NC Marine Fisheries Commission

Fishery Management Plans

August 2024 Quarterly Business Meeting

Document

Spotted Seatrout FMP Amendment 1 Decision Document

Draft Spotted Seatrout FMP Amendment 1

Southern Flounder Update Memo

Stock Assessment of Southern Flounder in the South Atlantic, 1989–2022

Fishery Management Plan Annual Review Summary

Draft N.C. Fishery Management Plan Schedule

DECISION DOCUMENT

Spotted Seatrout Fishery Management Plan

Amendment 1

This document was developed to help the MFC track previous activity and prepare for upcoming actions for Striped Mullet FMP Amendment 2.

August 2024

Summary

At their August 2024 business meeting, the Marine Fisheries Commission will review and provide input on the draft of Amendment 1 to the Spotted Seatrout Fishery Management Plan (FMP). They will then vote on sending draft Amendment 1 out for review by the Marine Fisheries Commission Advisory Committees and the public.

Background

The 2022 stock assessment indicated the Spotted Seatrout stock in North Carolina and Virginia waters is not overfished but overfishing is occurring. The North Carolina Fishery Reform Act of 1997 requires a Fishery Management Plan to specify a timeframe not to exceed two years from the date of adoption of the plan to end overfishing.

Amendment 1 to the Spotted Seatrout Fishery Management Plan is being developed to address overfishing in the Spotted Seatrout fishery. In developing management measures in Amendment 1, only harvest reductions from the North Carolina portion of Spotted Seatrout harvest were considered. The Spotted Seatrout fishery is primarily a recreational fishery, with recreational harvest accounting for 86% of total harvest since 2012. Commercial harvest has accounted for 14% of total Spotted Seatrout harvest since 2012. However, harvest in both sectors increased sharply in 2019 and has remained high through 2022. As such, management measures to achieve sustainable harvest focus on both sectors.

Amendment Timing

(gray indicates a step is complete)

March 2023	Division holds public scoping period
May 2023	MFC approves goal and objectives of FMP
May 2023 – March 2024	Division drafts FMP
April 2024	Division held workshop to review and further develop draft FMP with the Spotted Seatrout FMP Advisory Committee
May – July 2024	Division updates draft plan
August 2024	**MFC Reviews draft and votes on sending draft FMP for public and AC review**
October 2024	MFC Regional and Standing Advisory Committees meet to review draft FMP and receive public comment
November 2024	MFC selects preferred management options
December 2024 – January 2025	DEQ Secretary and Legislative review of draft FMP
February 2025	MFC votes on final adoption of FMP
TBD	DMF and MFC implement management strategies

You Are Here

Goals and Objectives

The goal of this plan is to manage the Spotted Seatrout (*Cynoscion nebulosus*) fishery to maintain a self-sustaining population that provides sustainable harvest based on science-based decision-making processes. The following objectives will be used to achieve this goal:

1. Implement management strategies within North Carolina that end overfishing and maintains the Spotted Seatrout spawning stock abundance and recruitment potential.
2. Promote restoration, enhancement, and protection of critical habitat and environmental quality in a manner consistent with the Coastal Habitat Protection Plan, to maintain or increase growth, survival, and reproduction of the Spotted Seatrout stock.
3. Monitor and manage the fishery in a manner that utilizes biological, socioeconomic, fishery, habitat, and environmental data.
4. Promote outreach and interjurisdictional cooperation regarding the status and management of the Spotted Seatrout stock in North Carolina and Virginia waters, including practices that minimize bycatch and discard mortality.

Summary of Preliminary Management Recommendations

A summary of the DMF's preliminary recommendations can be found below. Based on recreational harvest from 2019-2022, the recommendations for the recreational sector equate to a 39.5% reduction in recreational harvest. Based on commercial harvest from 2019-2022, the recommendations for the commercial sector equate to a 40.2% reduction in commercial harvest. When combined across sectors, the Division is preliminarily recommending a 39.6% total harvest reduction. ***Please note: these are the Division's initial recommendations and are subject to change.***

The DMF recommends the following options that are projected to end overfishing with a greater than 70% probability of keeping SSB above the target:

Recreational Recommendations

- 3 fish recreational bag limit (*Appendix 2: Sustainable Harvest Issue Paper)*
- 14"–20" recreational slot limit with allowance for one fish >26" (*Appendix 2: Harvest Issue Paper*)
- Jan–Feb statewide recreational harvest closure (*Appendix 2: Sustainable Harvest Issue Paper*)
- Eliminate the captain/crew allowance on for-hire trips with no broader vessel limit (*Amendment 3: Supplemental Management Issue Paper*)

Commercial Recommendations

- Oct–Dec, 11:59 p.m. Friday to 12:01 a.m. Tuesday statewide commercial harvest closure (*Appendix 2: Sustainable Harvest Issue Paper)*

- Jan–Feb statewide commercial harvest closure *(Appendix 2: Sustainable Harvest Issue Paper)*
- Stop Net Management *(Appendix 2: Sustainable Harvest Issue Paper)*
  - Restrict stop nets to the Atlantic Ocean on Bogue Banks with a 4,595 lb. Spotted Seatrout season quota.
  - A maximum of four stop nets are allowed between Beaufort Inlet and Bogue Inlet at any one time and each combined fishing operation is limited to a maximum of two stop nets at any one time.
  - The season will open no sooner than October 15 and close when the Spotted Seatrout quota is reached or no later than December 31.
  - Stop net crews must contact N.C. DMF Marine Patrol Communication each time a stop net is set and two hours prior to each time a stop net is fished.
  - The same day a stop net is fished and the catch is landed at the fish house, a representative of the stop net crew must contact DMF Fisheries Management Section to report the daily total of Spotted Seatrout in pounds as it appears on the trip ticket. Same day reporting is required even if zero Spotted Seatrout are harvested.
  - Failure to follow reporting requirements will result in an immediate closure of the stop net fishery.
  - Additional gear and setback requirements from previous proclamations will continue.

General Recommendations

Adaptive Management

The adaptive management framework allows for adjusting management measures outside of an updated stock assessment to ensure compliance with and effectiveness of management strategies adopted in Amendment 1 and is a tool to respond to concerns with stock conditions and fishery trends. Upon evaluation by the division, if the management strategy implemented to achieve sustainable harvest (either through Amendment 1 or a subsequent revision) is not achieving the intended purpose, management measures may be revised or removed and replaced using adaptive management; provided it conforms to part 2.

