May 2022

North Carolina Southern Flounder Fishery Management Plan Amendment 3

North Carolina Division of Marine Fisheries

North Carolina Department of Environmental Quality
North Carolina Division of Marine Fisheries
3441 Arendell Street
P. O. Box 769
Morehead City, NC 28557

ACKNOWLEDGMENTS

Amendment 3 to the North Carolina (NC) Southern Flounder Fishery Management Plan (FMP) was developed by the N.C. Department of Environmental Quality (NCDEQ), North Carolina Division of Marine Fisheries (NCDMF) under the direction of the N.C. Marine Fisheries Commission (NCMFC) with the advice of the Southern Flounder Advisory Committee (AC). Deserving special recognition are the members of the Southern Flounder AC and the NCDMF Plan Development Team (PDT) who contributed their time and knowledge to this effort.

Southern Flounder Advisory Committee

Mary Ellon D. Balance
Keneth M. Johnson, Jr.
Michael R. Oppegaard
Joe Romano
Frederick Scharf
Bradley Styron
Kurt D. Tressler
James M. Williams

Southern Flounder Plan Development Team

Alan Bianchi
Ashley Bishop
Barbie Byrd
Drew Cathey
David Dietz
Charlton Godwin
Casey Knight
Laura Lee
Michael Loeffler, Co-lead
Anne Markwith, Co-lead
Nick Mobley
Tina Moore
Lee Paramore
Jason Rock
Brian Spain
Chris Stewart
Odell Williams
Chris Wilson

This document may be cited as:
NCDMF (North Carolina Division of Marine Fisheries). 2022. North Carolina Southern Flounder Fishery Management Plan Amendment 3. North Carolina Division of Marine Fisheries, Morehead City, North Carolina. 164p.

Disclaimer: Data in this Fishery Management Plan may have changed since publication based on updates to source documents.

Note: This document was edited in May 2023 to correct TAL to TAC on pages 80 and 83.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

GLOSSARY OF TERMS

Links to resources with a glossary of fishery terms are available below.

NCDMF: Defining Fisheries: A User's Glossary
ASMFC: Acronyms and Glossary of Commonly Used Terms
NOAA: Fisheries Glossary
FAO: Term Portal

LIST OF ACRONYMS

ACCSP—Atlantic Coast Cooperative Statistics Program
APAIS—Access Point Angler Intercept Survey
APT—Average Landings Per Trip
ASAP—Age Structured Assessment Program
ASMFC—Atlantic States Marine Fisheries Commission
CAP—Coastal Angling Program
CHPP—Coastal Habitat Protection Plan
CRFL—Coastal Recreational Fishing License
EEZ—Exclusive Economic Zone
ESA—Endangered Species Act
F—Fishing Mortality
FAO—Food and Agriculture Organization of the United Nations
FES—Fishing Effort Survey
FEUS—Fishery Economics of the U.S.
FMP—Fishery Management Plan
G.S. —General Statute
IMPLAN—Impact Analysis for Planning
ISM—Inch Stretched Mesh
ITP—Incidental Take Permits
MAFMC—Mid-Atlantic Fishery Management Council
MRIP—Marine Recreational Information Program
NCAC—North Carolina Administrative Code
NCDEQ—North Carolina Department of Environmental Quality
NCDMF—North Carolina Division of Marine Fisheries
NCDWR—North Carolina Division of Water Resources
NCMFC—North Carolina Marine Fisheries Commission
NCTTP—North Carolina Trip Ticket Program
NMFS—National Marine Fisheries Service
NOAA—National Oceanic and Atmospheric Administration
PSE—Proportional Standard Error
RSCFL—Retired Standard Commercial Fishing License
RCGL—Recreational Commercial Gear License
SAV—Submerged Aquatic Vegetation
SCFL—Standard Commercial Fishing License
SSB—Spawning Stock Biomass
TAC—Total Allowable Catch
TAL—Total Allowable Landings
TL—Total Length
#PAR—Number of Participants

EXECUTIVE SUMMARY

North Carolina's southern flounder resource has been harvested since the 1800s, with the first recorded landings in 1889. Southern flounder supports one of the largest and most valuable commercial fisheries in North Carolina and accounts for approximately 99% of the Atlantic coast commercial southern flounder landings. Recreationally, southern flounder in North Carolina has been the most targeted species for 20 of the last 30 years. The North Carolina recreational southern flounder fishery ranks second on the east coast for harvest and has more releases than any other state.

The 2019 coast-wide stock assessment, including data through 2017, determined the southern flounder stock is overfished and overfishing is occurring. North Carolina law requires management action to end overfishing within two years. Recovery of the stock from an overfished condition must occur within 10 years and provide at least a 50% probability of success from the date the plan is adopted. Rebuilding of this stock in 10-years requires a minimum reduction of 52% in total annual removals by weight for both the commercial and recreational fisheries based on 2017 harvest (landings and dead discards). Amendment 3 further refines and builds on action taken in Amendment 2, which adopted a more conservative 72% reduction for the fisheries to help ensure the statutory requirements for rebuilding the southern flounder stock, described above, are met. Management strategies implemented through Amendment 3 will not restart the time requirements set in Amendment 2 as approved in August 2019, that are necessary to meet the statutory mandates.

The goal of Amendment 3 is to manage the southern flounder fishery to achieve a self-sustaining population that provides sustainable harvest using science-based decision-making processes. The objectives to achieve this goal include: maintain/restore the southern flounder spawning stock with expansion of age structure and abundance to prevent overfishing; restore, enhance, and protect habitat and environmental quality; monitor and manage the southern flounder fishery and its ecosystem impacts; promote stewardship of the resource through outreach and interjurisdictional cooperation; and promote the restoration, enhancement, and protection of habitat consistent with the Coastal Habitat Protection Plan (CHPP).

To meet statutory requirements to achieve a self-sustaining southern flounder population, sustainable harvest is addressed in the FMP to ensure the long-term viability of the commercial and recreational fisheries. Other issues in the plan include increased recreational access, inlet corridors, adaptive management, sector allocations, slot limits, and phasing out anchored large-mesh gill nets from the North Carolina southern flounder fishery. Specific management measures selected by the NCMFC for each issue are as follows:

1) Sustainable Harvest:
   Selected quantifiable management measures for recovering the stock are:
   - implementation of a commercial quota allocated between mobile gears and pound nets where the state's mobile commercial gears are divided into two areas using the existing Incidental Take Permit (ITP) boundary line for management units B–D and

the state's pound net fishery is divided into three areas, consistent with Amendment 2;

- maintain 72% reduction and current sub-allocation for the pound net fishery with direction from the North Carolina Marine Fisheries Commission (NCMFC) as follows: "In 2024, as the shift in allocation is set to start the division will provide recommendations to the NCMFC on approaches to maintaining a sustainable sub-allocation for the commercial pound net fishery, as needed based on the economic and biotic conditions at that time"; and
- implement a single season for the recreational gig and hook-and-line fisheries to constrain them to an annual quota.

These management measures in conjunction with accountability measures that will better maintain flounder harvest to the overall quota are estimated to result in a 72% harvest reduction from the 2017 harvest value.

Selected non-quantifiable management measures include:

- the use of trip limits specifically for pound nets and gigs to allow limited harvest within the quota after reaching the division's initial closure threshold;
- a reduction in the recreational bag limit to one fish per person per day; and
- prohibit the use of Recreational Commercial Gear License (RCGL) gear for the harvest of southern flounder.

These management measures, while not having measurable reductions, could help improve the condition of the southern flounder stock and provide tools for meeting management targets.

Additionally, a resolution was passed that the NCMFC recognizes that there may need to be consideration of a moratorium if there are continued excesses in the allowable catch of flounder in both sectors.

2) Increased Recreational Access by Managing Southern Flounder Separately from other Flounder Species:

   The selected management measures include:

   - one-fish ocellated flounder bag limit during March 1 – April 15 for hook-and-line in ocean waters only
   - one-fish any flounder bag limit during the southern flounder season.

   These measures increase recreational access to summer and Gulf flounder while maintaining the harvest reductions in the southern flounder fishery. The earliest this spring season could occur is 2023 as summer flounder management conservation equivalency is needed from the Atlantic States Marine Fisheries Commission (ASMFC) and Mid-Atlantic Fishery Management Council (MAFMC). Any harvest of southern flounder in this early season will impact the length of the fall southern flounder season.

3) Inlet Corridors:

   The selected management strategy is to not implement inlet corridors for southern flounder at this time. Landings and tagging data have not identified inlets as areas of increased exploitation for southern flounder, and research is being conducted to provide additional information about southern flounder inlet use.

4) Adaptive Management:
   The selected management strategy is to adopt the adaptive management framework based on the approved peer-reviewed stock assessment. Implementation of an adaptive management strategy for the North Carolina southern flounder fishery provides flexibility for maintaining the total allowable landings. The framework allows for additional protections for the fishery while ensuring future sustainability.
5) Sector Allocations in the Southern Flounder Fishery:
   At the Nov. 2020 business meeting, the NCMFC requested analysis of various recreational and commercial allocation percentages. In March 2021, the NCMFC voted on and approved sector allocations of 70/30 commercial to recreational for 2021 and 2022 and shifting to 60/40 for 2023, and 50/50 parity beginning in 2024.
   Based on recognition of a series of coincident concerns specific to the initial steps in rebuilding the southern flounder fishery, the NCMFC voted in Feb. 2022 to delay the transition to 50/50 parity by two years (time for at least one cycle of larval to female maturity). The selected allocations will be 70/30 for 2023 and 2024, 60/40 for 2025, and 50/50 parity starting in 2026.
6) Implementing a Slot Limit in the Southern Flounder Fishery:
   The impacts of harvest size slot limits at various sizes in the recreational hook-and-line southern flounder fishery were examined. The selected management measure is not to implement a slot limit and maintain the 15-inch total length (TL) minimum size.
7) Phasing Out Large-Mesh Gill Nets in the North Carolina Southern Flounder Fishery:
   The selected management strategy is to continue to allow anchored large-mesh gill nets to harvest southern flounder in the North Carolina southern flounder fishery. The issue to phase out large-mesh gill nets by the end of the current sea turtle ITP in 2023 originated from a request by the NCMFC. Sustainable harvest in the southern flounder commercial fishery can be achieved with or without the use of anchored large-mesh gill nets.

The NCMFC adopted Amendment 3 to the North Carolina Southern Flounder Fishery Management Plan on May 26, 2022. The NCDMF will implement management measures as selected under Amendment 3 and directed by the NCMFC.

INTRODUCTION

This is Amendment 3 to the N.C. Southern Flounder FMP. The last review of the plan (Amendment 2) was approved by the NCMFC in August 2019 and implemented a reduction in fishing mortality in the commercial and recreational fisheries to a level that ends overfishing within two years and allows the spawning stock biomass (SSB) to increase between the threshold and the target within 10 years. This was accomplished via targeted reductions of 62% in total removals in 2019 and 72% beginning in 2020. While the minimum statutory requirement to meet the rebuilding threshold was a 52% reduction, management actions approved through Amendment 2 exceeded the minimum to increase the probability of successfully rebuilding this important recreational and commercial resource. Amendment 2 followed a peer review workshop evaluating the 2018 coast-wide stock assessment for southern flounder. 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. Results of the 2019 update indicate the stock is overfished and overfishing is occurring (Flowers et al. 2019). Analyses were conducted to estimate projections of reductions to fishing mortality that is necessary to end overfishing and to determine which reductions would be necessary to rebuild the spawning stock biomass and end the overfished status.

Amendment 2 was expedited to begin rebuilding the stock immediately. Due to the shortened time frame for development, Amendment 2 incorporated a seasonal approach to meet reductions while deferring more complex and comprehensive management strategies to be developed in Amendment 3. In Amendment 3, the management strategies have been updated to include a quota-based fishery with accountability measures for both the commercial and recreational sectors based on delayed allocation changes, commercial gear sub-allocations, commercial trip limits, reductions in recreational bag limits, prohibiting recreational commercial gear license holders from harvesting southern flounder, increased recreational access through spring ocellated flounder season, and adaptive management. These strategies will be implemented through the Director's proclamation authority following the adaptive management framework adopted by this plan.

The original FMP, Amendments, Supplements, annual FMP update, and stock assessments are available on the NCDMF Fishery Management Plans webpage.

MANAGEMENT AUTHORITY

All management authority for the North Carolina southern flounder fishery is vested in the State of North Carolina. The NCMFC adopts rules and policies and implements management measures

for the southern flounder fishery. While sole management authority of southern flounder rests with the state, in North Carolina recreational flounder management is by an aggregate of three species [southern, summer (*P. dentatus*), and Gulf (*P. albigutta*) flounders]. Therefore, the state's management of southern flounder is also impacted in the ocean by the joint ASMFC/ MAFMC Summer Flounder, Scup, and Black Sea Bass FMP. This impacts southern flounder management in ocean waters off North Carolina with ASMFC impacting the state waters and MAFMC impacting the federal Economic Exclusion Zone (EEZ) waters. Approval of changes by ASMFC may not be required if the changes are expected to be more restrictive than the management measures already approved by ASMFC. Changes to the summer flounder fishery in EEZ waters off North Carolina may be impacted by the MAFMC and National Marine Fisheries Service (NMFS) until conservation equivalencies are approved by NMFS.

GOAL AND OBJECTIVES

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.

DESCRIPTION OF THE STOCK

BIOLOGICAL PROFILE

Physical Description

Southern flounder exhibit a unique body type compared to most other fish species, belonging to a subgroup known as flatfishes. While most fish species are bilaterally symmetrical and have body parts equally distributed on each side of their body, flatfish species, including southern flounder, possess both eyes on one side of the body and are considered to lack symmetry. Newly hatched southern flounder larvae have bilateral symmetry but after currents carry them into the estuaries

LEFTEYE FLOUNDER

Flounder are classified into families based on the side of their head their eyes are on, left or right. Southern flounder belong to the left eye flounder family because in almost all cases the right eye migrates to the left side of their head.

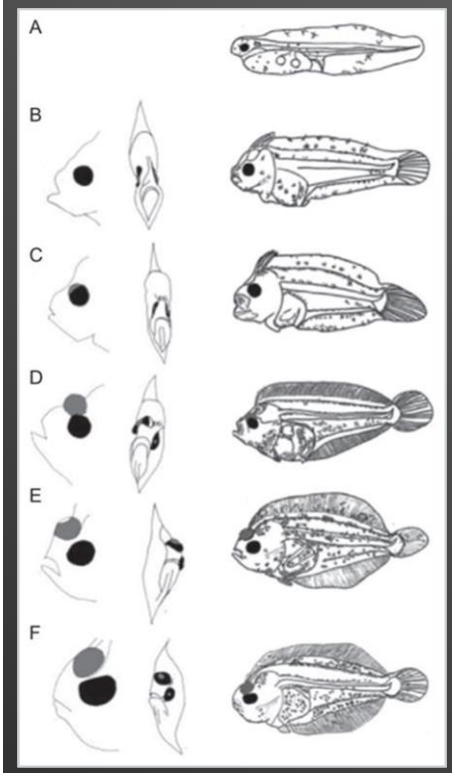


Figure 1. Stages of the summer flounder Paralichthys dentatus. (A) Hatched yolk-sac larva. (B) Pre transformation larva before eye migration (C) beginning of eye migration. (D) Mid-stage. (E) Climax, right eye has migrated over the dorsal midline. (F) Young juvenile. Left column shows the eye migration across the skull; migrating right eye is shaded in gray. Right column shows whole-body changes. Image originally printed in Martinez and Bolker 2003.

they, like other left-eyed flounder (e.g., summer flounder), undergo metamorphosis (Figure 1; Francis and Turingan 2008; Schreiber 2013).

Due to this metamorphosis, southern flounder are known to be "left handed" because the right eye shifts and the eye-side of the flounder is the left side (Daniels 2000). Southern flounder also exhibit a unique pattern of pigmentation where the "top" side of the fish is dark, contrasting with the white coloration typical of the "bottom" side. Southern flounder tend to be bottom dwellers and can use the dark pigmentation on the "top" side to blend into the surrounding habitat to hide from predators and ambush prey (Arrivillaga and Baltz 1999).

Distribution

Southern flounder are widely distributed along the United States (Blandon et al. 2001). In the Atlantic Ocean, southern flounder reside in coastal habitats from North Carolina to Cape Canaveral, Florida. A small number of southern flounder have been observed north of North Carolina. In the Gulf of Mexico, southern flounder can be found from northern Mexico to Tampa, Florida. Genetic studies have indicated there is little to no movement of southern flounder between the Gulf of Mexico and Atlantic Ocean as the peninsula of Florida acts as an ecological barrier (Blandon et al. 2001; Anderson and Karel 2012; Midway et al. 2014).

Tagging studies show that individual southern flounder are capable of undergoing movements from North Carolina to the east coast of Florida (Craig et al. 2015; Loeffler et al. 2019). Additionally, genetic studies indicate that individuals from North Carolina to Florida are capable of spawning together and that the Atlantic Ocean population is well mixed (Wang et al. 2015). While each Atlantic state manages southern flounder in their own waters, based on this life history information, a multi-state cooperative group stock assessment was used to determine the status of the unit stock (see the *Stock Status* section below).

Habitat

More information is known about habitat use for southern flounder in estuarine habitats than the ocean. As southern flounder mature around age-2 they migrate out of the estuaries and spawn in the ocean but this migration to ocean spawning grounds is not well understood (Figure 2). No surveys or large-scale fisheries exist for these fish in the ocean and therefore, it is difficult to directly observe where adult southern flounder go after they leave the estuary and what drives their habitat selection once offshore. The location and/or the number of offshore spawning ground(s) is currently unknown (Midway and Scharf 2012), though research is currently underway to determine these locations and migratory pathways. Most of the direct examination of southern flounder habitat use has occurred within estuarine environments where juveniles are easily accessible for scientific study (Burke et al. 1991; Fitzhugh et al. 1996; Froeschke et al. 2013).

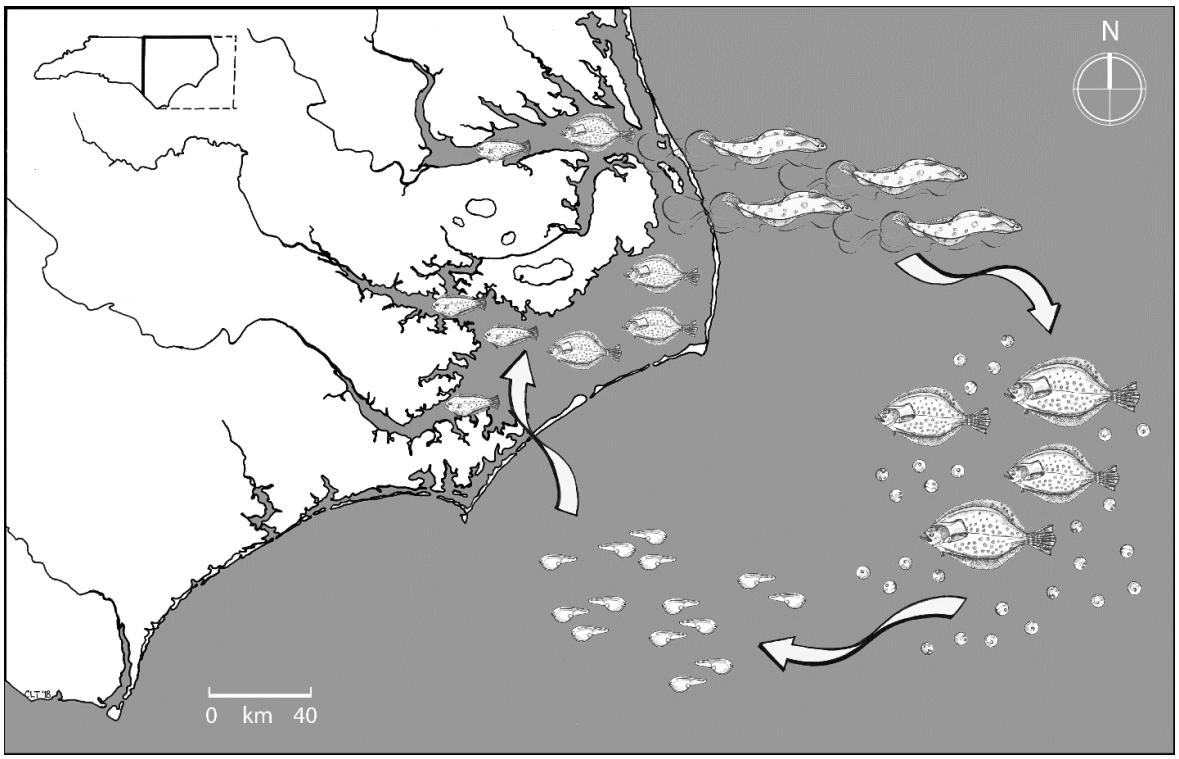


Figure 2. Artist interpretation of the southern flounder life cycle. Image originally printed in Hollensead 2018.

Larval southern flounder are transported into sounds and estuaries during late winter and early spring by wind-driven currents (Figure 2; Taylor et al. 2010) and survival is greatly influenced by a number of variables. Once within the estuary, southern flounder typically settle in low salinity areas (Burke et al. 1991; Miller et al. 1991; Lowe et al. 2011). Despite the tolerance of young juvenile southern flounder to various salinities, low dissolved oxygen values have been shown to inhibit growth of newly settled southern flounder (Taylor and Miller 2001; Del Toro-Silva et al. 2008). As southern flounder age they can tolerate prolonged periods of low dissolved oxygen, and are thought to remain in low oxygen areas as a trade-off to expending energy by moving into other areas where environmental conditions may not necessarily improve (Ellis 2007).

In addition to water quality influences, bottom structure and water depth are important drivers of juvenile southern flounder habitat selection. The presence of sea grass and/or marsh edge has been shown to have a positive effect on southern flounder abundance (Nañez-James et al. 2009; Furey and Rooker 2013) and these structures have been known to serve as refuge for estuarine juvenile fishes (Rooker et al. 1998; Stunz et al. 2002). Several studies have indicated that water depths of less than three feet are significantly related to southern flounder abundance (Walsh et al. 1999; Furey et al. 2013; Froeschke et al. 2013). Potentially, the use of shallow near-shore areas by southern flounder during their juvenile period increases survivorship by protecting individuals from predators (Manderson et al. 2004). However, southern flounder overwintering in the estuary may select deeper waters or move to higher salinity areas near ocean inlets where environmental conditions are more stable during winter months (Hollensead 2018). For additional information on how habitat and water quality affect southern flounder see the *Ecosystem and Fishery Impacts* section.

Reproduction

Southern flounder migrate out of North Carolina estuaries from mid-October to mid-November to spawn (Hollensead 2018). No direct observation of spawning has been observed in the wild, but laboratory experiments have been conducted to quantify southern flounder fecundity (number of eggs) and fertilization success (Watanabe et al. 2001).

In North Carolina, 50% of females are considered mature by 16 inches TL and ages 1 or 2 (Midway and Scharf 2012). This length at maturity is larger than what has been reported in Florida (8.4 inches TL; Topp and Hoff 1972) and the Gulf of Mexico (12 inches TL; Corey et al. 2017), indicating a potential shift in length-at-maturity the further south the species occurs (Lee et al. 2018).

The otoliths or ear bones of fish are used for balance. Researchers use otoliths to age fish much like counting rings of a tree.

Age and Growth

Growth rate and length-at-age in North Carolina are highly variable for southern flounder (Fitzhugh et al. 1996). Juvenile female southern flounder exhibit a higher growth rate than male southern flounder (Midway et al. 2015) and females generally attain a larger maximum size compared to males (Fischer and Thompson 2004). In North Carolina, the maximum observed age is older for females at nine years compared to six years for males and maximum observed length was 33 inches TL for females and 20

inches TL for males (Lee et al. 2018). More age and growth information is in the annual Southern Flounder FMP Update.

Predator-Prey Relationships

Southern flounder are bottom dwelling, ambush predators that use their unique coloring to camouflage themselves in order to opportunistically feed on a wide range of prey species (Burke 1995; Arrivillaga and Baltz 1999). Young juvenile southern flounder generally eat small invertebrate species (Ellis 2007) before shifting to a diet made up of mostly other fish species (Fitzhugh et al. 1996). In general, the most common prey fish species encountered in adult southern flounder diets are bay anchovy (*Anchoa mitchilli*), spot (*Leiostomus xanthurus*), and spotfin mojarra (*Eucinostomus argenteus*; Wenner et al. 1990). Some predators of southern flounder include sandbar sharks (*Carcharhinus plumbeus*; Ellis and Musick 2007) and bird species (Kellison et al. 2000; Hossain et al. 2002).

STOCK STATUS

For the full 2019 stock assessment report see Flowers et al. 2019.

Stock Unit Definition

The biological unit stock assumed for the stock assessment (Flowers et al. 2019) is based on multiple tagging studies (Ross et al. 1982; Monaghan 1996; Schwartz 1997; Craig and Rice 2008), genetic studies (Anderson and Karel 2012; Wang et al. 2015), and an otolith morphology study (Midway et al. 2014), all of which provide evidence of a single stock occurring in waters of North Carolina, South Carolina, Georgia, and the east coast of Florida.

Assessment Methodology

Landings and dead discards were incorporated into a quantitative model that estimates both historical and current population sizes and harvest rates. Landings and dead discards were available from the commercial and recreational fisheries. Eight fishery-independent surveys were also inputs into the model, including recruitment indices from North Carolina, South Carolina, and Florida and adult indices from North Carolina, South Carolina, Georgia, and Florida, and a near-shore ocean survey from Cape Hatteras, North Carolina to Cape Canaveral, Florida.

When considering population size and long-term viability, stock assessments most often use a measure of female spawning stock biomass to determine the population's health. Female spawning stock biomass includes female fish that are mature and capable of producing offspring. Fishing mortality, abbreviated as *F*, is a measure of how fast fish are being removed from the population by the different fisheries. Removals include those fish that are kept and those that are discarded dead or die after release.

The stock assessment's current (2017) estimates of female SSB and fishing mortality rates were compared to levels that are considered sustainable. These sustainable levels are based on established reference points that include a target and threshold. The threshold is the minimum level required for sustainability and when that level is achieved, the stock is considered healthy. The

target is a level that provides a buffer to minimize risk and increases the probability of successfully rebuilding the stock. If current female SSB is less than the threshold for biomass, the stock is said to be overfished. If the current harvest rate is greater than the associated threshold, the current rate of removals is too high and overfishing is said to be occurring. Overfishing is the state of removing fish at an unsustainable rate that will ultimately reduce the female spawning stock biomass and result in an overfished stock.

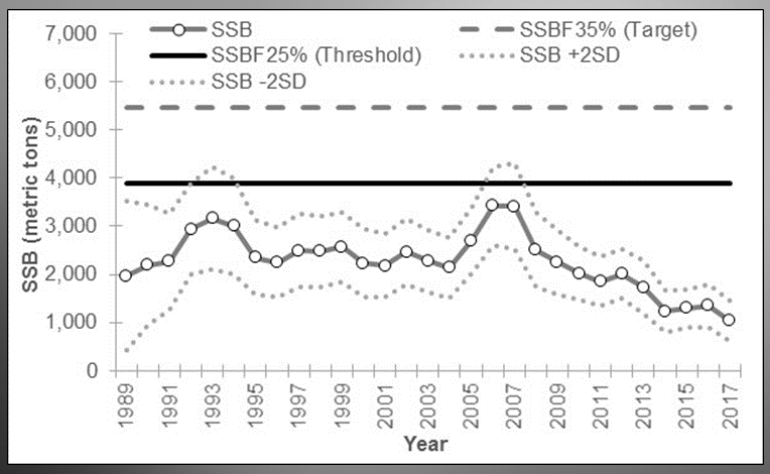


Figure 3. Predicted female spawning stock biomass (SSB) from the base run of the ASAP model, 1989–2017. Dotted lines represent ± 2 standard deviations (SD) of the predicted values. (Source: Flowers et al. 2019)

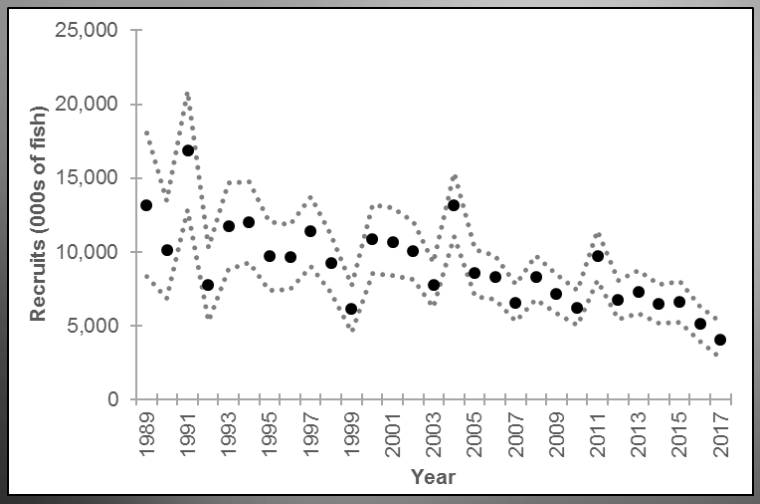


Figure 4. Predicted number of recruits (thousands of fish) from the base run of the ASAP model, 1989–2017. Dotted lines represent ± 2 standard deviations (SD) of the predicted values. (Source: Flowers et al. 2019)

Current Stock Status

Results show that SSB has decreased since 2006 (Figure 3) and recruitment, while variable among years, has a generally declining trend (Figure 4). Fishing mortality did not exhibit much inter-annual variability and suggests a decrease in the last year of the time series (Figure 5).

The model estimated a value of 0.35 for $F_{35\%}$ (fishing mortality target) and a value of 0.53 for $F_{25\%}$ (fishing mortality threshold; Figure 5). The estimate of $SSB_{35\%}$ (target) was 5,452 metric tons and the estimate of $SSB_{25\%}$ (threshold) was 3,900 metric tons (Figure 3).

The level of female SSB that represents the minimum level of sustainability for southern flounder was estimated at 8.6 million pounds. The stock assessment estimate of female SSB for southern flounder in 2017 was 2.3 million pounds.

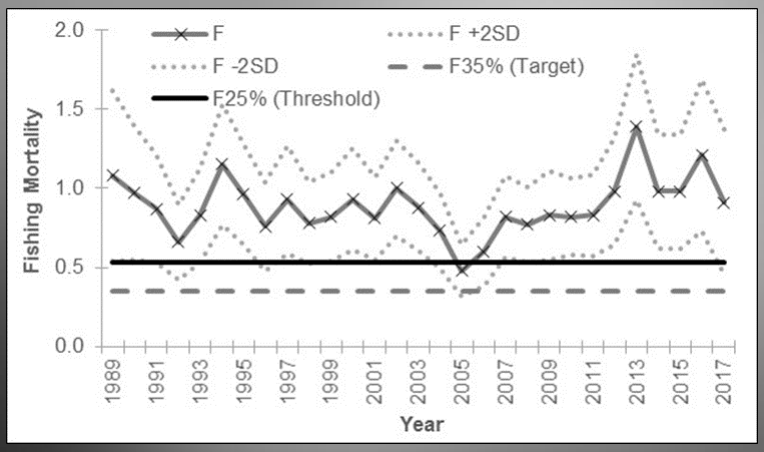


Figure 5. Predicted fishing mortality (F) rates (numbers-weighted, ages 2–4) from the base run of the ASAP model, 1989–2017. Dotted lines represent ± 2 standard deviations (SD) of the predicted values. (Source: Flowers et al. 2019)

Because the current (2017) estimate of female SSB is below the threshold reference point, the stock is considered overfished (Figure 3). The probability that the 2017 estimate of SSB is below the threshold value is 100%.

The assessment model estimated that *F* can be no greater than 0.53 for a sustainable southern flounder population. The current (2017) estimate of *F* from the stock assessment was 0.91, which is above the threshold *F* reference point (Figure 5). Because the current (2017) *F* is above the threshold, overfishing is occurring. The probability the 2017 *F* is above the threshold value is 96%.

Projections

Calculations were made to determine the reductions in total catch necessary to end overfishing and to reach the fishing mortality threshold and target. Additionally, a series of projections were performed to examine future stock conditions under various management scenarios. The calculations of percent reductions indicate that a minimum of a 31% reduction in total catch (landings plus discards from all fleets) would be required to end overfishing. However, while this reduction is sufficient to end overfishing in two years, it is not sufficient to rebuild SSB to meet the 10-year schedule to end the overfished status (Figure 6).

Projections were also carried out to determine the fishing mortality and the associated reduction in total catch necessary to end the overfished status and to reach the SSB target within 10 years (by 2028, assuming management-imposed regulations beginning in 2019). The projections indicate that an *F* equal to 0.34 and a 52% reduction in total catch is needed to reach the SSB threshold by 2028 and end the overfished status (Figure 7). To reach the SSB target by 2028, *F* needs to be lowered to 0.18 and total catch needs to be reduced by 72% (Figure 8).

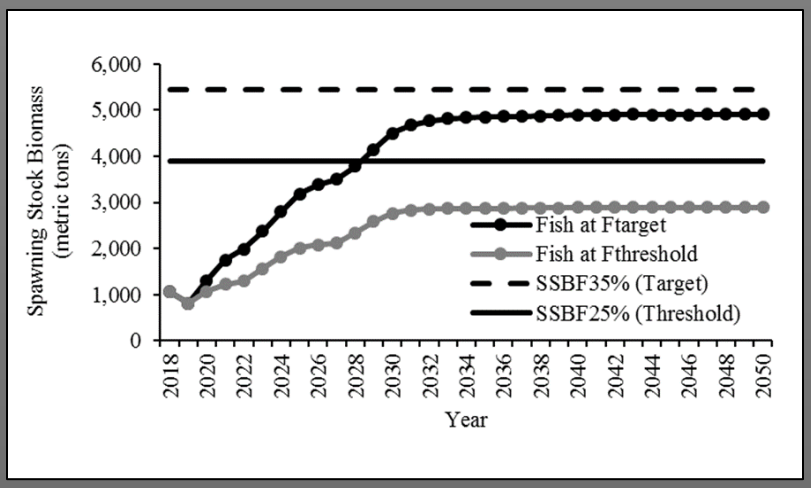
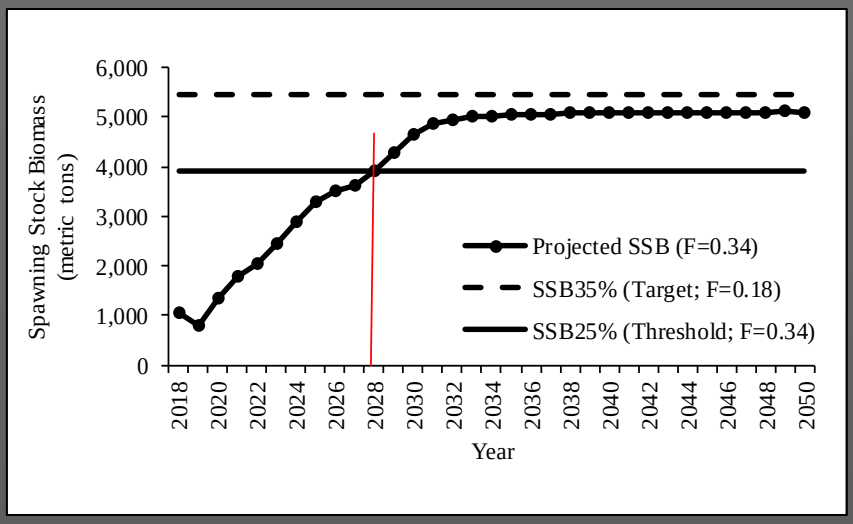


Figure 6. Projections of spawning stock biomass (SSB) related to fishing at a level to end overfishing in the required two-year period. Note: SSB does not rebuild within required ten-year time period. (Source: Flowers et al. 2019)

Figure 7. Predicted future spawning stock biomass (metric tons) assuming the fishing mortality value necessary to end the overfished status by 2028 (indicated by vertical red line). (Source: Flowers et al. 2019



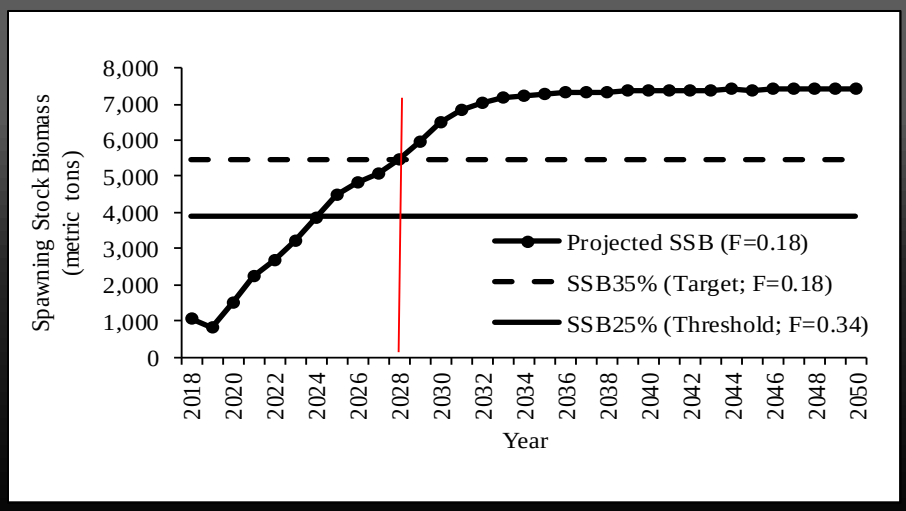


Figure 8. Predicted future spawning stock biomass (metric tons) assuming the fishing mortality value necessary to reach the SSBTarget by 2028 (indicated by vertical red line). (Source: Flowers et al. 2019)

ECOSYSTEM AND FISHERY IMPACTS

Habitat use patterns of southern flounder vary over time and space by life stage. The growth and survival of southern flounder within the habitats they use are maximized when water quality parameters, such as temperature, salinity, and dissolved oxygen, are within optimal ranges. For further information on habitat use by life stage and optimal water quality parameters, see the *Description of the Stock* section. Additional information on the habitats discussed below, threats to these habitats, and water quality degradation, as well as how these topics relate to fisheries can be found in the CHPP and various Division of Water Resources (NCDWR) publications (NCDWQ 2000a, 2008a; NCDEQ 2016a) (Figure 9).

While southern flounder can be found in both the estuaries and the ocean, more is known about the species as it occurs in the estuary. This section will mostly focus on the importance of the estuarine habitats, inlets, and ocean bottoms used by southern flounder and the broad effects of the southern flounder fishery on the habitat and ecosystem in these areas.

HABITAT DEGRADATION AND LOSS

Southern flounder migrate through the coastal ecosystem over their life cycle using multiple habitats. Many habitat types are particularly important as nursery, refuge, and forage habitats. Coastal inlets and ocean bottom also act as an important corridor from estuarine nursery habitat to ocean spawning areas. These and other potentially important flounder habitats are described in detail in the CHPP which can be found here: https://deq.nc.gov/about/divisions/marine-fisheries/public-information-and-education/habitat-information/chpp (NCDEQ 2016). Additionally, research is underway by the division and universities to identify spawning areas and associated habitats for southern flounder in the ocean.

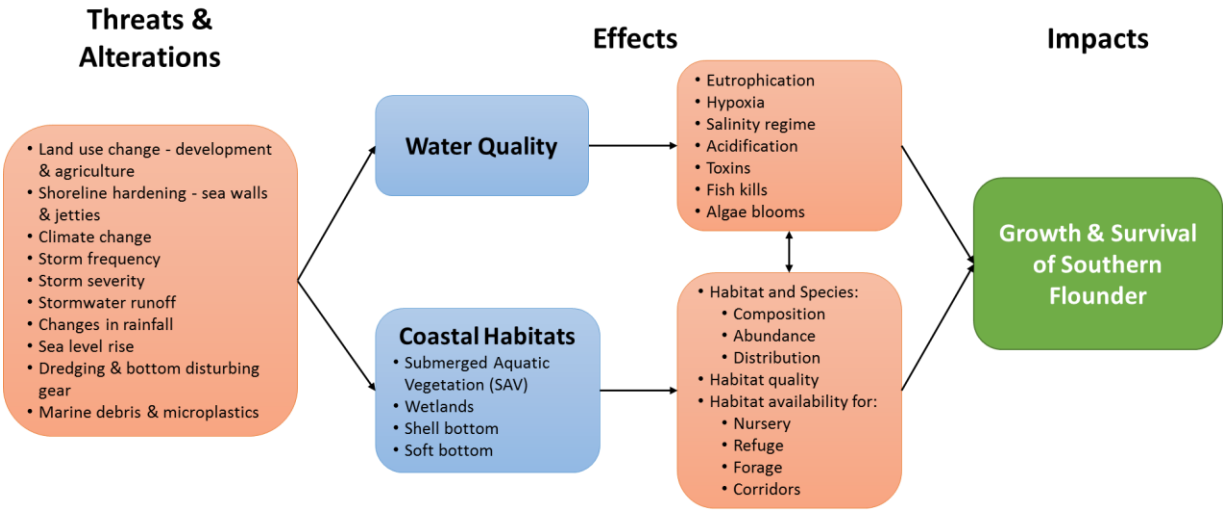


Figure 9. Effects of threats and alterations on water quality and coastal habitats and their ultimate impact on the growth and survival of southern flounder.

Portions of these habitats have been degraded or lost over time by a variety of anthropogenic (human caused) sources. It is difficult to quantify how habitat degradation may alter southern flounder population dynamics, but it is important to understand how habitat loss and condition controls the growth and survival of estuarine fish species. Protection and enhancement of these areas may be particularly important for growth and survival of juveniles to adult southern flounder. Key habitats for juvenile southern flounder in estuaries for foraging, refuge, and their growth to adults include: submerged aquatic vegetation (SAV), wetlands, shell bottom, and soft bottom (Table 1; Rozas and Odum 1987; Burke et al. 1991; Mitsch and Gosselink 1993; Walsh et al. 1999; Graff and Middleton 2001; Nañez-James et al. 2009; Meyer 2011; Furey 2012; Furey and Rooker 2013; Scyphers et al. 2015; Dance and Rooker 2015).

When southern flounder reach spawning sizes, both inlets and ocean bottoms become critical habitats. Adults move to offshore ocean spawning grounds during the fall and winter to complete their life cycle. Larvae spawned offshore are transported into the estuarine system by nearshore and tidal currents entering the estuary through coastal inlets before settling in preferred estuarine habitats. It is believed that some adult southern flounder return through the inlets to the estuaries and rivers after spawning; however, some adult flounder are thought to remain in the ocean after spawning (Watterson and Alexander 2004; Taylor et al. 2008). The proportion of the adult spawning stock remaining in the ocean versus those returning to the estuaries is unknown. For more information on the importance of inlets on the southern flounder populations, see the *Inlet Corridors* issue paper.

WATER QUALITY DEGRADATION

Good water quality is essential, both for supporting the various life stages of southern flounder (Table 1) and maintaining their habitats. Naturally occurring and human caused activities can alter the preferred salinity or temperature conditions, elevate toxins, nutrients, turbidity, as well as lower dissolved oxygen levels which can degrade water quality.

Table 1. Water quality parameter ranges and habitats associated with different life stages of southern flounder.

Life Stage	Salinity (ppt)	Temperature (°C)	Dissolved Oxygen (mg/L)	Associated Habitats	Related literature
Adult	0–36	4–35	Greater than 5.0	Entire estuary and ocean	Reagan and Wingo 1985; Farmer et al. 2013; NCDEQ 2016
Larvae	9–36	16–35	Greater than 3.7	Inlet and ocean water column, estuarine soft bottom	Williams and Duebler 1968; Reagan and Wingo 1985; Burke et al. 1991; Moustakas et al. 2004; NCDEQ 2016
Juveniles	0.02–35	16–35	Greater than 3.7	Wetlands, SAV, shell bottom, soft bottom	Reagan and Wingo 1985; Taylor et al. 2000; Taylor and Miller 2001; Del Toro-Silva et al. 2008; Nañez-James et al. 2009; Lowe et al. 2011; Farmer et al. 2013; NCDEQ 2016

More detailed information on water quality degradation, including the topics of hypoxia, toxins, and temperature in North Carolina and the effect on fish stocks can be found through the NCDWR guides (NCDWQ 2000, 2008) and the CHPP (NCDEQ 2016).

Low dissolved oxygen occurs often in summer resulting in "jubilees" which have been known to occur in the Gulf of Mexico and North Carolina estuarine waters. Due to low oxygen, flounder gather in shallow water in an attempt to find oxygen.

GEAR IMPACTS ON HABITAT

Bottom disturbing fishing gear can impact ecosystem function through habitat degradation. Static (or non-mobile) gear used in a fishery tends to have a lesser impact on habitat compared to mobile gear, as the amount of area affected by the static gear tends to be insignificant when compared to that of the mobile gear (Rogers et al. 1998). Both bottom disturbing and static gears can have impacts of bycatch while in operation and can have negative impacts if the gear is abandoned or lost.

The primary gears used in the southern flounder commercial fishery are pound nets, gill nets, and gigs. In the recreational fishery hook-and-line and gigs are the primary gears. Other gears that may harvest southern flounder as incidental catch include hard crab and peeler pots, crab and shrimp trawls, channel nets, fyke nets, and haul seines. Most gears that interact with southern flounder are considered static gear (Barnette 2001; NCDEQ 2016), thus, in general fishing gear targeting flounder have minimal impact on habitat.

BYCATCH AND DISCARDS OF NON-TARGET SPECIES

Finfish and shellfish species may be caught as incidental bycatch in fisheries targeting southern flounder and may be retained or discarded as a result of economic, regulatory, or personal considerations. For discussion on bycatch and discards of southern flounder from the commercial and recreational fisheries, see the *Description of the Fisheries* section.

Other Finfish Species

From 2013 to 2017, annual southern flounder gill net trips landed 162,141 pounds (24%) of fish other than flounder (incidental catch), while these same trips averaged 520,227 pounds (76%) of southern flounder. Four species, or groups of species, comprised over 77% of the incidental catch by weight: red drum (*Sciaenops ocellatus*), black drum (*Pogonias cromis*), catfishes, and sheepshead (*Archosargus probatocephalus)*. Over 40 additional species, including spotted seatrout (*Cynoscion nebulosus*), bluefish (*Pomatomus saltatrix*), striped mullet (*Mugil cephalus*), and striped bass (*Morone saxatilis*) comprised the remaining 23% of the catch.

Six species comprised approximately 76% of the observed discards (live and dead; by number): Atlantic menhaden (*Brevoortia tyrannus*), blue crab (*Callinectes sapidus*), common carp (*Cyprinus carpio*), cownose rays (*Rhinoptera bonasus*), red drum, and Atlantic stingrays (*Dasyatis sabina*). Additionally, southern flounder make up 10% of the overall discards from the southern flounder gill net fishery (for further discussion see the *Description of the Fisheries* section). An additional 135 species make up the remaining 14% of discarded catch, including bluefish, Atlantic croaker (*Micropogonias undulatus*), and horseshoe crab (*Limulus polyphemus*). From June through October (2013–2017) greater than 75% of all gill net trips made were targeted flounder trips.

Over 70% of the landings from flounder pound nets were southern flounder from 2013 to 2017. Summer and Gulf flounders comprised approximately 2% of the harvest during the same time frame. Other species commonly captured included black drum, harvest fish (*Peprilus alepidotus*), and red drum. More than thirty additional species including sheepshead, butterfish (*Peprilus triacanthus*), and catfish made up the remaining catch; with none of these species individually exceeding 1% of the total catch. Mortality of non-target species discarded from pound nets is likely minimal, provided fishing practices are such that non-harvested fish are handled carefully and released immediately.

Gigging for southern flounder results in very little bycatch of non-flounder species since fish are gigged by sight. Other flounder species, such as Gulf and summer flounder, are subject to the same size restrictions and may be taken in fishing operations targeting southern flounder. Giggers in both the recreational and commercial fisheries can be prone to gig undersized flounder, resulting in some regulatory discards of these other flounder species.

Protected Species

Protected species (sometimes referred to as “protected resources”) is a broad term that encompasses a range of organisms that are protected by federal or state statutes because their populations are at risk or vulnerable to risk of extinction. Federal statutes include the Endangered

Species Act (ESA), Marine Mammal Protection Act, and the Migratory Bird Treaty Act. Of the federally protected species, the following are known or suspected to be incidentally taken in the southern flounder fishery: sea turtle species, sturgeon species, common bottlenose dolphin (*Tursiops truncatus*), and various bird species. There may be additional protected species that occasionally occur in estuarine waters and rarely interact with the southern flounder fisheries. The division currently has two ITPs (Section 10(a)(1)(B) of the ESA) that establish legal take thresholds for sea turtles and Atlantic sturgeon (*Acipenser oxyrinchus*) in estuarine gill nets (NMFS 2013, 2014). As part of the ITPs, the division operates an observer program to monitor take levels and implement adaptive management measures based on those levels (for the most recent annual reports see Byrd et al. 2020a, 2020b).

The bottlenose dolphin is the predominant marine mammal in North Carolina estuarine waters (Hayes et al. 2018). Incidental takes of bottlenose dolphins in ocean gill nets have been documented by federal fisheries observers (Lyssikatos and Garrison 2018). Evidence of incidental takes in estuarine and ocean gill nets has been documented on bottlenose dolphin strandings; however, the level of bycatch in estuarine gill nets is unknown (Byrd et al. 2014; Byrd and Hohn 2017). State-wide observer coverage of estuarine gill nets (ITP year 2014–present) conducted by the division documented only one incidental take of a bottlenose dolphin (small-mesh; McConnaughey et al. 2019). Entanglement of bottlenose dolphins in North Carolina pound nets is thought to be uncommon, but the NMFS recovered one dead bottlenose dolphin entangled in a pound net during 2008 (Byrd et al. 2014).

North Carolina has a great diversity of birds, including migratory waterbirds (Potter et al. 1980). Within North Carolina estuarine waters, there are several species of birds that may be unintentionally caught in the southern flounder gill-net fishery. Bycatch estimates for the estuarine gill-net fishery are not available, though Warden (2010) documented bycatch of common loons (*Gavia immer)* and red-throated loons (*G. stellate)* in ocean-side and estuarine gill nets operating from Maine to North Carolina. Gill-net interactions with waterbirds have been documented in several division sampling programs; however, in-depth studies are needed to determine quantifiable bycatch estimates in the estuarine gill-net fishery and the levels of impact.

CLIMATE CHANGE AND RESILIENCY

Extreme weather events have always occurred, but scientists anticipate that changes to North Carolina's climate in this century will be larger than anything experienced historically (Kunkel et al. 2020). It is predicted that average annual temperatures will continue to increase, sea level will continue to rise, the intensity of hurricanes will increase, total annual precipitation from hurricanes and severe thunderstorms will increase resulting in increased flooding events, while severe droughts will also likely increase due to higher temperatures (Kunkel et al. 2020). Flood events can flush contaminated nutrient-rich runoff into estuaries causing degraded water quality. Runoff from flood events can cause eutrophication resulting in fish kills due to hypoxia, algal blooms, and alteration of the salinity regime. Flood events can also cause erosion of shorelines resulting in loss of important coastal habitats, such as SAV, shell bottom, and wetlands, that are critical to southern flounder throughout their life history. Potential increases in extreme weather events could have an inverse effect on the recruitment and survival of southern flounder in the estuarine system.

Increasing temperatures will also impact the distribution of finfish and invertebrate populations and the coastal habitats they use. It has been predicted that hundreds of finfish and invertebrate species will be forced to move northward due to increasing temperatures caused by climate change (Morley et al. 2018). North Carolina already exhibits one of the greatest northward shifts in commercial fishing effort, with average vessel landings occurring 24 km further north each year (Dubik et al. 2019). Studies have shown that the sex determination of southern flounder is sensitive to water temperatures during larval development. When southern flounder were grown in high and low water temperatures, a higher proportion of males were produced while a midrange water temperature produced a sex ratio closer to 1:1 (Luckenbach et al. 2003, 2009; Montalvo et al. 2012). Honeycutt et al. (2019) found the more southerly habitats of North Carolina exhibited warmer temperatures and consistently produced higher proportions of males in wild populations (up to 94%), indicating latitudinal variation in sex ratios. With trends in increasing water temperatures, this is an important factor in the understanding of population dynamics of southern flounder.

DEVELOPING ISSUES

Microplastics and emerging compounds, like PFAS, may affect flounder. For more information see the DEQ website for the Marine Debris Action Plan and Emerging Compound Resources.

The repeated impacts and compounding losses from the effects of climate change can be catastrophic not only to the coastal communities, but to coastal habitats and the fisheries they support. While the risks and hazards associated with climate change and extreme weather events cannot be completely eliminated, the effects can be decreased by improving coastal resilience, which can be broken down into two parts: 1) community resiliency – the ability of a community to withstand, respond to, and recover from a disruption, and 2) ecosystem resiliency – the ability of the natural environment to withstand, respond to, and recover from a disruption, such as hurricanes, tropical storms, and flooding. A resilient ecosystem can bounce back from disturbances over time compared to resistant ecosystems, whose function may not be able to recover with repeated disturbances. Building a more resilient coastal community and ecosystem will help ensure the persistence of coastal habitats critical to the life history of southern flounder and many other species (NCDEQ 2016, 2020).

HABITAT AND WATER QUALITY PROTECTION

The Fishery Reform Act statutes require that a CHPP be drafted by the NCDEQ and reviewed every five years (G.S. 143B-279.8). The CHPP is intended as a resource and guide compiled by NCDEQ staff to assist the Marine Fisheries, Environmental Management, and Coastal Resources commissions develop goals and recommendations for the continued protection and enhancement of fishery habitats of North Carolina. Habitat recommendations related to fishery management can be addressed directly by the NCMFC. The NCMFC has passed rules that provide protection for southern flounder habitat including the prohibition of bottom-disturbing gear in specific areas,

designation of sensitive fish habitat, such as nursery areas and SAV beds, with applicable gear restrictions. Habitat recommendations not under NCMFC authority (e.g., water quality management, shoreline development) can be addressed by the other commissions through the CHPP process. The CHPP helps to ensure consistent actions among these commissions as well as their supporting NCDEQ divisions. The CHPP also summarizes the economic and ecological value of coastal habitats to North Carolina, their status, and potential threats to their sustainability (NCDEQ 2016).

DESCRIPTION OF THE FISHERIES

Additional in-depth analyses and discussion of North Carolina's commercial and recreational southern flounder fisheries can be found in earlier versions of the Southern Flounder FMP (NCDMF 2005, 2013, 2017, 2019) on the division website or the License and Statistics Annual Report (NCDMF 2020).

The socio-economic information presented here is about the fishery as of 2017 and is not intended to be used to predict potential impacts from management changes. This and other information pertaining to FMP's are included to help inform decision-makers regarding the long-term viability of the state's commercially and recreationally significant species or fisheries. For a detailed explanation of the methodology used to estimate the economic impacts, please refer to the division's License and Statistics Section Annual Report (NCDMF 2020).

COMMERCIAL FISHERY

Southern flounder supports one of the largest and most valuable commercial fisheries in North Carolina, accounting for landings of 1.39 million pounds with a dockside value of $5.66 million in 2017. Historically, North Carolina has accounted for approximately 99% of annual southern flounder commercial landings from the U.S. South Atlantic coast since 1978 (Figure 10). Southern flounder have been harvested commercially since the 1800s in North Carolina, with the earliest documented landings reported in 1889 (Chestnut and Davis 1975). The average commercial fisherman in the southern flounder fishery is a middle-aged Caucasian male with more than 50% of their income coming from commercial fishing (Diaby 2000, 2001; Cheuvront 2002, 2003; Cheuvront and Neal 2004; Crosson 2010; Hadley 2012; Hadley and Wiegand 2014; Stemle and Wiegand 2017; Gambill and Bianchi 2019).

Another flounder species, the summer flounder, is also harvested in North Carolina. The commercial fisheries for summer and southern flounder differ in terms of where they operate and the gears they use. For example, summer flounder occur primarily in the ocean from North Carolina to Massachusetts where they are harvested primarily with trawl gear. Commercial fisheries for southern flounder occur almost exclusively in the estuaries where they are harvested with a greater variety of gears, primarily gill nets, pound nets, and gigs.

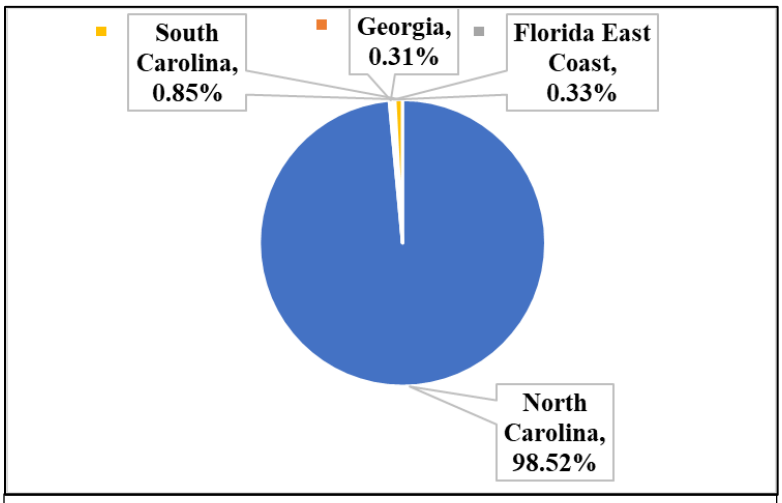


Figure 10. Average contribution to U.S. South Atlantic coast southern flounder commercial landings by state, 1978–2017. (Source: NOAA Fisheries Annual Commercial Landing Statistics and North Carolina Trip Ticket Program) *Percentages may not total 100% due to rounding.

In North Carolina, landings of southern flounder increased steadily in the mid-1970s, peaking in the mid-1990s before declining to nearly 1.4 million pounds in 2017 (Figure 11). Trends in southern flounder landings were influenced, in part, by management restrictions, including a quota implemented for summer flounder in the mid-1980s to early 1990s and restrictions in the anchored large-mesh gill-net fishery to reduce incidental takes of sea turtles starting in 2000. These restrictions decreased the harvest of summer flounder, which had historically accounted for most of the flounder landings in North Carolina. Concurrently with decreased summer flounder harvest, the southern flounder fishery expanded through growth in the pound net fishery and development of a fall large-mesh gill-net fishery in Pamlico Sound. These changes resulted in southern flounder ranking as the top commercially landed flounder species until 2014, when summer flounder regained the top spot.

