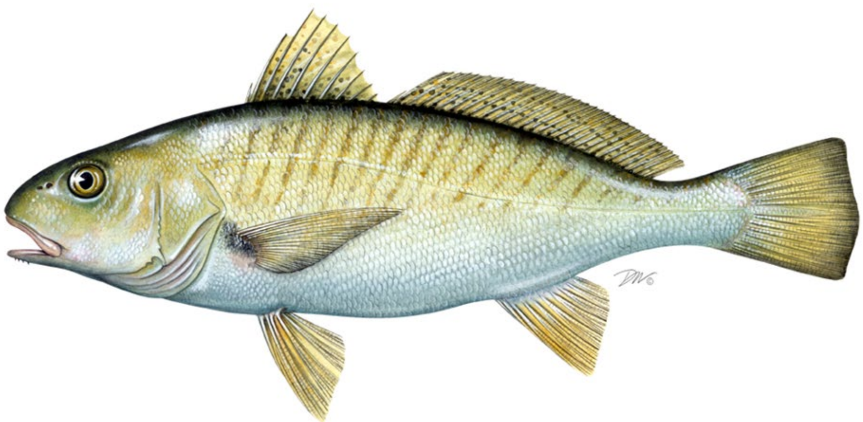
Atlantic States Marine Fisheries Commission

Traffic Light Analysis of Atlantic Croaker (*Micropogonias undulatus)*



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1 INTRODUCTION

Atlantic croaker are managed under Amendment 1 to the Interstate Fishery Management Plan for Atlantic Croaker (2005) and Addendum I (2011), Addendum II (2014), and Addendum III (2020). The Amendment does not require any specific measures restricting harvest but encourages states with conservative measures to maintain them. It also implemented a set of management triggers, based on an annual review of certain metrics, to respond to changes in the fishery or resource and initiate a formal stock assessment on an accelerated timeline if necessary. Addendum I revised the management program's biological reference points to assess stock condition on a coastwide basis as recommended by the 2010 stock assessment.

In August 2014, the South Atlantic State/Federal Fisheries Management Board (SAB) approved Addendum II to Amendment I to the Atlantic Croaker Fishery Management Plan (FMP). The Addendum established the Traffic Light Approach (or TLA) to evaluate fisheries trends and develop state-specified management actions (i.e., bag limits, size restrictions, time and area closures, and gear restrictions) when harvest and abundance thresholds are exceeded. Addendum II established the TLA as a precautionary management framework to evaluate fishery trends and develop management actions. Starting in the late 2000s, there were inconsistent signals in the data used to examine the resource. The lack of clear information from the TLA and the assessment made it difficult to provide management advice.

The most recent benchmark stock assessment for Atlantic croaker was completed in 2017 and was not recommended for management use, but did provide more data for further refinement and modification of the existing TLA, as recommended by the Atlantic Croaker Technical Committee (TC). In February of 2020, the SAB approved Addendum III to Amendment I allowing modification of the TLA to use a regional approach as well as establishing management actions to be taken if the TLA triggers were tripped. Addendum III addressed several issues by modifying the TLA to better reflect stock characteristics and identifying achievable management actions based on stock conditions.

The TLA is a statistically-robust way to incorporate multiple data sources (both fishery-independent and -dependent) into a single, easily understood metric for management advice. It is often used for data-limited species, or species that are not assessed on a frequent basis. As such, its serves as an appropriate management tool for Atlantic croaker. The name comes from assigning a color (red, yellow, or green) to categorize relative levels of indicators on the condition of the fish population (abundance metric) or fishery (harvest metric). For example, as harvest or abundance increase relative to their long-term mean, the proportion of green in a given year will increase, and as harvest or abundance decrease, the amount of red in that year becomes more predominant. Under Addendum II, state-specific management action would be initiated when the proportion of red exceeds specified thresholds (30% or 60%), for both harvest and abundance, over three consecutive years. The thresholds were maintained in Addendum III but the trigger mechanism was changed as described below.

Addendum III incorporated the following changes into the TLA:

1. Incorporation of indices from the Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP) and the South Carolina Department of Natural Resources (SCDNR) Trammel Net Survey into the adult composite characteristic index, in addition to the currently used indices from the Northeast Fishery Science Center (NEFSC) Multispecies Bottom Trawl Survey and Southeast Area Monitoring and Assessment Program (SEAMAP).

2. Use of revised adult abundance indices from the surveys mentioned above, in which age-length keys and length composition information are used to estimate the number of adult (age 2+) individuals caught by each survey.

3. Use of regional metrics to characterize the fisheries north and south of the Virginia-North Carolina state border. The ChesMMAP and NEFSC surveys will be used to characterize abundance north of the border, and the SCDNR Trammel Net and SEAMAP surveys will be used to characterize abundance south of the border.

4. Change/establish the reference time period for all surveys to be 2002-2012.

5. Change the triggering mechanism to the following: Management action will be triggered according to the current 30% red and 60% red thresholds if both the adult abundance and harvest thresholds are exceeded in any three of the four terminal years.

Addendum III retained the TC's ability to alter the TLA as needed to best represent trends in Atlantic croaker harvest and abundance, including selection of surveys and methods to analyze and evaluate these data. Such changes may be made without an addendum, but Addendum III was necessary because of the change to the management-triggering mechanism.

This report includes the harvest and abundance composite indices in Section 2 which are the TLAs that trigger management action. Individual TLAs for commercial and recreational harvest by region, which go into the harvest composite, as well as effort and discards of Atlantic croaker in the South Atlantic Shrimp Trawl Fishery are described in Section 4. South Atlantic Shrimp Trawl Fishery data are included as supplementary information to be reviewed by the TC and are not included in harvest composite indices,. TLAs for each fishery-independent index that go into the abundance composite and supplementary information for juvenile indices are described in Section 5. Supplemental information with NEAMAP incorporated into the TLAs is provided in Section 6.

2 TRAFFIC LIGHT ANALYSIS (COMPOSITE INDICES)

2.1 Harvest Composite Index

• The harvest (recreational and commercial landings) composite TLA index for the Mid-Atlantic indicates that the management response trigger would have been tripped for the sixth year in a row at the 30% threshold (Figure 1).

• The mean red proportion for the most recent three year time period (2017-2019) in the Mid-Atlantic was 68.3% with the red proportion being above 60% in 2018 and 2019 which indicates a significant level of concern (Figure 1).

• The harvest composite TLA index for the South Atlantic also triggered in 2019 at the 30% threshold and represented the seventh consecutive year above 30% (Figure 2).

• The mean red proportion in the South Atlantic for 2017-2019 was 46.2% (Figure 2).

• The important trend to point out in both regions is the continuing decline in recreational and commercial landings for Atlantic croaker with increasing red proportions in the TLA.

Figure 1. Annual color proportions for harvest composite TLA of Mid-Atlantic region (NJ-VA) for Atlantic croaker recreational and commercial landings

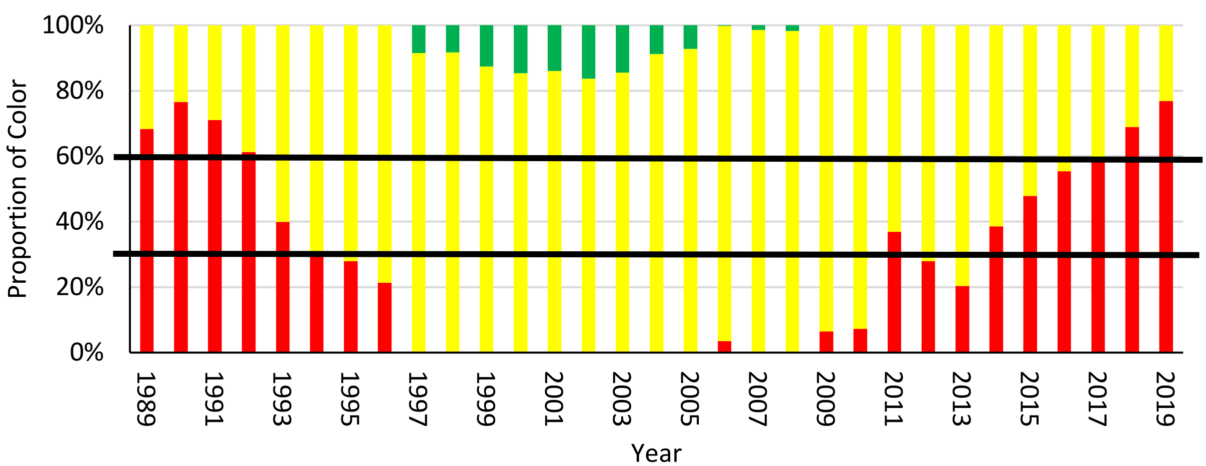
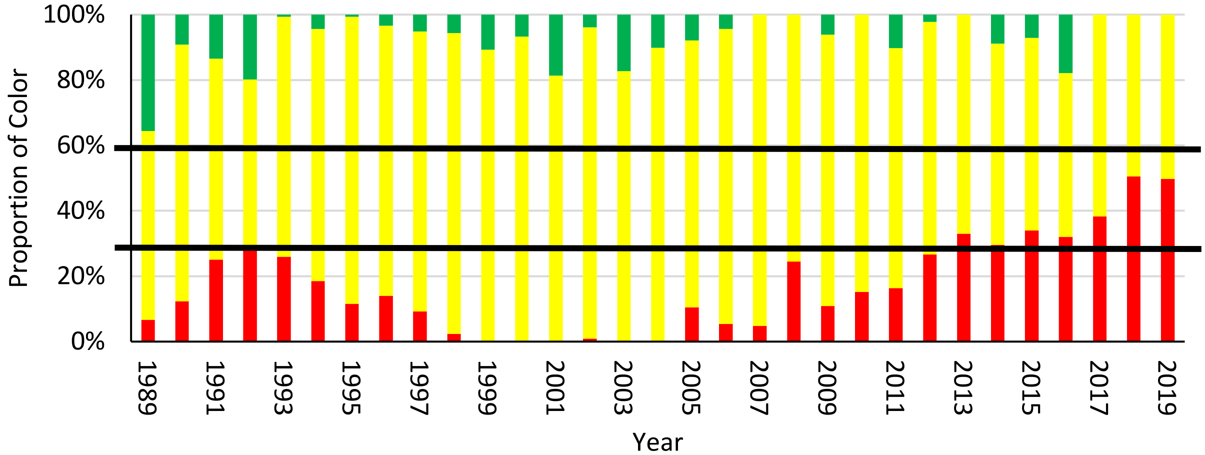


Figure 2. Annual color proportions for harvest composite TLA of South Atlantic region (NC-FL) for Atlantic croaker recreational and commercial landings using a 2002-2012 reference period

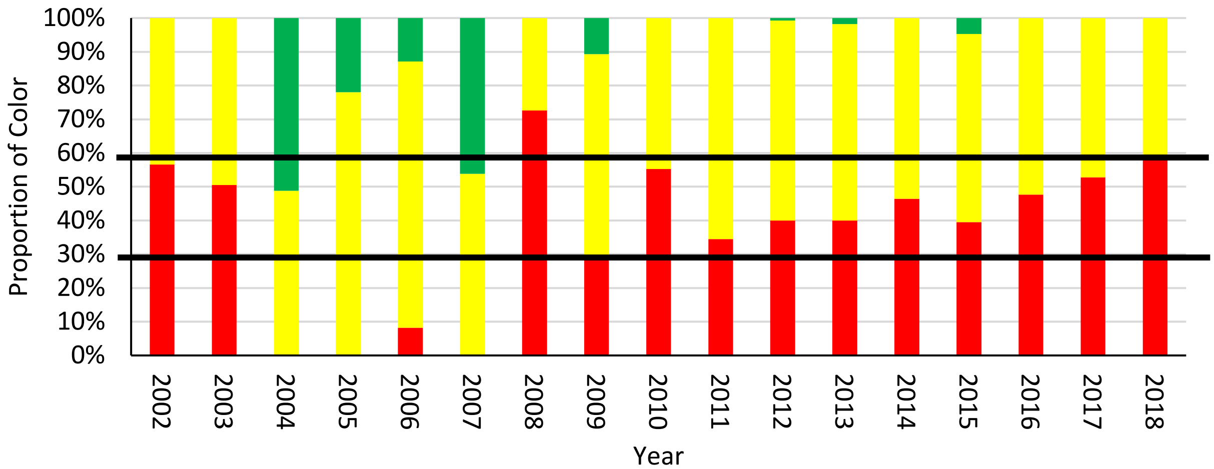


2.2 Abundance Composite Characteristic Indices

The abundance composite TLA index was broken into two components based on age composition in each region. The adult composite index was generated from the NEFSC and ChesMMAP surveys for the Mid-Atlantic and SEAMAP and SCDNR trammel net survey in the South Atlantic. There was not a Mid-Atlantic adult composite TLA in 2019 owing to the lack of an index for ChesMMAP. ChesMMAP should return to use for the 2020 sampling year, with a 2019 index once survey calibrations are complete. One additional survey that is available in the Mid-Atlantic is the North East Area Monitoring and Assessment Program (NEAMAP) which samples from Block Island Sound south to Cape Hatteras. The NEAMAP survey has been considered for use in the TLA but is currently not used due to the shorter time frame (2007-2019) compared to the other surveys. It is anticipated that this survey will come into use with the TLA once it reaches a 15 year sampling time span, which corresponds approximately to the max life span of Atlantic croaker. There is a supplemental section at the end of this report that describes the trends in the NEAMAP survey and gives composite characteristics that include NEAMAP. Only adult abundance will be used to determine if management action is triggered, but the juvenile composites are available as supplementary in section 5.7

- The adult composite TLA characteristic for the Mid-Atlantic (Figure 3) showed a trend of increasing red proportions over the last four years. There was not a 2019 data point for the Mid-Atlantic adult composite, as the ChesMMAP index was not available.
- The composite index has been above the 30% threshold since 2010 (Figure 3).
- The adult composite TLA for the Mid-Atlantic meets the 30% threshold of moderate concern and it did trigger at that level in 2019, as three of the four terminal years exceeded the 30% threshold.