- Management measures that may be adjusted using adaptive management include:
  a. Season closures
  b. Day of week closures
  c. Trip limits
  d. Size limits
  e. Bag limits
  f. Gear restrictions in support of the measures listed in a-e

Cold Stun Management

- Extend fishery closure until June 30th following a cold stun

- Adaptive Management Framework

Management Options

(Options recommended by DMF are outlines in blue)

Sustainable Harvest

These management options attempt to strike a balance between access to the fishery for both sectors, the necessary reductions to end overfishing, accounting for potential harvest recoupment, and maintaining the current abundance of Spotted Seatrout available. Additionally, management in the recently adopted Amendment 2 to the Striped Mullet Fishery Management Plan was considered as there is a high degree of overlap in the seasonality and gear types used in the Striped Mullet and Spotted Seatrout fisheries. These options are predicted to reduce the harvest of Spotted Seatrout in ways that are quantifiable using existing data.

A reduction in total harvest relative to 2019–2022 total harvest of 19.9% is required to reach the F20% threshold and meet the statutory requirement to end overfishing while a harvest reduction of 53.9% will reach the F30% target. Because of spikes in effort across both sectors in recent years and the potential for harvest recoupment from some management measures, the Division recommends a conservative reduction of 39.6% to increase the likelihood of achieving sustainable harvest.

Option 1: Size Limits

(Refer to pp. 46-52 in the Draft Spotted Seatrout FMP Amendment 1 for additional details)

Changes to the current Spotted Seatrout minimum size of 14” are unlikely to reach the needed harvest reductions to meet statutory requirements. Additionally, reductions from increasing the minimum size are most likely to be achieved in the short term while long term harvest reductions are lower with some portion of harvest being recouped. A delay in harvest could provide non-quantifiable benefits by allowing more fish to spawn prior to harvest. However, Spotted Seatrout growth rates would likely minimize these non-quantifiable benefits as sub-legal fish grow quickly back into the fishery. Harvest reductions from a slot limit are more likely to be realized in the long term as Spotted Seatrout would grow out of the fishery relatively quickly too. Implementing a slot limit for the commercial sector would likely increase dead discards. Pairing a slot limit with corresponding changes to allowable mesh sizes could prove ineffective at reducing dead discards due to the lack of size selectivity across various mesh sizes (Page 30 of Draft Amendment 1). A very narrow slot limit, even if implemented for just the recreational sector, could theoretically reduce total harvest more than the 19.9% reduction needed to reach $F_{Threshold}$ (Page 51 of draft Amendment 1, Table 2.3). However, size limit changes alone would not address the potential for increased dead discards, the high recoupment potential if commercial harvest shifted toward larger fish, and the recent trend of increased effort in both sectors. For a full discussion of size limits, see pp. 46–52 in draft Amendment 1.

a. *Status Quo – no change to commercial size limit. Consider recreational size limit changes as a part of the overall management strategy to achieve sustainable harvest but not as a single solution option.*

b. *Recreational 16”–20” slot limit with allowance for one fish over 24” and commercial 16” minimum size limit*

Option 2: Seasonal Closures

(Refer to pp. 52-56 in the Draft Spotted Seatrout FMP Amendment 1 for additional details)

Seasonal closures can be an effective way of limiting harvest, especially when closures are at the end of the biological year to prevent recoupment of harvest. It is possible to end overfishing through a closure that spans the spawning season (p. 54 of draft Amendment 1, Table 2.4), however; it is likely some amount of recoupment would occur after the season closure. A spawning season closure would also have to be longer than a winter closure (i.e., a closure at the end of the biological year) to reduce harvest to a level that will meet management objectives. Closures not at the end of the biological year should be extended or paired with other management options to increase the likelihood of reaching management objectives. Day of the week closures are a type of season closure and could be used for the commercial sector to reduce harvest. Similar to other seasonal closure options not at the end of the biological year, there is the potential for harvest recoupment if commercial effort shifts to days when the fishery is open. Day of the week closures could be considered in tandem with other management measures to ensure management objectives are met. See pp. 52-56 of draft Amendment 1 for a full discussion of seasonal closures.

a. *Status Quo – manage fishery without seasonal harvest closure*
b. *Dec 16 – Feb 28/29 harvest closure (both sectors)*
c. *11:59 p.m. Friday–12:01 a.m. Tuesday commercial harvest closure October 1–December 31 and Jan 1–February commercial harvest closure. Consider recreational seasonal closures as a part of the overall management strategy to achieve sustainable harvest but not as a single solution option.*
d. *Nov 1 – Feb 28/29 harvest closure (both sectors)*

Option 3: Bag and Trip Limits

(Refer to pp. 56-59 in the Draft Spotted Seatrout FMP Amendment 1 for additional details)

It is possible to reduce total Spotted Seatrout harvest to reach the $F_{Threshold}$ by decreasing the recreational bag and commercial trip limits, but it is not possible to reduce total harvest to reach the F_{Target} through changes to the bag or trip limits (draft Amendment 1 pp. 56 and 58, Tables 2.6 and 2.7). Any recreational bag or commercial trip limit would be a daily limit. Recreational bag and commercial trip limit changes could be accompanied by gear changes or limits to allowable gear (See Amendment 1 Appendix 1 and Appendix 3) to minimize the probable increase in dead discards caused by bag or trip limit changes. For a full discussion of bag and trip limit options, see pp. 56-59 of draft Amendment 1.

a. *Status Quo – manage fishery without changes to current trip limit and consider recreational bag limit changes as a part of the overall management strategy to achieve sustainable harvest but not as a single solution option.*

b. *Reduce recreational bag limit to 2 fish and commercial trip limit to 45 fish*

Option 4: Stop Nets

(Refer to pp. 58-59 in the Draft Spotted Seatrout FMP Amendment 1 for additional details)

The stop net fishery is a modification of a traditional beach seine that primarily targets Striped Mullet and is unique to Bogue Banks. The 2012 Spotted Seatrout FMP implemented a 75 fish trip limit, but the MFC tasked the DMF Director with addressing the stop net fishery outside the 2012 FMP. Since 2012, the Bogue Banks stop net fishery has opened and closed by proclamation and operates with a 4,595 lb. Spotted Seatrout quota with various reporting requirements outlined in a Memorandum of Agreement (MOA) signed by a party of the fishery and the DMF Fisheries Management Section Chief. Due to the strict existing management of this fishery, the potential for additional harvest reductions from the recently adopted Amendment 2 to the Striped Mullet FMP, and the low contribution to Spotted Seatrout landings under current management, additional harvest restrictions may not be necessary for the stop net fishery. However, formalizing current management of the stop net fishery should be considered in this amendment. See Spotted Seatrout FMP Amendment 1 pp. 58–59 for a full discussion of stop net management.