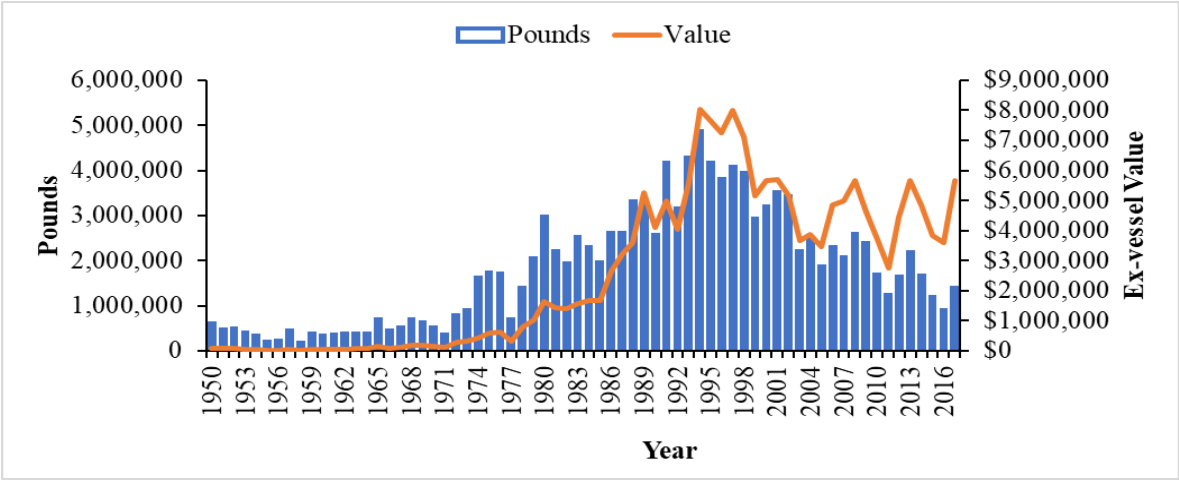


Figure 11. North Carolina annual southern flounder commercial landings and ex-vessel value, 1950–2017. (Source: North Carolina Trip Ticket Program)

Commercial Fishery Data Collection

Data used to describe the commercial fisheries for southern flounder comes from four sources: NMFS, the Atlantic Coast Cooperative Statistics Program (ACCSP), the North Carolina trip ticket program (NCTTP), and the North Carolina fishery-dependent sampling program. The data from NMFS includes historical data prior to 1978 and the data from ACCSP includes landings statistics collected from 1978 to 1993. Data prior to 1994 were collected on a voluntary basis with varying methodologies.

The NCTTP was implemented in 1994 to more accurately monitor commercial landings and fishing effort. Through the NCTTP, the division requires dealers purchasing finfish and/or shellfish from commercial fishermen to submit trip tickets that include information about the catch (e.g., species landed, pounds, gear, waterbody). Commercial fishermen are required to hold a Standard Commercial Fishing License (SCFL) or a Retired Standard Commercial Fishing License (RSCFL) to land southern flounder commercially in North Carolina. For commercial fishermen to sell their catch directly to consumers, they are required to possess a dealer's license and submit their own trip tickets. The combined number of SCFLs and RSCFLs issued during fiscal years 2008 through 2017 ranged from a low of 6,296 in 2017 to a high of 6,861 in 2008 (NCDMF 2020). The number of seafood dealers reporting landings of southern flounder has ranged from 249 in 2012 to 189 in 2016. Finally, the fishery-dependent sampling program has been ongoing since 1982. This program collects data at fish houses by sampling the catch and recording fishery characteristics, which allows the size and age distribution of southern flounder to be characterized for each of the major gears and fisheries that harvest southern flounder.

Annual Landings and Value

Flounder landings reported through the NCTTP are not tabulated by species. Data from the fishery-dependent sampling program indicate that southern flounder make up less than one percent of the catch from ocean waters, while summer flounder and Gulf flounder account for approximately two percent or less of the flounder harvested from internal waters (NCDMF, unpublished data). Therefore, it is assumed in this analysis that all flounder harvested from estuarine waters are southern flounder, while all flounder taken from the ocean are summer flounder.

Unless otherwise noted, data presented in this section are from the NCTTP from 2008 to 2017. Trends are shown for the dockside (ex-vessel) value; harvest volume is presented in pounds.

Commercial landings of southern flounder were highly variable with a low in the time series in 2016 since the peak in 1994 (Figure 11). Landings have been impacted by environmental conditions, such as hurricanes, and changes in management strategies. Southern flounder may be graded into five market categories: jumbo, large, medium, mixed, and small.

Table 2. North Carolina commercial southern flounder landings in pounds and value, 2008–2017. (Source: North Carolina Trip Ticket Program)

Year	Harvest	Reported Dockside Value	Reported Dockside Price Per Pound	Inflation Adjusted Dockside Value	Inflation Adjusted Dockside Price per Pound
2008	2,602,390	$5,650,295	$2.17	$6,500,664	$2.50
2009	2,396,240	$4,609,932	$1.92	$5,350,287	$2.23
2010	1,689,557	$3,695,889	$2.19	$4,086,544	$2.42
2011	1,247,450	$2,753,128	$2.21	$2,832,693	$2.27
2012	1,646,137	$4,451,482	$2.70	$4,600,162	$2.79
2013	2,186,391	$5,673,190	$2.59	$5,921,675	$2.71
2014	1,673,511	$4,839,672	$2.89	$4,833,380	$2.89
2015	1,202,885	$3,823,567	$3.18	$3,908,832	$3.25
2016	897,765	$3,610,533	$4.02	$3,731,125	$4.16
2017	1,394,617	$5,655,751	$4.06	$5,655,751	$4.06
Average	1,693,694	$4,476,344	$2.64	$4,742,111	$2.80

Dockside price per pound of southern flounder is influenced by several factors, including fish size and market. For example, the sushi and sashimi market have had the maximum price per pound in the past. It is important to note that the price-per-pound of southern flounder has increased over time, as average prices have shifted from roughly $2 per pound to $4 per pound across the time series. As the total poundage of southern flounder landings has decreased over time, ex-vessel values have remained relatively consistent, with the exception of 2011 when portions of the pound net fishery was disproportionately impacted by severe weather (Table 2; NCDMF 2020).

Landings by Gear

Historically, southern flounder were harvested commercially in North Carolina using pound nets, seines, gill nets, and gigs (Chestnut and Davis 1975); all but seines remain as primary gears (Lee et al. 2018). The use of gigs in the southern flounder fishery does not require a specific permit. However, a Pound Net Permit is required to use a pound net, including those used to harvest southern flounder. The average number of issued permits between 2008 and 2017 was 285 [range: 267 (2012) to 304 (2008); Table 3].

As of 2015, an Estuarine Gill Net Permit is required to fish with anchored gill-net gear in North Carolina's estuaries. The permits are used to facilitate observer coverage, which is a requirement of ITPs (Section 10(a)(1)(B) of the ESA) for sea turtles and Atlantic sturgeon (NMFS 2013, 2014). The lowest number of permits possessed during a license year was 2,672 in 2017 and the highest was 2,897 in 2016 (Table 3).

Table 3. Number of commercial pound net permits by year of expiration and estuarine gill net permits by license year (July 1 to June 30). (Source: Fisheries Information Network)

Year (Expiration Year or License Year)	Pound Net Permits Issued	Estuarine Gill Net Permits Issued
2008	304	
2009	299	
2010	296	
2011	293	
2012	267	
2013	271	
2014	285	
2015	271	2,674
2016	283	2,897
2017	278	2,672
Average	285	2,748

Table 4. Annual commercial southern flounder landings in pounds by gear type, 2008–2017. Numbers in parentheses are the percent of the total landings for each gear each year. (Source: North Carolina Trip Ticket Program)

Year	Gill Net	Pound Net	Gigs	Other	Total
2008	1,770,204 (68%)	685,546 (26%)	82,846 (3%)	63,793 (2%)	2,602,390
2009	1,658,074 (69%)	591,534 (25%)	84,303 (4%)	62,329 (3%)	2,396,240
2010	958,271 (57%)	571,151 (34%)	128,081 (8%)	32,054 (2%)	1,689,557
2011	652,810 (52%)	464,546 (37%)	113,414 (9%)	16,680 (1%)	1,247,450
2012	879,373 (53%)	569,388 (35%)	149,387 (9%)	47,989 (3%)	1,646,137
2013	1,096,060 (50%)	924,887 (42%)	118,489 (5%)	46,955 (2%)	2,186,391
2014	659,394 (39%)	860,216 (51%)	135,273 (8%)	18,628 (1%)	1,673,511
2015	392,339 (33%)	667,847 (56%)	130,277 (11%)	12,422 (1%)	1,202,885
2016	361,570 (40%)	398,258 (44%)	126,983 (14%)	10,953 (1%)	897,765
2017	552,292 (40%)	697,814 (50%)	136,094 (10%)	8,416 (1%)	1,394,617
Average	898,039 (53%)	643,119 (38%)	120,515 (7%)	32,022 (2%)	1,693,694

*Percentages may not total 100% due to rounding.

Pound nets and gill nets have been the dominant gears, with gill nets leading harvest from the early 1990s through 2013. Recent declines in gill-net landings can most likely be attributed to increased regulations on the large-mesh anchored gill-net fishery. The third most used gear for southern flounder in recent years is the gig, with gig harvest increasing since 2008 (Table 4). Landings from other gears account for approximately two percent of the total landings and include crab and peeler pots, crab and shrimp trawls, hook-and-line, fyke nets, and haul seines (Table 4).

Characterization of Trips

The annual number of commercial trips reporting landings of southern flounder averaged over 20,000 during 2008 to 2017 with a peak in 2009 (Table 5). The predominate gear by number of trips and participants is the anchored large-mesh gill-net fishery, followed by gigs and pound nets,

respectively (Table 5). Although large-mesh gill nets account for the largest volume of trips per year, the average landings per trip is 61 pounds, which is less than the average landings per trip for pound nets of 377 pounds.

The greater number of participants in the gill-net and gig fisheries may be reflective of the relative lower cost of gear compared to the monetary investment required for pound nets. Effort using other gears has occasionally represented the second highest number of trips each year, but the average pounds per trip are low (Table 5). Unlike the major gears, southern flounder catch from other gears is incidental rather than targeted (for further information see below in the *Discards and Bycatch of Southern Flounder* section). The number of trips and participants in the fishery can be dependent on the weather as well as management regulations.

Landings by Season and Waterbody

Commercial southern flounder landings and average dockside value, as well as the average price per pound in North Carolina, vary by season. The southern flounder commercial fishery typically begins with the gig fishery in the early summer in the southern part of the state (Core Sound south) as fish availability is high and good weather allows for increased water clarity necessary for giggers to see flounder when operating at night. During the late summer months, the gill net fishery intercepts the southern flounder that overwintered in the estuaries and have grown to legal size. Gill net harvest typically begins in the western portions of the river systems in Pamlico and Albemarle sounds shifting downstream and eastward as the fish migrate (NCDMF 2019; see the *Achieving Sustainable Harvest* issue paper).

During the fall, flounder migrate into the ocean to spawn, influencing both the harvest in the gill net and pound net fisheries. Although gill nets and gigs are mobile gears that can follow fish, the fall migration coincides with peak harvest for gill nets and pound nets. Pound nets are a passive gear that rely on the migration to be productive. Therefore, the flounder pound net fishery is not active until the fall migration begins. For pound nets, harvest typically begins in Currituck Sound in late August and early September following a north to south migration pattern, with Core Sound harvesting flounder through November after the northern portion of the fishery has ended (NCDMF 2019; see the *Achieving Sustainable Harvest* issue paper).

Data from the NCTTP include the waterbody in which the majority of the catch was caught during each trip. The Albemarle Sound Region (includes Albemarle, Croatan, Roanoke, and Currituck sounds as well as Alligator, Chowan, Pasquotank, Perquimans, and Roanoke rivers, and Back Bay) and the Pamlico Sound Region (includes Pamlico Sound and Neuse, Pamlico, Pungo, and Bay rivers) accounted for 76% of the total southern flounder harvest from 2008 to 2017 (Table 6). During this time period, the average real dockside value was marginally greater in the Pamlico Sound Region. Real prices account for inflation by adjusting all values to a pre-determined base-year, allowing prices across different years to reflect the same monetary value.

Table 5. Annual trips, average landings per trip (APT), and number of participants (#PAR) by gear type in the commercial southern flounder fishery, 2008–2017. (Source: North Carolina Trip Ticket Program)

Year	Trips[1] / APT / #PAR[2]	Gill Net Trips/ APT/ #PAR	Pound Net Trips / APT / #PAR	Gig Trips / APT / #PAR	Other Trips / APT / #PAR
2008	28,966 / 90 / 1,235	23,493/ 75 / 924	1,508 / 455 / 83	1,459 / 57 / 140	2,510 / 25 / 413
2009	29,395 / 82 / 1,299	23,691 / 70 / 992	1,746 / 339 / 85	1,450 / 58 / 143	2,510 / 25 / 426
2010	20,408 / 83 / 1,182	15,134 / 63 / 837	1,610 / 355 / 84	2,283 / 56 / 226	1,384 / 23 / 329
2011	15,810 / 79 / 1,039	11,403 / 57 / 759	1,370 / 339 / 63	2,076 / 55 / 212	963 / 17 / 250
2012	20,926 / 79 / 1,202	14,713 / 60 / 855	1,754 / 325 / 84	3,000 / 50 / 288	1,462 / 33 / 291
2013	23,579 / 93/ 1,286	16,968 / 65 / 933	2,111 / 438 / 82	2,408 / 49 / 270	2,094 / 22 / 343
2014	18,121 / 92 / 1,222	11,778 / 56 / 799	1,806 / 476 / 88	2,655 / 51 / 316	1,887 / 10 / 373
2015	13,880 / 87 / 1,029	8,465 / 46 / 674	1,803 / 370 / 81	2,616 / 50 / 307	1,002 / 12 / 249
2016	13,336 / 67 / 945	8,422 / 43 / 591	1,423 / 280 / 77	2,657 / 48 / 323	838 / 13 / 227
2017	17,963 / 78 / 1,048	12,363 / 45 / 713	1,908 / 366 / 88	2,752 / 49 / 310	943 / 9 / 237
Average	20,238 / 84 / 1,149	14,643 / 61 / 808	1,704 / 377/ 82	2,336 / 52 / 254	1,559 / 21 / 314

[1] The number of trips, average landings per trip, and number of participants are from all trips that recorded southern flounder across all gear types including pound nets, gill nets, gigs, and other.
[2] The annual number of participants cannot be summed by gear as many individuals fish multiple gears per trip.

Table 6. Commercial southern flounder landings (millions of pounds) and average dockside price per pound by area, 2008–2017. Numbers in parentheses are the percent of the total landings for each area for a given year. (Source: North Carolina Trip Ticket Program) *Percentages may not total 100% due to rounding.

Year	Albemarle Sound Region	Pamlico Sound Region	Core Sound and South	Statewide
2008	1.2 (44%) / $2.15	0.8 (31%) / $2.23	0.6 (25%) / $2.13	2.7 / $2.17
2009	1.1 (44%) / $1.91	0.9 (37%) / $1.95	0.5 (20%) / $1.90	2.5 / $1.92
2010	0.4 (27%) / $2.14	0.9 (51%) / $2.23	0.4 (23%) / $2.14	1.7 / $2.19
2011	0.1 (7%) / $2.15	0.8 (63%) / $2.20	0.4 (30%) / $2.23	1.3 / $2.21
2012	0.7 (40%) / $2.68	0.6 (37%) / $2.77	0.4 (23%) / $2.64	1.7 / $2.70
2013	0.9 (40%)/ $2.48	0.9 (43%) / $2.69	0.4 (17%) / $2.62	2.2 / $2.59
2014	0.5 (32%) / $2.84	0.8 (48%) / $2.90	0.3 (20%) / $2.97	1.6 / $2.89
2015	0.3 (28%) / $3.15	0.5 (44%) / $3.17	0.3 (28%) / $3.21	1.1 / $3.18
2016	0.2 (20%) / $3.99	0.4 (50%) / $4.04	0.3 (30%) / $4.02	0.9 / $4.02
2017	0.3 (23%) / $4.02	0.7 (50%) / $4.08	0.4 (27%) / $2.23	1.4 / $4.06
Average	0.6 (33%) / $2.75	0.7 (44%) / $2.89	0.4 (23%) / $2.79	1.7 / $2.79

Commercial Discards and Bycatch of Southern Flounder

Since 2016, the minimum size limit to harvest southern flounder in the commercial fishery has been 15 inches TL. Management measures, such as yardage restrictions, soak times, minimum mesh size requirements, and pound net escape panels, are used to minimize discards (NCDMF 2019). Any undersized southern flounder that are caught must be immediately returned to the water (regulatory discard). Discards of undersized flounder primarily occur from gill nets, pound nets, gigs, and shrimp trawls. In addition to regulatory discards, some legal-sized fish are discarded because they may not be marketable due to the presence of injuries or sores (unmarketable discards).

Pound Nets

Data are not available to estimate discards or post-release mortality of southern flounder from commercial pound nets. However, this fishery is known to have discards (unmarketable and regulatory). While the magnitude is unknown, post-release mortality is assumed to be relatively low. Pound nets capture fish by entrapment, as opposed to gilling or entanglement, so southern flounder discards, when culled in a timely and careful manner, can be released with a high likelihood of survival. Additionally, pound nets that are permitted as a "flounder pound net" are required to have escape panels. The escape panels consist of large-mesh [a minimum of 5.75-inch stretch mesh (ISM)] webbing and must be placed in all four bottom corners of the pound. The required minimum mesh size in the panel is adequate to allow a large portion of undersized southern flounder to escape while larger legal sized flounder are retained (Brown 2014; NCDMF 2017).

RAW SEAFOOD MARKET

Many flounder landed from pound nets are kept alive and sold to sushi and sashimi processors.

Gill Nets

Gill-net bycatch of undersized and unmarketable southern flounder commonly occurs in both large-mesh and small-mesh anchored estuarine gill nets. Since January 2016, gill nets landing southern flounder have been required to have a minimum stretched mesh size of six inches to minimize bycatch of sub-legal southern flounder. Commercial gill-net discards are monitored through onboard observers in the estuarine gill-net fishery.

Discard data from the observer program were used to calculate estimates of bycatch, both at-net mortality and post-release mortality, including years prior to the origination of the observer program. These estimates were incorporated into the most recent stock assessment (Flowers et al. 2019). Commercial southern flounder dead discard estimates (fish dead at time net was fished) ranged from a low of just over 4,179 fish in 2017 to over 87,410 fish in 1994 (Figure 12). In addition to the dead discards encountered at the net, post-release or delayed mortality (assumed to be 23% in stock assessment, Lee et al. 2018) associated with the release of live discards ranged from a low of 5,003 fish in 2011 to a high of 40,441 fish in 2008.

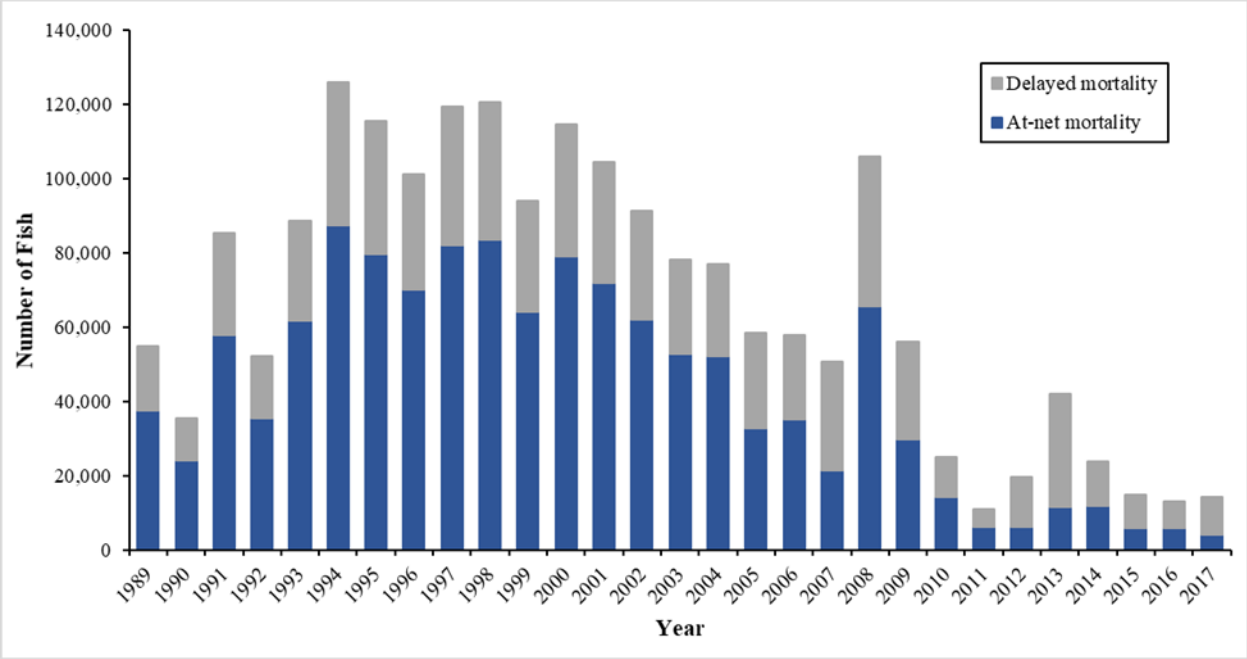


Figure 12. Estimated number of dead discards associated with the North Carolina commercial estuarine gill net fishery, 1989-2017.

Gigs

Due to size limits, regulatory discards in this fishery occur and post-release mortality is assumed to be 100%. Discard estimates in the commercial gig fishery are unknown.

Other Gears (Non-Target)

Marketable legal southern flounder from other gears (e.g., crab and peeler pots, crab and shrimp trawls, channel nets, fyke nets, and haul seines) that are retained (incidental catch) from these gears makes up less than 2% of the total commercial landings and has declined over the last 10 years (Table 7, Figure 13). From 2008 to 2017, approximately 55% of southern flounder harvested as incidental catch came from the crab and shrimp pot fishery, with landings from the shrimp and crab trawl fishery making up the second largest portion of southern flounder sold as bycatch. Since 2014, landings from trawls have been slightly higher than pots.

The portion of bycatch that is returned to the sea (discarded catch) due to economic, legal, or personal considerations is more difficult to quantify. Discard data are not available for many of the non-targeted fisheries that catch southern flounder. However, studies indicate that flounder species are captured as bycatch in the blue crab pot fishery, with a survival rate exceeding 85% (Doxey 2000; Thorpe et al. 2005). Currently, there are no management measures requiring the use of bycatch reduction devices in crab pots; however, the use of these devices in a tidal marsh creek in Virginia has been shown to be highly effective at excluding fish as bycatch (Morris et al. 2011).

Table 7. Pounds of southern flounder landed as bycatch in commercial non-major ("Other") gears, 2008–2017.

Year	Gear					Total Bycatch Landings	Total Commercial Landings
	Pots (crab & shrimp)	Trawls (crab & shrimp)	Fyke Nets	Channel Nets	Misc.		
2008	34,158	21,379	903	463	5,385	62,288	2,602,390
2009	29,091	28,874	654	32	2,046	60,697	2,396,240
2010	17,493	10,073	179	853	1,045	29,643	1,689,557
2011	5,275	8,963	38	162	795	15,232	1,247,450
2012	39,602	4,647	66	783	513	45,611	1,646,137
2013	30,080	13,549	292	395	331	44,646	2,186,391
2014	5,883	9,425	389	309	552	16,556	1,673,511
2015	2,256	3,451	4,538	215	207	10,666	1,202,885
2016	2,265	5,138	1,128	155	441	9,127	897,765
2017	2,492	3,429	80	161	552	6,714	1,394,617
Total	168,595	108,929	8,267	3,525	11,864	301,180	16,936,944
Percentage of Bycatch Only Landings	56	36	3	1	4	100	
Percentage of Total Commercial Landings	1	1	0	0	0	2	100

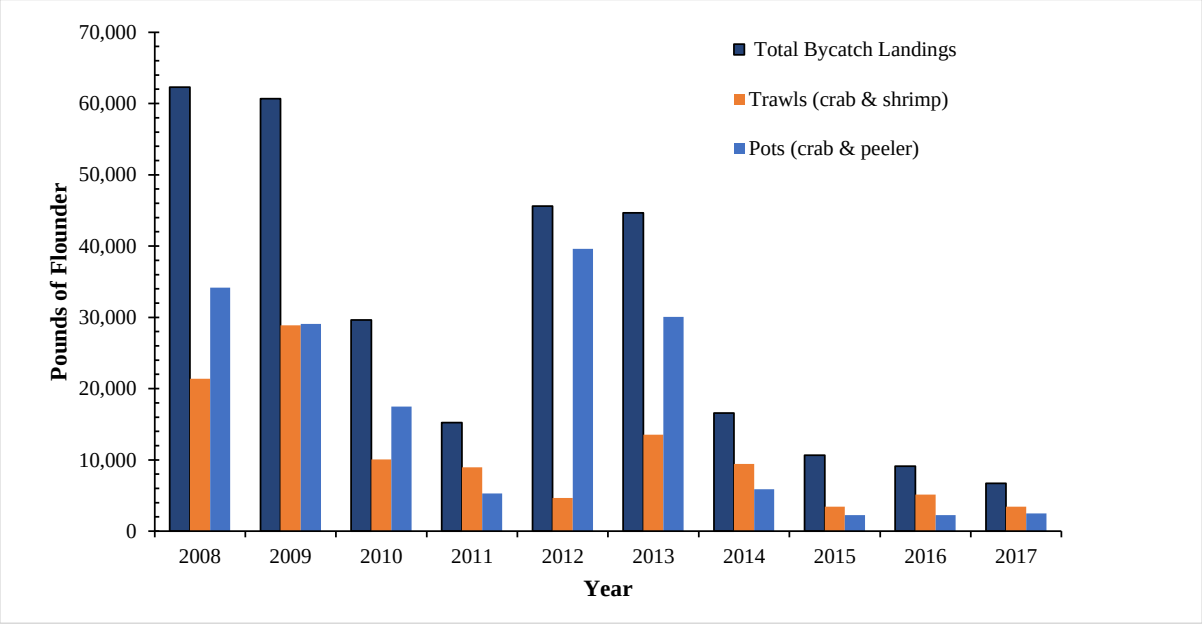


Figure 13. Pounds of southern flounder harvested as bycatch from commercial crab and peeler pots, crab and shrimp trawls, channel nets, fyke nets, and haul seines, 2008–2017. (Source: North Carolina Trip Ticket Program)

In North Carolina's shrimp trawl fishery, southern flounder represented 1% to 33% of the regulatory discards in the estuarine otter and skimmer trawls and ocean shrimp trawl fishery (Brown 2009, 2010a, 2010b, 2015, 2016; Brown et al. 2019). In an effort to minimize the discard of sublegal flounder in the shrimp trawl fishery, the 2006 Shrimp FMP initiated management measures limiting the total combined headrope length to 90 ft in the mouths of the Pamlico and Neuse Rivers and all of Bay River, as well as restricting the use of otter and crab trawls above the Highway 172 Bridge in the New River (NCDMF 2015). More recently, the NCMFC voted to require fishermen to use one of four gear combinations in the Pamlico Sound and portions of Pamlico, Bay, and Neuse rivers, which were tested by an industry workgroup and achieved at least a 40% reduction of finfish bycatch (NCDMF 2018; Brown et al. 2019).

Discard data from North Carolina's shrimp trawl observer program were used to help estimate bycatch rates of southern flounder in the U.S. South Atlantic shrimp trawl fishery. Results indicate a general decline in bycatch of southern flounder as well as fishing effort from 1989 to 2017. Discards from the shrimp trawl fishery were found to contribute minimally to the overall catch and were not found to bias the results of the 2019 stock assessment for southern flounder in the South Atlantic (Lee et al. 2018; Flowers et al. 2019).

Summary of Economic Impact of Commercial Fishing

As one of the largest commercial fisheries in the state, the southern flounder fishery is a strong economic driver for the industry. From 2008 to 2017, the average southern flounder fishery consistently included over 1,000 participants except for 2016 (Table 8). Additionally, during this period the ex-vessel value of southern flounder harvest was, on average, 5% of the total value of all commercial seafood landings in the state (NCDMF 2020).

Table 8. Economic impacts associated with commercial southern flounder fishery in North Carolina, 2008–2017. Data below represent the actual effort data from southern flounder harvest, along with the estimated economic impacts to North Carolina using IMPLAN statistical software. Data from the 2016 NOAA Fisheries Economics of the U.S. report, along with internal division survey data, are also used to generate estimates. Note: impact estimates across categories are not additive.

Year	Pounds Landed	Ex-vessel Value	Participants	Estimated Sales Impact	Estimated Income Impacts	Estimated Employment Impact	Estimated Value Added Impact
2008	2,602,390	$5,650,295	1,235	$25,473,137	$10,483,954	1,544	$19,654,727
2009	2,396,240	$4,609,932	1,299	$20,547,716	$8,550,927	1,545	$16,161,407
2010	1,689,557	$3,695,889	1,182	$15,743,327	$6,531,811	1,380	$12,223,365
2011	1,247,450	$2,753,128	1,039	$11,771,643	$4,884,958	1,186	$9,140,235
2012	1,646,137	$4,451,482	1,202	$18,795,084	$7,827,308	1,440	$14,613,360
2013	2,186,391	$5,673,190	1,286	$23,172,478	$9,654,261	1,591	$17,977,144
2014	1,673,511	$4,839,672	1,222	$19,547,618	$8,134,986	1,482	$15,109,459
2015	1,202,885	$3,823,567	1,029	$15,852,258	$6,621,987	1,235	$12,379,619
2016	897,765	$3,610,533	945	$10,724,064	$6,301,409	1,129	$11,716,727
2017	1,394,617	$5,655,751	1,048	$20,489,984	$9,494,322	1,335	$17,676,161
Average	1,693,694	$4,476,342	1,149	$18,211,731	$7,848,592	1,387	$14,665,220

More broadly, an economic impact assessment of the commercial southern flounder fishery helps demonstrate its influence on the state economy. Using IMPLAN modeling software along with expenditure estimates from National Oceanic and Atmospheric Administration's (NOAA) 2016 Fisheries Economics of the U.S. (FEUS) report, the indirect impacts of the southern flounder fishery to the state economy at-large can be estimated (IMPLAN 2013). For a detailed explanation of the methodology used to estimate the economic impacts refer to the division's License and Statistics Section Annual Report (NCDMF 2020).

The impact estimates of the commercial southern flounder fishery from 2008 to 2017, considering ex-vessel revenues, participants, NOAA FEUS expenditure modifiers, and division socioeconomic survey data are shown in Table 8. Overall, the large economic impact of southern flounder to the state's commercial fishing industry is also reflected in its effect on the state economy. Total impacts vary slightly year-to-year, though these values remain relatively consistent from a state-impact perspective. Additionally, it should be noted that the economic activity generated by commercial southern flounder fishing supports over 1,000 additional full- and part-time jobs in the state.

Lastly, within the direct impacts that effort and production have on the value of the commercial flounder industry, there are several other factors that can dictate the total economic impact of this fishery at any time, both on a broader market level and individual product level. As a popular seafood across the country, the value of flounder in North Carolina is influenced by broader trends of supply and demand. There is a wide range of competitive substitutes for North Carolina flounder, including flounder caught in other states, as well as seafood products with comparatively similar properties, such as halibut (*Hippoglossus spp*.) or sole (*Solea spp*.). Because of this, the value of flounder in North Carolina is not just influenced by the availability of the product in-state, but also the regulations, seasons, and effort for the harvest of flounder and substitute products across the world. However, as flounder is such a popular fish with a number of available substitutes, it is difficult to accurately track how supply of other products directly influences prices in the state.

In addition to the broader dynamics of supply and demand that can influence North Carolina's flounder market, there are also specific factors that can adjust product value on different time scales. Method of catch can often influence prices, as consumers will seek product caught with gears that are perceived as more environmentally friendly, or gears that produce higher-quality flounder (Asche and Guillen 2012). This can lead to increased prices on flounder caught with certain gears.

Additionally, enterprise-level marketing can often impact product value. Both fishermen and dealers can market their business and product how they wish. When marketing strategies are

successful, prices can be raised and value can increase, though this is on an individual level and demonstrates the volatility within the market. Such changes in value can be demonstrated by the positive effects that local product branding and direct-to-consumer strategies have produced in North Carolina (NCREDC 2013; Stoll et al. 2015). While these are just two examples of the variety of factors that can influence the value of North Carolina's flounder industry, they help demonstrate the complicated dynamics at play, as well as the fact that many factors driving the price of flounder are not dictated by fishery managers, but by consumers and producers within the market itself.

RECREATIONAL FISHERY

Southern flounder, or flounder species in general, are one of the most sought-after recreational species in North Carolina. Southern flounder are taken by recreational anglers using hook and line, gigs, and gill nets. Southern flounder are caught year-round, but most southern flounder harvest occurs during the summer and fall. Depending on the season, anglers fish for southern flounder in inland and coastal waters, including the surf, inlets, and nearshore waters of the Atlantic Ocean along live bottom reefs and wrecks. It should be noted that southern, summer, and Gulf flounder are currently managed as an aggregate fishery for the recreational sector. Additional discussion on species-specific management and implications of management as an aggregate can be found in the *Increased Recreational Access* issue paper.

In North Carolina, recreational landings and effort statistics for southern flounder are obtained through three fishery dependent survey programs: the Marine Recreational Information Program (MRIP), the Gig Mail Survey, and the RCGL Survey. A RCGL allows the use of limited amounts of commercial fishing gear in coastal fishing waters for recreational purposes. These surveys produce estimates of effort and catch with an associated measure of variability (proportional standard error; PSE). As with the commercial fishery, southern, summer, and Gulf flounder are all encountered through MRIP, the Gig Mail Survey, and the RCGL Survey.

Recreational Fishery Data Collection

Marine Recreational Information Program (MRIP)

The MRIP is a national program administered through NOAA Fisheries that uses several surveys to obtain catch and effort data at a regional level. The Access Point Angler Intercept Survey (APAIS) provides the catch rates and species composition from anglers fishing in estuarine or marine waters (not freshwater). Anglers who have completed a fishing trip are intercepted and interviewed to gather catch and demographic data, including fishing mode (charter boat, private/rental boat, beach/bank, and man-made structures), area fished, and wave (each two-month sampling period).

The MRIP implemented the Fishing Effort Survey (FES) in 2018, an improved methodology of the prior effort survey (Coastal Household Telephone Survey). The data from the APAIS and FES are combined to provide estimates of the total number of fish caught, released, and harvested. Additionally, information is collected on the weight of the harvest, total number of trips, and the number of people participating in marine recreational fishing. Additional information on MRIP is available through NOAA.

Flounder landings reported through MRIP are available to the species level through direct observation; however, releases are not observed and therefore are only available at the genus level, which includes southern, summer, and Gulf flounder. To properly estimate species level releases, a ratio of flounder species is obtained from the observed catch through MRIP and applied to the unobserved releases at the corresponding time of year, wave, and fishing area. For further information on species composition and discussion see the *Increased Recreational Access* issue paper.

Mail Surveys: Gig Survey and Recreational Commercial Gear License Survey

Gears other than hook and line, such as flounder gigs and the recreational use of commercial gear, are under-represented within MRIP sampling. The division implemented the RCGL Survey in 2002 and the Coastal Angling Program (CAP) Recreational Gigging Mail Survey in 2010. For additional information on these Gigging Mail Survey see the License and Statistics Annual Report.

The implementation of a mandatory recreational saltwater fishing license in 2007 (Coastal Recreational Fishing License, CRFL) for the harvest of all finfish provides an opportunity to survey participation in gigging at the time of license purchase. The ongoing Gig Mail Survey began in 2010 to collect data on effort and catch. For the gig survey, no observed catch is available, thus harvest is estimated at the genus level and includes all three flounder species. For further information on species composition and discussion see the *Increased Recreational Access* issue paper.

For eight years (2001–2008), two mail surveys of RCGL holders were conducted. Effort information such as seasonal activity, trip number estimates, and monetary expenditures were categorized by gear type and recorded. Additionally, species-specific information such as catch (both harvested and discarded) and target species was also obtained (NCDMF 2009).

Hook-and-Line Fishery

Regulatory measures have strongly influenced the species composition of flounder harvested recreationally in North Carolina. Summer flounder dominated harvest until a size limit change from 13 to 14 inches TL in 2002 redistributed the species composition towards southern flounder. In 2011, a 15-inch TL size limit for the recreational fishery was implemented for all waters within North Carolina, which resulted in a downward trend for both southern and summer flounder

(Figure 14). North Carolina represents the second largest proportion of recreationally harvested southern flounder in the U.S. South Atlantic using hook-and-line gear (Figure 15).

In the North Carolina recreational hook-and-line fishery, flounder species have been the most often reported target species in 20 of the last 37 years (Figure 16). Many flounder are also taken during trips when anglers are targeting other species, such as spotted seatrout and red drum. The recreational hook-and-line fishery accounted for 89% of total recreational flounder harvest in 2017.

Anglers catch southern flounder using an array of artificial and natural baits. Preferred artificial baits include soft bodied lures of various colors and shapes fished on the bottom. Bottom fishing using natural live baits (mullet, menhaden, mud minnows, and shrimp) is popular and productive, as well. The recreational harvest of southern flounder exhibits a distinct seasonality that is concentrated between May and October (Figure 17).

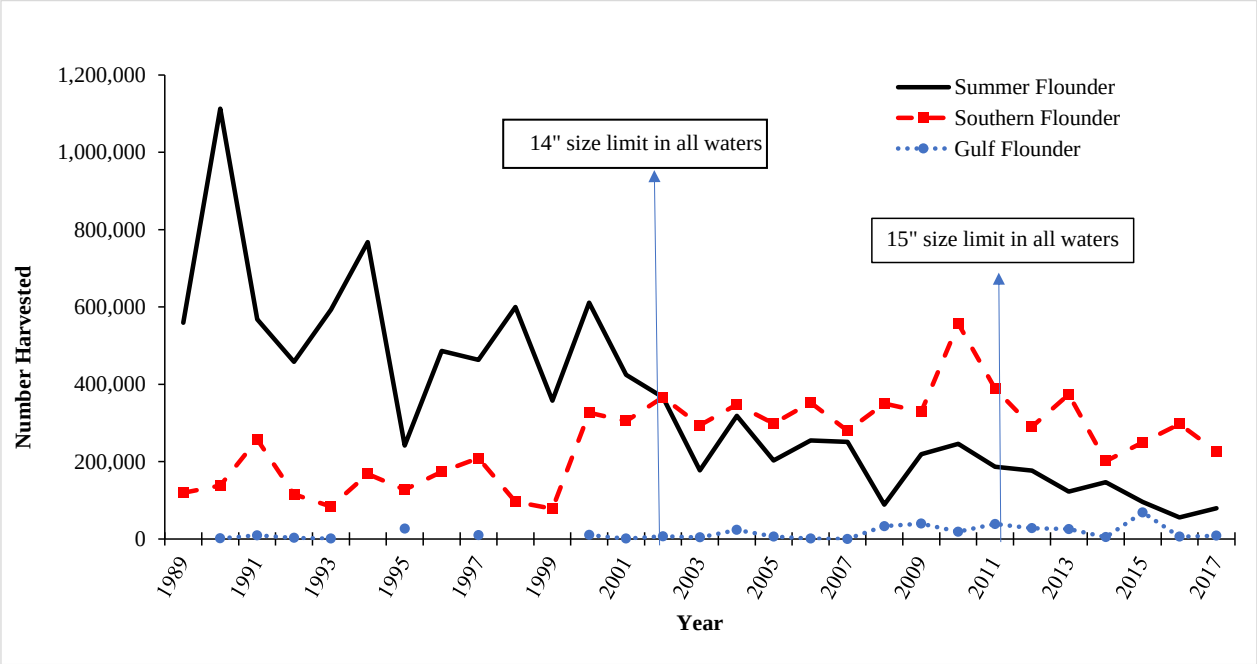


Figure 14. Distribution of flounder species harvested recreationally in North Carolina, 1989–2017. (Source: Marine Recreational Information Program)

For further information on recreational landings see the *Achieving Sustainable Harvest* and the *Increased Recreational Access* issue papers.

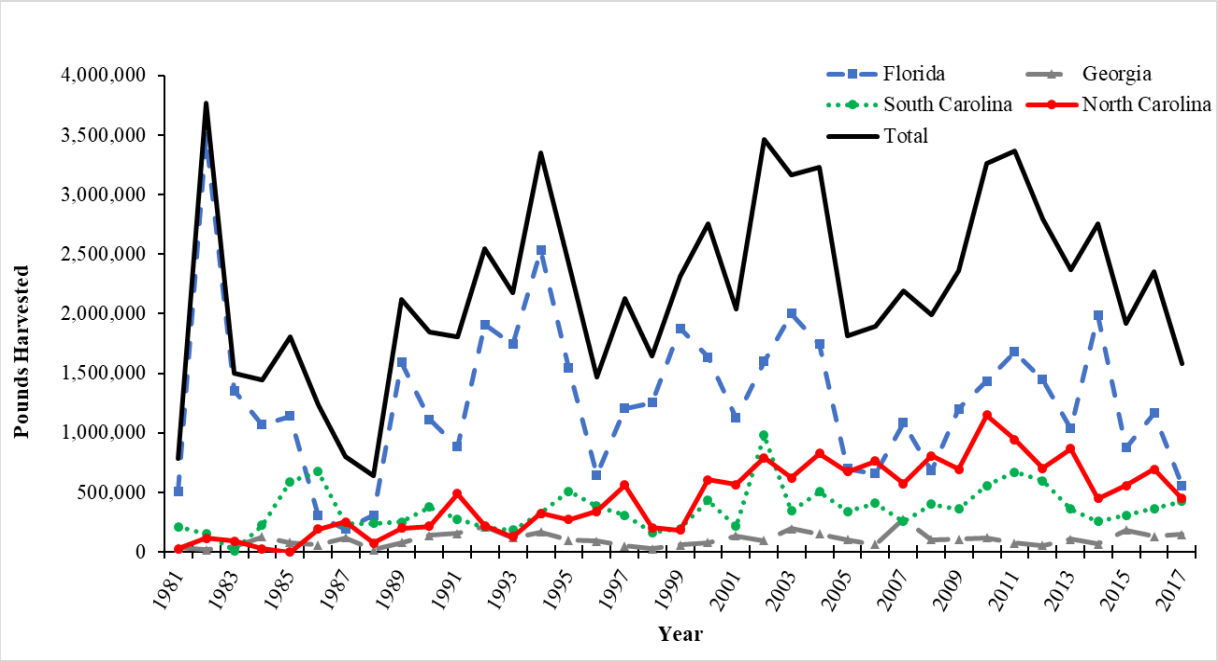


Figure 15. Hook-and-line recreational harvest of southern flounder (in pounds) estimated by MRIP for North Carolina through the east coast of Florida, 1981–2017. (Source: Marine Recreational Information Program)

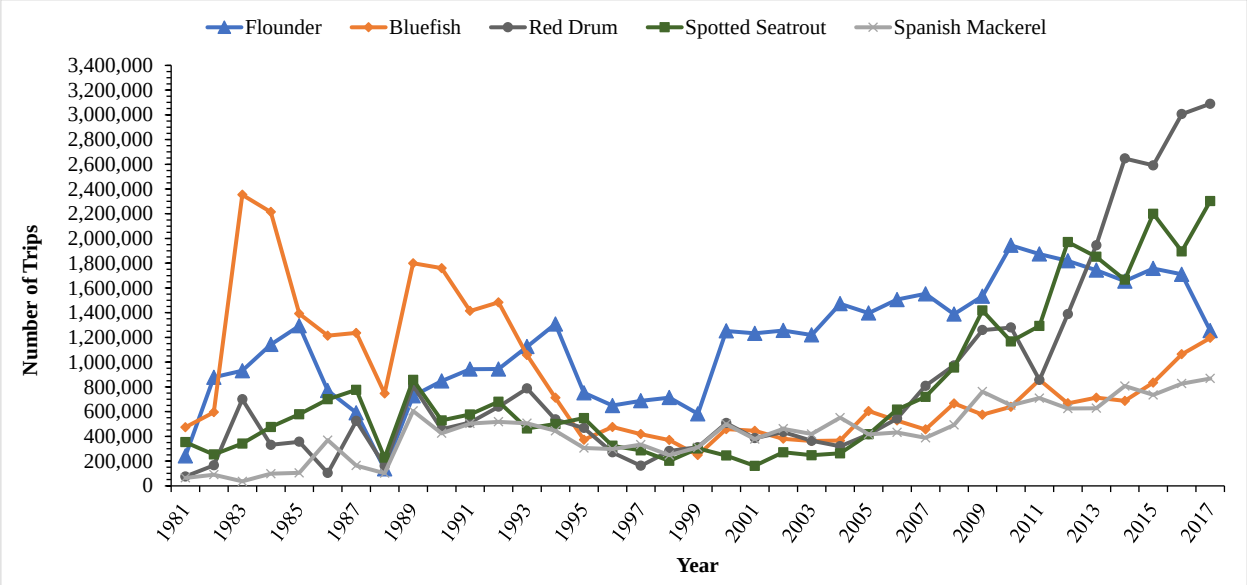


Figure 16. Recreational hook-and-line trips targeting five top species in North Carolina 1981–2017. (Source: Marine Recreational Information Program)

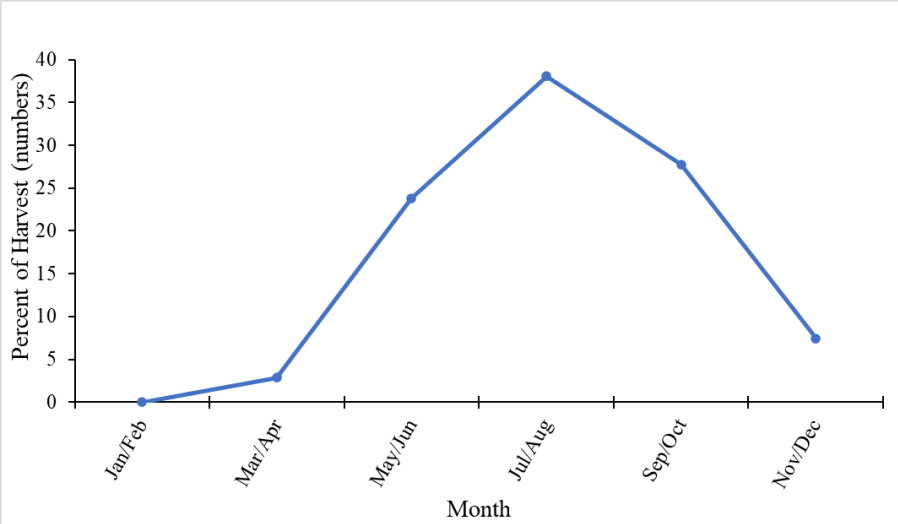


Figure 17. Seasonality of southern flounder recreational harvest in North Carolina, 1981–2017. (Source: Marine Recreational Information Program)

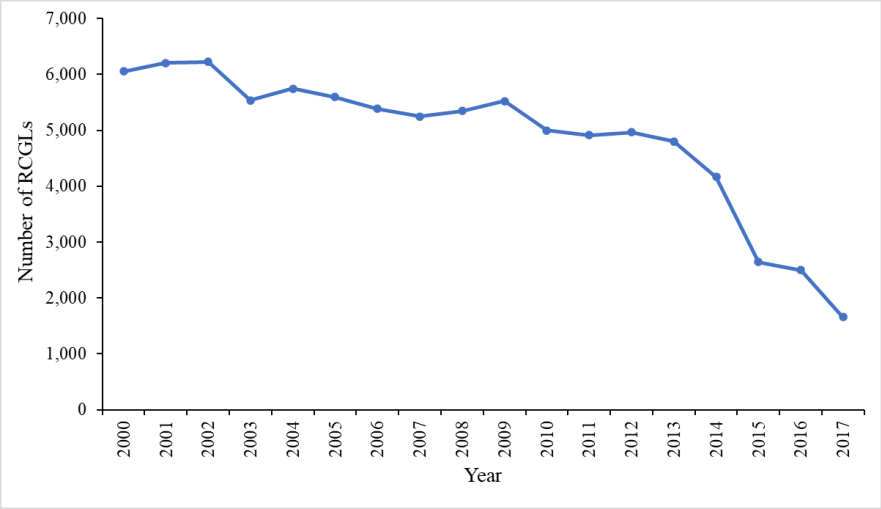
Gig Fishery

The recreational gig fishery accounted for 11% of total recreational flounder harvest in 2017. Effort estimates for 2008 through 2017 ranged from 13,524 to 25,666 trips annually, while harvest estimates ranged from 24,136 to 54,419 fish. Spatially, over 87% of gigging trips originated from Carteret County and south. Like the hook-and-line fishery, an increase in gigging trips was observed from May through October with a peak in harvest in the summer. For a more detailed description of the recreational gig fishery see the License and Statistics Annual Report and the *Achieving Sustainable Harvest* issue paper.

RCGL Fishery

Data on RCGL gears are only available from 2002 to 2008 due to funding being cut for the RCGL survey. Among the allowed gears, large-mesh gill nets comprised 74% of southern flounder harvest, with small-mesh gill nets (21%), crab pots (4%), and shrimp trawls (1%) constituting the remainder (NCDMF 2009). The number of flounder species (southern, summer, and Gulf) harvested between 2002 and 2008 ranged from 18,414 to 53,785 fish or 100,514 pounds in 2002 down to 37,315 pounds in 2008. The number of licensed individuals participating in the RCGL fishery has steadily decreased from approximately 6,000 in 2000 to 1,800 in 2017 (Figure 18). This is the best indicator currently available of declining effort in the RCGL fishery. For additional information on licenses see the License and Statistics Annual Report or for RCGL survey analysis see the 2009 License and Statistics Annual Report (NCDMF 2009).

Figure 18. The number of Recreational Commercial Gear Licenses (RCGL) issued 2000–2017. (Source: NCDMF License and Statistics Annual Report)



Recreational Discards and Bycatch of Southern Flounder

The minimum size limit to harvest southern flounder is 15 inches TL. Any southern flounder not legal for harvest must be immediately returned to the water. Primary gears used by recreational fishermen that capture southern flounder include hook-and-line and gigs.

Hook-and-line is the primary gear for taking southern flounder for recreational purposes in North Carolina. North Carolina represents the largest recreational proportion of released flounder in the U.S. South Atlantic (Figure 19). This is driven by the aforementioned regulatory measures. Specifically, the increase in size limit to 15 inches TL in 2011 resulted in a ratio of nine discarded fish for every one fish harvested in North Carolina (Figure 19). In contrast, a 12-inch TL size limit in Florida was allowed prior to March 2021 and the ratio of discard to harvest to was approximately 1:1.

The stock assessment assumes a post-release mortality for hook-and-line released southern flounder of 9% (See Section 2.1.4 in Flowers et al. 2019). The post-release mortality and magnitude of discards in this fishery make these removals a major contributor to the overall fishing mortality being experienced by this stock. In recent years, post-release mortality associated with recreational releases is nearly equal to the number of removals from recreational harvest.

In the recreational gig fishery, discard estimates are available from 2010 to 2017 through a division-led mail survey on recreational flounder gigging. This survey estimates the number of trips, as well as southern flounder harvest and discards (See Section 2.1.5 in Flowers et al. 2019,). Discard estimates ranged from 655 to 9,726 fish annually and represent only a small portion (less than 1%) of the overall removals from the recreational fishery.

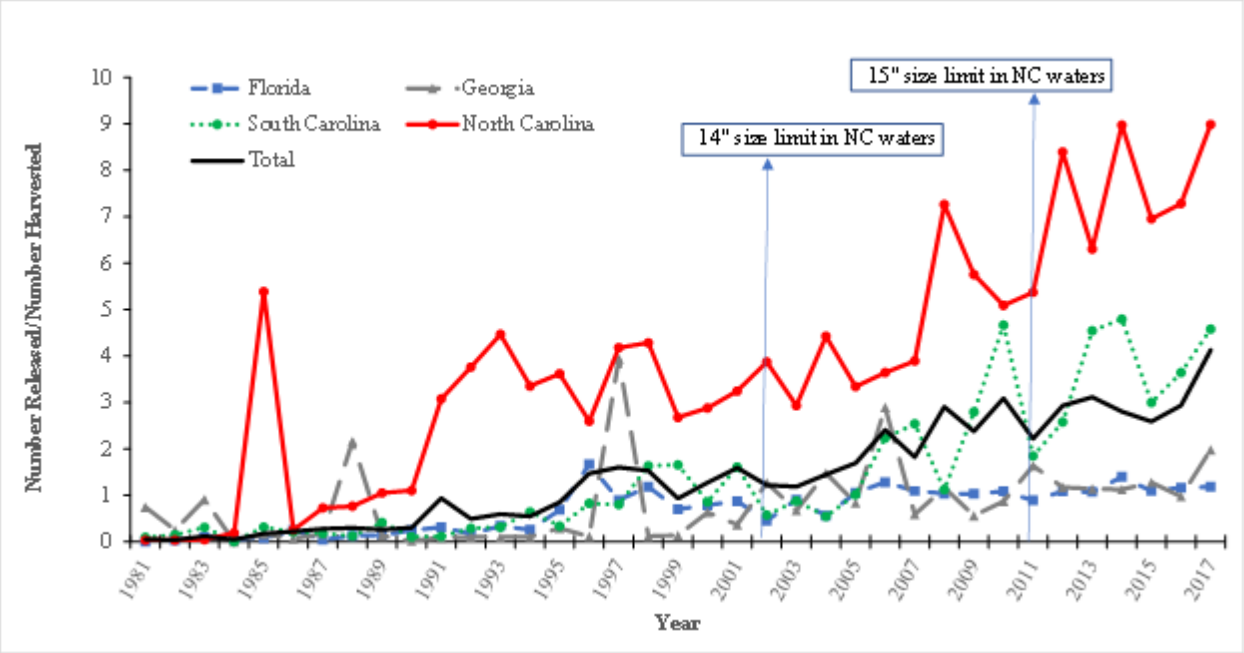


Figure 19. Ratio of the number of southern flounder released compared to harvested in the recreational hook-and-line fishery as estimated through MRIP for North Carolina through the east coast of Florida, 1981–2017. (Source: Marine Recreational Information Program)

Between 2002 and 2008, the number of discarded flounder species from RCGL gears ranged from approximately 15,000 to 52,000 fish (NCDMF 2009). Large- and small-mesh gill nets contributed 58.9% of discards throughout the time series. Despite making up a small portion of the overall trips (4.8%) and harvest (1.2%), shrimp trawls disproportionately contributed to discards of southern flounder. Flounder discards from shrimp trawls ranged from 15.1 to 51.2% and averaged 31.7% of all flounder discards from RCGL gears for the time series (NCDMF 2009).

Demographic Characteristics

The average angler participating in recreational harvest of southern flounder in North Carolina is a male older than 47 (NCDMF, unpublished data). Anglers targeting or harvesting southern flounder represented all 100 North Carolina counties, all 50 states, and the District of Columbia (Table 9). Anglers harvest southern flounder by three different modes: shore; for-hire boats; and private boats. Private boat anglers harvest the largest volume of southern flounder in the recreational fishery (Figure 20). Due to low sample sizes and high PSE, southern flounder data from the for-hire industry are limited. Data indicate that the for-hire fleet capture flounder at a higher rate than the recreational fishery suggesting that impact on a per angler basis tends to be higher by the for-hire industry.

Summary of Economic Impact of Recreational Fishing

The economic impact estimates presented for southern flounder recreational fishing represent the economic activity generated from trip expenditures. These estimates are a product of annual trip estimations originating from the NOAA Fisheries MRIP effort data by area and by mode (i.e.,

shore, for-hire, private/rental vessel, and man-made), and trip expenditures estimates from the division economics program biennial socioeconomic survey of CRFL license holders (Dumas et al. 2009; Crosson 2010; Hadley 2012; Stemle and Condon 2017). The product of these estimates gives us an annual estimate of trip expenditures made by all licensed anglers for a given year. For this analysis, a recreational flounder trip is defined as a fishing trip for which any flounder was the primary or secondary target species by the angler, or if southern flounder was caught during that trip.

Table 9. Contribution of North Carolina counties and other states to recreational flounder fisheries according to three sources of data: Access Point Angler Intercept Survey (APAIS), Recreational Commercial Gear License Survey (RCGL), and Gig Mail Survey.