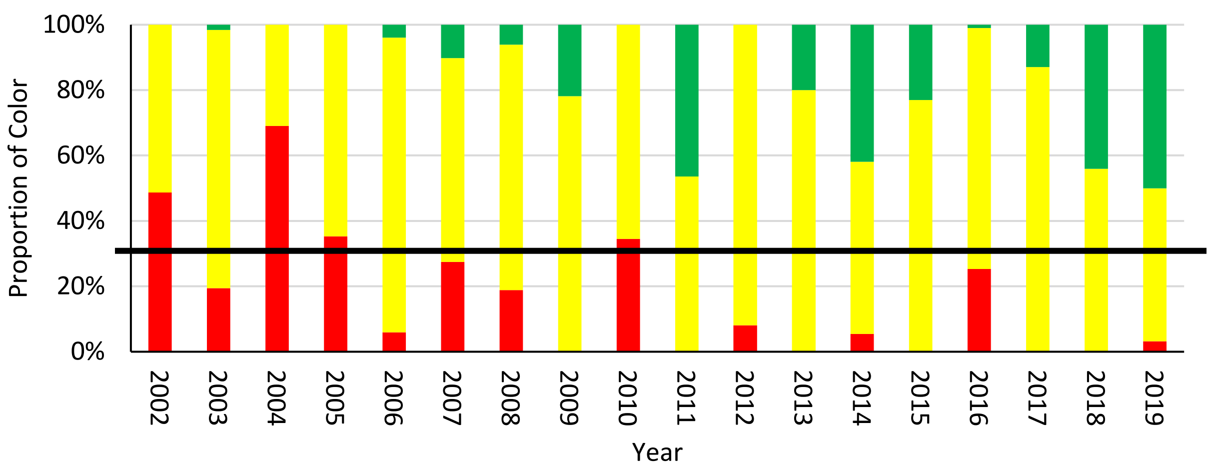
Figure 3. Adult (age 2+) Atlantic croaker TLA composite characteristic index for the Mid-Atlantic (NEFSC and ChesMMAP surveys, no 2019 ChesMMAP value included)



Both the adult abundance and harvest TLA composite characteristics triggered in the Mid-Atlantic at the 30% threshold in 2019. Both the adult abundance and harvest composite showed a continued declining trend which is cause for concern in the Mid-Atlantic region. The continued declining trend in the juvenile composite does not bode well for a positive change in the adult population if recruitment continues to decline (Figure 17).

- The adult composite TLA characteristic for the South Atlantic (Figure 4) showed an increasing trend with a relatively high proportion of green in both 2018 and 2019.
- This index did not trigger any management response in 2019 for the South Atlantic region.

Figure 4. Adult (age 2+) Atlantic croaker TLA composite characteristic index for the South Atlantic (SEAMAP and SCDNR trammel survey)



3 SUMMARY AND MANAGEMENT MEASURES

The harvest composite TLA characteristic triggered in both the Mid-Atlantic and South Atlantic in 2019 at the 30% threshold indicating moderate concern. The continued declining trend in the commercial and recreational harvests for the Atlantic coast is a concern since the decline has become greater in the last two years. 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. An implementation of the management guidelines in Addendum III have been triggered in the Atlantic croaker management unit coastwide due to the Mid-Atlantic region composite harvest and abundance TLAs exceeding the 30% threshold for at least three of the past four years. Based on management guidelines, recreational bag limit regulations of no more than 50 Atlantic croaker per person per day and a reduction in commercial harvest of 1% of the average state commercial harvest from the previous 10 years will be required in non-*de minimis* states.

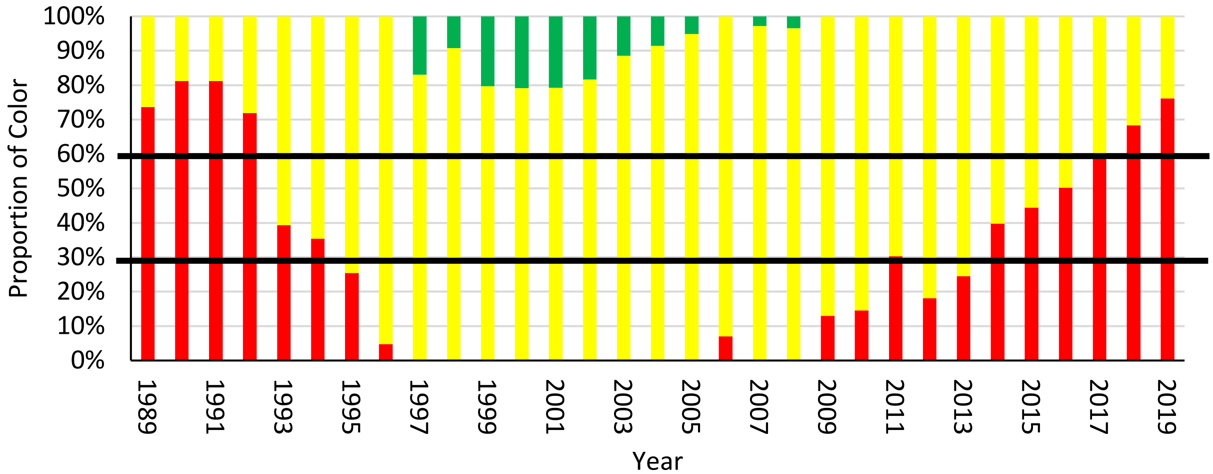
4 TRAFFIC LIGHT ANALYSIS (FISHERY DEPENDENT)

4.1 Commercial Landings

4.1.1 Mid-Atlantic

- Commercial landings in the Mid-Atlantic declined 54.2% in 2019 (385.9 metric tons) from 2018 (1,619 metric tons) and represented the 14th year of decline in commercial croaker landings (Figure 5).
- The TLA for commercial landings has been above the 30% threshold every year since 2014 and 2019 was the 6th year in a row where landings were above the 30% threshold.
- More concerning is that the red proportion has been above the 60% red threshold for the last two years of the series (2018-2019) and was just under 60% in 2017 (59.5%).
- The three year mean red proportion for croaker has exceeded 30% since 2010 and exceeded 60% in 2019. The continued steady decline in croaker landings in recent years represent some of the lowest landings levels in the time series.

Figure 5. Annual TLA color proportions for Atlantic croaker commercial landings for the Mid-Atlantic (NJ-VA) coast of the US



4.1.2 South Atlantic

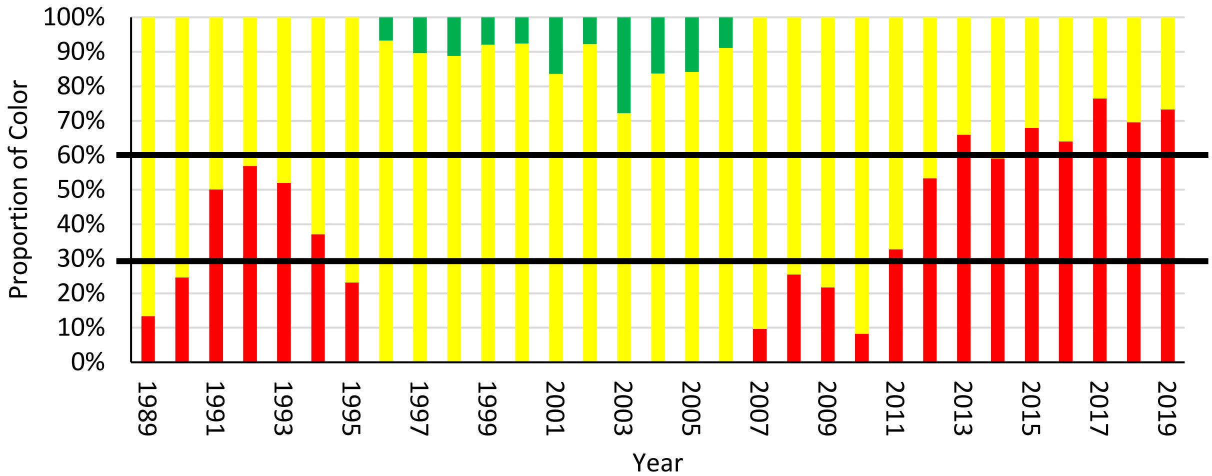
- Commercial landings in the South Atlantic declined 20.4% in 2019 (618.1 metric tons) from 2018 (776.1 metric tons) and represented the 11th year of decline in commercial croaker landings in the South Atlantic (Figure 6).

- The TLA for commercial landings in the South Atlantic has been at or above the 60% threshold every year since 2014 (Figure 6) and 2019 was the 9th year in a row where landings were above the 30% threshold.

- More concerning is that the red proportion has been near or above the 60% red threshold for six of the past seven years of the series (2013-2019) and was only just under 60% in 2014 (59.1%).

- The three year mean red proportion for croaker has exceeded 30% since 2011 and exceeded 60% for the past five years. The continued steady decline in croaker landings in recent years represent some of the lowest landings levels in the time series.

Figure 6. Annual TLA color proportions for Atlantic croaker commercial landings for the South Atlantic (NC-FL) coast of the US

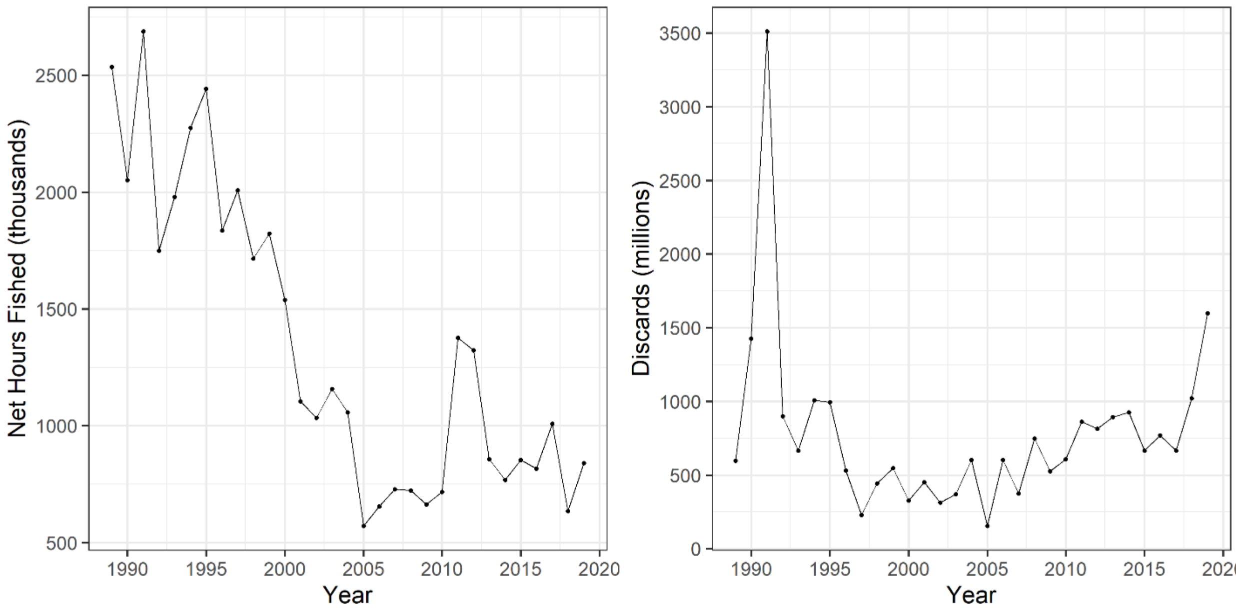


- Total effort (net hours) in the South Atlantic Shrimp Trawl Fishery declined from a time series high in 1991 to a time series low in 2005 and varied around an increasing trend through the remainder of the time series (Figure 7; left).