a. *Status quo – 4,595 lb. season quota with terms and conditions of stop net fishery and responsibilities of the stop net crew outlined in Memorandum of Agreement.*
b. *Restrict stop nets to the Atlantic Ocean on Bogue Banks with a 4,595 lb. Spotted Seatrout season quota. A maximum of four stop nets are allowed between Beaufort Inlet and Bogue inlet at any one time and each combined fishing operation is limited to a maximum of two stop nets at any one time. The season will open no sooner than October 15 and close no later than the sooner of December 31 or when the Spotted Seatrout quota is reached. Any weekend closures to commercial harvest implemented in Option 2 will also apply to the Bogue Banks stop net fishery. Stop net crews must contact N.C. DMF Marine Patrol Communication each time a stop net is set and at least two hours prior to each time a stop net is fished. The same day a stop net is fished and the catch is landed at the fish house, a representative of the stop net crew must contact DMF Fisheries Management Section to report the daily total of Spotted Seatrout in pounds as it appears on the trip ticket. Same day reporting is required even if zero Spotted Seatrout are harvested. Failure to follow reporting requirements will result in an immediate closure of the stop net fishery. Additional gear and setback requirements from previous proclamations will continue.*

Option 5/6: Combination Management Measures

(Refer to pp. 59-62 in the Draft Spotted Seatrout FMP Amendment 1 for additional details)

Combining multiple strategies to achieve management goals is common in fisheries management. Multiple management measures rather than a single, standalone management measure allow for more specific, targeted management to account for a variety of factors including species life history and biology, differences in the fishery (e.g., industry, regional, etc.), or competing interests in the fishery. As there are few standalone management measures to end overfishing in the Spotted Seatrout fishery, combination measures will help ensure management is realistic and management objectives are more likely to be achieved. See pp. 59–62 of the Spotted Seatrout FMP Amendment 1 for a full discussion of combination management measures.

Combination Management Measures

Table 2.8. Combination management measures to end overfishing and achieve sustainable harvest. The Total % Reduction column shows the total percent reduction if no changes to commercial management are implemented. Unless otherwise noted, season closures or bag limit reductions include the entirety of the month. *Total reduction does not reduce F to the 19.9% threshold (options 1.a, and 1.b). Harvest reduction in pounds is based on 2019–2022 average recreational harvest.

Option #	Season Closure	Bag Limit (number of fish)	Size Limit	Recreational Reduction (lb)	Recreational Reduction (%)	Total % Reduction
5.a	Jan-Feb	Oct-Dec 3 fish	-	738,113	22.1	18.9*
5.b		Nov-Feb 3fish	16” minimum	741,453	22.2	19.0*
5.c	-	Oct-Feb 3 fish	14-20”, 1 over 26”	824,950	24.7	21.1
5.d	Jan 16-Feb	-	14-20”, 1 over 26”	935,166	28.0	23.9
5.e	Dec 16-Feb	3 fish	-	1,015,323	30.4	26.0
5.f	Jan-Feb	-	14-20”, 1 over 26”	1,078,781	32.3	27.6
5.g	Jan-Feb	Oct-Dec 3 fish	14-20”, 1 over 26”	1,205,696	36.1	30.9
5.h	Jan-Feb	3 fish	14-20”, 1 over 26”	1,319,252	39.5	33.8
5.i	Dec 16-Feb	3 fish	14-20”, 1 over 26”	1,436,148	43.0	36.7
5.j	Dec-Feb	2 fish	14-20”, 1 over 26”	1,923,770	57.6	49.2

Table 2.9 Combination management measures to end overfishing and achieve sustainable harvest. The Total % Reduction column shows the total percent reduction if no recreational management changes are implemented. No management options applied solely to the commercial sector reduce *total* harvest to a level where F meets the 19.9% threshold. Unless otherwise noted, seasonal closures include the entirety of the month. Harvest reduction in pounds is based on 2019–2022 average commercial harvest.

Option #	Season Closure	Trip Limit (number of fish)	Size Limit	Commercial Reduction (lb)	Commercial Reduction (%)	Total % Reduction
6.a	Jan 16-Feb	60	-	131,210	23.1	3.4
6.b	Jan-Feb	65	-	145,979	25.7	3.7
6.c	Jan-Feb	-	16” min	149,955	26.4	3.8
6.d	Feb	45	-	164,155	28.9	4.2
6.e	Jan 16-Feb	45	-	193,124	34.0	4.9
6.f	Jan-Feb	50	-	197,100	34.7	5.0
6.g	Dec 16-Feb	60	-	202,780	35.7	5.2
6.h	Dec-Feb	40	-	314,110	55.3	8.0

Option 7: Adaptive Management

The current Spotted Seatrout adaptive management framework needs to be updated. Adaptive management is a structured decision-making process when uncertainty exists, with the objective of reducing uncertainty through time with monitoring. Adaptive management provides flexibility to incorporate new information and accommodate alternative and/or additional actions.

1. The adaptive management framework allows for adjusting management measures outside of an updated stock assessment to ensure compliance with and effectiveness of management strategies adopted in Amendment 1 and is a tool to respond to concerns with stock conditions and fishery trends. Upon evaluation by the division, if the management strategy implemented to achieve sustainable harvest (either through Amendment 1 or a subsequent revision) is not achieving the intended purpose, management measures may be revised or removed and replaced using adaptive management; provided it conforms to part 2.
2. Management measures that may be adjusted using adaptive management include:
    a. Season closures
    b. Day of week closures
    c. Trip limits
    d. Size limits
    e. Bag limits
    f. Gear restrictions in support of the measures listed in a-e

Supplemental Management

As a result of the popularity of Spotted Seatrout as a targeted species; Marine Fisheries Commission (MFC) commissioners, MFC Advisory Committee members, and the public have mentioned a wide variety of potential recreational and commercial management strategies that could benefit the Spotted Seatrout stock but the scope of which are not immediately quantifiable. The increase in recreational trips targeting Spotted Seatrout and increased total Spotted Seatrout harvest in recent years combined with the presence of a dedicated catch and release segment of the recreational fishery suggest that even management measures lacking immediately quantifiable benefits are worth exploring. Additionally, there are management measures that could provide supplementary benefits when paired with sustainable harvest measures discussed in Appendix 2.

Option 1: Vessel Limits

(Refer to pp. 66-74 in the Draft Spotted Seatrout FMP Amendment 1 for additional details)

Limiting the harvest of fish through a vessel limit less than the sum of individual bag limits when multiple anglers are on a vessel or by eliminating the allowance for captain and crew to keep a recreational limit when on for-hire trips are common practices in many state and federal fisheries. For a full discussion of vessel limits, see pp. 68–69 of draft Amendment 1.

a. Status Quo – Manage fishery without changes to vessel limit or for-hire captain/crew allowance
b. Eliminate captain/crew allowance for Spotted Seatrout on for-hire trips with no broader vessel limit
c. Implement 8 fish Spotted Seatrout vessel limit with captain/crew allowance on for-hire trips counted as part of vessel limit.

