FISHERY MANAGEMENT PLAN UPDATE
SOUTHERN FLOUNDER
AUGUST 2020

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

Original FMP Adoption:	February 2005
Amendments:	Amendment 1 – February 2013 Amendment 2 – August 2019
Revisions:	None
Supplements:	Supplement A to the 2005 FMP – February 2011 Supplement A to Amendment 1 – November 2015
Information Updates:	None
Schedule Changes:	None
Benchmark Review:	Amendment 3 is currently in development

Southern flounder (*Paralichthys lethostigma)* in North Carolina are currently management under Amendment 2 to the North Carolina Southern Flounder Fishery Management Plan (FMP)(NCDMF 2019). Development of Amendment 2 began January 2018, immediately following a peer review workshop evaluating the 2018 stock assessment. At the end of the peer review workshop, the Southern Flounder Review Panel accepted the pooled-sex run of the Age Structured Assessment Program (ASAP) model presented at the Review Workshop as a valid basis of management for at least the next five years, with the expectation that the model will be updated with data through 2017 to provide the best, most up to date estimate of stock status for management. The reviewers also noted that management advice based on the 2015 terminal year would be out of date by the time it could be implemented and that expected changes to recreational catch estimates derived from the Marine Recreational Information Program (MRIP) should be incorporated into the assessment.

During 2018 and 2019, the southern flounder stock assessment sub-committee updated all necessary data inputs for the ASAP model. The pooled-sex model was updated with data through 2017 including incorporating the new MRIP estimates that were available (Flowers et al. 2019). The plan development team developed Amendment 2 to the Southern Flounder FMP in conjunction with the Southern Flounder FMP Advisory Committee.

At it's Aug. 23, 2019 North Carolina Marine Fisheries Commission (NCMFC) business meeting, the NCMFC passed a motion to adopt Amendment 2 to the Southern Flounder FMP as proposed

by the North Carolina Division of Marine Fisheries (NCDMF) while allowing for seasonal flexibility in the commercial and recreational sectors to be determined by proclamation issued by the director of the NCDMF as long as the 62% harvest reductions in 2019 and the 72% harvest reductions for 2020 onward are met. The NCMFC also passed a motion asking the director of the NCDMF to consider a proclamation that would allow the for-hire charter captains to possess four flounder per vessel per day when the recreational season is closed. An additional motion was passed by the NCMFC to ask the NCDMF director to consider an exemption to Rule 15A NCAC 03J .0501(b)(2) for existing flounder pound net sets.

After careful consideration and looking at available data, the director of NCDMF did not issue a proclamation to create a special season for the for-hire industry outside of the recreational closure for 2019. The motion requesting an exemption for flounder pound net sets was handled through NCDMF policy.

Actions to achieve sustainable harvest in Amendment 2 include:

- Incorporating actions from Amendment 1 and Supplement A to Amendment 1 as modified by the Aug. 17, 2017 settlement agreement;
- Reduce fishing mortality in the commercial and recreational fisheries to a level that ends overfishing within two years and allows the SSB to increase to between the threshold and the target within 10 years via a 62% reduction (F=0.26) in total removals in 2019 and beginning in 2020, a 72% reduction (F=0.18) in total removals;
- The commercial harvest season closed by proclamation following the August 2019 NCMFC meeting, the NCDMF established three commercial southern flounder management areas with open flounder harvest seasons during 2019 as determined by proclamation issued by the director of the NCDMF as long as the 62% harvest reductions in 2019 and the 72% harvest reductions for 2020 onward are met;
- The recreational hook-and-line and gig flounder harvest season closed by proclamation following the August 2019 NCMFC meeting and will not re-open until the identified season in 2020 as determined by proclamation issued by the director of the NCDMF as long as the 62% harvest reductions in 2019 and the 72% harvest reductions for 2020 and onward are met;
- Upon the closure of the recreational hook-and-line flounder harvest season, the Recreational Commercial Gear License (RCGL) large mesh gill net flounder harvest season will also close as the recreational and commercial seasons must both be open to allow this gear.
- Remove all commercial gears targeting southern flounder from the water (e.g., commercial and RCGL anchored large mesh gill nets and gigs) or make them inoperable (flounder pound nets) in areas and during times outside of the seasons implemented. Exceptions will be allowed for commercial large mesh gill net fisheries that target American and hickory shad and catfish species if these fisheries are only allowed to operate during times of the year and locations where bycatch of southern flounder is unlikely;
- Reduce commercial anchored large-mesh gill net soak times to single overnight soaks where nets may be set no sooner than one hour before sunset and must be retrieved no later than one hour after sunrise the next morning in the Neuse, Tar-Pamlico rivers and the Albemarle Sound areas that have previously been exempt;
- Reduce the maximum yardage allowed in the commercial anchored large-mesh gill net fishery by 25% for each Management Unit; allowing a maximum of 1,500-yards in Management Units

A, B, and C, and a maximum of 750-yards in Management Units D and E unless more restrictive yardage is specified through adaptive management through the sea turtle or Atlantic sturgeon Incidental Take Permits (ITP);

- Making it unlawful to use any method of retrieving live flounder from pound nets that cause injury to released fish (no picks, gigs, spears, etc.);
- During the recommended closed commercial season, it will be unlawful to possess flounder harvested from the internal waters of the state;
- During the recommended closed recreational season, it will be unlawful to possess flounder in internal and ocean waters; and
- Adoption of Amendment 2 authorizes development of Amendment 3 and more robust management strategies.

Management Unit

In Amendment 2 to the North Carolina Southern Flounder FMP, the management unit was defined as North Carolina coastal waters. However, due to increased information relative to genetic identification and tagging studies the unit stock for the 2018 stock assessment was changed to include all waters from North Carolina through the East coast of Florida.

Goal and Objectives

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

1. Implement management strategies within North Carolina and encourage interjurisdictional management strategies that maintain/restore the southern flounder spawning stock with expansion of age structure of the stock and adequate abundance to prevent overfishing.

2. Restore, enhance, and protect habitat and environmental quality necessary to maintain or increase growth, survival, and reproduction of the southern flounder population.

3. Use biological, environmental, habitat, fishery, social, and economic data needed to effectively monitor and manage the southern flounder fishery and its ecosystem impacts.

4. Promote stewardship of the resource through increased public outreach and interjurisdictional cooperation throughout the species range regarding the status and management of the southern flounder fishery, including practices that minimize bycatch and discard mortality.

5. Promote the restoration, enhancement, and protection of habitat and environmental quality in a manner consistent with the Coastal Habitat Protection Plan.

STATUS OF THE STOCK

Life History

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

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

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

Stock Status

Following the recommendation of the peer review panel, the southern flounder working group recommended that the stock size threshold and target be defined in terms of Spawning Stock Biomass (SSB) associated with the fishing mortality target and threshold. Based on the results of the 2019 stock assessment, the probability that fishing mortality in 2017 is above the threshold value of 0.53 is 96.4%, whereas there is a 100% chance the fishing mortality in 2017 is above the target value of 0.35. The probability that the SSB in 2017 is below the threshold or target value (3,900 and 5,452 mt, respectively) is 100%. Therefore, the current status of the southern flounder stock is overfished and overfishing is occurring (Figures 1 and 2).

Stock Assessment

The 2009 stock assessment used a statistical catch-at-age model run using the Age Structured Assessment Program (Takade 2009). Results showed the stock to be overfished with overfishing occurring throughout the time series. These were the most recent assessment results included in Amendment 1. The 2014 Southern Flounder Stock Assessment used a statistical catch-at-age model run using Stock Synthesis (NCDMF 2015). Upon review of the assessment, external peer reviewers and the NCDMF determined the model could not fully account for stock mixing during spawning, nor quantify migration of southern flounder to and from North Carolina waters. Consequently, the assessment was not accepted for determining stock status.

As a result, a multistate southern flounder stock assessment was developed and included data and expertise of state agency staff from North Carolina. South Carolina, Georgia, and Florida, as well as researchers from the University of North Carolina at Wilmington and Louisiana State University. The multistate assessment was an attempt to further address the geographical distribution of the unit stock and was peer reviewed in December 2017. This assessment used a statistical catch-at-age model run using the Age Structured Assessment Program (Lee et. al. 2018).

The Southern Flounder Review Panel accepted the pooled-sex run of the ASAP model presented at the Review Workshop and was approved as a valid basis of management for at least the next five years, with the expectation that the model will be updated with data through 2017 to provide the best, most up to date estimate of stock status for management. The reviewers also noted that management advice based on the 2015 terminal year would be out of date by the time it could be implemented and that expected changes to recreational catch estimates (MRIP) should be incorporated into the assessment model and management response.

During 2018, the southern flounder stock assessment sub-committee updated all necessary data inputs for the ASAP model. The pooled-sex model was updated with data through 2017 including incorporating the new MRIP estimates that were available, results indicate the stock is overfished and overfishing is still occurring (Figures 1 and 2)(Flowers et al. 2019). Analyses that provided projections of reductions to fishing mortality necessary to end overfishing and to determine what reductions would be necessary to rebuild the spawning stock biomass and end the overfished status were completed (Flowers et al. 2019).

STATUS OF THE FISHERY

Current Regulations

Commercial: 15-inches total length (TL) minimum size limit from internal waters and 14-inches TL minimum size limit from ocean waters, 6 inch stretched mesh minimum mesh size for gill nets, closed season in internal waters unless opened by proclamation, 2020 season dates will be September 15, 2020 through October 6, 2020 for the Northern Management Area, October 1, 2020 through October 19, 2020 for the Central Management Area, and October 1, 2020 through November 2, 2020 for the Southern Management Area (Proclamation FF-25-2020). There are no trip limits in internal waters and a 100-pound trip limit in ocean waters unless the individual has

a License to Land Flounder from the Atlantic Ocean; commercial ocean landings allowed using trawl gear only.