Total discards of Atlantic croaker in the South Atlantic Shrimp Trawl Fishery were high during the late 1980s and early 1990s, declined to relatively low levels in the early to mid-2000s, and then increased to levels similar to the beginning of the time series during the 2010s (Figure 7; right). Discards during the final two years of the time series were the highest since 1991 and included the second highest number of the time series in 2019. Increases are primarily being driven by increasing CPUE from SEAMAP and observer program (Figure A2). CPUE for the shrimp observer program and SEAMAP have been steadily increasing since 2007, though effort generally has been increasing since this time as well (Figure 7). Even though increased discards equate to more removals from the fishery, the increase in discards could be an indicator of higher abundance of juveniles in the region.

- For additional information on the South Atlantic Shrimp Trawl Fishery, please see Appendix 1.

Figure 7. Total net hours fished (left) and discards of Atlantic croaker (right) in the South Atlantic Shrimp Trawl Fishery.



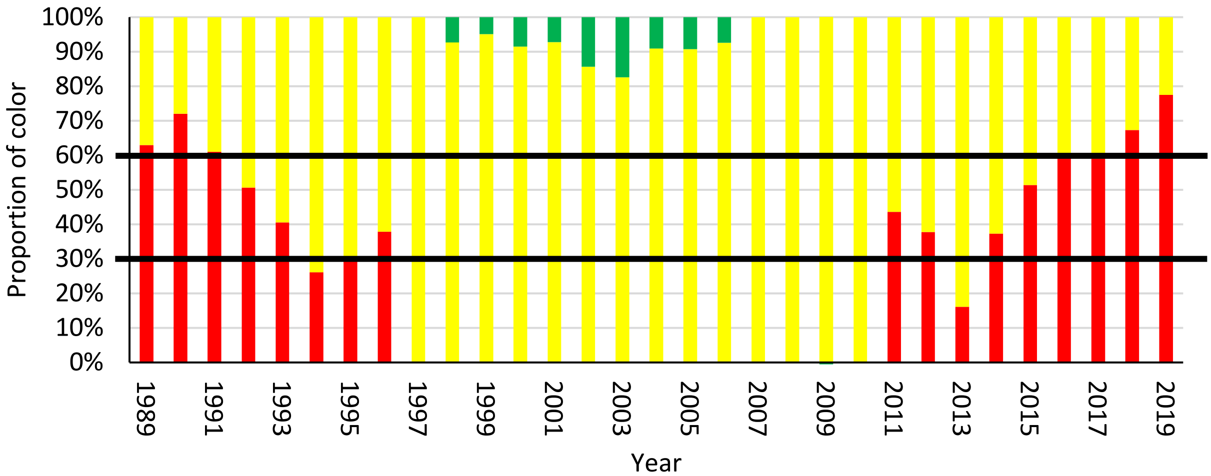
4.2 Recreational Harvest

In July 2018, the Marine Recreational Information Program transitioned from the catch estimates based on effort information from the Coastal Household Telephone Survey (CHTS) to effort information from the mail-based Fishing Effort Survey (FES). FES estimates are used in this and future reports, so recreational estimates and analyses may be different from previous years that used CHTS estimates.

4.2.1 Mid-Atlantic

- The recreational harvest index continued to decline in 2019, down 58% (468.2 metric tons) from 2018 (1,113.6 metric tons).
- The recreational harvest level in 2019 was the lowest annual harvest in the entire time series (1981-2019) for the Mid-Atlantic.
- The proportion of red in the TLA was 77.5% in 2019 increasing from 64.1% in 2018 (Figure 8), indicating the recreational index has exceed the 30% threshold level for the last six years (Figure 8).
- As with commercial landings, the continued decline in harvest levels for Atlantic croaker in the recreational fishery are cause for concern.

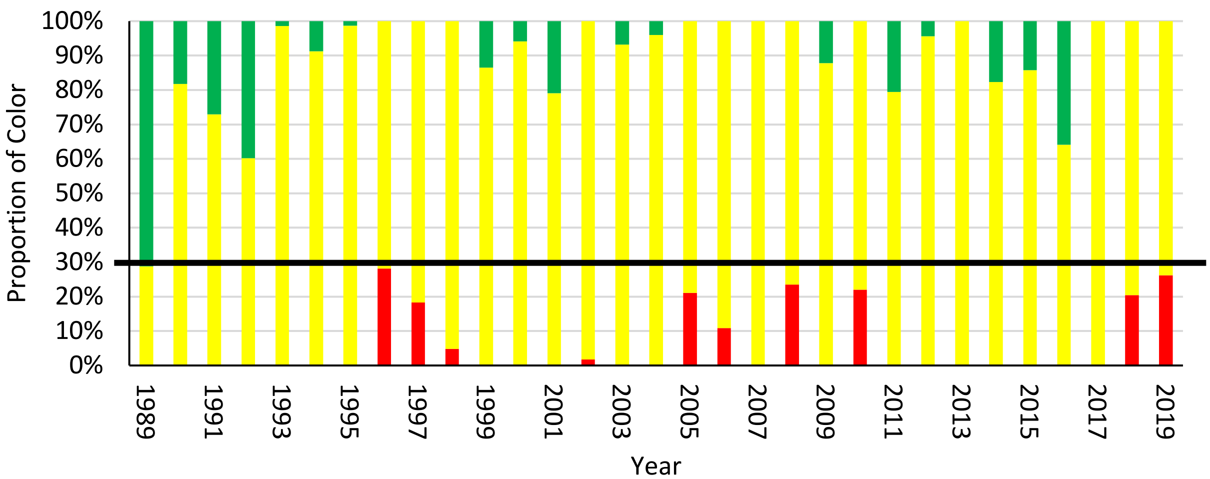
Figure 8. Annual TLA color proportions for Atlantic croaker from the Mid-Atlantic (NJ-VA) coast recreational harvest of the U.S. based on a 2002-2012 reference period



4.2.2 South Atlantic

- The recreational harvest index for the South Atlantic declined 9.3% in 2019 to 429.5 metric tons from 473.4 metric tons in 2018.
- While recreational landings in the South Atlantic have declined over the past two years, red proportion levels have remained below the 30% threshold (Figure 9).

Figure 9. Annual TLA color proportions for Atlantic croaker for the South Atlantic (NC-FL) recreational harvest of the U.S. based on a 2002-2012 reference period

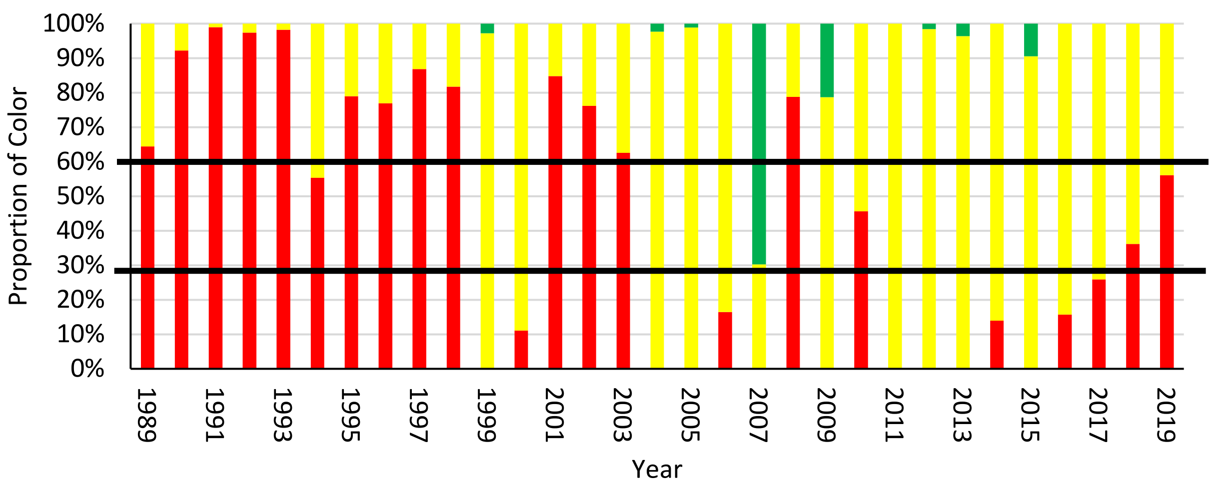


5 TRAFFIC LIGHT ANALYSIS (FISHERY-INDEPENDENT SURVEYS)

5.1 NEFSC Fall Groundfish Survey

- The index value for 2019 was 269.8.0 fish per tow and represented a 31.5% decrease from 2018 (394.0 fish per tow).
- The NEFSC was not carried out in 2017 due to mechanical problems with the RV Bigelow. An imputed index for 2017 was calculated as the mean of 2015-2016 and 2018 (Figure 10).
- The index has been below the long term mean (452.7 fish per tow) for the past four years.
- The general trend for the index has been declining since the series peak in 2007.
- The red proportion of the TLA has exceeded the 30% threshold for the last two years with the 3 year red proportion average being 39.4%.

Figure 10. Annual TLA color proportions for adult Atlantic croaker from the Mid-Atlantic NEFSC ground-fish trawl survey based on 2002-2012 reference period



5.2 ChesMMAP Survey

- The ChesMMAP survey made major changes to the survey in 2019 (vessel change, gear change, altered protocols, etc.) but maintained the same sampling strata and design. Side-by-side comparison tows were made between the new and old vessels/gears and the survey is in the process of producing conversion factors by species so that historic survey index values can be compared to ongoing survey values in the future. Since the conversion factor determination won't likely be finished until the end of 2020, the ChesMMAP index is only available through 2018 for the adult and juvenile TLA composite characteristics.
- The overall declining trend in catch of Atlantic croaker was evident in both the adult (age 2+) and juvenile (ages 0-1) indices, although the adult index was higher than the juvenile

index in the early years of the survey (Figure 11 and Figure 12). The series peak for juveniles occurred in 2007 and the series peak for adults occurred in 2004. Since 2008 abundances for both age groups have remained relatively low.

• The TLA reflected these trends with high proportions of red since 2008 (Figure 11 and Figure 12).

• Proportionately, the decline was slightly greater for juveniles than for adults in recent years.

Figure 11. Mid-Atlantic ChesMMAP survey annual TLA color proportions for juvenile Atlantic croaker ages 0-1 using a 2002-2012 reference period

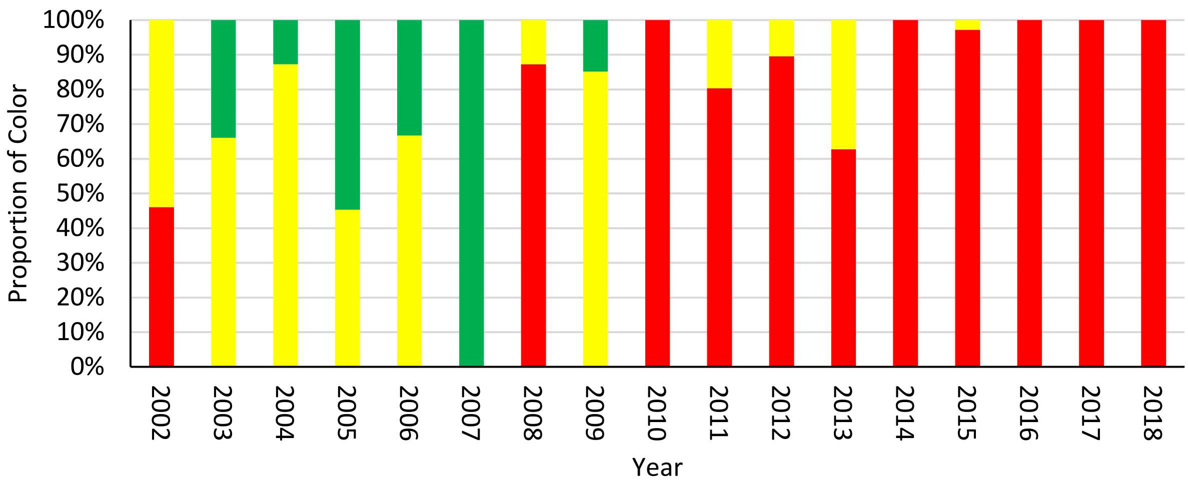
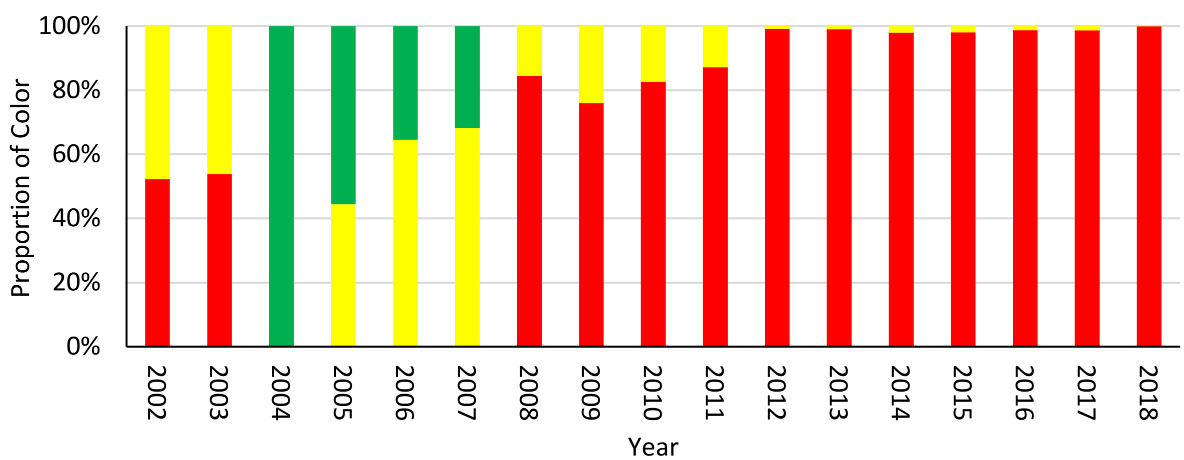