Cold Stun Management

Spotted Seatrout are susceptible to periodic cold stun events which occur when water gets so cold that it slows down a fish's body functions, making them sluggish or unable to move. In North Carolina, Spotted Seatrout are more likely than other commercially and recreationally important fish species to experience population-level effects from these events. Cold stun events can occur because of snow and ice melt following a winter storm or by sudden and-or prolonged periods of cold temperatures. At their February 2012 business meeting, the Marine Fisheries Commission (MFC) directed the division to remain status quo regarding spotted seatrout cold stun management, with the assumption that in the event of a "catastrophic" cold stun the director would use proclamation authority to enact a temporary closure. The objective of a spotted seatrout fishery closure after a cold stun event is to allow surviving fish an opportunity to spawn during their spring spawning season, potentially increasing recruitment the following year. Cold stun management options include size limits (draft Amendment 1 pp. 79–80), recreational bag and commercial trip limits (draft Amendment 1 pp. 80–81), seasonal closures (draft Amendment 1 pp. 81-82), area closures (draft Amendment 1 pp. 82–83), and an adaptive management framework (draft Amendment 1 pp. 83–84).

Option 1: Season Closures

(Refer to pp. 81-82 in the Draft Spotted Seatrout FMP Amendment 1 for additional details)

a. Status quo – fishery closed until June 15 following a cold stun
b. Extend fishery closure until June 30 following a cold stun
c. Extend fishery closure until October 15 following a cold stun

Option 2: Size Limits

(Refer to pp. 79-80 in the Draft Spotted Seatrout FMP Amendment 1 for additional details)

a. Status quo – no size limit change following a cold stun
b. Temporary adjustment of size and-or slot limits following a cold stun

Option 3: Bag and Trip Limits

(Refer to pp. 80-81 in the Draft Spotted Seatrout FMP Amendment 1 for additional details)

a. Status quo – no recreational bag or commercial trip limit changes following a cold stun
b. Temporary adjustment of recreational bag or commercial trip limits following a cold stun

Option 4: Adaptive Management Framework

(Refer to pp. 83-84 in the Draft Spotted Seatrout FMP Amendment 1 for additional details)

1. If a severe cold stun event occurs the Director will close the spotted seatrout fishery statewide through the date adopted in this Amendment
2. Temporary measures that may be implemented through adaptive management to aid in stock recovery after the standard closure period following a cold stun event include:
    a. recreational bag limit
    b. commercial trip limit
    c. size limit changes
    d. seasonal closure
    e. gill net yardage restrictions
    f. Use of adaptive management to further aid in stock recovery once the fishery reopens following a cold stun event is contingent on approval by the Marine Fisheries Commission.

Next Steps

At their August business meeting the Marine Fisheries Commission will review draft Amendment 1 of the Spotted Seatrout FMP, including the full list of management options. This is an opportunity for the Commission to provide input on the management strategies and options that are included in the draft FMP for public and MFC Advisory Committee review. The Division of Marine Fisheries has recommended a conservative total harvest reduction of 39.6%.

Following their review and input, the Commission will vote to send the draft Amendment 1 out for public and MFC Advisory Committee review. If approved, the draft is expected to go out to the appropriate MFC Advisory Committees in October 2024 with a public comment period held around that same time. The outcome of that comment period and MFC AC review would then be presented to the Commission during their November business meeting.

DRAFT, 2024

North Carolina
Spotted Seatrout
Fishery Management Plan Amendment 1

North Carolina Division of Marine Fisheries

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

ACKNOWLEDGMENTS

Amendment 1 to the North Carolina (NC) Spotted Seatrout Fishery Management Plan (FMP) was developed by the NC Department of Environmental Quality (NCDEQ), Division of Marine Fisheries (NCDMF) under the auspices of the NC Marine Fisheries Commission (NCMFC) with the advice of the Spotted Seatrout Advisory Committee (AC). Deserving special recognition are the members of the Spotted Seatrout AC and the NCDMF Plan Development Team (PDT) who contributed their time and knowledge to this effort.

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EXECUTIVE SUMMARY

*** This section is completed prior to final approval***

INTRODUCTION

This is Amendment 1 to the Spotted Seatrout Fishery Management Plan (FMP). FMPs are the ultimate product that brings all information and management considerations into one document. The N.C. Division of Marine Fisheries (NCDMF) prepares FMPs for adoption by the N.C. Marine Fisheries Commission (NCMFC) for all commercially and recreationally significant species or fisheries that comprise state marine or estuarine resources. The goal of these FMPs is to ensure long-term viability of these fisheries. By law, each FMP must be reviewed at least once every five years (G.S. 113-182.1). The NCDMF reviews each FMP annually and a comprehensive review is undertaken approximately every five years. The last comprehensive review of the Spotted Seatrout FMP was approved by the NCMFC in 2012. All management authority for the North Carolina Spotted Seatrout fishery is vested in the State of North Carolina. The NCMFC adopts rules and policies and implements management measures for the Spotted Seatrout fishery in Coastal and Joint Fishing Waters in accordance with G.S. 113-182.1. Until Amendment 1 is approved for management, Spotted Seatrout is managed under the Spotted Seatrout FMP (NCDMF, 2012, 2014).

Fishery Management Plan History

Original FMP Adoption:	February 2012
Amendments:	None
Revisions:	None
Supplements:	Supplement A to the 2012 FMP – February 2014
Information Updates:	None
Schedule Changes:	None
Comprehensive Review:	Five years after the adoption of Amendment 1

The original Spotted Seatrout FMP (NCDMF 2012) and Supplement A to the 2012 FMP (NCDMF 2014) are available on the NCDMF website.

Management Unit

The management unit includes all Spotted Seatrout within the Coastal and Joint Fishing Waters of North Carolina.

Goal and Objectives

The goal of this plan is to manage the Spotted Seatrout (*Cynoscion nebulosus*) fishery to maintain a self-sustaining population that provides sustainable harvest based on science-based decision-making processes. The following objectives will be used to achieve this goal.

1. Implement management strategies within North Carolina that end overfishing and maintain the Spotted Seatrout spawning stock abundance and recruitment potential.
2. Promote restoration, enhancement, and protection of critical habitat and environmental quality in a manner consistent with the Coastal Habitat Protection Plan, to maintain or increase growth, survival, and reproduction of the Spotted Seatrout stock.
3. Monitor and manage the fishery in a manner that utilizes biological, socioeconomic, fishery, habitat, and environmental data.
4. Promote outreach and interjurisdictional cooperation regarding the status and management of the Spotted Seatrout stock in North Carolina and Virginia waters, including practices that minimize bycatch and discard mortality., including practices that minimize bycatch and discard mortality.

