for restoring and maintaining essential Atlantic croaker habitat.
4) Develop research priorities that will further refine the Atlantic croaker management program to maximize the biological, social, and economic benefits derived from the Atlantic croaker population.

Amendment 1 expanded the management area to include the states from New Jersey through Florida. Consistent with the stock assessment completed in 2004, the amendment defined two Atlantic coast management regions: the south-Atlantic region, from Florida through South Carolina; and the mid-Atlantic region, from North Carolina through New Jersey.

Amendment 1 established biological reference points (BRPs) to define an overfished and overfishing stock status for the mid-Atlantic region only. Reliable stock estimates and BRPs for the South Atlantic region could not be developed during the 2004 stock assessment due to a lack of data. The BRPs were based on maximum sustainable yield (MSY), and included threshold and target levels of fishing mortality (F) and spawning stock biomass (SSB): F threshold = F_{MSY} (estimated to be 0.39); F target = 0.75 X F_{MSY} (estimated to be 0.29); SSB threshold = 0.7 X SSB_{MSY} (estimated to be 44.65 million pounds); and SSB target = SSB_{MSY} (estimated to be 63.78 million pounds). An SSB estimate below the SSB threshold resulted is an overfished status determination, and an F estimate above the F threshold resulted is an overfishing status determination. The Amendment established that the Board would take action, including a stock rebuilding schedule if necessary, should the BRPs indicate the stock is overfished or overfishing is occurring.

Amendment 1 did not require any specific measures restricting recreational or commercial harvest of Atlantic croaker. States with more conservative measures were encouraged to maintain those regulations (Table 1). The Board was able to revise Amendment 1 through adaptive management, including any regulatory and/or monitoring requirements in subsequent addenda, along with procedures for implementing alternative management programs via conservation equivalency.

The Board initiated Addendum I to Amendment I at its August 2010 meeting, following the updated stock assessment, in order to address the proposed reference points and management unit. The stock assessment evaluated the stock as a coastwide unit, rather than the two management units established within Amendment I. In approving Addendum I, the Board endorsed consolidating the stock into one management unit, as proposed by the stock assessment. In addition, Addendum I established a procedure, similar to other species, by which the Board may approve peer-reviewed BRPs without a full administrative process, such as an amendment or addendum.

In August 2014, the Board approved Addendum II to the Atlantic Croaker FMP. The Addendum established the Traffic Light Approach (TLA) as the new precautionary management framework to evaluate fishery trends and develop management actions. The TLA was originally developed as a management tool for data poor fisheries. The name comes from assigning a color (red, yellow, or green) to categorize relative levels of population indicators. When a population characteristic improves, the proportion of green in the given year increases. Harvest and abundance thresholds of 30% and 60% were established in Addendum II, representing moderate and significant concern for the fishery. If thresholds for both population characteristics achieve or exceed a threshold for a three year period, then management action is enacted.

The TLA framework replaces the management triggers stipulated in Addendum I, which dictated that action should be taken if recreational and commercial landings dropped below 70% of the previous two year average. Those triggers were limited in their ability to illustrate long-term declines or increases in stock abundance. In contrast, the TLA approach better illustrates trends in the fishery through changes in the proportion of green, yellow, and red coloring.

Addenda I and II did not add or change any management measures or requirements. The only existing requirement is for states to submit an annual compliance report by July 1st of each year that contains commercial and recreational landings as well as results from any monitoring programs that intercept Atlantic croaker.

II. Status of the Stock

The most recent stock assessment, conducted in 2017, upon peer review was not recommended for management use. Therefore, current stock status is unknown, although the Peer Review Panel did not indicate any large problems in the Atlantic croaker fishery that would require immediate management action.

The results of the 2010 stock assessment (ASMFC 2010), which is the most recent assessment that was recommended by peer review for management use, are presented here for reference. Results include revised biological reference points (below), which are ratio-based and apply to the entire coastwide resource (unlike those in Amendment 1). Overfishing is occurring if F/F_{MSY} is greater than 1 and the stock is considered overfished if $SSB/(SSB_{MSY}(1-M))$ is less than 1.

	Overfishing Definition	Overfished Definition
Target	$F/(F_{MSY}*0.75) = 1$	$SSB/SSB_{MSY} = 1$
Threshold	$F/F_{MSY} = 1$	$SSB/(SSB_{MSY}(1-M)) = 1$

Atlantic croaker is not experiencing overfishing. According to the 2010 stock assessment, biomass has been increasing and fishing mortality decreasing since the late 1980s. Biomass conclusions are based on information from the data compiled for the assessment, namely increasing indices of relative abundance and expanding age structure in the catch and indices. Model estimated values of fishing mortality (F), spawning stock biomass (SSB), and biological reference points are too uncertain to be used to determine stock status. However, the ratio of F to F_{MSY} (the F needed to produce maximum sustainable yield) is reliable and can be used to determine that overfishing is not occurring. The 2010 assessment was unable to confidently determine stock status, particularly with regards to biomass, due to an inability to adequately estimate removals from discards of the South Atlantic shrimp trawl fishery. Improvements on estimation of these discards were made in the 2017 assessment, allowing the potential for shrimp trawl discards to be included in the annual TLA. Annual monitoring of shrimp trawl fishery discards is important because these discards represent a considerable proportion of

Atlantic croaker removals, ranging from 7% to 78% annually during 1988-2008, according to the 2010 assessment (ASMFC 2010).

Absolute estimates of total F are unavailable because of model uncertainty; however, the general trend in total F from the model is considered reliable due to support from the data. The trend in total F decreases substantially during the first five years of the time series (1988-1992) and shows an overall decline over the remainder of the time series, except for occasional, brief spikes (Figure 1). Retrospective analysis of the model showed that estimates of F decreased as more years of data were used. A series of sensitivity runs conducted over a range of plausible values of shrimp-trawl fishing mortality found that the ratio of directed fishing mortality to F_{MSY} was less than one in all cases, indicating overfishing was not occurring.

Again, absolute estimates of SSB are unavailable because of model uncertainty; however, the general trend in SSB from the model is considered reliable due to support from the data. Spawning stock biomass shows a nearly consistent increasing trend since 1998 (Figure 2). Sensitivity runs of the model, including rough estimates of shrimp trawl discards, do not change the overall trend in SSB. Retrospective analysis of the model showed that estimates of SSB increased as more years of data were used.

Recruitment, estimated in the model as age-1 abundance, has been variable but generally increasing over the time series. Figure 2 shows the trend in recruitment; absolute values are omitted because of uncertainty in abundance estimates. The model estimated the production of strong year classes in 1997, 2001, and 2007.

III. Status of the Fishery

Total Atlantic croaker harvest from New Jersey through the east coast of Florida in 2016 is estimated at 8.31 million pounds (Tables 2 and 3, Figure 3). This represents an 80% decline in total harvest since the peak of 41.2 million pounds in 2001 (79% commercial decline, 82% recreational decline). The commercial and recreational fisheries harvested 76.5% and 23.5% of the total, respectively. The vast majority of landings are from the Mid-Atlantic region (94% in 2016), and the recent decline in total landings is a result of both commercial and recreational landings declines in that region (Figure 4). Commercial and recreational landings in the South Atlantic region have been generally stable over the last decade; however, 2010 showed large decreases in the South Atlantic states' recreational harvests, followed by a slow general increase in recreational harvest in this region. Recreational and commercial harvests in the South Atlantic region rose to 5.8% of coastwide harvest in 2016 from 0.6% in 2010.

Atlantic coast commercial landings of Atlantic croaker exhibit a cyclical pattern, with low domains in the 1960s to early 1970s and the 1980s to early 1990s, and high domains in the mid-to-late 1970s and the mid-1990s to early 2000s (Figure 3). Commercial landings increased from a low of 3.7 million pounds in 1991 to 30.1 million pounds in 2001 (Table 2); however, landings have declined consistently since 2003 to 6.4 million pounds in 2016, which registers below the 1950-2016 average of 11.9 million pounds. Within the management unit, the majority of 2016

commercial landings came from Virginia (61%) and North Carolina (33%). The Potomac River Fisheries Commission (PRFC) had the next highest level, with 2.7% of coastwide landings.