	APAIS		RCGL		Gig Mail Survey	
Categories	**Counties/States**	**%**	**Counties/States**	**%**	**Counties/States**	%
Top 10 Counties	New Hanover	11.3	Craven	9.3	Wake	7.61
	Dare	6.4	Carteret	7.4	New Hanover	6.94
	Brunswick	6.1	New Hanover	6.9	Carteret	5.56
	Carteret	4.5	Beaufort	6.1	Onslow	4.64
	Wake	3.8	Brunswick	5.9	Brunswick	3.98
	Onslow	3.2	Wake	5.2	Johnston	3.08
	Pitt	2.2	Pitt	4.8	Pender	3.07
	Craven	2.1	Onslow	4.3	Craven	2.99
	Pender	2.1	Pamlico	4.1	Guilford	2.63
	Guilford	1.8	Dare	3.7	Dare	2.58
Top 5 Other States	Virginia	10.3	Florida	0.2	Virginia	2.39
	Pennsylvania	2.9	Pennsylvania	0.2	South Carolina	1.06
	Maryland	2.3	Tennessee	0.2	Pennsylvania	0.48
	South Carolina	1.0	California	0.2	Maryland	0.34
	New Jersey	0.9			Georgia	0.20

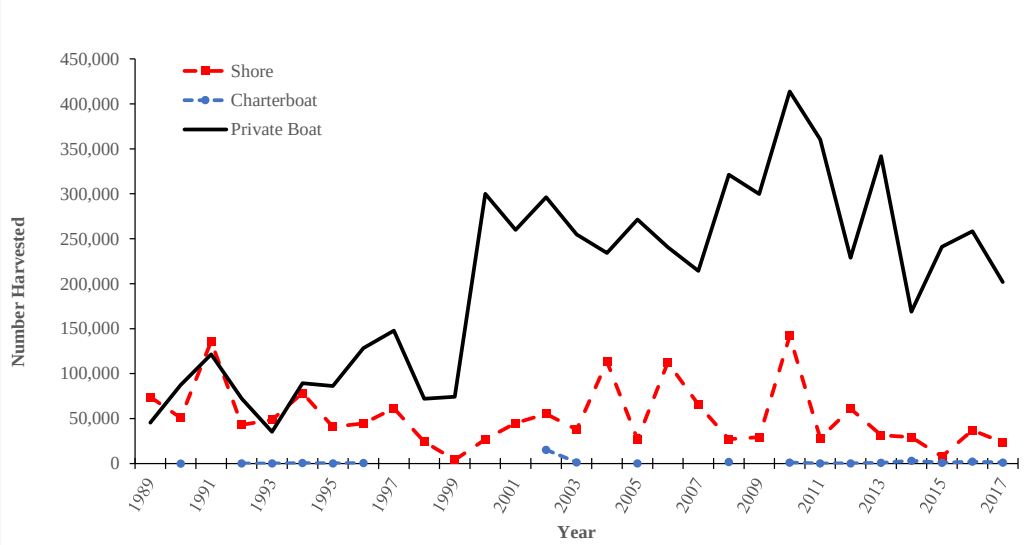


Figure 20. Number of southern flounder harvested in the recreational fishery by MRIP mode, 1989–2017. (Source: Marine Recreational Information Program)

Additionally, these data are used to generate state-level economic impact estimates of recreational flounder fishing in North Carolina. Using IMPLAN statistical software, these direct expenditure estimates from recreational flounder fishing produce indirect output impacts to the state economy across four categories: sales, labor income, value-added impacts, and employment (IMPLAN 2013). Additionally, all imputed expenditure estimates are adjusted for inflation based on 2016 prices, as this was the most recent year of expenditure survey data. For a detailed explanation of the methodology used to estimate the economic impacts please refer to the division's License and Statistics Section Annual Report.

Aside from a spike in 2008 and a dip in 2017, recreational flounder effort is relatively stable over time (Table 10). With this, the economic impact from this fishery is also stable over time, as recreational flounder angling represents a sizeable contribution to the state economy. The top industries impacted by recreational southern flounder fishing in terms of output sales and employment are retail gasoline stores, retail sporting goods stores, retail food and beverage stores, real estate, and wholesale trade businesses.

Table 10. Economic impacts associated with recreational southern flounder fishing in North Carolina from 2008–2017. Impacts are generated using IMPLAN statistical software and division recreational survey data. Trips are defined as a fishing trip for which any flounder is the primary or secondary target, or if southern flounder was caught during that trip. All job impacts represent both part- and full-time jobs. Note: impact estimates across categories are not additive.

Year	Estimated Total Flounder Trips	Trip Expenditures	Estimated Sales Impact	Estimated Income Impact	Estimated Employment Impact	Estimated Value-Added Impact
2008	2,701,930	$403,612,123	$376,417,686	$135,957,566	3,292	$205,722,681
2009	1,482,500	$215,695,683	$200,699,372	$72,448,738	1,770	$109,870,023
2010	1,877,504	$280,546,465	$262,481,379	$95,039,325	2,312	$143,569,612
2011	1,796,204	$283,056,149	$250,861,698	$90,609,485	2,212	$137,255,698
2012	1,744,458	$277,772,559	$244,156,371	$88,393,860	2,159	$133,589,470
2013	1,707,904	$273,226,860	$238,202,597	$86,449,024	2,105	$130,332,132
2014	1,639,593	$269,763,604	$229,373,566	$83,466,334	2,027	$125,444,042
2015	1,708,499	$279,669,886	$228,724,518	$83,228,735	2,037	$125,250,995
2016	1,714,200	$279,905,674	$232,116,853	$84,789,195	2,079	$127,093,283
2017	1,250,216	$210,976,279	$171,358,430	$62,652,077	1,532	$93,793,106
Average	1,762,301	$277,422,528	$243,439,247	$88,303,434	2,153	$133,192,104

It should be noted that not included in these estimates, but often presented in the division's overall recreational impacts models, are the durable good impacts from economic activity associated with the consumption of durable goods (e.g., rods and reels, other fishing related equipment, boats, vehicles, and second homes). Durable goods represent goods that have multi-year life spans and are not immediately consumable. Some equipment related to fishing is considered durable goods, however, we cannot estimate the durable goods expense of anglers for a given species. Durable goods expenses and impacts are estimated on an annual basis and serve to supplement angler expenditures outside of trip-based estimates.

Lastly, due to the size and popularity of recreational flounder fishing in North Carolina, changes in access to this fishery may lead to tangible, yet unquantifiable impacts to the value of other sport fisheries (Scheld et al. 2020). Broadly, participants target or catch flounder more than other recreational species due to higher personal satisfaction gained from fishing for this species over others in North Carolina. However, it is unknown whether this benefit from flounder fishing would transfer to other fisheries if effort restrictions were put in place. There is a possibility that when faced with reduced access to flounder fishing, some anglers may choose to not fish at all, rather than seek out new target species. Alternatively, the utility of flounder fishing may not be significantly greater than other species, and anglers would target other species more frequently.

Through this complicated dynamic, the value and economic impact of other recreational species may increase or decrease based on this concept of per-species utility. However, while it is important to acknowledge how flounder management may economically impact other fisheries, this interaction is not fully understood, and, therefore, it cannot be determined how the value of other recreational species would shift with changes in access to flounder.

SUMMARY OF FISHERIES CONCLUSION

Both the commercial and recreational fisheries combine to create a very dynamic southern flounder fishery in North Carolina with a combined economic value of over 600 million dollars to the state of North Carolina. Effort and harvest in the commercial fishery have continuously declined from nearly 42,475 trips in 1994 to 17,963 trips in 2017 and landings from over 4.8 million pounds in 1994 down to roughly 1.4 million pounds in 2017 (Figure 21).

The recreational sector has seen an increase in both effort and harvest and a major increase in releases since 1994, with trips remaining relatively steady from 1.31 million trips in 1994 to 1.25 million trips in 2017 and harvest increasing from 300,000 pounds in 1994 to 400,000 pounds in 2017 with over one-million pounds harvested in 2010 (Figure 21). Recreational releases have also increased through the years from 209,956 fish in 1999 to over 1.9 million fish released in 2017. Additional information describing discards is in the *Stock Assessment of Southern Flounder (Paralichthys lethostigma) in the U.S. South Atlantic, 1989-2017*.

An in-depth analysis and discussion of North Carolina's commercial and recreational southern flounder fisheries can be found in earlier versions of the Southern Flounder FMP (NCDMF 2005, 2013, 2017, 2019); and 2018 and 2019 Southern Flounder Stock Assessments (Lee et al. 2018; Flowers et al. 2019); all documents are available on the division website, the License and Statistics Annual Report, or the *Achieving Sustainable Harvest* issue paper in this FMP.

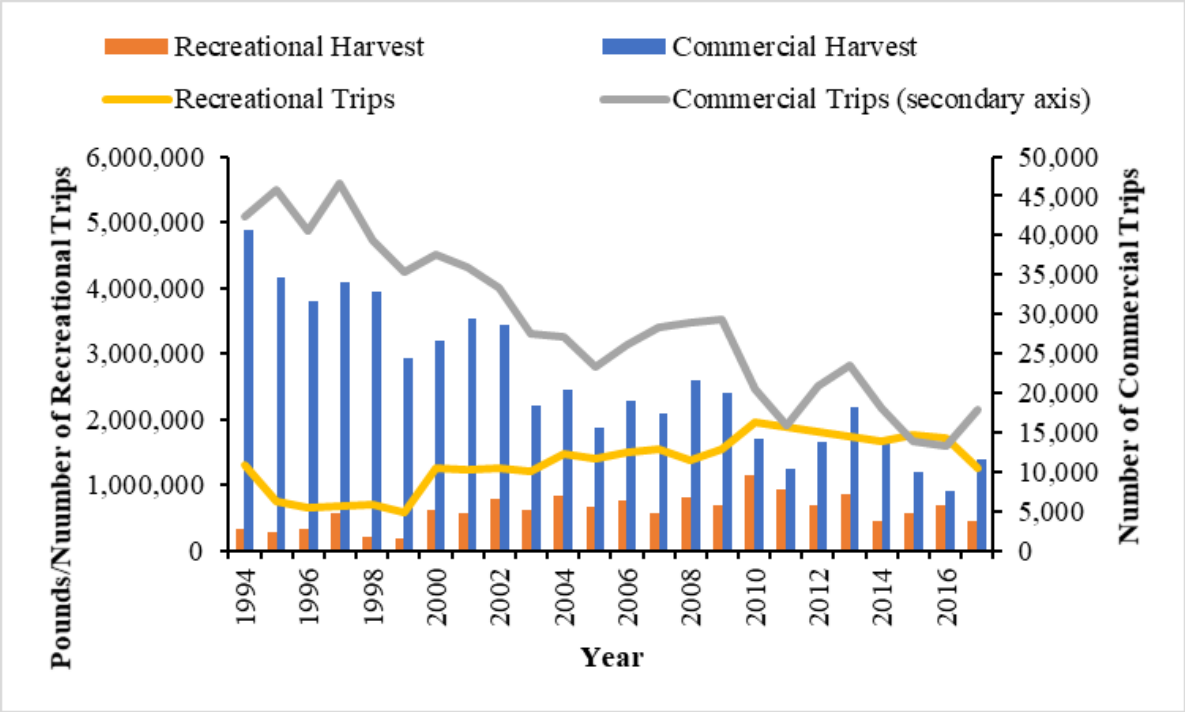


Figure 21. Commercial and recreational harvest (measured in pounds) and effort (measured in trips) from the N.C. Southern Flounder Fishery, 1994–2017. Recreational landings and trips do not include recreational commercial gear or the gig fishery due to data limitations. (Source: North Carolina Trip Ticket Program and Marine Recreational Information Program)

RESEARCH RECOMMENDATIONS

The research recommendations listed below are offered by the PDT and the stock assessment working group to improve future management strategies and stock assessments of the South Atlantic southern flounder stock. Those recommendations followed by an asterisk (*) were identified as the top five high priority research recommendations and are discussed further below. Otherwise, recommendations within each category, High (H), Medium (M), Low (L), are not listed in order of importance.

BIOLOGICAL/STOCK ASSESSMENT/FISHERY

- H - Conduct studies to quantify fecundity and fecundity-size/age relationships in Atlantic southern flounder. *
- H - Improve estimates of the discard (B2) component (catches, lengths, and ages) for southern flounder from MRIP (underway). *
- H - Expand, improve, or add fisheries-independent surveys of the ocean component of the Stock. *
- H - Determine locations of spawning aggregations of southern flounder (underway). *
- H - Complete an age validation study using known age fish. *

- H - Research and evaluate data on the sub-legal fish in the recreational fishery as it relates to potential future reductions in minimum size limits (underway).
- M - Promote data sharing and research cooperation across the South Atlantic southern flounder range (North Carolina, South Carolina, Georgia, and Florida).
- M - Further research on factors that impact release mortality of southern flounder in the recreational hook-and-line fishery.
- M - Research on deep hooking events of different hook types and sizes on southern flounder.
- M - Coast-wide at-sea observations of the flounder pound net fishery.
- M - Develop a survey that will provide estimates of harvest and discards for the recreational gig fisheries in North Carolina, South Carolina, Georgia, and Florida.
- M - Develop a survey that will provide estimates of harvest and discards from gears used to capture southern flounder for personal consumption.
- M - 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).
- M - Expand, improve, or add inshore and offshore surveys of southern flounder to develop indices for future stock assessments.
- M - Collect age and maturity data from the fisheries-independent South East Area Monitoring and Assessment Program (SEAMAP) Trawl Survey given its broad spatial scale and potential to characterize offshore fish.
- M - Conduct studies to better understand ocean residency of southern flounder.
- M - 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.
- M - Consider the application of a spatial model to account for inshore and ocean components of the stock as well as movements among states.
- M - Work to reconcile different state-level/regional surveys to better explain differences in trends.
- M - Evaluate the utility of circle hooks in the southern flounder recreational hook-and-line fishery.
- L - Develop a recreational catch per unit effort (CPUE; e.g., from MRIP intercepts or the Southeast Regional Headboat Survey if sufficient catches are available using a species guild approach to identify trips, from headboat logbooks, etc.) as a complement to the more localized fishery independent indices.
- L - Explore reconstructing historical catch and catch-at-length data prior to 1989 to provide more contrast in the removals data.
- L - Study potential species interactions among Paralichthid flounders to explain differences in population trends where they overlap.
- L - Explore potential impacts stocking may have on the southern flounder population and the costs associated with implementing a stocking program.
- L - Continued otolith microchemistry research to gain a better understanding of oceanresidency of southern flounder (underway).
- L - Implement fishery dependent sampling of the commercial spear fishery for flounder in the ocean.

- L - Determine harvest estimates and implement fishery dependent sampling of the recreational spear fishery for flounder in the ocean.
- L - Further research on flatfish escapement devices in crab pots that minimize undersized flounder bycatch and maximize the retention of marketable blue crabs.
- L - Expand tagging study to ocean component of the stock to estimate emigration, immigration, movement rates, and mortality rates throughout the stock's range.
- L - 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.
- L - Examine the variability of southern flounder maturity across its range and the effects this may have on the assessment model.
- L - Further research on the size distribution of southern flounder retained in pound nets with 5.75-ISM and 6-ISM escape panels.
- L - Research on the species composition and size distribution of fish and crustaceans that escape pound nets through 5.75-ISM and 6-ISM escape panels.
- L - Develop a survey that will estimate harvest and discards from commercial gears used for recreational purposes.
- L - Continue at-sea observations of the large-mesh gill-net fishery including acquiring biological data on harvest and discards (underway).
- L - Develop survey that better represents the for-hire industry.

ECOSYSTEM

- M - Development of alternative gears to catch southern flounder (some research completed, more may be needed).
- L - Continued gear research in the design of gill nets and pound nets to minimize protected species interactions (some research completed, more may be needed).
- L - Investigate the impacts of warming water temperature on the southern flounder stock.
- L - Develop a study that evaluates inlets and their relationship to southern flounder migration.
- L - Develop studies to investigate the impacts of emerging compounds on southern flounder.

SOCIO/ECONOMIC

- M - Study revenue variability and profitability of commercial southern flounder fishing in North Carolina based on catch characteristics.
- M - Generate a stated preference survey of North Carolina recreational anglers to understand perceived value of targeting southern flounder compared to other estuarine finfish species.

RESEARCH RECOMMENDATIONS SUMMARY

The top five research priorities with an (*) identify data needs for continued improvements to the coast-wide stock assessment. Gaining a better understanding of the ocean component of the stock is critical and includes gathering information on the spawning locations, expanding and developing surveys to provide independent abundance trends for the ocean component of the stock, and conducting research to identify fecundity estimates for spawning females by length. Determining the age of fish is critical when estimating maturity and stock structure so verifying the ages of wild

fish through an age validation study would provide additional precision. Finally, a large component of removals from this stock is fish released during recreational fishing activities. Many of these fish are not intercepted by port agents during sampling as they are not kept. It is critical that estimates of discards by size and species are available for the various flounder species across the species range.

SOUTHERN FLOUNDER AMENDMENT 3 MANAGEMENT STRATEGY

The NCMFC selected the following management options:

1. Combine mobile gears (gill nets, gigs, and "other" gears) into one gear category and maintain pound nets as their own separate commercial fishery.
2. Divide mobile gears into two areas using the ITP boundary line for management units B-D.
3. Divide the pound net fishery into three areas maintaining consistency with areas in Amendment 2.
4. Maintain 72% reduction and current sub-allocation for the pound net fishery with direction from the NCMFC as follows: "In 2024, as the shift in allocation is set to start the Division will provide recommendations to the NCMFC on approaches to maintaining a sustainable sub-allocation for the commercial pound net fishery, as needed based on the economic and biotic conditions at that time".
5. Implement trip limits for pound nets and gigs only to maximize reopening after reaching division closure threshold.
6. Implement a single season for the recreational gig and hook-and-line fisheries to constrain them to an annual quota.
7. Reduce the recreational bag limit of flounder to one fish per person per day.
8. Do not allow harvest of southern flounder using RCGL.
9. One-fish ocellated bag limit during March 1 through April 15 in ocean waters only using hook-and-line gear and one-fish bag limit consisting of any species of flounder during the southern flounder season.
10. Do not establish inlet corridors for southern flounder during spawning migrations.
11. Adopt the adaptive management framework based on the peer-reviewed and approved stock assessment.
12. At the Nov. 2020 business meeting, the NCMFC requested analysis of various recreational and commercial allocation percentages. In March 2021, the NCMFC voted on and approved sector allocations of 70/30 commercial to recreational for 2021 and 2022 and shifting to 60/40 for 2023, and 50/50 parity beginning in 2024.

    Based on recognition of a series of coincident concerns specific to the initial steps in rebuilding the southern flounder fishery, the NCMFC voted in Feb. 2022 to delay the transition to 50/50 parity by two years (time for at least one cycle of larval to female maturity). The selected allocations will be 70/30 for 2023 and 2024, 60/40 for 2025, and 50/50 parity starting in 2026.
13. Do not implement a slot limit and maintain the 15-inch TL current minimum size limit.
14. Continue to allow anchored large-mesh gill nets to harvest southern flounder in the North Carolina southern flounder fishery.

LITERATURE CITED

Anderson, J. D., and W. J. Karel. 2012. Population genetics of southern flounder with implications for management. North American Journal of Fisheries Management 32(4):656–662.

Arrivillaga, A., and D. M. Baltz. 1999. Comparison of fishes and macroinvertebrates on seagrass and bare-sand sites on Guatemala's Atlantic coast. Bulletin of Marine Science 65(2):301–319.

Asche, F., and J. Guillen. 2012. The importance of fishing method, gear and origin: The Spanish hake market. Marine Policy 36(2):365–369.

Barnette, M. C. 2001. A review of the fishing gear utilized within the Southeast Region and their potential impacts on essential fish habitat. National Marine Fisheries Service, Technical Memo MFFS-SEFSC-499. 68 p.

Blandon, I. R., R. Ward, and T. L. King. 2001. Preliminary genetic population structure of southern flounder, *Paralichthys lethostigma*, along the Atlantic Coast and Gulf of Mexico. Fisheries Bulletin 99(4):671–678.

Brown, K. 2009. Characterization of the near-shore commercial shrimp trawl fishery from Carteret County to Brunswick County, North Carolina. Completion report for NOAA Award NA05NMF4741003. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 34 p.

Brown, K. 2010a. Compare catch rates of shrimp and bycatch of other species in standard (control) and modified (experimental) otter trawls in the Neuse River and Pamlico Sound, North Carolina. Completion report for NOAA Award NA08NMF4740476. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 28 p.

Brown, K. 2010b. Characterization of the inshore commercial shrimp trawl fishery in Pamlico Sound and its tributaries, North Carolina. Completion report for NOAA Award NA08NMF4740476. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 28 p.

Brown, K. 2014. Determine the selectivity of escape panels in the flounder pound nets in Back Sound, North Carolina. Completion Report for NOAA Award No. NA08NMF4740476. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 26 p.

Brown, K. 2015. Characterization of the commercial shrimp otter trawl fishery in the estuarine and ocean (0-3 miles) waters of North Carolina. Completion report for National Fish and Wildlife Foundation Award 8015.12.030677 and NOAA Award NA08NMF4740476 and NA13NMF4740243. North Carolina Department of Environmental Quality, Division of Marine Fisheries, Morehead City, NC. 177 p.

Brown, K. 2016. Characterization of bycatch and discards, including protected species interactions, in the commercial skimmer trawl fishery in North Carolina. Completion report NOAA Award NA14NMF47400363 and NA13NMF4740243. North Carolina Department of Environmental Quality, Division of Marine Fisheries, Morehead City, NC. 36 p.

Brown, H. K., B. Price, L. Lee, M. S. Baker Jr., and S. E. Mirabilio. 2019. Simple gear modifications for achieving greater than 40% bycatch reduction in an estuarine shrimp trawl fishery. Fishery Bulletin 117(4): 372–385.

Burke, J. S. 1995. Role of feeding and prey distribution of summer and southern flounder in selection of estuarine nursery habitats. Journal of Fish Biology 47:355–366.

Burke, J. S., J. M. Miller, and D. E. Hoss. 1991. Immigration and settlement pattern of *Paralichthys dentatus* and *P. lethostigma* in an estuarine nursery ground, North Carolina, USA. Netherland Journal of Sea Research 27:393–405.

Byrd, B. L., and A. A. Hohn. 2017. Differential risk of bottlenose dolphin (*Tursiops truncatus*) bycatch in North Carolina, USA. Aquatic Mammals 43(5):558–569.

Byrd, B. L., A. A. Hohn, G. N. Lovewell, K. M. Altman, S. G. Barco, A. Friedlaender, C. A. Harms, W. A. McLellan, K. T. Moore, P. E. Rosel, and V. G. Thayer. 2014. Strandings as indicators of marine mammal biodiversity and human interactions off the coast of North Carolina. Fishery Bulletin 112(1):1–23.

Byrd, B., J. McConnaughey, and S. Smith. 2020a. Annual Atlantic Sturgeon interaction monitoring of anchored gill net fisheries in North Carolina for Incidental Take Permit Year 2019 (1 September 2018 – 31 August 2019). Annual Completion Report for Activities under Endangered Species Act Section 10 Incidental Take Permit No. 18102. North Carolina Department of Environmental Quality, Division of Marine Fisheries, Morehead City, NC. 47 p.

Byrd, B., J. McConnaughey, and S. Smith. 2020b. Annual sea turtle interaction monitoring of the anchored gill-net fisheries in North Carolina for Incidental Take Permit Year 2019 (1 September 2018 – 31 August 2019). Annual Completion Report for Activities under Endangered Species Act Section 10 Incidental Take Permit

No. 16230. North Carolina Department of Environmental Quality, Division of Marine Fisheries, Morehead City, NC. 61 p.

Chestnut, A. F., and H. S. Davis. 1975. Synopsis of marine fisheries of North Carolina: Part I: Statistical Information, 1880-1973. University of North Carolina, Sea Grant Program, Sea Grant Publication UNC-SG-75-12, Raleigh.

Cheuvront, B. 2002. A social and economic analysis of commercial fisheries of Core Sound, North Carolina. A report submitted to the Atlantic Coastal Fisheries Cooperative Management Act, NOAA Award No. NA16FG1220-1. Division of Marine Fisheries, Morehead City, NC. 45 p.

Cheuvront, B. 2003. A social and economic analysis of commercial fisheries in North Carolina: Beaufort Inlet to the South Carolina state line. A report submitted for the N.C. Technical Assistance to the South Atlantic Fisheries Management Council, Task 5: NEPA related activities. Contract Award No: SA-03-03-NC. Division of Marine Fisheries, Morehead City, NC. 56 p.

Cheuvront, B., and M. Neal. 2004. A social and economic analysis of Snapper Grouper complex fisheries in North Carolina south of Cape Hatteras. A report submitted for the N.C. Technical Assistance to the South Atlantic Fisheries Management Council, Task 5: NEPA related activities. Contract Award No: SA-03-03-NC. Division of Marine Fisheries, Morehead City, NC. 54 p.

Corey, M. M., R. T. Leaf, N. J. Brown-Peterson, M. S. Peterson, S. D. Clardy, and D. A. Dippold. 2017. Growth and spawning dynamics of southern flounder in the North-Central Gulf of Mexico. Marine and Coastal Fisheries 9:231–243.

Craig, J. K., and J. A. Rice. 2008. Estuarine residency, movements, and exploitation of southern flounder (*Paralichthys lethostigma*) in North Carolina. North Carolina Sea Grant, Final Report Grant 05-FEG-15, Raleigh.

Craig, J. K., W. E. Smith, F. S. Scharf, and J. P. Monaghan. 2015. Estuarine residency and migration of southern flounder inferred from conventional tag returns at multiple spatial scales. Marine and Coastal Fisheries 7:450–463.

Crosson, S. 2010. A social and economic analysis of commercial fisheries in North Carolina. A report submitted to the Atlantic Coastal Fisheries Cooperative Management Act. NOAA Award No. NA05NMF4741003. Division of Marine Fisheries, Morehead City, NC. 25 p.

Dance, M. A., and J. R. Rooker. 2015. Habitat- and bay-scale connectivity of sympatric fishes in an estuarine nursery. Estuarine, Coastal and Shelf Science 167:447–457.

Daniels, H. V. 2000. Species profile: southern flounder. Southern Regional Aquaculture Center, Publication No. 726. 4 p.

Del Toro-Silva, F. M., J. M. Miller, J. C. Taylor, and T. A. Ellis. 2008. Influence of oxygen and temperature on growth and metabolic performance of *Paralichthys lethostigma* (Pleuronectiformes: Paralichthyidae). Journal of Experimental Marine Biology and Ecology 358:113–123.

Diaby, S. 2000. An economic analysis of commercial fisheries in the Albemarle Sound Management Area, North Carolina. A report submitted to the Atlantic Coastal Fisheries Cooperative Management Act. NOAA Award No. NA87FG0367-1. Division of Marine Fisheries, Morehead City, NC. 26 p.

Diaby, S. 2001. An economic analysis of commercial fisheries in the Pamlico Sound Area, North Carolina. A report submitted to the Atlantic Coastal Fisheries Cooperative Management Act. NOAA Award No. NA87FG0367-2. Division of Marine Fisheries, Morehead City, NC. 36 p.

Doxey, R. 2000. Bycatch in the crab pot fishery. North Carolina Sea Grant, Final Report Fishery Resource Grant 99-FEG-45, Raleigh.

Dubik, B.A., E.C. Clark, T. Young, S.B.J. Ziegler, M.M. Provost, M.L. Pinsky, and K. St. Martin. 2019. Governing fisheries in the face of change: Social responses to long-term geographic shifts in a U.S. fishery. Marine Policy 99:243–251.

Dumas, C. F., J. C. Whitehead, C. E. Landry, and J. H. Herstine. 2009. Recreation value and economic impacts of the North Carolina for-hire fishing fleet. North Carolina State University, North Carolina Sea Grant, Final Report Grant 07-FEG-05, Raleigh.

Ellis, J. K., and J. A. Musick. 2007. Ontogenetic changes in the diet of the sandbar shark, *Carcharhinus plumbeus*, in lower Chesapeake Bay and Virginia (USA) coastal waters. Environmental Biology of Fishes 80:51–67.

Ellis, T. A. 2007. Assessing nursery quality for southern flounder, *Paralichthys lethostigma*, through fish energy content and habitat abiotic conditions. Master's thesis, North Carolina State University, Raleigh, North Carolina.

Farmer, T. M., D. R. DeVries, R. A. Wright, and J. E. Gagnon. 2013. Using seasonal variation in otolith microchemical composition to indicate largemouth bass and southern flounder residency patterns across an estuarine salinity gradient. Transactions of the American Fisheries Society 142(5):1415–1429.

Fischer, A. J., and B. A. Thompson. 2004. The age and growth of southern flounder, *Paralichthys lethostigma*, from Louisiana estuarine and offshore waters. Bulletin of Marine Science 75(1):63–77.

Fitzhugh, G. R., L. B. Crowder, and J. P. Monaghan, Jr. 1996. Mechanisms contributing to variable growth in juvenile southern flounder (*Paralichthys lethostigma*). Canadian Journal of Fisheries and Aquatic Sciences 53:1964–1973.

Flowers, A. M., S. D. Allen, A. L. Markwith, and L. M. Lee (editors). 2019. Stock assessment of southern flounder (*Paralichthys lethostigma*) in the South Atlantic, 1989–2017. Joint report of the North Carolina Division of Marine Fisheries, South Carolina Department of Natural Resources, Georgia Coastal Resources Division, Florida Fish and Wildlife Research Institute, University of North Carolina at Wilmington, and Louisiana State University. NCDMF SAP-SAR-2019-01. 213 p.

Francis, A. W., and R. G. Turingan. 2008. Morphological and biomechanical changes of the feeding apparatus in developing southern flounder, *Paralichthys lethostigma*. Journal of Morphology 269:1169–1180.

Froeschke, B. F., G. W. Stunz, M. M. R. Robillard, J. Williams, and J. T. Froeschke. 2013. A modeling and field approach to identify essential fish habitat for juvenile bay whiff (*Citharichthys spilopterus*) and southern flounder (*Paralichthys lethostigma*) within the Aransas Bay Complex, TX. Estuaries and Coasts 36:881–892.

Furey, N. B. 2012. Spatial and temporal shifts in estuarine nursery habitats used by juvenile southern flounder (*Paralichthys lethostigma*). Master's thesis, Texas A&M University.

Furey, N. B., M. A. Dance, and J. R. Rooker. 2013. Fine-scale movements and habitat use of juvenile southern flounder *Paralichthys lethostigma*, in an estuarine seascape. Journal of Fish Biology 82:1469–1483.

Furey, N. B., and J. R. Rooker. 2013. Spatial and temporal shifts in suitable habitat of juvenile southern flounder (*Paralichthys lethostigma*). Journal of Sea Research 76:161–169.

Gambill, M., and A. Bianchi. 2019. The North Carolina striped bass (*Morone saxatilis*) commercial fishery. North Carolina Department of Environmental Quality, Division of Marine Fisheries, Morehead City, NC. 181 p.

Graff, L., and J. Middleton. 2001. Wetlands and Fish: Catch the Link. 52 p.

Hadley, J. 2012. A social and economic profile of ocean fishing piers in North Carolina. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC.

Hadley, J., and C. Wiegand. 2014. An economic and social analysis of commercial fisheries in North Carolina: Albemarle Sound and Pamlico Sound. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 52 p.

Hayes, S. A., E. Josephson, K. Maze-Foley, and Rosel. 2018. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2017: (second edition). National Marine Fisheries Service, NOAA Technical Memorandum NMFS-NE-245, Woods Hole, Massachusetts. 378 p.

Hollensead, L. D. 2018. Multi-scale examination of habitat use and migration dynamics of southern flounder in a North Carolina estuary using acoustic telemetry techniques. Doctoral dissertation, University of North Carolina Wilmington, Wilmington, North Carolina.

Honeycutt, J. L., C. A. Deck, S. C. Miller, M. E. Severance, E. B. Atkins, J. A. Luckenbach, J. A. Buckel, H. V. Daniels, J. A. Rice, R. J. Borski, and J. Godwin. 2019. Warmer waters masculinize wild populations of a fish with temperature-dependent sex determination. Scientific Reports 9(1):6527.

Hossain, M. A. R., M. Tanaka, and R. Masuda. 2002. Predator–prey interaction between hatchery-reared Japanese flounder juvenile, *Paralichthys olivaceus*, and sandy shore crab, *Matuta lunaris*: daily rhythms, anti-predator conditioning and starvation. Journal of Experimental Marine Biology and Ecology 267:1–14.

IMPLAN. 2013. IMPLAN System. IMPLAN Group, LLC, Huntersville, NC.

Kellison, G. T., D. B. Eggleston, and J. S. Burke. 2000. Comparative behavior and survival of hatchery-reared versus wild summer flounder (*Paralichthys dentatus*). Canadian Journal of Fisheries and Aquatic Sciences 57:1870–1877.

Kunkel, K. E., D. R. Easterling, A. Ballinger, S. Bililign, S. M. Champion, D. R. Corbett, K. D. Dello, J. Dissen, G. M. Lackmann, R. A. Luettich, Jr., L. B. Perry, W. A. Robinson, L. E. Stevens, B. C. Stewart, and Terando. 2020. North Carolina climate science report. North Carolina Institute for Climate Studies.

Lee, L. M., S. D. Allen, A. M. Flowers, and Y. Li. 2018. Stock assessment of southern flounder (*Paralichthys lethostigma*) in the South Atlantic, 1989–2015. Joint report of the North Carolina Division of Marine Fisheries, South Carolina Department of Natural Resources, Georgia Coastal Resources Division, Florida

Fish and Wildlife Research Institute, University of North Carolina at Wilmington, and Louisiana State University. NCDMF SAP-SAR-2018-01. 426 p.

Loeffler, M. S., L. M. Paramore, S. P. Darsee, T. M. Mathes, A. M. Comer-Flowers, C. B. Stewart, S. J. Poland, T. C. Bauer, A. L. Markwith, and T. K. Scheffel. 2019. North Carolina multi-species tagging program. North Carolina Division of Marine Fisheries, CRFL Grant 2F40 F017, Morehead City, NC. 29 p.

Lowe, M. R., D. R. DeVries, R. A. Wright, S. A. Ludsin, and B. J. Fryer. 2011. Otolith microchemistry reveals substantial use of freshwater by southern flounder in the northern Gulf of Mexico. Estuaries and Coasts 34:630–639.

Luckenbach, J. A., R. J. Borski, H. V. Daniels, and J. Godwin. 2009. Sex determination in flatfishes: Mechanisms and environmental influences. Seminars in Cell & Developmental Biology 20(3):256–263.

Luckenbach, J. A., J. Godwin, H. V. Daniels, and R. J. Borski. 2003. Gonadal differentiation and effects of temperature on sex determination in southern flounder (*Paralichthys lethostigma*). Aquaculture 216(1–4):315–327.

Lyssikatos, M. C., and L. P. Garrison. 2018. Common bottlenose dolphin (*Tursiops truncatus*) gillnet bycatch estimates along the US mid-Atlantic Coast, 2007-2015. 43 p.

Manderson, J. P., J. Pessutti, J. G. Hilbert, and F. Juanes. 2004. Shallow water predation risk for a juvenile flatfish (winter flounder; *Pseudopleuronectes americanus*, Walbaum) in a northwest Atlantic estuary. Journal of Experimental Marine Biology and Ecology 304:137–157.

Martinez, G. M., and J. A. Bolker. 2003. Embryonic and larval staging of summer flounder (*Paralichthys dentatus*). Journal of Morphology 255:162–176.

McConnaughey, J., J. Boyd, and L. Klibansky. 2019. Annual sea turtle interaction monitoring of the anchored gill-net fisheries in North Carolina for Incidental Take Permit Year 2018. Annual Completion Report for Activities under Endangered Species Act Section 10 Incidental Take Permit No. 16230. North Carolina Department of Environmental Quality, Division of Marine Fisheries, Morehead City, NC. 58 p.

Meyer, G. 2011. Effects of land use change on juvenile fishes, blue crab, and brown shrimp abundance in the estuarine nursery habitats of North Carolina. Dissertation, East Carolina University, Greenville, NC.

Midway, S. R., S. X. Cadrin, and F. S. Scharf. 2014. Southern flounder (*Paralichthys lethostigma*) stock structure inferred from otolith shape analysis. Fishery Bulletin 112:326–338.

Midway, S. R., and F. S. Scharf. 2012. Histological analysis reveals larger size at maturity for southern flounder with implications for biological reference points. Marine and Coastal Fisheries 4:628–638.

Midway, S. R., T. Wagner, S. A. Arnott, P. Biondo, F. Martinez-Andrade, and T. F. Wadsworth. 2015. Spatial and temporal variability in growth of southern flounder (*Paralichthys lethostigma*). Fisheries Research 167:323–332.

Miller, J. M., J. S. Burke, and G. R. Fitzhugh. 1991. Early life history patterns of Atlantic North American flatfish: Likely (and unlikely) factors controlling recruitment. Netherlands Journal of Sea Research 27:261–275.

Mitsch, W. J., and J. G. Gosselink. 1993. Wetlands, 2nd edition. Van Nostrand Reinhold, New York, NY.

Monaghan, J. P. 1996. Life history aspects of selected marine recreational fishes in North Carolina: Study 2, Migration of Paralichthid flounders tagged in North Carolina. Completion Report Grant F-43. North Carolina Division of Marine Fisheries, Morehead City, NC. 44 p.

Montalvo, A. J., C. K. Faulk, and G. J. Holt. 2012. Sex determination in southern flounder, *Paralichthys lethostigma*, from the Texas Gulf Coast. Journal of Experimental Marine Biology and Ecology 432–433:186–190.

Morley, J. W., R. L. Selden, R. J. Latour, T. L. Frölicher, R. J. Seagraves, and M. L. Pinsky. 2018. Projecting shifts in thermal habitat for 686 species on the North American continental shelf. PloS one 13(5).

Morris, S., S. M. Wilson, E. F. Dever, and R. M. Chambers. 2011. A test of bycatch reduction devices on commercial crab pots in a tidal marsh creek in Virginia. Estuaries and Coasts 34:386–390.

Moustakas, C. T., W. O. Watanabe, and K. A. Copeland. 2004. Combined effects of photoperiod and salinity on growth, survival, and osmoregulatory ability of larval southern flounder *Paralichthys lethostigma*. Aquaculture 229(1–4):159–179.

Nañez-James, S. E., G. W. Stunz, and S. A. Holt. 2009. Habitat use patterns of newly settled southern flounder, *Paralichthys lethostigma*, in Aransas–Copano Bay, Texas. Estuaries and Coasts 32:350–359.

NCDEQ (North Carolina Department of Environmental Quality). 2016. North Carolina Habitat Protection Plan: Source document. Division of Marine Fisheries, Morehead City, NC. 475 p.

NCDEQ. 2020. North Carolina Climate Risk Assessment and Resiliency Plan. 1601 Mail Service Center, Raleigh, NC.

NCDMF (North Carolina Division of Marine Fisheries). 2005. North Carolina southern flounder (*Paralichthys lethostigma*) fishery management plan. North Carolina Division of Marine Fisheries, Morehead City, NC. 260 p.

NCDMF. 2009. Chapter 4: North Carolina recreational commercial gear survey *in* 2009 North Carolina license and statistics annual report. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 473 p.

NCDMF. 2013. North Carolina southern flounder (*Paralichthys lethostigma*) fishery management plan: Amendment 1. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 380 p.

NCDMF. 2015. North Carolina shrimp fishery management plan: Amendment 1. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 519 p.

NCDMF. 2017. North Carolina southern flounder (*Paralichthys lethostigma*) fishery management plan: Supplement A to Amendment 1. North Carolina Division of Marine Fisheries, Morehead City, NC. 83 p.

NCDMF. 2018. May 2018 Revision to Amendment 1 to the North Carolina Shrimp Fishery Management Plan. North Carolina department of Environment and Natural Resources. North Carolina Division of Marine Fisheries. Morehead City, NC. 64 pp.

NCDMF. 2019. North Carolina southern flounder (*Paralichthys lethostigma*) fishery management plan: Amendment 2. North Carolina Department of Environmental Quality, Division of Marine Fisheries, Morehead City, NC. 62 p.

NCDMF. 2020. 2020 License and statistics annual report. North Carolina Department of Environmental Quality, Division of Marine Fisheries, Morehead City, NC. 454 p.

NCREDC (North Carolina Rural Economic Development Center). 2013. A Supply Chain Analysis of North Carolina's Commercial Fishing Industry.

NCDWQ (North Carolina Division of Water Quality). 2000. DWQ_Water quality citizen guide. 165 p.

NCDWQ. 2008. Supplemental guide to North Carolina's basinwide planning: Support document for the basinwide water quality plans, second revision. North Carolina Department of Environmental Quality, North Carolina Division of Water Quality. 211 p.

NMFS (National Marine Fisheries Service). 2013. Endangered species; File No. 16230. Notice of permit issuance. Federal Register 78:57132–57133.

NMFS. 2014. Endangered species; File No. 18102. Issuance of permit. Federal Register 79:43716–43718.

Potter, E. F., J. E. Parnell, and R. P. Teulings. 1980. Birds of the Carolinas. University of North Carolina Press.

Reagan, R., and W. M. Wingo. 1985. Species profiles:life histories and environmental requirements of coastal fishes and invertebrates (Gulf of Mexico): Southern flounder. Biological Report 82.

Rogers, S. I., M. J. Kaiser, and S. Jennings. 1998. Ecosystem effects of demersal fishing: a European perspective. Page 160 *in* E. M. Doresy and J. Pederson, editors. Effect of Fishing Gear on the Sea Floor of New England. Conservation Law Foundation, Boston, Massachusetts.

Rooker, J. R., S. A. Holt, M. A. Soto, and G. J. Holt. 1998. Postsettlement patterns of habitat use by Sciaenid fishes in subtropical seagrass meadows. Estuaries 21:318–327.

Ross, S. W., J. H. Hawkins, D. A. DeVries, C. H. Harvell, and R. C. Harriss. 1982. North Carolina estuarine finfish management program, Completion report for Project 2-372-R, North Carolina Department of Natural Resources and Community Development, Division of Marine Fisheries, Morehead City, NC. 175 p.

Rozas, L. P., and W. E. Odum. 1987. The role of submerged aquatic vegetation in influencing the abundance of nekton on contiguous tidal fresh-water marshes. Journal of Experimental Marine Biology and Ecology. 114:289-300.

Scheld, A. M., W. M. Goldsmith, S. White, H. J. Small, and S. Musick. 2020. Quantifying the behavioral and economic effects of regulatory change in a recreational cobia fishery. Fisheries Research 224. [online serial].

Schreiber, A. M. 2013. Flatfish: An asymmetric perspective on metamorphosis. Pages 167–194 *in* Current Topics in Developmental Biology. Academic Press.

Schwartz, F. J. 1997. Distance movements of fishes, white shrimp, and blue crabs tagged in or near the estuarine Cape Fear River and adjacent Atlantic Ocean, North Carolina, 1973 through 1978. The Journal of Elisha Mitchell Scientific Society 113:123–132.

Scyphers, S. B., J. S. Picou, and S. P. Powers. 2015. Participatory conservation of coastal habitats: The importance of understanding homeowner decision making to mitigate cascading shoreline degradation: participatory conservation of coastlines. Conservation Letters 8(1):41–49.

Stemle, A., and M. Condon. 2017. Socioeconomic survey of recreational saltwater anglers in North Carolina 2016. North Carolina Division of Marine Fisheries, Morehead City, NC. 21 p.

Stemle, A., and C. Wiegand. 2017. A social and economic analysis of commercial fisheries in North Carolina: Core Sound to the South Carolina state line. North Carolina Division of Marine Fisheries, Morehead City, NC. 31 p.

Stoll, J. S., B. A. Dubik, and L. M. Campbell. 2015. Local seafood: rethinking the direct marketing paradigm. Ecology and Society 20(2):40. [online serial].

Stunz, G. W., T. J. Minello, and P. S. Levin. 2002. Growth of newly settled red drum *Sciaenops ocellatus* in different estuarine habitat types. Marine Ecology Progress Series 238:227–236.

Taylor, J. C., and J. M. Miller. 2001. Physiological performance of juvenile southern flounder, *Paralichthys lethostigma* (Jordan and Gilbert, 1884), in chronic and episodic hypoxia. Journal of Experimental Marine Biology and Ecology 258:195–214.

Taylor, J. C., J. M. Miller, L. J. Pietrafesa, D. A. Dickey, and S. W. Ross. 2010. Winter winds and river discharge determine juvenile southern flounder (*Paralichthys lethostigma*) recruitment and distribution in North Carolina estuaries. Journal of Sea Research 64:15–25.

Taylor, J. C., J. M. Miller, and D. Hilton. 2008. Inferring southern flounder migration from otolith microchemistry. Final Report Fishery resource Grant 05-FEG-06, Morehead City, NC.

Taylor, W. E., J. R. Tomasso, C. J. Kempton, and T. I. J. Smith. 2000. Low-temperature tolerance of southern flounder *Paralichthys lethostigma*: effect of salinity. Journal of the World Aquaculture Society 31(1):69–72.

Thorpe, T. M., M. Hooper, and T. Likos. 2005. Bycatch potential, discard mortality and condition of fish and turtles associated with the spring commercial blue crab (*Callinectes sapidus*) pot fishery. Final Report 04-POP-03. North Carolina Sea Grant, Raleigh.

Topp, R. W., and F. H. Hoff. 1972. Flatfishes (Pleuronectiformes). Florida Department of Natural Resources Marine Research Laboratory, 4(2): 1-135.

Walsh, H. J., D. S. Peters, and D. P. Cyrus. 1999. Habitat utilization by small flatfishes in a North Carolina estuary. Estuaries and Coasts 22:803–813.

Wang, V. H., M. A. McCartney, and F. S. Scharf. 2015. Population genetic structure of southern flounder inferred from multilocus DNA profiles. Marine and Coastal Fisheries 7:220–232.

Warden, M. 2010. Bycatch of wintering common and red-throated loons in gillnets off the USA Atlantic coast, 1996–2007. Aquatic Biology 10(2):167–180.

Watanabe, W. O., P. Carrol, and H. V. Daniels. 2001. Sustained, natural spawning of southern flounder *Paralichthys lethostigma* under an extended photothermal regime. Journal of World Aquaculture Society 32:153–166.

Watterson, J. C., and J. L. Alexander. 2004. Southern flounder escapement in North Carolina, July 2001-June 2004. North Carolina Division of Marine Fisheries, Final Report Grant F-73, Segments 1-3, Morehead City, NC.

Wenner, C. A., W. A. Roumillat, J. E. Moran Jr., M. B. Maddox, L. B. Daniel III, and J. W. Smith. 1990. Investigations on the life history and population dynamics of marine recreational fishes in South Carolina: Part 1. Marine Resources Institute, South Carolina Wildlife and Marine Resource Department, Charleston, SC. 180 p.

Williams, A. B., and E. E. Duebler. 1968. A ten-year study of meroplankton in North Carolina estuaries: Assessment of environmental factors and sampling success among bothid flounders and penaeid shrimps. Chesapeake Science 9(1):27–41.

APPENDICES

APPENDIX 1. MANAGEMENT ISSUES CONSIDERED BUT NOT DEVELOPED

A scoping period to solicit input on management strategies for the Southern Flounder Fishery Management Plan Amendment 3 was held Dec. 4 through Dec. 18, 2019. During this time, members of the public were encouraged to provide written comments or verbal comments at one of three in-person scoping meetings held within the scoping period. In addition, the NCMFC was provided the opportunity to offer input on management strategies at its February 2020 business meeting. The division received many comments during this scoping period, but few were relevant to potential management strategies. Comments received that were focused on a management strategy included:

- Elimination of specific gear types for the harvest of southern flounder;
- Limiting entry in the flounder pound net fishery;
- Stocking of southern flounder;
- The use of circle hooks in the recreational flounder fishery; and
- Reducing bycatch of southern flounder in the shrimp trawl fishery.

These suggested strategies were reviewed by the division during development of Amendment 3 but are not included as fully developed issue papers. A description of the management strategy and rationale for not developing them are provided for each strategy below.

ELIMINATION OF GEARS INCLUDING GIGS (BOTH SECTORS), GILL NETS, AND RCGL

The possible elimination of specific gears (i.e., gigs for one or both sectors, anchored large-mesh gill nets) for harvesting southern flounder for either the commercial or recreational fishery is statutorily granted to the NCMFC by G.S. 143B-289.52., Marine Fisheries Commission–powers and duties, which states the NCMFC "shall have the power and duty to authorize, license, regulate, prohibit, prescribe, or restrict all forms of marine and estuarine resources in coastal fishing waters with respect to time, place, character, or dimensions of any methods or equipment that may be employed in taking fish." Such actions follow from the NCMFC's charge to "adopt rules to be followed in the management, protection, preservation, and enhancement of the marine and estuarine resources within its jurisdiction…." (G.S. 143B-289.52). The division provides the best available data for a fishery (gear) to meet the mandate for producing a sustainable harvest of the southern flounder stock and to evaluate impacts to habitat. Each allowable gear is similarly presented regardless of its contribution to overall removals from the stock and the division does not presume any NCMFC changes in gear use, unless directed to do so by the NCMFC, which in this case initiated the development of the *Phasing Out Anchored Large-Mesh Gill Nets from the North Carolina Southern Flounder Fishery* issue paper.

Regulations involving the RCGL are found in G.S. 113-173 and Rule 15A NCAC 03O.0302 which authorizes certain commercial fishing gear for recreational use under a valid Recreational Commercial Gear License. A rule change by the NCMFC is required to alter the allowable gears used by RCGL license holders.

LIMITED ENTRY IN THE POUND NET FISHERY

G.S. 113-182.1(g) provides narrowly constrained authority to the NCMFC to limit entry into a fishery states the following:

(g) To achieve sustainable harvest under a Fishery Management Plan, the Marine Fisheries Commission may include in the Plan a recommendation that the General Assembly limit the number of fishermen authorized to participate in the fishery. The Commission may recommend that the General Assembly limit participation in a fishery only if the Commission determines that sustainable harvest cannot otherwise be achieved. In determining whether to recommend that the General Assembly limit participation in a fishery, the Commission shall consider all of the following factors:

(1) Current participation in and dependence on the fishery

(2) Past fishing practices in the fishery

(3) Economics of the fishery

(4) Capability of fishing vessels used in the fishery to engage in other fisheries

(5) Cultural and social factors relevant to the fishery and any affected fishing communities

(6) Capacity of the fishery to support biological parameters

(7) Equitable resolution of competing social and economic interests

(8) Any other relevant considerations

Flounder pound nets are a stationary gear that funnel fish along a lead and into a pound (holding area) where they are removed while the fishermen slowly bunt the net. While fish are trapped in the pound, they remain in the water until harvest. This allows fishermen to be selective about fish they harvest or release. Flounder pound nets operate from upper Currituck Sound south through Core Sound. The southern flounder pound net fishery was the dominant gear landing southern flounder into the early 1990s when large-mesh gill nets became the dominate gear. Pound nets again became the top means of southern flounder harvest in 2014. This is likely due to increased regulatory burden on the large-mesh gill-net fishery.

During the last 10 years, the average number of pound net permits issued was 285, ranging from 267 to 304. To obtain a flounder pound net permit, an individual must complete an application package and the selected site goes through a review process including a public comment period. Unlike other gears, pound nets require an extensive monetary investment and many pound net fishermen have been building their stands for multiple generations. Due to the monetary investment, permitting process, and limited productive fishing areas, there has not been a sharp increase in pound net permits. While the possibility does exist that the number of pound net

applications may rise in the future, there is no evidence that limited entry is the only way to achieve sustainable harvest, as required by state law in order to pursue.

Sustainable harvest in the southern flounder fishery is predicted to be achievable within 10 years of adoption of Amendment 3 through reductions in total removals for all fisheries and gears. As a result, this statute cannot be employed at this time to pursue limited entry. In addition, Amendment 3 proposes implementing a commercial quota on the harvest of southern flounder, thus the volume of pound nets operating in the fishery will not impact the volume of removals, just the rate at which the quota is harvested. Once the level of harvest has been met, the fishery closes. This closure is not impacted by the number of nets that are set, although the number of pound nets in use may shorten the time in which the quota is reached.

STOCKING

Stock enhancement is the stocking of fish to enhance or improve the condition or distribution of a wild stock. North Carolina State University initiated a series of workshops on flounder stock enhancement in North Carolina in the mid-1990s. This effort brought together fish ecologists, culturists, and managers from around the world and was a good forum to discuss successes and failures in aquaculture and stock enhancement. A report of these conversations was developed and outlined several research priorities that should be investigated (Waters 1998), but few if any have been investigated leaving many of the questions unanswered. These unanswered questions leave data gaps that are critical in determining if stocking is appropriate at this time for achieving a self-sustaining southern flounder population.

While management actions for southern flounder have not had the expected response in rebuilding the spawning stock biomass to necessary levels to sustain the stock, not all strategies have been attempted. Amendment 3 will expand on conventional management strategies and employ a quota system for both the commercial and recreational southern flounder fisheries for the first time. Moving forward with Amendment 3 without including stocking as a management strategy does not prohibit researchers from investigating stocking strategies for southern flounder. If more information becomes available about stocking strategies, additional consideration may be warranted during a future review of this FMP.

USE OF CIRCLE HOOKS IN THE SOUTHERN FLOUNDER FISHERY

The use of circle hooks for multiple species was addressed by the division as directed by the NCMFC. At its August 2019 business meeting, the NCMFC directed staff to provide information on the science supporting the use of circle hooks and bent barbed treble hooks and provide input on the efficacy of requiring their use. The NCMFC passed a motion at its May 2020 business meeting directing the division to "develop an issue paper for rulemaking to require the use of barbless non-offset circle hooks when hook size relates to 2/0 or larger while using natural bait. In addition, barbs on treble hooks would be required to be bent down." The division developed the issue paper and presented management options to the NCMFC at their February 2021 business meeting. The NCMFC voted not to move forward with rule making but instead directed the division to consider circle hook requirements on a species-by-species basis through the fishery management plan process. After a review of available literature of the effect of circle hooks on

southern flounder, there is minimal research available at the species level. Inferences could be made from available literature on summer flounder that found no difference in survival rates post-release for fish captured with circle or J-hooks (Malchof and Lucy 1998). Additionally, Stuntz and McKee (2006) concluded that angler education had a greater effect on post-release survival of fish than hook type and bait configuration. Due to the lack of available literature on the effect of circle hook on southern flounder, a research recommendation was added to this FMP (see the *Research Recommendations* section).

Reducing Shrimp Trawl Bycatch

Management strategies to reduce the bycatch of non-target species in the shrimp trawl fishery as well as potential changes to existing shrimp management strategies are being examined as part of the ongoing development of Amendment 2 to the N.C. Shrimp FMP. The division determined that is the most appropriate plan to address shrimp trawl bycatch. Through the original Shrimp FMP (NCDMF 2006) and Amendment 1 (NCDMF 2015), the following were implemented that are having a positive impact on reducing southern flounder bycatch in shrimp trawls.

- Portions of Core Sound (banks side north of Drum Inlet to Wainwright Island), Intracoastal Waterway (Rich Inlet to Carolina Beach), as well as the bays adjacent to the Cape Fear River and Bald Head Island were closed to trawling.
- The use of otter trawls was prohibited upstream of the Highway 172 Bridge in the New River, limiting trawling to skimmer trawls.
- A maximum combined 90 ft. headrope length was implemented in the mouths of the Pamlico and Neuse rivers and all of Bay River to minimize southern flounder bycatch and protect critical habitat used by southern flounder.
- The requirement to use two bycatch reduction devices (BRD) in shrimp trawls and skimmer trawls was implemented.
- A maximum combined headrope length of 220 feet was established in all internal coastal waters where there was no existing maximum combined headrope requirements.
- The requirement to use one of four gear combinations tested by the industry workgroup that achieved at least 40% finfish bycatch was implemented in the Pamlico Sound and portions of Pamlico, Bay, and Neuse rivers (NCMDF 2018).
- Shrimp trawling was prohibited in the Intracoastal Waterway channel from the Sunset Beach Bridge to the South Carolina line, including the Shallotte River, Eastern Channel, and lower Calabash River to protect small shrimp and reduce bycatch (NCDMF 2021).

The division continues to work with commercial fishermen to develop new gear configurations to reduce bycatch in the shrimp trawl fishery as well as to characterize the fishery. While estimates of shrimp trawl bycatch are accounted for in the southern flounder stock assessment (Lee et al. 2018; Flowers et al. 2019) further actions to address bycatch of southern flounder from shrimp trawls is most appropriately handled through the N.C. Shrimp FMP or gear specific management.

LITERATURE CITED

Flowers, A. M., S. D. Allen, A. L. Markwith, and L. M. Lee (editors). 2019. Stock assessment of southern flounder (*Paralichthys lethostigma*) in the South Atlantic, 1989–2017. Joint report of the North Carolina Division of

Marine Fisheries, South Carolina Department of Natural Resources, Georgia Coastal Resources Division, Florida Fish and Wildlife Research Institute, University of North Carolina at Wilmington, and Louisiana State University. NCDMF SAP-SAR-2019-01. 213 p.

Lee, L. M., S. D. Allen, A. M. Flowers, and Y. Li. 2018. Stock assessment of southern flounder (*Paralichthys lethostigma*) in the South Atlantic, 1989–2015. Joint report of the North Carolina Division of Marine Fisheries, South Carolina Department of Natural Resources, Georgia Coastal Resources Division, Florida Fish and Wildlife Research Institute, University of North Carolina at Wilmington, and Louisiana State University. NCDMF SAP-SAR-2018-01. 426 p.

Malchoff, M. H., & Lucy, J. A. 1998. Short-term hooking mortality of summer flounder in New York and Virginia. Marine Resource Report No. 98-7. Virginia Institute of Marine Science, College of William and Mary.

NCDMF (North Carolina Division of Marine Fisheries). 2006. North Carolina shrimp fishery management plan. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 390 p.

NCDMF. 2015. North Carolina shrimp fishery management plan: Amendment 1. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 519 p.

NCDMF. 2018. May 2018 Revision to Amendment 1 to the North Carolina Shrimp Fishery Management Plan. North Carolina department of Environment and Natural Resources. North Carolina Division of Marine Fisheries. Morehead City, NC. 64 pp.

NCDMF. 2021. May 2021 Revision to Amendment 1 to the North Carolina Shrimp Fishery Management Plan. North Carolina department of Environment and Natural Resources. North Carolina Division of Marine Fisheries. Morehead City, NC. 28 pp.

Stunz, G.W. and McKee, D.A., 2006. Catch-and-release mortality of spotted seatrout in Texas. North American Journal of Fisheries Management, 26(4), pp.843-848.

Waters, E.B. 1998. Flounder aquaculture and stock enhancement in North Carolina: issues, opportunities, and recommendations. North Carolina Sea Grant, Publication UNC-SG-99-02. 24 p.

APPENDIX 2. REGULATIONS OF OTHER STATES

Table 2.1. East coast and Gulf of Mexico southern flounder regulations by state as of September 2021.