Figure 12. Mid-Atlantic ChesMMAP survey annual TLA color proportions for adult Atlantic croaker ages 2+ using a 2002-2012 reference period



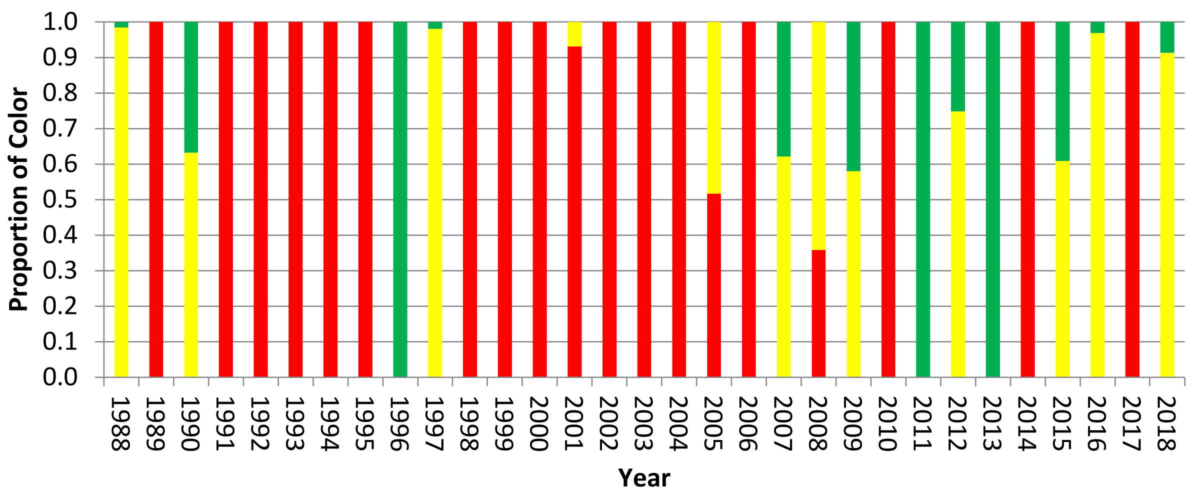
5.3 VIMS Survey

• The inability to do field work in June of 2020 due to work restrictions from the COVID-19 pandemic resulted in no juvenile VIMS index for 2019. The VIMS juvenile trawl survey uses the relative catch levels of 1-year-old juvenile croaker as the proxy for the previous year's recruitment index. The results from the 2018 report were left in this report as a placeholder. The VIMS index was not used in the trigger mechanism but is included in the composite indices in this report in Section 5.7.

• The VIMS index increased significantly (2447%) in 2018 from 2017 going from 0.614 fish per tow in 2017 to 15.64 fish per tow in 2018. High variability in the TLA color proportions was likely due to annual recruitment variations, which would not be uncommon for a juvenile index (Figure 13).

• The index value was above the long term mean in 2018 with a red proportion of 6.8%.

Figure 13. Annual TLA color proportions for juvenile Atlantic croaker ages 0-1 from Mid-Atlantic VIMS spring trawl survey using 2002-2012 reference period



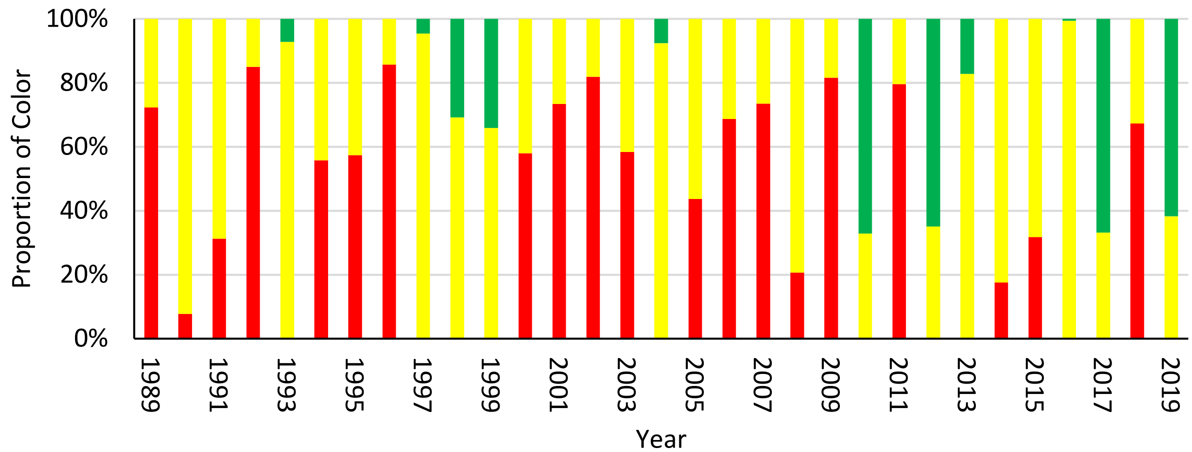
5.4 SEAMAP Survey

• The SEAMAP spring season survey index used was for the spring season when more adult Atlantic croaker (ages 2+) are captured than in the fall season.

• The SEAMAP index increased 12.7% in 2019 (34.7 kg/tow) from 2018 (30.7 kg/tow).

• Index values have remained above the long term mean since 2011 so there was no red in the TLA for 2019 (Figure 14).

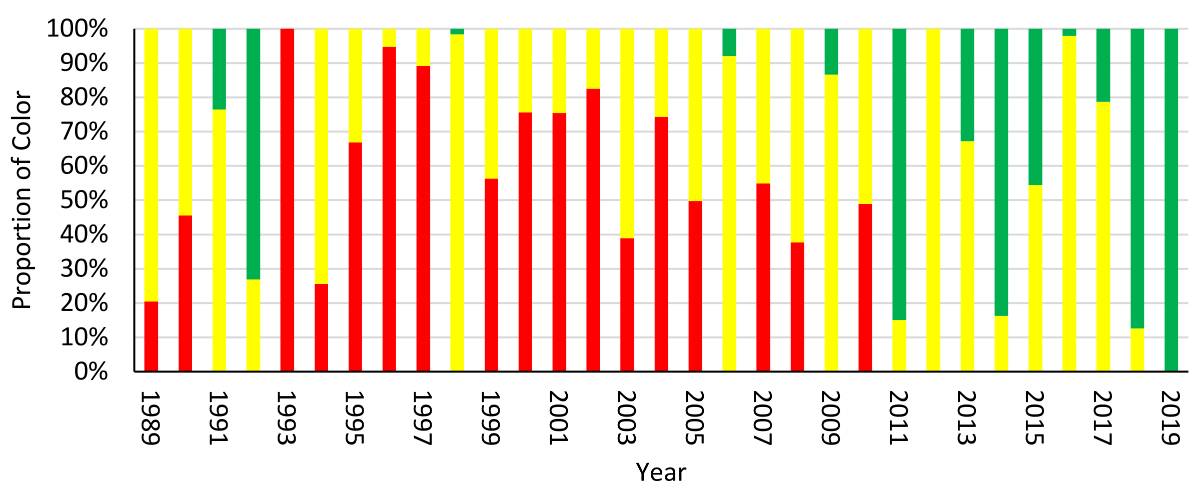
Figure 14. Traffic Light Analysis for South Atlantic SEAMAP catch data by weight in spring for Adult Atlantic croaker using a 2002-2012 reference period



5.5 North Carolina Program 195

- The North Carolina index increased significantly in 2019 (88.1%) to 1,110.8 fish/tow (versus 136.7 fish/tow in 2018) and was well above the long term mean (290.3 fish per tow) resulting in a green proportion of 1.0 in the TLA (Figure 15).
- The increase in CPUE and resulting high green proportion was likely due to a very strong year-class for Atlantic croaker in 2019 in North Carolina.

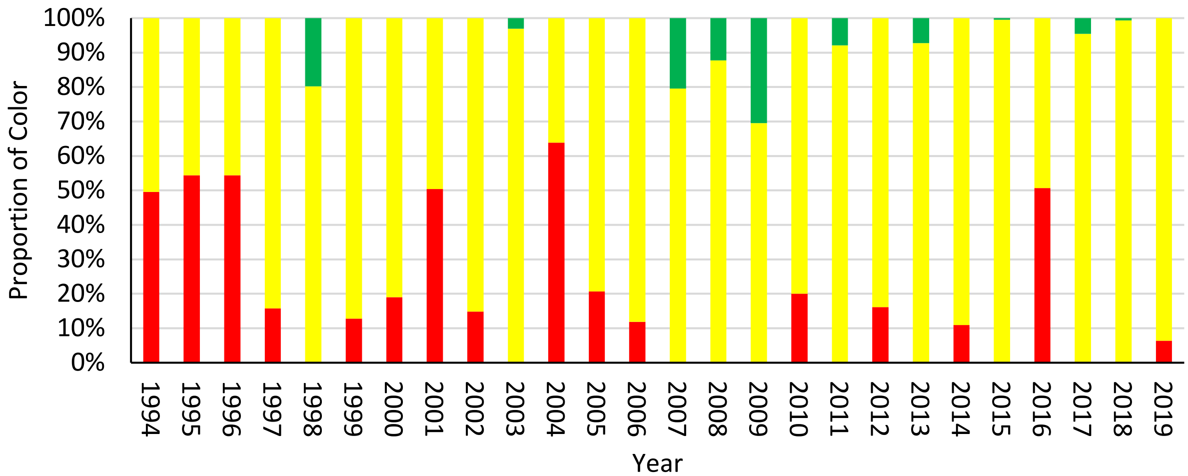
Figure 15. South Atlantic NCDMF Program 195 TLA color proportions for juvenile Atlantic croaker using 2002-2012 reference period



5.6 SCDNR Trammel Net Survey

- The SCDNR trammel index declined 12.7% in 2019 (1.35 fish per set) compared to 2018 (1.54 fish per set). Annual CPUE has been variably above and below the long term mean (1.34 fish per set) since 2009, indicated by annual alterations between red and green proportions in the TLA (Figure 16).
- The 2019 index value was only just below the long term mean.

Figure 16. South Atlantic SCDNR trammel net survey TLA color proportions for adult Atlantic croaker using a 2002-2012 reference period.



5.7 Juvenile Abundance Composites by Region

The juvenile composite index in the Mid-Atlantic was generated from the ChesMMAP and VIMS surveys because VIMS is a juvenile survey and ChesMMAP has an age specific index for ages 0-1. There was not a Mid-Atlantic juvenile composite TLA in 2019 owing to the lack of indices for both ChesMMAP and VIMS. Both of these indices should return to use for the 2020 sampling year, with a 2019 index for ChesMMAP but not VIMS. The advisory juvenile composite characteristic was above the 60% threshold in the Mid-Atlantic, but not in the South Atlantic.

- The juvenile composite TLA characteristic (Figure 17) in 2018 was above the 60% red threshold using ChesMMAP and VIMS for the third year. The Mid-Atlantic juvenile composite exceeded the 60% level of concern in 2019 regardless of whether index values had been available since it exceeded the threshold in three of the previous four years.
- The high red proportions in recent years are indicative of continued poor Atlantic croaker recruitment in the Mid-Atlantic region.
- The juvenile index for the South Atlantic TLA has been below the 30% red threshold, and uses only the NC Program 195 index (Figure 18).