From 1981-2016, recreational landings of Atlantic croaker from New Jersey through Florida have varied between 2.8 million fish (1.3 million pounds) and 13.2 million fish (11.1 million pounds; Tables 3 and 4, Figure 5). Landings generally increased until 2001, held stable from 2001-2006 before exhibiting a declining trend from 2007 through 2016. The 2016 landings are estimated at 4.5 million fish and 2.0 million pounds. Virginia was responsible for 67% of the 2016 recreational landings, in numbers of fish, followed by Florida, Maryland, and North Carolina (12.5%, 9.5%, and 8.1%, respectively).

The number of recreational releases increased over the time series until 2008, when numbers released began to generally decline (Figure 5). However, percentage of released recreational catch has remained stable, ranging from 52 to 61% from 2008-2016. In 2016, anglers released approximately 6.9 million fish, a decline from the 13.8 million fish released in 2013. Anglers released an estimated 61% of the croaker catch in 2016 (Figure 5).

IV. Status of Assessment Advice

A statistical catch-at-age (SCA) model was used in the 2010 Atlantic croaker stock assessment (ASMFC 2010). This model combines catch-at-age data from the commercial and recreational fisheries with information from fishery-independent surveys and biological information such as growth rates and natural mortality rates to estimate the size of each age class and the exploitation rate of the population. The assessment was peer reviewed by a panel of experts in conjunction with the Southeast Data, Assessment, and Review (SEDAR) process.

The Review Panel was unable to support some of the 2010 assessment results due to uncertainty regarding the estimation of Atlantic croaker discards in the shrimp trawl fishery, and the application of estimates in modeling. Specifically, model-estimated values of stock size, fishing mortality, and biological reference points are too uncertain for use; however, the trends in model-estimated parameters and ratio-based fishing F reference points are considered reliable. Despite the uncertainty in assessment results caused by shrimp trawl bycatch, the Review Panel concluded that it is unlikely that the stock is in trouble. The stock is not experiencing overfishing, biomass has been trending up, commercial catches are stable, and discards from the shrimp trawl fishery have been reduced.

A benchmark stock assessment was conducted in 2017, but was not recommended for management use due to 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. One noted improvement in this assessment was in the estimation of Atlantic croaker discards by the shrimp trawl fishery. The Review Panel recommended incorporation of shrimp trawl discard estimates into the annual monitoring of Atlantic croaker through the TLA. The Plan Review Team supports this recommendation.

V. Status of Research and Monitoring

There are no research or monitoring programs required of the states except for the submission of an annual compliance report. The following fishery-dependent (other than catch and effort data) and fishery-independent monitoring programs were reported in the 2016 compliance reports.

Fishery-Dependent Monitoring

- New Jersey: initiated biological monitoring of commercially harvested Atlantic croaker in 2006 in conjunction with ACCSP (2016 n=166)
- Delaware: collects trip-based information on pounds landed, area fished, effort, and gear type data through mandatory monthly state logbook reports submitted by fishermen.
- Maryland: commercial pound net fishery biological sampling (2,239 length measurements, 175 samples aged in 2016, one fish older than age seven).
- PRFC: has a mandatory commercial harvest daily reporting system, with reports due weekly.
- Virginia: commercial fishery biological sampling (9,453 length measurements, 9,434 weight measurements, 346 otolith ages, and 895 sex determinations in 2016)
- North Carolina: commercial fishery biological sampling since 1982 for length (2016 n=6,492), weight, otolith, sex determination, and reproductive condition.
- South Carolina: recreational fishery biological sampling via SCDNR State Finfish Survey, MRIP, and a SCDNR-managed mandatory trip reporting system for licensed charter boat operators. In 2013, SCDNR took over its portion of MRIP data collection.
- Georgia: collects biological information, including length, sex, and maturity stage, through the Marine Sportfish Carcass Recovery Project (3 fish in 2016)
- Florida: commercial fishery biological sampling

Fishery-Independent Monitoring

- New Jersey: 3 nearshore ocean (within 12 nm) juvenile trawl surveys (New Jersey Ocean Trawl Survey, 1988-present: 2016 CPUE was well below time-series average; nearshore Delaware Bay juvenile trawl survey, 1991-present: 2016 survey index was well below time series average but above 2015 value; Delaware River juvenile seine survey, 1980-present: 2016 survey index was below time series average but above 2015 value)
- Delaware: offshore Delaware Bay adult finfish trawl survey (1990-present; 2016 #/tow = 2.22; 27% decrease in relative abundance from 2015 index, below mean and median for time series); nearshore Delaware Bay juvenile finfish trawl survey (1980-present; 2016 index decreased from 8.48 in 2015 to 1.17; Inland Bays index decreased from 1.19 in 2015 to 0.43 in 2016).
- Maryland: summer gill net survey was initiated in 2013 on lower Choptank (steady decline in catch; 476 fish in 2013, 269 in 2014, 21 in 2015; 32 fish were captured in 2016); Atlantic coast bays juvenile otter trawl survey (standardized from 1989-present; 2016 GM of 1.10 fish/hectare above time series median but below time series mean); Chesapeake Bay juvenile trawl index (standardized from 1989-present; CPUE increased from 0.21 in 2015 to 0.81 in 2016).
- PRFC: Maryland DNR conducts an annual juvenile beach haul seine survey in the Potomac River (1954-present; YOY GM increased from 0 in 2014 and 2015 to 0.27 in 2016).

- Virginia: Independent monitoring results are not yet available for the 2015 fishing year. VIMS Juvenile Finfish and Blue Crab Trawl Survey (1988-present; 2015 index representing the 2014 year class was 0.73, which is down from the 2014 value of 1.55).
- North Carolina: Pamlico Sound juvenile trawl survey (1987-present; 2016 juvenile abundance index (mean number of individuals/tow) was 369.8, above the time series average)
- South Carolina: estuarine electroshock survey for juveniles (2001-present; 2016 CPUE increased slightly since 2015, third consecutive year below the long-term mean); SEAMAP shallow water (15-30 ft) trawl survey from Cape Hatteras to Cape Canaveral (1989-present; 2016 CPUE decreased by 41% from 2015; inshore estuarine trammel net survey for adults (May-September, 1991-present; 2016 CPUE decreased 59.5% from 2015); SCECAP estuarine trawl survey (1999-present, primarily targets juveniles, 2016 CPUE increased from 2015, well below long-term mean and continuing a declining trend).
- Georgia: Marine Sportfish Population Health Survey (trammel and gill net surveys in the Altamaha River Delta and Wassaw estuary, 2002-present; 2016 n=180); Ecological Monitoring Survey (trawl, 2003-present; 2016 n=39,664; CPUE (#/tow) increased from 55.53 in 2015 to 95.35 in 2016).
- Florida: juvenile seine survey (2002-present; 2016 index continued variable trend with an increase from 2015); juvenile trawl survey (2002-present; 2016 index continued variable trend with an increase from 2015); adult haul seine survey (2001-present; 2016 index value decreased from 2015)

The Northeast Fishery Science Center performs a randomly stratified groundfish survey along the U.S. east coast. Atlantic croaker are one of the main species caught throughout much of the survey area and, since the surveys started in 1972, it provides a long term data set. Regionally, mean CPUE (catch-per-unit-effort) of Atlantic croaker has increased from north to south. Since 1994, there has been an increase in annual catch variability. Catch levels in 2016 decreased 34.6% from 2015 and were above the long term mean.