State	Size Limit	Daily Bag Limit	Commercial Trip Limits	Seasons
North Carolina	15"	4 fish per person per day	None	Recreational: Sep. 1–Sep. 14: Commercial: Northern Sep. 15–Oct 1., Central Oct. 1–19, Southern Oct. 1–Oct. 21
South Carolina	16"	5 per person per day—not to exceed 10 per boat per day	Commercial fishermen are held to recreational limits, trawling and trapping are exempt.	Open all year
Georgia	12"	15 per person per day	Commercial fishermen must abide by season, creel, and size limits.	Open all year
Florida	14"	5 per person per day	Commercial trip and vessel limit 150 fish from Dec. 1–Oct. 14, and 50 fish from Oct 15.–Nov. 30; a federal waters trawl bycatch limit of 150 flounder/trip from Dec. 1–Oct. 14, and 50 fish/trip from Oct. 15–Nov. 30	Oct. 15–Nov. 30 recreational closed season
Alabama	14"	5 per person per day	40 per person or per vessel	Closed Nov. 1–30 for both commercial and recreational
Mississippi	12"	10 per person per day	None; 74,000 pound quota that once reached will close fishery for remainder of year	Open all year
Louisiana	none	10 per person per day	10 fish daily limit for each licensed fisherman; however, commercial shrimping vessels may retain and sell all southern flounder harvested as bycatch	Open all year
Texas	15"	5 per person per day with the exception of Nov. 1–Dec. 14 when it is closed	30 per person per day with the exception of Nov. 1 – Dec. 14 when season is closed. On a shrimp boat the limit is equal to the recreational limit per person with a current shrimp boat captains license and is subject to the 50% bycatch rule.	Open all year with the exception of the gig fishery being closed from Nov. 1–30

APPENDIX 3. NORTH CAROLINA FISHERY MANAGEMENT

The N.C. General Assembly enacts fisheries statutes, or laws, and provides the NCMFC authority to adopt rules to implement those statutes in coastal and joint fishing waters. These rules are found in Chapters 03 and 18 of Title 15A of the N.C. Administrative Code. The following list, while not exhaustive, includes the primary rules used to manage the southern flounder fishery. In inland fishing waters, the N.C. Wildlife Resources Commission rule 15A NCAC 10C .0307 establishes the same recreational seasons, size limits, and bag limits for flounder as those established by NCMFC rules and proclamations issued by the Fisheries Director in adjacent joint and coastal fishing waters. Please refer to the N.C. Administrative Code for the full text of the rules at http://reports.oah.state.nc.us/ncac.asp.

In addition to adopting rules, the NCMFC has the authority to delegate to the Fisheries Director the ability to issue public notices, called proclamations, suspending or implementing particular commission rules that may be affected by variable conditions. The proclamation authority granted to the Fisheries Director in commission rules includes the ability to open and close seasons and fishing areas, set harvest and gear limits, and establish conditions governing various fishing activities. Rules that contain proclamation authority are marked by a diamond symbol ("♦"). Proclamations are not included in this document because they change frequently and are found at https://deq.nc.gov/fisheries-management-proclamations.

- 15A NCAC 03I. 0120 Possession or Transportation Limits Through State Waters; Sale of Native Species

Sets requirements for possession and transportation of species subject to state season, size, or harvest restrictions. Applies to management across species of flounder (i.e., southern, summer, and Gulf flounder).

- 15A NCAC 03J .0101 Fixed or Stationary Nets

Establishes where it is unlawful to set fixed or stationary nets.

- 15A NCAC 03J .0102 Nets or Net Stakes

Establishes where it is unlawful to use nets or net stakes.

- ♦ 15A NCAC 03J .0103 Gill Nets, Seines, Identification, Restrictions

Establishes requirements for the use of gill nets and seines, including proclamation authority for time, area, means and methods, and seasons.

- ♦ 15A NCAC 03J .0500 Pound Nets

Establishes requirements for pound net sets, including flounder pound net sets. Limited proclamation authority may be implemented only for escape panel requirements.

- ♦ 15A NCAC 03M .0503 Flounder

Contains proclamation authority that allows the Fisheries Director, within the bounds of the current Southern Flounder Fishery Management Plan (FMP), to specify size, season, area, quantity, and means and methods, and the proclamation authority to require submission of statistical and biological data. This rule is the primary management tool to implement management measures, subject to variable conditions, and to implement adaptive management for the southern flounder fisheries ***within the bounds of the current FMP****.*

- ♦ 15A NCAC 03O .0500, Permits

Establishes procedures and requirements for permits, including eligibility and standard permit conditions such as reporting. Rule 15A NCAC 03O .0506, Special Permit Required for Specific Management Purposes, provides authority to require a new permit for quota monitoring in the southern flounder fishery.

- 15A NCAC 10C .0307, Flounder, Sea Trout, and Red Drum

Wildlife Resources Commission rule, as described above.

APPENDIX 4. ISSUE PAPERS

APPENDIX 4.1. ACHIEVING SUSTAINABLE HARVEST IN THE NORTH CAROLINA SOUTHERN FLOUNDER FISHERY

ISSUE

Implement long-term management measures to achieve sustainable harvest in the North Carolina southern flounder fishery that end overfishing and rebuild the spawning stock.

ORIGINATION

The NCMFC adopted Amendment 2 to the Southern Flounder FMP in August 2019. Amendment 2 authorized the development of Amendment 3 to begin immediately in order to implement more comprehensive, long-term management measures. State law requires these management measures to achieve sustainable harvest in the southern flounder fishery (Fisheries Reform Act, G.S. 113-182.1).

BACKGROUND

The southern flounder is a demersal species found in the Atlantic Ocean and Gulf of Mexico from northern Mexico to Virginia. The biological unit stock for southern flounder inhabiting U.S. South Atlantic coastal waters includes waters of North Carolina, South Carolina, Georgia, and the east coast of Florida (see the *Introduction* and the *Description of the Stock* sections for more information on the management authority, distribution, and unit stock definition of southern flounder).

To address the coast-wide nature of the southern flounder stock, a comprehensive stock assessment was completed to determine the status of the stock using data from North Carolina through the east coast of Florida from 1989 through 2017 (Flowers et al. 2019). The assessment model indicated the stock was overfished and overfishing was occurring (Figure 3, Figure 5 in the *Description of the Stock* section). Projections were performed to determine the reduction in fishing mortality necessary to end overfishing and to rebuild the spawning stock biomass and end the overfished status.

Fishing mortality was estimated at the target of $F_{35\%}$ as 0.35 and the threshold of $F_{25\%}$ as 0.53. In 2017, F was 0.91, which is higher than the F threshold of 0.53 and indicates overfishing is occurring (Figure 5, in the *Description of the Stock* section). The probability that fishing mortality in 2017 was above the threshold value of 0.53 is 96%, whereas there is a 100% probability fishing mortality in 2017 was above the target value of 0.35.

The spawning stock biomass target ($SSB_{35\%}$) was estimated to be 5,452 metric tons (approximately 12.0 million pounds) and threshold ($SSB_{25\%}$) to be 3,900 metric tons (approximately 8.6 million pounds). In 2017, the estimated SSB was 1,031 metric tons (approximately 2.3 million pounds), which is lower than the SSB threshold of 3,900 metric tons and indicates the stock is overfished (Figure 3 in the *Description of the Stock* section). The probability that SSB in 2017 was below the threshold and target values (3,900 and 5,452 metric tons, respectively) is 100%.

The General Statutes of North Carolina require that a FMP specify a time period not to exceed two years from the date of the adoption to end overfishing (G.S. 113-182.1). The statutes also require that a FMP specify a time period not to exceed 10 years from the date of adoption and at least a 50% probability to achieve a sustainable harvest. A sustainable harvest is attained when the stock is no longer overfished (G.S. 113-129). The statutes allow some exceptions to these stipulations related to biology, environmental conditions, or lack of sufficient data.

To meet statutory requirements, calculations were made to determine the reductions in total coast-wide removals (all fishery removals from each of the four states) necessary to end overfishing within two years and recover the stock from an overfished status within the 10-year period. Total removals are defined as the total pounds of landed southern flounder plus dead discards. Dead discards are comprised of fish that were dead upon retrieval of gear and not harvested and fish that were released alive that experience delayed mortality. For more information on projections and the resulting removal reductions refer to Amendment 2 or the 2019 updated stock assessment, which includes assumptions and computational details (Flowers et al. 2019; NCDMF 2019).

The projections are based on the conditions and restrictions such as minimum size limits for both the commercial and recreational fishery, current gear requirements, and selected soak time and daytime restrictions in effect at the time that resulted in the annual total removals. These measures, along with recruitment strength, environmental conditions, and fishing effort, influenced the fishery during the 2017 terminal year of the stock assessment which is the base year for reduction calculations. Any changes in these past conditions will have an undetermined impact on the projections and the rebuilding schedule.

As required by North Carolina law, a fishing mortality of 0.34 is needed to reach the SSB threshold by 2028 and end the overfished status (Figure 7 in the *Description of the Stock* section). This will require at a minimum a 52% reduction in total removals coast-wide. To increase the probability of success of rebuilding to the higher SSB target by 2028, fishing mortality would need to be lowered to 0.18 (Figure 8 in the *Description of the Stock* section). This will require a 72% reduction in total removals coast wide. A fishing mortality that falls between the identified target and threshold values meets the statutory requirements (e.g., 62%; Figure 4.1.1). All projections are associated with at least a 50% probability of achieving sustainable harvest for the fishery.

The management measures implemented in North Carolina from the original Southern Flounder FMP (NCDMF 2005), Amendment 1 (NCDMF 2013), and Supplement A to Amendment 1 (NCDMF 2017a) as modified by the Aug. 17, 2017 settlement agreement have not resulted in the necessary increase in SSB to end the stock's overfished status, thus continued reductions are necessary. In developing management measures for Amendment 2 and Amendment 3, the division applied the reductions only to North Carolina's portion of total removals. To account for North Carolina's portion of these reductions in the recreational and commercial fisheries, the identified reduction was applied to both the dead discards and landings, or total removals, for each sector of the North Carolina southern flounder fishery from the terminal year of the assessment (2017).

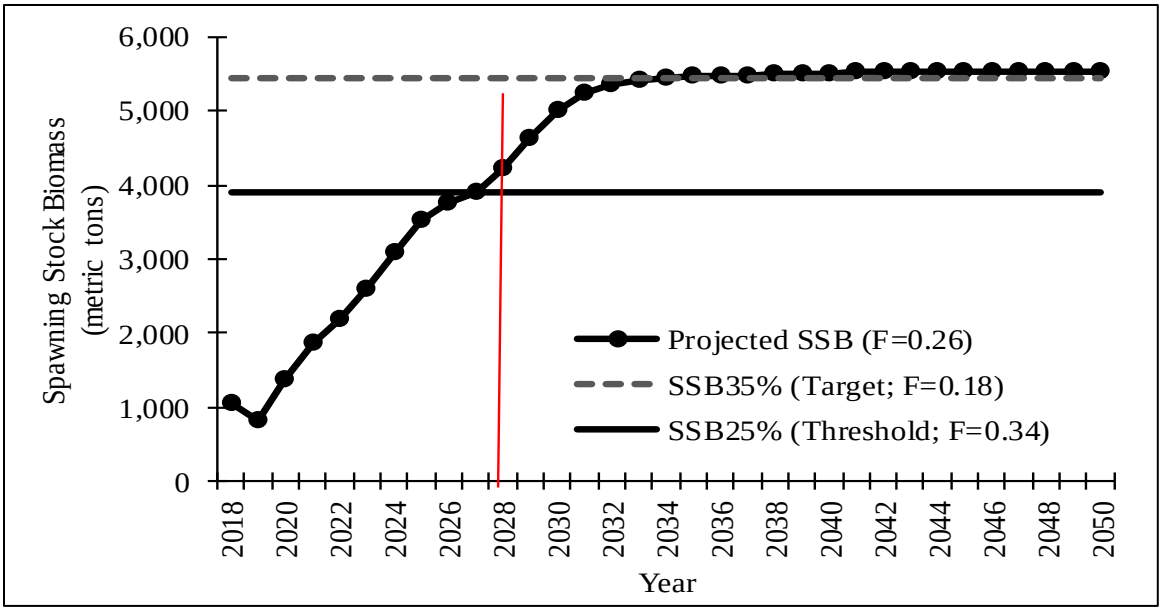


Figure 4.1.1. Predicted future spawning stock biomass (metric tons) assuming the fishing mortality value (F=0.26; 62% reduction in total removals) necessary to reach between the SSBTarget and SSBThreshold by 2028 (indicated by vertical red line). (Source: Flowers et al. 2019)

In 2017, total removal for all sectors including dead discards was 1,957,264 pounds; the commercial fishery accounted for 72.2% (including 0.9% dead discards) and the recreational fishery (hook-and-line and gigs) accounted for 27.9% (including 2.0% dead discards) of the total North Carolina removals (Figure 4.1.2). Additional options for allocations were requested by the NCMFC at its November 2020 business meeting. These options are presented in the *Recreational and Commercial Sector Allocation* issue paper and NCMFC preferred option was used to develop this *Achieving Sustainable Harvest* issue paper.

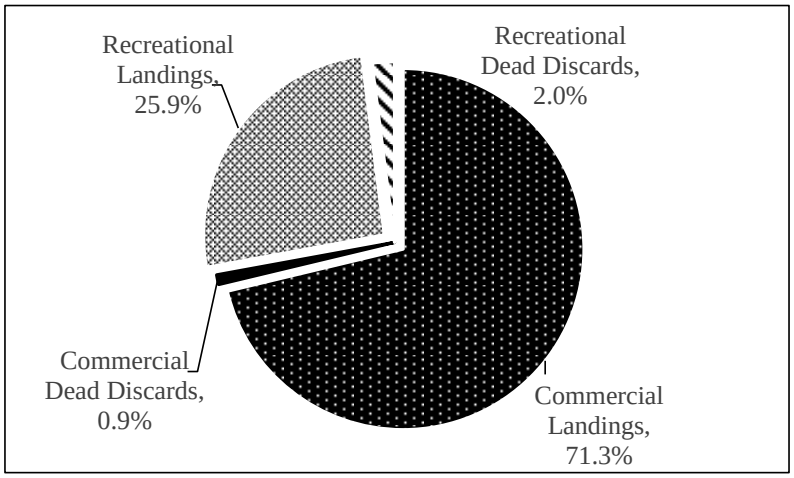


Figure 4.1.2. Contribution of the total removals (observed harvest and dead discards in percent pounds) for the commercial and recreational (hook-and-line and gig) fisheries in North Carolina, 2017. (Source: North Carolina Trip Ticket Program, Marine Recreational Information Program, NCDMF Gig Mail Survey).

In Amendment 3, the management measure proposed to meet sustainable harvest may be changed from a seasonal approach to a quota-based approach. This change does not alter analyses used to calculate reductions but does adjust the terminology used to describe the individual pieces used from Total Allowable Catch (TAC) to Total Allowable Landings (TAL) as landings are the quantifiable mechanism used to manage the quota. Reductions in discards will be accounted for at the end of the fishery as discards are not part of daily quota monitoring and will be added to the annual landings to create total catch and make sure the TAC is not exceeded. This approach differs slightly from Amendment 2. In each amendment, reductions were based on TAC, but as seasons were the selected management measure implemented through Amendment 2, the seasons accounted for estimated reductions in harvest and discards. Based on a fishing mortality that falls between the identified threshold (52% reduction) and target (72% reduction), the range in annual landings of southern flounder that could occur for all sectors is 912,603 pounds to 532,352 pounds, respectively (Table 4.1.1; Figures 4.1.3 and 4.1.4).

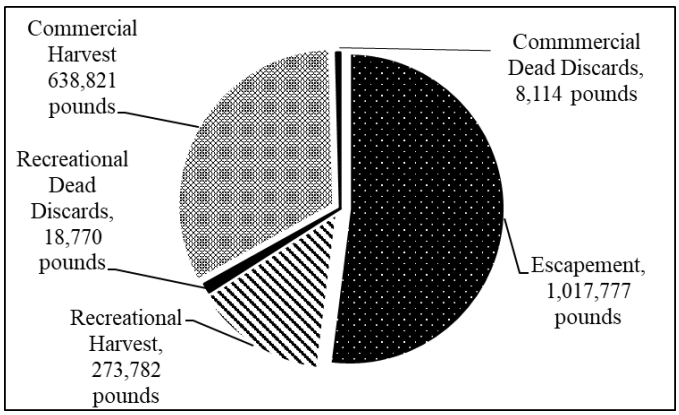


Figure 4.1.3. Estimated escapement of southern flounder (pounds) and contribution of the total removals for the commercial and recreational (hook-and-line and gig) fisheries in North Carolina, 2017, at a 52% reduction and a 70% commercial and 30% recreational allocation. (Source: North Carolina Trip Ticket Program, Marine Recreational Information Program, NCDMF Gig Mail Survey)

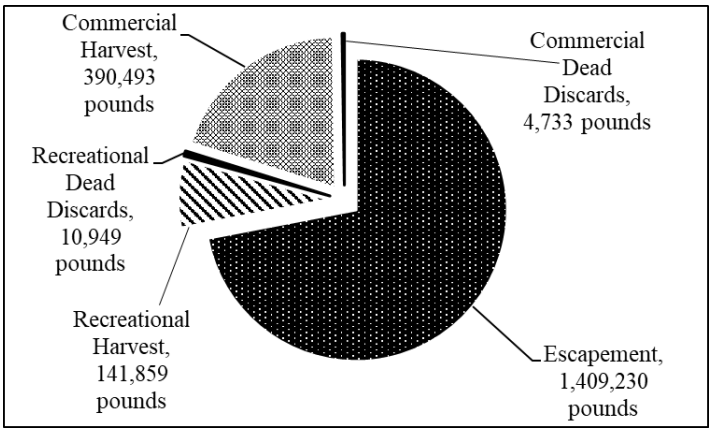


Figure 4.1.4. Estimated escapement of southern flounder (pounds) and contribution of the total removals for the commercial and recreational (hook-and-line and gig) fisheries in North Carolina, 2017, at a 72% reduction and a 70% commercial and 30% recreational allocation. (Source: North Carolina Trip Ticket Program, Marine Recreational Information Program, NCDMF Gig Mail Survey)

Table 4.1.1. Southern flounder total allowable catch (TAC) and total allowable landings (TAL) in pounds needed to meet the necessary reductions for the overfishing threshold and SSB threshold and target of the commercial and recreational fisheries, following the NCMFC selection of a 70/30 allocation.

				Commercial Fisheries			Recreational Fisheries*		
Percent Reduction from 2017 Terminal Year	Total Allowable Catch	Dead Discards	Total Allowable Landings	Total Allowable Commercial Landings	Mobile Gears	Pound Nets	Total Allowable Recreational Landings	Hook and Line	Gigs
2017	1,957,264	56,008	1,901,256	1,330,879	664,957	665,922	570,377	507,877	62,500
52%	939,487	26,884	912,603	638,821	319,179	319,642	273,782	243,782	30,000
62%	743,760	21,283	722,477	505,734	252,684	253,050	216,743	192,993	23,750
72%	548,034	15,682	532,352	372,646	186,188	186,458	159,706	142,206	17,500

*Recreational commercial gear harvest is unknown since 2008 and could not be quantified in the reductions.

Management measures (seasonal closures) implemented in Amendment 2 met the statutory requirements and were critical for reducing removals and initiating the rebuilding of the southern flounder stock. Seasonal closures do not enforce a maximum removal level on the fishery and only limit the time when targeted harvest can occur. Fishing effort can be more concentrated during the open season, potentially altering fishing behaviors from previous years that were used to estimate harvest windows; that is, fishing effort may increase during the open season and lead to higher than predicted removals. Though seasonal flexibility is provided to the NCDMF Fisheries Director by the NCMFC motion approving the adoption of Amendment 2, seasonal closures alone may not result in the needed increase in SSB even if maintained long term (NCDMF 2019). Consequently, the approval of Amendment 2 specified the development of Amendment 3 to begin immediately to implement more comprehensive, long-term management measures to achieve sustainable harvest. Management strategies implemented through Amendment 3 will not restart the time requirements set in Amendment 2 that are necessary to meet the statutory mandates.

Amendment 2 required a 62% reduction in 2019 and a 72% reduction from 2020 onward, both above the minimum 52% reduction that is statutorily required. Preliminary analysis of reductions achieved in 2019 from implementation of Amendment 2 management measures indicate an overall reduction of 35% was achieved or a 43% reduction in total removals for the commercial fishery and a 15% reduction in total removals for the recreational fishery. A level of reduction less than the required 62% was anticipated as the seasons did not begin until Sept. 4, 2019. The fisheries operated three quarters of the calendar year, as compared to estimates that were based on a closure beginning Jan. 1. While Amendment 2 did not meet the 62% reduction in 2019, the 35% reduction achieved was greater than the minimum of 31% to end overfishing. The 2020 landings and preliminary estimates of dead discards indicated a 52% reduction was achieved, exceeding the ending overfishing target and meeting the ending overfished threshold but not the 72% reductions approved under Amendment 2. Harvest exceeded the TAC to meet the 72% reduction for both the commercial and recreational fisheries.

Management measures for Amendment 3 will be selected and implemented from the allowable total removals (landings and dead discards) that are calculated based on the fishing mortality estimates of the terminal year (2017) of the stock assessment (Flowers et al. 2019). Quota-based management accounts for dead discards at the end of each sector's fishing year, therefore quota

management is based on total allowable landings. Total allowable catch for the southern flounder fishery was reduced by 72%. Removing dead discards for each corresponding sector results in the estimated total allowable landings that can be removed through the southern flounder fishery. The total allowable landings were allocated 70% commercial and 30% recreational based on the NCMFC decision at the February 2021 business meeting. At a special meeting in March 2021, the NCMFC amended the sector allocations to 70% commercial and 30% recreational in 2021 and 2022, 60% commercial and 40% recreational in 2023, and 50% commercial and 50% recreational in 2024 (see the *Recreational and Commercial Sector Allocations* issue paper for further discussion). While the motion included allocating the southern flounder fishery in 2021, allocations will not take effect until the final approval of Amendment 3; however, to keep consistent with the NCMFC motion 2021 allocations are presented below. The reductions are only applied to North Carolina's portion of total removals. Calculations to predict future harvest reductions depends on environmental parameters, recruitment, and fishing effort remaining similar to previous years, an assumption of the 2019 updated stock assessment. Any changes to these factors will impact the stock's response and whether the statutory requirement of sustainable harvest is achieved.

Building on the seasonal closures in Amendment 2, additional quantifiable and non-quantifiable management measures in Amendment 3 will serve to improve the overall southern flounder stock to reduce total removals and increase likelihood of improved southern flounder SSB and recruitment, while still providing flexibility for fishermen, when possible, in the timing of the harvest for the sectors. This issue paper required assumptions about the fishery to be made as a quota-based management strategy was developed. It evaluates management measures, in addition to seasonal closures, for a long-term approach by constraining harvest in the southern flounder fishery to achieve sustainable harvest in Amendment 3.

AUTHORITY

North Carolina General Statutes

G.S. 113-134 RULES
G.S. 113-182 REGULATION OF FISHING AND FISHERIES
G.S. 113-182.1 FISHERY MANAGEMENT PLANS
G.S. 113-221.1 PROCLAMATIONS; EMERGENCY REVIEW
G.S. 143B-289.52 MARINE FISHERIES COMMISSION – POWERS AND DUTIES

North Carolina Marine Fisheries Commission Rules

15A NCAC 03H .0103 PROCLAMATIONS, GENERAL
15A NCAC 03M .0503 FLOUNDER
15A NCAC 03M .0512 COMPLIANCE WITH FISHERY MANAGEMENT PLANS

DISCUSSION

The N.C. Department of Environmental Quality and the division recognize the required reductions in the southern flounder fishery are significant but necessary to increase the probability of successfully rebuilding this important recreational and commercial resource. A 72% reduction is

used based on the following criteria for the discussion of potential management measures in Amendment 3.

- Amendment 2 required a 72% reduction from 2020 onward until adoption of Amendment 3.
- Projections for rebuilding are based on a minimum of a 50% probability of success. Adopting a reduction greater than the 52% minimum increases the likelihood of achieving the minimum necessary for rebuilding.
- The projections were made with the assumption that each state that participated in the coast-wide stock assessment would implement measures for the necessary reductions required to rebuild SSB. There are uncertainties surrounding the other states with implementing cooperative management and the timing of regulations if implemented. The reductions in Amendment 3 are only to North Carolina's portion of total removals through the time series of the assessment.
- The management measures implemented in North Carolina from the original Southern Flounder FMP (NCDMF 2005), Amendment 1 (NCDMF 2013), and Supplement A to Amendment 1 (NCDMF 2017a) as modified by the Aug. 17, 2017 settlement agreement has not resulted in the necessary increase in SSB to end the stock's overfished status, thus further reductions are necessary.

A fishing mortality that falls between the identified threshold (52% reduction; Figure 7 in the *Description of the Stock* section) and target (72% reduction; Figure 8 in the *Description of the Stock* section) meets the statutory requirements (Figure 4.1.1).

As the potential management measures for Amendment 3 are presented there are several assumptions and limitations provided in the background section of this paper that are important to take into consideration.

- To account for North Carolina's portion of these reductions in the recreational and commercial fisheries, the identified reduction was applied to both the dead discards and landings, or total removals, for each sector (commercial and recreational) of the North Carolina southern flounder fishery from the terminal year of the assessment (2017; Figure 4.1.2).
- Dead discards will be accounted for at the end of the fishery as dead discards are not part of daily quota monitoring and will be added to the landings to adjust the value to make sure the TAC is not exceeded. This approach differs slightly from Amendment 2, in each amendment reductions were based on TAC, but as seasons were the selected management measure implemented through Amendment 2, the seasons accounted for estimated reductions in harvest and dead discards.
- The projections for rebuilding necessary to end overfishing and the overfished status included the minimum size limits for both the commercial and recreational fishery, the current gear requirements, and selected soak time and daytime restrictions. These measures influenced the fishery during the terminal year of the stock assessment and any consideration of changes to those values should be viewed with caution as they will have an undetermined impact on the projections and the rebuilding schedule.

- The approval of Amendment 2 specified the development of Amendment 3 to begin immediately to implement comprehensive, long-term management measures to achieve sustainable harvest. Management measures for Amendment 3 will be selected and implemented from the allowable total removals (landings and dead discards) that are calculated based on the fishing mortality estimates of the terminal year (2017) of the stock assessment.
- Additional quantifiable and non-quantifiable management measures to augment the seasonal closures will serve to improve the overall southern flounder stock to ensure total removals are reduced and southern flounder SSB and recruitment increase, while still providing flexibility for fishermen, when possible, in the timing of the harvest for the sectors. Quantifiable measures are calculable and count towards the requirements to end overfishing and rebuild the stock, while non-quantifiable measures serve as a buffer and help to prevent the expansion of harvest as the stock rebuilds.

MANAGEMENT CARRIED FORWARD

There are several management measures from Amendment 2 to carry forward into Amendment 3 to serve the purpose of addressing fishing behavior and potential changes in effort to minimize the possibility of catching southern flounder in a greater volume than predicted.

Management measures from the Southern Flounder FMP Amendment 2 that will be clarified and carried forward in Amendment 3 are:

- A minimum distance (area dependent) between gill-net and pound net sets, per NCMFC Rule 15A NCAC 03J .0103 (d);
- No greater than a recreational fishery four fish bag limit;
- A recreational minimum size limit of 15 inches TL;
- A commercial minimum size limit of 15 inches TL;
- A minimum mesh size of 6.0-ISM for anchored large-mesh gill nets used in the taking of flounder;
- A minimum mesh size of 5.75-ISM for pound net escape panels;
- Reduced 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;
- For anchored large-mesh gill nets with a stretched mesh length of 4.0 inches through 6.5 inches, maintain 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 or through the sea turtle or sturgeon ITPs;
- 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 an open season with exceptions for commercial large-mesh gill-net fisheries that target American (*Alosa sappidissima*) and hickory shad (*A. mediocris*) 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;

- Unlawful to use any method of retrieving live flounder from pound nets that cause injury to released fish (e.g., picks, gigs, spears, etc.); and
- Unlawful for the commercial fishery to possess any species of flounder harvested from the internal waters of the state during the closed southern flounder season.

QUANTIFIABLE AND NON-QUANTIFIABLE MANAGEMENT MEASURES

Both quantifiable and non-quantifiable management measures are presented to meet the North Carolina harvest reduction for southern flounder based on the terminal year of the stock assessment (2017). Quantifiable management measures include a quota for the commercial fishery, which relies on daily quota monitoring, and a quota implemented by seasons for the recreational fishery, which serves to constrain the recreational fishery within a quota; these measures relate specifically to the stock assessment total removals and are calculable.

Additional types of management measures that are non-quantifiable are likely to be effective in reducing mortality, but the resulting reduction cannot be determined using existing data sources. Examples of non-quantifiable measures explored in this paper include certain management measures carried forward from Amendment 2 as described above, as well as changes to trip limits in the commercial fisheries, changes to bag limits in the recreational fisheries, and a RCGL season. Additionally, a discussion of slot limits as a non-quantifiable management measure can be found in the *Implementing a Slot Limit in the Southern Flounder Fishery* issue paper. Such non-quantifiable measures are needed to prevent the expansion of harvest as the stock rebuilds, increasing the likelihood of rebuilding success; however, the magnitude of these management measures, as well as the possible response of the stock, is unknown.

QUANTIFIABLE MANAGEMENT MEASURES: QUOTA

For Amendment 3, a quota will be set so the TAL that establishes maximum fishing limits (in pounds) in a year for all participants does not exceed a pre-determined amount. A quota is a specified numerical harvest objective, the attainment of which causes closure of the fishery for that species (Blackhart et al. 2005). For the North Carolina southern flounder fisheries, the quota is measured in pounds of fish. The quota that meets the required reductions and the NCMFC allocation motion is a 548,034 pounds TAC which results in 532,352 pounds of TAL for management. This TAL will be further divided into commercial and recreational allocations based on a motion approved by the NCMFC in March 2021, which was further refined in February 2022. The allocations will be 70% commercial and 30% recreational for 2021 through 2024, 60% commercial and 40% recreational in 2025, and 50% commercial and 50% recreational beginning in 2026. The TAL for each sector can be found in Table 4.1.2 and additional information on allocations can be found in the *Recreational and Commercial Sector Allocation* issue paper.

When using a quota to manage a fishery, decisions need to be made on how to split or allocate the resource within each of the sectors and determine whether rollover of unused quota, payback of exceeded quota, or both will occur. Accountability measures implemented provide a means to manage the quota. A conservative approach benefits the resource by protecting any unharvested fish and not exceeding the TAC. This benefits the resource but may have consequences to user groups by shortening seasons or limiting access in some areas during subsequent years. A more

liberal approach to accountability measures benefits the user groups by allowing harvest of any remaining allocation during subsequent years and not requiring paybacks for any harvest over an allocation but may have consequences to the resource.

Table 4.1.2. Allocations for commercial and recreational fisheries and associated sub-allocations for each sector for the North Carolina Southern Flounder Fishery that maintains overall reductions of 72%.

					Commercial Fisheries	Recreational Fisheries*
Year	Allocation	Total Allowable Catch	Dead Discards	Total Allowable Landings	Total Allowable Commercial Landings	Total Allowable Recreational Landings
2021	70/30	548,034	15,682	532,352	372,646	159,706
2022	70/30	548,034	15,682	532,352	372,646	159,706
2023	70/30	548,034	15,682	532,352	372,646	159,706
2024	70/30	548,034	15,682	532,352	372,646	159,706
2025	60/40	548,034	15,682	532,352	319,411	212,941
2026	50/50	548,034	15,682	532,352	266,176	266,176

*RCGL gear removals not included in the Total Allowable Landings

Commercial Fisheries

For all commercial fisheries combined, the total allowable landings are 372,646 pounds of southern flounder for 2021 through 2024, 319,411 pounds in 2025, and 266,176 pounds beginning in 2026 (Table 4.1.2). This is the commercial allocation of the overall quota. To ensure the commercial allocation is not exceeded and provides all sectors continued access to the resource under these restrictions, further refinement maybe necessary to allow an annual harvest, to manage by areas, gears and opening dates. The division analyzed data to determine individual gear allocations for different areas and opening time frames, as well as data that combined some gears into one allocation for a given area. This analysis was undertaken with the understanding that increasing the complexity of management also increases the complexity of monitoring the quota, reducing the ability to effectively meet the targets to achieve sustainable harvest.

Commercial Gear Allocation

Given the large reduction needed to achieve sustainable harvest and the importance of each allocation staying within its allowed landings, it is most practical to separate the gears into two categories: pound nets and mobile gears (including gears that target southern flounder, primarily gigs and gill nets, and "other" gears that do not target southern flounder such as shrimp trawls, crab pots, and fyke nets). Using these two categories of mobile gears and pound nets also provides flexibility by allowing fishermen to use multiple gears in a trip without having to separate catches unless a pound net is involved. Combining mobile gears into a single category prevents users from switching between the two categories or altering their behavior that may increase harvest. For example, if there is a closure for gill nets due to protected species interactions, the remaining allocation would be available for harvest using non-gill net gears within the mobile gear category. In addition, the NCMFC has requested the division evaluate phasing out large-mesh gill nets in the southern flounder fishery by the terminal year of the current sea turtle ITP, August 2023. If the

NCMFC selects this as a management measure it may impact the sub-allocations for each gear category. More information can be found in the *Phasing out Large-Mesh Gill Nets in the North Carolina Southern Flounder Fishery* issue paper in Appendix 4.7.

All mobile gears have the capability to harvest southern flounder throughout the year, although there is variability in their use among the individual gears. Combining mobile gears into one allocation makes monitoring the daily harvest more efficient with less risk of exceeding the annual allocation. Based on the seasonality and movement of southern flounder, commercial gigs and "other" gears would likely benefit from opening in the late spring or early summer to maximize the economic benefit of the market at that time. The gig fishery could open in early summer and any remaining allocation would be available for harvest by gill nets and other gears at a specific opening date later in the fall. Consequences of the southern flounder gill-net fishery operating in the early spring or summer include at-net mortality, discards of non-marketable fish, as well as post-release mortality of undersized flounder.

The commercial southern flounder pound net fishery only has the capability to operate during the fall months, beginning in late August in Albemarle Sound and ending in late November in Core Sound. Allocating harvest to the pound net fishery outside of the fall migration would not be appropriate. Flounder pound nets are stationary gears and are only actively fishing when southern flounder are migrating to the ocean. The pound net gear is most susceptible to changes in average price per pound, as the market typically drops in value in October due to the opening of the summer flounder winter trawl fishery.

Commercial Gear Sub-Allocations

Due to the shift in allocation based on the March 2021 and February 2022 NCMFC motions, it is prudent to evaluate the sub-allocations for the commercial fishery. Presented below are three potential scenarios that account for the NCMFC approved allocation changes as well as changes to the sub-allocations for the commercial fishery sectors. The first scenario is showing the TAL by year for each sector based on historical landings and can be found in Table 4.1.3. A second scenario is to meet the NCMFC approved allocation and adjust the commercial sub-allocations so the pound net fishery maintains their current harvest estimate of 186,458 pounds. This scenario provides a level of harvest that maintains the fishery at a reduced level but accounts for the increased monetary investment of operating and maintaining the pound net gear. Sub-allocations for this scenario can be found in Table 4.1.4. A final scenario considered is to adjust the allocation and phase out large-mesh gill nets in the southern flounder fishery at the end of the current ITP in 2023 as proposed by the NCMFC. Under this scenario the sub-allocations remain consistent with the first scenario for 2021 and 2022 but beginning in 2023 half of the gill net landings are transferred to the pound net gear category and the other half remaining with the mobile gear category (Table 4.1.5). This 50/50 transfer of gill net allocation is just one example and can be altered based on NCMFC, Advisory Committee, or public input.

Table 4.1.3. Allocations for the North Carolina Southern Flounder commercial and recreational fisheries and associated sub-allocations for each sector for the North Carolina Southern Flounder Fishery that maintains overall reductions of 72% and historical sub-allocations. *RCGL gear removals not included

					Commercial Fisheries			Recreational Fisheries*		
Year	Allocation	Total Allowable Catch	Dead Discards	Total Allowable Landings	Total Allowable Commercial Landings	Mobile Gears	Pound Nets	Total Allowable Recreational Landings	Hook and Line	Gigs
2021	70/30	548,034	15,682	532,352	372,646	186,188	186,458	159,706	142,206	17,500
2022	70/30	548,034	15,682	532,352	372,646	186,188	186,458	159,706	142,206	17,500
2023	70/30	548,034	15,682	532,352	372,646	186,188	186,458	159,706	142,206	17,500
2024	70/30	548,034	15,682	532,352	372,646	186,188	186,458	159,706	142,206	17,500
2025	60/40	548,034	15,682	532,352	319,411	159,590	159,821	212,941	189,608	23,333
2026	50/50	548,034	15,682	532,352	266,176	132,992	133,184	266,176	237,010	29,166

Table 4.1.4. Allocations for the North Carolina Southern Flounder commercial and recreational fisheries and associated sub-allocations for each sector that maintains overall reductions of 72% but maintains the current level of sub-allocation for the pound net fishery. *RCGL gear removals not included

					Commercial Fisheries			Recreational Fisheries*		
Year	Allocation	Total Allowable Catch	Dead Discards	Total Allowable Landings	Total Allowable Commercial Landings	Mobile Gears	Pound Nets	Total Allowable Recreational Landings	Hook and Line	Gigs
2021	70/30	548,034	15,682	532,352	372,646	186,188	186,458	159,706	142,206	17,500
2022	70/30	548,034	15,682	532,352	372,646	186,188	186,458	159,706	142,206	17,500
2023	70/30	548,034	15,682	532,352	372,646	186,188	186,458	159,706	142,206	17,500
2024	70/30	548,034	15,682	532,352	372,646	186,188	186,458	159,706	142,206	17,500
2025	60/40	548,034	15,682	532,352	319,411	132,953	186,458	212,941	189,608	23,333
2026	50/50	548,034	15,682	532,352	266,176	79,718	186,458	266,176	237,010	29,166

Table 4.1.5. Allocations for the North Carolina Southern Flounder commercial and recreational fisheries and associated sub-allocations for each sector that maintains overall reductions of 72% but redistributes the gill net allocation equally between mobile and pound net gears. *RCGL gear removals not included

					Commercial Fisheries			Recreational Fisheries*		
Year	Allocation	Total Allowable Catch	Dead Discards	Total Allowable Landings	Total Allowable Commercial Landings	Mobile Gears	Pound Nets	Total Allowable Recreational Landings	Hook and Line	Gigs
2021	70/30	548,034	15,682	532,352	372,646	186,188	186,458	159,706	142,206	17,500
2022	70/30	548,034	15,682	532,352	372,646	186,188	186,458	159,706	142,206	17,500
2023	70/30	548,034	15,682	532,352	372,646	186,188	186,458	159,706	142,206	17,500
2024	70/30	548,034	15,682	532,352	372,646	186,188	186,458	159,706	142,206	17,500
2025	60/40	548,034	15,682	532,352	319,411	99,102	220,309	212,941	189,608	23,333
2026	50/50	548,034	15,682	532,352	266,176	85,803	180,373	266,176	237,010	29,166

Commercial Areas and Seasons Allocation

Because of the migratory nature of southern flounder, areas were investigated by the NCTTP waterbody locations to allow more equitable access by fishermen across the state with seasonal openings varying by area. As the weather begins to change during the fall, southern flounder migrate to estuarine waters in the south and east before moving into the ocean (Craig et al. 2015). The migration begins in the northern and western sounds and tributaries before it begins in the southern areas. As previously stated, increasing the complexity of management also increases the complexity of monitoring the quota, reducing the ability to effectively meet the targets; however, the benefit of this type of flexibility is the potential for staggered opening dates that will be determined by the Fisheries Director after consultation with user groups (more information on how the division will determine opening dates is available in the *Adaptive Management* issue paper). Staggering opening dates minimizes the chances of a "derby fishery," which forces all participants to fish at the same time ultimately leading to a flooded market and lower prices. Altering opening dates allows for specific areas and gears to target southern flounder when they are accessible and most valuable to fishermen with the expectation that harvest is tracked daily so the total allowable landings are not exceeded.

Analysis indicates that gear and area combinations with no more than three areas statewide would provide the best chance of success of achieving sustainable harvest through daily quota monitoring. For some gear and area combinations, two areas would allow some flexibility to the sectors and make accountability more manageable.

Landings data for the southern flounder commercial fishery were reviewed using waterbody locations and gear type identified by the NCTTP to determine if natural breaks by area and gear occurred (NCDMF 2017b). Identification of natural breaks by waterbody and gear determines how finely the areas can be managed within each gear category. A natural break in commercial effort and landings occurs in several areas across the state, but for ease of enforcement and knowledge of existing areas by fishermen, it is beneficial to use regulatory boundaries already in place.

Dividing mobile gears into two areas using current boundaries would result in a northern area from the North Carolina/Virginia border south to the B-D ITP boundary line in Core Sound (34° 48.2700' N latitude which runs approximately from the Club House on Core Banks westerly to a point on the shore at Davis near Marker "1") and a southern area from the 34° 48.2700' N latitude south to the North Carolina/South Carolina Border (Figure 4.1.5). Splitting mobile gears into three areas may best be approached with a northern area encompassing the Albemarle Sound and its tributaries including the Croatan and Roanoke sounds, a central area encompassing the Pamlico Sound and its tributaries, and a southern area encompassing all waters from Core Sound south (Figure 4.1.5).

If the NCMFC selects to phase out large-mesh gill nets the boundary line for mobile gears can be re-evaluated or removed all together and create a single statewide fishery for mobile gears (Table 4.1.6). The ITP B-D boundary line was selected due to the inclusion of large-mesh gill nets under the mobile gear category to remain consistent with ITP boundary areas.

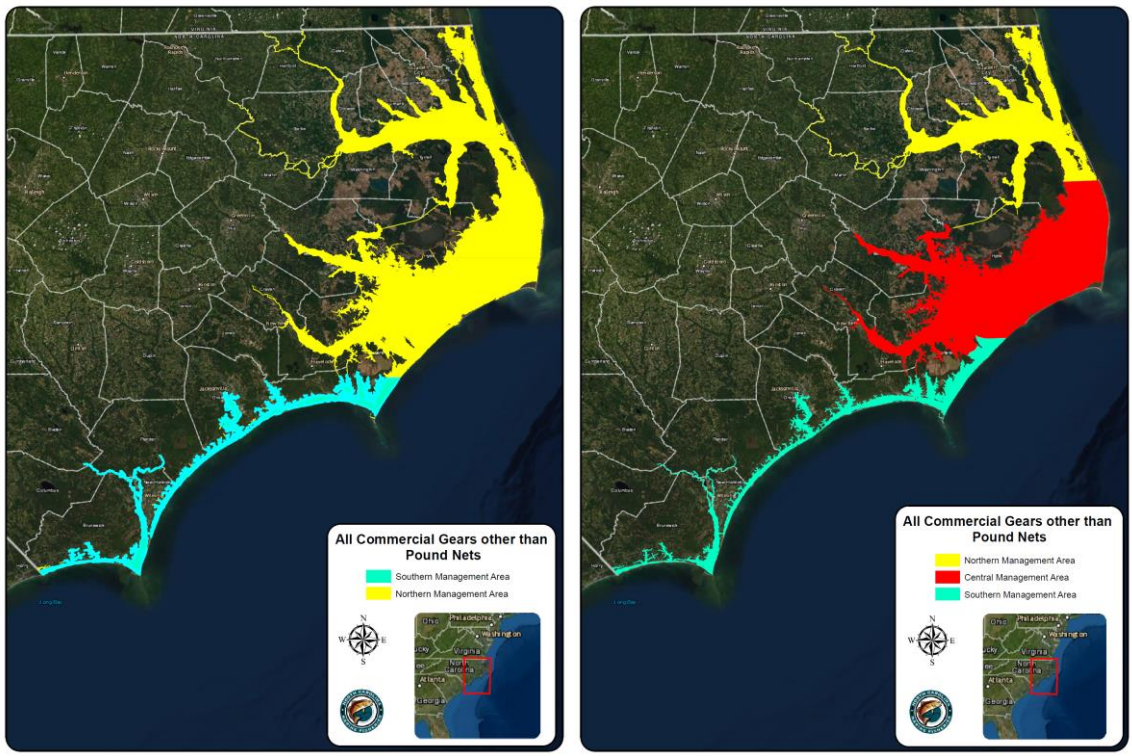


Figure 4.1.5. Boundary descriptions for two (left) and three (right) areas to consider for mobile gears. The three area boundaries are identical as seen for pound nets.

Dividing the state's pound net fishery into two areas may best be approached with a northern area from the North Carolina/Virginia border south to the 35° 46.3000' N latitude which runs approximately from the north end of Pea Island (old Coast Guard station) westerly to a point on the shore at Point Peter Canal and a southern area from 35° 46.3000' N latitude south to the North Carolina-South Carolina border (Figure 4.1.6). Three areas for the pound net fishery would be consistent with areas already in place under Amendment 2 for this fishery and would be the same boundaries described for mobile gears (Figure 4.1.6).

Based on the NCMFC allocations, the annual commercial TAL allocation in 2021 through 2024 is 372,646 pounds (Table 4.1.1). This allocation will be reduced in 2025 to 60% (319,411 lb) and again in 2026 to 50% (266,176 lb) to meet the requirements outlined by the NCMFC (Table 4.1.2). Three options presenting associated pounds of available allocation by area and gear can be found in Tables 4.1.6, 4.1.7, and 4.1.8. Commercial landings for mobile gears were combined and allocated by waterbody, with the exception of landings from Core Sound. Due to Core Sound being split in two areas, 50% of the landings from Core Sound were counted towards the northern area and 50% were counted towards the southern area (Table 4.1.2; Tables 4.1.6-4.1.8). Commercial pound net landings were allocated to each waterbody within the areas.

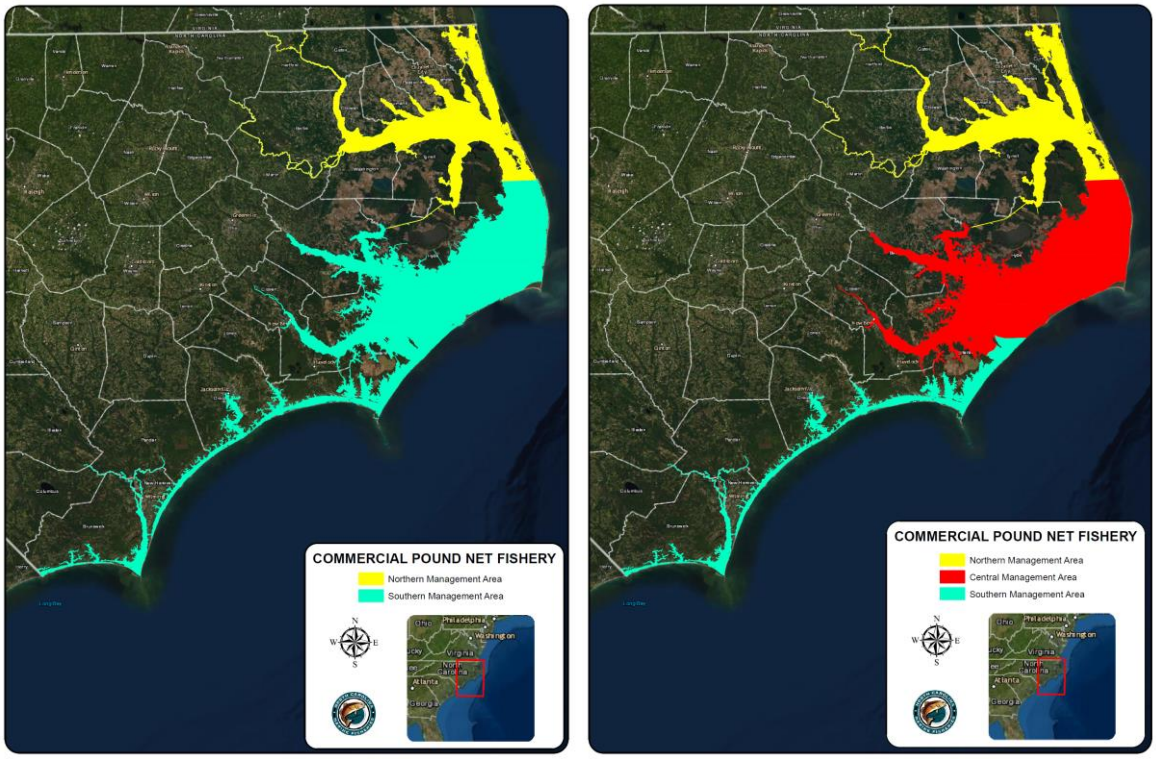


Figure 4.1.6. Boundary descriptions for two (left) and three (right) areas to consider for the pound net fishery. The three area boundaries are the same as mobile gears.

Landings data for the southern flounder commercial fisheries were evaluated to determine how landings and price per pound fluctuated during the year. This helped to identify what time frames would allow for the most productive fishery while minimizing discard mortality and meeting the necessary reductions. Commercial landings remain low through the majority of the first half of the year and begin to increase in late summer and peak in October and early November (Figure 4.1.7).

Southern flounder landings vary by location, month, and gear but typically increase in the Albemarle Sound area (northern) in early September, Pamlico Sound (central) in mid-to-late September, and Core Sound and south (southern) by October. Due to these variations in seasonal landings by gear and area, landings were analyzed to show the weekly rate of harvest as a percent of the total average landings from 2008 to 2017 (Figures 4.1.8 and 4.1.9). This analysis shows harvest rates through the year for each gear category statewide and by area as identified in Figures 4.1.5 and 4.1.6. One exception is in the southern portion of the state where the commercial gig fishery harvests flounder beginning in early summer and drives the harvest in the summer for the southern area (Figure 4.1.8).

Table 4.1.6. Allocation for the North Carolina Southern Flounder commercial fishery and associated sub-allocations for each sector that maintains overall reductions of 72% and historical sub-allocations.

Commercial Gear	Allocation %	Area/Allocation (lb)			Total Allocation (lb)	Option
Mobile gears	70	Statewide 186,188			186,188	1.1B
	70	Northern 123,879	Southern 62,309		186,188	1.1A
	70	Northern 47,082	Central 65,355	Southern 73,751	186,188	1.1C
	60	Statewide 159,590			159,590	1.1B
	60	Northern 106,182	Southern 53,408		159,590	1.1A
	60	Northern 40,356	Central 56,018	Southern 63,216	159,590	1.1C
	50	Statewide 132,992			132,992	1.1B
	50	Northern 88,486	Southern 44,506		132,992	1.1A
	50	Northern 33,360	Central 46,682	Southern 52,680	132,992	1.1C
Pound nets	70	Statewide 186,458			186,458	1.2B
	70	Northern 37,900	Southern 146,758		186,458	1.2C
	70	Northern 39,700	Central 121,756	Southern 25,002	186,458	1.2A
	60	Statewide 159,821			159,821	1.2B
	60	Northern 34,028	Southern 125,793		159,821	1.2C
	60	Northern 34,028	Central 104,363	Southern 21,430	159,821	1.2A
	50	Statewide 133,184			133,184	1.2B
	50	Northern 28,357	Southern 104,827		133,184	1.2C
	50	Northern 28,357	Central 86,969	Southern 17,858	133,184	1.2A

Table 4.1.7. Allocation for the North Carolina Southern Flounder commercial fishery and associated sub-allocations for each sector that maintains overall reductions of 72% but maintains the current level of sub-allocation for the pound net fishery.

Commercial Gear	Allocation %	Area/Allocation (lb)			Total Allocation (lb)	Option
Mobile gears	70	Statewide 186,188			186,188	1.1B
	70	Northern 123,879	Southern 62,309		186,188	1.1A
	70	Northern 47,082	Central 65,355	Southern 73,751	186,188	1.1C
	60	Statewide 132,593			132,953	1.1B
	60	Northern 88,460	Southern 44,493		132,953	1.1A
	60	Northern 33,621	Central 46,668	Southern 52,664	132,953	1.1C
	50	Statewide 79,718			79,718	1.1B
	50	Northern 53,040	Southern 26,678		79,718	1.1A
	50	Northern 20,159	Central 27,982	Southern 31,577	79,718	1.1C
Pound nets	70	Statewide 186,458			186,458	1.2B
	70	Northern 37,900	Southern 146,758		186,458	1.2C
	70	Northern 39,700	Central 121,756	Southern 25,002	186,458	1.2A
	60	Statewide 186,458			186,458	1.2B
	60	Northern 37,900	Southern 146,758		186,458	1.2C
	60	Northern 39,700	Central 121,756	Southern 25,002	186,458	1.2A
	50	Statewide 186,458			186,458	1.2B
	50	Northern 37,900	Southern 146,758		186,458	1.2C
	50	Northern 39,700	Central 121,756	Southern 25,002	186,458	1.2A

Table 4.1.8. Allocation for the North Carolina Southern Flounder commercial fishery and associated sub-allocations for each sector that maintains overall reductions of 72% but redistributes the gill net allocation equally between mobile and pound net gears beginning in 2023 (shown in the 60% and 50% allocations).

Commercial Gear	Allocation %	Area/Allocation (lb)			Total Allocation (lb)	Option
Mobile gears	70	Statewide 186,188			186,188	1.1B
	70	Northern 186,188	Southern 186,458		186,188	1.1A
	70	Northern 47,082	Central 65,355	Southern 73,751	186,188	1.1C
	60	Statewide 99,102			99,102	1.1B
	60	Northern 65,937	Southern 33,165		99,102	1.1A
	60	Northern 25,060	Central 34,786	Southern 39,255	99,102	1.1C
	50	Statewide 85,803			85,803	1.1B
	50	Northern 57,089	Southern 28,714		85,803	1.1A
	50	Northern 21,697	Central 30,118	Southern 33,988	85,803	1.1C
Pound nets	70	Statewide 186,458			186,458	1.2B
	70	Northern 37,900	Southern 146,758		186,458	1.2C
	70	Northern 39,700	Central 121,756	Southern 25,002	186,458	1.2A
	60	Statewide 220,309			220,309	1.2B
	60	Northern 46,907	Southern 173,402		220,309	1.2C
	60	Northern 46,907	Central 143,861	Southern 29,541	220,309	1.2A
	50	Statewide 180,373			180,373	1.2B
	50	Northern 38,404	Southern 141,969		180,373	1.2C
	50	Northern 38,404	Central 117,783	Southern 24,186	180,373	1.2A

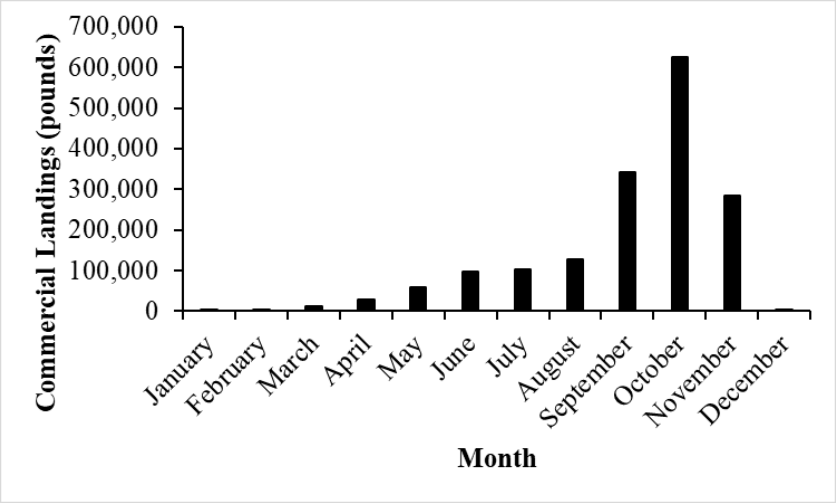


Figure 4.1.7. Average commercial southern flounder landings (pounds) by month in North Carolina, 2008-2017. (Source: North Carolina Trip Ticket Program)

Combining all mobile gears into a single group would allow for flexibility in determining opening dates for gears within the larger category, possibly allowing a gig fishery to operate during these summer months when the fish are available. For example, a sub-allocation of 38,614 pounds of the mobile gear allocation can be set aside for gigs and other gears, excluding gill nets, for harvest beginning May 1 and operating until this sub-allocation is harvested. This sub-allocation is based on the commercial gig fishery portion of the mobile gears category but could change if the NCMFC selects to phase out large-mesh gill nets in the southern flounder fishery. Once this sub-allocation is met, the remaining harvest would be available for harvest during the fall fishery where all gears, excluding pound nets, would be able to harvest the remainder of the available allocation for mobile gears. It is important to note that this summer sub-allocation is not independent of the mobile gear allocation. All reporting from dealers during this period will be accounted to the mobile gear allocation. In addition to seasonal information, effort data, environmental changes, ITP constraints, and quota monitoring requirements all provided information for the division to select management areas, opening dates, and gear combinations.

Combining all mobile commercial gears into one category split between two areas of the state, with each area having its own mobile gear allocation, will provide the most flexibility to accommodate opening dates within an area based on southern flounder movements. Dividing the pound net fishery into three areas will allow the timing of the openings for this gear to be more relevant to their geographic locations. Because pound nets are stationary gear, areas to further split the allocation will accommodate some flexibility on opening dates based on southern flounder movements; however, there will be consequences of disproportionate impacts to individual areas and gears that should be noted within these added layers to the quota allocation.