Figure 17. Juvenile croaker (ages 0-1) TLA composite characteristic index for the Mid-Atlantic (ChesMMAP and VIMS through 2018)

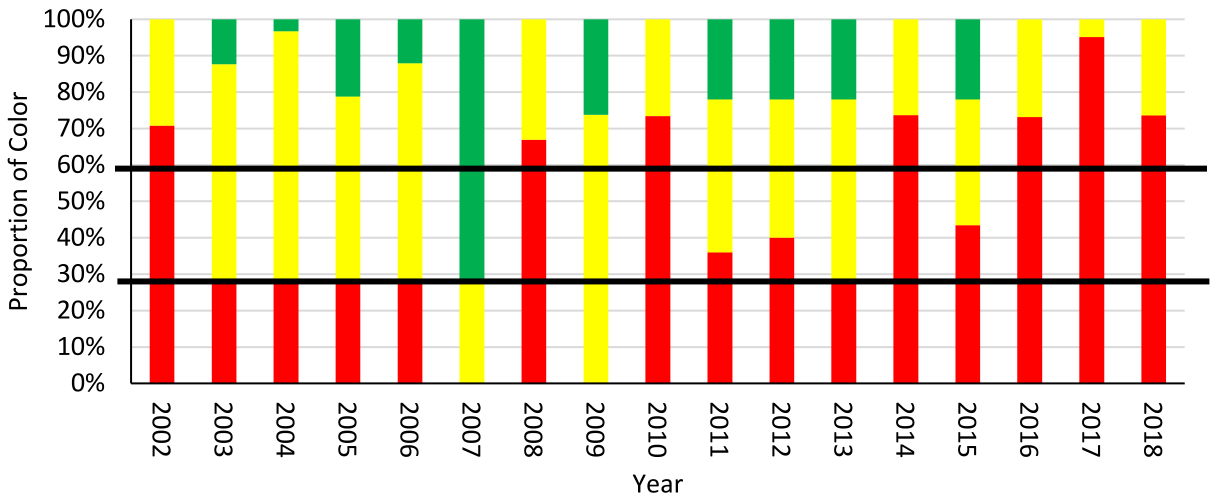
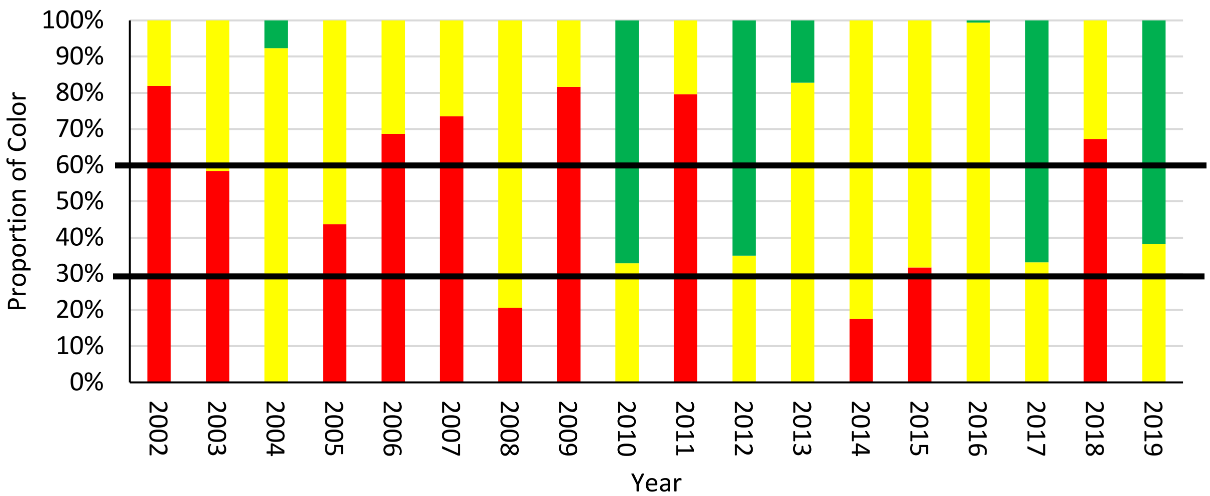


Figure 18. Juvenile (ages 0-1) Atlantic croaker composite characteristic index for the South Atlantic (NC Program 195)



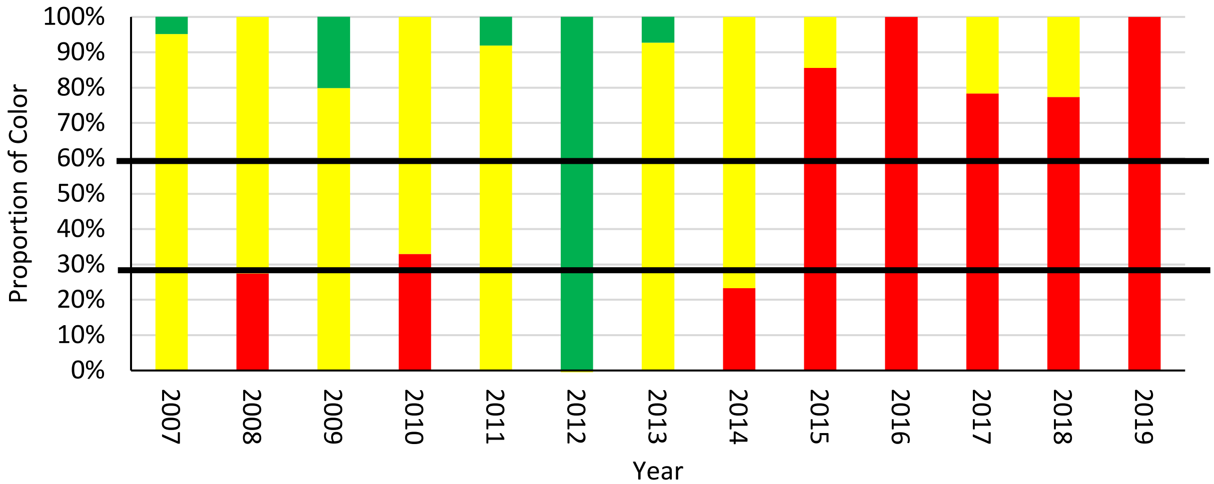
6 SUPPLEMENTAL MATERIAL

6.1 NEAMAP Survey

• Juvenile recruitment has been on a declining trend since 2012 as indicated by high red proportions above the 60% threshold for the last five years (Figure 19).

• This corresponds well with the decline seen in the ChesMMAP survey for juveniles in recent years as well.

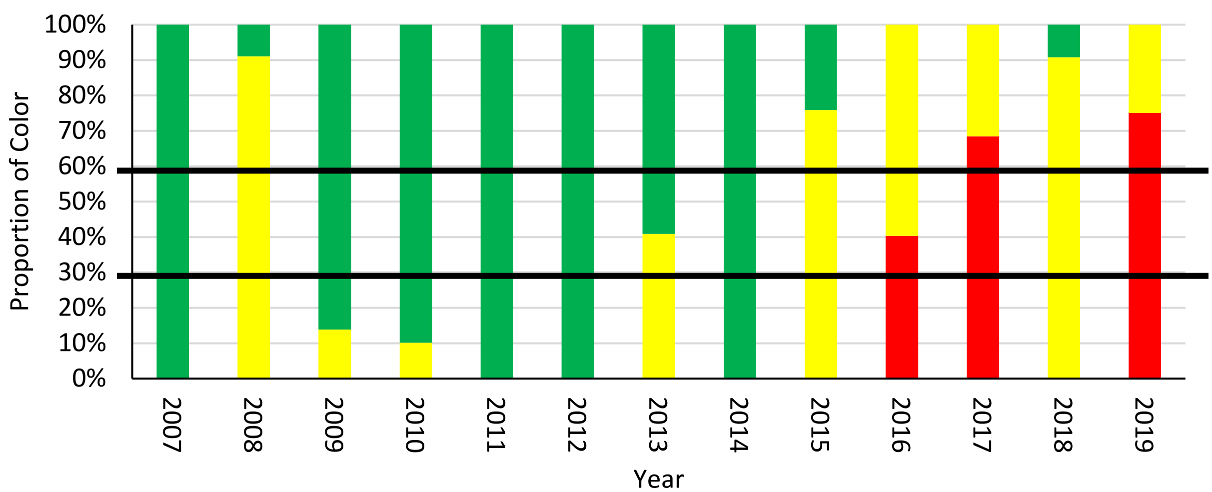
Figure 19. Juvenile (ages 0-1) TLA color proportions for Atlantic croaker from NEAMAP survey using a 2007-2019 reference period



• The adult Atlantic croaker index for NEAMAP also showed a declining pattern in recent years (Figure 20), although not as much of decline as that seen in the juvenile fish.

• The NEAMAP survey adult TLA had red proportions above the 30% threshold for three of the four previous years (Figure 20). Red proportions in 2017 and 2019 exceeded the 60% threshold as well.

Figure 20. Adult (ages 2+) TLA color proportions for Atlantic croaker from the NEAMAP survey using a 2007-2019 reference period



6.2 Composite TLA Characteristic for Mid-Atlantic including NEAMAP

In order to generate the composite TLA index that included NEAMAP in the Mid-Atlantic, the other Mid-Atlantic indices (NEFSC, ChesMMAP, VIMS) had to be recalculated using the common time period of all three surveys (2007-2019) in order to have a common reference.

- The addition of NEAMAP to the Mid-Atlantic TLA composite characteristic for juvenile Atlantic croaker showed the same general trend of declining recruitment and high levels (> 60%) of red in recent years (Figure 21). While the composite only went through 2018 in order to correspond to data available from the ChesMMAP and VIMS surveys, red proportions were still above 60% for just the NEAMAP survey (Figure 21).
- The adult Atlantic croaker composite characteristic for the Mid-Atlantic with NEAMAP included also showed increasing proportions of red and would have triggered in 2019 at the 30% threshold (0).

Figure 21. Juvenile Atlantic croaker (ages 0-1) TLA composite characteristic index for the Mid-Atlantic through 2018 using NEAMAP, ChesMMAP, and VIMS with a 2007-2018 reference period

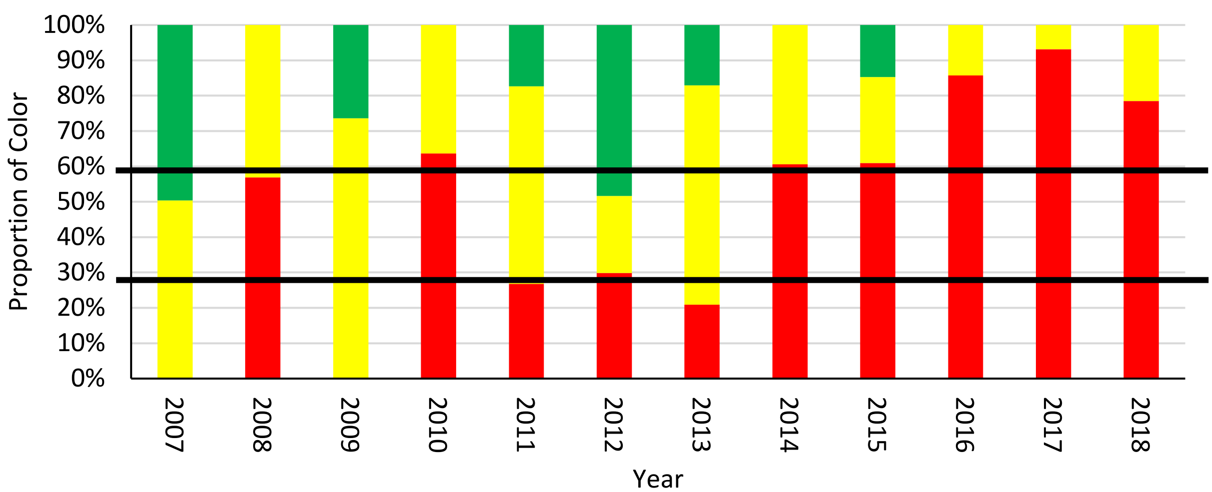
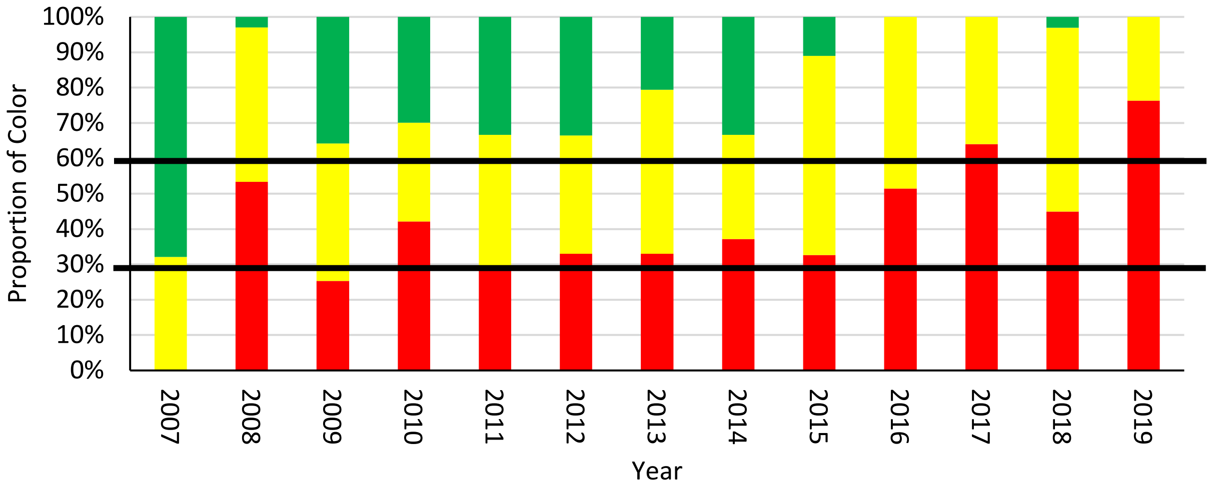


Figure 22. Adult Atlantic croaker (ages 2+) TLA composite characteristic index for the Mid-Atlantic (NJ-VA) through 2018 using NEFSC, NEAMAP and ChesMMAP with a 2007-2019 reference period



The addition of the NEAMAP survey to the Mid-Atlantic composite characteristics supports trends seen with the other indices used in the composite characteristic. The only limitation on the NEAMAP survey is a more limited time frame compared to the other surveys. The NEAMAP survey may be added to the TLA data sets after either the next benchmark assessment for Atlantic croaker (currently scheduled for completion in 2024) or after it has 15 years or more of index values.