The Southeast Area Monitoring and Assessment Program - South Atlantic (SEAMAP-SA) Coastal Survey (previously known as the Shallow Water Trawl Survey) began in 1986 and is conducted by the SCDNR Marine Resources Division (MRD). This survey has provided long-term, fisheries-independent data characterizing the seasonal abundance and biomass of finfish and other organisms that are accessible by high-rise trawls from the coastal zone of the South Atlantic Bight (SAB) between Cape Hatteras, North Carolina, and Cape Canaveral, Florida. Croaker abundance index values have generally trended upward since the early 2000s. The 2016 index decreased 40.8% from the time series high in 2015 and was above the long-term mean.

VI. Status of Management Measures and Issues

Fishery Management Plan

Amendment 1 was fully implemented by January 1, 2006, and provided the management plan for the 2009 fishing year. There are no interstate regulatory requirements for Atlantic croaker. Should regulatory requirements be implemented in the future, all state programs must include law enforcement capabilities adequate for successfully implementing the regulations.

Addendum I to Amendment 1 was initiated in August 2010 and approved in March 2011, in order to 1) revise the biological reference points to be ratio-based, and 2) remove the distinction of two regions within the management unit, based on the results of the 2010 stock assessment. Addendum II was approved August 2014 and established the TLA management framework for Atlantic croaker in order to better illustrate long-term trends in the fishery.

Traffic Light Approach
Addendum II established the TLA as the new management framework for Atlantic croaker. Under this management program, if thresholds for both population characteristics (harvest and adult abundance) achieve or exceed the proportion of threshold for the specified three year period, management action will be taken.

Analysis of the harvest composite index for 2016 shows that this population characteristic tripped for a fourth consecutive year (Figure 6). The mean proportion of red color from 2014-2016 was 58.1%, well above the 30% threshold. The harvest composite index was comprised of commercial and recreational landings. Both commercial and recreational indices would have individually tripped in 2014 at the 30% level. The TLA for commercial landings was just below the 60% threshold in 2016, and has exceeded 50% in three consecutive years.

The abundance composite TLA index was broken into two components based on age composition. The adult composite index was generated from the NMFS and SEAMAP surveys, since the majority of Atlantic croaker captured in those surveys were ages 1+. The juvenile composite index was generated from the NC program 195 and VIMS surveys because these two captured primarily young-of-the-year Atlantic croaker.

All four TLA composite abundance indices showed increases in both 2015 and 2016 with no red proportion occurring in either year. The adult composite TLA characteristic (Figure 7) did not trigger in 2016 with no red proportion and no red in the two previous years. The juvenile composite characteristic index (Figure 8) also had no red proportion for 2015 or 2016, indicating an increase in abundance since 2014. The higher annual variability for the different color proportions in the juvenile composite characteristic, in comparison to the adult composite characteristic, is likely a reflection annual recruitment variability rather than population trends.

Overall, management triggers were not tripped in 2016 since both population characteristics (harvest and abundance) were not above the 30% threshold for the 2014-2016 time period. This continues a trend of disconnect between the harvest and abundance indices since the mid-2000s, with the harvest index generally decreasing and abundance index generally increasing.

De Minimis Requests
States are permitted to request *de minimis* status if, for the preceding three years for which data are available, their average commercial landings or recreational landings (by weight) constitute less than 1% of the coastwide commercial or recreational landings for the same three year period. A state may qualify for *de minimis* in either its recreational or commercial sector, or both, but will only qualify for exemptions in the sector(s) that it qualifies for as *de*

minimis. Amendment 1 does not include any compliance requirements other than annual state reporting, which is still required of *de minimis* states, thus *de minimis* status does not exempt states from any measures.

In the annual compliance reports, the following states requested *de minimis* status: Delaware (commercial fishery), South Carolina (commercial fishery), Georgia (commercial fishery), and Florida (commercial fishery). The commercial and recreational *de minimis* criteria for 2016 are based on 1% of the average coastwide 2014-2016 landings in each fishery: 67,705 pounds for the commercial fishery and 25,419 pounds for the recreational fishery. The Delaware commercial fishery qualifies for *de minimis* status with a three-year average of 4,806 pounds. The South Carolina commercial fishery qualifies for *de minimis* status with a three-year average of 206 pounds. The Georgia commercial fishery qualifies for *de minimis* status with a three-year average of zero pounds. The Florida commercial fishery qualifies for *de minimis* status with a three-year average of 46,612 pounds.

Changes to State Regulations

In 2016, North Carolina enacted several gill net restrictions for coastal waters pertaining to area closures/openings, gear modifications, and attendance rules to avoid interactions with endangered species. These restrictions may indirectly affect the harvest and bycatch of Atlantic croaker and are defined by North Carolina Proclamations: M-32-2016, M-30-2016, M-27-2016, M-25-2016, M-24-2016, M-23-2016, M-20-2016, M-19-2016, M16-2016, M-13-2016, M-12-2016, M-9-2016, M-8-2016, and M-5-2016.

Atlantic Croaker Habitat

In Winter of 2017, the ASMFC Habitat Committee released *Atlantic Sciaenid Habitats: A Review of Utilization, Threats, and Recommendations for Conservation, Management, and Research*, which outlines the habitat needs of Atlantic croaker at different life stages (egg, larval, juvenile, adult). This report also highlights threats and uncertainties facing these ecological areas and identifies Habitat Areas of Particular Concern. It can be found online at: http://www.asmfc.org/files/Habitat/HMS14_AtlanticSciaenidHabitats_Winter2017.pdf.

Bycatch Reduction

Atlantic croaker is subject to both direct and indirect fishing mortality. Historically, croaker ranked as one of the most abundant bycatch species of the south Atlantic shrimp trawl fishery, resulting in the original FMP's recommendation that bycatch reduction devices (BRDs) be developed and required in the shrimp trawl fishery. Since then, the states of North Carolina through Florida have all enacted requirements for the use of BRDs in shrimp trawl nets in state waters, reducing croaker bycatch from this fishery (ASMFC 2010). However, bycatch and discard monitoring from the shrimp trawl fishery have historically been inadequate, resulting in a major source of uncertainty for assessing this stock, as well as other important Mid- and South Atlantic species. Most of the discarded croaker are age-0 and thus likely have not yet reached maturity (ASMFC 2010). The North Carolina Division of Marine Fisheries conducted a two-year study, published in 2015, to collect bycatch data from state shrimp trawlers. It found that Atlantic croaker represent between 34-49% of the total observed finfish bycatch by weight

in estuarine waters and between 20-42% in ocean waters. The at-net mortality for Atlantic croaker was found to be 23% (Brown 2015). These data will be valuable for incorporating estimates of removals in future stock assessments.

Atlantic croaker are also discarded from other commercial fishing gears, primarily due to market pressures and few restrictions on croaker harvest at the state level. The NMFS Pelagic Observer Program provides data to estimate these discards for use in assessments; however, the time series is limited and only discards from gill nets and otter trawls could be estimated for the 2010 assessment based on the available data. Since 1988, estimated discards have fluctuated between 94 and 15,176 mt without trend, averaging 2,503 mt (ASMFC 2010).

Atlantic croaker is also a major component of the scrap/bait fishery. Landings from this fishery are not reported at the species level, except in North Carolina, which has a continuous program in place to sample these landings and enable estimation of croaker scrap landings for use in the stock assessment. As part of the 2010 stock assessment, North Carolina estimated the scrap/bait landings, which have declined in recent years, from a high of 1,569 mt in 1989 to a low of 84 mt in 2008, primarily due to restrictions placed on fisheries producing the highest scrap/bait landings (ASMFC 2010). Regulations instituted by North Carolina include a ban on flynet fishing south of Cape Hatteras, incidental finfish limits for shrimp and crab trawls in inside waters, minimum mesh size restrictions in trawls, and culling panels in long haul seines.

South Carolina has also begun a state monitoring program to account for scrap landings. The state initiated a bait harvester trip ticket program for all commercial bait harvesters licensed in South Carolina. The impetus for this program is to track bait usage of small sciaenid species (croaker, spot, and whiting) as well as other important bait species.