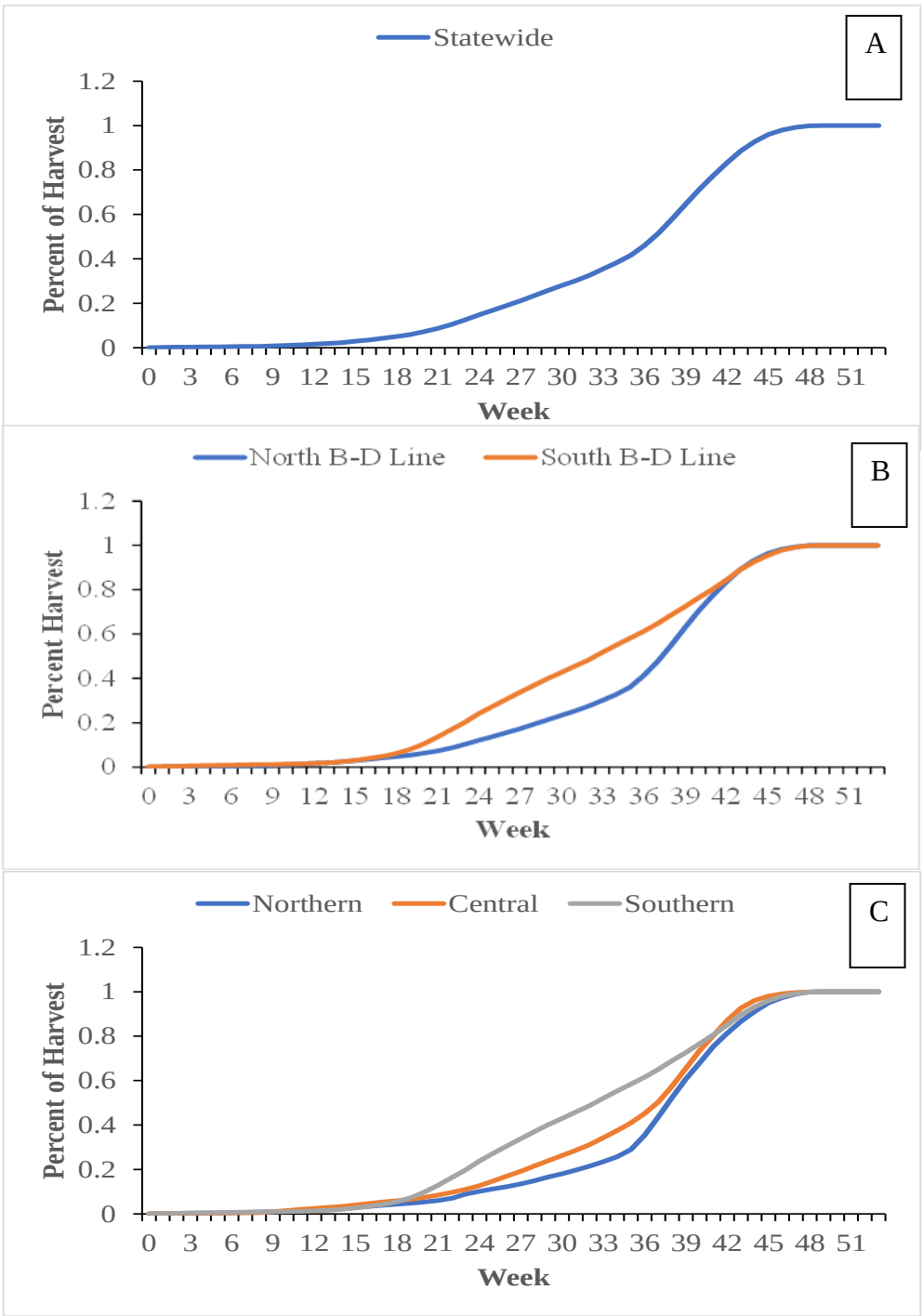


Figure 4.1.8. Average weekly harvest (in percent, 2008–2017) through the year from mobile gears statewide (A) and for two (B) and three (C) areas management scenarios as identified in Figure 4.1.5.

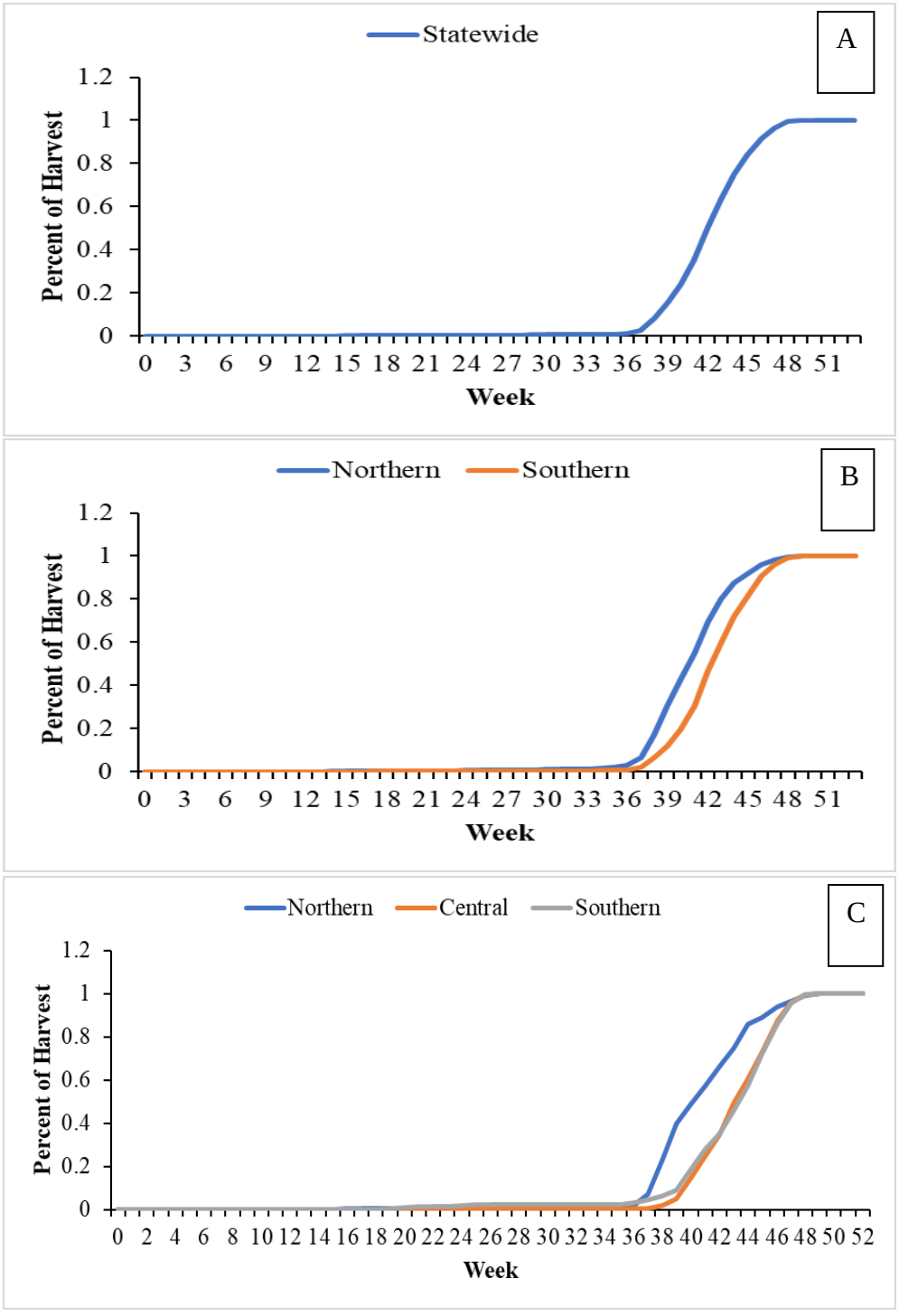


Figure 4.1.9. Average weekly harvest (in percent, 2008–2017) from the commercial pound net fishery statewide (A) and for two (B) and three (C) areas management scenarios as identified in Figure 4.1.6.

Commercial Accountability Measures

For the commercial fishery, if the combined TAC for all gear and area combinations is not exceeded at the end of a fishing year, accountability measures will not be applied. If the combined TAC is exceeded, paybacks due to overages of an allocation for a particular year from landings and dead discards would be applied to the responsible gear and area combination, meaning overages would be subtracted from the following year's allocation for that gear and area combination. These overages will be applied on a pound for pound basis. Any unused allocation or rollover would not be added to the subsequent year's allocation and would serve as a benefit to the resource and potentially decrease the time for rebuilding. The final total of pounds landed (including estimates of dead discards for the gill net fishery) from a year's harvest will be determined through verification of the quota monitoring forms and NCTTP landings data. It is important to restate that it is not the individual gear and area allocations that are driving management, rather it is the overall quota. The NCDMF will do what is necessary to maintain landings to meet the needs of rebuilding of the stock. Flexibility in managing each gear and area combination is necessary for the overall success of a quota system; see the *Adaptive Management* issue paper for further flexibility in developing long-term management measures.

Division staff will monitor the quota on a daily basis in order to prevent landings from becoming so large that the quota will be exceeded, and the stock will continue to be overfished. When the sum of the daily reporting for an area and gear combination approaches approximately 80% of the allocated landings, the division will issue a proclamation immediately to close the gear and area combination to the harvest of southern flounder. The mechanism for closing the southern flounder commercial fishery is through G.S. 113-221.1 (b) and Rule 15A NCAC 03M .0503 that provide the Fisheries Director proclamation authority to immediately close a fishery that is monitored by a quota. Closure under this rule does not require a 48-hour notice and can be issued effective immediately. This may be necessary to prevent additional overfishing as certain gear-area combinations can harvest a large percentage of the commercial quota if left unchecked.

Daily quota monitoring of the commercial fisheries will be key in achieving a long-term sustainable harvest of the southern flounder stock. A quota in combination with area, season openings, and trip limits for some gears will also provide access to the fish as they migrate through the sounds and into the ocean and maintain some buffer to reduce the potential for overages in the quota.

If remaining allocation is available, the division may reopen the gear and area combination for a short window to provide opportunity to harvest the remaining allocation; however, if the remaining allocation is not practical to manage while ensuring an overage will not occur, the fishery in question will not be reopened. This reopening may include trip limits for gears where this type of management would not increase dead discards as an additional regulation to prevent any overage of the allocation.

For gears where trip limits are not a viable option, like gill nets, the division may open the fishery daily. Daily openings may prove futile in keeping landings within an allocation and may not be a good option to use; the remaining allocation could be made available for other gears within the

mobile gears category in this case; however, if the remaining allocation is not practical to manage while ensuring an overage will not occur, the fishery in question will not be reopened.

Recreational Fisheries

The recreational fisheries, hook and line and gigs, TAL will change from 159,706 pounds in 2021 through 2024, 212,941 pounds in 2025 and from 2026 onward the TAL will be 266,176 pounds (Table 4.1.9). These are the recreational allocations of the overall quota as determined by the NCMFC. To ensure the recreational allocation is not exceeded but provides continued access to the resource under these restrictions, the allocation will be further refined to allow an annual harvest of 89% of the recreational TAL for the hook-and-line fishery and 11% of the recreational TAL for the recreational gig fishery. The associated pounds can be found in Table 4.1.9. The ability to monitor a recreational quota in real time is possible with a well-designed creel survey specific to the species and covering the geographic range of harvest and gears. The division relies on the MRIP, in which southern flounder is a species encountered regularly in the hook-and-line recreational fishery. The survey design of MRIP does not allow for results on a daily or weekly basis. Instead, results are available by two-month waves, several months after the data are collected. As a result, historical catch data must be used to predict future catch rates. Once the level of harvest for each reduction value was identified, catch from the MRIP was analyzed by two-week increments (the finest level of detail available) and summed to determine seasonal dates the fishery could operate while meeting the necessary reduction (Table 4.1.10). Seasons may vary as the TAL increases from 30% in 2021 until 50% parity is reached in 2026. This will be determined through Adaptive Management, see the *Adaptive Management* issue paper.

Although the recreational hook-and-line fishery is monitored through the MRIP, this program does not collect necessary information to provide estimates for the recreational gig fishery. As a result, the division conducts an annual mail survey for gig fishery effort and harvest estimates (see the *Description of the Fisheries* section for additional details on MRIP and the Recreational Gig survey).

Recreational use of limited commercial fishing gears is allowed in North Carolina and is subject to the same reductions as the other recreational and commercial fisheries. RCGL holders primarily use large-mesh gill nets to harvest southern flounder but may occasionally harvest southern flounder from shrimp trawls and crab pots. The collection of RCGL harvest data has not occurred since 2008 and is not reliable for estimating reductions due to multiple management changes since the survey ended. See the section on the *Description of the Fisheries* for trends in the RCGL fishery.

The use of RCGL gear is only allowed when both the recreational and commercial fisheries are open for the particular gear, and the user can only harvest recreational limits. Due to these requirements, the only options available to regulate the harvest of flounder using a RCGL is to allow harvest during a period of time when the commercial and recreational fisheries are open simultaneously or prohibit the harvest of flounder using a RCGL.

The limitations in monitoring for the recreational southern flounder fisheries allows for less flexibility in management measures to ensure the recreational allocation is not exceeded. Final

estimates of recreational harvest are not available until the season ends, so real time accounting of catch cannot be determined for underage or overage to the sector allocation. To complement a seasonal approach to the allocations, further non-quantifiable measures such as bag limits and allowable RCGL harvest are considered, as maintaining the four-fish daily bag limit allows for harvest just above the maximum required within the current season. These additional management tools are needed to increase the likelihood of meeting required reductions in the recreational fisheries and are discussed below.

Table 4.1.9. Southern flounder recreational fishery total allowable landings allocations in pounds by gear and total recreational allocation percentage.

		Recreational Gear		
Year	**Allocation %**	**Hook-and-Line**	**Gig**	**Total**
2021-2024	30	142,206	17,500	159,706
2025	40	189,608	23,333	212,941
2026	50	237,010	29,166	266,176

Table 4.1.10. Seasons identified to reach the TAL (142,206 pounds in 2021 through 2024, 189,608 pounds in 2025, and 237,010 pounds beginning in 2026) of the N.C. recreational hook-and-line fishery quota in pounds at the current four fish bag limit based on average landings from 2008–2017. Seasons may vary as the TAL increases until 50% parity is reached and will be determined through Adaptive Management. (2020 landings for the recreational hook and line fishery for the Aug 16 – Sep. 30 season with a four-fish bag limit was 362,119 pounds).

	Landings (lb)			
Season	**4-Fish Bag Limit**	**3-Fish Bag Limit**	**2-Fish Bag Limit**	**1-Fish Bag Limit**
No closure	451,126	428,594	400,502	332,075
Apr 16–Jun 30	109,157	107,657	105,569	100,911
May 1–Jun 30	102,622	102,622	99,249	94,985
Jun 1–Jul 15	110,702	109,102	106,836	102,184
Aug 1–Sep 30	179,895	175,782	171,480	161,015
Aug 16–Sep 30	127,706	125,359	123,267	118,071
July 16–Sep. 30	222,360	216,583	210,150	194,024
June 16–Sep. 15	272,287	263,508	252,502	226,790
Aug 16-Oct 15	156,040	152,524	149,254	*141,382
Aug-16-Oct 30	177,680	173,505	169,590	159,554

*This season and bag limit does meet the harvest level of TAL but exceeds estimates at the TAC level.

Further discussion on species-specific management measures is considered and presented in the *Increased Recreational Access* issue paper.

Recreational Season Allocation

The recreational hook-and-line fishery is allocated an increasing volume from 142,206 pounds in 2021 up to 237,010 pounds of southern flounder beginning in 2026 (Tables 4.1.1 and 4.1.9). With the current four-fish bag limit, the identified season of Aug. 16 through Sept. 30 meets the

reductions when combined with the inability to provide estimates of gig harvest and discards at reduced bag levels and the potential additional harvest from an ocellated flounder season (see the *Increased Recreational Access* issue paper). While this seasonal approach does meet the reductions, changes to bag limits are discussed in detail later due the potential for increased angler success. Seasonal allocation results in a quota that is validated using MRIP landings only after the season has closed. In North Carolina, the previous years' MRIP landings are available by mid-April of the following year.

The recreational gig fishery is allocated an increasing volume from 17,500 pounds in 2021 up to 29,166 pounds of southern flounder beginning in 2026 (Table 4.1.9). It is necessary to maintain concurrent seasons for the recreational hook-and-line and gig fisheries to keep from undermining the success of achieving necessary reductions (Table 4.1.11). Allowing a gig fishery to operate longer than the recreational hook-and-line fishery would allow excess harvest from the gig fishery that would exceed the gig allocation. In addition, if the gig fishery and the hook-and-line fishery operated during independent seasons, anglers could alter their current behavior by participating in each of the seasons, increasing effort and harvest on an already limited allocation.

When the recreational fishery is closed, recreational harvest of flounder in both internal and ocean waters will be unlawful as all flounder species (southern, summer, Gulf) are managed collectively in North Carolina. Other measures may be available to allow for species-specific management (see the *Increased Recreational Access* issue paper).

Table 4.1.11. Seasons identified to reach the initial TAL (17,500 lb in 2021 through 2024, 23,333 lb in 2025, and 29,166 lb beginning in 2026) of the N.C. recreational gig fishery landings (observed harvest) at the current four-fish bag limit based on average landings from 2010–2017. Seasons may vary as the TAL increases until 50% parity is reached and will be determined through Adaptive Management. (2020 landings for the recreational gig fishery for the Aug 16 – Sep. 30 season with a four-fish bag limit was 26,475 pounds).

Season	Landings (lb)
No closure	85,688
Jul 1–Sep 30	33,532
Jul 16–Sep 30	28,060
Jul 1–Sep 15	27,711
Aug 1–Sep 30	22,587
Aug 16–Sep 30	17,115

Recreational Accountability Measures

Accountability measures will also be necessary for the recreational hook-and-line and gig fisheries. The final recreational TAC will be determined by adding the total landings from the MRIP and gig surveys to the estimates of dead discards. To account for overages from landings and dead discards, the following year's recreational quota and season will be adjusted based on the results of the MRIP and gig mail surveys from the previous year. If the TAC for the recreational sector combined is not exceeded, then accountability measures will not be applied. If the TAC is exceeded, any overages to the TAC will be applied to the subsequent season (which includes both hook-and-line and gig gears). Using the conservative approach described in the commercial

accountability measures, any remaining allocation will not be rolled over to subsequent years. These data are typically available by mid-April for the previous calendar year, can be calculated quickly, and are expected to be finalized prior to the usual recreational season, assuming the season does not open prior to June 1. For the recreational fishery, final total of pounds harvested from a year's harvest, discard estimates, and estimates of number of trips will be determined through verification of the final MRIP and Gig Mail Survey.

An annual quota is the most appropriate tool for the recreational fisheries to maintain sustainable harvest, but it is more challenging to track every trip because harvest data are only available in two-month intervals with delays in verification. Instead, a season for the recreational fisheries that will maintain the allocation within its bounds may be the most reasonable approach. Due to a high level of discards in the recreational hook-and-line fishery, there is concern that the volume of discards can have a large direct impact on subsequent seasons if anglers continue to target and release southern flounder during closed seasons. Recreational hook-and-line discards are not monitored through a quota and are not available until after the season is complete. It is important to restate that it is not the individual gear allocations that are driving management, rather it is the overall quota. Additional measures can be implemented in concert to further refine harvest management to limit impacts due to overages while the fishery is recovering. This approach does limit angler access during periods of no harvest, but it does not stop the unintended consequences of large volumes of discards through indirect hooking while targeting other species or intentional catch and release discards. Unintended discards are a major source of removals in the southern flounder recreational fishery (Flowers et al. 2019; NCDMF 2019).

OTHER NON-QUANTIFIABLE MANAGEMENT MEASURES

Non-quantifiable measures are those that are not directly part of the stock assessment model and there is no way to measure the impact on the modeled fishing mortality. This does not mean that these non-quantifiable measures are not important to consider in management, they merely are not able to be included in the percent reduction needed to end overfishing/overfished status as statutorily required. If non-quantifiable measures are implemented, future stock assessments will indirectly reflect their effect on the fishery status. The non-quantifiable management measures under consideration to control effort in the fishery include trip limits in the commercial fisheries and bag limits in the recreational fisheries. Because specific impacts on recruitment and overfishing cannot be calculated, relevant empirical data for the various measures are presented herein. Earlier in the discussion section, the management carried forward was described. In addition to those non-quantifiable management measures carried forward, there are other non-quantifiable management measures to consider.

Commercial Fisheries Trip Limits

In the southern flounder commercial fishery, the use of a trip limit may be useful to maintain the quota allocation in the gig and pound net fisheries but is not ideal for the gill-net fishery due to the potential for increased dead discards. Unlike gigs or pound nets where commercial fishermen can selectively harvest flounder or release captured flounder with a high rate of survival, gill nets, although selective for fish size, cannot select for volume of fish entangled. As a result, any fish

entangled in a gill net that is over a trip limit would be released with a higher rate of discard mortality, increasing the pounds of removals and impacting the overall quota.

To calculate trip limits for the gig and pound net fisheries, average landings for the past 10 years by proposed areas were reviewed in conjunction with the numbers of trips with landings in varying poundage increments for each area based on the 10-year average for that fishery. For the gig fishery, a trip limit in numbers of fish, not pounds, is needed for the trip limit to be enforceable. To calculate this, the pounds harvested were converted to numbers of fish based on an average of 2.56 pounds per gigged fish as determined from commercial fish house sampling.

Trip limits for the commercial pound net and gig fisheries cannot be determined at this time because trip limits may change depending on the fishery and how many pounds are available to harvest. The Fisheries Director will determine the trip limit amounts dependent upon how close the fishery is to their allocation and what overall daily harvest amounts have already occurred in the season. Information is available to identify the volume of trips that remove southern flounder based on various intervals to provide some guidance (Tables 4.1.12 and 4.1.13). There are concerns with a trip limit for the pound net fishery, particularly if set too low. Because southern flounder can be held in pound nets, it is possible for fishermen to hold southern flounder until they can be landed. Multiple people can harvest from a single operation in order to land the fish available. If the pound net trip limit is set too low, safety becomes a consideration as well and fishermen may be forced to fish their sets in unfavorable weather conditions; currently, sets are fished on good weather days, not every day. Understanding these shortcomings in the pound net fishery, a trip limit would allow harvest of southern flounder while minimizing dead discards as discards from pound nets are assumed to have a high survival rate. Allowing the gig fishery additional landings within the allocation using trip limits on the remaining quota will allow harvest and minimize discards as the gig fisherman can stop harvesting fish when the daily limit is reached. A trip limit for the gill-net fishery creates additional discards, once their trip limit has been reached remaining gear soaking will capture fish in excess of the specified trip limit and be released with an estimated mortality of 23% (Lee et al. 2018). Additional information on trip limits can be found in the *Adaptive Management* issue paper.

Recreational Fisheries Bag Limits

Potential changes to bag limits for all recreational gear were evaluated. Reductions in recreational bag limits may increase the likelihood of meeting required reductions as the stock rebuilds. The current daily bag limit for flounder is set at four fish; the average angler success rate for a single trip is one harvestable southern flounder (Figures 4.1.10 and 4.1.11). During 2017, recreational anglers released nine southern flounder for every one southern flounder that was harvested (Figure 19 in the *Description of the Fisheries* section). Angler success rates are tied to stock size (fish availability) and minimum size limits. As stock abundance increases during the rebuilding period, it is likely angler success will increase as well. If angler success improves, any gains achieved through limited open seasons will be lessened, limiting the actual recovery of the species. Harvest should be constrained using multiple measures in the recreational fisheries while rebuilding occurs.

Reducing the southern flounder bag limit would minimize the impacts of increased angler success on the rebuilding stock. Current data show that recreational anglers harvest 93% of the southern

flounder total landings during trips where only one fish is harvested in a daily trip, although there is a four-fish daily bag limit in addition to the minimum size limit (Table 4.1.14). A reduction from four fish to three fish or from four fish to two fish daily bag limit does not curtail actual harvest (Table 4.1.14). Dropping the recreational bag limit for southern flounder to zero fish still results in dead discards of over 50,000 pounds for all identified potential season dates by anglers who are not targeting southern flounder and happen to catch and release some.

If angler success increases during the rebuilding time period, the volume of removals could increase relative to the original reduction calculations (Figure 4.1.11). If angler success doubles, which would be a two-fish daily harvest limit, paybacks from overharvest have the potential to severely curtail continued recreational angling opportunities as the stock recovers (Figure 4.1.12). Preliminary analyses of 2020 MRIP data indicate that angler success increased during the 2020 recreational season, when compared to 2015-2019, with the most notable increase with the number of anglers catching a single southern flounder. Limiting the potential future harvest during times of increased abundance will allow the stock to rebuild, making further bag limits necessary to constrain recreational harvest to meet the required reductions.

Table 4.1.12. Commercial southern flounder pound net trip limit scenarios (in pounds), including the number and cumulative of % trips, and % harvest within each trip limit bounds, September through November, 2008–2017. Note: Rounding of values may cause cumulative percentages to differ slightly.

	Management Area									
	Northern					Central				
Pounds Per Trip	Number of Trips	% of Trips	Cumulative Trip %	% of Harvest	Cumulative Harvest %	Number of Trips	% of Trips	Cumulative Trip %	% of Harvest	Cumulative Harvest %
<251	1,633	65	65	8	8	4,173	51	51	11	11
251-500	291	12	77	8	16	1,533	19	70	14	24
501-750	159	6	83	7	24	794	10	80	12	36
751-1,000	86	3	87	6	29	518	6	86	11	47
1,001-1,250	63	3	89	5	34	315	4	90	9	56
1,251-1,500	43	2	91	5	39	212	3	93	7	63
1,501-2,000	66	3	93	8	47	252	3	96	11	74
2,001-3,000	63	3	96	11	59	209	3	98	12	86
3,001-4,000	36	1	97	10	68	76	1	99	6	92
4,001+	66	3	100	32	100	59	1	100	8	100
Average Pounds Per Trip	539					503				

	Management Area									
	Southern					Statewide				
Pounds Per Trip	Number of Trips	% of Trips	Cumulative Trip %	% of Harvest	Cumulative Harvest %	Number of Trips	% of Trips	Cumulative Trip %	% of Harvest	Cumulative Harvest %
<251	1,850	66	66	18	18	7,656	57	57	11	11
251-500	420	15	81	15	33	2,244	17	74	13	24
501-750	197	7	88	13	46	1,150	9	82	11	35
751-1,000	123	4	92	12	57	727	5	88	10	45
1,001-1,250	63	2	94	7	64	441	3	91	8	52
1,251-1,500	40	1	96	6	70	295	2	93	6	59
1,501-2,000	48	2	98	9	78	366	3	96	10	69
2,001-3,000	40	1	99	10	89	312	2	98	12	81
3,001-4,000	20	1	100	7	96	132	1.0	99	7	88
4,001+	9	0	100	4	100	134	1.0	100	12	100
Average Pounds Per Trip	344					475				

Table 4.1.13. Commercial southern flounder gig fishery trip limit scenarios (in number of fish), including the number and cumulative % of trips, and % of harvest within each trip scenario, 2008–2017. Note: Rounding of values may cause cumulative percentages to differ slightly.

Number of Fish	Number of Trips	% of Trips	Cumulative Trip %	% of Harvest	Cumulative Harvest %
25	17,288	74	74	44	44
50	4,504	19	94	33	77
75	941	4	98	12	89
100	324	1	99	6	95
125	92	0	100	2	97
150	32	0	100	1	98
175	19	0	100	1	99
200	23	0	100	1	100
Average Pounds Per Trip	52				

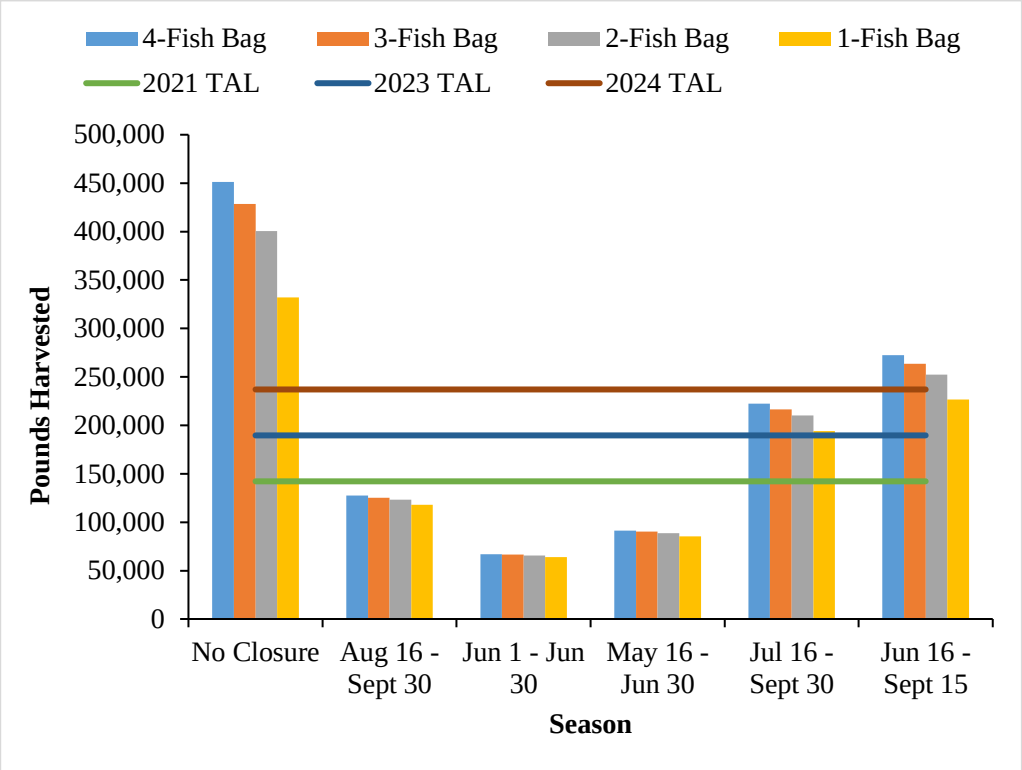


Figure 4.1.10. North Carolina southern flounder recreational fishing season relating to the increasing TAL (142,206 pounds in 2021 and 2022, 189,608 pounds in 2023, and 237,010 in 2024) and changes to the daily bag limit.

Table 4.1.14. Percent contribution of bag limit trips to total harvest of southern flounder for select seasons.

	Percent Contribution of Bag Limit to Total Harvest			
Season	**4-Fish Bag Limit**	**3-Fish Bag Limit**	**2-Fish Bag Limit**	**1-Fish Bag Limit**
No Season	5%	6%	15%	74%
Aug 1 - Sept 30	2%	2%	6%	90%
Aug 16 - Sept 30	2%	2%	4%	93%
Jun 1 - Jun 30	1%	1%	2%	95%
Apr 1 - June 30	1%	2%	4%	92%
Apr 1 - Sep 30	4%	6%	13%	77%
Mar 1 - Apr 15	0%	0%	0%	100%
Sep 1 – Sep 30	1%	1%	2%	96%
Apr 16 - Jun 30	1%	2%	4%	92%
May 1 - Jun 30	1%	2%	4%	93%
May 16 - Jun 30	1%	2%	3%	94%

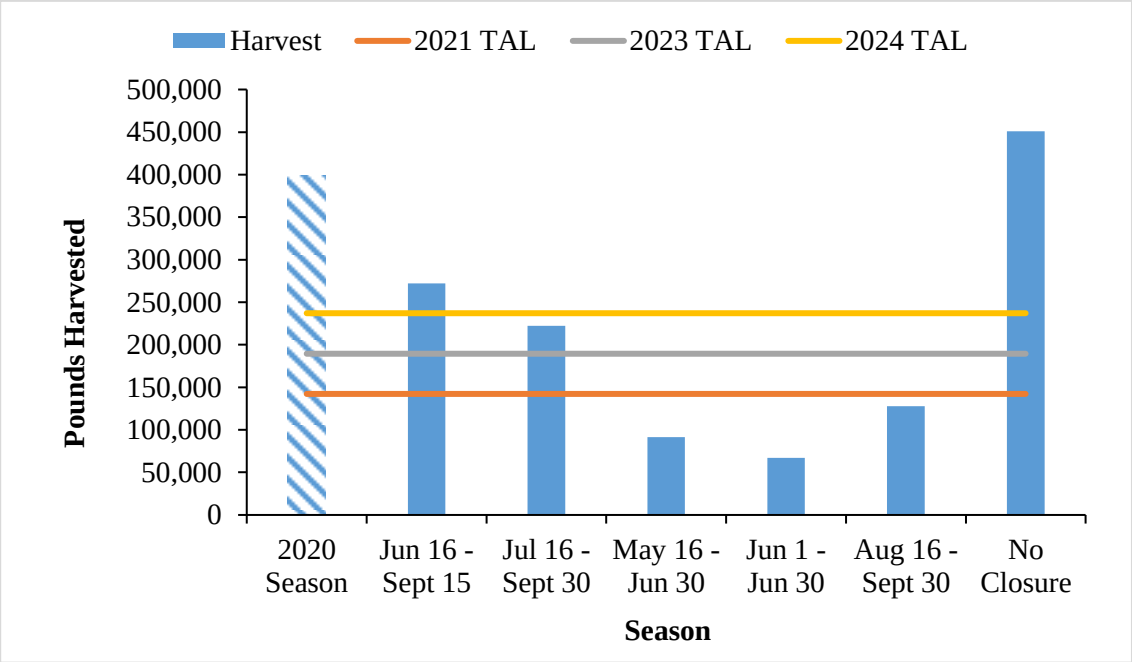


Figure 4.1.11. North Carolina southern flounder recreational fishing season relating to the increasing TAL (142,206 pounds in 2021 and 2022, 189,608 pounds in 2023, and 237,010 in 2024). The 2020 season was Aug. 16 through Sept. 30.

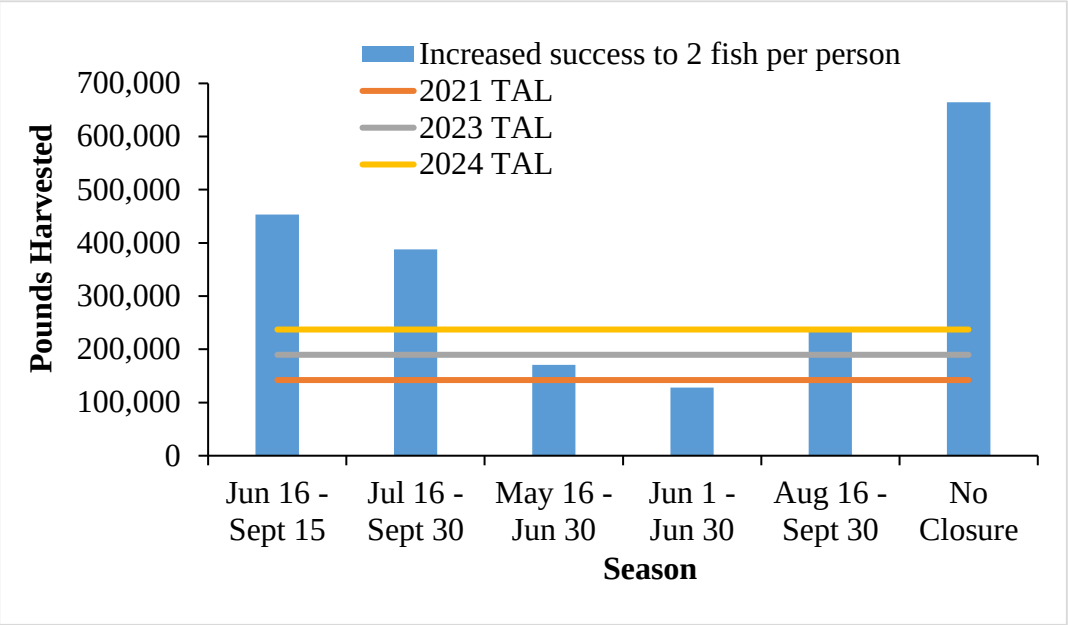


Figure 4.1.12. North Carolina southern flounder recreational fishing season relating to the increasing TAL (142,206 pounds in 2021 and 2022, 189,608 pounds in 2023, and 237,010 in 2024) anticipating angler success increasing to two fish per trip in the future.

Additional discussion of bag limits and the potential for increased angler opportunities through species-specific management of summer, southern, and Gulf flounder can be found in the *Increased Recreational Access* issue paper.

Recreational Commercial Gear

Recreational use of limited commercial fishing gears is allowed by law in North Carolina and is subject to the same reductions as the other recreational and commercial fisheries. Calculating reductions for the RCGL fishery is not possible because collection of RCGL harvest data has not occurred since 2008. Data collected in 2008 and prior may not be reliable for estimating reductions for Amendment 3 due to multiple management changes that have also occurred since the surveys ended. See the *Description of the Fisheries* section for trends in the RCGL fishery

Recreational gear license holders primarily use large-mesh gill nets to harvest southern flounder but may occasionally harvest southern flounder from shrimp trawls and crab pots. The use of commercial gears for recreational purposes is also only allowed during concurrently open recreational and commercial fishing seasons that allow the specific gear, and the user is only allowed harvest that does not exceed the recreational limits. Due to these requirements, the only measures available for harvest of flounder using a RCGL is during a period of time if and when the commercial and recreational fisheries are open simultaneously or prohibit the use of the RCGL for the harvest of southern flounder.

The volume of removals cannot be estimated for RCGL gears, but the number of license holders has continually declined from 6,055 participants in 2000 to a low of 1,662 participants in 2017 (additional information on RCGL can be found in the *Description of the Fisheries* section).

Amendment 2 provides minimal opportunity to fish RCGL gears targeting southern flounder when both the recreational and commercial seasons are open. In addition, if the bag limit for recreational harvest is reduced, the resulting change could also further limit the impacts of the RCGL fishery. If harvest of southern flounder is prohibited from RCGL gear, then an increase in discards will occur if these gears continue in targeting other non-flounder species.

CONCLUSION

Certain measures are better to attain the goal to maintain sustainable harvest at the much-reduced harvest levels than others, while other measures provide more flexibility to benefit the sectors both in access to the resource and for higher economic value. Below we expand on the key measures that are the most risk averse in that they have the highest likelihood of succeeding in maintaining sustainable harvest while providing some flexibility in access to the resource for all sectors in the fisheries.

A summary of the key decision choices that are discussed as potential management measures in this paper are found in Tables 4.1.15 and 4.1.16.

Table 4.1.15. Summary of quantifiable management measures for Amendment 3.

Management Option	Management Sub-option	Management Measure	Gear	# Management Areas	Description
1	1.1A	Commercial Quota	All gear other than pound nets	2	Division at the ITP B-D Boundary Line
1	1.1B	Commercial Quota	All gear other than pound nets	1	Statewide
1	1.1C	Commercial Quota	All gear other than pound nets	3	Same areas as Amendment 2
1	1.2A	Commercial Quota	Pound Nets	3	Same areas as Amendment 2
1	1.2B	Commercial Quota	Pound Nets	1	Statewide
1	1.2C	Commercial Quota	Pound Nets	2	Division at approximately Pea Island
2	2.1	Commercial Sub-Allocations	All commercial gears	N/A	2017 landings
2	2.2	Commercial Sub-Allocations	All commercial gears	N/A	Maintain current pound net allocation
2	2.3	Commercial Sub-Allocations	All commercial gears except gill nets	N/A	Allocate gill net harvest to mobile and pound net gears equally (50/50)
3	3	Recreational Quota (through season)	Hook-and- Line, Gigs	1	Statewide

Table 4.1.16. Summary of non-quantifiable management measures for Amendment 3.

Management Option	Management sub-option	Management Measure	Description
4	4A	Commercial Fishery Trip Limits	Implement trip limits for pound nets and gigs only to maximize potential opportunities for reopening a fishery to harvest remaining allocation
4	4B	Commercial Fishery Trip Limits	Implement trip limits for all gears
4	4C	Commercial Fishery Trip Limits	Status quo, do not implement trip limits
5	5A	Recreational Fishery Bag Limits	Reduce recreational bag limit of flounder to one fish per person per day
5	5B	Recreational Fishery Bag Limits	Reduce recreational bag limit of flounder to no more than three fish per person per day
5	5C	Recreational Fishery Bag Limits	Reduce recreational bag limit of flounder to no more than two fish per person per day
5	5D	Recreational Fishery Bag Limits	Status quo, keep the recreational bag limit of flounder at no more than four fish per person per day
6	6A	Recreational Commercial Gear	Allow the RCGL to be used to harvest flounder only during a period of time when the commercial and recreational fisheries are both open
6	6B	Recreational Commercial Gear	Prohibit the use of RCGL to harvest southern flounder

PROPOSED MANAGEMENT OPTIONS

Management Options

(+ potential positive impact of action)
(- potential negative impact of action)

Below are overarching positive (+) and negative (-) impacts for all options, specific impacts from an option may be found below that option.

+ May increase the abundance of female southern flounder helping to rebuild the spawning stock
+ Will impact both the commercial and recreational fisheries
+ No rule changes required
- Decreased harvest and economic impacts

Option 1. Implement A Quota for Mobile Gears and Pound Nets

The following positive and negative impacts apply to all of Option 1; specific impacts are listed under each sub-option.

+ Two gear categories reduce potential for increased error in dealer reporting
+ Allows individuals to fish and report multiple gears under the mobile gear category
+ Meets the requirements for rebuilding
+ If gill-net fishing is closed due to ITP, then allocation would be available to other gears in combined category
+ Would allow fishermen to explore alternate fishing gears to reduce bycatch
+/- Could allow for different opening dates
- Seasonal selections may impact landings from certain gears and locations more than others
- The more gears and areas are divided, the more complex dealer reporting and division monitoring becomes and we will be less likely to meet targets

1.1A. Dividing the states mobile commercial gears into two areas using the ITP boundary line for management units B–D.

+ Meets requirements for reductions
+ Maintains consistency for gill-net ITP boundary lines
+ Allows flexibility in opening dates for each area
+/- May shift fishing effort and alter behavior
- Some regions may be impacted more than others
- Some gears may be impacted more than others
- More areas make monitoring the daily landings more difficult

1.1B. A single statewide mobile commercial gear allocation that includes all coastal estuarine waters.

+ Single allocation area is easiest to monitor
+ Combing mobile gears makes reporting by dealers easier and reduces error
+ Equal access to commercial fishers
+ Meets requirements for reductions
- Seasonal selection may impede landings in certain locations

1.1C. Dividing the states mobile commercial gears into three areas (northern, central, and southern). The northern area would encompass the Albemarle Sound and its tributaries including the Croatan and Roanoke sounds, the central would encompass the Pamlico Sound and its tributaries, and the southern would encompass all waters from Core Sound south matching the boundaries described for the pound net fishery three-area option 2.2A.

+ Meets requirements for reductions
- Some regions may be impacted more than others
- Some gears may be impacted more than others
- Enforcement issues through increased boundaries not consistent with current ITP lines
- More areas make monitoring the daily landings more difficult
- More areas increase complexity for dealers daily reporting

1.2A. Dividing the state's pound net fishery into three areas maintaining consistency with areas in Amendment 2.

+ Meets requirements for reductions
+ Allows flexibility for different opening dates for each area
+ Maintains consistency with Amendment 2 boundaries
- Some regions may be impacted more than others
- Some fishers may have pound nets in multiple areas
- More areas make monitoring the daily landings more difficult

1.2B. A single statewide pound net allocation.

+ Meets requirements for reductions
+ Makes monitoring the daily landings easier
- No flexibility in opening dates
- Availability of fish varies across the state; may impact some areas more depending on when fishery is open

1.2C. Dividing the states pound net fishery into two-areas using the 35° 46.3000' N latitude.

+ Meets requirements for reductions
- Some fishermen may have pound nets in multiple areas
- Availability of fish varies across the state; may impact some areas more depending on when fishery is open

Option 2. Commercial Sub-Allocations

Decisions on commercial sub-allocations may be influenced based on the option selected in Appendix 4.7: *Phasing out Large-Mesh Gill Nets from the N.C. Southern Flounder Fishery* issue paper.

2.1. Maintain overall reductions of 72% and 2017 sub-allocations (Table 4.1.6)

+ Allows for all commercial gears to harvest southern flounder
+ Meets the requirements for sustainable harvest
- May reduce pound net sub-allocation to a level that is not economically viable
- May reduce pound net sub-allocations to a level where daily quota monitoring may be problematic

2.2. Maintain overall reductions of 72% and the current level of sub-allocation for the pound net fishery (Table 4.1.7).

+ Allows for all commercial gears to harvest southern flounder
+ Meets the requirements for sustainable harvest
- Reduces the available sub-allocation for mobile gears
- Decreases the economic benefit of the commercial mobile gear fisheries

2.3. Maintain overall reductions of 72% and redistributes the gill net allocation equally between mobile and pound net gears beginning in 2023 (shown in the 60% and 50% allocations) (Table 4.1.8).

+ Meets the requirements for sustainable harvest
+ Increases the sub-allocations for remaining mobile gears and pound nets
+ May increase the economic impact of the remaining gears
- Does not allow for harvest of southern flounder using gill nets
- Decreases the economic benefit of the commercial gill net fishery

Option 3. Recreational Quota

+ Meets requirements for reductions
+ Consistent with Amendment 2
+ Should limit removals and allow rebuilding of the stock
+ Allows for continued access to stock during rebuilding
- Several month delay to receive final estimates after season ends due to MRIP data availability
- Reduces access to anglers during closed seasons
- Difficult to account for angler behavior changes
- Does not stop indirect discards while targeting other species
- Does not limit future harvest during times of increased abundance from rebuilding

Option 4. Commercial Fisheries Trip Limits

The following positive and negative impacts apply to all of option 4; specific impacts are listed under each sub-option.

+ Allows for maximizing available allocations
+ Meets requirements for reductions
- May create additional discards if the trip limits are set too low
- Any SCFL or RSCFL holder can fish a permitted pound net with permission; a single net could distribute fish to multiple SCFL/RSCFL holders that normally would not use that gear

4A. Implement trip limits for pound nets and gigs only to maximize reopening after reaching division closure threshold.

+ Can be effective for gears with limited discard mortality
- Any SCFL or RSCFL holder can fish a permitted pound net with permission; a single net could distribute fish to multiple SCFL/RSCFL holders that normally would not use that gear

4B. Implement trip limits for all commercial gears.

+ May limit harvest from non-targeted gears as the stock recovers
+ May alleviate concerns of a derby fishery
- Not effective for gears where discard mortality is high (gill nets)
- May force fishermen to fish in unfavorable weather

4C. Status quo, do not implement trip limits

+ Any quota not harvested would act as additional savings for the spawning stock biomass
+/- Would not allow fisheries to re-open after closure due to approaching the TAL
- Economic impacts to the commercial sector would be greater if unable to harvest all of the TAL

Option 5. Recreational Fisheries Bag Limits

The following positive and negative impacts apply to all of Option 5; specific impacts are listed under each sub-option.

+ Meets requirements for reductions
- Decreases potential access to recreational anglers
- May increase discards

5A. Reduce recreational bag limit of flounder to one fish per person per day.

+ Provides the greatest chance of rebuilding and maintaining growth in the stock
+ May allow for quickest rebuilding of spawning stock biomass
+ May limit harvest during times of increased abundance from rebuilding
- May slow rebuilding if fish are continued to be harvested
- Would increase discards

5B. Reduce recreational bag limit of flounder to no more than three fish per person per day.

+ Reduces harvest for anglers who were successful at catching more than three flounder per trip
- Does not limit future harvest during times of increased abundance from rebuilding
- May delay rebuilding of spawning stock biomass

5C. Reduce recreational bag limit of flounder to no more than two fish per person per day.

+ Reduces harvest for anglers who were successful at catching more than two flounder per trip
- Does not limit future harvest during times of increased abundance from rebuilding
- May delay rebuilding of spawning stock biomass

5D. Status quo, keep the recreational bag limit of flounder at no more than four fish per person per day

+ Regulations are consistent with Amendment 2
- Does not limit future harvest during times of increased abundance from rebuilding
- May delay rebuilding of spawning stock biomass

Option 6. Recreational Commercial Gear

6A. Allow the RCGL to be used to harvest flounder only during a period of time when the commercial and recreational fisheries are both open.

+ Consistent with Amendment 2
+ Allows continued access to fishery
- Cannot account for harvest or discards from RCGL gear
- May increase discards if gear is allowed and bag limits are reduced
- Potential protected species interactions
- If allowed, there will be disparity among areas

6B. Prohibit the use of RCGL for the harvest of southern flounder.

+ Eliminates harvest from RGCL gears
- Cannot account for harvest or discards from RCGL gear
- Removes access to fishery for license holders
- May increase discards if species cannot be harvested but gear is still allowed

RECOMMENDATION

See Appendix 5 for a summary of all comments and recommendations gathered from NCDMF, the NCMFC advisory committees, and public for the Southern Flounder FMP Amendment 3.

NCMFC Selected Management Strategy*

Commercial Fisheries:

- Combine mobile gears (gill nets, gigs, and "other" gears) into one gear category and maintain pound nets as their own separate commercial fishery (Option 1).
- Divide mobile gears into two areas using the ITP boundary line for management units B-D (Option 1.1A).
- Divide the pound net fishery into three areas maintaining consistency with areas in Amendment 2 (Option 1.2A).
- Maintain 72% reduction and current sub-allocation for the pound net fishery with direction from the MFC as follows: "In 2024, as the shift in allocation is set to start the Division will

provide recommendations to the NCMFC on approaches to maintaining a sustainable sub-allocation for the commercial pound net fishery, as needed based on the economic and biotic conditions at that time".

- Implement trip limits for pound nets and gigs only to maximize reopening after reaching division closure threshold (Option 4A).

Recreational Fisheries:

- Implement a single season for the recreational gig and hook-and-line fisheries to constrain them to an annual quota (Option 3).
- Reduce the recreational bag limit of flounder to one fish per person per day (Option 5A).
- Do not allow harvest of southern flounder using RCGL (Option 6B).

**Includes management measures and clarifications carried forward from Amendment 2.*

In addition, the NCMFC adopted a resolution that the NCMFC recognizes that there may need to be consideration of a moratorium if there are continued excesses in the allowable catch of flounder in both sectors.

LITERATURE CITED

Blackhart, K., D.G. Stanton, and A.M. Shimada. 2005. NOAA fisheries glossary, U.S. Dept. of Commerce, NOAA Tech. Memo. F/SPO-69, 61 p.

Craig, J.K., W.E. Smith, F.S. Scharf, and J.P. Monaghan. 2015. Estuarine residency and migration of southern flounder inferred from conventional tag returns at multiple spatial scales. Marine and Coastal Fisheries 7:450–463.

Flowers, A.M., S.D. Allen, A.L. Markwith, and L.M. Lee (editors). 2019. Stock assessment of southern flounder (*Paralichthys lethostigma*) in the South Atlantic, 1989–2017. Joint report of the North Carolina Division of Marine Fisheries, South Carolina Department of Natural Resources, Georgia Coastal Resources Division, Florida Fish and Wildlife Research Institute, University of North Carolina at Wilmington, and Louisiana State University. NCDMF SAP-SAR-2019-01. 213 p.

Lee, L. M., S. D. Allen, A. M. Flowers, and Y. Li. 2018. Stock assessment of southern flounder (*Paralichthys lethostigma*) in the South Atlantic, 1989–2015. Joint report of the North Carolina Division of Marine Fisheries, South Carolina Department of Natural Resources, Georgia Coastal Resources Division, Florida Fish and Wildlife Research Institute, University of North Carolina at Wilmington, and Louisiana State University. NCDMF SAP-SAR-2018-01. 426 p.

NCDMF (North Carolina Division of Marine Fisheries). 2005. North Carolina southern flounder (*Paralichthys lethostigma*) fishery management plan. North Carolina Division of Marine Fisheries, Morehead City, NC. 260 p.

NCDMF. 2013. North Carolina southern flounder (*Paralichthys lethostigma*) fishery management plan: Amendment 1. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 380 p.

NCDMF. 2017a. North Carolina southern flounder (*Paralichthys lethostigma*) fishery management plan: Supplement A to Amendment 1. North Carolina Division of Marine Fisheries, Morehead City, NC. 83 p.

NCDMF. 2017b. North Carolina Division of Marine Fisheries Trip Ticket User Manual, Version 9. North Carolina Department of Environmental Quality, Division of Marine Fisheries, Morehead City, NC. 43 p.

NCDMF. 2019. North Carolina southern flounder (*Paralichthys lethostigma*) fishery management plan: Amendment 2. North Carolina Department of Environmental Quality, Division of Marine Fisheries, Morehead City, NC. 62 p.

APPENDIX 4.1.A. MANAGEMENT MEASURES AND STRATEGIES CONSIDERED BUT NOT DEVELOPED

Appendix 4.1.A was developed to provide additional data analysis and discussion on management measures and strategies that have been explored in this issue paper. These strategies do not have sufficient data necessary to support moving forward at this time but may provide research needs so they can be considered in future updates to the Southern Flounder Fishery Management Plan.

STATUS QUO

An option of "status quo," which means continue only what is in Amendment 2, is not presented in this issue paper. Final adoption of Amendment 2 to the Southern Flounder Fishery Management Plan authorized development of Amendment 3 with more comprehensive management strategies.

LIMITED ENTRY

North Carolina G.S. 113-182.1 states the NCMFC can only recommend the General Assembly limit participation in a fishery if the NCMFC determines sustainable harvest in the fishery cannot otherwise be achieved. Sustainable harvest can be achieved without the use of limited entry; therefore, limited entry is not an option at this time. For further information see *Appendix 1: Management Issues Considered but Not Developed*.

DYNAMIC QUOTA

A dynamic quota refers to a total allowable catch that fluctuates among years relative to the abundance of the resource and fishing pressure. In the case of southern flounder, the quota for a given year would be primarily driven by the strength of the year classes being subjected to fishing pressure. As with the static quota, all of the same drawbacks, including issues with monitoring the landings on a daily basis and the high degree of variability in the daily landings, go along with implementing a dynamic quota. In addition, to adequately manage a dynamic quota, the division would need to determine if the fishery-independent surveys used to estimate recruitment in the 2019 stock assessment can accurately predict year-class strength for quota management purposes. The terminal year estimates of recruitment from stock assessments tend to be the most uncertain; the use of recruitment indices to determine a dynamic quota is not a viable possibility. Due to limited availability of real time data that is reflective of the southern flounder stock, a dynamic quota is not a viable management option.

CHANGES TO SIZE LIMITS

Calculations necessary for developing projections based on increasing the current minimum size limit, decreasing the current minimum size limit, or developing a slot limit cannot be calculated on an individual state basis. The current stock assessment does not include a spatial component and, as a result, the lack of this spatial component means all size limit changes would be relative to the entire stock of southern flounder. Currently, there are multiple minimum size limits in place across the unit stock, ranging from 12- to 15-inches TL. If an increase or decrease in the minimum size limit, or a slot limit, for North Carolina. waters is considered, it is necessary to note that calculations referencing reductions that affect the fishing mortality rates of spawning stock

biomass are not possible. Any changes made would be based on previous years' data for fish within North Carolina harvest estimates and may or may not have intended impacts on the rebuilding of the stock. It would not be possible to attribute changes to size limits as the cause of changes to stock size.

Using North Carolina harvest estimates, calculations were performed to determine what additional effect size limit changes would have on the TAL in North Carolina. As stated above, these calculations do not account for the entire unit stock and are only for guidance as the effect over the entire unit stock would be non-quantifiable. The discussion below addresses these effects, as well as potential drawbacks to increasing the minimum size. Slot limits and a decrease in the minimum size are discussed in the *Implementing a Slot Limit* issue paper.

Increase in Minimum Size Limit

An increase in the minimum size limits is not recommended for the commercial fishery. In 2017, 80% of the fish harvested in the commercial fishery were less than 18 inches TL (Figure 4.1.11 in the *Achieving Sustainable Harvest* issue paper). Increasing the minimum size limit would increase the volume of releases from this fishery. In addition, continued increase in the minimum size limit would place increased harvest on the largest fish in the stock, which would disproportionately be females. For the commercial fishery, an increase in the minimum size limit would result in additional dead discards, particularly in the gill-net fishery that has a discard mortality rate of 23% (Lee et al. 2018).

Public comment for increasing the minimum size limit in the recreational fishery has been received numerous times over the years, with an increase to 18-inches most often mentioned. For the recreational fishery, increasing the minimum size limit would increase the volume of releases from this fishery, many of which may be mortalities and would decrease angler success. In 2017, 71% of the southern flounder harvested (by weight, pounds) by the recreational fishery were under 18-inches TL (Figure 4.6.2 in the *Implementing a Slot Limit* issue paper). If the recreational minimum size limit were to be set at 18-inches TL, an additional 28,000 pounds of dead discards would be created based on 2017 data with a total harvest savings of approximately 283,352 pounds over the year. To determine what impact changing the minimum size limit to 18-inches TL would have on the TAL, seasonal calculations were re-evaluated. Several seasons were identified, in addition to the season currently established (Aug. 16 to Sept. 30) in Amendment 2, that would meet the overall harvest target reduction of 142,206 pounds (Table 4.1.A1). Although an increase in the minimum size limit has the potential to increase the length of a season, there is increased error around these estimates. Additionally, as the stock rebuilds, the seasons identified may not continue to meet the target harvest reduction due to increased angler success (Figure 4.1.A1).

Table 4.1.A1. Season and total harvest for an 18-inch TL minimum size limit based on 2017 data.

Season	Total Harvest (pounds)
No Closure	167,774
Aug 16–-Sep 30	47,401
Aug 1–-Sep 30	49,149
Jul 16–-Sep 30	64,576
Jul 1–-Sep 30	91,376
Aug 1–Oct 15	52,914
Aug 16–Oct 15	51,167
Jul 1–Aug 31	47,493
Jul 1–Sep 15	66,396
Sep 1–Oct 31	58,760
Sep 1–Nov 15	68,808

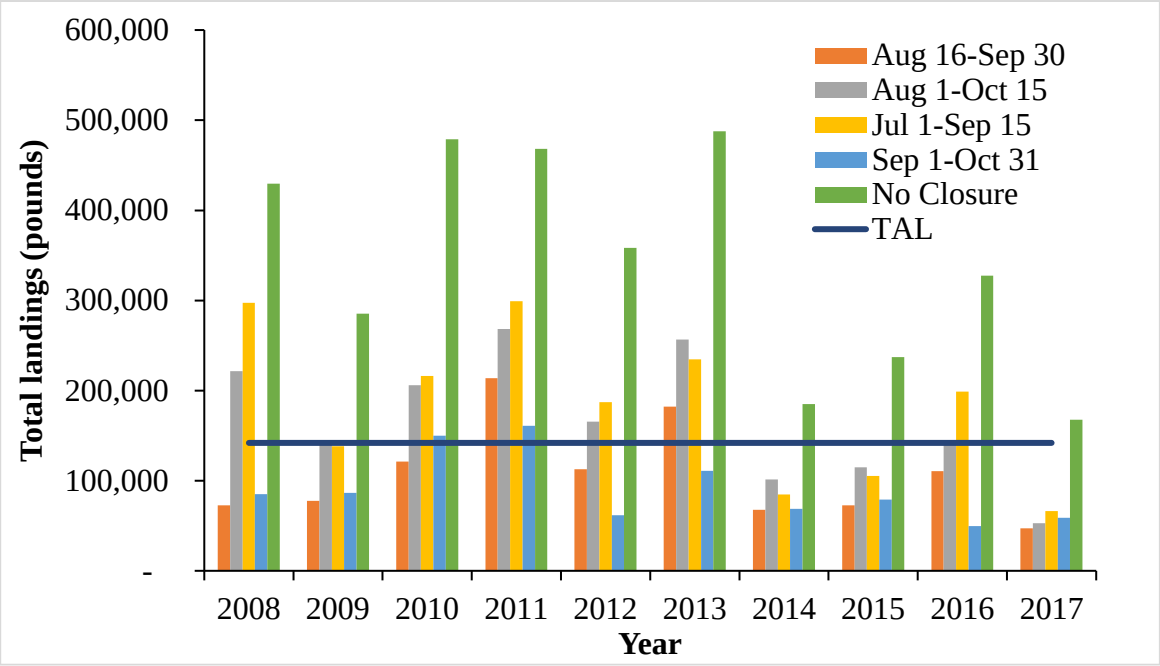


Figure 4.1.A1. Total hook-and-line harvest for seasonal options based on data for 18-inch minimum size limit from 2008–2017. Years 2010, 2011, and 2013 represent years of above average harvest. TAL of 142,206 pounds is represented by the blue solid line.