DESCRIPTION OF THE STOCK

Biological Profile

Spotted seatrout, also known as speckled trout, are an estuarine fish species that inhabit rivers, estuaries, and shallow coastal systems. Spotted seatrout are found in coastal waters ranging from Massachusetts to southern Florida continuing throughout the Gulf of Mexico but are most abundant in the mid-Atlantic and southeastern regions of the United States. Genetic markers in North Carolina fish suggest mixing between two genetically distinct populations: one population from Georgia to the Cape Fear River, North Carolina and a another that expands north from Bogue Sound, North Carolina (Ellis et al., 2018; O'Donnell et al., 2014).

Spotted seatrout have distinct seasonal migrations. In the winter, fish migrate to shallow estuarine habitats (Ellis, 2014). As waters warm, fish will return to oyster beds, shallow bays, and grass flats (Daniel, 1988). Although Spotted Seatrout seasonally migrate, based on tag return studies, most individuals exhibit strong site fidelity traveling less than 50 km (Music, 1981; Ellis, 2014; Moulton et al., 2017; Loeffler et al., 2019).

Spawning occurs from April to October with peak spawning occurring in May and June (Burns, 1996). Spawning generally occurs near inlets or within estuaries. Because Spotted Seatrout are batch spawners, females are capable of spawning multiple times throughout the season. Fish mature between the ages of one and three. Younger, newly matured fish may spawn every four days while fish older than three years may spawn every two days (Roumillat & Brouwer, 2004). Estimates of the number of eggs a female can produce in a year vary based on age and size but ranges between 3-20 million eggs per year (Nieland et al., 2002; Roumillat & Brouwer, 2004; Murphy et al., 2010). Most male Spotted Seatrout in North Carolina are mature at 7.9 inches total length (TL) and most females are mature at 9.9 inches TL. All males are mature at 12 inches and all females are mature at 15 inches.

North Carolina's state record is currently a 12.5 pound, 33.5-inch fish caught from the lower Neuse River in 2022. The annual average size of Spotted Seatrout from 1991-2021 ranged from 14.4 to 18.3 inches in North Carolina's commercial fisheries and 14.2 to 17.6 inches in the recreational fishery. Spotted seatrout can live as long as ten years old. The oldest, otolith-based age of both male and female fish reported in North Carolina is 9 years old.

Spotted seatrout are especially susceptible to cold stun events, times in which water temperatures drop below what fish can survive. The effect of cold stuns on Spotted Seatrout abundance depends on the severity and duration of the event. The impact can be minimal if only sub-adults are affected, if the event is localized to a few areas, or if the event is short lived. Cold stun events can have a substantial impact if all size classes are affected, if larger areas are affected, or if the event lasts for an extended period. Interannual Spotted Seatrout abundance can be driven by cold stun events that cause large losses to the stock, which can prompt management to suspend both recreational and commercial harvests (Hurst, 2007; NCDMF, 2012).

These fish are known to be highly opportunistic predators, feeding on a variety of prey items depending on their size and availability. Their diet mainly consists of small fish, shrimp, crabs, and other invertebrates. Spotted seatrout are ambush predators, relying on camouflage and patience to wait for prey to come within striking distance. They are most active during dusk and dawn.

Assessment Methodology

A seasonal size-structured assessment model was applied to data characterizing commercial and recreational landings and discards, fisheries-independent survey indices, and biological data collected from 1991 through 2019. A nonstationary process was assumed for natural mortality and growth in the model. The seasonal time step and nonstationary natural mortality assumption allows for capturing the cold-stun effects that have been observed for Spotted Seatrout. Both the observed data and model predictions suggest a shift in population dynamics around 2004 when the fisheries-independent survey index data became available. Lower fishing mortality and higher spawning stock biomass and recruitment with greater variation were predicted for the period after 2004. This trend was also observed in the recreational landing and discards data which exhibited higher values after 2004.

Stock Status

Reference point thresholds for the Spotted Seatrout stock were based on 20% spawner potential ratio (SPR). Due to large uncertainty in the terminal year (2019) estimates, a weighted average of the estimates over the most recent three years (2017–2019) was used to represent the terminal year estimate for determination of stock status. The estimates of 2017–2019 from the base model were weighted by the inverse of their CV values before calculating the average. The threshold and target values for the terminal year were also averaged over 2017–2019. The estimated *F* threshold *F*20% was 0.60 per year, and the estimated terminal year (2019) *F* was 0.75 per year. Thus, the estimated *F*/*F*20% for 2019 is greater than one (1.3), suggesting the stock is currently experiencing overfishing (Figure 11). The estimated SSB threshold (SSB20%) for 2019 was 1,143 metric tons, and the estimated 2019 SSB was 2,259 metric tons. Therefore, the estimated

SSB/SSB20% for 2019 is greater than one (2.0), suggesting the stock is not currently overfished (Figure 22).

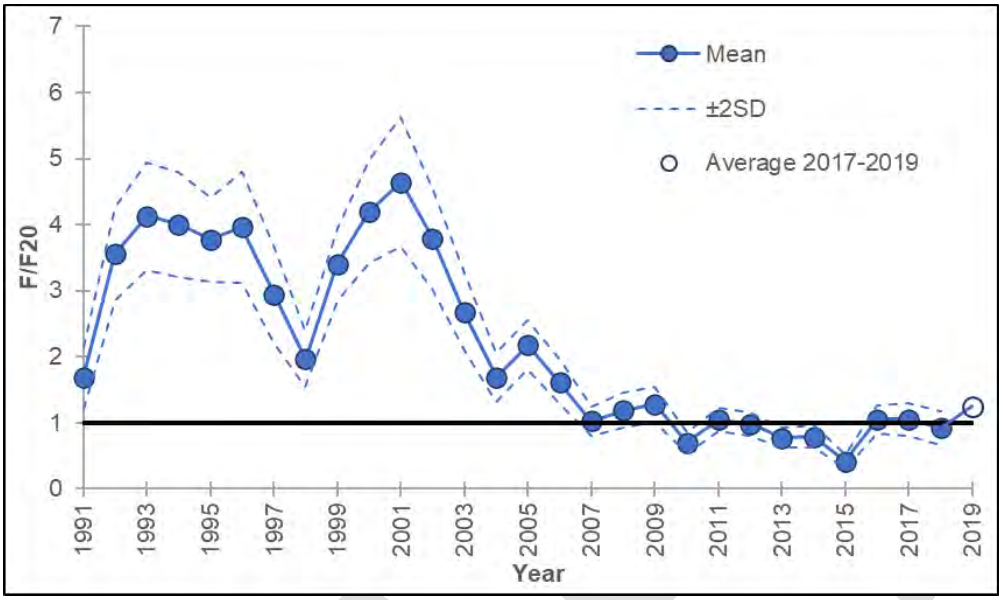

Figure 11. Annual predicted fishing mortality relative to the fishing mortality threshold (F/F20) from the base model of the stock assessment, biological years (Mar–Feb) 1991–2019. The horizontal black line shows a ratio of one. The terminal-year estimate is an average of the most recent three years weighted by the inverse CV values.