Several states have implemented other commercial gear requirements that further reduce bycatch and bycatch mortality, while others continue to encourage the use of the BRD devices. NOAA Fisheries published a notice on June 24, 2011 for public scoping in the Federal Register to expand the methods for reducing bycatch interactions with sea turtles, which may have additional effects on the bycatch of finfish like Atlantic croaker in trawls (76 FR 37050). Continuing to reduce the quantity of sub-adult croaker harvested should increase spawning stock biomass and yield per recruit.

Atlantic croaker are also subject to recreational discarding. The percentage of Atlantic croaker released alive by recreational anglers has generally increased over time. Discard mortality was estimated to be 10% for the 2010 stock assessment (ASMFC 2010). The use of circle hooks and appropriate handling techniques can help reduce mortality of released fish.

VII. Implementation of FMP Compliance Requirements for 2015

The PRT finds that all states have fulfilled the requirements of Amendment 1.

VIII. Recommendations

Management and Regulatory Recommendations

- Encourage the use of circle hooks to minimize recreational discard mortality.
- Consider approval of the *de minimis* requests from Delaware, South Carolina, Georgia, and Florida.
- Consider the basic research and monitoring information needed for informed management in light of the budgetary constraints limiting all state governments.

Research and Monitoring Recommendations

<u>High Priority</u>

- Increase observer coverage for commercial discards, particularly the shrimp trawl fishery. Develop a standardized, representative sampling protocol for observers to use to increase the collection of individual lengths and ages of discarded finfish.
- 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 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, MD) and coastal data sets (MARMAP, EcoMon).

<u>Medium Priority</u>

- Conduct studies of discard mortality for recreational and commercial fisheries by each gear type in regions where removals are highest.
- In the recreational fishery, develop sampling protocol for collecting lengths of discarded finfish and collect otolith age samples from retained fish.
- Encourage fishery-dependent biological sampling, with proportional landings representative of the distribution of the fisheries. Develop and communicate clear protocols on truly representative sampling.
- Investigate environmental covariates in stock assessment models including climate cycles (e.g., Atlantic Multi-decadal Oscillation, AMO, and El Niño Southern Oscillation, El Niño) and recruitment and/or year class strength, spawning stock biomass, stock distribution, maturity schedules, and habitat degradation.
- Utilize NMFS Ecosystem Indicators bi-annual reports to consider folding indicators into the assessment; identify mechanisms for how environmental indicators affect the stock.

- Encourage efforts to recover historical landings data, determine whether they are available at a finer scale for the earliest years than are currently reported.
- Collect data to develop gear-specific fishing effort estimates and investigate methods to develop historical estimates of effort.
- Develop gear selectivity studies for commercial fisheries with emphasis on age 1+ fish.
- Conduct studies to measure female reproductive output at size and age (fecundity, egg and larval quality) and impact on assessment models and biomass reference points.
- Develop and implement sampling programs for state-specific commercial scrap and bait fisheries in order to monito the relative importance of Atlantic croaker. Incorporate biological data collection into the program.
- Investigate the relationship between estuarine nursery areas and their proportional contribution to adult biomass, i.e., are select nursery areas along Atlantic coast ultimately contributing more to SSB than others, reflecting better quality juvenile habitat?

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X. Figures

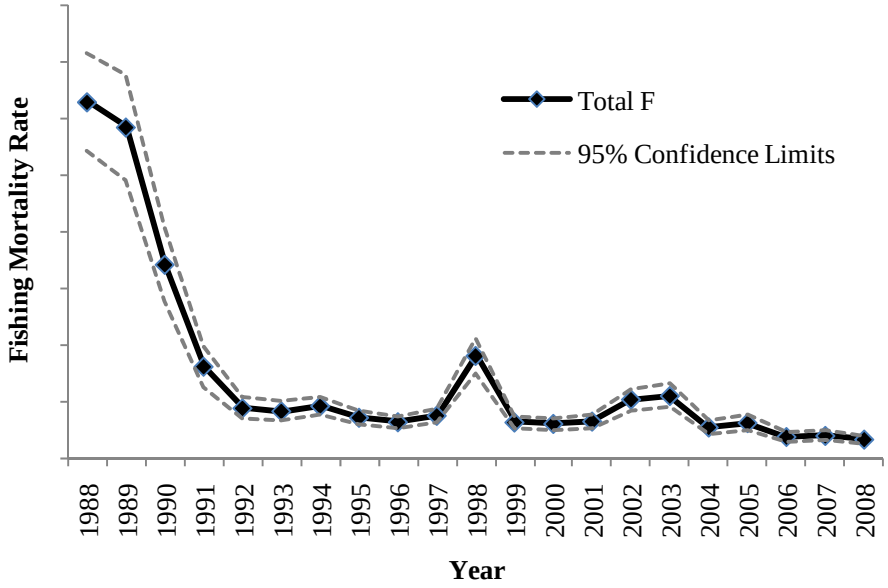

Figure 1. Trend in estimated total fishing mortality rate (F) of Atlantic croaker
(Absolute estimates of F are unreliable due to uncertainty regarding the estimation of Atlantic croaker discards in the shrimp trawl fishery, and the application of estimates in modeling. Source: ASMFC 2010.)

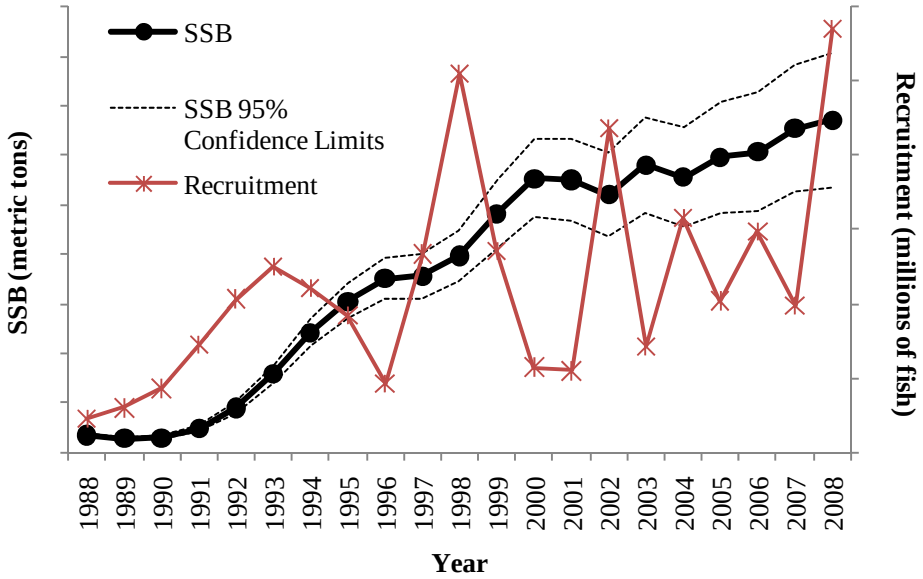

Figure 2. Trends in estimated spawning stock biomass (SSB, metric tons) and age-1 recruitment (numbers of fish) of Atlantic croaker
(Absolute estimates of stock size are unreliable due to uncertainty regarding the estimation of Atlantic croaker discards in the shrimp trawl fishery, and the application of estimates in modeling. Source: ASMFC 2010.)