Appendix

Shrimp Trawl Discard Estimates

Estimates of Atlantic croaker discards in South Atlantic shrimp trawl fisheries were developed following the methods of Walter and Isley (2014) and Zhang and Walter (2020). Discard rate data from the Southeast Shrimp Trawl Observer Program were used to estimate the magnitude and trend of discard rates and discard rate data from the Southeast Area Monitoring and Assessment Program (SEAMAP) Trawl Survey were used to supplement the observer program data for estimating the trend of discard rates. Total effort data from the South Atlantic Shrimp System (SASS) and state trip ticket programs were used to extrapolate estimated discard rates to the scale of the fishery to estimate total discards.

Discard Rate Data Sets

Southeast Shrimp Trawl Observer Program

A voluntary shrimp trawl bycatch observer program was implemented in the South Atlantic (NC-FL) through a cooperative agreement between NOAA Fisheries, the Gulf and South Atlantic Fishery Management Councils, and the Gulf and South Atlantic Fisheries Foundation, Inc. to characterize catch and bycatch, as well as evaluate bycatch reduction devices (BRDs). Total catch, total shrimp catch, and a subsample (one basket per net, or approximately 32 kg) for species composition is taken from each observed net. Beginning in 2008, the program became mandatory in the South Atlantic and NOAA Fisheries-approved observers were placed on randomly selected shrimp vessels. The voluntary component of the observer program also continued. Penaeid shrimp (primarily inshore) and rock shrimp (primarily offshore) fisheries in the South Atlantic are covered by the observer program. Observed coverage is allocated by previous effort, or shrimp landings when effort data are not available. Based on nominal industry sea days, observer coverage of South Atlantic shrimp trawl fisheries ranged from 0.2-1.4% and totaled 0.9% from 2007-2010 (see Scott-Denton (2012) Table 1). Number of observed tows are in Table 1. See Scott-Denton (2007) for more details on the voluntary component of the Shrimp Trawl Observer Program and Scott-Denton et al. (2012) for more details on the mandatory Shrimp Trawl Observer Program.

Biological information, such as length and weight of bycatch species, was collected from the subsample of total catch in observed nets. Very limited biological sampling has been conducted for Atlantic croaker. Only 1,343 Atlantic croaker were measured for length, caught from just thirty six tows on two trips occurring from October to November in 2003. Lengths ranged from 10 to 29 cm TL (Figure 1). No Atlantic croaker age samples have been collected.

Atlantic croaker is typically one of the most prevalent bycatch species, often outweighing and/or outnumbering individual shrimp of all species (see Scott-Denton (2007) Figure 9, Figure 11, Table A2 and Scott-Denton (2012) Table 9, Table 11, Table 12, Figure 6).

SEAMAP Trawl Survey
The SEAMAP - South Atlantic (SEAMAP-SA) Coastal Survey (previously known as the Shallow Water Trawl Survey) began in 1986 and is conducted by the South Carolina Department of Natural Resources (SCDNR) Marine Resources Division (MRD). This survey has provided long-term, fisheries-independent data characterizing the seasonal abundance and biomass of all finfish, elasmobranchs, decapod and stomatopod crustaceans, sea turtles, horseshoe crabs, and cephalopods that are accessible by high-rise trawls. The sampling area extends from the coastal zone of the South Atlantic Bight (SAB) between Cape Hatteras, North Carolina, and Cape Canaveral, Florida (SEAMAP-South Atlantic Committee 2005). The survey uses a stratified random design, where strata are delineated by the 4-m depth contour inshore and the 10-m depth contour off shore. A total of 102 stations are sampled each season within 24 shallow water strata. The R/V Lady Lisa, a 23-m wooden-hulled, double-rigged, St. Augustine shrimp trawler owned and operated by the SCDNR, is used to tow paired 22.9-m mongoose-type Falcon trawl nets, without turtle excluder devices (TEDs). The body of the trawl is constructed of #15 twine with 47.6-mm stretch mesh. The cod end of the net is constructed of #30 twine with 41.3-mm stretch mesh and is protected by chafing gear of #84 twine with 10-cm stretch "scallop" mesh. A 91.4-m three-lead bridle is attached to each of a pair of wooden chain doors, which measure 3.0 m × 1.0 m and to a tongue centered on the headrope. The 26.3-m headrope, excluding the tongue, has one large (60 cm) Norwegian "polyball" float attached top center of the net between the end of the tongue and the tongue bridle cable and two 22.3-cm PVC foam floats located one-quarter of the distance from each end of the net webbing. A 1-ft chain drop-back is used to attach the 89-ft footrope to the trawl door. A 0.6-cm tickler chain, which is 0.9 m shorter than the combined length of the footrope and drop-back, is connected to the door alongside the footrope. Trawls are towed for twenty minutes, excluding wire-out and haul-back time, exclusively during daylight hours (1 hour after sunrise to 1 hour before sunset). Each net is processed separately and assigned a unique collection number. Multi-legged cruises are conducted in the spring (April–May), summer (July), and fall (October).

After each tow, the contents of each net are sorted to species or genus, and the total biomass and number of individuals are recorded for all species of finfish, elasmobranchs, decapod and stomatopod crustaceans, cephalopods, sea turtles, xiphosurans, and cannonball jellies. Where a large number of individuals of a species occur in a tow, the entire catch is sorted and all individuals of that species are weighed; a random subsample is processed and the total number is estimated. For large trawl catches, the contents of each net are weighed prior to sorting and a randomly chosen subsample of the total catch is then sorted and processed. In every collection, each of the majority of priority species is weighed collectively and individuals were measured to the nearest centimeter. When a large number of individuals of any of the priority species are collected in a tow, a random subsample consisting of 30 to 50 individuals is weighed and measured

Modeled Discard Rates
Only discarded Atlantic croaker are recorded by shrimp trawl observers, so no adjustments were needed to account for fish landed. Observer data were subset to exclude operation codes X, M, H, and J (Appendix 1a). Observations with all other operation codes were included under

the assumption that these observations are representative of effort in the shrimp trawl fisheries.
Trends in catch rates (number of fish/hour fished) of the SEAMAP Trawl Survey and the Shrimp Trawl Observer Program are in Figure 2 and generally track well during overlapping years. Spatial coverage of both surveys overlap throughout most of the sampled ranges.

Discard rates in numbers of Atlantic croaker were modeled with the delta-lognormal method (Lo et al. 1992). The delta lognormal method combines a lognormal generalized linear model (GLM) used to predict discard rates of positive observations and a binomial GLM to predict the probability of a positive observation, with effort as an offset variable. The final discard rate is the product of the response variables from these two models. A negative binomial GLM was also applied to the data to estimate discard rates, but did not converge with full or reduced model structures. Factors considered in the models were year, data set, depth zone, state, and season. Data sets included observer data from the rock shrimp (observer project types W, X, Y) and penaeid shrimp (observer project types A, C) commercial fisheries and fishery-independent data from SEAMAP tows. Depth zones were less than or equal to 10 meters (=<10m), greater than 10 meters to 30 meters (10-30m), and greater than 30 meters (>30m). All SEAMAP tows were conducted in the shallowest depth zone. State borders were defined by the latitudes used by Scott-Denton et al. (2012). Seasons were December through March (offseason) and April through November (peak season). The seasons were defined to align with shrimp fishing relative to operation in nearshore waters throughout the time series. Shrimp fishing in nearshore waters where catch rates are expected to increase has generally started as early as April and lasted through November. Discard rate data by factor are summarized in Table 2.

Model structure was evaluated with stepwise deletion of factors and the model with the lowest AIC was selected as the final model. Final model summaries are in Tables 3-4. All factors were retained in the final models (Table 5).

Shrimp Trawl Effort Data

Detailed catch and effort statistics from individual commercial shrimp fishing trips were collected and processed by a cooperative effort between the South Atlantic states and, beginning in 1982, the NOAA Fisheries Southeast Fisheries Science Center (SEFSC). Early trip data starting in 1978 were collected through the South Atlantic Shrimp System (SASS), while more recent data were collected through individual state trip ticket programs. Trip ticket data are available from FL since 1986, GA since 2001, SC since 2004, and NC since 1994. Trip counts and total hours fished were provided by the SEFSC by state, year, month, and gear following the methods described in Gloeckner (2014). There was a gap in 1993 in NC when data were not available from either a trip ticket program or the SASS. The number of monthly trips in NC in 1993 were estimated as the average of the two adjacent years (1992, 1994). Discard rates are estimated on an hourly basis by individual net, so there is the need for hours and number of nets fished per trip to extrapolate the discard rates to total effort. Average hours fished per trip by state and year were used from Walter and Isley (2014) and updated for years 2011-2019 from shrimp effort data provided by the SEFSC. Average number of nets fished per tow by state and year were used from Zhang and Walter (2020) for 2011 and later. Averages from 2016-

2017 were used for 2018-2019. Total effort was calculated as the product of total number of trips, average hours fished per trip, and average number of nets fished per tow. Effort is summarized by month in Figure 3. As effort was only available by state, year, and month, some assumptions were made to partition the effort among depth zones and fisheries. The proportions of observations from the observer data by depth zone were applied to overall effort, assuming that the observer data are representative of fishing effort at depth and that fishing effort at depth is static over time. The proportions of observations in each depth zone allocated to penaeid and rock shrimp fisheries were applied to the effort data in the respective depth zone. Proportions used to partition effort are in Table 6.

Total Discard Estimates

Discard rates were applied to effort data summarized by "strata" (i.e., combination of factors included in the discard rate models). BRDs were required in federal penaeid shrimp fisheries in 1996 under Amendment 2 to the Shrimp FMP for the South Atlantic Region (1995) and federal rock shrimp fisheries in 2005 under Amendment 6 to the Shrimp FMP (2004). State BRD regulations generally fit these time frames. There were no observer data before BRDs were required in the penaeid shrimp fishery, so discard estimates for penaeid shrimp trawl effort prior to 1997 were adjusted for the reduction in catch due to the required use of certified BRDs on observed tows. Adjustments were based on a weighted average of Atlantic croaker catch reductions in the Gulf of Mexico shrimp trawl fishery estimated depending on the distance of fisheye BRDs from tie-off rings (Helies et al. 2009). 99.6% of observer trips used fisheye BRDs. BRDs in the observed trips ranged from 6 to 21 feet from tie-off rings. Catch reduction estimates were available for BRDs <9 feet (69.7% reduction), 9-10 feet (0% reduction), and 10-11 feet (17.2% reduction) from the tie off rings. There was no estimated reduction for fisheye BRDs greater than 11 feet from the tie-off rings, so the estimate for the 10-11 foot category was used for the proportion of nets greater than 11 feet from the tie-off rings. The proportion of observed trips that fell into the categories of <9 feet, 9-10 feet, 10-11 feet, and >11 feet were 0.26, 0.26, 0.29, and 0.19, respectively. The weighted average adjustment was 0.26 (i.e., adjusted discard = discard*1/(1-adjustment)). Observed trips were assumed representative of BRDs used in the fisheries.

Final discard estimates with 95% confidence intervals are in Table 7 and Figure 4. Discards were high during the late 1980s and early 1990s, declined to relatively low levels in the early to mid-2000s, and then increased to levels similar to the beginning of the time series during the 2010s. The increase in recent years appears to be driven primarily by increasing catch rates (Figure 5).

Shrimp Trawl Discard Mortality Rate

A study by Johnson (2003) determined the immediate (15–30 minutes) survival of discards onboard estuarine commercial shrimp trawlers. His results showed that the survival of Atlantic croaker decreased as time on deck increased—from 40% survival for Atlantic croaker that were on deck less than 20 minutes to 8% survival for Atlantic croaker that were on deck longer than 20 minutes. This study does not take into account mortality due to tow time or mortality and increased vulnerability to predation post discarding. Duration of observed tows from the

Shrimp Trawl Observer Program ranged from twelve minutes to just under nine hours with a median of three hours.

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Tables

Table 1. Number of tows observed by the Southeast Shrimp Trawl Observer Program by South Atlantic fishery and year.