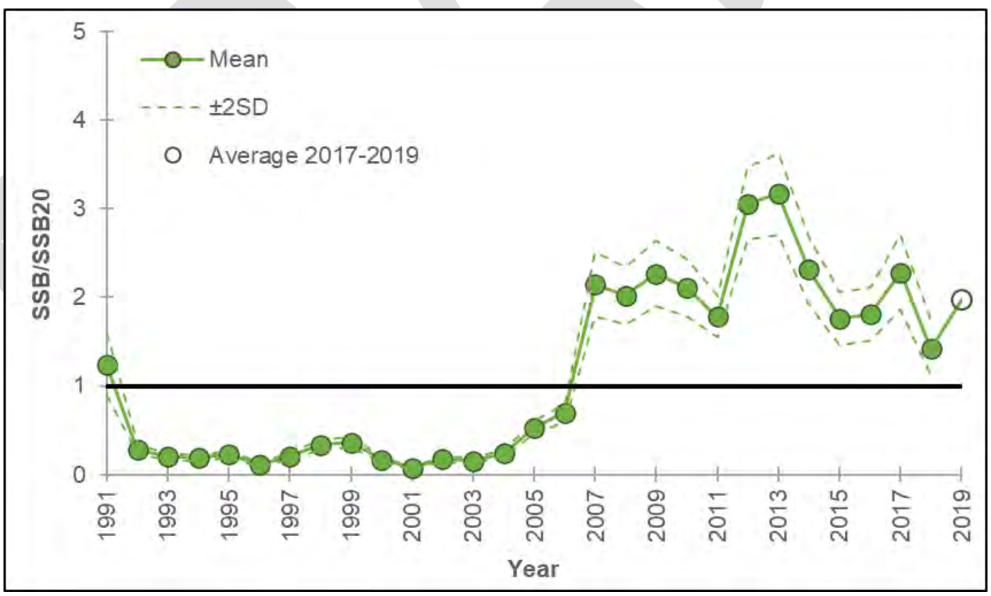

Figure 22. Annual predicted spawning stock biomass (metric tons) relative to the spawning stock biomass threshold (SSB/SSB20) from the base model of the stock assessment, biological years (Mar–Feb) 1991–2019. The horizontal black line shows a ratio of one. The terminal-year estimate is an average of the most recent three years weighted by the inverse CV values.

DESCRIPTION OF THE FISHERY

Additional in-depth analyses and discussion of North Carolina's commercial and recreational Spotted Seatrout fisheries can be found in the original Spotted Seatrout FMP and Supplement A (NCDMF 2012 and 2014); all FMP documents are available on the DMF Fishery Management Plans website and commercial and recreational landings can be found in the License and Statistics Annual Report (NCDMF 2023) produced by the DMF which can be found on the DMF Fisheries Statistics page.

Recreational and commercial landings are typically variable from year to year and are influenced by winter weather conditions (i.e., low harvest follows severe winters) and fish availability. Confirmed cold stun events, with varying severity, occurred in 1995, 2000, 2001, 2003, 2004, 2009, 2010, 2014, 2015, 2018, and 2022 (Table 1). Since cold stuns typically occur in December and January (the end of the biological year), their impacts to recreational and commercial landings are experienced the following year.

Table 1. Confirmed Spotted Seatrout cold stun events and fishery closure dates, 1995-2022.

Calendar Year	Month	Biological Year	Closure	Fishery Closure Dates*
1995	December	1995	No	-
2000	January	1999	No	-
2001	January	2000	No	-
2003	January	2002	No	-
2004	December	2004	No	-
2010	January	2009	No	-
2010	December	2010	Yes	Jan. 14 - June 15, 2011
2014	January	2013	Yes	Feb. 5 - June 14, 2014
2015	February	2014	No	-
2018	January	2017	Yes	Jan. 5 - June 14, 2018
2022	December	2022	No	-

Commercial Fishery

DMF instituted a mandatory, dealer-based, trip-level, reporting system known as the North Carolina Trip Ticket Program (NCTTP) for all commercial species in 1994. All seafood landed in North Carolina and sold by licensed commercial fishermen must be reported on a trip ticket by a licensed seafood dealer. For more information about licensing requirements for purchasing and selling seafood in North Carolina and how commercial fishing data were collected prior to 1994, please refer to the DMF License and Statistics Section Annual Report (NCDMF, 2023). In 2022, 138 seafood dealers reported Spotted Seatrout on trip tickets, landed by 701 fishery participants during 11,756 fishing trips (Figure 33).

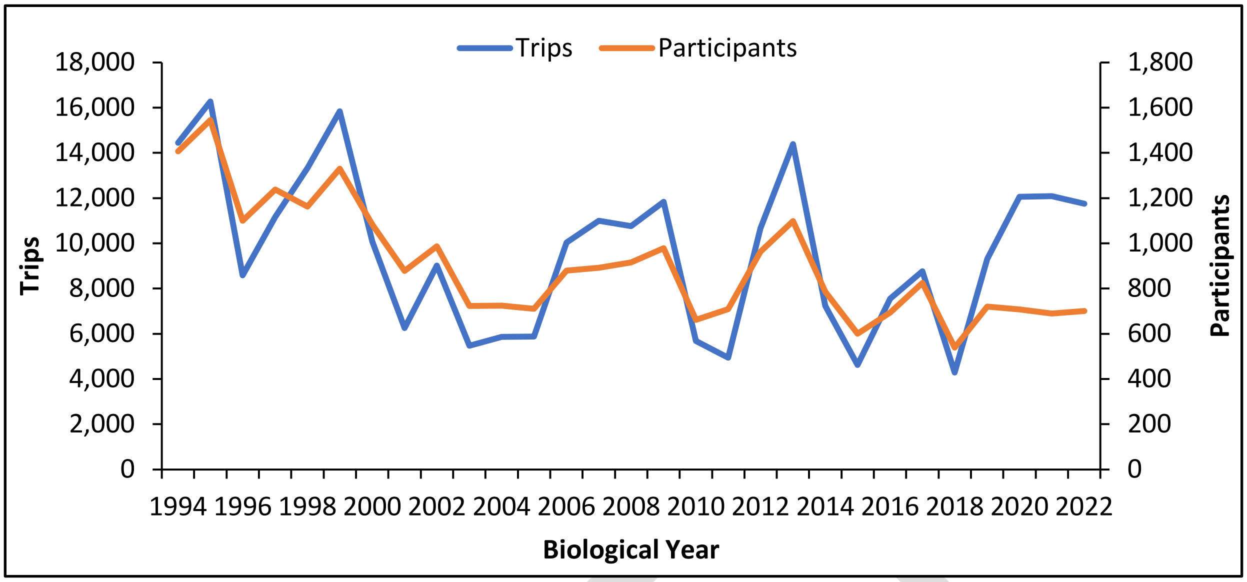

Figure 33. Annual number of trips and participants for the North Carolina Spotted Seatrout fishery from 1994 to 2022.