Recreational: 15-inches TL minimum size limit, four-fish creel limit from all joint and coastal waters, closed season for internal and ocean waters except if opened by proclamation (2020 recreational season is August 16th through September 30th)(Proclamation FF-10-2020).

At the August 2019 NCMFC business meeting the commission adopted Amendment 2 which instituted several new management changes effective immediately. Please check the NCDMF's website for a summary of the actions http://portal.ncdenr.org/web/mf/08-2019-news-releases.

Commercial Landings

All landings reported as caught in inshore waters are considered to be southern flounder by the NCDMF Trip Ticket Program. Most southern flounder landings are from gill nets and pound nets, although gigs and other inshore gears (e.g., trawls) catch flounder in smaller numbers. Historically, pound nets were the dominant gear but landings from gill nets were higher in 1994-2013 (Figure 3). Peak commercial landings occurred in 1994 (Table 1). Since 1994, pound net landings decreased greatly, while gill net landings remained relatively high until 2010. Decreases in gill net landings from 2010 to 2012 were mainly due to lower landings in the Albemarle Sound. The Sea Turtle Settlement Agreement (2010) added regulations to gill nets in portions of the state, resulting in lower effort in many areas, however, the Albemarle Sound was mostly unaffected by these regulations. The Albemarle Sound is typically where the majority of southern flounder gill net harvest occurs. In 2013, gill net harvest increased in the Albemarle Sound, but decreased in Pamlico Sound and Core Sound; pound net landings also increased in 2013. Since 2014, gill net harvest has decreased in all areas of the state, especially in the Albemarle Sound due to widespread gill net closures to avoid catches of red drum and protected species interactions. Pound net harvest surpassed gill net harvest 2014 through 2019 (Figure 3). Gig harvest of southern flounder has generally increased, especially since 2010. Harvest by other commercial gears has generally decreased to its lowest point in 2019 and currently makes up a small portion of commercial harvest. Commercial harvest is the highest in fall months.

Trends in commercial trips have generally followed landings trends (Figure 4). Trips include the number of trip ticket records with landings reported; some trips may represent more than one day of fishing. The majority of trips that harvest flounder are from gill nets. Gill net trips have been variable around a decreasing trend since 2010. Pound net trips were decreasing until 2002, since they have been variable on a lower level. Gigging trips have been variable around an increasing trend since 2010.

Recreational Landings

Recreational harvest of southern flounder is mainly by hook and line and gigs, with a small amount of harvest by spearfishing or Recreational Commercial Gear License (RCGL) gears. NCDMF does not have information on long-term trends of the gig fishery. This is because the Marine Recreational Information Program (MRIP) rarely encounters gig fishermen. A DMF mail-based survey of gigging that began in 2010 indicates the gig harvest from 2010-2019

averaged 10% of the recreational harvest (with hook and line harvest making up the remainder). Hook and line harvest can be split into ocean and inshore harvest, with most southern flounder harvested inshore (Figure 5). Hook and line harvest peaked in 2010 (Table 1). Recreational harvest is highest during summer months.

Trends in recreational trips are somewhat difficult to interpret because they represent all *paralichthid* flounder species commonly caught in North Carolina (southern, summer and Gulf). This is because anglers simply report targeting 'flounder' rather than a particular species of flounder. Trips can be defined in several ways, but in this document all trips that harvested or released any *paralichthid* flounder species were included. Trends in trips and harvest are roughly similar throughout most of the time-series, but trips have been declining since 2013 while harvest has been variable. (Figure 6). Recreational estimates across all years have been updated and are now based on the Marine Recreational Information Program (MRIP) new Fishing Effort Survey-based calibrated estimates. For more information on MRIP see https://www.fisheries.noaa.gov/topic/recreational-fishing-data.

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

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

There were no clear trends in commercial length and age data from 2005 to 2019 (Table 2). In 2019, 47% of southern flounder were harvest by pound nets, followed by gill nets (41%), gigs (11%), and other gear accounted for 1% (Figure 7). Commercial age data for 2018 and 2019 are preliminary at this time. Annual mean lengths were fairly consistent; however, an increase in mean length was observed due to the changes in minimum commercial size regulation, increasing to 15-inches (Table 2; Figure 8).

There were no clear trends in recreational length and age data from 2005 to 2019 (Table 3). Recreational age data for 2018 and 2019 are preliminary at this time. Annual mean lengths collected through age sampling programs have been consistent, 2019 average length of 18 inches was slightly different than previous years where 17 inches was the mean length as seen 12 of the

last 15 years. MRIP length frequency data show harvest of smaller fish has declined as changes to minimum size limits has occurred (Table 3; Figure 9).

Fishery-Independent Monitoring

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

There were no clear trends in fishery-independent length and age data from 2005 to 2019 (Table 4). Independent age data for 2018 and 2019 are preliminary at this time. Annual mean lengths were fairly consistent and 2016 and 2019 had the second largest mean length in the time-series. However, the number of fish measured in 2016 was the lowest of any year from 2005 to 2019.

Data collected by Program 915 were used for an index of relative (juvenile and adult) abundance in the January 2019 stock assessment. The survey is designed to characterize the size and age distribution for key estuarine species in Pamlico Sound and its major river tributaries. Sampling began in Pamlico Sound in 2001 and was expanded to the current sampling area (including tributaries) in 2003. Each array of nets consists of floating gill nets in 30-yard segments of 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, and 6.5-inch stretched mesh, for a total of 240 yards of nets. Catches from an array of gill nets comprise a single sample; two samples (one shallow, one deep) totaling 480 yards of gill net are completed each trip. Gill nets are typically deployed within an hour of sunset and fished the following morning. Efforts are made to keep all soak times within 12 hours. All gill nets are constructed with a hanging ratio of 2:1. Gill net sets are determined using a random stratified survey design, based on area and water depth. Each region is overlaid with a one-minute by one-minute grid system (equivalent to one square nautical mile) and delineated into shallow (less than six feet) and deep (greater than six feet) strata. Deep strata were not included in data analysis for this report. Sampling in Pamlico Sound is divided into two regions: Region 1, which includes areas of eastern Pamlico Sound adjacent to the Outer Banks from southern Roanoke Island to the northern end of Portsmouth Island; and Region 2, which includes Hyde County bays from Stumpy Point Bay to Abel's Bay and adjacent areas of western Pamlico Sound. Each of the two regions is further stratified into four similar sized areas, denoted by either Hyde or Dare and numbers one through four. The rivers are divided into four areas in the Neuse River, three areas in the Pamlico River, and one area for the Pungo River. Although the survey is conducted in all months except January, only July-September data were used to analyze the index of abundance trends because these months had the peak catches of southern flounder. The survey was expanded to include areas in the southern portion of the state in 2008, but these data were not analyzed for the index due to the short time-series. The relative abundance index for Program 915 peaked in 2010 and the low point was in 2016 for the time-series analyzed (2003-2019) and

has a decreasing trend (Table 5; Figure 10). The relative abundance index each of the last five years are all below the time series average but there has been an increase each year since the low in 2016.

Data collected by Program 135 was not used as an index of relative (juvenile and adult) abundance in the January 2019 stock assessment but continues to provide an additional data source to monitor trends in the population. Beginning in 1990, Program 135 has conducted gill net sets in waters of Albemarle Sound. The survey was designed to monitor the striped bass population. The survey follows a random stratified design, stratified by geographic area. This survey divides the Albemarle region into six sample zones that are further subdivided into one-mile square quadrants with an average of 22 quadrants per zone. Four arrays of twelve meshes (2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 8.0, 10.0-inch stretch) of gill nets are set in each quadrant by the fishing crew, two arrays are sinking gill nets and two are floating. One unit of effort is defined as each 40-yard net fished for 24 hours. The relative abundance index for Program 135 peaked in 1992 and the low points were in 2011, 2016, 2017, and 2018 for the time-series analyzed (1991-2019; Table 5; Figure 11). The relative abundance index for each of the last five years have all been below the series average.

Data collected by Program 120 were used for a relative Juvenile Abundance Index (JAI) in the January 2019 stock assessment. The Estuarine Trawl Survey (Program 120) is a fishery-independent multispecies monitoring program that has been ongoing since 1971 in the months of May and June. One of the key objectives of this program is to provide a long-term data base of annual juvenile recruitment for economically important species. This survey samples fixed stations, a set of 104 core stations with additional stations as needed. The core stations are sampled from western Albemarle Sound south through the South Carolina border each year without deviation one sample for each station each month during the months of May and June. This survey targets juvenile finfish, blue crabs, and Penaeid shrimp. A two-seam 10 and one-half foot headrope trawl with a one-fourth inch mesh in the body and one-eighth inch mesh in the tailbag is used. A one-minute tow is conducted covering a distance of 75 yards. All species collected are sorted, identified, and a total number is recorded for each species. For target species, a subset of at least 30 to 60 individuals is measured. Environmental data is collected, including salinity, dissolved oxygen, temperature, wind speed and direction. Data from this survey were used to produce a southern flounder JAI from 1991 to 2019. The JAI for Program 120 peaked in 1996 and the low point was in 2016 for the time-series analyzed (1991-2019) and shows a variable trend (Table 5; Figure 12) with each of the last 5 years being below the time series average. This survey is the only one presented that showed a decrease in abundance during 2019.