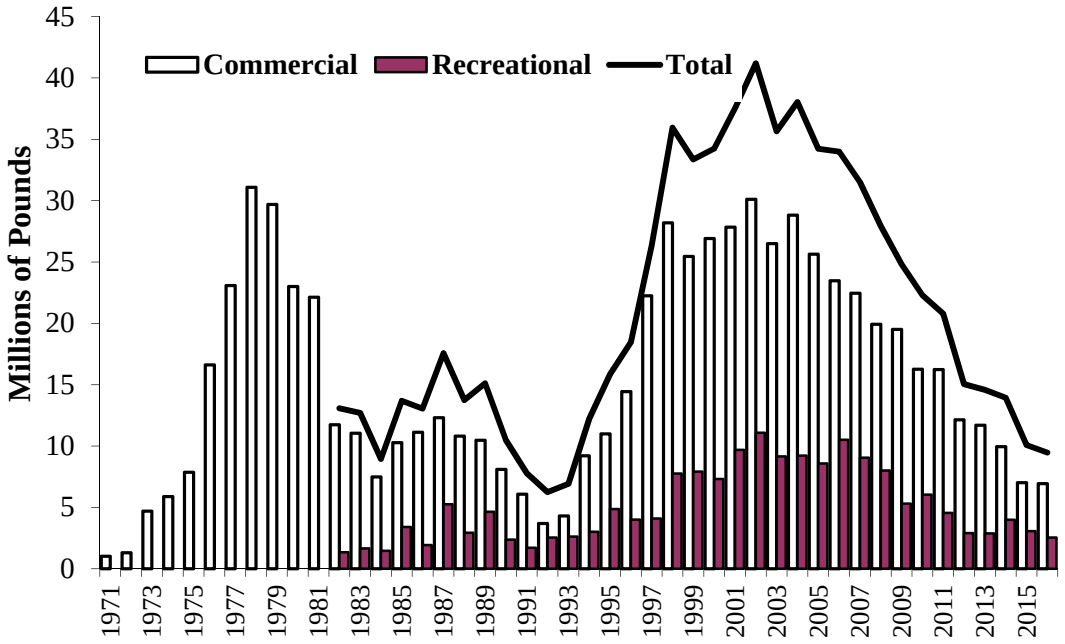

Figure 3. Atlantic croaker commercial, recreational, and total landings (pounds)
(See Tables 2 and 3 for values and source information. Commercial landings estimate for 2015 is preliminary. Reliable recreational landings estimates are not available before 1981.)

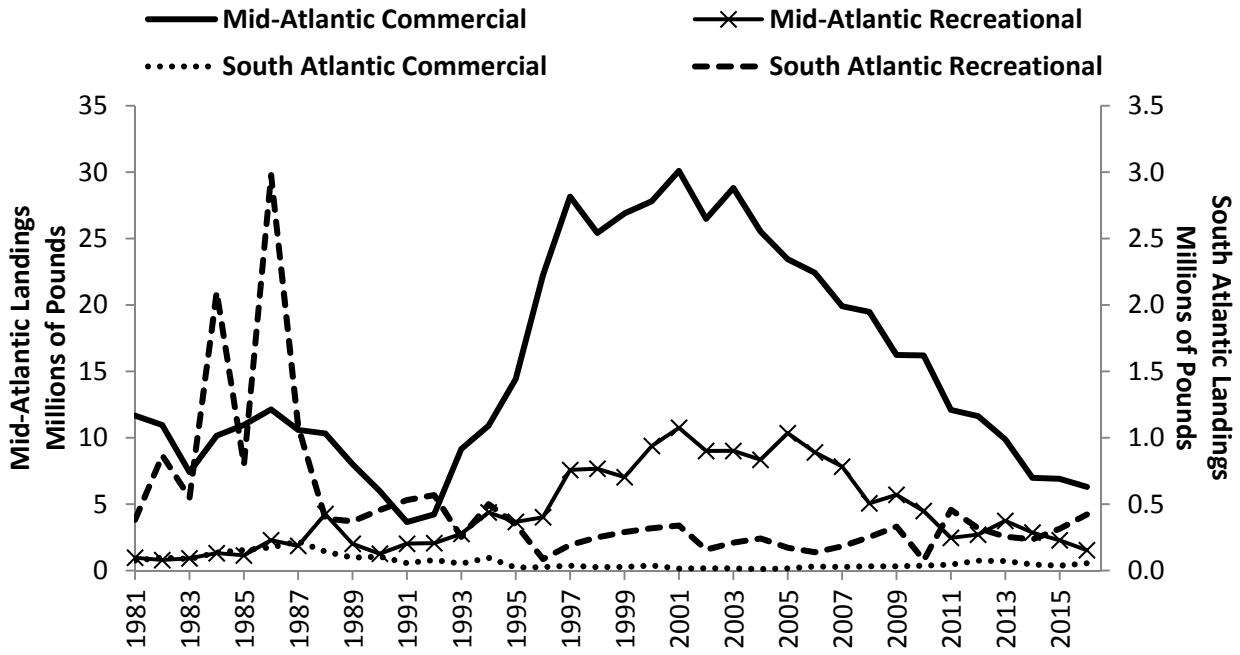

Figure 4. Mid-Atlantic (NJ-NC) and South Atlantic (SC-FL) landings (pounds)
(See Tables 2 and 3 for values and source information.)

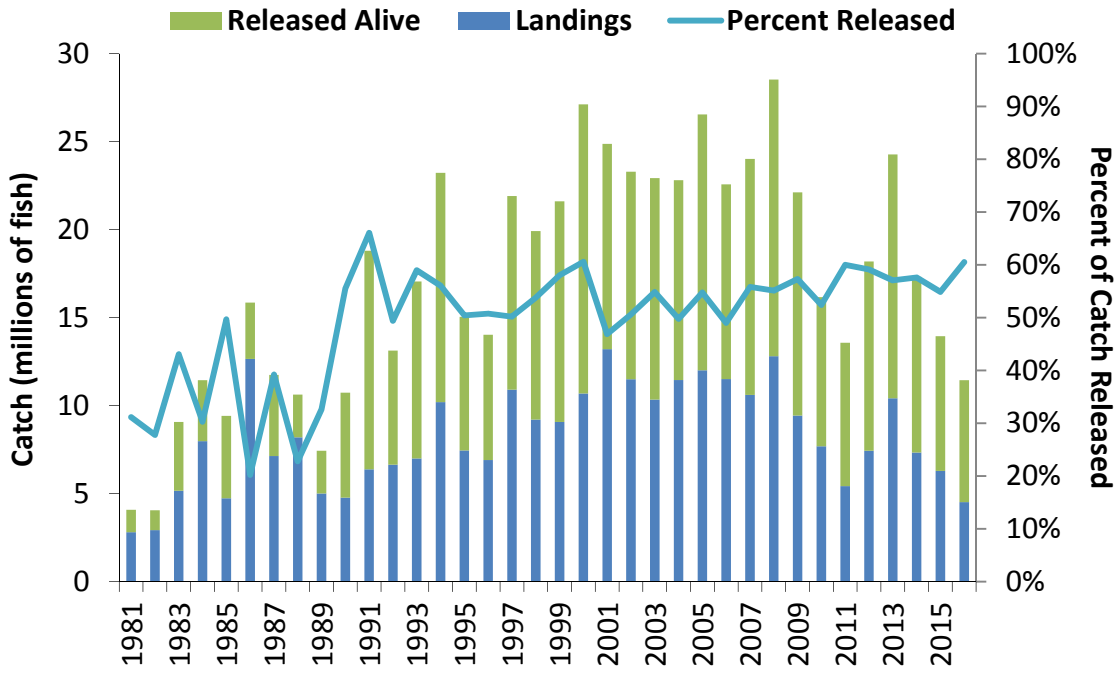

Figure 5. Recreational catch (landings and alive releases, in numbers) and the percent of catch that is released, 1981-2015
(See Tables 4 and 5 for values and source information.)