COMMERCIAL GEAR LIMITATIONS

Current gear configurations, including 6.0 ISM for large-mesh gill nets, 5 and ¾ ISM escape panels in pound nets combined with a 15-inch TL minimum size limit for flounder, have reduced the

volume of discards observed. Although the only fishery for which discards can currently be estimated is the large mesh gill-net fishery, anecdotal evidence supports limited discards in the pound net fishery. Due to the apparent effectiveness of the current gear configurations and the current minimum size limit, additional changes to gear are not recommend at this time; however, if size limits are considered for the estuarine flounder fishery, changes to gear configurations may be warranted.

DEVELOPMENT OF FISHING DAYS (WEEKEND/WEEKDAYS/HOLIDAYS) FOR THE RECREATIONAL FISHERY

The adoption of Southern Flounder Amendment 2 by the NCMFC mandated a 72% reduction in pounds for both the commercial and recreational sectors beginning in 2020 to achieve sustainability of the stock within 10 years. To achieve this reduction within the recreational fishery, MRIP data from 2008-–2017 were analyzed to determine appropriate bag limits that operate in concurrence with seasonal closures. A reduction in pounds necessitated incorporation of the discard mortality estimates across specific bag and season combinations. The harvest of southern flounder exhibits a distinct seasonality and the bulk of the harvest occurs during the summer months. To achieve an acceptable reduction in harvest, seasonal scenarios focused on reducing harvest during the summer months. This analysis demonstrated that the only scenario in which the recreational TAL was not exceeded was through a four-fish bag limit on southern flounder within a season spanning Aug. 16 through Sept. 30. At the request of the NCMFC, the division explored the possibility of protracting the recreational season through combinations of weekday and weekend day types. Additional input from the Southern Flounder Advisory Committee recommended a weekday specific season during the summer months with an allowance for weekend only fishing during the fall.

MRIP catch rate estimates were obtained through a variety of weightings reflective of angler avidity including location, day type (weekend vs. weekday), and time of day. MRIP produces catch estimates by applying the weighted catch rates to estimates of effort obtained through the Fishing Effort Survey (see *Description of the Fisheries* section). Importantly, the MRIP definition of day type includes Friday as a weekend day type due to angler avidity aligning more closely with observations from Saturday and Sunday. As such, it is disproportionately weighted with expanded catch rate estimates reflecting this increased avidity. Thus, it is of particular note that Friday is included as a weekend day type when data are deconstructed for analysis. Initial analyses sought to achieve targeted reductions for particular day types as a proportion of day type specific contributions. Specifically, a weekend target of 76,000 pounds and a weekday target of 46,000 pounds would achieve the overall target reduction of 142,206 pounds. This analysis demonstrated that when individual day types were given equal consideration regarding targeted reductions, there was no deviation from initial reduction projections using the combined data set; however, when individual day types were considered within the context of the recreational hook-and-line TAL (142,206 lb), it is possible to achieve a variety of scenarios that extend the season for over three months and still achieve desired reductions but with increased error around the produced estimates.

The scenario that most closely approaches the harvest allowance includes a summer season from July 16 through Sept. 30 that permits harvest only during MRIP defined weekdays (Monday, Tuesday, Wednesday, and Thursday). This weekday season will provide a projected harvest of

92,354 pounds. A subsequent season consisting of MRIP defined weekend days (Friday, Saturday, Sunday) will begin on Oct. 15 and last until Nov. 30. This fall weekend season will provide a projected harvest of 27,803 pounds. The combined harvest of 121,666 pounds will fall below the TAL of 142,206 pounds (Table 4.1.A2; Figure 4.1.A2).

Alternate management scenarios incorporate species-specific harvest (i.e., summer, southern., Gulf) and are further evaluated in the *Increased Recreational Access* issue paper. When constituent flounder species are given consideration in establishing bag limits, there is potential to craft additional seasons that further extend the seasonal harvest of flounder. Verifying the recreational angling community's ability to differentiate among North Carolina's three flounder species will be requisite before single species management options can be explored.

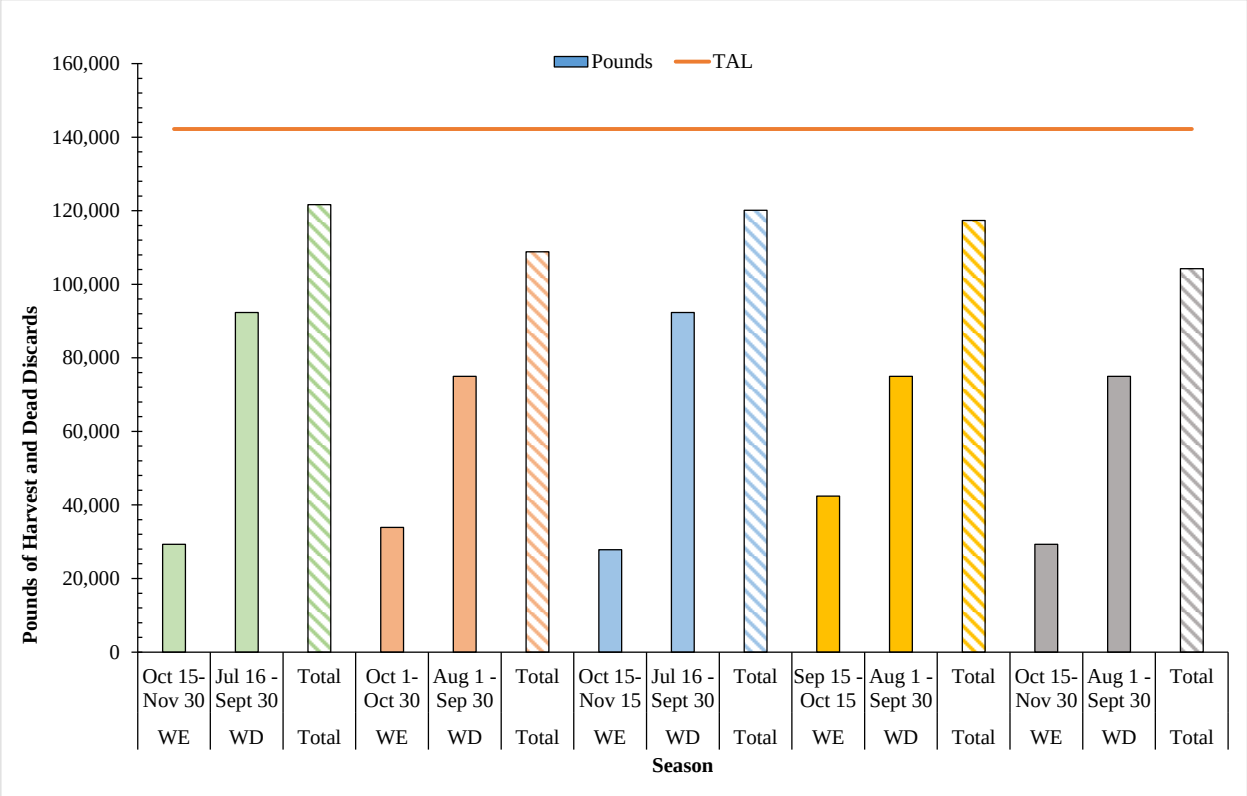


Figure 4.1.A2. Southern flounder harvest projections from seasons using day-type specific combinations. (Note: WD = Weekdays and WE = Weekends).

The scenarios provided will allow greater access to the resource by providing concessions for for-hire stakeholders who rely heavily on weekday clientele during the summer months while also affording anglers access to the fall flounder fishery. The primary concern with this approach is that under the initial season combining all day types provided anglers with a defined window within which to fish, thus increasing the likelihood of achieving targeted reductions. The extension of a season across multiple months between specific day types increases the opportunity for individuals to alter their behavior to capitalize on the resource, which has the potential to compromise projected reductions. It may be beneficial to consider options with a lower projected harvest to provide a buffer against temporal displacement across a protracted season. This is also suggested

as the reductions are based on the terminal year (2017) of the assessment. During periods of higher abundance (e.g., 2013), weekday and weekend estimates vary greatly and are often greater than allowed for the recreational hook-and-line TAL (Figure 4.1.A3

Table 4.1.A2. Southern flounder harvest projections from seasons using day-type specific combinations.

Day Type	Season	Pounds
Weekend	Oct 15 –Nov 30	29,313
Weekday	Jul 16–Sept 30	92,354
	Total	121,666
Weekend	Oct 1–Oct 30	33,903
Weekday	Aug 1– - Sep 30	74,953
	Total	108,856
Weekend	Oct 15 –Nov 15	27,803
Weekday	Jul 16–Sept 30	92,354
	Total	120,157
Weekend	Sep 15–Oct 15	42,386
Weekday	Aug 1–Sept 30	74,953
	Total	117,339
Weekend	Oct 15- Nov 30	29,313
Weekday	Aug 1 - Sept 30	74,953
	Total	104,266

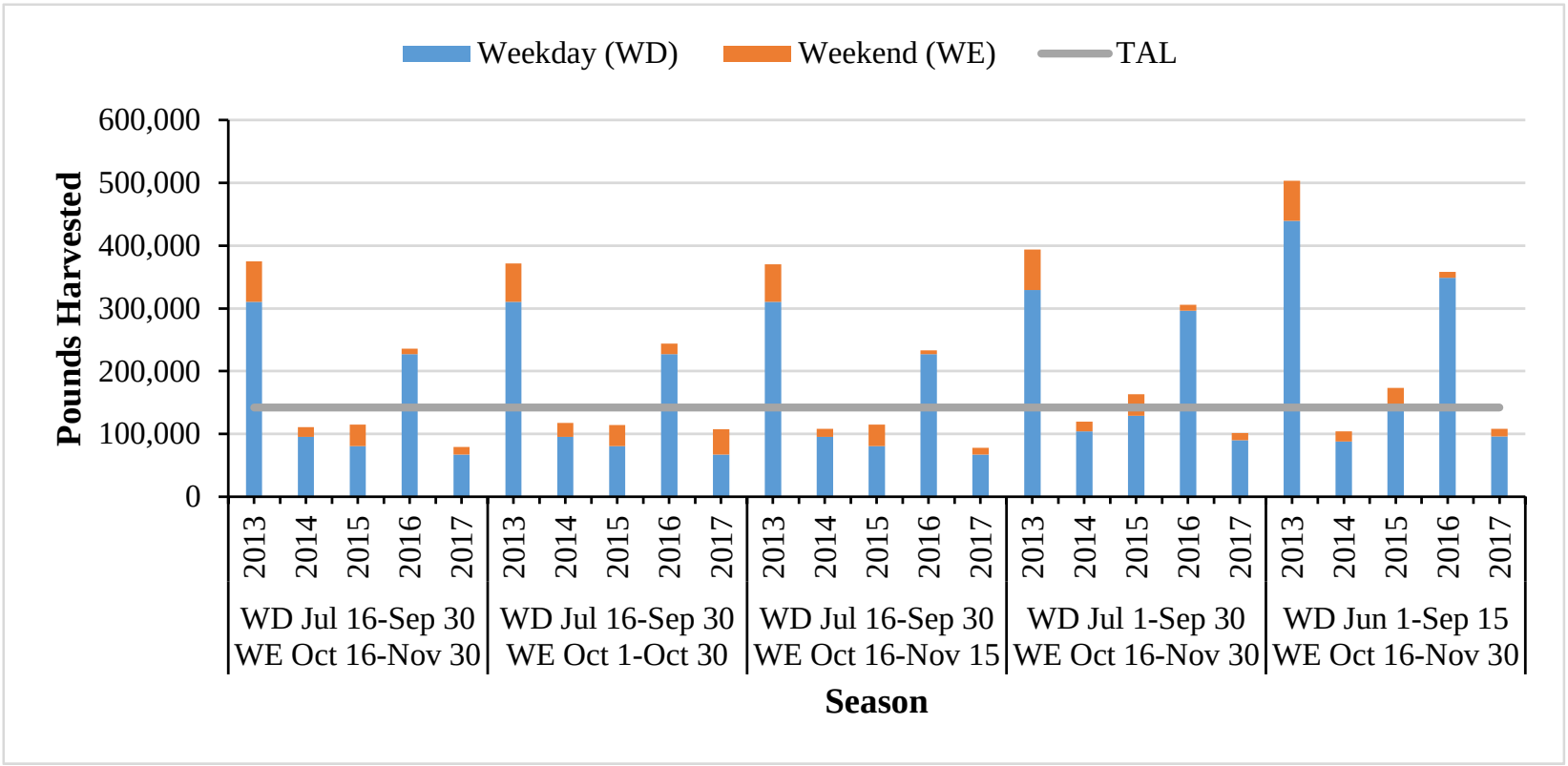


Figure 4.1.A3. Annual variability in harvest of southern flounder (pounds) during identified day type combinations, 2013–2017. (Note: WD = Weekdays and WE = Weekends)

RECREATIONAL FISHERY VESSEL LIMITS

Potential implementation of vessel limits for all recreational gear were evaluated. The Private/Rental boat mode in MRIP is responsible for the largest portion of the recreational landings of southern flounder. The vessels intercepted by MRIP had an average of two anglers present from 2008 through 2017; however, the number of anglers ranged from one to 11 (Table 4.1.A3). It is the trips where more than two anglers are present that cause concern. In the southern flounder recreational fishery, the use of a trip limit may be useful to maintain the quota allocation for the hook-and-line and gig fisheries. Vessel limits may have a larger impact to recreational southern flounder harvest if bag limits are not reduced from four fish per person per day. Much like reduction in bag limits, effects of vessel limits are not quantifiable at this time as estimates would be based on prior years which will not be reflective of the fishery moving forward. Due to this, implementing trip limits would serve to reduce the chances of exceeding the TAL for the recreational fishery and thus reduce the chances of significant impacts in subsequent seasons due to required accountability measures. As stock abundance increases during the rebuilding period, it is likely angler success will increase as well. If angler success improves, any gains achieved through limited open seasons will be lessened, limiting the actual recovery of the species. Harvest must be constrained using multiple measures in the recreational fisheries while rebuilding occurs; however, if the recreational bag limit is reduced to one fish then the implementation of vessel limits may not be necessary. If reductions in bag limits are not implemented and vessel limits are imposed, the vessel limits themselves may not be adequate to limit harvest as rebuilding occurs. Under the proposed quota system, any overages that occur, even if under vessel limit constraints, will be applied to subsequent years. Data suggest that limiting harvest and thus reducing the chances of exceeding the recreational TAL is best suited with a reduction in bag limit.

Table 4.1.A3. Average, minimum, and maximum number of anglers present on a vessel in the Private/Rental Boat mode for the recreational southern flounder fishery from 2008–2017.

Year	Average	Minimum	Maximum
2008	2	1	8
2009	2	1	9
2010	2	1	11
2011	2	1	10
2012	2	1	6
2013	2	1	7
2014	2	1	6
2015	2	1	6
2016	2	1	5
2017	2	1	6
Total	2	1	11

APPENDIX 4.2. INCREASED RECREATIONAL ACCESS BY MANAGING SOUTHERN FLOUNDER SEPARATELY FROM OTHER FLOUNDER SPECIES

ISSUE

Implement single species or genus level management to increase recreational access to summer and Gulf flounder while maintaining harvest reductions in the southern flounder fishery.

ORIGINATION

The adoption of Southern Flounder FMP Amendment 2 by the NCMFC mandated a 72% reduction in pounds starting in 2020 for both the commercial and recreational sectors to achieve sustainability of the stock within 10 years (NCDMF 2019). To achieve this reduction within the recreational fishery, MRIP data from 2008-2017 were analyzed relative to the terminal year (2017) landings to determine appropriate bag-limits that operate in concurrence with seasonal closures. Importantly, Amendment 2 contained acute management measures (seasons) to achieve sustainable harvest and was predicated on the immediate development of Amendment 3 for the purpose of implementing more comprehensive long-term management measures to achieve sustainable harvest.

At the request of the NCMFC and the Southern Flounder FMP Advisory Committee, the division examined alternative management scenarios that incorporate species-specific harvest of flounder (i.e., summer, southern, Gulf). When constituent flounder species are given consideration, the potential exists to develop additional scenarios that further extend the seasonal harvest of flounder species.

BACKGROUND

Southern flounder, or flounder species in general (*Paralicthys* spp.), are one of the most targeted recreational species in North Carolina. Southern flounder are primarily landed by recreational fishermen using hook and line. Additional harvest, albeit to a lesser extent, is accomplished with gigs and recreational use of commercial gears (e.g., anchored large-mesh gill nets). Between 2008 and 2017, North Carolina's total recreational removals (in pounds) were approximately 19% of the total coast-wide southern flounder removals (North Carolina to the east coast of Florida; NCDMF 2019). The recreational flounder fishery in North Carolina accounted for 28% of the state's total removals (26% in landings and an additional 2% of dead discards) in 2017 (the terminal year of the assessment; NCDMF 2019). Additionally, between 2008 and 2017 southern flounder contributed 73% of total flounder landings with summer contributing 22% and Gulf contributing 5%. For additional information on landings see the *Description of the Fisheries* section and *Achieving Sustainable Harvest* issue paper.

In North Carolina, the recreational flounder fishery is managed as an aggregate consisting of three main species of flounder (southern, summer, and Gulf). Thus, a closure on the southern flounder recreational fishery means the harvest of the other flounder species is prohibited. This is particularly relevant for the closure of the recreational ocean fishery and is acknowledged as an unintended consequence of this aggregate management. Based on MRIP data, most flounder harvest across all species occurs in estuarine waters (Figure 4.2.1). Of the flounder landed in state

territorial seas and the EEZ (referred to as "ocean" from this point in the document forward), approximately 50% of the ocean recreational harvest are species other than southern flounder. Specifically, summer flounder are more frequently encountered in the ocean fishery relative to southern flounder. Gulf flounder represents less than 6% of total flounder harvest and is predominately harvested in ocean waters (Figure 4.2.1). Pending species-specific management, recreational access to summer and Gulf flounder will not be possible when the southern flounder season is closed.

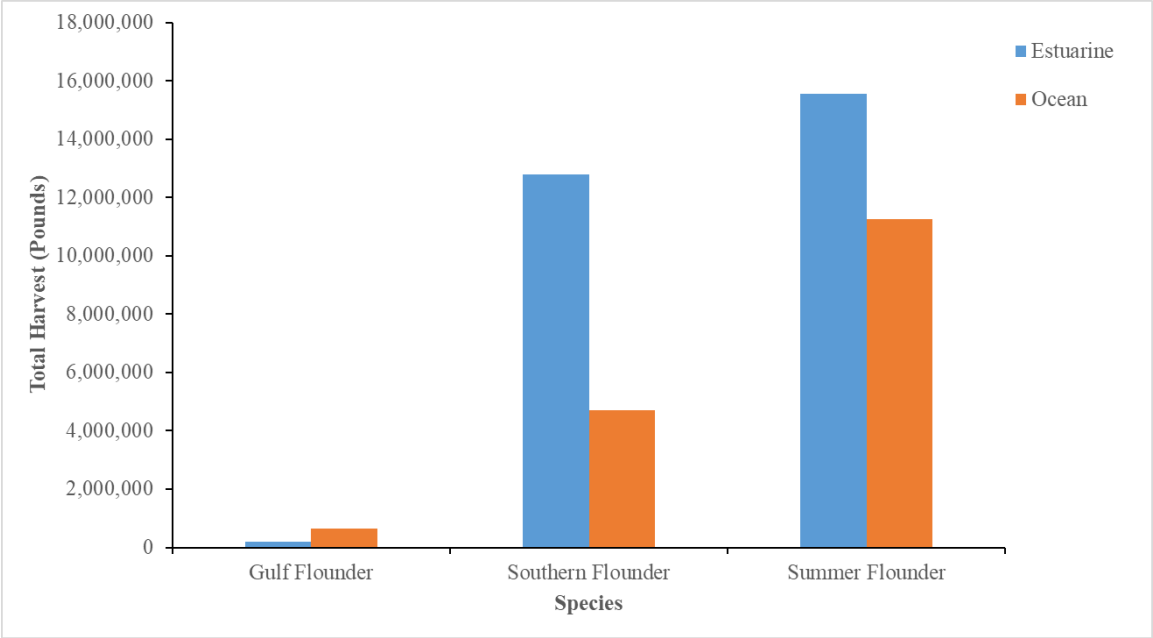


Figure 4.2.1. Pounds of harvest by flounder species from the ocean and estuarine waters, 1981–2019.

This issue paper examines the application of single-species management within a seasonal framework. The deconstruction of flounder species into discrete management units will provide an opportunity for stakeholders to have continued access to summer and Gulf flounder while simultaneously maintaining the required reduction for southern flounder as defined in Amendment 2.

Educational outreach is key to this issue as species identification lays the groundwork for successful implementation and long-term viability of managing flounder by species or aggregations. The division has developed a Flounder Identification Guide that is available through the "Hot Topics" page of the NCDEQ website. This guide describes the main characteristics (presence of ocellated or non-ocellated spots, gill rakers, and fin ray counts) to identify the three main flounder species in North Carolina waters and serves as a reference to educate anglers.

The absence of ocellated spots in southern flounder relative to Gulf and summer flounder is a defining characteristic that can used as the primary metric to differentiate among flounder species. Because the primary characteristic for identification (i.e., ocellated spots) is shared between summer and Gulf flounder, it may be possible to aggregate summer and Gulf flounder into a single ocellated flounder category.

In North Carolina, the management of flounder species has undergone several regulatory iterations to promote the sustainability of the stock. The first implementation of a minimum size limit occurred in 1979 at 11 inches TL for both estuarine and ocean waters. In 2005, the first bag limit was implemented for estuarine waters at eight fish. Subsequent minimum size limits have been implemented through the original North Carolina Southern Flounder FMP (NCDMF 2005), Amendment 1 (NCDMF 2013), Supplement A to Amendment 1 (NCDMF 2017), and revisions to the joint Atlantic States Marine Fisheries Commission (ASMFC) and Mid-Atlantic Fishery Management Council Summer Flounder, Scup, and Black Sea Bass FMP (ASMFC 2017; MAFMC 2019). Despite changes in regulations through time, the overall trend for southern flounder harvest has declined. This decline was underscored by the coast-wide stock assessment. As such, the acceptance of Amendment 2 to the Southern Flounder FMP mandated a 72% reduction in pounds beginning in 2020 to promote the recovery of the stock within 10 years. This reduction could best be accomplished through a 45-day southern flounder recreational season spanning Aug. 16 through Sept. 30 as discussed in the *Achieving Sustainable Harvest* issue paper.

AUTHORITY

North Carolina General Statutes

G.S. 113-134 RULES
G.S. 113-182 REGULATION OF FISHING AND FISHERIES
G.S. 113-182.1 FISHERY MANAGEMENT PLANS
G.S. 113-221.1 PROCLAMATIONS; EMERGENCY REVIEW
G.S. 143B-289.52 MARINE FISHERIES COMMISSION – POWERS AND DUTIES

North Carolina Marine Fisheries Commission Rules

15A NCAC 03H .0103 PROCLAMATIONS, GENERAL
15A NCAC 03I .0120 POSSESSION OR TRANSPORTATION LIMITS THROUGH STATE WATERS; SALE OF NATIVE SPECIES
15A NCAC 03M .0503 FLOUNDER
15A NCAC 03M .0512 COMPLIANCE WITH FISHERY MANAGEMENT PLANS

DISCUSSION

MRIP data from 2008 through 2017 were analyzed to determine seasons that would allow harvest of ocellated flounder and not jeopardize rebuilding of the southern flounder stock. Seasons for additional access to ocellated flounder have been identified, in addition to the Aug. 16 to Sept. 30 season for southern flounder. Seasons identified will be selected so as not to exceed the total allowable landings for the recreational fishery for southern flounder while minimizing the potential of additional discards to not exceed the total removals. See the *Achieving Sustainable Harvest* issue paper for further explanation.

Importantly, increases in minimum size limits for flounder species have caused an inversion of harvest between summer and southern flounder, such that the latter has accounted for most flounder harvest since 2001 (Figure 14 in the *Description of the Fisheries* section). The ASMFC has implemented state and/or regional level conservation equivalencies for the management of summer flounder since 2001 (ASMFC 2017). The 2017 summer flounder landings were 33.2% lower than the 10-year average and 57.7% lower than the 20-year average. The ASMFC must be notified of any changes to the summer flounder fishery in North Carolina state waters; however,

approval of changes by the ASMFC is not required if the changes are expected to be more restrictive than the management measures already approved by the ASMFC. Changes to the summer flounder fishery in EEZ waters off North Carolina may be impacted by the Mid-Atlantic Fishery Management Council and National Marine Fisheries Service (NMFS). Until conservation equivalencies are approved by NMFS, coast-wide measures for summer flounder in the EEZ include a four-fish possession limit, a 19-inch TL minimum size limit, and an open season of May 15–Sept. 15 (MAFMC 2019). These measures serve as a default each year until annual conservation equivalencies are approved by the NMFS, which allow state regulations to be applied to EEZ waters. The impacts to the proposed ocellated flounder fishery in the early season are that these conservation equivalencies are not usually approved until May or June, which is after this proposed season. The timing of NMFS approving conservation equivalency management measures in EEZ waters would potentially limit the ocellated flounder season to state territorial waters only. These federal regulations impact the North Carolina fishery differently as state management of flounder is collective and not by individual species.

Discussed below is the option that meets the required reductions for southern flounder and increases access to the summer and Gulf flounder fisheries. Some seasons are more conservative than others, which may be more prudent to select until factors such as correct species identification and increased discards can be evaluated as they relate to the recovery of southern flounder. Any southern flounder harvest during the additional season will need to be accounted for in the recreational fishery quota so the required reductions are not compromised. In addition, flounder harvest will only be allowed in the ocean when the southern flounder season is closed and only with hook-and-line; no gigging will be allowed as anglers cannot correctly identify species prior to harvest. All explored seasons presented assume that all anglers correctly identify all southern flounder and release them.

As stated above, flounder fishing will be limited to the ocean during the ocellated season and is allowed by the transportation limits rule, 15A NCAC 03I .0120. This rule allows summer and Gulf flounder to be transported during the open ocellated season through closed waters, provided anglers do not stop and fish in estuarine waters with flounder on board.

The division recommendation in the achieving sustainable harvest issue paper is that southern flounder harvest be constrained to the season selected in Amendment 2; this is a 45-day season spanning Aug. 16 through Sept. 30 with a one-fish bag limit. The most conservative alternative option (besides status quo) is allowing stakeholders access to ocellated stocks from March 1 through April 15 from ocean waters only with a one-fish bag limit and also a one-fish bag limit during the southern flounder season. This satisfies the target southern flounder reduction while allowing an estimated harvest of an additional 1,025 pounds of ocellated flounder (Table 4.2.1). Though the additional estimated harvest of ocellated flounder during this time is low, this does not account for potential changes in angler behavior wherein additional ocellated landings may occur within this short season. The March 1 through April 15 season also minimizes potential southern flounder harvest compared to other potential seasons. This additional season has the potential to increase the harvest of southern flounder by an estimated 1,267 pounds or approximately 1.0% of the annual harvest allocation.

Table 4.2.1. Estimated ocean ocellated flounder landings and anticipated southern flounder landings under various options for the hook-and-line fishery.

Ocean Only				Ocean and Estuarine				
Ocellated Flounder Season	Bag Limit Ocellated Season	Estimated Ocellated Flounder Landings	Southern Flounder Landings Early Season	Southern Flounder Season	Bag Limit Southern Flounder Season	Southern Flounder Landings Late Season	Total Southern Flounder Landing	Total Allowable Southern Flounder Landings
None	0	0	0	Aug 16 – Sep 30	1	118,128	118,128	142,206
Mar 1– Apr 15	1	1,025	1,267	Aug 16 – Sep 30	1	118,128	119,395	142,206
Apr 1– June 30	1	23,116	50,159	Aug 16 – Sep 30	1	118,128	168,287	142,206
Apr 1– Sep 30	1	56,009	143,330	Aug 16 – Sep 30	1	74,860	218,190	142,206

Note: Recreational gig fishery would not be allowed to operate during the ocellated season.

Note: None of the southern flounder seasons would allow harvest of more than one southern flounder in the aggregate.

Importantly, as the southern flounder stock recovers there will be increased access to the resource. Analysis of MRIP data during the development of Amendment 2 reveals that recreational anglers rarely achieved the four-fish bag limit and catch rates are typically one fish. From approximately 17,000 in-person angler intercepts conducted in 2017 only one angler achieved the four-fish bag limit and only 2% of trips harvested more than one fish. To buffer against increased harvest compromising targeted reductions it will be beneficial to constrain the bag limit to one fish in any flounder season. For additional discussion on bag limits and angler success see the *Achieving Sustainable Harvest* issue paper.

Additional analysis of ocellated flounder seasons provide examples of the potential for excessive southern flounder harvest during additional seasons relative to a year-round ocellated season. These included a three-month ocellated season from April 1 through June 30 and a six-month ocellated season from April 1 through Sept 30, with a one-fish bag limit with harvest allowed in ocean waters. These truncated seasons provide a means to further reduce incidental harvest of non-ocellated (southern) flounder while allowing an estimated 23,116 and 56,009 pounds of ocellated harvest respectively (Table 4.2.1). Conversely, the potential southern flounder harvest during these truncated seasons will negatively impact management actions necessary to constrain harvest below the TAL. These longer (three- and six-month) ocellated seasons are expected to have impacts on the southern flounder fishery by 50,159–68,470 additional pounds of southern flounder harvest if anglers misidentify southern flounder (Table 4.2.1; Figure 4.2.2). These estimates are the least conservative but provide contrast to show the potential problems when attempting to allow additional ocellated harvest. The potential magnitude of southern flounder harvest precludes these additional seasons from being developed as options.

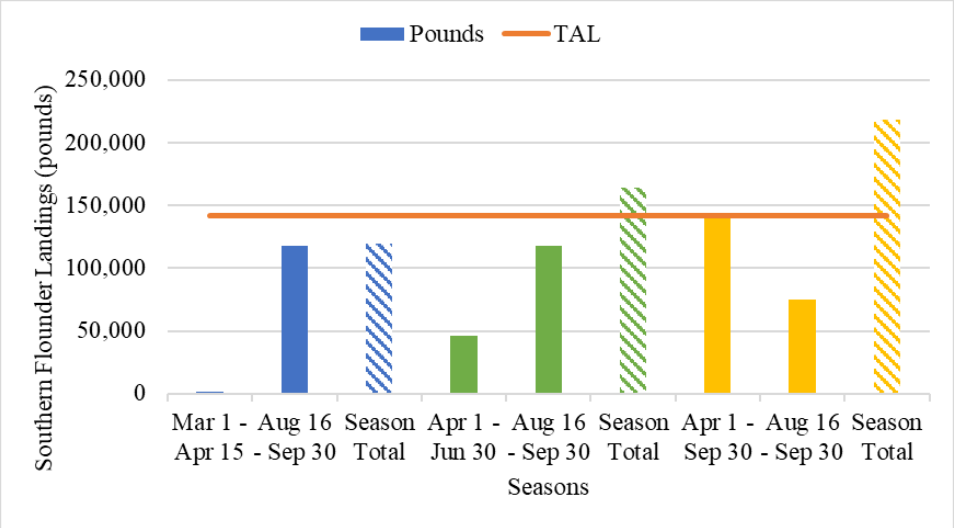


Figure 4.2.2. Southern flounder landings (in pounds) for seasons in reference to total allowable landings (TAL). All scenarios are based on a one-fish bag limit.

The most important caveat of single-species management is the evaluation of the recreational angler's ability to distinguish among North Carolina's constituent flounder species. The CAP is currently developing a mobile phone application to empirically investigate the recreational angler's ability to correctly identify flounder. The results of this investigation will be necessary before any implementation of single-species management. Analysis of potential ocellated flounder seasons assumed that accurate species identification does not occur to show the worst-case scenario projected. If anglers adapt and learn identification of flounder species, impacts presented will be lower and subsequently the southern flounder season during the fall may not be as impacted.

Allowing increased access to the recreational fishery through species-specific management by allowing the division to implement seasons through the adaptive management framework would be the most risk averse approach while still allowing harvest of other flounder species. It allows access to summer and Gulf flounder during a trial six-week season during March 1 through April 15 for the hook-and-line fishery in ocean waters only. Using gigs to harvest flounder may not be allowed during the ocellated flounder season as identifying flounder to the species level prior to harvest is necessary.

Anticipated harvest of southern flounder during the ocellated season will be accounted for through MRIP sampling. Though southern flounder are not allowed to be harvested during this time, if angler identification is not accurate, landings of southern flounder have the potential to be higher than currently estimated. If the preliminary estimates of southern flounder harvest are higher in the early season than anticipated, the fall fishery will be shortened. The total volume of southern flounder harvest from both seasons will comprise the estimates of harvest to compare to the annual quota. Any overages will be deducted from the subsequent year's quota and the seasons will be adjusted as necessary. This change in seasons to account for southern flounder harvest is necessary to maintain required reductions in the recreational southern flounder fishery.

Allowing harvest of summer and Gulf flounder when the southern flounder season is closed increases the possibility that southern flounder will be harvested to a greater extent than allowed under the sustainable harvest requirements. The potential for increased harvest may negate reductions achieved through the southern flounder season and limit rebuilding of the stock. Development of adaptive management measures to manage increased access to summer and Gulf flounder can be found in the *Adaptive Management* issue paper.

PROPOSED MANAGEMENT OPTIONS

(+ potential positive impact of action)
(- potential negative impact of action)

Option 1: **Status quo, do not allow species-specific management to increase access to the recreational fishery**

+ Maintains stringent management measure to ensure best chance of rebuilding
- Does not allow for access to more abundant summer and Gulf flounder stocks

Option 2: **One-fish ocellated bag limit from March 1 through April 15 in ocean waters only and one-fish bag limit consisting of any species of flounder during the southern flounder season**

+ Allows for harvest of summer and Gulf flounder outside of identified southern flounder season
+ Complements recommended sustainable harvest bag limit
+ Minimizes potential impacts of misidentification by limiting seasons
+ Harvest of all southern flounder accounted for to meet required reductions
+/- Ocean harvest only during early season
- Increased chance of southern flounder harvest due to species misidentification concerns
- Unequal access among recreational fishing gears during the early season
- Potential impacts to fall season due to excess southern flounder harvest in the early season

RECOMMENDATION

See Appendix 5 for a summary of all comments and recommendations gathered from NCDMF, the NCMFC advisory committees, and public for the Southern Flounder FMP Amendment 3.

NCMFC Selected Management Strategy

Option 2: One-fish ocellated bag limit during March 1 through April 15 in ocean waters only using hook-and-ling gear and one-fish bag limit consisting of any species of flounder during the southern flounder season.

LITERATURE CITED

ASMFC (Atlantic States Marine Fisheries Commission). 2017. Addendum XXVIII to the summer flounder, scup, and black sea bass fishery management plan: summer flounder recreational management in 2017. Arlington, VA. 13 p.

ASMFC. 2018. Draft Addendum XXXI to the summer flounder, scup, and black sea bass fishery management plan for public comment. Arlington, VA. 36 p.

MAFMC (Mid-Atlantic Fisheries Management Council). 2019. Framework adjustment 14 to the summer flounder, scup, and black sea bass fishery management plan. Dover, DE. 161 p.

NCDMF (North Carolina Division of Marine Fisheries). 2005. North Carolina southern flounder (*Paralichthys lethostigma*) fishery management plan. North Carolina Division of Marine Fisheries, Morehead City, NC. 260 p.

NCDMF. 2013. North Carolina southern flounder (*Paralichthys lethostigma*) fishery management plan: Amendment 1. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 380 p.

NCDMF. 2017. North Carolina southern flounder (*Paralichthys lethostigma*) fishery management plan: Supplement A to Amendment 1. North Carolina Division of Marine Fisheries, Morehead City, NC. 83 p.

NCDMF. 2019. North Carolina southern flounder (*Paralichthys lethostigma*) fishery management plan: Amendment 2. North Carolina Department of Environmental Quality, Division of Marine Fisheries, Morehead City, NC. 62 p.

APPENDIX 4.3. INLET CORRIDORS AS A MANAGEMENT TOOL TO INCREASE SOUTHERN FLOUNDER ESCAPEMENT

ISSUE

Consider the development of inlet corridors to provide additional protection to mature female southern flounder during their escapement or migration out of coastal inlets to oceanic spawning areas.

ORIGINATION

The feasibility of establishing inlet corridors as a management tool is being explored based on comments by the Southern Flounder Advisory Committee at their October 2019 meeting and comments provided during the public scoping period.

BACKGROUND

Southern flounder is an estuarine-dependent species, spending most of their early life history as juveniles and sub-adults in the estuary before exiting the estuary at maturity and migrating to the ocean to spawn offshore (see the *Description of the Stock* section). It is during these fall estuarine migrations southern flounder are most vulnerable to capture. Inlets, such as those common to North Carolina's estuaries, create a natural bottleneck that southern flounder must navigate to escape the final area of internal fishing pressure before entering the ocean to migrate offshore. The implementation of inlet corridors has been suggested as a possible management tool that, in theory, could alleviate fishing mortality on migrating southern flounder during this presumed period of increased vulnerability. This issue paper will explore available data and possible strategies regarding the use of inlet corridors for southern flounder management. The questions to be explored are as follows:

1) Do data exist that provide insight into which coastal inlets (i.e., corridors) are critical to southern flounder spawning migrations? Is there an inlet-specific seasonality to the migrations through these inlets to the ocean?
2) Do data indicate inlets are truly acting as a bottleneck where elevated fishing mortality is occurring due to increased vulnerability to capture?
3) What are the potential gear interactions that may occur in coastal inlets and what potential restrictions should be considered for these gears? What will be the impact to other fisheries (species) that are pursued by these same gears?
4) Can any savings from inlet corridors be quantified or do the data indicate this will be a non-quantifiable precautionary measure?

AUTHORITY

North Carolina General Statutes

G.S. 113-134 RULES
G.S. 113-182 REGULATION OF FISHING AND FISHERIES
G.S. 113-182.1 FISHERY MANAGEMENT PLANS
G.S. 143B-289.52 MARINE FISHERIES COMMISSION – POWERS AND DUTIES

DISCUSSION

1) Do data exist that provide insight into which coastal inlets (i.e., corridors) are critical to southern flounder spawning migrations? Is there an inlet-specific seasonality to the migrations through these inlets to the ocean?

Removals due to harvest and discards of southern flounder, regardless of sector, are comprised primarily of juvenile southern flounder residing in the estuary (Flowers et al. 2019a). Southern flounder tend to remain within the estuaries until the onset of maturity. As fish of both sexes begin to mature (approximately age-2), they undergo a fall migration. Eventually, mature southern flounder will traverse through one of several coastal inlets into oceanic waters where spawning occurs.

Current understanding of southern flounder movements and maturity is based on multiple studies that include tagging, otolith microchemistry, and maturity data along with commercial and recreational catch information. Movement of juveniles within the estuary has been shown to be limited and often somewhat localized (Scharf et al. 2015). Data indicate southern flounder overwinter as juveniles in the estuary (Monaghan 1996; Taylor et al. 2008; Craig et al. 2015). Southern flounder tend to reside in the estuary until age 2 or the onset of maturity (Rulifson et al. 2009), at which point migration offshore occurs from September through November of primarily age-2 and older fish (Monaghan and Watterson 2001; Loeffler 2018). Movement begins in a southerly direction within the Albemarle and Pamlico sound estuarine systems, with fish eventually exiting the estuaries through coastal inlets (Craig et al. 2015). After fish migrate into the ocean, fish tend to continue moving in a southerly direction. Fish leaving North Carolina estuaries in the fall have been recaptured in all states south of North Carolina [i.e., South Carolina, Georgia, and Florida; Monaghan 1992; NCDMF, unpublished data]. Craig et al. (2015) found all southern flounder recaptures that made large scale movements in the fall (>50 km) were recaptured in systems south of the original tagging location.

The timing of emigration through inlet corridors has been explored using acoustic telemetry methods (Scharf et al. 2015; Scheffel et al. 2020). These studies used acoustic tags to investigate seasonal movement patterns and determine the rate and seasonality of movements from the estuary to the ocean (emigration) in New River, North Carolina. In this system, southern flounder emigration peaked between October and November (Figure 4.3.1) and emigration patterns were similar across years (Scheffel et al. 2020). This period also corresponds to the seasonal peak in statewide landings seen in the commercial fishery each year with increased movement and landings occurring in the upper estuary during September and transitioning to the lower estuary into October and November. Existing data from conventional tagging and commercial landings indicate this general window of time (October through November) is likely the primary period of emigration for southern flounder, not just in New River, but throughout coastal North Carolina.

Current data do not allow any determination of which inlet(s) are most critical or most commonly used for southern flounder emigration. Tagging data do indicate, however, that Oregon Inlet is less frequently used than the numerous inlets to the south (NCDMF, unpublished data). As a result, inlets from Cape Hatteras southward are likely to be most critical for emigration by southern flounder, which is supported by available tagging data and the aforementioned studies. The timing of emigration is likely more defined and quantified than the specific inlets being used.

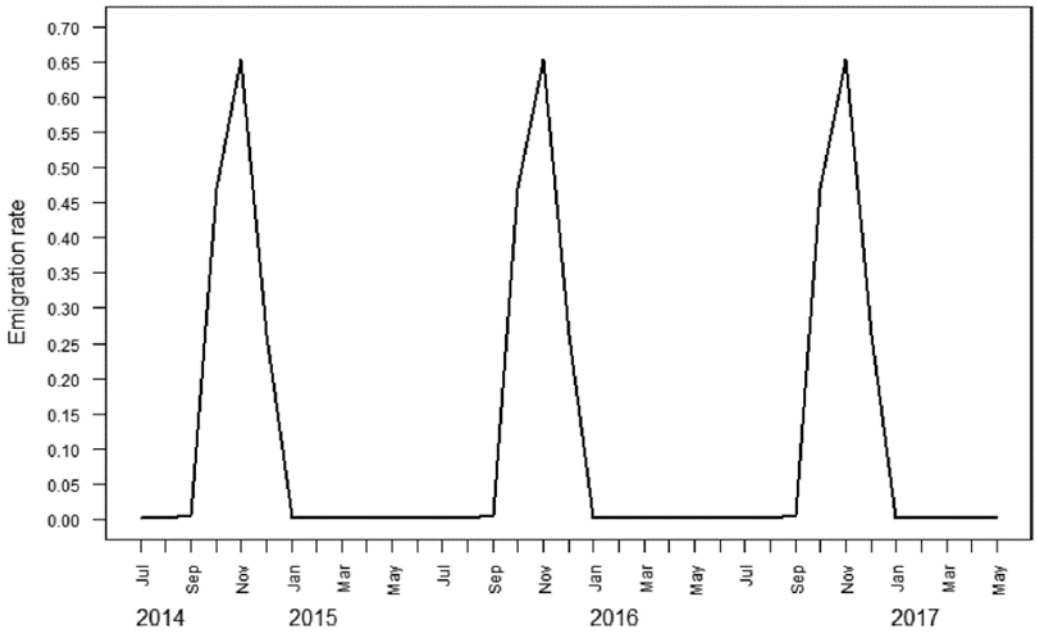


Figure 4.3.1. Estimates of instantaneous Emigration (E) for the New River estuary produced by a telemetry model. Annual E assumed to be equal across years. (Source: Scheffel et al. 2020)

2) Do data indicate inlets are truly acting as a bottleneck where elevated fishing mortality is occurring due to increased vulnerability to capture?

It is unknown if, and to what extent, southern flounder exploitation may be increased based on their emigration in the fall through coastal inlets. Harvest data specific to these locations would provide a good indicator to gauge whether coastal inlets serve as a bottleneck allowing for elevated exploitation. Unfortunately, landings data for neither commercial nor recreational sectors can be pared down to include only harvest or releases from inlets. Activities in and around coastal inlets include a variety of means used to capture southern flounder. Recreational fishing for flounder species is very popular in coastal inlets. It occurs over many months, particularly from summer through early fall; however, flounder harvested include not just southern flounder, but also summer and Gulf flounder. Gigging, by both the recreational and commercial sectors, occurs in and around coastal inlets with fish targeted from summer through fall. While these more active and mobile gears effectively capture flounder in coastal inlets, the high energy habitat in many coastal inlets can be a limiting factor to the use of passive gears such as gill nets and pound nets. That is not to say these gears are not used near coastal inlets, but the available areas suitable for fishing these gears in these high energy areas is limited.

Tagging data specific to coastal inlets may offer another indicator to gauge whether coastal inlets are areas of increased exploitation for southern flounder. During a telemetry study conducted by Scharf et al. (2015) in New River, the inlet corridors were monitored for any acoustically tagged southern flounder emigrating from the estuarine system. In the study, it was noted that southern flounder exhibited two distinct behaviors. One behavior was described as resident behavior where southern flounder were more sedentary with only limited movement within the estuary. This behavior occurred over a protracted time period. The second was a more sudden behavior where there was a brief but more extensive movement representing the onset of the spawning migration in the fall. This shift in behavior resulted in southern flounder leaving the system within a matter of days (Figure 4.3.2). This increased movement meant less time was spent by fish in the inlet corridor. Peak movement occurred between Oct. 19 and Nov. 16, when 85% of the emigrations occurred. Tagged fish harvested in this study occurred primarily within the estuary and movement through the inlet occurred over just a short time period.

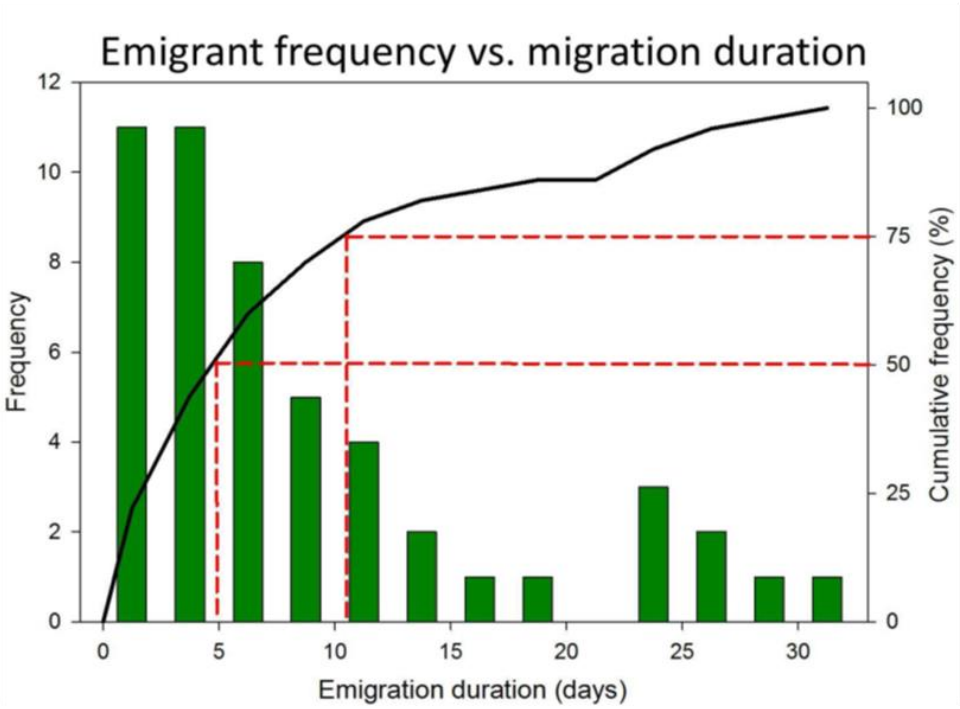


Figure 4.3.2. The number of days from the initiation of migratory behavior until southern flounder emigrated out of the New River estuary. The cumulative frequency distribution (solid black line) indicated that 50% of emigrants left the system within five days after initiation of migration behavior (bottom dashed red line), while 75% of emigrants exited within about 10 days of first showing emigration behavior (top dashed red line). (Source: Scharf et al. 2015)

A broader look at statewide tagging data provides more insight into whether coastal inlets act as a bottleneck leading to increased harvest of southern flounder. Data were examined for external tags applied to southern flounder by the NCDMF from 2014 through 2019 (NCDMF, unpublished data). These flounder were tagged over a wide range of areas and across all months (Figure 4.3.3). Movements of southern flounder documented in this study are consistent with those described by Scharf et al. (2015). During this period, 299 recaptures have occurred for southern flounder where time at large has been at least 10 days (Figure 4.3.4). Of these recaptures, 270 (90%) were

recaptured within the estuary, 25 (8%) were captured in the inlet corridor, and four (<2%) were captured from the ocean. Inlet recaptures occurred from multiple gears and across sectors, with most taken by hook-and-line (n=10) followed by both recreational giggers (n=6) and commercial giggers (n=6). Inlet corridors were defined by placing two-mile perimeters around larger inlets (Oregon Inlet, Hatteras Inlet, Ocracoke Inlet and Barden Inlet) and one-mile or half mile perimeters around smaller southern inlets (Figure 4.3.4).

Available tagging data indicate coastal inlets do not appear to be acting as a bottleneck serving as an area of increased exploitation of southern flounder. The primary source of fishing mortality on this species is occurring within the estuarine system.

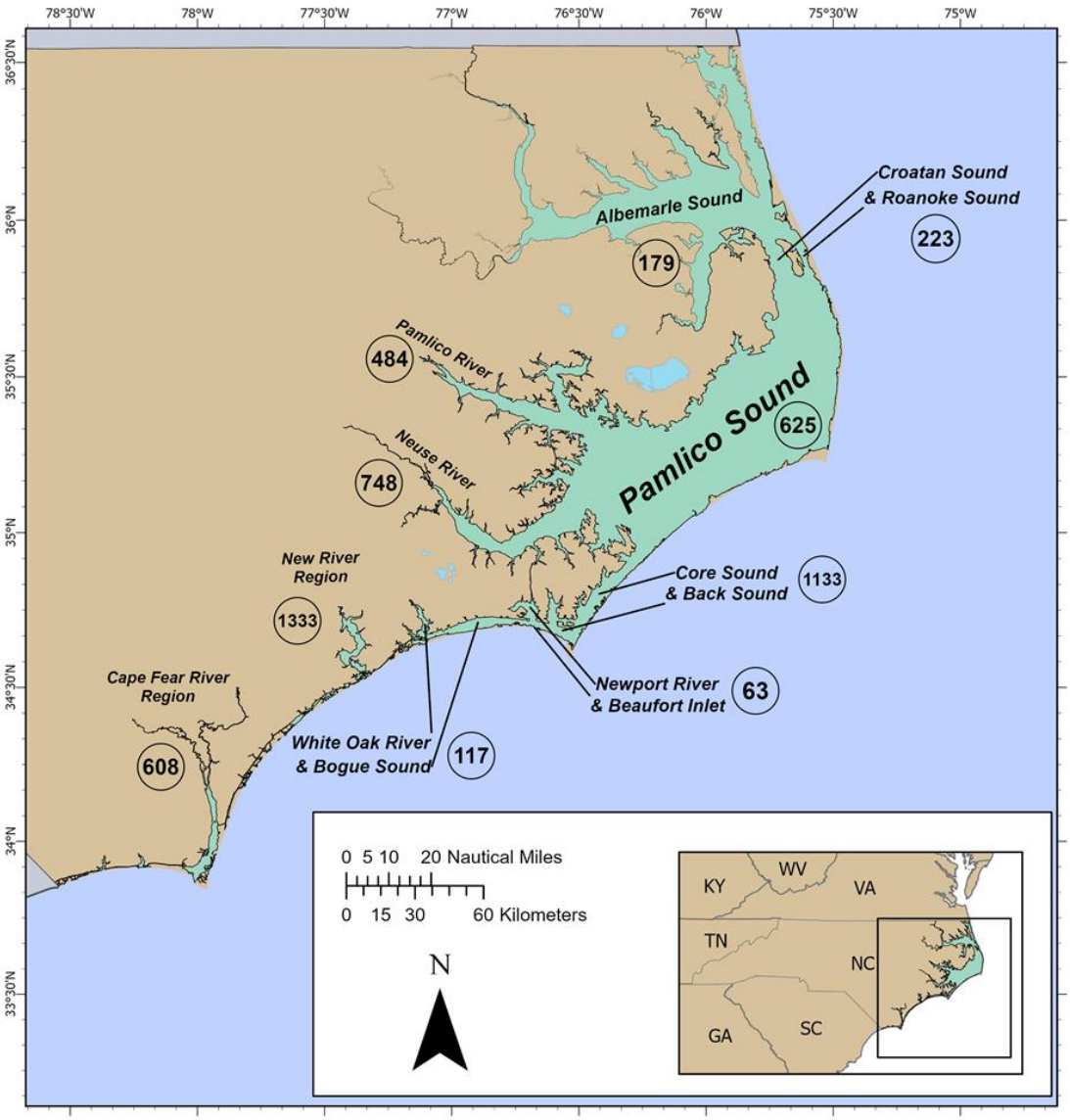


Figure 4.3.3. Tagging locations and number of southern flounder tagged (in circles by waterbody) in North Carolina estuarine waters from 2014 through 2019.

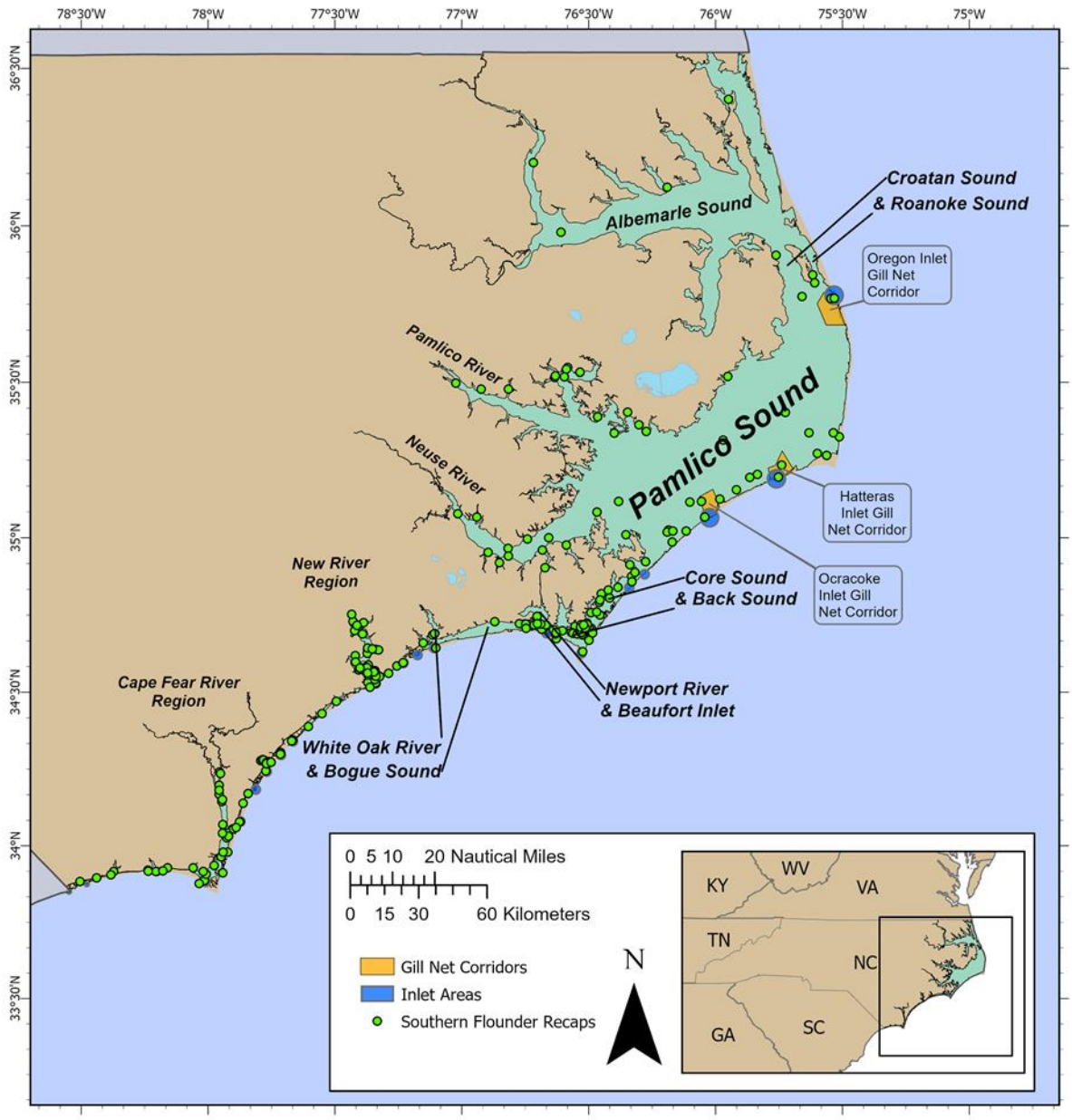


Figure 4.3.4. Recapture locations of southern flounder tagged in North Carolina estuarine waters from 2014 to 2019.

3) What are the potential gear interactions that may occur in coastal inlets and what potential restrictions should be considered for these gears? What will be the impact to other fisheries (species) that are pursued by these same gears?

The southern flounder stock is subject to fishing mortality from the recreational and commercial sectors for much of the year and across a wide range of habitats from the upper estuaries to the inlets and oceans. Recreational harvest typically peaks in the summer months, while commercial

harvest peaks in the fall. A likely reason for this contrast is that recreational anglers are mobile and typically fish their gear in an active fashion that is not dependent on fish movement to capture fish. The commercial sector, however, relies primarily on passive gear (gill nets and pound nets). These passive gears by nature require southern flounder (or any fish species) to move in order to be captured. For this reason, the fall commercial fishery is directly linked to, and largely dependent on, the fall migration of southern flounder. It is during this fall migration period of September through November that harvest peaks for these gears (NCDMF Trip Ticket Program). Scharf et al. (2015) observed some evidence for southern flounder movements and the rate of emigration coinciding with the passage of cold fronts in the fall. This is consistent with observed increases in catches reported by pound netters in other parts of the state after these types of fall weather events.