Data collected by Program 195 were not used as a JAI in the January 2019 stock assessment but continues to provide an additional data source to monitor trends in the population. Program 195 conducts trawls using a random-stratified survey design in waters of Pamlico Sound and major river tributaries in June and September. Only data from September were used for the JAI in the 2014 stock assessment. Stations are randomly selected from strata based upon depth and geographic location. Randomly selected stations are optimally allocated among the strata based upon all previous sampling in order to provide the most accurate abundance estimates (PSE <20). Tow duration is 20 minutes; using double rigged demersal mongoose trawls (9.1m

headrope, 1.0m X 0.6m doors, 2.2-cm bar mesh body, 1.9-cm bar mesh cod end and a 100-mesh tailbag extension. Data from this survey were used to produce a southern flounder JAI from 1991 to 2019. The JAI for Program 195 peaked in 1996 and the low point was in 1998 for the time-series analyzed (1991-2019; Table 5; Figure 13). However, annual relative abundance for four of the last five years has been above the time series average.

In order to describe the age structure of harvest and indices, southern flounder age structures are collected from various fishery independent (scientific surveys) and dependent (fisheries) sources throughout the year. In 2019, 1,954 southern flounder were aged ranging in age from 0 to 5 years (Tables 2-4). Growth in length is rapid for the first year of life and then slows. The relationship of length and age for southern flounder is unpredictable with much overlap in age for a given length (Figure 14).

MANAGEMENT STRATEGY

Until Amendment 3 is approved for management by the NCMFC, Southern flounder are managed under Amendment 2 to the Southern Flounder FMP, adopted in August 2019. In concurrence with the incorporated actions from Amendment 1 and Supplement A to Amendment 1 as modified by the Aug. 17, 2017 settlement agreement, a management strategy was implemented in Amendment 2 to reduce fishing mortality in the commercial and recreational fisheries to a level that ends overfishing within two years and allows the SSB to increase between the threshold and the target within 10 years via a 62% reduction (F=0.26) in total removals in 2019 and beginning in 2020, via a 72% reduction (F=0.18) in total removals.

To meet the reduction in fishing mortality, seasons were established for the commercial and recreational sectors for the first time in the North Carolina Southern Flounder Fishery. These reductions in total removals will allow for increased escapement of spawning stock to begin rebuilding of the stock.

Development of Amendment 3 and more comprehensive management strategies is under way and began immediately after adoption of Amendment 2. Management actions under Amendment 2 will remain in effect until adoption of Amendment 3 which is scheduled to be completed in 2021.

RESEARCH NEEDS

The management strategies and implementation status from Amendment 2 to the N.C. Southern Flounder FMP can be found in Table 6. The following research recommendations were included in Amendment 1 as Amendment 2 did not include research recommendations; status of need is provided in parentheses:

- Investigate the feasibility of a quota as a management tool for the commercial southern flounder fishery (underway).
- Annual survey of the recreational gig fishery (mail-based survey underway, dockside survey still needed).
- Further research on southern flounder that remain in the ocean after the spawning season (tagging studies underway, but other studies may be needed).

- Determine the exact locations of spawning aggregations of southern flounder in the ocean (tagging studies underway, but other studies may be needed).
- Continued otolith microchemistry research to gain a better understanding of ocean residency of southern flounder (more research needed).
- Tagging study of southern flounder in the ocean to gain a better understanding of migration patterns into the estuaries (underway).
- Update the southern flounder maturity schedule (completed).
- Fishery dependent sampling of the commercial spear fishery for flounder in the ocean (some sampling done under NCDMF sampling, but more may be needed).
- Harvest estimates and fishery dependent sampling of the recreational spear fishery for flounder in the ocean (not done except what MRIP encounters).
- Increased fish house sampling of the Currituck Sound flounder gill net and pound net fisheries (sampling has increased, more may be needed).
- Increased at-sea observer trips with gill netters and pound netters in Currituck Sound (underway for gill nets, pound net observing needed).
- Reestablish a RCGL survey to obtain harvest, discard, and effort information (needed).
- Establish an at-sea observer program of the RCGL fishery (needed).
- Formulate a bycatch estimate of southern flounder from crab pots (more research needed).
- Further research on degradable materials to determine which material works best in a given water body and how other parameters, such as microbial activities and the effects of light penetration impact degradation rates and performance of the crab pot (progress unknown).
- Further research on flatfish escapement devices that minimize undersized flounder bycatch and maximize the retention of marketable blue crabs (needed).
- Further research on factors that impact release mortality of southern flounder in the recreational hook and line fishery (more research needed).
- Research on deep hooking events of different hook types and sizes on southern flounder (needed)
- Population dynamics research for all Atlantic protected species (some research completed, more is needed).
- Continued gear research in the design of gill nets and pound nets to minimize protected species interactions (some research completed, more may be needed).
- Development of alternative gears to catch southern flounder (some research completed, more may be needed).
- Further research on the size distribution of southern flounder retained in pound nets with 5.75-inch and 6-inch escape panels (some research completed, more is needed).
- Research on the species composition and size distribution of fish and crustaceans that escape pound nets through 5.75-inch and 6-inch escape panels (some research completed, more is needed).
- Coast wide at-sea observations of the flounder pound net fishery (needed).
- Discard mortality estimates of southern flounder from pound nets (needed).
- Continue at-sea observations of the large mesh gill net fishery, especially outside of the PSGNRA, including acquiring biological data on harvest and discards (underway).
- Increase the number of large mesh gill net catches sampled in areas such as Albemarle Sound and the Newport River (sampling has increased, more may be needed).

Research recommendations from the January 2018 stock assessment:

- Develop a survey that will provide estimates of harvest and discards for the recreational gig fisheries in North Carolina, South Carolina, Georgia, and Florida
- Conduct sampling of the commercial and recreational ocean spear fishery harvest and discards
- Develop a survey that will estimate harvest and discards from commercial gears used for recreational purposes
- Develop a survey that will provide estimates of harvest and discards from gears used to capture southern flounder for personal consumption
- Improve estimates of the B2 component (catches, lengths, and ages) for southern flounder from the MRIP
- Collect additional discard data (ages, species ratio, lengths, fates) from other gears (in addition to gill nets) targeting southern flounder (pound net, gigs, hook-and-line, trawls)
- Develop and implement consistent strategies for collecting age and sex samples from commercial and recreational fisheries and fisheries-independent surveys to achieve desired precision for stock assessment
- Complete an age validation study using known age fish
- Implement a tagging study to estimate emigration, movement rates, and mortality rates throughout the stock's range
- Expand, improve, or add inshore and offshore surveys of southern flounder to develop indices for future stock assessments
- Expand, improve, or add fisheries-independent surveys of the ocean component of the stock
- Collect age and maturity data from the fisheries-independent SEAMAP Trawl Survey given its broad spatial scale and potential to characterize offshore fish
- Conduct studies to better understand ocean residency of southern flounder
- Determine locations of spawning aggregations of southern flounder
- Develop protocol for archiving and sharing data on gonads for microscopic observation of maturity stage of southern flounder for North Carolina, South Carolina, Georgia, and Florida
- Examine the variability of southern flounder maturity across its range and the effects this may have on the assessment model
- Investigate how environmental factors (wind, salinity, temperatures, or oscillations) may be driving the stock-recruitment dynamics for southern flounder
- Promote data sharing and research cooperation across the South Atlantic southern flounder range (North Carolina, South Carolina, Georgia, and Florida)
- Consider the application of areas-as-fleets models in future stock assessments given the potential spatial variation (among states) in fishery selectivity and fleet behavior in the southern flounder fishery
- Consider the application of a spatial model to account for inshore and ocean components of the stock as well as movements among states

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

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

FISHERY MANAGEMENT PLAN RECOMMENDATION

At its August 2019 business meeting the NCMFC approved Amendment 2 to the N.C. Southern Flounder FMP. Upon adoption, Amendment 2 authorized the division to immediately begin development of Amendment 3 where more comprehensive management strategies and measures will be developed based on the results of the 2019 coast-wide stock assessment. Development of Amendment 3 is underway and may augment management with more comprehensive strategies, but will not restart the rebuilding timeframe identified through Amendment 2.

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TABLES

Table 1. Southern flounder recreational harvest and number released (Marine Recreational Information Program) and commercial harvest (North Carolina Trip Ticket Program) for 1989-2019. All weights are in pounds.

	Recreational				
	Numbers		Weight (lb)		
Year	Landed	Released	Landed	Commercial Weight (lb)	Total Weight (lb)
1989	119,047	125,192	199,850	3,225,955	3,425,805
1990	138,106	152,895	216,960	2,560,459	2,777,419
1991	257,319	791,778	489,865	4,163,374	4,653,239
1992	115,329	433,576	219,720	3,145,020	3,364,740
1993	83,811	370,372	127,860	4,272,368	4,400,228
1994	168,237	562,915	323,869	4,878,609	5,202,478
1995	127,106	459,800	271,703	4,166,966	4,438,669
1996	173,400	449,876	339,228	3,807,009	4,146,237
1997	209,038	873,901	560,323	4,076,793	4,637,116
1998	96,124	411,939	205,569	3,952,729	4,158,298
1999	78,321	209,956	184,969	2,933,331	3,118,300
2000	326,712	942,560	607,053	3,205,792	3,812,845
2001	304,791	990,335	567,568	3,522,136	4,089,704
2002	366,671	1,415,247	789,539	3,436,753	4,226,292
2003	293,793	860,052	621,985	2,198,503	2,820,488
2004	347,492	1,537,924	827,593	2,454,577	3,282,170
2005	298,307	997,132	675,856	1,870,754	2,546,610
2006	352,942	1,287,601	761,069	2,287,823	3,048,892
2007	279,916	1,075,735	572,064	2,083,043	2,655,107
2008	349,860	2,532,079	807,867	2,602,390	3,410,257
2009	329,117	1,889,921	692,704	2,396,240	3,088,944
2010	556,812	2,835,142	1,149,899	1,689,557	2,839,456
2011	388,647	2,087,604	942,373	1,247,450	2,189,823
2012	290,035	2,434,621	701,698	1,646,137	2,347,835
2013	374,215	2,357,529	869,223	2,186,391	3,055,614
2014	209,228	1,856,280	447,337	1,673,511	2,120,848
2015	249,166	1,709,189	558,303	1,202,952	1,761,255
2016	299,273	2,178,145	695,713	899,932	1,595,645
2017	221,321	1,988,000	451,126	1,394,906	1,846,032
2018	217,805	1,002,753	495,289	903,055	1,398,344
2019	163,045	1,353,286	387,203	799,027	1,186,230
Average	218,219	1,011,219	448,162	2,573,709	3,021,872

Table 2. Southern flounder total length (inches) and age data for NCDMF commercial fishery sampling programs (includes harvest and some discard information).