Annual Landings and Value

In recent years (2012 to 2022), total landings averaged 361,656 pounds per year (Figure 44). The lowest landings during this period was 115,547 pounds in 2015 and the highest was 654,327 pounds in 2021. Spotted seatrout landings have increased in recent years, exceeding 650,000 pounds in 2020 and 2021. Annual dockside value of Spotted Seatrout commercial landings averaged $891,180 from 2012 to 2022. Annual dockside value was lowest in 2015 at $290,709 and reached a high of just under $1.7 million in 2021.

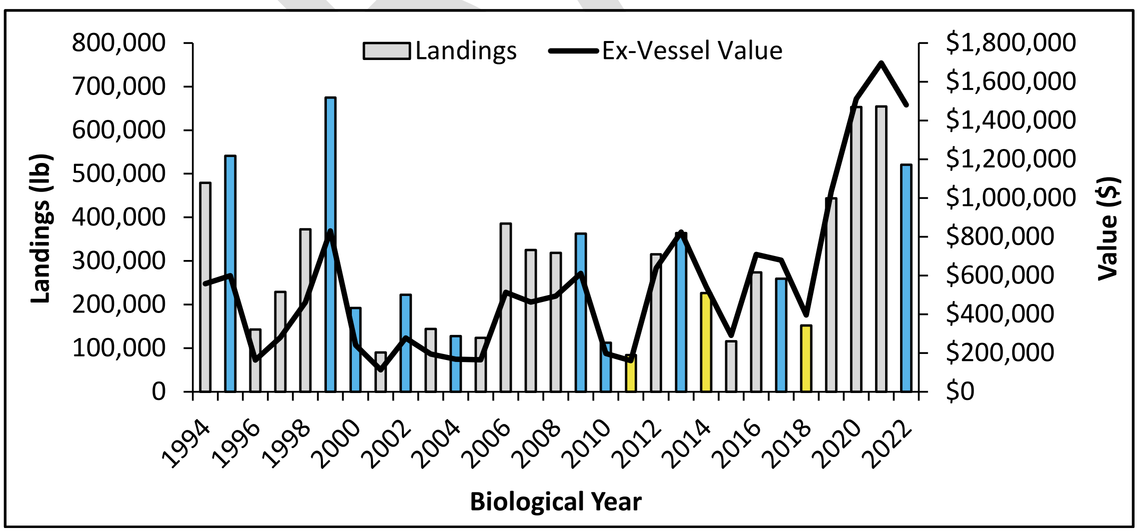

Figure 44. North Carolina annual Spotted Seatrout commercial landings and ex-vessel value, 1994-2022. Values include all market grades and are not adjusted for inflation. The biological year begins in March and ends in February the following year (ex.: biological year 1994 begins in March 1994 and ends in February 1995). Gray bars indicate years without a cold stun or cold stun closure, blue bars indicate years with a confirmed cold stun event, and yellow bars indicate years with a cold stun closure.

Landings by Month

Spotted seatrout are harvested year-round but there are distinct seasonal peaks (Figure 55). From 1994 through 2022, on average the largest harvest peak occurs from October through February, with a second smaller harvest plateau occurring from April through May. The fall/winter harvest season has accounted for 71% of the harvest and the shorter spring season has accounted for 12% of the harvest from 1994-2022. Harvest is typically highest in colder months as Spotted Seatrout aggregate in smaller waterbodies and can be caught in higher numbers. Harvest tends to taper off as waters warm and fish disperse in preparation for the summer spawning season.

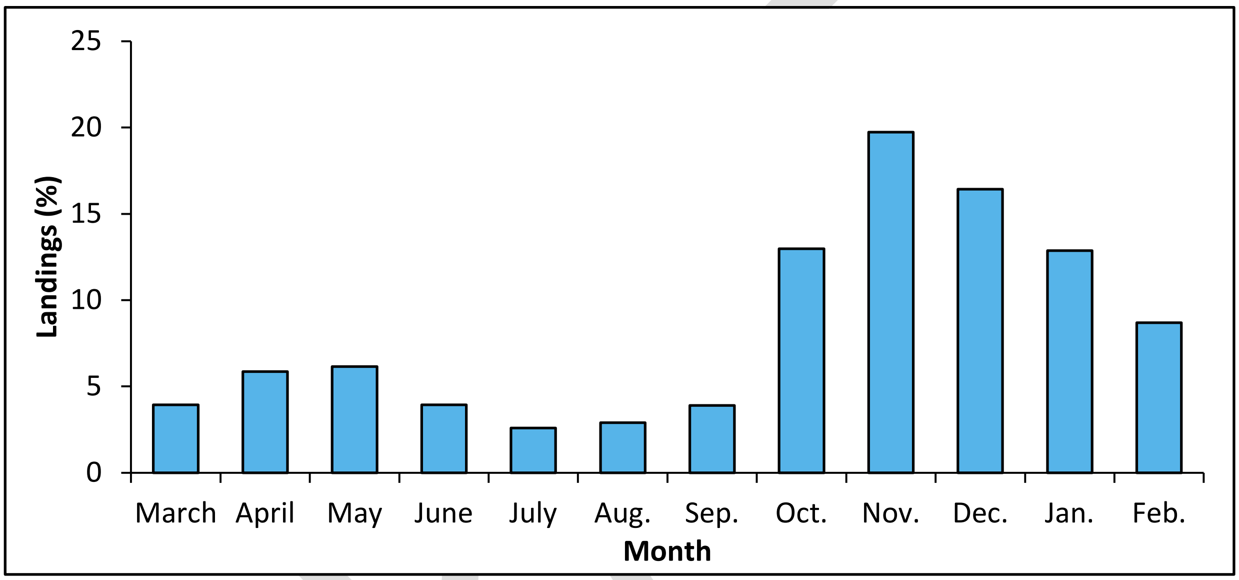

Figure 55. North Carolina Spotted Seatrout commercial landings proportion by month, 1994-2022. Months are ordered according to the biological year which begins in March and ends in February the following year.