Recreational hook-and-line trips occurring in coastal inlets capture a diverse set of species. Anglers fishing with gear typically used to capture southern flounder will commonly encounter other species, and southern flounder will also be encountered when targeting other species. Summer flounder, Gulf flounder, red drum, spotted seatrout, bluefish, and many other species are captured using similar tactics in coastal inlets. Closing inlet corridors to recreational fishing would be far reaching in its impact to these fisheries.

Gigging around coastal inlets is a commercial and recreational endeavor. Unlike hook-and-line fishing, gigging can be more selective as many fish species are typically identified before they are gigged while some are not. For example, southern flounder, there is the added issue of their similarity in appearance to summer and Gulf flounder, which occur in these same areas. For this reason, it is not likely that gigging for flounder species would be feasible in inlet corridors if the intention of the regulation was to protect southern flounder.

Stationary gears such as flounder pound nets and gill nets have traditionally been fished in areas adjacent to but not within inlets. All current flounder pound net sets are located from Core Sound and north to the Albemarle and Currituck sounds. As previously mentioned, flounder pound nets are somewhat limited in the immediate vicinity of coastal inlets. Flounder pound nets do, however, occur with regularity in areas adjacent to inlets as shallower habitat and lower energy conditions allow. These locations are productive fishing areas for southern flounder during the fall migration. Similarly, gill nets have traditionally been fished around coastal inlets, although much of the habitat in the high energy portion of the inlet is not conducive to setting anchored gill nets. It should be noted corridors already exist that limit large-mesh gill nets, crab pots, and trawling in the vicinity of inlets. The large-mesh gill-net closures exist in some inlet corridors because of restrictions maintained through the ITP under Section 10(a)(1)(B) of the ESA of 1973 (Public Law 93-205) to “minimize, monitor, and mitigate” sea turtle interactions in the commercial anchored gill-net fisheries. Inlet corridors to protect sea turtle ingress and egress through coastal inlets exist for Oregon Inlet, Hatteras Inlet, and Ocracoke Inlet (Figure 4.3.4). These inlet closures are in effect from Sept. 1 through Dec. 31, which is inclusive of the period of the spawning migration for southern flounder. Additionally, the area around Barden Inlet has also been closed to large mesh anchored gill nets during the last two years (2018 and 2019). This closure was due to excessive interactions with green sea turtles (*Chelonia mydas*) in 2017, but it is not explicitly required by the ITP.

4) How will any savings from inlet corridors be quantified or do the data indicate this will be a non-quantifiable precautionary measure?

Implementing inlet corridors for southern flounder cannot be quantified in terms of reductions in catch or harvest. No data sources exist to estimate what proportion of the catch comes from these specific areas. Based on available results from tagging studies, it does not appear that inlets serve as areas of increased exploitation (NCDMF, unpublished data). Telemetry studies indicate southern flounder may limit their travel time in inlets, specifically during their fall migration period (Scharf et al. 2015). Recapture data from traditional tags support this finding and show that most of the catch and exploitation on this species is occurring within the estuary and not in the inlet or ocean (NCDMF, unpublished data). Based on these findings, it is unlikely that inlet corridors would limit exploitation rates without more quantifiable and effective management measures across the fisheries.

While inlet corridors do not offer a viable management alternative that provides a quantifiable measure to rebuild southern flounder stocks, inlet corridors do provide an important transition habitat for this species, linking the estuarine nursery habitat with the offshore spawning habitat. For further information on habitat use and the importance of habitat by life stage for this species see the *Description of the Stock* and the *Ecosystem and Fishery Impacts* sections. Additionally, a comprehensive review of habitats important to southern flounder is further described in the CHPP (NCDEQ 2016).

In summary, inlet corridors, while providing an essential function in the life history of southern flounder, present specific challenges when considered as a management tool to reduce harvest. Specific inlets critical to southern flounder migration are not fully understood and additional research is currently underway to investigate southern flounder migration patterns and spawning locations. With respect to impacts on other fisheries, inlet corridor closures by season, area, or gear would have negative impacts on commercial and recreational fisheries for other species captured in these locations. Any potential harvest reductions resulting from inlet corridors would be unquantifiable. Further, available data do not suggest inlets currently serve as a bottleneck resulting in increased harvest. In terms of the overfished status, the most prudent approach would be to remove the incentive to overharvest southern flounder through more quantifiable measures such as quota management or seasonal closures. Seasonal closures could effectively act in the same manner as inlet corridors if the closed seasons correspond to periods of emigration related to spawning. Likewise, quota management would set harvest levels to end overfishing and rebuild depleted stocks. Finally, evaluation of inlet corridors may be best approached during the next revision of the CHPP. A thorough evaluation of inlet corridors for the protection of migrating or spawning species may be more applicable on a broad scale and not at the individual species level.

PROPOSED MANAGEMENT OPTIONS

(+ potential positive impact of action)
(- potential negative impact of action)

Option 1: Status quo, do not establish inlet corridors for southern flounder during spawning migrations.

+ No negative impact on current fishing practices (commercial and recreational)
+ Inlet corridors do not appear to result in increased fishing pressure for southern flounder
- Corridors would afford additional, albeit unquantifiable protection for stock
- Corridors would indirectly provide additional protection for other species

Option 2: Implement inlet corridors during the southern flounder spawning migration for North Carolina coastal inlets.

+ Additional protection for southern flounder
+ Additional indirect impact and protection of other species
- Unquantifiable, would not contribute toward needed harvest reductions
- Loss of harvest opportunities for other species in these areas due to removal of gears that interact with southern flounder
- May simply shift fishing pressure to areas adjacent to inlet corridors. Contribution in magnitude of southern flounder and exact timing of migration by inlet is unknown

2A. Implement inlet corridors affecting all gears in the selected areas
2B. Implement inlet corridors affecting only specific gears in the selected areas

RECOMMENDATION

See Appendix 5 for a summary of all comments and recommendations gathered from NCDMF, the NCMFC advisory committees, and public for the Southern Flounder FMP Amendment 3.

NCMFC Selected Management Strategy

Option 1: Status quo, do not establish inlet corridors for southern flounder during spawning migrations.

LITERATURE CITED

Craig, J. K., W. E. Smith, F. S. Scharf, and J. P. Monaghan. 2015. Estuarine residency and migration of southern flounder inferred from conventional tag returns at multiple spatial scales. Marine and Coastal Fisheries 7:450–463.

Flowers, A. M., S. D. Allen, A. L. Markwith, and L. M. Lee (editors). 2019. Stock assessment of southern flounder (*Paralichthys lethostigma*) in the South Atlantic, 1989–2017. Joint report of the North Carolina Division of Marine Fisheries, South Carolina Department of Natural Resources, Georgia Coastal Resources Division, Florida Fish and Wildlife Research Institute, University of North Carolina at Wilmington, and Louisiana State University. NCDMF SAP-SAR-2019-01. 213 p.

Loeffler, M. S. 2018. Fishery section 4: Flounder pound net fishery assessment (Job 4) *in*: assessment of North Carolina commercial finfisheries, 2013-2018. Final Performance Report Award Number NA13NMF4070191. North Carolina Department of Environmental Quality, Division of Marine Fisheries, Morehead City, NC. 23 p.

Monaghan, J. P. 1992. Tagging studies of southern flounder (*Paralichthys lethostigma*) and Gulf flounder (*Paralichthys albigutta*) in North Carolina. Completion Report F-29, Study 3B. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 25 p.

Monaghan, J. P. 1996. Life history aspects of selected marine recreational fishes in North Carolina: Study 2, migration of Paralichthid flounders tagged in North Carolina. Completion Report Grant F-43. North Carolina Division of Marine Fisheries, Morehead City, NC. 44 p.

Monaghan, J. P., and J. C. Watterson. 2001. Flounder pound net fishery assessment *in:* assessment of North Carolina finfisheries, 1997-2000. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Completion Report NA 76 FI 0286, 1-3, Morehead City, NC. 27 p.

NCDEQ (North Carolina Department of Environmental Quality). 2016. North Carolina Habitat Protection Plan: Source Document. Division of Marine Fisheries, Morehead City, NC. 475 p.

Rulifson, R. A., C. Van Salisbury, and M. R. Spidel. 2009. Critical habitat for southern flounder, *Paralichthys lethostigma*: do coastal watersheds play an important role in life history and growth? N.C. Sea Grant, Final Report FRG 08-EP-03, Morehead City, NC.

Scharf, F., J. W. White, L. Hollensead, and N. D. Messenger. 2015. An acoustic tagging study to evaluate migration dynamics and within-estuary habitat use of southern flounder (*Parlichthys lethostigma*) in North Carolina. Final Report. North Carolina Division of Marine Fisheries, Morehead City, NC. 44 p.

Scheffel, T. K., J. E. Hightower, J. A. Buckel, J. R. Krause, and F. S. Scharf. 2020. Coupling acoustic tracking with conventional tag returns to estimate mortality for a coastal flatfish with high rates of emigration. Canadian Journal of Fisheries and Aquatic Sciences 77(1):1–22.

Taylor, J. C., J. M. Miller, and D. Hilton. 2008. Inferring southern flounder migration from otolith microchemistry. Final Report FRG 05-FEG-06, Morehead City, NC.

APPENDIX 4.4. ADAPTIVE MANAGEMENT STRATEGY FOR THE NORTH CAROLINA SOUTHERN FLOUNDER FISHERY

ISSUE

Implement an adaptive management strategy for the North Carolina southern flounder fishery.

ORIGINATION

North Carolina Division of Marine Fisheries (NCDMF)

BACKGROUND

Adaptive management combines management and monitoring with the aim of updating knowledge and improving decision making over time. Adaptive management uses a learning process to improve management outcomes (Holling 1978). The challenge with using adaptive management is to find a balance between gaining knowledge to improve management and achieving the best outcome based on current knowledge (Allan and Stankey 2009). As more is learned about a fishery, adaptive management provides flexibility to incorporate new data and information to accommodate alternative and/or additional actions. In the context of North Carolina FMPs, adaptive management is an optional management framework that allows for specific management changes to be implemented between FMP reviews under specified conditions to accomplish the goal and objectives of the plan. A FMP that uses adaptive management as a tool needs to identify specifically:

- The circumstances under which adaptive management changes may be made (when);
- The types of measures that may be changed (what);
- The schedule for implementation of changes (effective date); and
- The procedural steps necessary to effect a change (how).

The more clearly defined "when," "what" and "how" for adaptive management, the fewer unintended consequences there will be and the more certainty there is for the regulated public and managers.

Amendment 3 to the Southern Flounder FMP establishes management strategies including an adaptive management strategy for the North Carolina southern flounder fishery based on the peer-reviewed and approved stock assessment for the South Atlantic southern flounder stock (Flowers et al. 2019). The stock assessment established biological reference points necessary for managing the southern flounder stock within sustainable harvest.

A reduction of 72% of total removals (in pounds of fish) is projected to end overfishing within two years to achieve sustainable harvest and rebuild the southern flounder spawning stock to the target within 10 years of the date of adoption of Amendment 2 with at least a 50% probability of success; this timeline does not restart with Amendment 3. This level of reduction is projected to bring spawning stock abundance to the target value of 12 million pounds of mature females.

Adoption of the adaptive management framework for Amendment 3 in conjunction with the other management strategies in the plan provides the best likelihood of success in achieving sustainable harvest in the southern flounder fishery while maximizing flexibility for fishermen in harvesting flounder. The Southern Flounder FMP Amendment 3 defines and documents the scope of management measures the Fisheries Director may implement within the bounds of Amendment 3. The record of specific actions is in the form of the issued flounder proclamations each year.

AUTHORITY

North Carolina General Statutes

G.S. 113-134. RULES.
G.S. 113-182. REGULATION OF FISHING AND FISHERIES.
G.S. 113-182.1. FISHERY MANAGEMENT PLANS.
G.S. 113-221.1. PROCLAMATIONS; EMERGENCY REVIEW.
G.S. 143B-289.52. MARINE FISHERIES COMMISSION – POWERS AND DUTIES.

North Carolina Marine Fisheries Commission Rules

15A NCAC 03H .0103 PROCLAMATIONS, GENERAL
15A NCAC 03M .0503 FLOUNDER
15A NCAC 03M .0512 COMPLIANCE WITH FISHERY MANAGEMENT PLANS

DISCUSSION

Adoption of management measures presented in the *Achieving Sustainable Harvest*, *Increased Recreational Access*, *Implementing a Slot Limit*, and *Phasing Out Large-Mesh Gill Net* issue papers will determine the adaptive management measures needed for Amendment 3. Adaptive management gives the Fisheries Director flexibility under specified conditions to manage the southern flounder fishery. Flexible management measures could include adjusting opening dates for gears and areas or sectors, implementing trip limits in the commercial sector for certain gears, or altering areas where the fishery can occur. This strategy allows changes to the framework of Amendment 3 and the specific management measures implemented each year may vary as the stock responds to selected measures. For example, if the recreational fishery sector exceeds its TAL for a given year, the Fisheries Director could cancel the early ocellated season or implement a complete closure for the recreational fishery. If a complete closure is not warranted, the Fisheries Director may choose to shorten the selected seasons or reduce the daily bag limit to reduce the chances of exceeding the TAL in subsequent years.

As long-term sustainable harvest strategies are implemented, participants in the commercial and recreational fisheries will likely adapt over time, potentially changing fishing behavior. As fisheries adapt to the new harvest levels, it will be crucial to provide flexibility to the Fisheries Director to close the seasons based on specified conditions, like the potential to exceed the TAL. This is within proclamation authority to adjust certain management measures for success in achieving sustainable harvest. Thorough discussion of each of the management actions presented below can be found in the *Achieving Sustainable Harvest*, *Increased Recreational Access*, *Implementing a Slot Limit*, and *Phasing out Large-Mesh Gill Net* issue papers.

Amendment 3 proposes modifying the commercial seasons to maintain a quota with allocations based on gear and area; modifying the recreational season with quota allocations to the hook-and-line and gig fisheries; implementing and altering recreational bag limits; and implementing commercial trip limits and recreational vessel limits. Upon adoption of Amendment 3, management strategies approved in Amendment 3, including adaptive management, will be implemented through use of proclamation authority allowing the Fisheries Director to:

- Determine opening dates for commercial seasons based on measures selected through the *Achieving Sustainable Harvest* issue paper.
- Close the commercial fishery based on quota monitoring data to maintain harvest levels at or below the TAL, including closure when a majority of harvest has occurred (typically about 80% of the quota allocation, but it can be less or more).
- Develop and implement commercial trip limits to maximize the harvest and minimize the risk of exceeding the quota during the open season.
- Select recreational season dates for the hook-and-line and gig fisheries.
- Implement and alter bag limits for the recreational fishery.
- Implement and alter vessel limits for the recreational fishery.
- Change the recreational southern flounder season based on harvest of southern flounder that occurs during the ocellated season.
- Cancel the early recreational ocellated season if it is necessary to prevent exceeding the TAL for the recreational southern flounder fishery.
- Apply accountability measures for both the commercial and recreational fisheries.

To inform the decision to exercise and implement this authority, the Fisheries Director would use available information including information on gear and area combinations and quota available for harvest for each management area as described in the *Achieving Sustainable Harvest* issue paper. The Fisheries Director would use the results from quota monitoring to determine when closures of the commercial fishery would occur. If the Fisheries Director decides there is sufficient quota remaining, the Fisheries Director may approve additional harvest periods using trip limits to constrain the harvest.

Selection of recreational season dates would be informed by the volume of quota allocation available for a year after any quota overages the prior year have been taken into account. The selected seasons must conform to the required reductions outlined in the *Achieving Sustainable Harvest* issue paper. The recreational seasons selected may be impacted if a separate non-southern flounder season is adopted as part of Amendment 3. Additional information on the potential impacts described below can be found in the *Increased Recreational Access* issue paper.

Quota overages in a year will need to be deducted from commercial or recreational allocations for subsequent years. Any overage adjustments would be completed prior to the identification of season dates for the subsequent year.

Development of trips limits could be based on annual or interannual harvest levels and the amount of quota allocation remaining for a specific gear/area combination. Trip limits can also vary among gear/area combinations due to the number of participants in the fishery or available landings. Trip

limits would need to be identified on an annual basis and would only be implemented if sufficient quota remains to be caught and if continued harvest, with trip limits in place, does not increase the risk of exceeding the quota allocation. Determination of whether or not sufficient quota remains for a re-opening is solely within the discretion of the Fisheries Director.

The bag limit for flounder is currently set at four fish by Amendment 2; however, a bag limit of two or more fish increases the likelihood that the recreational sector will exceed its TAL due to increased angler success as the fishery rebuilds. The ability to implement and subsequently alter bag limits would allow the Fisheries Director to constrain the recreational fishery if an initial bag limit greater than one fish through Amendment 3 allows for unsustainable removals.

Currently, there are no vessel limit requirements in the North Carolina southern flounder recreational fishery. Vessel limits may be useful in constraining the harvest of southern flounder in the recreational fishery as the fishery rebuilds. Vessel limits may be more important if the recreational fishery bag limit is set at two fish or greater in order to avoid exceeding the TAL. This is especially important as the stock rebuilds and angler success increases. If the bag limit is reduced to one fish per person per day, the usefulness of a vessel limit is likely reduced. Additional information on vessel limits can be found in the *Achieving Sustainable Harvest* issue paper.

Development of the *Increased Recreational Access* issue paper outlines a strategy for a seasonal approach for additional harvest of ocellated species of flounder outside of the southern flounder recreational season. If the Fisheries Director determines that the allowed ocellated season is preventing a sustainable recreational southern flounder fishery due to excessive landings, the Fisheries Director may cancel subsequent ocellated seasons to maintain required reductions necessary to rebuild the southern flounder stock. In addition, the ASMFC must be notified of any changes to the summer flounder fishery in North Carolina state waters; however, approval of changes by the ASMFC is not required if the changes are expected to be more restrictive than the management measures already approved by the ASMFC. Changes to the summer flounder fishery in EEZ waters off North Carolina may be impacted by the MAFMC and NOAA Fisheries. Due to the ASMFC, MAFMC, and NOAA Fisheries requirements, the Fisheries Director's ability to adaptively manage the ocellated seasons may be impacted.

Future increases in quota would likely not occur until the southern flounder spawning stock biomass is recovered and this cannot be determined until completion of an updated stock assessment. If a stock assessment determines that an increase in quota is possible due to stock rebuilding, the resulting increase can be allocated to the sectors. Revisions to allocations can occur, most commonly to account for changes among sectors or stock status. Changes among sectors include scenarios where one group consistently has excess allocation remaining, or where one group consistently exceeds its allocation. Under each scenario TAL can be re-allocated to another sector based on management preferences. This can be achieved through future amendments.

Adoption of the adaptive management framework for Amendment 3 in conjunction with the other management strategies in the plan provides the best likelihood of success in achieving sustainable harvest in the southern flounder fishery while maximizing flexibility for fishermen in harvesting flounder. Not adopting an adaptive management framework for Amendment 3 would result in the

division not having the flexibility to alter management measures to maintain sustainable harvest in the southern flounder fishery.

Upon adoption of this adaptive management strategy, any additional changes in management strategies beyond those outlined must be undertaken through the amendment or supplement process. These adaptive management strategies and measures will be evaluated for success by completing an updated stock assessment prior to the next comprehensive review of the N.C. Southern Flounder FMP.

PROPOSED MANAGEMENT OPTIONS

(+ potential positive impact of action)
(- potential negative impact of action)

Option 1: Adopt the adaptive management framework based on the peer-reviewed and approved stock assessment.

+ Management is based on biological reference points for stock rebuilding.
\+ Provides for the protection and future sustainability of the southern flounder stock
\+ Provides for the greatest amount of flexibility while maintaining total allowable landings
+/- Provides potential for additional access to other flounder stocks while maintaining total allowable landings of southern flounder
\- Potential uncertainty in selected seasons
\- Impacts may be greater for some gear or areas more than others

Option 2: Do not adopt the adaptive management framework.

- Difficult to maintain TAL
- Does not allow for flexibility in management strategies
- Lack of flexibility jeopardizes stock rebuilding to meet statutory requirements

RECOMMENDATION

See Appendix 5 for a summary of all comments and recommendations gathered from NCDMF, the NCMFC advisory committees, and public for the Southern Flounder FMP Amendment 3.

NCMFC Selected Management Strategy

Option 1: Adopt the adaptive management framework based on the peer-reviewed and approved stock assessment.

LITERATURE CITED

Allan, C., and G.H. Stankey. 2009. Adaptive environmental management: a practitioner's guide. Dordrecht, Netherlands.

Flowers, A.M., S.D. Allen, A.L. Markwith, and L.M. Lee (editors). 2019. Stock assessment of southern flounder (*Paralichthys lethostigma*) in the South Atlantic, 1989–2017. Joint report of the North Carolina Division of

Marine Fisheries, South Carolina Department of Natural Resources, Georgia Coastal Resources Division, Florida Fish and Wildlife Research Institute, University of North Carolina at Wilmington, and Louisiana State University. NCDMF SAP-SAR-2019-01. 213 p.

Holling, C.S., editor. 1978. Adaptive environmental assessment and management. John Wiley and Sons, London, England.

APPENDIX 4.5. RECREATIONAL AND COMMERCIAL SECTOR ALLOCATION IN THE NORTH CAROLINA SOUTHERN FLOUNDER FISHERY

ISSUE

Provide the NCMFC with analysis that shows various commercial and recreational allocation percentages.

ORIGINATION

At the November 2020 NCMFC business meeting, the NCMFC passed a motion to consider commercial and recreational allocations in the Southern Flounder FMP Amendment 3 of 70/30, 65/35, 60/30 with 10% allotment for gigging, 60/40, and 50/50.

BACKGROUND

The NOAA defines allocation as a direct and deliberate distribution of the opportunity to participate in a fishery among identifiable, discrete user groups or individuals (Blackhart 2005). In fisheries managed by the South Atlantic and Gulf of Mexico fishery management councils, the share a sector gets is typically based on historical harvest amounts. Revisions to allocations do occur, most commonly to account for changes among sectors or stock status. Changes among sectors includes scenarios where one group consistently has excess allocation remaining, which can be re-allocated to another sector based on management preferences. Changes to stock status also impact reallocation; if the stock rebuilds and harvest levels can be increased, quota would be increased to allow for more harvest. Authority to make changes to allocations lies with the commission or body charged with making management decisions. For the purpose of this paper the term "sector" will be used to differentiate between the commercial and recreational components of the southern flounder fisheries.

At its November 2020 business meeting, the NCMFC asked the division to review several allocation scenarios for Amendment 3 to the N.C. Southern Flounder FMP. The sector allocation selected by the NCMFC will provide the basis for implementing quota management in the southern flounder fishery. Selection of allocations is informed by data provided by the division, in this case historical landings. The commission can also rely on economic, social, and behavioral aspects of each sector that may influence allocation decisions.

The historically based allocation of 73% commercial 27% recreational (Table 4.5.1) in Amendment 2 is based on historical harvest for each sector from 2017. As with the 73/27 historically based allocation, the commercial and recreational sectors include gear sub-allocations based on historical harvest. In the initial draft of Amendment 3 discussed with the FMP advisory committee, the recommendation for the commercial sector is for separate mobile gear (all gears except pound nets) and pound net categories (approximately 50/50 sub-allocations) and for the recreational sector to have separate hook-and-line and gig gears (89/11 sub-allocation). Different allocation scenarios will significantly change available harvest in a sector, so the commission will need to consider ramifications to the gear sub-allocations and whether those fisheries remain realistically viable to prosecute. The available landings for a specific fishery may be too low to invest further in the expense of the gear, if sub-allocations are not changed.

Much like regional councils, the NCMFC and N.C. Wildlife Resources Commission have historically allocated quotas to fishing sectors based on historical harvest. In some fisheries, like the Albemarle Sound and Roanoke River Management Areas striped bass fishery, the quota was ultimately revised so a 50/50 parity was achieved between the commercial and recreational sectors. In 1991, the initial striped bass quota was allocated 62.5/37.5 based on historical landings. After seven years of rebuilding at this initial allocation, the stock's SSB was declared recovered, allowing for an increase in quota. In 1998, the quota was increased by 94,340 pounds, of which 29% was allocated to the commercial sector and the remaining 71% was allocated to the recreational sector. This increase brought the quota allocation to a 50/50 parity.

Table 4.5.1. Allocation options for the North Carolina southern flounder fishery that maintain overall landings reduction of 72%.

	Total Allowable Landings (TAL) in Pounds				Change in TAL
	Commercial		Recreational		
NCMFC Options (% Allocation)	**TAL**	**% Reduction**	**TAL**	**% Reduction**	**Pounds**
Historical Harvest	390,493	72	141,859	72	0
70/30	372,646	73	159,706	68	+/- 17,847
65/35	346,029	75	186,323	63	+/- 44,464
*60/30/10	358,459	74	173,893	66	+/- 32,034
60/40	319,411	77	212,941	58	+/- 71,082
50/50	266,176	81	266,176	47	+/- 124,317

**This denotes a 10% allocation for gigs that was further divided out to each sector based on historical allocation (73/27).*

AUTHORITY

North Carolina General Statutes

G.S. 113-134 RULES
G.S. 113-182 REGULATIONS OF FISHING AND FISHERIES
G.S. 113-182.1 FISHERY MANAGEMENT PLANS
G.S. 143B-289.52 MARINE FISHERIES COMMISSION – POWERS AND DUTIES

DISCUSSION

Initial analyses of southern flounder quota allocations followed the convention of using historical landings from a previous year or years. To provide information for the NCMFC motion, commercial and recreational data were analyzed based on 2017 harvest data, the terminal year of the stock assessment. Table 4.5.1 shows the allocation options as requested by the NCMFC.

Shifting allocation between sectors is within the authority of the NCMFC (G.S. 113-134, 113-182, 113-182.1, and 143B-289.52). Changes to sector allocation may have negative and positive impacts to different sub-sectors in the southern flounder fishery. Allocation shifts to the recreational sector would provide additional harvest, possibly allowing for longer seasonal access if the daily bag limit is lowered. If the bag limit is not lowered, gains from increased allocation may help to provide a buffer against potential overages from increased angler success (see the *Achieving Sustainable Harvest* issue paper).

The commercial sector TAL would be lowered by the same amount of the recreational gains. As noted earlier, it is also prudent to consider the gear sub-allocations within the sectors (Table 4.5.2) as allocation shifts may have consequences that impact one gear category more than another. Reductions in the commercial allocation may have negative impacts on the commercial fishery as a lower allocation will result in a reduced harvest period.

The *Description of the Fisheries* section contains additional information that provides background details on landings, effort, and economic data for the commercial and recreational fisheries. Tables 4 and 5 in the *Description of the Fisheries* section provides commercial southern flounder landings by year and gear and the number of trips, average pounds per trip, and the number of participants by year and gear.

Table 4.5.2. Sub-allocations for the commercial and recreational sectors for the NCMFC options based on the 2017 harvest.

	Commercial		Recreational	
NCMFC Option	**Mobile Gear**	**Pound Net**	**Hook-and-Line**	**Gig**
Historical Allocation	195,105	195,388	126,315	15,544
70/30	186,188	186,458	142,206	17,500
65/35	172,889	173,140	65,907	20,416
*60/30/10	180,228	178,231	159,706	14,187
60/40	159,590	59,821	89,608	23,333
50/50	132,992	133,184	237,010	29,166

*This denotes a 10% allocation for gigs that was further divided out to each sector based on historical allocation (73/27).

Table 4.5.3 shows the annual variation in harvest for the recreational hook-and-line fishery and what the following years' TAL consequences might have been. In Table 4.5.3, landings during the identified season are displayed on a yearly basis to provide examples of overages that could occur while trying to meet the TAL necessary for rebuilding based on historical allocations. If more fish are available because of a good year class both sectors would likely see increases in harvest. For the recreational sector, where daily reporting is not available, the larger the bag limit the greater the risk of exceeding the landings.

Tables 4.5.4 and 4.5.5 demonstrate the effects to the recreational sector between the historical allocation (73/27) and a 60/40 allocation. For each table, annual landings data (2008 through 2017) were prorated to an Aug. 16–Sept. 30 season under different bag limits (one fish, two fish, three fish, four fish). Estimated landed pounds were then compared to a 73/27 allocation (Table 4.5.4) and a 60/40 allocation (Table 4.5.5) to determine whether or not the TAL would be exceeded for each bag limit option based on the percent of the allocated harvested. Finally, the percent of the allocated harvested for each year was used to calculate the subsequent year allocation for each bag limit option. Any overages that occur in one year will be deducted in subsequent years, possibly resulting in no recreational fishery for a year or more. It should be noted that for the recreational sector, where daily reporting is not realistic, the larger bag limits increase the risk of exceeding the TAL. When compared to each other, Tables 4.5.4 and 4.5.5 also show that with more allocation

provided to the recreational fishery and a lower bag limit, the lower the chance of the recreational fishery of exceeding their TAL.

Table 4.5.3. Recreational hook-and-line landings of southern flounder Aug. 16–Sept. 30 at the four-fish bag limit for current season and years compared to the status quo allocation (73/27 does not include discards). Highlighted cells indicate overages in TAL the previous year resulting in closures the following year.

Year	Pounds Landed	% Overage	Subsequent Year Allocation
2008	106,493	-15.7	126,315
2009	204,422	61.8	48,209
2010	260,665	*106.4	0
2011	348,203	*175.7	0
2012	213,170	68.8	39,461
2013	396,543	^213.9	0
2014	133,016	5.3	119,615
2015	142,540	12.8	110,091
2016	172,348	36.4	80,283
2017	108,420	-14.2	126,315

* *Denotes a scenario where the recreational hook-and-line fishery would not have quota in subsequent year resulting in a one-year closure due to overages.*

^ *Denotes a scenario where the recreational hook-and-line fishery would not have a quota in two subsequent years resulting in a two- year closure due to overages.*

Future increases in total quota would not occur until the southern flounder SSB is recovered and this cannot be determined until an updated stock assessment is completed. Additionally, changes in allocation may alter the rebuilding schedule. Projections for rebuilding use a model that estimates changes in SSB by looking at the rate of removals according to the size classes that each sector harvests. Allocation changes would impact the overall size range of fish removed from the population and could therefore impact model projections.

All of the proposed reallocation scenarios increase recreational quota while lowering the commercial quota, there is the expectation that similar economic effects will follow. Specifically, as the overall commercial allocation is reduced, the total value of the commercial southern flounder industry will decrease, while the value of the recreational southern flounder fishery may be mitigated to some extent due to increased angler expenditures to target this species (Table 4.5.6; *Description of the Fisheries* section Tables 8 and 10); however, economic losses and gains are unpredictable.

Decreasing the commercial allocation may result in a proportional decrease in value. It is possible, per-pound southern flounder prices may rise with reduced supply, counteracting the losses from reduced quota; however, if commercial quota reductions were large enough, the southern flounder fishery could see reduced participation, creating even larger socio-economic losses. The magnitude of these economic changes within each sector is unknown and unquantifiable.

Allocation deliberations should take into consideration the limited southern flounder TAL. Reallocation between sectors at this time could have unintended social and economic

consequences that are most noticeable at the finer level of specific fisheries within each sector. It may be more prudent to allocate future quota increases towards one sector over the other as SSB expands. This can be achieved in future amendments with methodic increases until the preferred allocation is achieved.

Table 4.5.4. Example of predicted harvest of southern flounder for a recreational hook-and-line season and compared to a 73/27 allocation and then applied to subsequent years to show future harvest during an Aug. 16–Sept. 30 season. Highlighted cells indicate bag limits that exceed the TAL for the indicated year: the darker the shade the higher the overage.

		Harvest of Southern Flounder (pounds)				Percent of Allocation Harvested based on 73/27 allocation				Subsequent Year Allocation (pounds)			
Season	**Year**	**4-Fish Bag**	**3-Fish Bag**	**2-Fish Bag**	**1-Fish Bag**	**4-Fish Bag**	**3-Fish Bag**	**2-Fish Bag**	**1-Fish Bag**	**4-Fish Bag**	**3-Fish Bag**	**2-Fish Bag**	**1-Fish Bag**
Aug 16 - Sep 30	2008	106,492	106,492	106,492	91,066	84	84	84	72	126,315	126,315	126,315	126,315
Aug 16 - Sep 30	2009	204,486	187,897	160,774	126,395	162	149	127	100	48,144	64,733	91,856	126,235
Aug 16 - Sep 30	2010	260,612	246,868	218,187	166,911	206	195	173	132	-	5,762	34,443	85,719
Aug 16 - Sep 30	2011	349,421	326,406	310,900	247,169	277	258	246	196	-	-	-	5,461
Aug 16 - Sep 30	2012	213,292	198,612	184,701	145,504	169	157	146	115	39,338	54,018	67,929	107,126
Aug 16 - Sep 30	2013	396,801	313,050	278,762	210,948	314	248	221	167	-	-	-	41,682
Aug 16 - Sep 30	2014	132,458	132,458	127,395	114,937	105	105	101	91	120,172	120,172	125,235	126,315
Aug 16 - Sep 30	2015	142,881	137,615	129,351	90,711	113	109	102	72	109,749	115,015	123,279	126,315
Aug 16 - Sep 30	2016	168,236	168,236	165,769	156,700	133	133	131	124	84,394	84,394	86,861	95,930
Aug 16 - Sep 30	2017	114,667	114,667	110,461	97,184	91	91	87	77	126,315	126,315	126,315	126,315

Table 4.5.5. Example of predicted harvest of southern flounder for a recreational hook-and-line season and compared a 60/40 allocation and then applied to subsequent years to show future harvest during an Aug. 16–Sept. 30 season. Highlighted cells indicate bag limits that exceed the TAL for the indicated year.

		Harvest of Southern Flounder (pounds)				Percent of Allocation Harvested based on 60/40 allocation				Subsequent Year Allocation (pounds)			
Season	**Year**	**4-Fish Bag**	**3-Fish Bag**	**2-Fish Bag**	**1-Fish Bag**	**4-Fish Bag**	**3-Fish Bag**	**2-Fish Bag**	**1-Fish Bag**	**4-Fish Bag**	**3-Fish Bag**	**2-Fish Bag**	**1-Fish Bag**
Aug 16 - Sep 30	2008	106,492	106,492	106,492	91,066	56	56	56	48	189,608	189,608	189,608	189,608
Aug 16 - Sep 30	2009	204,486	187,897	160,774	126,395	108	99	85	67	174,730	189,608	189,608	189,608
Aug 16 - Sep 30	2010	260,612	246,868	218,187	166,911	137	130	115	88	118,604	132,348	161,029	189,608
Aug 16 - Sep 30	2011	349,421	326,406	310,900	247,169	184	172	164	130	29,795	52,810	68,316	132,047
Aug 16 - Sep 30	2012	213,292	198,612	184,701	145,504	112	105	97	77	165,924	180,604	189,608	189,608
Aug 16 - Sep 30	2013	396,801	313,050	278,762	210,948	209	165	147	111		66,166	100,454	168,268
Aug 16 - Sep 30	2014	132,458	132,458	127,395	114,937	70	70	67	61	189,608	189,608	189,608	189,608
Aug 16 - Sep 30	2015	142,881	137,615	129,351	90,711	75	73	68	48	189,608	189,608	189,608	189,608
Aug 16 - Sep 30	2016	168,236	168,236	165,769	156,700	89	89	87	83	189,608	189,608	189,608	189,608
Aug 16 - Sep 30	2017	114,667	114,667	110,461	97,184	60	60	58	51	189,608	189,608	189,608	189,608

Table 4.5.6. Ex-vessel value of the commercial southern flounder fishery by year and gear.

	Gear				
Year	**Gigs**	**Gill Net**	**Other**	**Pound Net**	**Total**
2008	$173,360	$3,798,463	$132,613	$1,545,858	$5,650,295
2009	$159,031	$3,160,714	$116,727	$1,173,459	$4,609,932
2010	$267,482	$2,067,067	$66,801	$1,294,539	$3,695,889
2011	$256,846	$1,397,565	$34,239	$1,064,477	$2,753,128
2012	$388,313	$2,343,199	$126,800	$1,593,169	$4,451,482
2013	$320,380	$2,742,687	$114,816	$2,495,307	$5,673,190
2014	$414,206	$1,884,626	$53,263	$2,487,577	$4,839,672
2015	$417,189	$1,235,836	$38,535	$2,132,007	$3,823,567
2016	$506,533	$1,442,921	$42,423	$1,618,655	$3,610,533
2017	$547,308	$2,220,595	$32,975	$2,854,873	$5,655,751
Total	**$3,450,649**	**$22,293,674**	**$759,193**	**$18,259,922**	**$44,763,437**

PROPOSED MANAGEMENT OPTIONS

Management Options

(+ potential positive impact of action)
(- potential negative impact of action)

Below are overarching positive (+) and negative (-) impacts for all options. The options are listed after the impacts.

+/- Allocation not based on biological need.
+/- Allocation other than status quo not based on historical landings.
+/- Increasing allocation to the recreational sector provides more fish to harvest but depending on amount may not increase the season dates, season lengths, or bag limits.
+ Increasing allocation to the recreational sector mitigates some of the economic impact of the reductions to the recreational fishery.
- Decreasing allocation to the commercial fishery exacerbates the economic impact of the commercial fishery.
- Increasing allocation to the recreational fishery provides additional harvest to the sector with the least precise estimates.
- Changes in allocation may alter the rebuilding schedule (changing allocation changes the fish available to each sector and their associated selectivity, projections are based on sector specific selectivity).
- Depending on how much allocation is shifted to the recreational sector there may be significant impacts to the commercial seasons.
- May be necessary to adjust allocations within a sector to maintain specific gear-based fisheries.

Option 1. Historical Harvest/ Status quo (73 commercial/27 recreational)
Option 2. 70/30
Option 3. 65/35
Option 4. 60/30/10, includes a 10 percent allocation for the gig fishery
Option 5. 60/40
Option 6. 50/50

NCMFC SELECTED MANAGEMENT STRATEGY

The NCMFC approved a motion to set the allocation for Amendment 3 at 70% commercial and 30% recreational at the February 26, 2021, business meeting.

At a March 2021 special meeting, the NCMFC approved a motion to amend the previously adopted southern flounder allocation to adjust the allocation to 70/30 in 2021 and 2022 to 60% commercial and 40% recreational in 2023 and achieve a 50/50 parity in allocation in 2024.

At its February 2022 business meeting, the NCMFC approved a motion that "based on recognition of a series of coincident concerns specific to the initial steps in rebuilding the southern flounder fishery [they delayed] the transition to a 50/50 commercial/recreational parity allocation by 2 years (time for at least 1 cycle of larval to female maturity) allocations: 2023: 70/30; 2024: 70/30; 2025: 60/40; 2026: 50/50."

LITERATURE CITED

Blackhart, K., D.G. Stanton, and A.M. Shimada. 2005. NOAA Fisheries Glossary, U.S. Dept. of Commerce, NOAA Tech. Memo. F/SPO-69, 61 p.

APPENDIX 4.6. IMPLEMENTING A SLOT LIMIT IN THE SOUTHERN FLOUNDER FISHERY

ISSUE

Examine the impacts of changing size limits by implementing a harvest size slot limit in the southern flounder fishery.

ORIGINATION

This issue originated from a request brought forth by the North Carolina Marine Fisheries Commission.

BACKGROUND

Managing fisheries using size regulations to constrain harvest is common practice, but there is often a trade-off between conservation (i.e., spawning stock biomass) and fishery objectives (i.e., maximizing sustainable yield or harvest numbers; Gwinn et al. 2015; Ayllon et al. 2018, 2019). Often minimum size limits are used but can negatively impact a stock by truncating the age and size structure if effort is high (Moreau and Matthais 2018). Slot limits, particularly in freshwater recreational fisheries, are becoming more popular as they have the ability to protect juveniles and spawning adults (Gwinn et al. 2015) and can help maintain a more mature age structure when compared to minimum size limit regulations (Ayllon et al. 2019). However, if overfished stocks are to be recovered, management actions must first focus on reducing both fishing effort and hooking/bycatch mortality. Once these rates are under control, slot limit regulations could lead to improved sustainability (Ayllon et al. 2018).

Slot limits are not appropriate for all species, but should be considered if the population in question has the following characteristics (Baker et al. 1993; Brousseau and Armstrong 1987):

- good natural reproduction,
- slow growth, especially of young fish,
- relatively high natural mortality of young fish, and
- high angling effort.

Additionally, the upper limit of a slot limit should provide meaningful harvest protection for the species in question (Oliver et al. 2021). If discard mortality and non-compliance for a species are high, then slot limits become less effective as a management tool (Ayllon et al. 2019). Based on the criteria defined by Baker et al. (1993) for slot limits, southern flounder may not be an appropriate candidate as the current fishing mortality is above the threshold reference point, the spawner-recruit relationship is unknown, and juvenile flounder are fast growing (Flowers et al. 2019).

Slot limits may be useful to constrain harvest after fishing effort and mortality are reduced and the stock rebuilds. Benefits for the development of a slot limit for southern flounder revolve around increasing harvest of males, protection of large mature females, and the idea that releasing all

larger southern flounder would speed up recovery through increased egg production. Southern flounder are sexually dimorphic, with females reaching larger sizes than males. Males over 20 inches TL have not been recorded and few males are over 17 inches TL (Figure 4.6.1). While a 50:50 ratio is assumed for southern flounder smaller than 5-inches TL, the female proportion increases for fish 5.5-inches TL or greater and becomes more pronounced at 12-inches TL. Therefore, a slot limit does not guarantee a higher harvest of males. Water temperatures have been shown to influence the sex ratios of southern flounder where higher or lower temperatures can result in a higher proportion of males to females (Luckenbach et al. 2003, 2009; Honeycutt et al. 2019; Montalvo et al. 2012) indicating there may be more males available for harvest. It is unknown what impact annual changes in environmental factors have on the recovery of southern flounder, even if all fish over a certain size are released. For more information on environmental influence on sex ratios, see the *Ecosystem and Fishery Impacts* section.

Most, if not all, fish released over a potential slot limit would be female (Figure 4.6.1). However, the length at which half of female southern flounder are mature is 16-inches TL (Midway and Scharf 2012; Flowers et al. 2019). Division data indicates all females over 19 inches TL are likely mature (NCDMF, unpublished data). While there are no fecundity data currently available from wild individuals to indicate whether larger fish produce more offspring, fecundity generally increases with female body size. In a hatchery setting, southern flounder are capable of producing up to 18 million eggs with an average hatching rate of 15% (Watanabe et al. 2001). These estimates should be viewed with caution because the laboratory experiments were conducted under ideal conditions.

In 2017, approximately 10% of the total commercial and recreational harvest were fish greater than 20 inches TL (Figures 4.6.2 and 4.6.3). In 2020, catches of fish larger than 20 inches TL increased for both sectors. It is expected that larger fish will continue to show up in the catches due to the limited seasons occurring in the fall which allow for a longer period of growth prior to being harvested. The current stock shows a truncated age and size structure (Flowers et al. 2019), meaning larger fish are not necessarily older fish. The maximum age observed in both fisheries has decreased over the last decade, and the majority of fishing pressure for both sectors is focused on one or two age classes of fish where most fish harvested are age-2 (NCDMF 2021). Both the age and length structure of the population are expected to improve as the stock recovers. Along with the poor age structure of the stock, it is unknown if the few fish over age-3 have spawned multiple times. It should be noted that while the additional escapement of larger fish may benefit the stock, any fish discarded outside of the slot have an associated post-release mortality, adding to the dead discards.

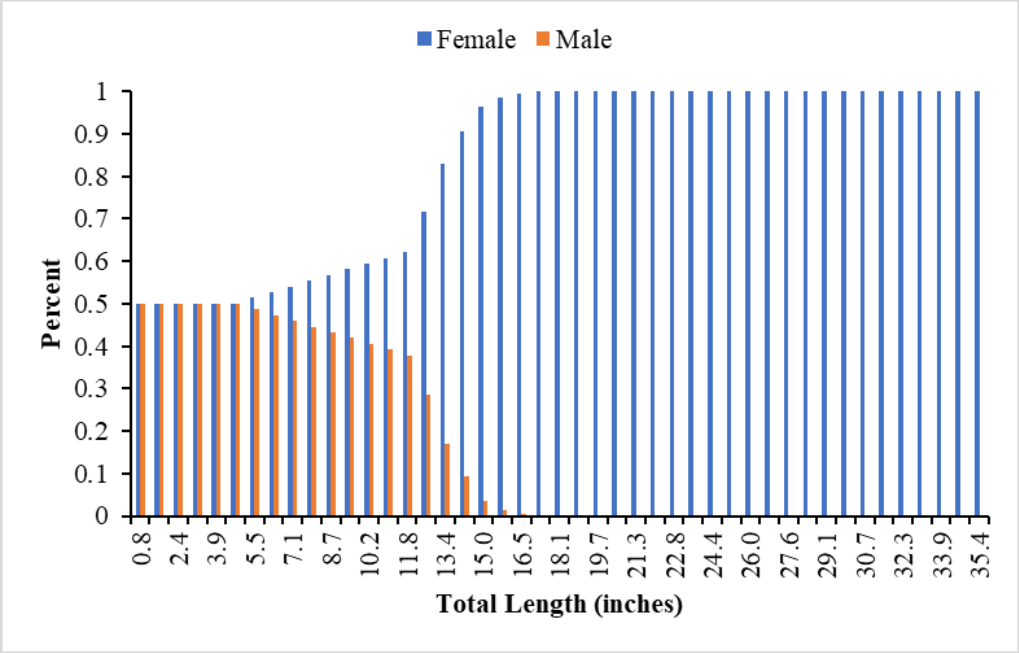


Figure 4.6.1. Sex ratios of southern flounder relative to total length.

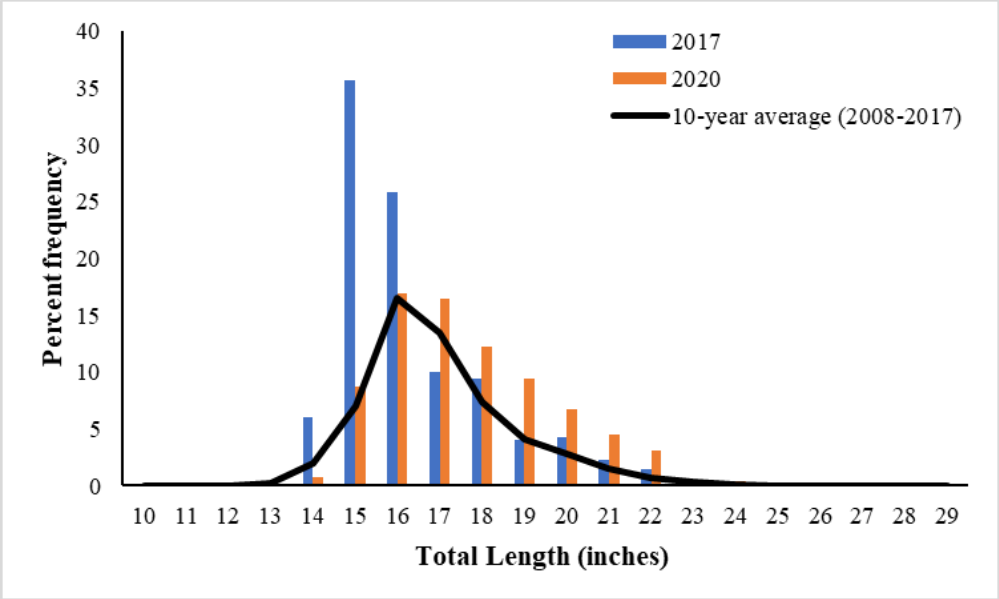


Figure 4.6.2. Percent frequency (by pound per inch) of commercial southern flounder harvest by total length, 2017 and 2020. The 10-year average (2008-2017) is also included for reference. (Source: North Carolina Trip Ticket Program and NCDMF fish house sampling biological data)

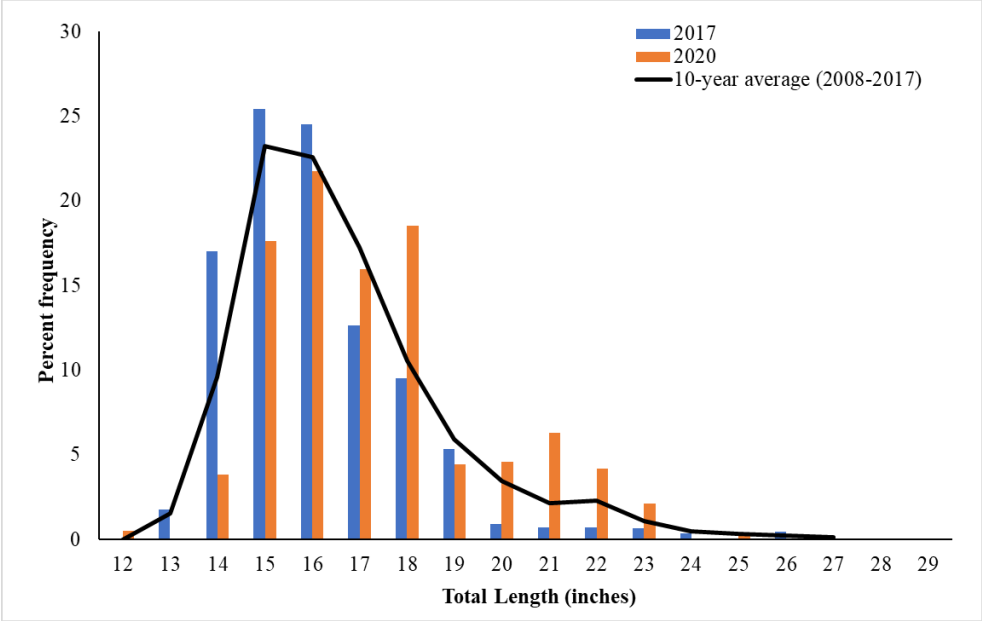


Figure 4.6.3. Percent frequency (by pound per inch) of recreational southern flounder harvest by length, 2017 and 2020. The 10-year average (2008-2017) is also included for reference. (Source: Marine Recreational Information Program)

In North Carolina, the management of flounder species has undergone several regulatory changes to promote the sustainability of the stock. The first implementation of a minimum size limit occurred in 1979 at 11 inches TL for both estuarine and ocean waters. Subsequent minimum size limits have been implemented through the original North Carolina Southern Flounder FMP (NCDMF 2005), Amendment 1 (NCDMF 2013), Supplement A to Amendment 1 (NCDMF 2017), and revisions to the joint Atlantic States Marine Fisheries Commission (ASMFC) and Mid-Atlantic Fishery Management Council Summer Flounder, Scup, and Black Sea Bass FMP (ASMFC 2018; MAFMC 2019). The use of a slot limit, as a potential management tool for curtailing harvest in the southern flounder fishery, has not been explored in previous management plans. A slot limit could be implemented for the recreational and/or commercial fisheries. At this time, the focus of this issue paper will be the potential implementation of a slot limit for the recreational hook-and-line fishery only as requested by the NCMFC.

AUTHORITY

North Carolina General Statutes

G.S. 113-134 RULES
G.S. 113-182 REGULATION OF FISHING AND FISHERIES
G.S. 113-182.1 FISHERY MANAGEMENT PLANS
G.S. 113-221.1 PROCLAMATIONS; EMERGENCY REVIEW
G.S. 143B-289.52 MARINE FISHERIES COMMISSION – POWERS AND DUTIES

North Carolina Marine Fisheries Commission Rules

15A NCAC 03H .0103 PROCLAMATIONS, GENERAL
15A NCAC 03M .0503 FLOUNDER
15A NCAC 03M .0512 COMPLIANCE WITH FISHERY MANAGEMENT PLANS

DISCUSSION

The population level effects of implementing a slot limit for the recreational southern flounder hook-and-line fishery in North Carolina is non-quantifiable as developing projections based on a slot limit cannot be calculated on an individual state basis. The 2019 stock assessment does not include a spatial component; as a result, all size limit changes would be relative to the entire stock of southern flounder. There are multiple minimum size limits in place across the unit stock, which have ranged in recent years from 12- to 16-inches TL. The analyses of implementing a slot limit are based solely on North Carolina harvest estimates and may or may not be representative of the coast-wide stock and it would not be possible to attribute the implementation of a slot limit as the cause of changes to stock size.

Slot limits of 15 to16 inches (1 inch), 15 to17 inches (2 inch), 15 to 18 inches (3 inch), and 15 to 19 inches (4 inch) TL were explored for the recreational hook-and-line fishery. For ease of enforcement and education, these slot limits include fish at but not greater than the maximum length. For example, the 15- to 16-inch TL slot is only one inch as it includes fish from 15 inches up to and no greater than 16 inches TL. Most harvest for both sectors is less than 20 inches TL thus, implementing a slot limit may act as a buffer to prevent overages to the TAL. The implementation of a slot limit will not extend the season or increase the TAL (Table 4.6.1). In fact, to account for the additional dead discards the TAL would need to be reduced, resulting in fewer harvest opportunities so not to exceed the TAC. Releasing larger fish may help in the recovery of the stock but at this time the effects cannot be quantified. It is also likely that more larger fish are emigrating to the ocean since implementation of the harvest reductions through seasonal closures implemented in Amendment 2.

Estimates in recreational harvest can only be analyzed at the season and bag level for the hook-and-line fishery as length data are not available from the gig survey. The identified slot limits are very narrow and may be imperceptible to fishermen using gigs. Therefore, it is not realistic for the recreational gig fishery to operate under a slot limit as gigs have an assumed 100% mortality associated with capture. Due to the anticipated increase in dead discards that would occur outside of the slot limit, gigs become detrimental to re-building unless a non-lethal gig-like gear was implemented. The gig fishery could continue to operate under the current minimum size limit. However, this creates a greater potential for enforcement issues and non-compliance.

The MRIP survey design for the hook-and-line fishery includes length data with an associated sampling weight equivalent to the sampling weight applied to generate the expanded harvest estimates. Therefore, slot limit analyses can be compared to estimates produced in reference to the TAL but not the TAC. Importantly, the contribution of generated discards can be substantial. For example, analysis of MRIP size data demonstrates that the only slot limit scenario with landings below the TAL during the 2020 6-week season was 15 to 16 inches TL (Table 4.6.2). Generated dead discards for those fish greater than the upper bound for this slot limit are 24,604 pounds. Estimates of existing dead discards average 41,331 pounds between 2008 and 2017. The additional generated dead discards would increase this average creating the need to reduce the TAL to offset the increase in discards. Additionally, changes in bag limits substantially decrease reliability of estimates. For example, in 2017 only 29 southern flounder were observed between Aug. 16 and Sept. 30. A one fish bag limit analysis during this season excludes 41% of the observations. This

is further compounded by a skewed age structure where 89% of observed southern flounder were 19 inches TL or less. For these reasons, estimates produced for slot limits are not a reliable indicator of the effect a slot may have on recreational harvest.

Table 4.6.1. Pounds of southern flounder harvest (no discards) at a four-fish and one-fish bag limit, 2013. This year represents a year of high harvest and what could happen as the stock rebuilds. For reference, the NCMFC allocations are 142,206 lb (30% recreational allocation), 189,608 lb (40%), and 237,010 lb (50%).

	Landings (lb)- Slot Limit							
	15 to 16 inches		15 to 17 inches		15 to 18 inches		15 to 19 inches	
Season	4-Fish Bag Limit	1-Fish Bag Limit	4-Fish Bag Limit	1-Fish Bag Limit	4-Fish Bag Limit	1-Fish Bag Limit	4-Fish Bag Limit	1-Fish Bag Limit
No closure	266,659	218,399	380,114	280,432	544,443	396,391	638,143	439,743
Apr 16–Jun 30	29,669	26,707	47,222	42,164	95,532	69,216	141,213	94,341
May 1–Jun 30	29,669	26,707	40,159	35,101	88,469	62,153	134,149	87,277
Jun 1–Jul 15	24,130	24,130	41,736	38,370	96,656	72,344	145,238	99,257
Aug 1–Sep 30	170,542	127,984	226,416	147,034	313,735	208,979	347,159	218,135
Aug 16–Sep 30	156,752	114,193	204,120	128,528	284,590	184,428	316,724	193,202
July 16–Sep. 30	178,324	135,232	234,197	154,282	323,470	217,495	359,504	229,262
July 1 -Sep.30	189,893	146,801	252,883	171,698	522,892	242,022	389,586	256,474
June 16–Sep. 15	161,353	131,993	222,932	162,920	354,683	257,242	437,354	293,976
Aug 16-Oct 15	159,344	116,785	209,928	133,809	295,774	195,085	330,095	206,047
Aug-16-Oct 30	183,686	138,921	253,082	164,360	344,925	231,068	385,245	243,618

Table 4.6.2. Pounds of southern flounder harvested by the recreational hook-and-line fishery during the 2020 season, by slot limit option. The no slot example shows the harvest under the current 15-inch TL minimum size limit. The TAL in 2020 was 126,315 pounds.

Season	Slot Limit (in)	Harvest (lb)
Aug. 16 - Sept. 30	No slot	362,119
Aug. 16 - Sept. 30	15-16	88,743
Aug. 16 - Sept. 30	15-17	140,448
Aug. 16 - Sept. 30	15-18	218,009
Aug. 16 - Sept. 30	15-19	238,565

There are several data limitations hindering the evaluation of slot limits including fecundity at age, effect of seasons on the size of fish harvested, and distribution of flounder as they emigrate into the ocean. Additionally, species level biological data are currently unavailable for unobserved discarded flounder. North Carolina's three constituent flounder species are notoriously difficult to differentiate. This ambiguity presents a unique challenge for fisheries management in that discard information provided by the recreational angling community may be inadvertently errant. To properly consider the discard estimates of these species produced by the APAIS conducted in North Carolina, the number of fish discarded and reported at the genus species level must be evaluated. Only a very small percentage of the angling community are perceived to have the ability to identify flounder to the species level. Thus, samplers are instructed to record all reported flounder discards at the left-eyed flounder genus level. To partition the unobserved catch to the species level, a ratio of southern, summer, and Gulf flounder is first determined from the observed

catch. The ratio of catch is applied to the estimated unobserved catch to produce estimates of discards for each species. It is unlikely that the relative contribution of each species within the harvested catch is identical with that of discarded catch. Specifically, the assumption that discarded individuals share the same spatiotemporal distribution as those harvested has not been validated. This concern is underscored by demonstrated ontogenetic differences in habitat use and migratory patterns for these congener species (Walsh et al. 1999; Dorval et al. 2005). The ability to accurately identify discarded flounder to the species level is critical to characterize unobserved dead discards. If these data limitations can be addressed, it will be possible to more accurately quantify the use of implementing a slot limit.