Year	Mean Length	Minimum Length	Maximum Length	Total Measured	Modal Age	Minimum Age	Maximum Age	Total Aged
2005	16	2	31	28,972	2	0	7	83
2006	16	5	31	39,572	3	0	6	80
2007	16	4	29	23,768	2	0	5	94
2008	16	1	28	39,302	2	0	7	212
2009	16	4	28	33,403	2	1	6	34
2010	16	5	29	27,176	2	1	5	33
2011	16	5	30	32,000	3	1	6	90
2012	16	4	30	29,865	2	0	6	38
2013	16	1	32	33,776	1	1	5	245
2014	16	1	28	26,354	2	0	4	408
2015	16	2	30	19,717	1	0	5	330
2016	17	6	27	14,712	0	0	4	246
2017	17	3	30	14,775	0	0	5	418
2018*	17	2	27	8,962	1	0	4	351
2019*	16	9	27	6,725	1	0	4	1,103

* 2018 and 2019 age data are preliminary

Table 3. Southern flounder total length (inches) and age data for NCDMF recreational fishery sampling.

Year	Mean Length	Minimum Length	Maximum Length	Total Measured	Modal Age	Minimum Age	Maximum Age	Total Aged
2005	17	13	26	202	3	1	6	112
2006	16	10	31	343	3	1	6	188
2007	17	14	24	220	2	1	8	137
2008	17	13	27	311	3	1	6	79
2009	17	12	26	306	2	1	4	45
2010	17	11	28	754	2	1	7	127
2011	17	14	26	478	2	1	6	91
2012	18	14	30	400	2	1	6	57
2013	17	13	27	390	3	1	5	47
2014	17	14	26	199	2	1	7	42
2015	17	14	24	177	3	1	6	36
2016	17	14	25	225	2	0	5	123
2017	17	14	26	215	2	0	7	140
2018*	17	13	27	276	2	0	5	80
2019*	18	14	24	131	1	1	6	59

* 2018 and 2019 age data are preliminary

Table 4. Southern flounder total length (inches) and age data for NCDMF fishery-independent sampling programs.

Year	Mean Length	Minimum Length	Maximum Length	Total Measured	Modal Age	Minimum Age	Maximum Age	Total Aged
2005	8	0	25	3,769	2	0	4	516
2006	9	0	23	3,560	3	0	4	539
2007	7	0	22	3,812	1	0	5	513
2008	10	0	27	4,270	1	0	5	816
2009	10	1	27	3,230	1	0	5	414
2010	9	1	23	4,168	1	0	5	1,072
2011	12	1	28	2,604	1	0	6	720
2012	10	1	26	4,878	1	0	3	1,112
2013	9	1	27	3,534	1	0	6	678
2014	9	1	25	2,339	1	0	3	802
2015	9	1	24	2,133	1	0	3	463
2016	11	2	30	1,426	1	0	3	404
2017	9	1	22	2,238	1	0	3	620
2018*	9	0	24	2,123	1	0	3	562
2019*	11	1	24	2,631	1	0	4	792

* 2018 and 2019 age data are preliminary

Table 5. Annual nominal relative abundance index values for southern flounder and standard error (SE) in N.C. Division of Marine Fisheries independent surveys (programs 120, 195, 135 and 915). Indices for programs 120 and 195 are considered juvenile (young-of-year) abundance indices.

Year	P915 Index	P915 SE	P135 Index	P135 SE	P195 Index	P195 SE	P120 Index	P120 SE
1991			0.17	0.01	0.6	0.2	1.13	0.17
1992			0.18	0.02	4.83	1.3	2.49	0.30
1993			0.15	0.01	3.81	1.1	2.93	0.38
1994			0.08	0.01	3.33	1.2	1.79	0.24
1995			0.11	0.01	2.83	0.7	1.69	0.24
1996			0.03	0	9.65	2.0	7.82	0.95
1997			0.1	0.01	3.1	0.8	2.74	0.29
1998			0.08	0.01	0.37	0.1	0.90	0.15
1999			0.04	0	1.91	0.5	2.49	0.30
2000			0.05	0.01	0.77	0.2	3.74	0.43
2001			0.1	0.01	0.82	0.3	4.38	0.46
2002			0.14	0.01	3.28	1.5	4.49	0.56
2003	3.41	0.35	0.03	0	2.94	0.8	6.31	1.01
2004	3.11	0.34	0.09	0.01	1.28	0.2	3.89	0.46
2005	2.64	0.25	0.08	0.01	3.25	1.0	3.05	0.38
2006	1.84	0.29	0.13	0.01	1	0.3	2.63	0.33
2007	1.44	0.17	0.16	0.01	1.07	0.3	3.64	0.39
2008	2.97	0.35	0.17	0.01	0.94	0.5	2.40	0.33
2009	2.04	0.27	0.12	0.01	1.28	0.3	1.93	0.26
2010	3.57	0.46	0.05	0.01	1.14	0.3	5.03	0.66
2011	2.33	0.35	0.02	0	0.6	0.2	1.09	0.19
2012	2.22	0.22	0.08	0.01	4.44	1.9	3.07	0.39
2013	2.57	0.24	0.1	0.01	1.05	0.3	2.64	0.33
2014	1.81	0.19	0.05	0	0.64	0.2	1.86	0.30
2015	1.32	0.23	0.04	0	2.46	0.4	1.67	0.27
2016	1.14	0.15	0.02	0	0.73	0.3	0.53	0.11
2017	1.34	0.15	0.02	0	6.02	2.2	1.03	0.16
2018	1.51	0.18	0.02	0	2.94	1.0	1.36	0.18
2019	1.96	0.25	0.04	0	3.74	1.0	1.03	0.20

Table 6. Management action taken as a result of Amendment 2 to the N.C Southern Flounder FMP.

MANAGEMENT STRATEGY	OUTCOME
Management measures limiting the number of fishing days per week and the amount of yardage allowed for large mesh gill nets in various areas of the state	Implemented through proclamation (refer to Amendment 1)
A minimum distance (area dependent) between gill net and pound net sets, per NCMFC Rule 15A NCAC 03J .0103 (d)	Implemented through proclamation (refer to Amendment 1)
A recreational minimum size limit of 15 inches TL	Implemented through proclamation (Refer to Amendment 1)
Increase minimum mesh size to harvest southern flounder to 6.0-inch stretched mesh	Implemented through Proclamation (Refer to Supplement A to Amendment 1)
Increase minimum size limit for commercial fisheries to 15 inches	Implemented through Proclamation (Refer to Supplement A to Amendment 1)
Increase minimum mesh size for escape panels to 5.75-inch stretched mesh	Implemented through Proclamation (Refer to Supplement A to Amendment 1)
Maintain daily bag limit for recreational harvest of southern flounder at 4 flounder per person per day	Implemented through Proclamation (Refer to Supplement A to Amendment 1)
Implement commercial harvest season	Implemented through Proclamation (Refer to Amendment 2)
Implement recreational (hook and line, gig) harvest season	Implemented through Proclamation (Refer to Amendment 2)
Closure of the RCGL large mesh gill net fishery	Implemented through Proclamation (Refer to Amendment 2)
Removal of all commercial gears targeting southern flounder from the water (e.g., commercial and RCGL anchored large mesh gill nets and gigs) or make them inoperable (flounder pound nets) in areas and during times outside of the seasons implemented. Exceptions will be allowed for commercial large	Implemented through Proclamation (Refer to Amendment 2)

MANAGEMENT STRATEGY	OUTCOME
mesh gill net fisheries that target American and hickory shad and catfish species if these fisheries are only allowed to operate during times of the year and locations where bycatch of southern flounder is unlikely	
Making it unlawful to possess flounder in internal and ocean waters during the closed recreational season.	Implemented through Proclamation (Refer to Amendment 2)
Making it unlawful to possess flounder harvested from the internal waters of the state during the closed commercial season	Implemented through Proclamation (Refer to Amendment 2)
Making it unlawful to use any method of retrieving live flounder from pound nets that cause injury to released fish (no picks, gigs, spears, etc.)	Implemented through Proclamation (Refer to Amendment 2)
Reduce commercial anchored large-mesh gill net soak times to single overnight soaks where nets may be set no sooner than one hour before sunset and must be retrieved no later than one hour after sunrise the next morning in the Neuse, Tar/Pamlico rivers and the Albemarle Sound areas that have previously been exempt	Implemented through Proclamation (Refer to Amendment 2)
Reduce the maximum yardage allowed in the commercial anchored large-mesh gill net fishery by 25% for each Management Unit; allowing a maximum of 1,500-yards in Management Units A, B, and C, and a maximum of 750-yards in Management Units D and E unless more restrictive yardage is specified through adaptive management through the sea turtle or sturgeon Incidental Take Permits (ITP).	Implemented through Proclamation (Refer to Amendment 2)
Begin development of Amendment 3 to the N.C. Southern Flounder Fishery Management Plan	Ongoing