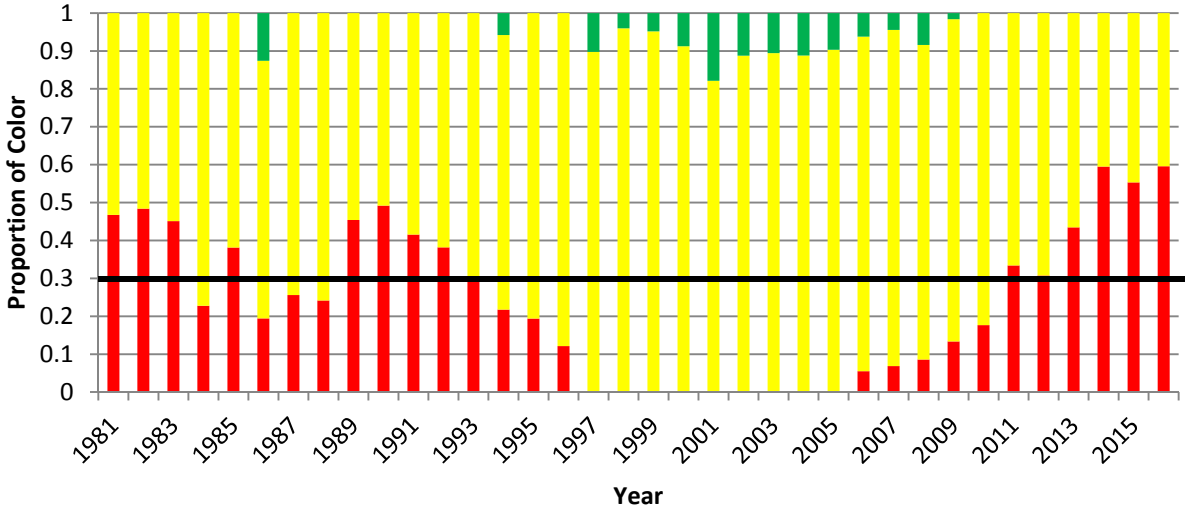

Figure 6. Annual color proportions for the harvest composite TLA of Atlantic croaker recreational and commercial landings.

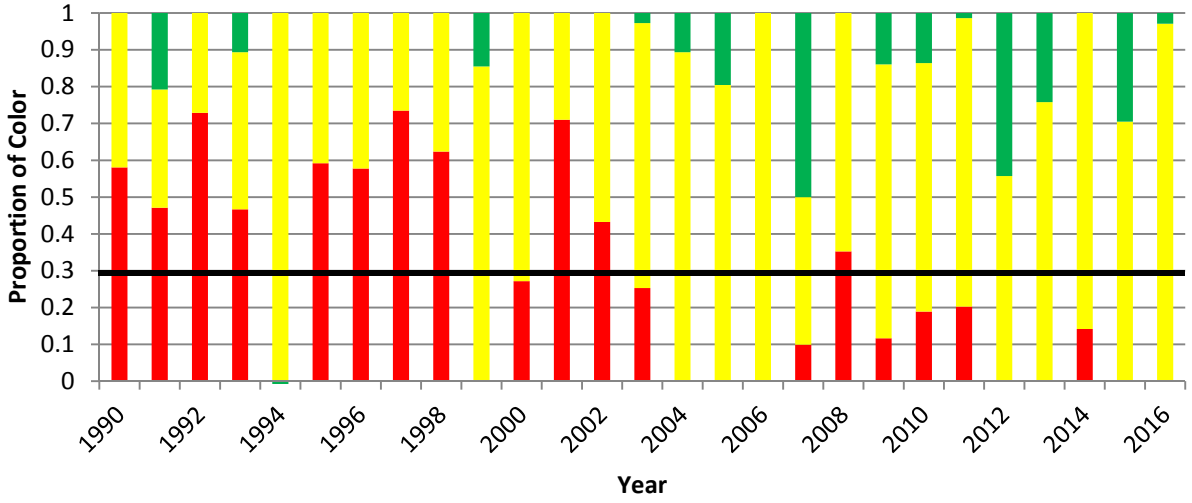

Figure 7. Adult croaker TLA composite characteristic index (NMFS and SEAMAP surveys).

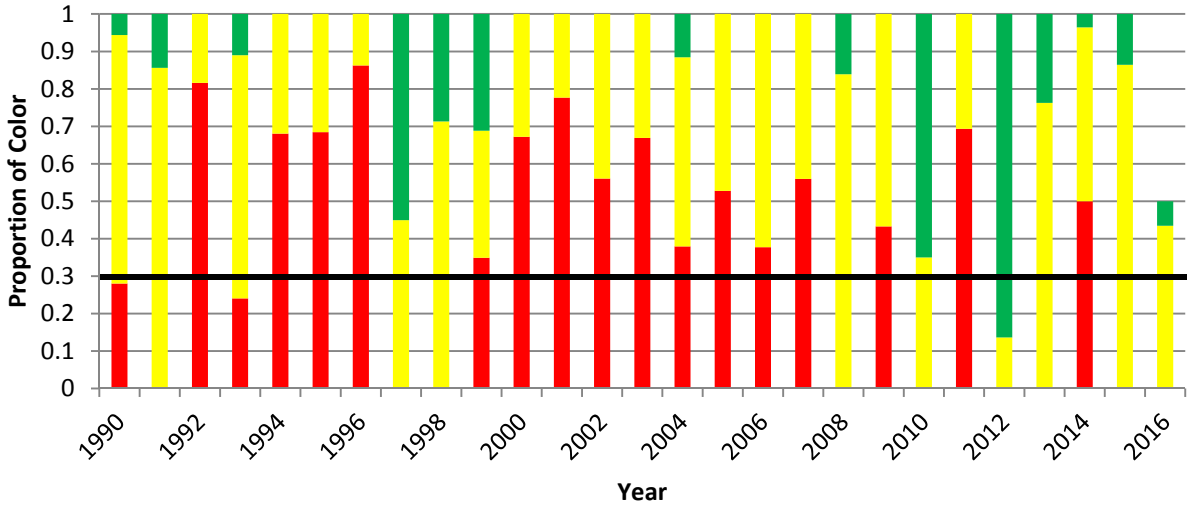

Figure 8. Juvenile croaker TLA composite characteristic index (NC 195 and VIMS surveys).
(2016 VIMS survey is not yet available.)

XI. Tables

Table 1. Summary of state regulations for Atlantic croaker in 2016*

State	Recreational	Commercial
NJ	none	otter/beam trawl mesh restriction for directed croaker harvest (>100 lbs in possession)
DE	8" minimum; recreational gill nets (up to 200 ft.) with license	8" minimum
MD	9" min, 25 fish/day, charter boat logbooks	9" minimum; open 3/16 to 12/31
PRFC	25 fish/day	pound net season: 2/15 to 12/15
VA	none	none
NC	recreational use of commercial gears with license and gear restrictions	
SC	mandatory for-hire logbooks, small Sciaenidae species aggregate bag limit of 50 fish/day	
GA	25 fish/day	25 fish/day limit except for trawlers harvesting shrimp for human consumption (no limit)
FL	none	none

* A commercial fishing license is required to sell croaker in all states with fisheries. For all states, general gear restrictions affect commercial croaker harvest.

Table 2. Commercial harvest (pounds) of Atlantic croaker by state, 1981-2015
(Estimates for 2016 are preliminary. Sources: 2017 state compliance reports for 2016 fishing year and for years prior to 2016, personal communication with ACCSP, Arlington, VA [07/18/2017], except DE [state compliance reports 1985-2016 and ACCSP for years prior to 1985], MD [state compliance reports only], and Virginia [state compliance reports only].)