Year	Fishery	
	Penaeid Shrimp	Rock Shrimp
2001	30	23
2002	34	146
2003	0	177
2005	158	0
2006	0	22
2007	135	0
2008	239	111
2009	458	19
2010	187	60
2011	320	0
2012	377	0
2013	308	96
2014	174	39
2015	279	51
2016	417	73
2017	389	46
2018	401	11
2019	195	32

Table 2. Number of observations, number of positive observations, proportion positive observations, and mean CPUE (number) of Atlantic croaker by factor level considered in the model.

season	N	N_pos	prop_pos	mean_CPUE
off	496	377	0.760	112.557
peak	21,565	13,167	0.611	578.118
depth_zone	**N**	**N_pos**	**prop_pos**	**mean_CPUE**
=<10m	19,799	12,037	0.608	612.067
>30m	837	188	0.225	5.415
10-30m	1,425	1,319	0.926	280.773
data_set	**N**	**N_pos**	**prop_pos**	**mean_CPUE**
penaeid_shrimp	4,034	3,736	0.926	397.618
rock_shrimp	903	235	0.260	10.820
SEAMAP	17,124	9,573	0.559	637.070
state	**N**	**N_pos**	**prop_pos**	**mean_CPUE**
FL	5,392	3,126	0.580	404.305
GA	4,694	2,443	0.520	184.040
NC	4,684	3,926	0.838	1,389.485
SC	7,291	4,049	0.555	407.448
year	**N**	**N_pos**	**prop_pos**	**mean_CPUE**
1989	318	153	0.481	215.406
1990	462	273	0.591	365.792
1991	466	284	0.609	678.155
1992	468	241	0.515	636.019
1993	468	215	0.459	313.724
1994	468	231	0.494	356.590
1995	468	255	0.545	225.462
1996	468	248	0.530	176.083
1997	468	186	0.397	110.615
1998	468	274	0.585	358.013
1999	468	190	0.406	331.577
2000	468	189	0.404	257.000
2001	664	398	0.599	343.322
2002	789	309	0.392	195.130
2003	789	411	0.521	264.890
2004	612	303	0.495	532.054
2005	769	460	0.598	465.637
2006	634	302	0.476	551.468
2007	742	410	0.553	232.829
2008	962	523	0.544	413.954
2009	1,149	819	0.713	386.804
2010	917	465	0.507	482.719
2011	992	615	0.620	937.164
2012	1,044	796	0.762	648.359
2013	981	771	0.786	851.860
2014	822	586	0.713	1,241.479
2015	985	723	0.734	853.172
2016	1,145	814	0.711	623.013
2017	1,003	745	0.743	585.311
2018	866	746	0.861	997.207
2019	738	609	0.825	1,525.690

Table 3. Lognormal model summary for Atlantic croaker discard rate in numbers.

```
Call:
glm(formula = lncatch ~ YEAR + data_set + depth_zone + state + 
    season, family = gaussian, data = trips_pr_pos, na.action = na.exclude, 
    offset = log_eff)

Deviance Residuals: 
    Min       1Q   Median       3Q      Max  
-6.4859  -1.3385   0.1927   1.3799   5.4632  

Coefficients:
                    Estimate Std. Error t value Pr(>|t|)    
(Intercept)          1.44693    0.20480   7.065 1.68e-12 ***
YEAR1990             1.16800    0.19751   5.914 3.43e-09 ***
YEAR1991             1.79456    0.19620   9.147  < 2e-16 ***
YEAR1992             1.31767    0.20217   6.518 7.39e-11 ***
YEAR1993             0.79071    0.20689   3.822 0.000133 ***
YEAR1994             0.97009    0.20390   4.758 1.98e-06 ***
YEAR1995             0.91807    0.19997   4.591 4.45e-06 ***
YEAR1996             0.63995    0.20102   3.183 0.001459 ** 
YEAR1997             0.20298    0.21347   0.951 0.341673    
YEAR1998             0.99039    0.19737   5.018 5.29e-07 ***
YEAR1999             1.11663    0.21241   5.257 1.49e-07 ***
YEAR2000             0.66588    0.21265   3.131 0.001744 ** 
YEAR2001             1.15676    0.18636   6.207 5.55e-10 ***
YEAR2002             0.75629    0.19511   3.876 0.000107 ***
YEAR2003             0.93729    0.18823   4.979 6.46e-07 ***
YEAR2004             1.47454    0.19413   7.595 3.27e-14 ***
YEAR2005             1.33704    0.18298   7.307 2.88e-13 ***
YEAR2006             1.97396    0.19423  10.163  < 2e-16 ***
YEAR2007             1.15770    0.18578   6.232 4.75e-10 ***
YEAR2008             1.82580    0.18104  10.085  < 2e-16 ***
YEAR2009             1.53955    0.17399   8.848  < 2e-16 ***
YEAR2010             1.81810    0.18312   9.929  < 2e-16 ***
YEAR2011             2.19992    0.17755  12.390  < 2e-16 ***
YEAR2012             1.86266    0.17384  10.715  < 2e-16 ***
YEAR2013             2.16420    0.17407  12.433  < 2e-16 ***
YEAR2014             2.40826    0.17823  13.512  < 2e-16 ***
YEAR2015             1.88773    0.17508  10.782  < 2e-16 ***
YEAR2016             1.98366    0.17385  11.411  < 2e-16 ***
YEAR2017             1.75292    0.17508  10.012  < 2e-16 ***
YEAR2018             2.52178    0.17544  14.374  < 2e-16 ***
YEAR2019             2.87587    0.17778  16.176  < 2e-16 ***
data_setrock_shrimp -0.12184    0.27308  -0.446 0.655473    
data_setSEAMAP       0.61779    0.04834  12.780  < 2e-16 ***
depth_zone>30m      -1.70920    0.30198  -5.660 1.54e-08 ***
depth_zone10-30m     0.34506    0.07959   4.335 1.47e-05 ***
stateGA             -0.65321    0.05777 -11.307  < 2e-16 ***
stateNC              1.36730    0.05401  25.316  < 2e-16 ***
stateSC             -0.02852    0.05370  -0.531 0.595334    
seasonpeak           1.18708    0.11470  10.349  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 3.823534)

    Null deviance: 65548  on 13543  degrees of freedom
Residual deviance: 51637  on 13505  degrees of freedom
AIC: 56642

Number of Fisher Scoring iterations: 2
```

Table 4. Binomial model summary for Atlantic croaker discard rate in numbers.

```
Call:
glm(formula = success ~ YEAR + data_set + depth_zone + state +
    season, family = binomial(link = "logit"), data = trips_pr,
    na.action = na.exclude, offset = effort)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-3.5073  -1.0300   0.3392   0.9666   3.2459

Coefficients:
                    Estimate Std. Error z value Pr(>|z|)
(Intercept)         -3.09509    0.20894 -14.813  < 2e-16 ***
YEAR1990             0.46766    0.15190   3.079 0.002079 **
YEAR1991             0.55102    0.15202   3.625 0.000289 ***
YEAR1992             0.13589    0.15085   0.901 0.367681
YEAR1993            -0.10390    0.15124  -0.687 0.492110
YEAR1994             0.04400    0.15091   0.292 0.770615
YEAR1995             0.26455    0.15094   1.753 0.079661 .
YEAR1996             0.20017    0.15087   1.327 0.184579
YEAR1997            -0.37876    0.15259  -2.482 0.013058 *
YEAR1998             0.45362    0.15130   2.998 0.002716 **
YEAR1999            -0.33542    0.15229  -2.203 0.027624 *
YEAR2000            -0.35266    0.15240  -2.314 0.020666 *
YEAR2001             0.38773    0.14428   2.687 0.007203 **
YEAR2002            -0.53863    0.14190  -3.796 0.000147 ***
YEAR2003             0.36514    0.14169   2.577 0.009964 **
YEAR2004            -0.05609    0.14448  -0.388 0.697853
YEAR2005             0.05163    0.14238   0.363 0.716912
YEAR2006            -0.07772    0.14388  -0.540 0.589049
YEAR2007            -0.05911    0.14233  -0.415 0.677930
YEAR2008            -0.07530    0.14064  -0.535 0.592400
YEAR2009             0.35843    0.13900   2.579 0.009917 **
YEAR2010            -0.26957    0.14039  -1.920 0.054833 .
YEAR2011             0.13262    0.13832   0.959 0.337684
YEAR2012             0.77172    0.14145   5.456 4.88e-08 ***
YEAR2013             1.22728    0.14607   8.402  < 2e-16 ***
YEAR2014             0.77443    0.14436   5.364 8.12e-08 ***
YEAR2015             0.79048    0.14261   5.543 2.97e-08 ***
YEAR2016             0.62986    0.13988   4.503 6.70e-06 ***
YEAR2017             0.64813    0.14364   4.512 6.41e-06 ***
YEAR2018             1.48839    0.15835   9.399  < 2e-16 ***
YEAR2019             1.50833    0.15638   9.646  < 2e-16 ***
data_setrock_shrimp -3.42236    0.30268 -11.307  < 2e-16 ***
data_setSEAMAP       0.05738    0.08878   0.646 0.518055
depth_zone>30m      -1.00655    0.31381  -3.207 0.001339 **
depth_zone10-30m     0.83596    0.16088   5.196 2.04e-07 ***
stateGA             -0.23109    0.04826  -4.788 1.68e-06 ***
stateNC              1.45568    0.05493  26.503  < 2e-16 ***
stateSC              0.01577    0.04461   0.354 0.723702
seasonpeak           2.43531    0.16963  14.356  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 30175  on 22060  degrees of freedom
Residual deviance: 24495  on 22022  degrees of freedom
AIC: 24573

Number of Fisher Scoring iterations: 6
```

Table 5. Model selection summary for Atlantic croaker lognormal (left) and binomial (right) models of discard rate in numbers.

Drop	Df	Deviance	AIC	scaled dev.	Pr(>Chi)	Drop	Df	Deviance	AIC	LRT	Pr(>Chi)
none	NA	51,637	56,642	NA	NA	none	NA	24,495	24,573	NA	NA
YEAR	30	56,164	57,720	1,138	2.88E-220	YEAR	30	25,514	25,532	1,019	6.01E-195
data_set	2	52,267	56,802	164	1.99E-36	data_set	2	24,602	24,676	107	7.14E-24
depth_zone	2	51,894	56,705	67	2.46E-15	depth_zone	2	24,566	24,640	71	4.18E-16
state	3	58,698	58,372	1,736	0	state	3	25,893	25,965	1,398	7.99E-303
season	1	52,046	56,747	107	4.47E-25	season	1	24,692	24,768	197	1.16E-44

Table 6. Proportions used to partition effort data. Effort data are partitioned across depth zones first and then within each depth zone across fisheries.

	Depth Zone		
	=<10m	10-30m	>30m
proportion all effort	0.542	0.289	0.170
proportion penaeid shrimp effort	0.998	0.950	0.013
proportion rock shrimp effort	0.002	0.050	0.987

Table 7. Atlantic croaker discard estimates in numbers (1,000s of fish) with 95% confidence intervals. Unadjusted estimates are estimates before making adjustments due to catch reductions by BRDs.

Year	Lower CI	Discards	Upper CI	Unadjusted Discards
1989	424,970	597,843	852,263	444,978
1990	1,087,396	1,426,869	1,904,871	1,064,632
1991	2,687,720	3,510,665	4,669,243	2,620,867
1992	673,354	898,864	1,215,819	668,881
1993	491,643	664,820	909,669	494,300
1994	752,295	1,007,773	1,367,585	749,841
1995	751,785	995,491	1,337,540	741,457
1996	399,050	530,321	714,506	394,789
1997	165,623	229,747	319,058	NA
1998	334,849	443,856	589,251	NA
1999	395,883	547,612	758,423	NA
2000	236,458	327,129	453,083	NA
2001	353,970	452,083	578,372	NA
2002	238,065	313,153	412,432	NA
2003	286,711	368,918	475,351	NA
2004	459,347	601,924	789,904	NA
2005	121,971	154,330	195,615	NA
2006	458,718	601,235	789,197	NA
2007	294,663	374,830	477,666	NA
2008	603,519	748,638	930,529	NA
2009	435,274	525,631	636,210	NA
2010	483,999	608,131	765,405	NA
2011	695,526	860,890	1,067,612	NA
2012	670,200	813,704	990,379	NA
2013	735,964	894,466	1,089,901	NA
2014	748,056	925,938	1,148,662	NA
2015	545,547	665,743	814,401	NA
2016	633,714	769,664	937,076	NA
2017	545,438	664,939	812,660	NA
2018	837,942	1,021,878	1,249,576	NA
2019	1,289,248	1,598,670	1,988,057	NA

Figures

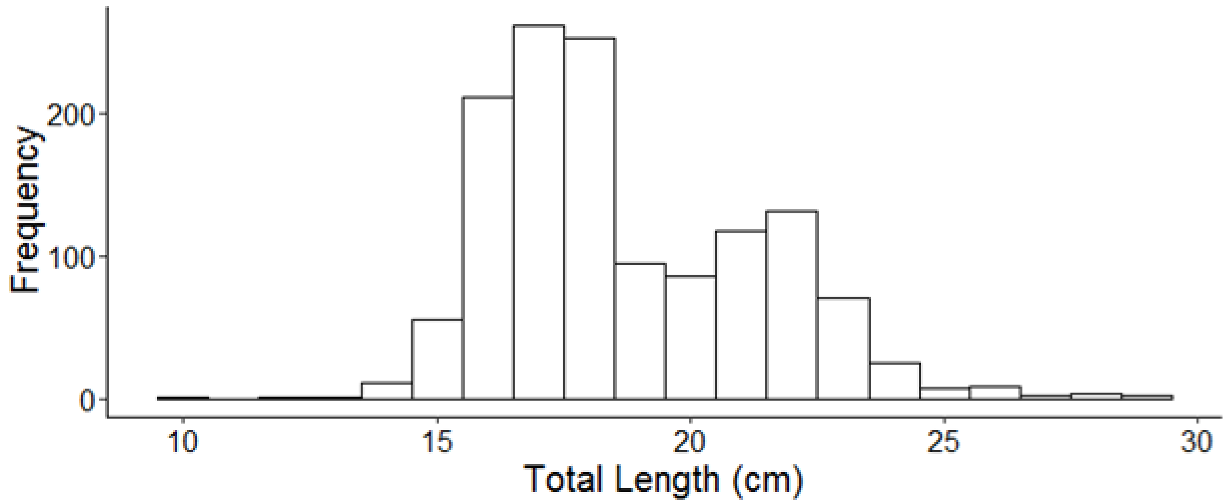

Figure 1. Length distribution of Atlantic croaker measured by shrimp trawl observers. All length samples were collected in 2003.