FIGURES

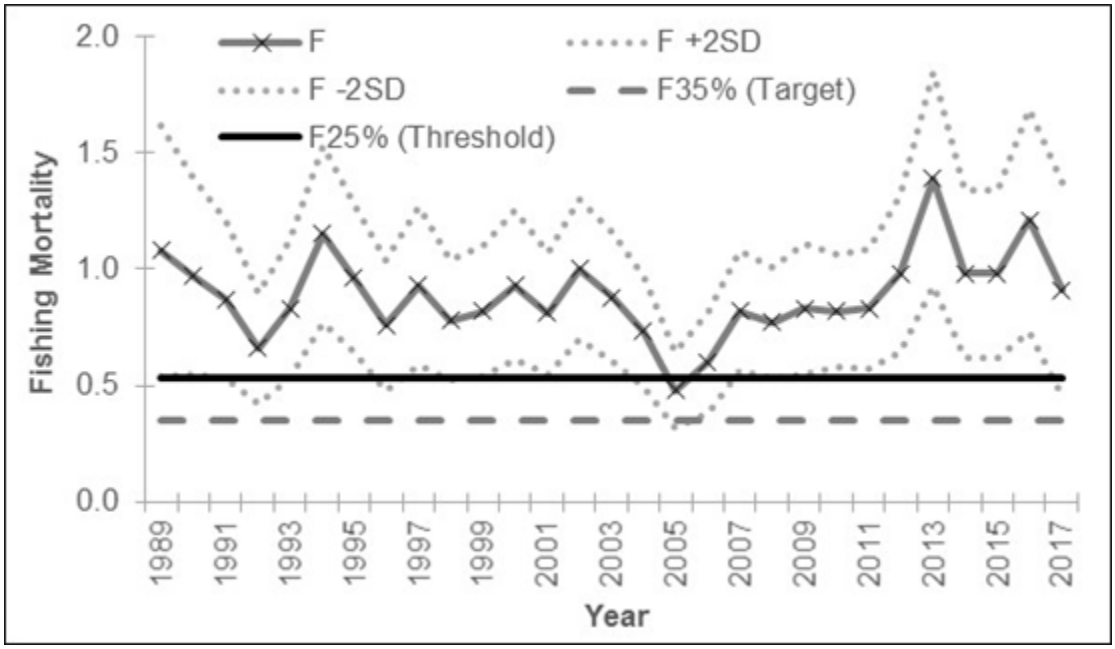

Figure 1. Estimated fishing mortality rates (numbers-weighted, ages 2–4) compared to established reference points, 1989–2017. (Source: Flowers et al. 2019).

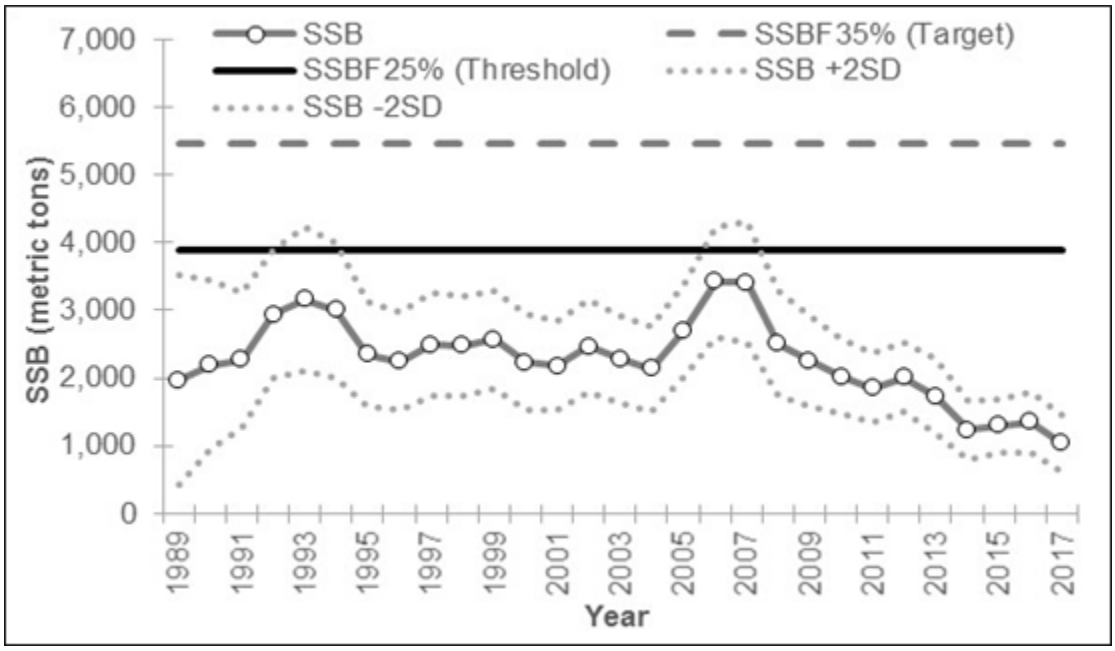

Figure 2. Estimated spawning stock biomass compared to established reference points, 1989–2017. (Source: Flowers et al. 2019).

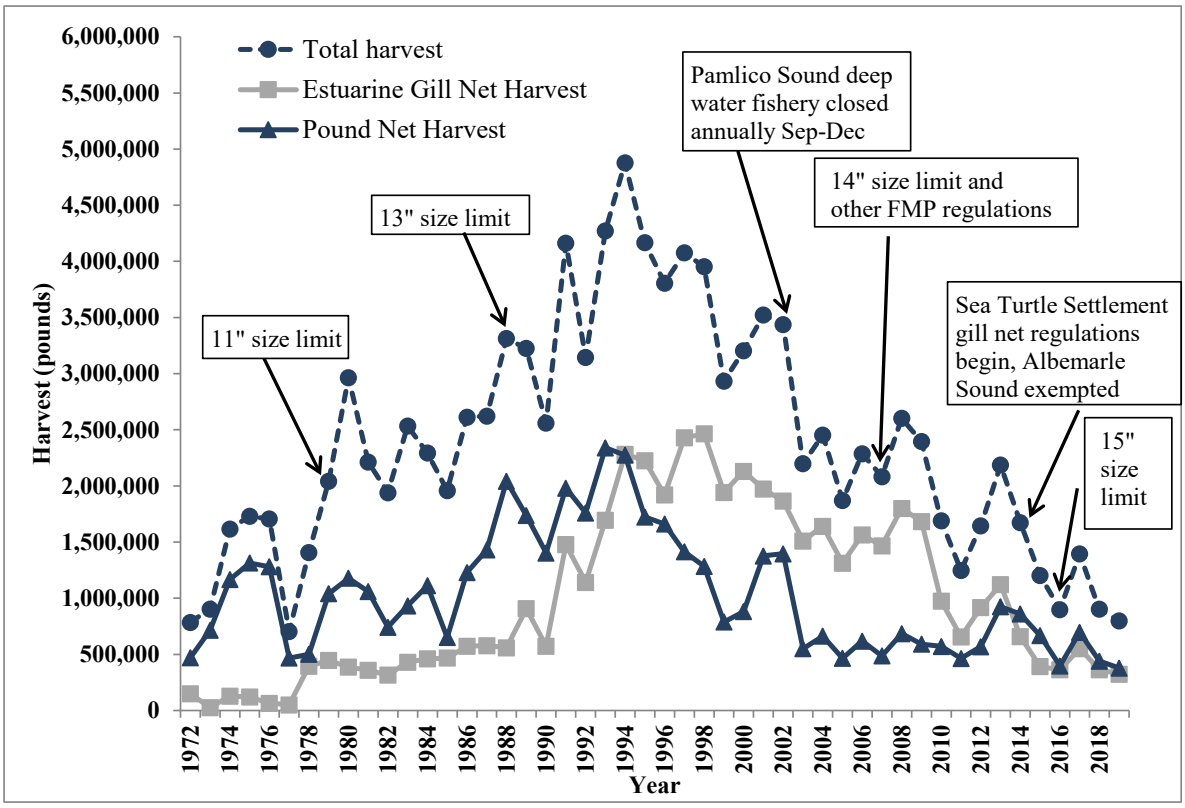

Figure 3. Southern flounder harvest (pounds) for total commercial fishery and top two gears (gill nets and pound nets) from N.C. Trip Ticket Program 1972-2019 with major fishery regulation changes.

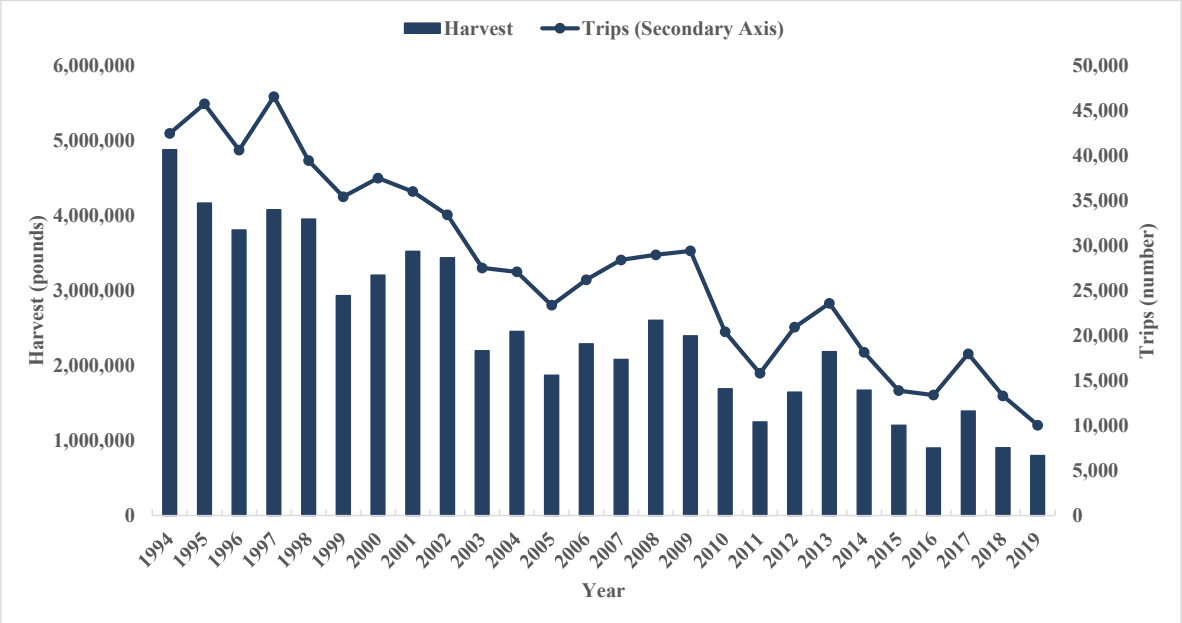

Figure 4. Southern flounder commercial trips (numbers) and harvest (pounds) from N.C. Trip Ticket Program, 1994-2019.