Year	NJ	DE	MD	PRFC	VA	NC	SC	GA	FL	Total
1981	23,500		2,104	648	429,800	11,205,342	*	1,038	72,112	11,734,544
1982	100		7,091	188	119,300	10,824,953	386	2,177	95,357	11,049,552
1983	200		417	1,549	150,400	7,249,680	*	1,097	81,737	7,485,080
1984	57,700		27,072	73,701	817,700	9,170,775	3,793	*	131,375	10,282,116
1985	48,800	66	9,510	19,854	2,171,821	8,714,432	*		115,641	11,080,124
1986	106,000	466	135,922	99,373	2,367,000	9,424,828	924		173,531	12,308,044
1987	357,600	770	119,409	102,691	2,719,500	7,289,191	698	553	217,995	10,808,407
1988	30,100	162	98,855	12,796	1,749,200	8,434,415	2,614	304	140,051	10,468,497
1989	137,100		89,173	5,579	949,649	6,824,088	*	*	95,021	8,100,610
1990	644	42	2,473	5,115	201,353	5,769,512	1,190	*	104,402	6,084,731
1991	31,292	1,111	6,183	996	164,126	3,436,960	*	*	56,739	3,697,407
1992	51,600	687	17,050	17,692	1,339,353	2,796,612		*	79,040	4,302,034
1993	183,414	2,435	114,159	262,482	5,326,293	3,267,652	*		52,031	9,208,466
1994	117,256	3,044	158,918	240,271	5,718,085	4,615,754	*	*	96,018	10,949,346
1995	334,654	12,106	489,506	606,184	6,949,639	6,021,284	*	*	22,879	14,436,252
1996	621,889	9,681	792,326	1,427,285	9,320,283	9,961,834		*	26,045	22,159,343
1997	1,994,446	10,509	1,088,969	1,518,196	12,829,212	10,711,667	*	*	36,577	28,189,576
1998	1,029,332	10,384	1,006,529	610,885	11,285,458	10,865,897		*	26,418	24,834,903
1999	2,071,046	15,068	948,191	1,190,138	12,476,074	10,185,507		*	26,824	26,912,848
2000	2,130,465	11,118	902,379	1,812,130	12,822,400	10,122,676		*	31,566	27,832,734
2001	1,389,837	21,759	1,488,815	1,963,294	13,214,731	12,017,424		*	16,511	30,112,370
2002	1,828,484	10,515	894,879	1,421,094	12,104,334	10,189,153	*	*	18,216	26,466,675
2003	1,575,738	16,612	713,205	1,128,003	10,935,574	14,429,197	140	*	18,868	28,817,337
2004	2,096,305	30,369	1,354,982	1,631,596	8,535,638	11,993,488	*	*	11,407	25,653,785
2005	1,847,753	36,624	972,801	481,912	8,211,802	11,903,292	41	*	16,809	23,471,033
2006	1,617,227	19,307	466,833	670,276	9,252,110	10,396,554	160	*	30,520	22,452,986
2007	1,357,999	13,522	477,887	188,567	10,557,370	7,271,162	*	*	26,726	19,893,233
2008	946,339	10,465	592,211	337,062	11,796,771	5,791,766	116	*	30,407	19,505,137
2009	585,552	16,341	448,550	234,101	8,808,677	6,135,437	75		32,151	16,260,884
2010	342,116	6,182	490,067	162,571	7,879,847	7,312,159	*		37,229	16,230,171
2011	458,397	12,252	704,019	243,196	5,611,885	5,054,186	*		47,649	12,131,583
2012	363,381	2,811	908,619	273,849	6,963,815	3,106,616	*		74,527	11,693,617
2013	332,813	6,700	850,336	130,285	6,626,517	1,927,938	*		76,463	9,951,052
2014	265,166	9,647	479,079	177,777	3,406,958	2,629,908	247		45,587	7,014,369
2015	81,311	3,975	288,331	118,996	4,585,623	1,819,067	69		39,096	6,936,468

2016	55,210	795	101,141	168,889	3,882,869	2,092,135	302		55,154	6,356,495

* confidential data

Table 3. Recreational harvest (pounds) of Atlantic croaker by state, 1981-2015
(Source: personal communication with NMFS Fisheries Statistics Division. [07/18/2017])

Year	NJ	DE	MD	VA	NC	SC	GA	FL	Total
1981	582	2,317		535,297	426,240	67,284	9,665	305,547	1,346,932
1982			70,276	455,250	264,607	67,015	45,161	754,956	1,657,265
1983			32,053	486,006	395,402	14,158	25,412	510,599	1,463,630
1984			86,462	634,870	584,660	161,661	80,684	1,856,599	3,404,936
1985			17,169	843,414	278,214	72,780	40,421	684,449	1,936,447
1986		2,595	116,542	2,034,337	126,888	173,028	21,504	2,783,651	5,258,545
1987			191,628	1,306,814	352,346	64,696	14,947	1,005,053	2,935,484
1988		826	926,399	2,390,573	935,460	54,313	20,313	316,900	4,644,784
1989		283	19,189	1,329,680	658,567	80,580	21,138	268,335	2,377,772
1990		112	37,873	875,427	347,183	123,795	205,352	127,525	1,717,267
1991	4,264	10,972	117,210	1,728,021	157,660	16,173	54,116	460,453	2,548,869
1992		3,292	53,556	1,768,962	233,533	28,512	132,596	407,672	2,628,123
1993	844	9,640	476,866	1,993,915	282,910	18,005	55,604	180,517	3,018,301
1994	818	2,892	991,166	3,024,118	351,230	128,306	34,048	337,474	4,870,052
1995	9,515	82,863	567,149	2,675,381	326,135	25,386	20,862	301,918	4,009,209
1996	39,099	205,527	702,037	2,716,759	346,501	14,480	21,797	50,038	4,096,238
1997	278,758	340,198	1,117,999	5,522,195	309,457	53,863	26,272	113,096	7,761,838
1998	135,733	293,561	1,150,459	5,920,436	161,117	76,821	30,966	141,756	7,910,849
1999	301,957	522,201	1,024,398	4,969,283	212,991	26,356	32,375	231,694	7,321,255
2000	1,125,730	483,963	2,672,996	4,888,910	201,306	13,457	62,390	242,914	9,691,666
2001	1,132,214	304,126	1,278,699	7,674,759	355,009	10,750	7,844	320,487	11,083,888
2002	268,423	250,900	1,162,278	7,075,130	242,184	29,343	10,622	117,880	9,156,760
2003	682,698	262,113	2,069,176	5,674,111	317,606	59,399	71,881	79,397	9,216,381
2004	859,373	307,312	1,078,951	5,792,487	306,029	69,510	15,597	156,395	8,585,654
2005	1,193,848	750,857	987,379	7,240,971	168,797	34,922	14,995	121,320	10,513,089
2006	632,085	717,803	865,433	6,460,336	222,286	16,240	9,210	112,512	9,035,905
2007	453,854	321,200	806,826	6,111,612	131,185	11,109	12,756	159,077	8,007,619
2008	527,179	322,166	465,064	3,612,065	132,731	16,212	12,948	223,121	5,311,486
2009	114,015	240,468	1,504,806	3,708,788	131,742	71,517	36,771	222,239	6,030,346
2010	36,063	41,533	976,143	3,185,485	241,993	11,970	10,067	56,023	4,559,277
2011	21,460	52,889	444,595	1,837,183	99,298	240,665	21,548	194,848	2,912,486
2012	96,366	63,037	535,325	1,905,100	105,530	12,433	13,503	292,365	3,023,659
2013	539,125	103,444	737,291	2,217,664	141,880	32,138	17,209	205,970	3,994,721
2014	205,388	207,903	607,046	1,602,504	227,949	35,785	32,833	165,353	3,084,761
2015	99,768	73,579	432,325	1,479,567	190,808	76,531	37,363	200,948	2,590,889
2016	2,318	3,636	110,398	1,269,504	141,571	16,695	17,637	388,304	1,950,063

Table 4. Recreational harvest (numbers) of Atlantic croaker by state, 1981-2015
(Source: personal communication with NMFS Fisheries Statistics Division. [07/18/2017])