While these analyses have data limitations, they do illustrate potential annual variation. Figures 4.6.4-4.6.7 illustrate the effect a slot limit may have on the recreational fishery relative to the allocation changes passed by the NCMFC in March 2021. As the stock rebuilds the potential recreational seasons identified in the *Achieving Sustainable Harvest* issue paper may fail to meet the target harvest reduction due to increased angler success (Figures 4.6.4-4.6.7). In 2020, angler success increased relative to the last five years, particularly for anglers catching only one fish. Catch rates, indicative of success, almost doubled between 2019 and 2020. Therefore, decreasing the bag limit, even if a slot limit is implemented, is necessary to constrain harvest and prevent massive overages. For further discussion on the effects of increased angler success and bag limits, see the *Achieving Sustainable Harvest* issue paper.

Moreau and Matthias (2018) found narrow slot limits for certain freshwater species can be used to prevent overharvest when bag limits are left unchanged. However, in this study if the bag limit was reduced to one fish, the slot limit range could potentially be expanded allowing for the harvest of larger fish. This would be more appropriate as the stock rebounds and the length and age structure expands. Any slot limit will potentially increase the discarded fish which is problematic for species such as southern flounder which have high post-release mortality (9%) and discard to catch ratios (nine released for every fish kept; Moreau and Matthias 2018). Slot limits generally result in lower harvest and more discards by weight, and therefore higher and more frequent overages would occur compared to a minimum size limit (Wiedenmann et al. 2013). As older, larger fish become more abundant, the volume of removals due to discard mortality and non-compliant harvest is expected to increase (Kasper et al. 2020).

The discards of larger, heavier fish will increase the poundage of dead discards. This increase could be especially problematic for the recreational fishery due to the volume of releases each year. It is assumed that most fish discarded in the recreational fishery are discarded because they are below the minimum size limit and therefore weigh less than half a pound. By discarding fish above the slot limit the overall weight of dead discards would increase, potentially to greater than five pounds per fish. Thus, increasing the likelihood of not just exceeding the TAL each year but the TAC as well.

Previous analysis of summer flounder slot limits showed an increase in harvest of smaller fish, while only reducing some harvest on the larger fish. This increased fishing mortality rates and resulted in only marginal benefits (Wong 2009). Non-compliance and high-grading within the slot were concerns with the implementation of a slot limit. As such, it was recommended that narrow slot ranges be avoided due to issues related to angler satisfaction, non-compliance, and

enforcement. Importantly, the use of slot limits for a flounder species was not recommended until rebuilding goals and data needs for the species were met (Wong 2009; ASMFC 2018).

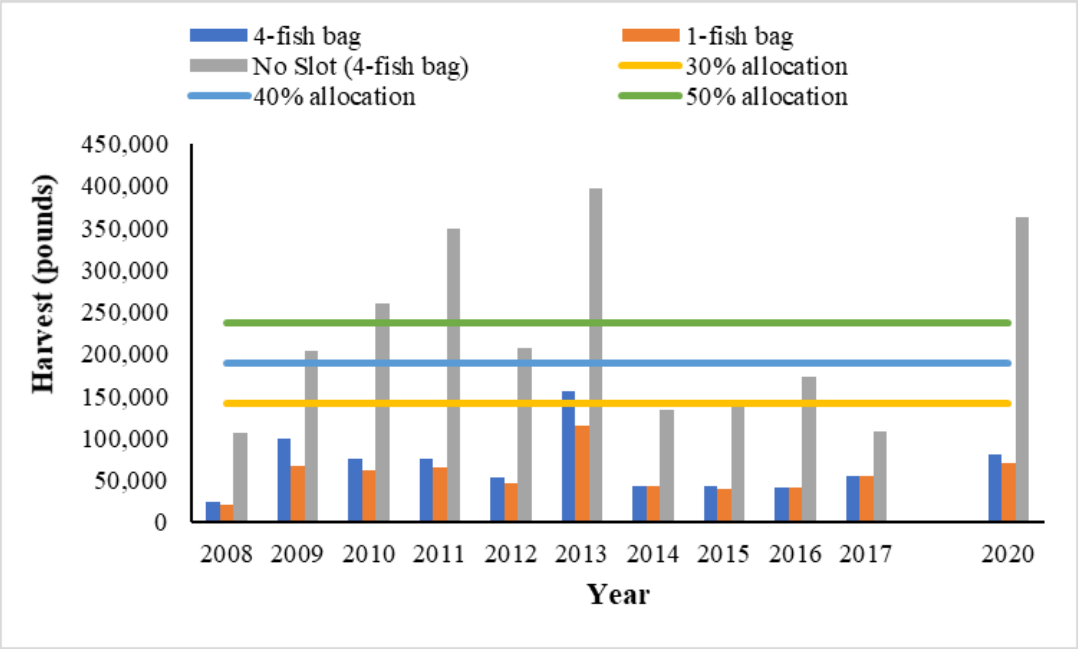


Figure 4.6.4. Total hook-and-line harvest during Aug. 16–Sept.30 at a four-fish and one-fish bag limit and a 15–16-inch slot based on data from 2008 to 2017 and 2020. The years 2010, 2011, and 2013 represent years of above average harvest; 2020 represents the first full year under seasonal management through Amendment 2. NCMFC allocations are presented for reference.

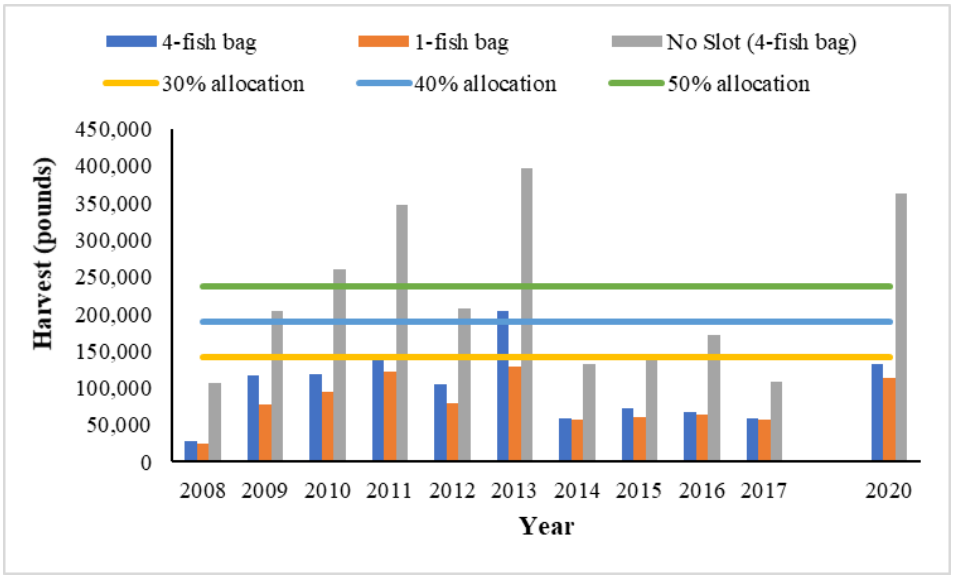


Figure 4.6.5. Total hook-and-line harvest during Aug. 16–Sept.30 at a four-fish and one-fish bag limit and a 15–17-inch TL slot based on data from 2008 to 2017 and 2020. The years 2010, 2011, and 2013 represent years of above average harvest; 2020 represents the first full year under seasonal management through Amendment 2. NCMFC allocations are presented for reference.

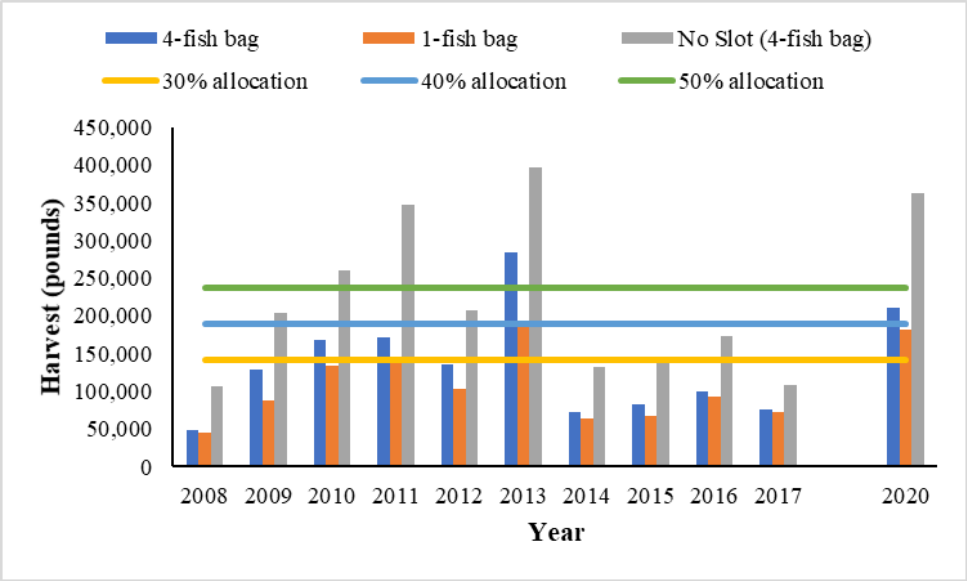


Figure 4.6.6. Total hook-and-line harvest during Aug. 16–Sept.30 at a four-fish and one-fish bag limit and a 15–18-inch TL slot based on data from 2008 to 2017 and 2020. The years 2010, 2011, and 2013 represent years of above average harvest; 2020 represents the first full year under seasonal management through Amendment 2. NCMFC allocations are presented for reference.

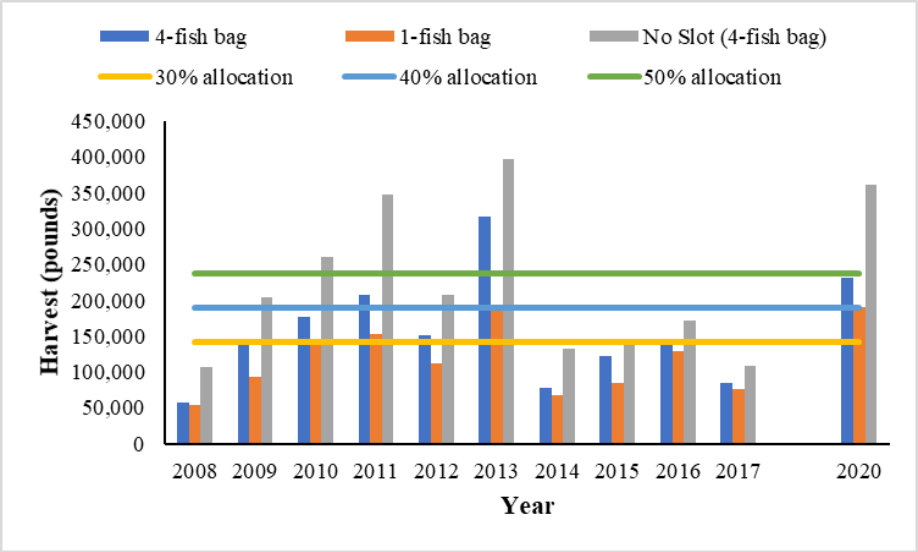


Figure 4.6.7. Total hook-and-line harvest during Aug. 16–Sept.30 at a four-fish and one-fish bag limit and a 15–19-inch TL slot based on data from 2008 to 2017 and 2020. The years 2010, 2011, and 2013 represent years of above average harvest; 2020 represents the first full year under seasonal management through Amendment 2. NCMFC allocations are presented for reference.

As the stock rebuilds, any benefit of a buffer may disappear as more fish become available within the slot. Though slot limits are normally associated with the recreational sector, slot limits may be implemented in both sectors since there are differences in fishing seasons. Any savings may be lost if larger fish are released by the recreational sector only to be available for harvest in the commercial fishery (as is currently being discussed). This is also true within the recreational sector

if gigs are not held to the same slot. Finally, it is also an important consideration for the recreational fishery if there is an early and late season; fish may grow into or out of the slot between those seasons to an unknown effect.

Though size limits could not be changed under Amendment 2, the 2020 season offers an opportunity to see how the implementation of a slot limit may have affected landings under seasonal management. Of the options presented in this issue paper, only the narrowest slot limit may have possibly prevented the recreational hook-and-line fishery from exceeding their TAL (126,315 pounds) in 2020 (Table 4.6.2). The other options presented would have minimized the overages when compared to no slot limit.

Selection of Slot Limits with a Minimum Size Limit Lower than 15 Inches

Decreasing the minimum size limit could potentially increase harvest on males while decreasing pressure on larger females. However, it cannot be guaranteed that more males will be harvested. Depending on the minimum slot size, males could account for 10% to 40% of the fish available for harvest (Figure 4.6.1). In the summer flounder headboat fishery, Morson et al. (2017) found that lowering the minimum size for a slot limit below the current minimum size regulations could potentially meet management goals while distributing harvest over both sexes for summer flounder. However, the slot limits that did not increase fishing mortality were all narrow (2-4 inches), contained the current minimum size within the slot limit, and were not applicable to all areas and habitats.

Even at previous minimum size limits, southern flounder landings were still dominated by female fish (NCDMF, unpublished data). It is thought that males move offshore at a smaller size than females and do not return to the estuary after spawning (Stokes 1977), potentially decreasing the efficacy of a lower minimum size. While it is understood that harvest of larger females could be detrimental to the recovery of the stock, many female fish less than 16 inches TL are not mature, and harvest of these fish can also negatively impact recovery. It is not possible to determine the sex of southern flounder prior to harvest and therefore, immature females would still be harvested.

Slot limits with a minimum length smaller than the current minimum length would increase the harvest of small fish. Because the southern flounder population is dominated by young fish (Flowers et al. 2019), this could significantly increase the overall number of fish harvested due to their greater availability. This increase in harvest would increase the fishing mortality rate.

In contrast, a reduction in the minimum size limit when implementing a slot limit may allow increased harvest on summer flounder. Summer flounder caught in North Carolina are typically smaller than southern flounder. As recreational size limits have increased through regulatory changes over the years, the ratio of harvest between summer and southern flounder has changed (Figure 14 in the *Description of Fisheries* section).

The recreational size limit for flounder has been 15 inches TL since 2011 and multiple size limit changes have occurred over the time series making it difficult to determine any effect lowering the size limit would have. Any calculations performed would introduce a high level of imprecision and be based on data that may not be representative of the current fishery. There are numerous concerns with decreasing the minimum size limit for the recreational sector. These concerns

revolve around the large volume of recreational discards of fish that are currently under the 15-inch TL minimum size limit (approximately 1.9 million fish in 2017). Lowering the minimum size limit would potentially turn these discards into harvest. Increasing the harvest from the recreational fishery would not meet the projected reductions necessary for rebuilding, and under adaptive management would lead to shortened or closed seasons. Data are not available on the size of discards so it is unclear how harvest would change if the minimum size for a slot was dropped to 12- or 13-inches TL. When the size limits were lower (1989-2007), these smaller fish accounted for 30-40% of the recreational harvest.

The slot limit options proposed have a minimum size of 15 inches TL. This is because MRIP staff do not see discarded flounder and therefore do not collect any associated biological data. Data on the species composition and length of discarded flounder is not available. This overwhelming data limitation prohibits calculating the potential impact of lowering the size limit or implementing a slot limit with a lower bound below the current size limit. The division's License and Statistics section has developed a smartphone application (Catch U Later!) to collect information on discarded flounder to help identify not only species composition of discards but length frequency as well. Data from this app will be available over the next several years. As these data are collected, determining the impact of lowering the size limit will be possible.

The following are additional positive (+) and negative (-) impacts on lowering the minimum size limit below 15 inches TL.

+ Would reduce the harvest of larger females
+ May increase the harvest of males
- Cannot evaluate sustainable harvest of slot limits with a reduced minimum size limit
- Would likely increase the number of fish harvested
- Smaller minimum size limit would expose smaller fish to harvest, including smaller females
- No guarantee that harvest of males will increase
- Would not prevent dead discards of larger fish
- The larger fish that are released and die will contribute to increasing the average weight of dead discards reducing the available weight for harvest
- The combination of increased harvest of small fish and increased dead discard weight of larger fish is likely to lead to overages in the fishery
- Would impact summer flounder harvest and require ASMFC/MAFMC approval

<u>Additional Management Considerations</u>

It should be noted that while the NCMFC may choose a preferred slot limit as a management option, the NCDMF would need approval from ASMFC to implement any changes to the current minimum size limit. The ASMFC has implemented state and/or regional level conservation equivalencies for the management of summer flounder since 2001 (ASMFC 2017). Conservation equivalency management measures are reviewed annually and based on the coast-wide summer flounder recreational harvest limit and overages when they occur. The ASMFC must be notified of any changes to the summer flounder fishery in North Carolina state waters; however, approval of changes by the ASMFC is not required if the changes are expected to be more restrictive than

the management measures already approved by the ASMFC. Conservation equivalencies may not be approved by ASMFC until the February following Amendment 3 implementation. Therefore, slot limits, if approved by the NCMFC and the ASMFC, would not be implemented until the 2023 fishing year at the earliest. If ASMFC does not approve slot limits as part of North Carolina's conservation equivalency for summer flounder, the state could be found out of compliance through the Summer Flounder, Scup, and Black Sea Bass FMP. These interjurisdictional regulations impact the North Carolina fishery as state management of flounder is collective and not by individual species. Further, management regulations through ASMFC continue to increase the summer flounder minimum size limit, indicating approval of a lower minimum size might not occur. If the NCMFC were to implement a slot limit with a lower minimum size without ASMFC approval, North Carolina could be found out of compliance leading to a closure of the fishery.

Changes to the summer flounder fishery in EEZ waters off North Carolina may be impacted by the Mid-Atlantic Fishery Management Council and National Marine Fisheries Service (NMFS). Until conservation equivalencies are approved by NMFS (which usually occurs in May or June), coast-wide measures for summer flounder in the EEZ include a four-fish possession limit, a 19-inch TL minimum size limit, and an open season of May 15–Sept. 15 (MAFMC 2019). These measures serve as a default each year until annual conservation equivalencies are approved by the NMFS, which allow state regulations to be applied to EEZ waters.

PROPOSED MANAGEMENT OPTIONS

Management Options

(+ potential positive impact of action)
(- potential negative impact of action)

Below are overarching positive (+) and negative (-) impacts for all options, specific impacts from an option may be found below that option.

Option 1. Status quo, Do not implement a slot limit and maintain the 15-inch TL current minimum size limit.

+ Maintains current regulations and allows anglers to harvest citation size flounder
+ Meets compliance requirements for summer flounder through the joint ASMFC/MAFMC plans
+ Doesn't create regulatory disparity between the recreational hook-and-line and gig fisheries
+ Meets sustainability if harvest is below the TAL
+ Escapement of mature fish is occurring through the 72% reduction
- Would not reduce the harvest of larger, more fecund females
- Does not provide additional protections to the stock

Option 2. Implement a slot limit for the recreational hook-and-line fishery.

The following positive and negative impacts apply to all of option 2.

+ May help to constrain harvest and prevent overages if used in conjunction with the TAL and seasons for the recreational hook-and-line fishery

+ Meets sustainability if harvest is below the TAL
+/- Potentially allows for additional escapement of the larger, more fecund females
- Requires approval from ASMFC/MAFMC for conservation equivalency, which may not be approved
- Larger fish protected by the slot limit in the recreational fishery may be harvested by the commercial fishery later in the year
- Fish discarded outside of the slot have an associated mortality and dead discards would increase
- May increase the number of fish harvested to meet the same TAL
- Would increase overall weight of dead discards and could potentially lead to exceeding TAC and not meeting the needed overall reduction
- May disproportionately impact gig and RCGL gill-net fisheries if applied to all recreational gear, not just the hook-and-line fishery
- Greater potential for noncompliance and high grading
- Does not allow anglers to harvest citation size flounder

2A. Implement a 15 to16 Inch (1 inch) TL Slot Limit.
2B. Implement a 15 to 17 Inch (2 inch) TL Slot Limit.
2C. Implement a 15 to 18 Inch (3 inch) TL Slot Limit.
2D. Implement a 15 to 19 Inch (4 inch) TL Slot Limit.

RECOMMENDATION

See Appendix 5 for a summary of all comments and recommendations gathered from NCDMF, the NCMFC advisory committees, and public for the Southern Flounder FMP Amendment 3.

NCMFC Selected Management Strategy

Option 1. Status quo, Do not implement a slot limit and maintain the 15-inch TL current minimum size limit.

LITERATURE CITED

ASMFC (Atlantic States Marine Fisheries Commission). 2017. Addendum XXVIII to the summer flounder, scup, and black sea bass fishery management plan: summer flounder recreational management in 2017. Arlington, VA. 13 p.

ASMFC. 2018. Draft Addendum XXXI to the summer flounder, scup, and black sea bass fishery management plan for public comment. Arlington, VA. 36 p.

Ayllon, D., S.F. Railsback, A. Almodovar, G.G. Nicola, S. Vincenzi, B. Elvira, and V. Grimm. 2018. Eco-evolutionary responses to recreational fishing under different harvest regulations. Ecology and Evolution 8:9600-9613.

Ayllon, D., G.G. Nicola, B. Elvira, and A. Almodovar. 2019. Optimal harvest regulations under conflicting tradeoffs between conservation and fisheries objectives. Fisheries Research 2016: 47-58.

Baker, J.P., H. Olem, C.S. Creager, M.D. Marcus, and B.R. Parkhurst. 1993. Chapter 8: Management techniques for Improving and Maintaining Fisheries in Lakes and Reservoirs *in* Fish and Fisheries Management in Lakes and Reservoirs. EPA 841- R - 93-002. Terrene Institute and U.S. Environmental Protection Agency, Washington, DC.

Brousseau, C.S. and E.R. Armstrong. 1987. The role of size limits in walleye management. Fisheries 12(1): 2-5.

Dorval, E. et al. 2005. Can otolith chemistry be used for identifying essential seagrass habitats for juvenile spotted seatrout, *Cynoscion nebulosus*, in Chesapeake Bay? Marine and freshwater research 56(5): 645-653

Flowers, A.M., S.D. Allen, A.L. Markwith, and L.M. Lee (editors). 2019. Stock assessment of southern flounder (*Paralichthys lethostigma*) in the South Atlantic, 1989–2017. Joint report of the North Carolina Division of Marine Fisheries, South Carolina Department of Natural Resources, Georgia Coastal Resources Division, Florida Fish and Wildlife Research Institute, University of North Carolina at Wilmington, and Louisiana State University. NCDMF SAP-SAR-2019-01. 213 p.

Gwinn, D.C., M.S. Allen, F.D. Johnston, P.Brown, C.R. Todd, and R. Arlinghaus. 2015. Rethinking length-based fisheries regulations: the value of protecting old and large fish with harvest slots. Fish and Fisheries 16: 259-281.

Honeycutt, J. L., C. A. Deck, S. C. Miller, M. E. Severance, E. B. Atkins, J. A. Luckenbach, J. A. Buckel, H. V. Daniels, J. A. Rice, R. J. Borski, and J. Godwin. 2019. Warmer waters masculinize wild populations of a fish with temperature-dependent sex determination. Scientific Reports 9(1):6527.

Kasper, J.M., J. Brust, A. Caskenette, J. McNamee, J.C. Vokoun, and E.T. Shultz. 2020. Using harvest slot limits to promote stock recovery and broaden age structure in marine recreational fisheries: a case study. North American Journal of Fisheries Management 40(6):1451–1471.

Luckenbach, J. A., R. J. Borski, H. V. Daniels, and J. Godwin. 2009. Sex determination in flatfishes: Mechanisms and environmental influences. Seminars in Cell & Developmental Biology 20(3):256–263.

Luckenbach, J. A., J. Godwin, H. V. Daniels, and R. J. Borski. 2003. Gonadal differentiation and effects of temperature on sex determination in southern flounder (*Paralichthys lethostigma*). Aquaculture 216(1–4):315–327.

MAFMC (Mid-Atlantic Fisheries Management Council). 2019. Framework adjustment 14 to the summer flounder, scup, and black sea bass fishery management plan. Dover, DE. 161 p.

Midway, S. R., and F. S. Scharf. 2012. Histological analysis reveals larger size at maturity for southern flounder with implications for biological reference points. Marine and Coastal Fisheries 4:628–638.

Montalvo, A. J., C. K. Faulk, and G. J. Holt. 2012. Sex determination in southern flounder, *Paralichthys lethostigma*, from the Texas Gulf Coast. Journal of Experimental Marine Biology and Ecology 432–433:186–190.

Moreau, C.M. and B.G. Matthias. 2018. Using limited data to identify optimal bag and size limits to prevent overfishing. North American Journal of Fisheries Management 38:747-758.

Morson, J.M., D. Munroe, R. Harner, and R. Marshall. 2017. Evaluating the potential for a sex-balanced harvest approach in the recreational summer flounder fishery. North American Journal of Fisheries Management 37(6):1231–1242.

NCDMF (North Carolina Division of Marine Fisheries). 2005. North Carolina southern flounder (*Paralichthys lethostigma*) fishery management plan. North Carolina Division of Marine Fisheries, Morehead City, NC. 260 p.

NCDMF. 2013. North Carolina southern flounder (*Paralichthys lethostigma*) fishery management plan: Amendment 1. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 380 p.

NCDMF. 2017. North Carolina southern flounder (*Paralichthys lethostigma*) fishery management plan: Supplement A to Amendment 1. North Carolina Division of Marine Fisheries, Morehead City, NC. 83 p.

NCDMF. 2021. Southern flounder *in* 2020 Fishery management plan review. North Carolina Division of Marine Fisheries, Morehead City, NC.

Oliver, D.C., N.P. Rude, G.W. Whitledge, and D.S. Stich. 2021. Evaluation of recently implemented harvest regulations in a data-limited catfish fishery with Bayesian estimation. North American Journal of Fisheries Management. [online serial]

Stokes, G.M. 1977. Life history studies of southern flounder (*Paralichthys lethostigma*) and Gulf flounder (*P. albigutta*) in the Aransas Bay area of Texas. Technical Series 25. Texas Parks and Wildlife Department. 21 p.

Walsh, H.J., D. S. Peters, and D.P. Cyrus. 1999. Habitat utilization by small flatfishes in a North Carolina estuary. Estuaries 22(3): 803-813.

Watanabe, W.O., P. Carrol, and H.V. Daniels. 2001. Sustained, natural spawning of southern flounder *Paralichthys lethostigma* under an extended photothermal regime. Journal of World Aquaculture Society 32:153–166.

Wiedenmann, J., M. Wilberg, E. Bochenek, J. Boreman, B. Freeman, J. Morson, E. Powell, B. Rothschild, and P. Sullivan. 2013. Evaluation of management and regulatory options for the summer flounder recreational fishery. Available (March 2021): http://www.mafmc.org/s/A-Model-to-Evaluate-Recreational-Management-Measures.pdf

Wong, R. 2009. Slot limit management for recreational summer flounder harvest. Delaware Division of Fish and Wildlife.

APPENDIX 4.7. PHASING OUT ANCHORED LARGE-MESH GILL NETS IN THE NORTH CAROLINA SOUTHERN FLOUNDER FISHERY

ISSUE

Explore the impacts of phasing out anchored large-mesh gill nets from the North Carolina southern flounder fishery by the end of the current Incidental Take Permit (ITP) year.

ORIGINATION

This issue originated from a request brought forth by the North Carolina Marine Fisheries Commission.

BACKGROUND

At their March 2021 NCMFC special business meeting, the NCMFC requested the division explore the impacts of phasing out anchored large-mesh gill nets from the southern flounder fishery by the end of the current ITP. The current North Carolina ITP for the authorized incidental take of threatened and endangered sea turtles expires August 31, 2023, and the ITP authorizing incidental takes of threatened and endangered Atlantic sturgeon expires July 17, 2024 (NMFS 2013, 2014). The division is drafting an application for a new ITP to authorize incidental takes of sea turtles and Atlantic sturgeon for 10 years after the sea turtle ITP expires in 2023. If an option included in this issue paper is approved by the NCMFC, the use of anchored large-mesh gill nets could be phased out by the end of the current sea turtle ITP in August 2023. Due to the timing of the southern flounder season, 2022 may be the final year of the North Carolina southern flounder large-mesh gill net fishery if these measures are adopted by the NCMFC.

Early commercial fishermen tended to use pound nets, seines, gill nets, and spears (gigs) to harvest southern flounder in North Carolina (Chestnut and Davis 1975). Throughout the 1970s - early 1990s, pound net gear ranked highest in the total landings of southern flounder. During the mid-1990s, gill net landings surpassed those of pound nets. Gill nets continued to maintain the highest ranking in landings until 2014, when pound nets once again moved into the top position. The third highest ranking gear for southern flounder is gigs. From 2008 to 2017, on average 53% of southern flounder landings have been from gill nets, 38% from pound nets, and 7% from gigs (Table 4 in the *Description of the Fisheries* section, Figure 4.7.1). Landings from other gears accounted for, on average, 2% of the total landings and included crab and peeler pots, crab and shrimp trawls, rod and reel, fyke nets, and haul seines. Due in part to increased regulatory measures, landings from gill nets have declined from 68% to near 40% during this time frame.

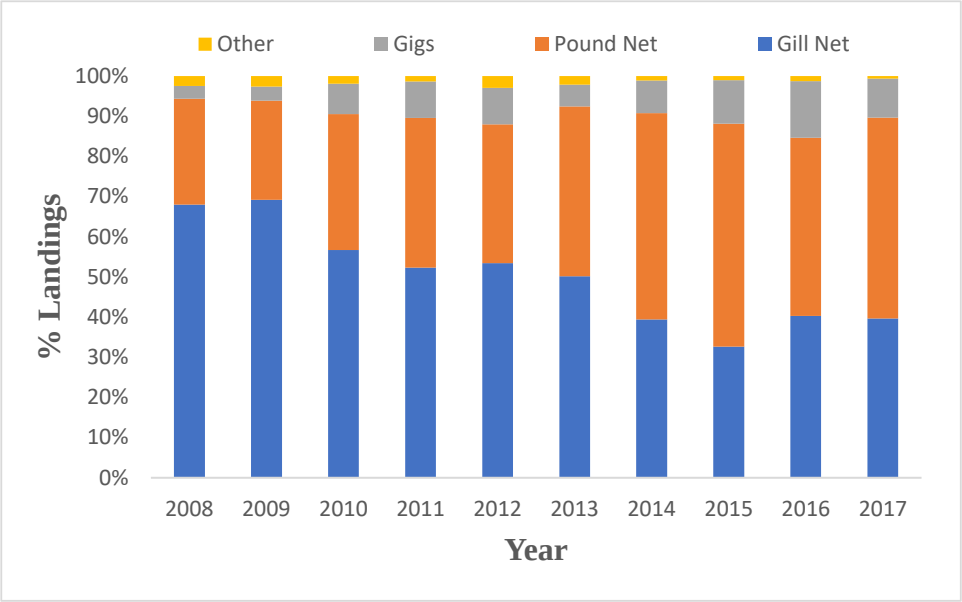


Figure 4.7.1. Percent of annual southern flounder commercial landings by gear type, 2008-2017.

Phasing out a single gear in the southern flounder fishery does not impact sustainable harvest of the southern flounder stock if a quota management system is implemented. Harvest by all gears can be allowed if the total harvest level does not exceed the TAL and dead discards and harvest combined do not exceed the TAC. Phasing out anchored large-mesh gill nets would allow the sub allocation for that gear to be applied to the remaining gears in the commercial fishery. This would result in additional TAL for pound nets and/or mobile gears, but the dead discards of southern flounder occurring through other large-mesh gill net fisheries (i.e., shad, catfish) would be applied to the TAC.

North Carolina additionally allows the recreational use of commercial gears. RCGL holders may use large and small mesh gill nets as well as shrimp trawls and crab pots to harvest species including southern flounder. Between 2002 and 2008, large-mesh gill nets comprised 74% of southern flounder harvested using RCGL gears, with small mesh gill nets (21%), crab pots (4.0%), and shrimp trawls (1%) constituting the remainder among RCGL gears. The number of flounder species harvested between 2002 and 2008 ranged from 18,414 to 53,785 fish annually (Figure 4.7.2).

Estimates of RCGL harvest have not been available since 2008 and thus impacts are not quantifiable. If phasing out of the large-mesh gill net commercial fishery is not approved, the use of RCGL gill nets to harvest southern flounder may still be disallowed through Amendment 3 under sustainable harvest. For more information on RCGL and southern flounder see the *Description of the Fisheries* section and the *Achieving Sustainable Harvest* issue paper.

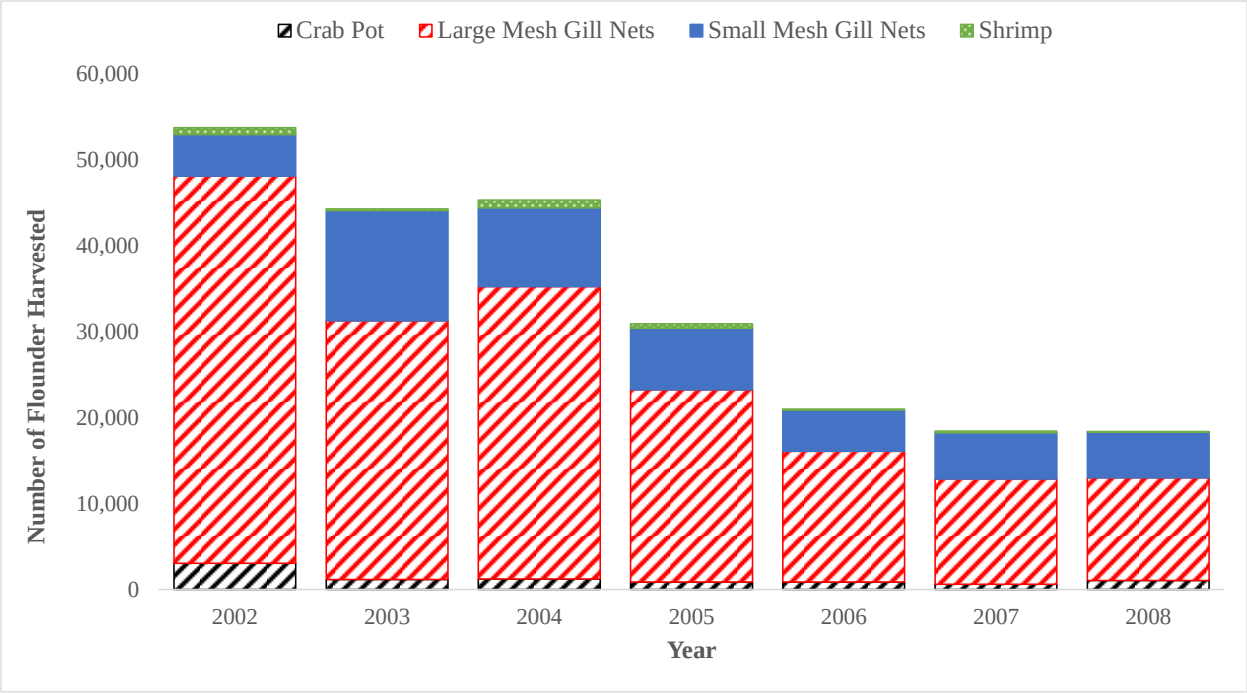


Figure 4.7.2. Number of flounder species harvested by RCGL gear type, 2002-2008.

AUTHORITY

North Carolina General Statutes

G.S. 113-134 RULES
G.S. 113-173 RECREATIONAL COMMERCIAL GEAR LICENSE
G.S. 113-182 REGULATION OF FISHING AND FISHERIES
G.S. 113-182.1 FISHERY MANAGEMENT PLANS
G.S. 143B-289.52 MARINE FISHERIES COMMISSION – POWERS AND DUTIES

North Carolina Marine Fisheries Commission Rules

15A NCAC 03H .0103 PROCLAMATIONS, GENERAL
15A NCAC 03M .0503 FLOUNDER
15A NCAC 03O. 0302 AUTHORIZED GEAR

DISCUSSION

At the March 2021 special meeting, the NCMFC requested that the division evaluate the potential to phase out the use of large-mesh gill nets in the southern flounder fishery by the end of the current ITP during development of Amendment 3. The possible elimination of specific gears (i.e., anchored large-mesh gill nets) for harvesting southern flounder for either the commercial or recreational fishery is statutorily granted to the NCMFC by G.S. 143B-289.52. The division provides the best available data for a fishery (gear) to meet the mandate for producing a sustainable harvest of the southern flounder stock and to evaluate impacts to habitat.

Large-mesh gill nets are regulated by NCDMF through proclamation authority provided by the NCMFC to the Fisheries Director. Phasing out large-mesh gill nets in the southern flounder fishery

would be accomplished using this authority by prohibiting the use of large-mesh gill nets for harvesting southern flounder. This would impact RCGL holders as well since large-mesh gill nets would not be an allowable gear to harvest southern flounder. Regulations involving the RCGL are found in G.S. 113-173 and NCMFC Rule 15A NCAC 03O.0302 that authorize certain commercial fishing gear for recreational use. A rule change(s) by the NCMFC is required to completely prevent a specific gear from being used across all fisheries in the state by commercial and RCGL license holders. Additional information on the RCGL can be found in the *Description of the Fisheries* section and the *Achieving Sustainable Harvest* issue paper.

Southern Flounder Large-Mesh Gill Net Fishery

During 2008-2017, an annual average of 808 participants (range: 591- 992) reported southern flounder landings from gill nets. These participants landed southern flounder from 14,643 trips on average from 2008-2017, though not all trips that landed southern flounder were targeting them (Figure 4.7.3). The number of trips landings southern flounder has declined from a high of 23,691 trips in 2009 to a low of 8,422 trips in 2016 (Table 5 in the *Description of the Fisheries* section).

In order to characterize common species caught in the southern flounder gill net fishery, a targeted southern flounder trip reported to the NCTTP was defined as any large-mesh gill net trip where southern flounder represented the most abundant species (by weight). This definition accounted for greater than 93% of all southern flounder landings from large-mesh gill nets from 2013 to 2017. Generally, trips targeting southern flounder increased through the summer and peak in the fall (September and October) coinciding with the migration of southern flounder from the estuaries to the ocean prior to spawning as shown in Figure 4.7.3. During the remainder of the year, southern flounder were harvested in gill nets as part of other directed fisheries but were most commonly taken as part of a mixed finfish fishery. From 2013 to 2017, 73% of the large-mesh gill net trips landed southern flounder and 54% met the definition of a targeted trip for southern flounder. From June through October, greater than 75% of all trips made were targeted flounder trips. Only during December (closed season) and January through April, were directed southern flounder trips not the dominate trip type in the large-mesh gill net fishery. Trips during these months tend to be dominated by catches of catfishes, striped bass, and American shad, among other species.

Both finfish and shellfish species may be caught as bycatch in gill net trips targeting southern flounder. This bycatch may be retained or discarded as a result of economic, regulatory, or personal considerations. While southern flounder dominates the catch, the estuarine gill net fishery represents a mixed fishery with multiple species being taken on any given trip. Species include red drum, black drum, catfish species (including invasive blue catfish), sheepshead, spotted seatrout, American and hickory shad, striped bass, bluefish, striped mullet, and an additional 40+ species (Figure 4.7.4). Phasing out anchored large-mesh gill nets would impact the harvest of these other species as well. In addition, continuing to set large-mesh gill nets in areas where southern flounder are present could have an impact on rebuilding the stock as the species would be required to be discarded. Southern flounder caught in gill nets have an initial at net mortality associated with entanglement and an approximate 23% post-release mortality (Flowers et al. 2019).

Protected Species and Incidental Take Permits

Since the 1970s, the NCDMF has been proactive in developing ways to minimize impacts to threatened and endangered marine species. The NCDMF works closely with the National Oceanic and Atmospheric Administration (NOAA) Fisheries and other state and federal agencies to develop regulations that minimize impacts to protected species and still allow for economically important fisheries. Of the many federal and state protected species, sea turtles and sturgeon are considered to have the greatest potential to interact with the North Carolina southern flounder fishery. Gill nets may capture protected species as a result of entanglement in the webbing or buoy and anchor lines.

Incidental capture of protected sea turtles and Atlantic sturgeon commonly occurs in the southern flounder gill net fishery. The fishery has undergone various regulations since the early 2000s to monitor and minimize impacts to protected sea turtles. The NCDMF currently allows the estuarine anchored gill net fishery to operate under the authorization from permits (ITP; Section 10(a)(1)(B) of the ESA) granted to the state by NOAA Fisheries for the incidental take of sea turtles and Atlantic sturgeon associated with otherwise lawful commercial gill net fishery in North Carolina inshore state waters (NMFS 2013, 2014). The permits outline authorized levels of annual incidental takes in these fisheries. The state as permit holder must monitor, minimize, and mitigate incidental takes as set forth in the conservation plan provided in the permit. The permits are in effect for a 10-year period: the sea turtle permit was issued in September 2013 and the Atlantic sturgeon permit was issued in July 2014. Since September 2014 (2015 license year), the division has been issuing estuarine gill net permits to any commercial fisherman or RCGL holder who wants to fish anchored gill nets (https://files.nc.gov/ncdeq/Marine-Fisheries/fisheries-management-proclamations/2014/M-24-2014-EGNP.pdf). During 2016-2021, an average of 2,619 permits were issued annually (Table 3 in the *Description of the Fisheries* section). These permits provide the division with the number of participants who may choose to participate in the gill net fishery using large-mesh or small-mesh gill nets. Not all commercial license holders who obtain an estuarine gill net permit report flounder landings using the gear. For information specific to the North Carolina Incidental Take Permit for sea turtle interactions in the estuarine gill net fishery see: https://www.federalregister.gov/documents/2013/09/17/2013-22592/endangered-species-file-no-16230. For specific details related to the Atlantic sturgeon incidental take permit see: https://www.federalregister.gov/documents/2014/07/28/2014-17645/endangered-species-file-no-18102.

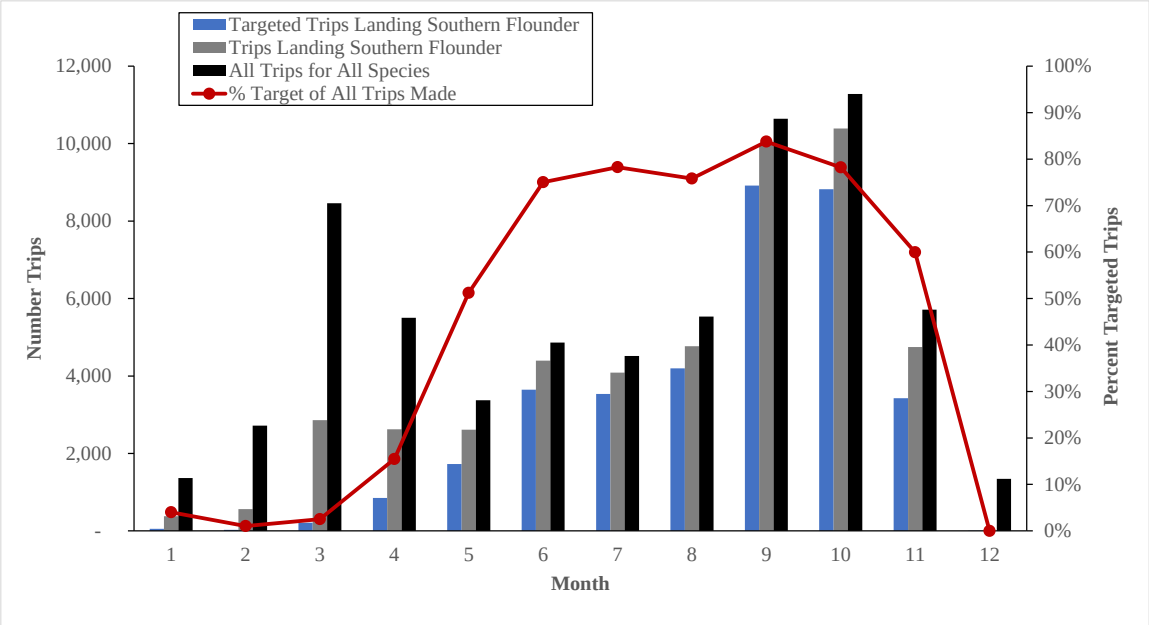


Figure 4.7.3. Total gill net trips compared to gill net trips targeting or landing southern flounder.

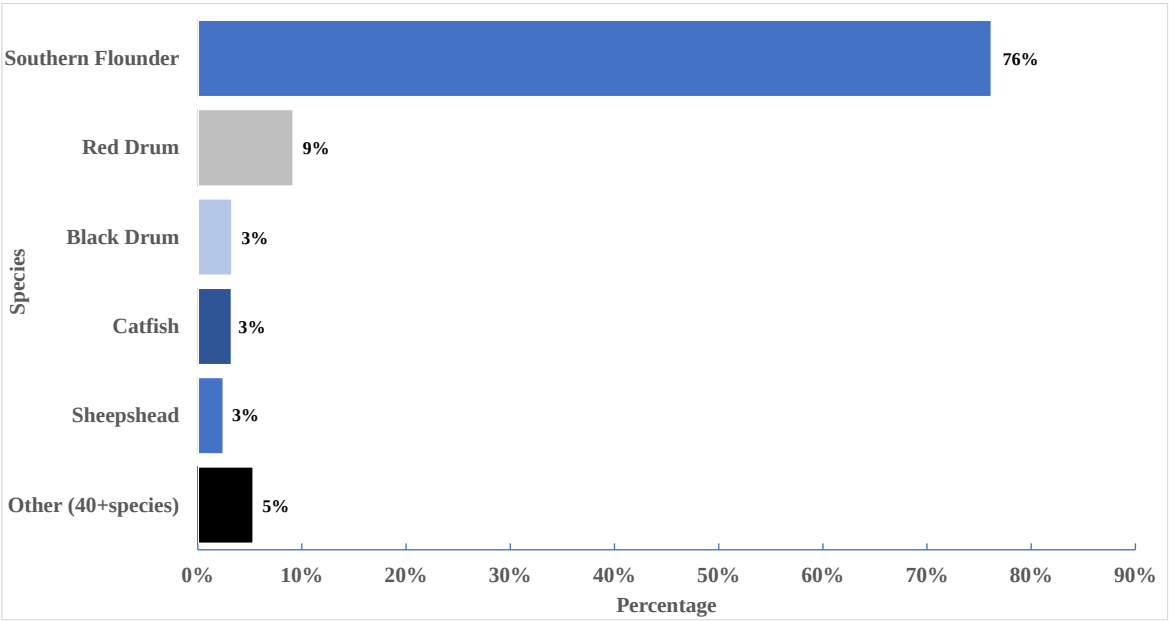


Figure 4.7.4. Top species harvested from anchored large-mesh gill nets where southern flounder are the most abundant species, 2013-2017.

Habitat Impacts

Phasing out anchored large-mesh gill nets in the southern flounder fishery would not offer significant habitat protections. Studies on the effect of anchored (or fixed) gill nets on habitat degradation indicate their impact is minor for soft bottom and SAV habitat (Barnette 2001; West et al. 1994; ASMFC 2000).

Economic Impacts

Economic impacts of phasing out the anchored large-mesh gill net fishery for southern flounder would be negative to all commercial license holders who participate in the fishery. The landings could be transferred to the pound net or other mobile gear fisheries, increasing the economic benefits of those gears. The economic impacts may include up to 808 participants on average in the gill net fishery but the participants may choose to enter the gig and or pound net fishery if they do not already participate in them (Table 5 in the *Description of the Fisheries* section). This could alter the average ex-vessel dockside value of $4,476,342 from the southern flounder commercial fishery by moving the gill net values to another gear category where price per pound may be higher on average (Table 8 in the *Description of the Fisheries* section). Over the last 10 years, the gill net fishery has accounted for a total of $22,293,674 of ex-vessel value from the southern flounder fishery (Table 4.5.6 in the *Recreational and Commercial Sector Allocation* issue paper). If large-mesh gill nets are no longer allowed to harvest southern flounder these values may shift to another gear. These effects are a guide as some license holders participate in multiple fisheries.

In terms of evaluating the economic impact of removing all inshore large-mesh gill nets from North Carolina, traditional methods of quantifying this change would not be adequate. Specifically, a change of this magnitude would no longer result in marginal shifts in landings from specific fisheries in the state. Rather, this regulation would likely lead to large-scale behavioral adjustments from a range of stakeholders in the seafood supply chain, causing market shifts, changes in spending and employment, and an overall reorganizing of the state's inshore fisheries. While there would likely be large benefits in certain facets, such as stock health and recreational access, the costs associated with restructuring part of the state's inshore fishing fleet are nearly impossible to predict and go beyond traditional economic impact assessments.

Impacts to the stock due to changes in gill net regulations can be difficult to quantify due to many factors including behavior shifts in the fishery participants. Luczkovich et al. (2021) developed a pair of socio-ecological model scenarios that showed differing impacts based on no additional effort using alternative gears and increasing effort using alternative gears in Core Sound, NC. If effort using alternative gears was not increased, the model predicted increases to the stock size, but if effort using alternative gears did increase the model predicted reductions to the stock size, depending on the behavior changes within the industry (Luczkovich et al. 2021). This study showed a species response to management actions can be contrary to management goals. That is, prohibiting the use of gill nets may alter the behavior of fishermen and make them use alternate gears with higher impacts on the target species or the ecosystem as a whole (Luczkovich et al. 2021).

PROPOSED MANAGEMENT OPTIONS

Management Options

(+ potential positive impact of action)
(- potential negative impact of action)

Option 1. Phase out anchored large-mesh gill nets from the southern flounder fishery at the end of the current sea turtle ITP.

+ Would allow for increased harvest from other commercial gears
+ Would increase protections of threatened and endangered species
+ May increase the economic impact of the remaining gears
+ May reduce user conflict
+ May reduce costs associated with the large mesh observer program or allow increased coverage for other gears
+/- Gear elimination not based on sustainable harvest
+/- Would require adjusting the sub-allocations for the commercial fishery
+/- Would impact harvest of non-target species
- Would eliminate a historical gear from the southern flounder fishery
- Would impact the largest group by number of trips and participants in the commercial fishery
- Gill nets would still be allowed for other species so discards of southern flounder may still occur
- Would decrease the economic benefit of the commercial gill net fishery
- Some regions may be impacted more than others

Option 2. Status Quo, continue to allow anchored large-mesh gill nets to harvest southern flounder in the North Carolina southern flounder fishery.

+ Continued use of large-mesh gill net fishery to harvest southern flounder
+ Maintain economic impacts of the large-mesh gill net fishery
+ Less impacts to the largest user group in numbers and trips
+/- Continued harvest of non-target species
+/- Less impacts to sub-allocations
- Continued impacts to threatened and endangered species
- May not allow for increased harvest of other gears

RECOMMENDATION

See Appendix 5 for a summary of all comments and recommendations gathered from NCDMF, the NCMFC advisory committees, and public for the Southern Flounder FMP Amendment 3.

NCMFC Selected Management Strategy

Option 2. Status Quo, continue to allow anchored large-mesh gill nets to harvest southern flounder in the North Carolina southern flounder fishery.

LITERATURE CITED

ASMFC (Atlantic States Marine Fisheries Commission). 2000. Evaluating fishing gear impacts to submerged aquatic vegetation and determining mitigation strategies. ASMFC Habitat Management Series #5, Washington D.C., 46p.

Barnette, M.C. 2001. A review of the fishing gear utilized within the Southeast Region and their potential impacts on essential fish habitat. NOAA Technical Memorandum NMFS-SEFSC-449, 62p.

Chestnut, A. F., and H. S. Davis. 1975. Synopsis of marine fisheries of North Carolina: Part I: Statistical Information, 1880-1973. University of North Carolina, Sea Grant Program, Sea Grant Publication UNC-SG-75-12, Raleigh.

Luczkovich, J.J, J.C. Johnson, R.A. Deehr, K.J. Hart, L. Clough, and D.C Griffith. 2021. Linking Fishing Behavior and Ecosystem Dynamics Using Social and Ecological Network Models. Front. Ecol. Evol. 9:662412. DOI: 10.3389/fevo.2021.662412.

NMFS (National Marine Fisheries Service). 2013. Endangered Species; File No. 16230. Notice of permit issuance. Federal Register 78:57132–57133.

NMFS. 2014. Endangered Species; File No. 18102. Issuance of permit. Federal Register 79:43716–43718.

West, T.L., W.C. Ambrose Jr, and G.A. Skilleter. 1994. A review of the effects of fish harvesting practices on the benthos and bycatch: implications and recommendations for North Carolina. US Environmental Protection Agency and N.C. DEHNR, Raleigh, NC. 107p.

APPENDIX 5. SUMMARY OF NCDMF AND ADVISORY COMMITTEE RECOMMENDATIONS FOR ISSUE PAPERS IN DRAFT AMENDMENT 3 TO THE SOUTHERN FLOUNDER FISHERY MANAGEMENT PLAN

Table 5.1. NCDMF and MFC regional and standing committees recommendations and public review for Southern Flounder FMP Amendment 3, March 2022.

Issue paper recommendations	NCDMF	Northern Regional Advisory Committee - 1/11/22	Southern Regional Advisory Committee - 1/12/22	Finfish Standing Advisory Committee - 1/13/22	Public Questionnaire
Sustainable Harvest Issue Paper					
Commercial - quota	Implement a commercial quota through a mobile gear and pound net category with the mobile gears divided in to 2 areas at the B-D boundary line and the pound net fishery divided into 3 areas consistent with Amendment 2	Support the division's recommendation of Option 1.1.A and 1.2.A.	Accept the division recommendation option 1.1.A and 1.2.A.	Accept division recommendations Option 1.1.A and 1.2.A.	• Respondents who self-identified as recreational supported a single state-wide area for both mobile gears and pound nets • Respondents who self-identified as commercial supported three areas for both mobile gears and pound nets
Commercial - sub-allocation	Maintain the commercial pound net allocation as reductions occur through allocation changes	Support the division recommendation of Option 2.2 Maintain current sub-allocations for pound net fishery.	Accept the division recommendation of Option 2.2 Maintain current sub-allocation for pound net fishery.	Support Option 2.1 Sub-allocations based on 2017 landings.	Respondents supported dividing the gill net landings between the other mobile gears and pound nets.
Recreational Season - hook & line/gigs	Implement a recreational quota through a single recreational season	Support the division's recommendation on managing the recreational fishery by season.	Accept the division recommendation Option 3 recreational season.	Support the division recommendation Option 3 of a recreational season	Respondents supported managing the recreational fishery by a season
Commercial - trip limit	Allow the division to implement trip limits for the commercial pound net and gig fishery only as a way to reopen the fishery after initial closure	Support Option 4A: Implement trip limit for pound net and gigs upon reopening after reaching division closure threshold.	Accept the division recommendation Option 4A: Implement trip limit for pound net and gigs upon reopening after reaching division closure threshold.	Support Option 4C: Status quo, no trip limits.	• Respondents who self-identified as recreational supported trip limits. • Respondents who self-identified as commercial narrowly did not support trip limits. • Respondents who supported trip limits supported trip limits for all gears.
Recreational - bag limit	Reduce the recreational hook-and-line and gig fisheries bag limit to a 1-fish per person/per day	Support the division recommendation of Option 5.A 1 fish/person/day.	Support 1 fish/person/day bag limit if there was a considerably longer open season (during summer/fall).	Support division recommendation Option 5.A. 1 fish/person/day.	• Most respondents supported changing bag limits • Most respondents still supported 4 fish/person/day. The second most supported bag limit was 2 fish/person/day

Issue paper recommendations	NCDMF	Northern Regional Advisory Committee - 1/11/22	Southern Regional Advisory Committee - 1/12/22	Finfish Standing Advisory Committee - 1/13/22	Public Questionnaire
Recreational - RCGL	Prohibit RCGL holders from harvesting southern flounder	Follow the division recommendation Option 6B- prohibit use of RCGL to harvest flounder.	Support the division recommendation Option 6B: Prohibit use of RCGL to harvest flounder.	Support Option 6A: Allow RCGL to harvest flounder when commercial and recreational fisheries both open.	• Respondents who self-identified as recreational supported not allowing RCGL to harvest flounder • Respondents who self-identified as commercial supported allowing RCGL to harvest flounder when commercial and recreational fisheries both open
Increased Recreational Access Issue Paper	Allow an ocellated flounder season in the ocean using hook-and-line gear only from March 1 through April 15 with a 1 fish bag limit	Support Option1 status quo, manage as one group.	Support the division recommendation Option 2: 1-fish ocellated bag March 1-April 15 in ocean; 1-fish any species bag during southern flounder season.	Recommend the MFC design an ocean caught recreational ocellated flounder fishery that will not hinder the present southern flounder fishery established in Amendment 3.	Respondents did not support increasing recreational access through an ocellated season.
Inlet Corridors Issue Paper	Do not implement inlet corridors at this time	Support Option 1: Status quo, do not establish inlet corridors during spawning migration.	Maintain the ability to implement inlet corridors as adaptive management if research indicates it is appropriate.	Support Option 1: Status quo, do not establish inlet corridors during spawning migration.	• Respondents who self-identified as recreational supported implementing inlet corridors for all gears • Respondents who self-identified as commercial supported not implementing inlet corridors. If inlet corridors were implemented, commercial respondents supported them for specific gears only.
Adaptive Management Issue Paper	Adopt adaptive management framework for Amendment 3	Support Option 1- adaptive management framework.	Support the division recommendation to adopt an adaptive management framework.	No motion passed	Respondents supported adopting the adaptive management framework.
Slot Limits Issue Paper	Do not implement slot limits for flounder at this time	Support slot limits be considered as soon as the division has sufficient data on discard size distribution to inform the size of slot.	Support the division recommendation Option 1 status quo, no slot limit.	Support Option 1: Status quo, no slot limit.	• Most respondents did not support a slot limit. • Respondents that supported a slot limit supported a 15 – 19-inch slot.
Phase Out Large-Mesh Gill Nets Issue Paper	Allow harvest of southern flounder using commercial anchored large- mesh gill nets	Support Option 2: Status quo, allow large-mesh gill nets to harvest southern flounder during the commercial season.	No motion passed.	Support Option 2: Status quo, allow large-mesh gill nets to harvest southern flounder during the commercial season.	• Respondents who self-identified as recreational supported phasing out anchored large-mesh gill nets. • Respondents who self-identified as commercial supported not phasing out anchored large-mesh gill nets.