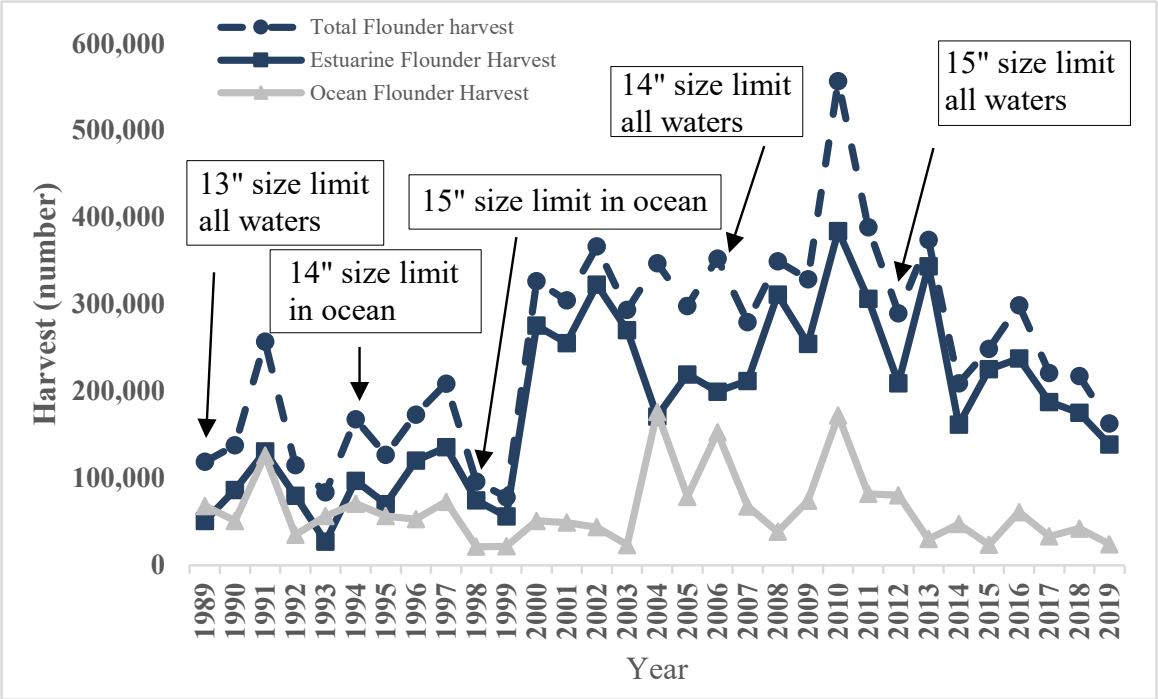

Figure 5. Southern flounder recreational hook and line harvest in numbers of fish from MRIP data 1989-2019 and major fishery regulation changes.

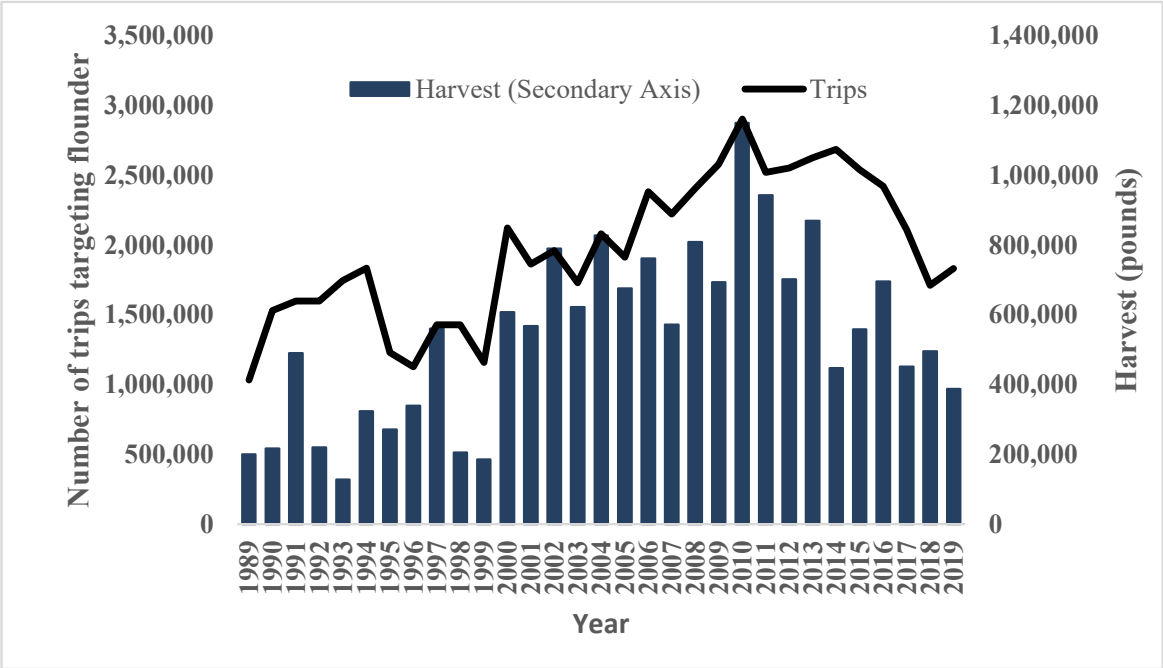

Figure 6. Recreational hook and line harvest (in numbers of fish) and all trips that harvested or released paralichthid flounder species, from MRIP data 1992-2019. Data from prior to 2004 were calibrated to align with MRIP estimates post-2004.

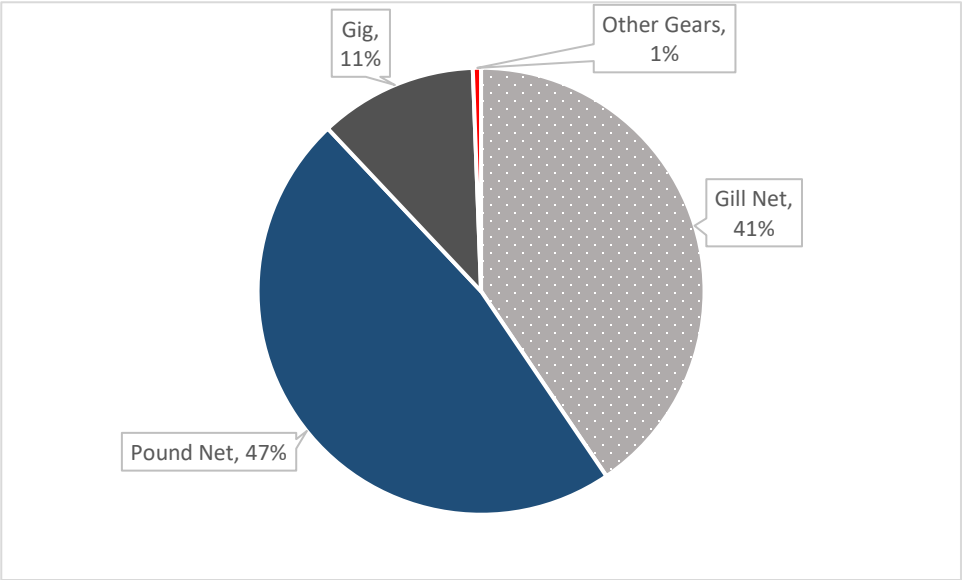

Figure 7. Commercial harvest of southern flounder in 2019 by gear type.

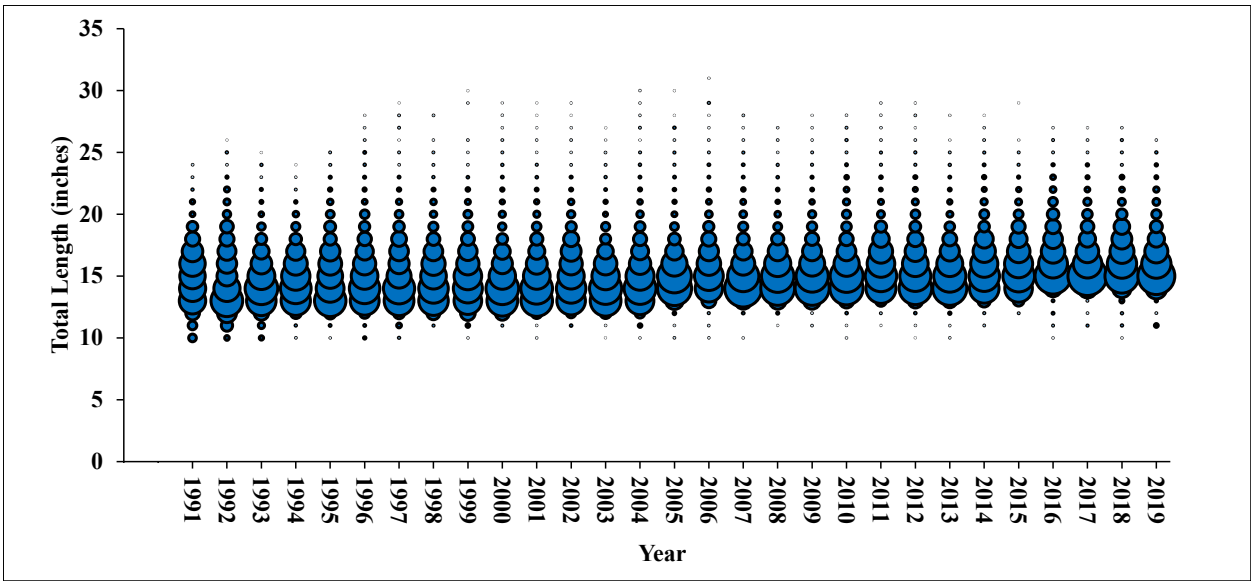

Figure 8. Commercial length frequency (total length, inches) of southern flounder harvested from 1991 through 2019. Bubbles represent fish harvested at length and the size of the bubble is equal to the proportion of fish at that length.