Year	NJ	DE	MD	VA	NC	SC	GA	FL	Total
1981	1,054	3,003	0	964,013	1,043,240	165,742	35,591	598,896	2,811,539
1982			10,452	273,039	596,493	193,554	169,749	1,682,619	2,925,906
1983			108,355	2,154,133	1,620,909	60,811	75,173	1,148,227	5,167,608
1984			211,035	2,047,720	2,147,871	588,114	202,364	2,781,742	7,978,846
1985			21,276	2,284,334	723,933	260,265	144,341	1,306,955	4,741,104
1986		392	123,578	6,384,966	356,742	599,442	69,887	5,118,552	12,653,559
1987	0	0	208,488	3,234,224	904,030	166,978	44,783	2,580,727	7,139,230
1988		604	1,005,452	4,048,690	2,256,128	144,057	64,093	685,778	8,204,802
1989		478	22,871	2,203,504	2,131,763	217,023	72,598	359,417	5,007,654
1990		281	100,673	2,374,679	1,063,452	346,631	585,380	304,064	4,775,160
1991	16,235	28,837	288,471	4,298,542	434,067	100,816	184,435	1,030,115	6,381,518
1992	0	9,281	117,427	4,524,040	723,823	74,051	440,185	754,595	6,643,402
1993	2,552	19,352	805,560	4,990,098	755,998	32,700	89,734	304,067	7,000,061
1994	1,567	4,970	1,633,581	6,494,691	1,179,735	188,520	102,974	599,032	10,205,070
1995	15,184	122,720	827,183	5,029,708	850,606	75,422	100,826	438,076	7,459,725
1996	35,037	221,423	775,115	4,997,021	662,240	37,464	61,957	116,575	6,906,832
1997	342,089	373,621	1,053,232	8,066,926	661,116	118,428	64,050	235,430	10,914,892
1998	143,404	352,468	1,126,058	6,730,181	387,427	170,528	64,953	234,360	9,209,379
1999	357,261	618,676	1,209,572	5,881,671	442,185	54,761	104,438	403,982	9,072,546
2000	1,023,442	497,491	2,674,880	5,486,159	391,056	32,332	128,922	455,870	10,690,152
2001	1,177,813	278,907	1,319,928	9,335,313	635,552	19,802	21,503	426,264	13,215,082
2002	253,472	207,344	1,223,385	9,129,060	408,944	66,409	36,497	177,751	11,502,862
2003	692,391	238,617	1,619,766	6,695,192	490,399	198,339	248,853	165,459	10,349,016
2004	855,927	306,801	896,855	8,259,608	511,418	171,544	38,599	415,570	11,456,322
2005	1,227,349	391,456	1,921,122	7,657,147	326,777	143,387	39,561	302,784	12,009,583
2006	511,220	419,010	2,538,525	7,221,148	556,024	58,500	34,081	172,586	11,511,094
2007	406,238	272,092	2,130,970	6,944,886	461,162	38,147	45,068	310,130	10,608,693
2008	600,975	198,531	2,747,160	8,388,497	317,940	65,853	38,246	449,054	12,806,256
2009	193,464	319,734	2,473,018	5,327,388	368,990	238,900	82,269	438,209	9,441,972
2010	63,027	46,152	2,147,825	4,743,697	478,156	46,464	35,635	132,664	7,693,620
2011	40,855	45,523	919,922	3,305,707	246,676	349,463	44,044	476,292	5,428,482
2012	266,832	72,284	2,710,294	3,445,232	288,813	27,873	38,402	589,642	7,439,372
2013	889,754	197401	4,076,910	4273744	411,882	106,938	54915	411,858	10,423,402
2014	263,734	366,608	2,226,095	3,429,768	541,657	149,890	64,138	298,322	7,340,212
2015	116,109	139,031	1,441,241	3,342,008	471,869	216,168	111,344	456,802	6,294,572
2016	4,277	5,057	432,683	3,044,851	368,203	48,537	54,211	563,174	4,520,993

Table 5. Recreational releases (number) of Atlantic croaker by state, 1981-2015

(Source: personal communication with NMFS Fisheries Statistics Division. [07/18/2017])

Year	NJ	DE	MD	VA	NC	SC	GA	FL	Total
1981			16,233	324,238	704,259	128,192	13,481	85,740	1,272,143
1982				77,756	641,327	107,340	111,630	188,277	1,126,330
1983			1,507,184	1,410,151	424,562	119,036	70,499	379,021	3,910,453
1984			70,192	673,080	1,701,418	746,905	37,573	236,432	3,465,600
1985			13,132	1,616,052	1,596,901	238,678	66,649	1,146,582	4,677,994
1986		1,757	43,399	2,578,268	137,841	84,335	40,623	318,511	3,204,734
1987	1,374	861	32,074	2,056,580	560,853	108,366	76,908	1,770,697	4,607,713
1988		582	273,231	832,284	984,219	112,271	20,021	200,630	2,423,238
1989		1,307	41,822	1,342,169	891,926	58,642	17,632	72,822	2,426,320
1990		1,268	88,688	3,922,564	1,351,152	111,085	317,497	168,144	5,960,398
1991	91,633	75,319	3,352,190	7,418,045	669,385	25,168	140,402	647,824	12,419,966
1992	4,103	43,583	856,292	4,167,137	954,494	26,729	178,267	251,343	6,481,948
1993	5,799	13,194	2,504,362	5,795,479	1,499,217	16,949	83,203	138,875	10,057,078
1994	17,253	14,069	1,628,824	7,676,780	3,110,528	141,513	99,026	331,736	13,019,729
1995	31,019	51,574	496,046	5,494,289	1,172,716	108,345	89,609	141,732	7,585,330
1996	17,585	76,851	403,776	5,151,206	1,218,799	64,494	60,282	126,300	7,119,293
1997	111,468	384,233	1,497,670	7,275,160	1,443,568	138,107	25,630	116,276	10,992,112
1998	221,324	839,932	3,021,780	4,990,541	1,060,928	266,068	159,928	152,744	10,713,245
1999	860,325	1,017,499	2,483,800	5,668,925	1,368,478	116,826	57,567	967,894	12,541,314
2000	688,746	694,813	4,967,856	7,811,048	1,569,385	96,402	169,903	428,131	16,426,284
2001	853,621	285,123	1,585,806	7,086,706	1,256,807	115,284	192,362	282,461	11,658,170
2002	369,003	361,355	2,523,276	7,107,656	925,806	92,498	194,474	217,054	11,791,122
2003	833,508	654,697	1,393,224	6,543,524	1,552,315	440,446	965,496	192,356	12,575,566
2004	1,237,163	599,207	854,132	6,276,767	1,656,049	320,788	154,259	253,951	11,352,316
2005	1,692,401	674,684	1,136,846	8,738,109	1,401,413	321,861	280,889	293,692	14,539,895
2006	503,491	937,193	1,783,557	4,193,675	2,578,819	595,075	283,851	187,562	11,063,223
2007	590,078	672,771	1,258,131	8,504,212	1,608,120	224,454	228,564	321,559	13,407,889
2008	2,373,945	601,994	2,427,219	7,806,627	1,419,019	205,373	293,926	596,450	15,724,553
2009	108,371	537,587	1,137,578	7,621,484	1,912,670	514,839	434,608	406,822	12,673,959
2010	167,191	228,936	1,011,236	4,824,151	1,598,139	187,184	263,987	188,637	8,469,461
2011	62,391	88,524	365,716	4,872,928	1,798,230	240,605	262,493	452,669	8,143,556
2012	1,151,045	446,879	1,731,079	5,091,063	1,255,216	271,321	167,488	641,570	10,755,661
2013	773,763	770,454	2,936,927	5,968,340	1,984,701	799,982	298,409	318,139	13,850,715
2014	205,601	664,648	1,146,192	3,606,078	2,713,787	780,171	470,751	393,360	9,980,588
2015	78,135	118,565	626,529	2,760,541	2,477,625	959,887	210,454	422,164	7,653,900
2016	41,595	169,076	245,155	2,543,800	2,147,160	976,768	152,037	652,440	6,928,031