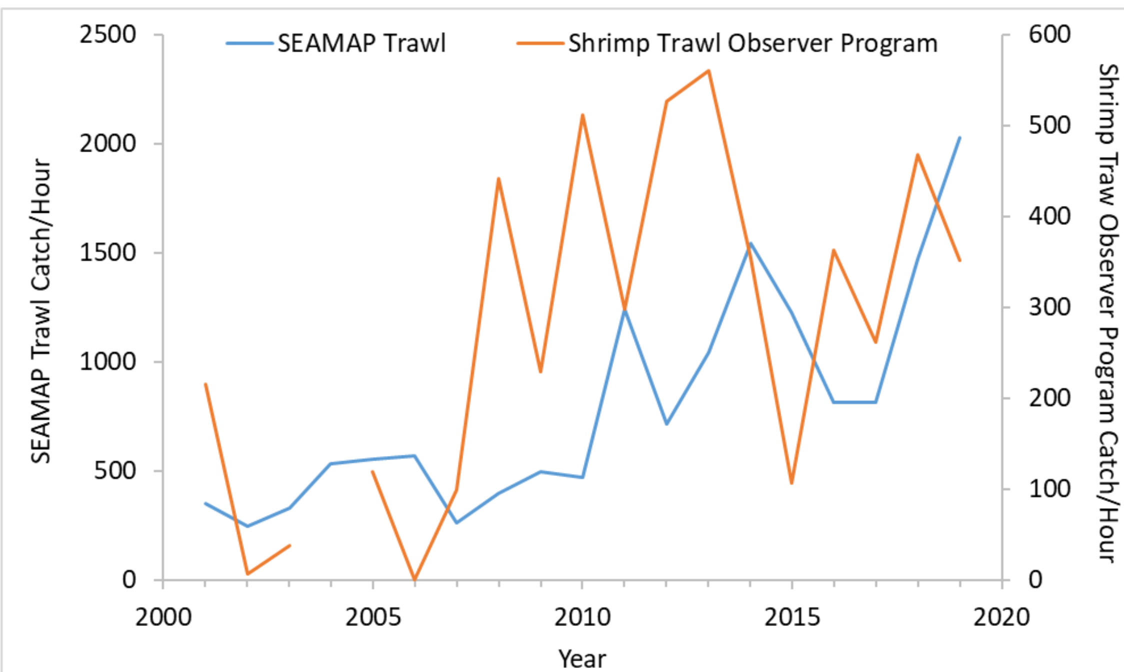

Figure 2. Annual mean CPUE of Atlantic croaker (number of fish/hour fished) during SEAMAP tows and observer program tows.

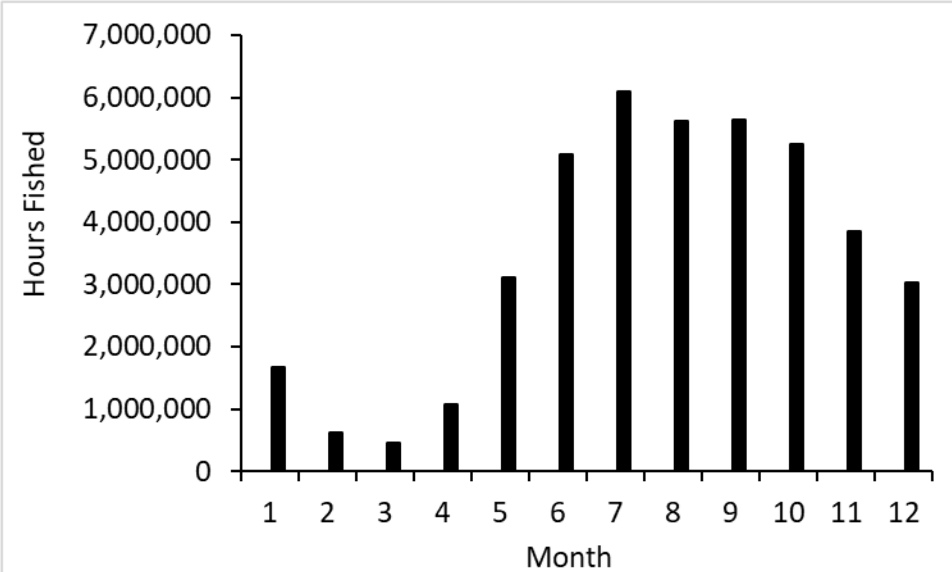

Figure 3. Shrimp trawl fishery effort (hours fished) by month.

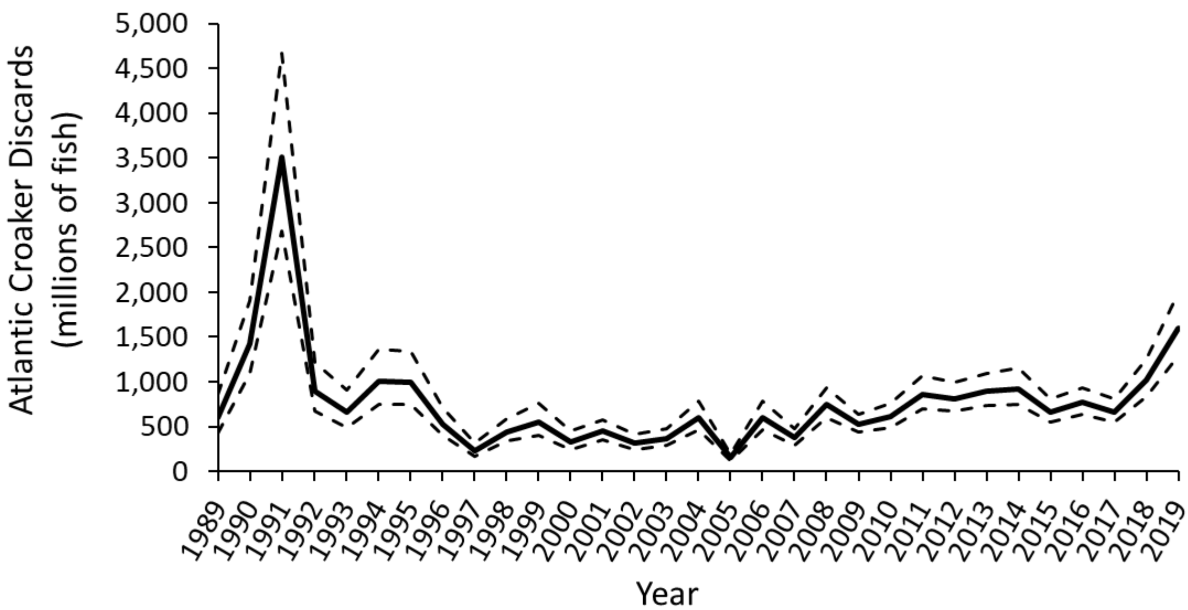

Figure 4. Atlantic croaker discard estimates (millions of fish, solid line) from South Atlantic shrimp trawl fisheries with 95% confidence intervals (dashed lines).

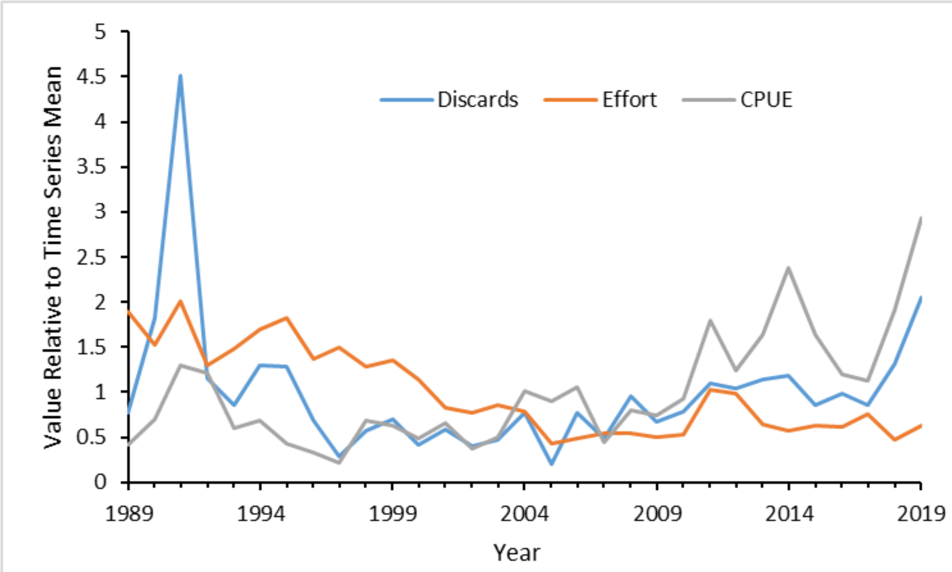

Figure 5. Shrimp trawl effort, Atlantic croaker discard estimates (numbers), and mean Atlantic croaker CPUE (number of fish/hour fished) scaled to time series means.

Appendix 1a. Shrimp trawl observer database net performance operation codes.

A - Nets not spread; typically doors are flipped or doors hung together so net could not spread.
B - Gear bogged; the net has picked up a large quantity of sand, clay, mud, or debris in the tail bag possibly affecting trawl performance.
C - Bag obstructed; the catch in the net is prevented from getting into the bag by something (i.e. grass, sticks, turtle, tires, metal/plastic containers etc.) or constriction of net (i.e. twisting of the lazy-line around net).
D - Gear not digging; the net is fishing off the bottom due to insufficient weight or not enough cable let out (etc.).
E - Twisted warp or line; the cables composing the bridle get twisted (from passing over blocks which occasionally must be removed before continuing to fish). Use this code if catch was affected.
F - Gear fouled; the gear has become entangled in itself or with another net. Typically this involves the webbing and some object like a float or chains or lazy line (etc.).
G -Bag untied; bag of net not tied when dragging net.
H - Rough weather. Bags mixed due to rough seas (too dangerous to separate); if the weather is so bad fishing is stopped, then the previous tow should receive this code if the rough conditions affected the catch.
I - Torn, damaged, or lost net; usually results from hanging the net and tearing it loose. The net comes back with large tears etc. if at all. Do not use this code if there are only a few broken meshes. Continue using this code until net is repaired or replaced
J - Dumped catch; tow was made but catch was discarded, perhaps because of too mud. Give reason in comments.
K - Catch not emptied on deck; nets brought to surface, boat changes location, nets redeployed. (explain in comments)
L - Hung up; untimely termination of a tow by a hang. Specify trawl(s) which were hung and caused lost time in Comments.
M - Bags dumped together, catches could not be kept separate.
N - Net did not fish; no apparent cause. Describe reasoning in comments.
O - Gear fouled on submerged object but tow was not terminated. Performance of tow could be affected. Give specifics in Comments.
P - No measurement taken of shrimp and/or total catch.
Q - Main cable breaks and entire rigging lost. Describe in Comments.
R - Net caught in wheel.
S - Tickler chain heavily fouled, tangled, or broken.
T - Other problems. Describe in comments.
U - Turtle excluder gear intentionally disabled.
V – Unknown operation code.
W - Damaged (i.e., bent or broken) excluder gear.
X - BRD intentionally disabled or non-functional. (Damaged) Describe in comments.
Y - Net trailing behind try net.
Z - Successful tow.