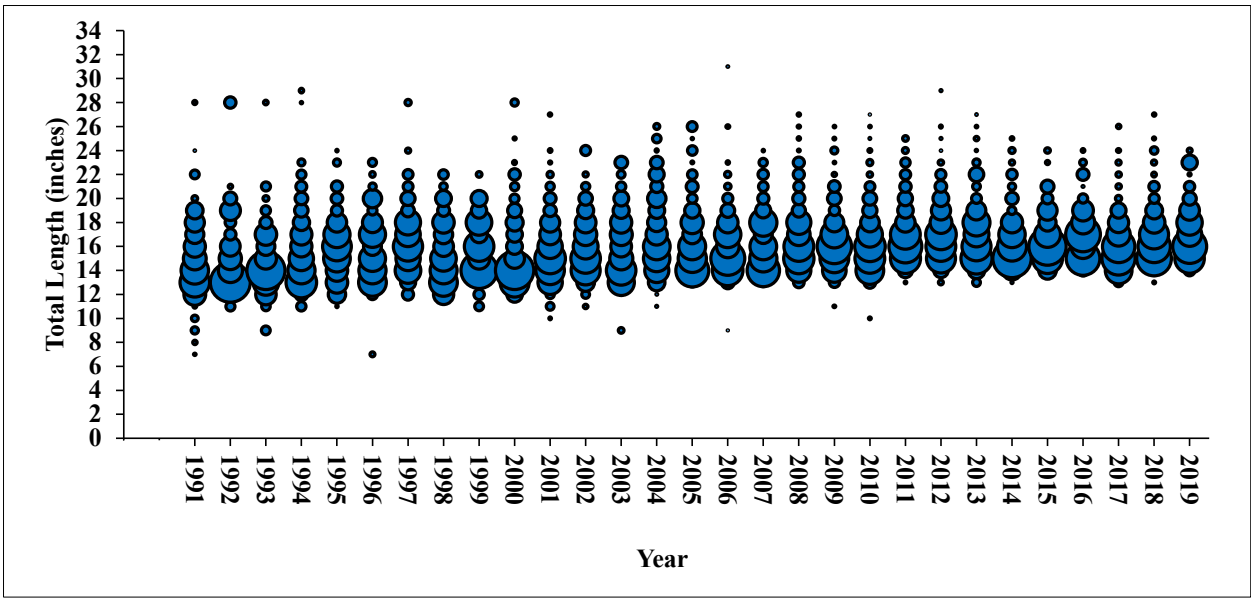

Figure 9. Recreational length frequency (total length, inches) of southern flounder harvested in North Carolina from MRIP, 1991 through 2019. Bubbles represent fish harvested at length and the size of the bubble is equal to the proportion of fish at that length.

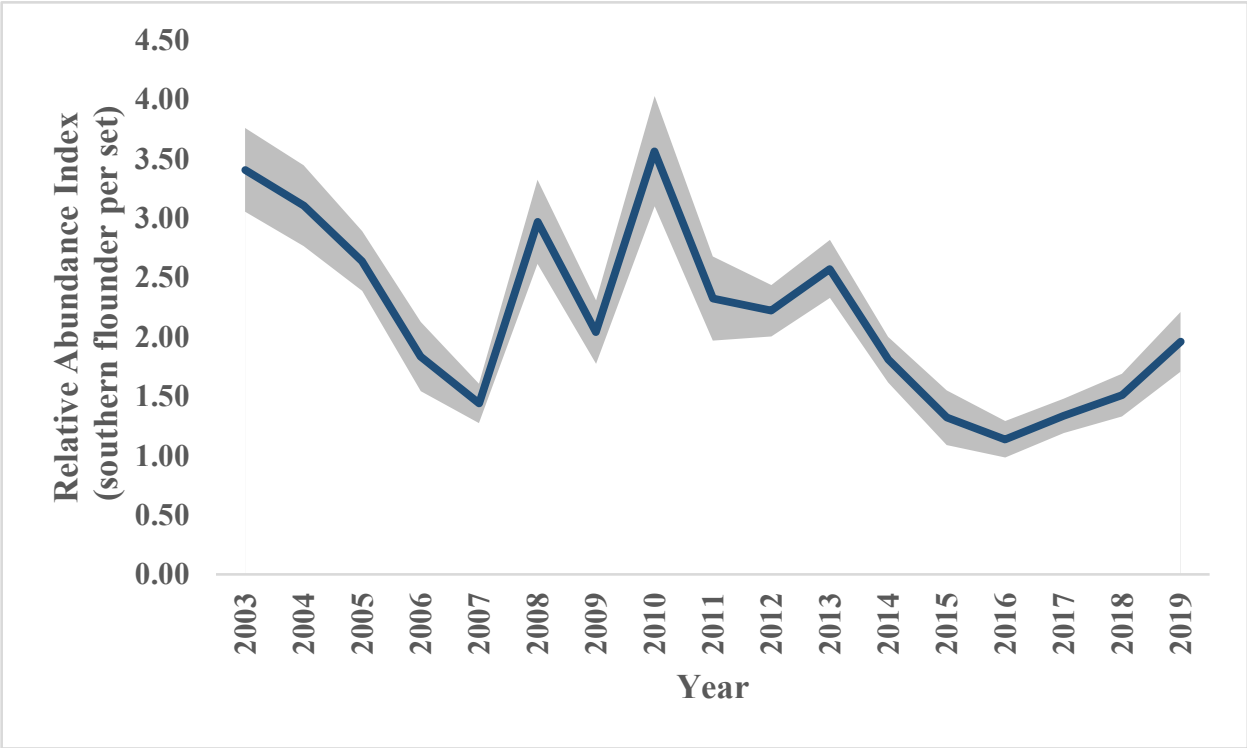

Figure 10. Annual nominal relative abundance index with standard error shaded in gray for southern flounder (juveniles and adults) caught in the North Carolina Pamlico Sound Independent Gill Net Survey.

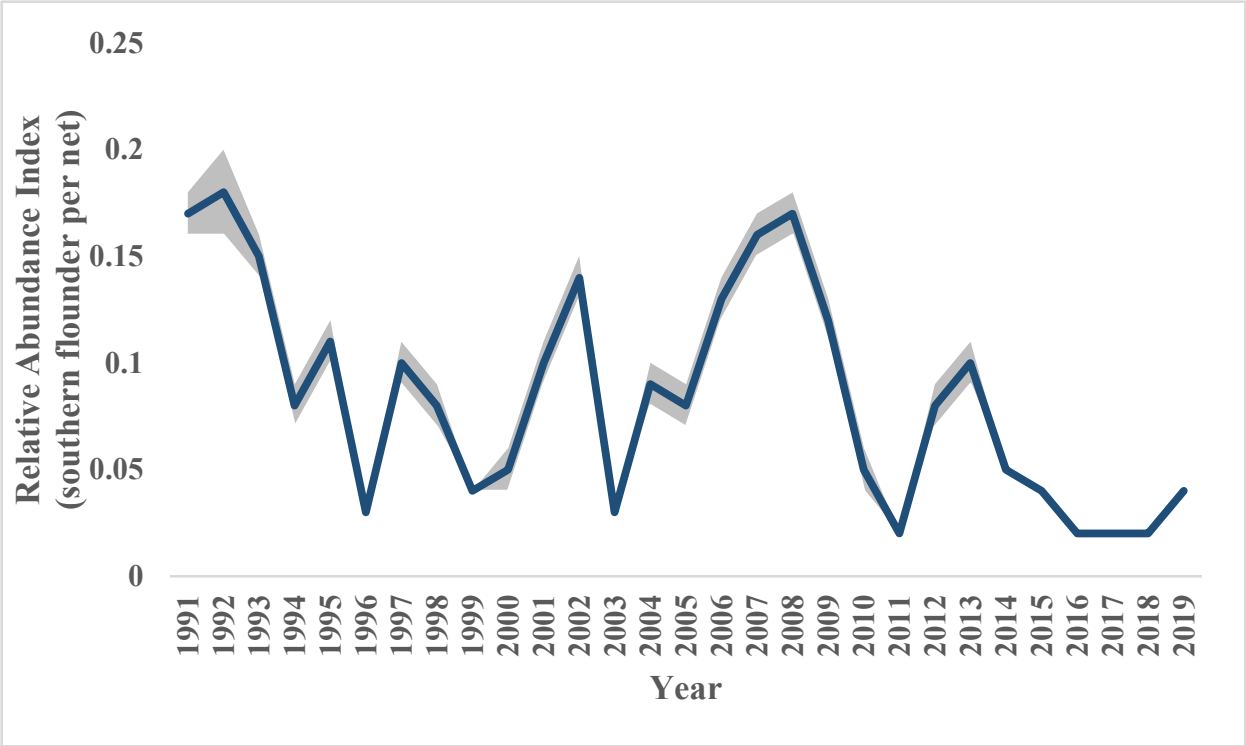

Figure 11. Annual nominal relative abundance index with standard error shaded in gray for southern flounder (juveniles and adults) caught in the North Carolina Striped Bass Independent Gill Net Survey.

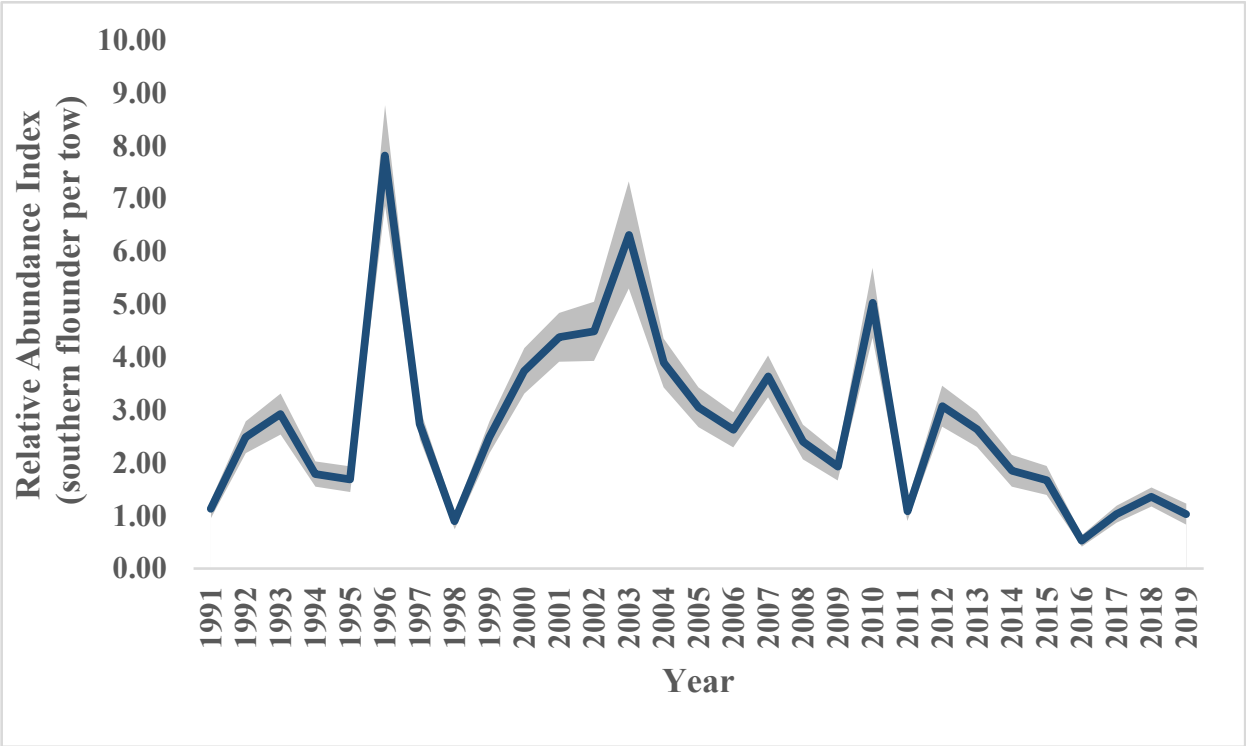

Figure 12. Annual nominal relative abundance index with standard error shaded in gray for southern flounder (juveniles and adults) caught in the North Carolina Estuarine Trawl Survey.

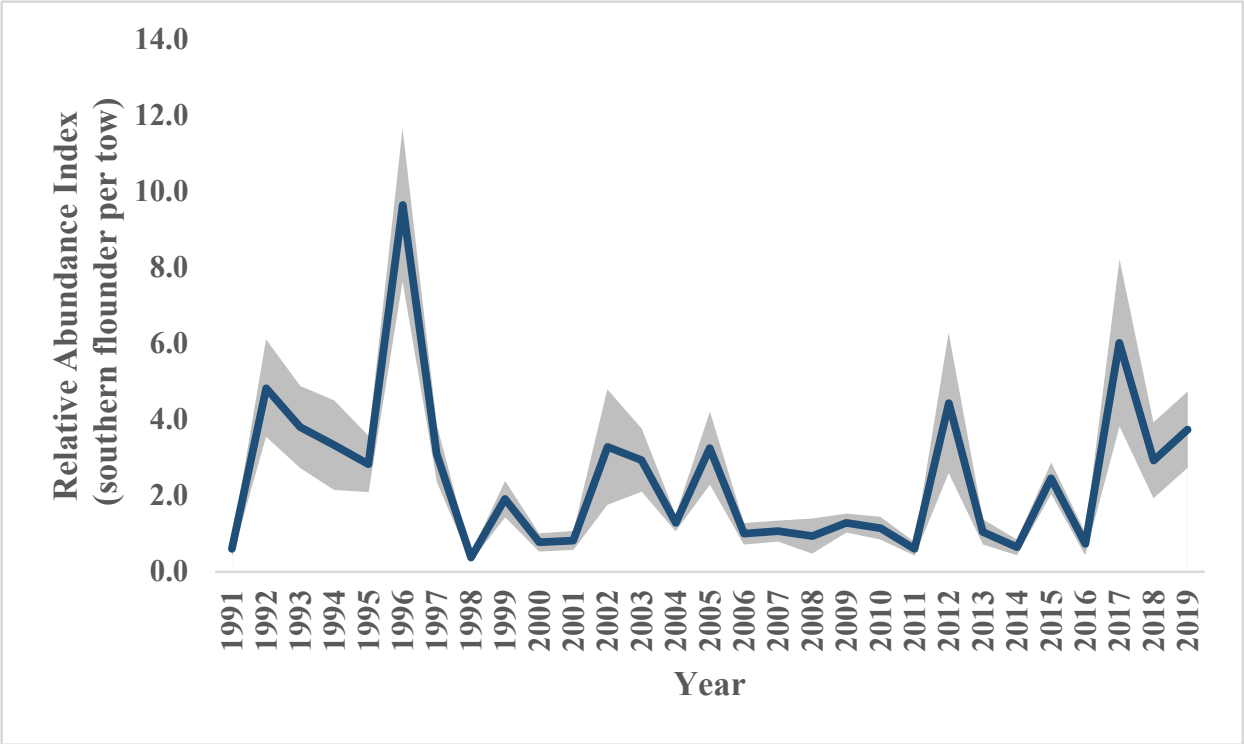

Figure 13. Annual nominal relative abundance index with standard error shaded in gray for southern flounder (juveniles and adults) caught in the North Carolina Pamlico Sound Survey.

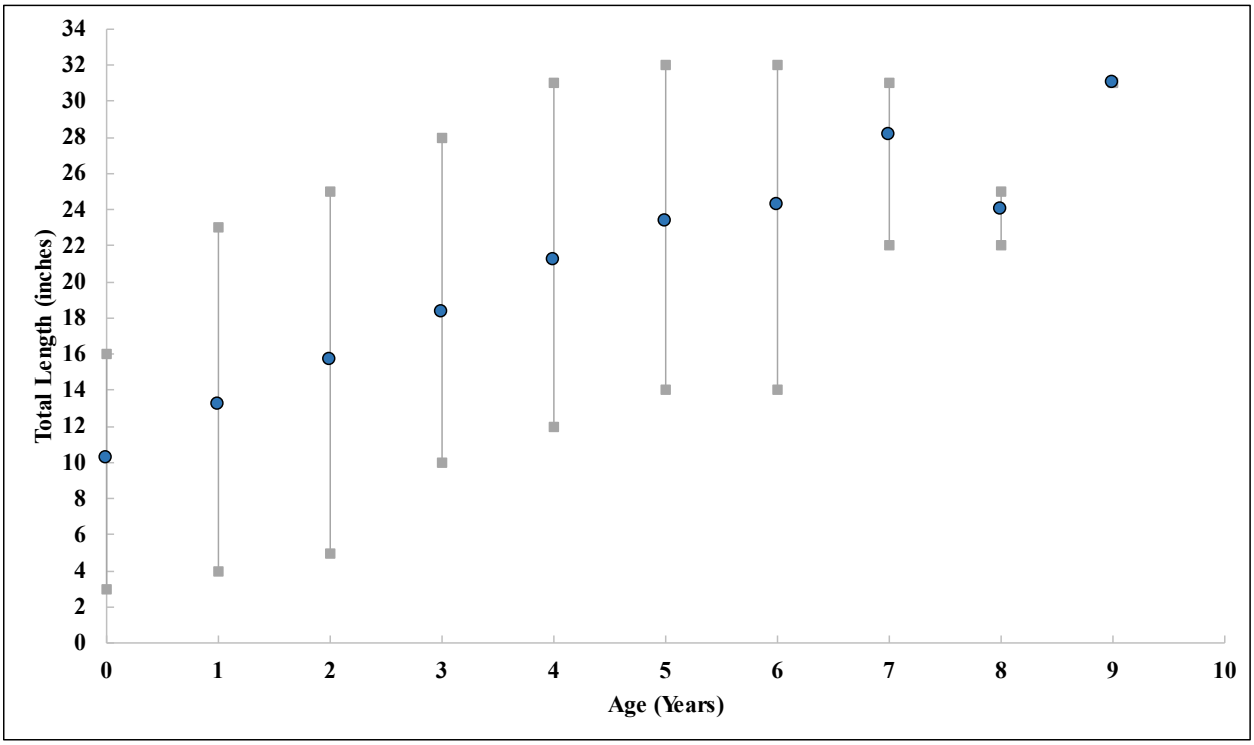

Figure 14. Southern flounder length at age based on all age samples collected from 1991 through 2017. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age. Note: preliminary 2018 and 2019 have not been included in this figure.