Landings by Area

Spotted seatrout are harvested statewide. The main harvest areas are typically Pamlico Sound, followed by the Neuse and Bay rivers and Central Sounds area (Core, Back, and Bogue sounds; Figure 66). Pamlico Sound accounted for 28% of the harvest from 2012 through 2022. Annual harvest from Pamlico Sound during this period ranged from 11,569 lb in 2018 to 255,176 lb in 2021. During this same period, the Neuse and Bay rivers accounted for 24%, the Central Sounds and Southern area each accounted for 13%, Albemarle Sound accounted for 11%, the Pamlico and Pungo rivers accounted for 9%, and the Ocean accounted for 2% of the harvest.

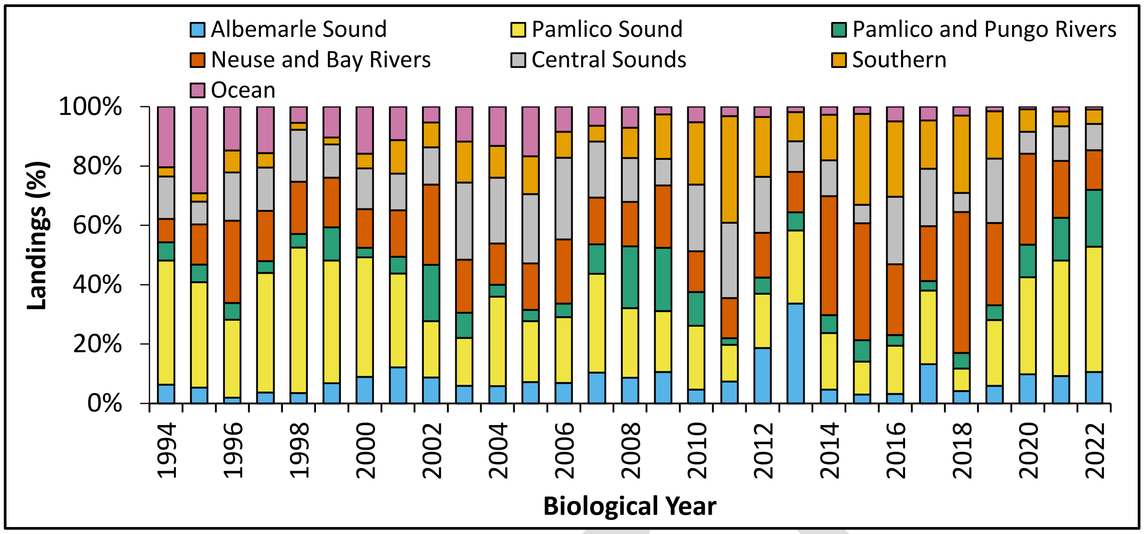

Figure 66. North Carolina annual Spotted Seatrout commercial landings proportion by area, 1994-2022. Albemarle Sound includes Albemarle, Currituck, Croatan, and Roanoke sounds and their tributaries. Pamlico Sound includes Pamlico Sound and its bays and tributaries. Central Sounds includes Core, Back, and Bogue Sounds and their tributaries. Southern includes the White Oak River and all waters south to the SC state line.

Landings by Gear Type

Spotted seatrout are harvested with a variety of gears but anchored gill nets and runaround gill nets account for most of the current harvest (Figure 77). Other gears used include haul seines, beach seines, and ocean gill nets. Since 2012, anchored gill nets have accounted for 43% of the harvest and runaround gill nets have accounted for 49% of the harvest.

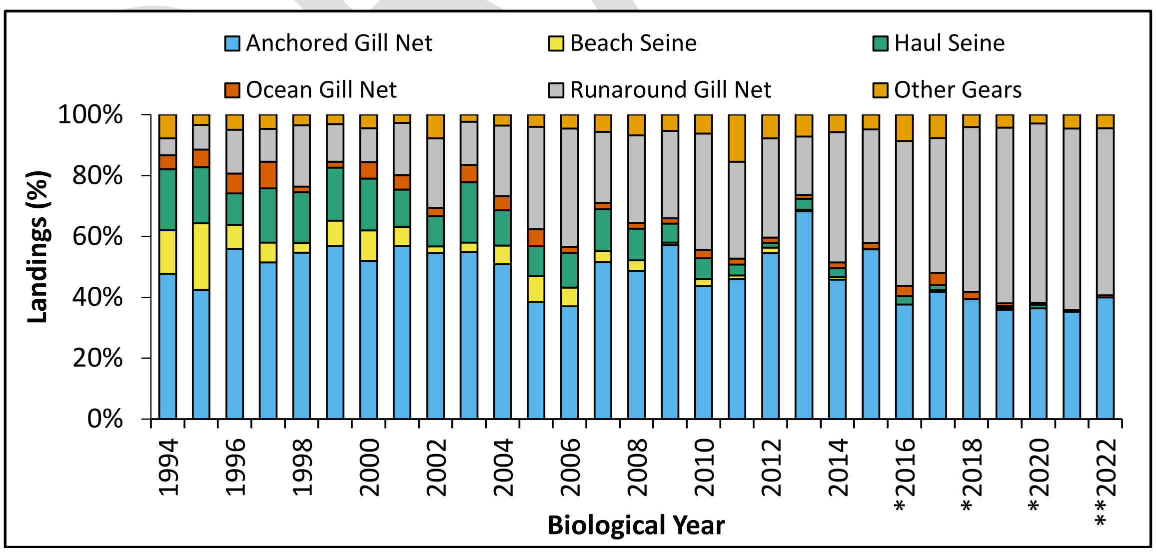

Figure 77. North Carolina annual Spotted Seatrout commercial landings proportion by gear type, 1994-2022. *Beach Seine landings combined with Other Gears due to data confidentiality. **Beach Seine and Haul Seine landings combined with Other Gears due to data confidentiality.

Commercial bycatch

Large mesh anchored gill nets target demersal fish such as flounder during the fall months and pelagic fish such as clupeids during the spring months. Small-mesh anchored gill-net trips occur consistently throughout the year dependent on the target species for that time of year. Spotted Seatrout are targeted primarily during fall and winter. The Spotted Seatrout small-mesh fishery would potentially interact with green sea turtles and Atlantic sturgeon. Most sea turtle interactions occur in the late summer and fall months. Sea turtle movement is typically influenced by water temperature. As soon as water temperatures start to decline within the estuaries, incidental takes significantly decline. Atlantic Sturgeon have the greatest abundance in spring but fall and winter make up for 47% of estimated discards in the small-mesh fishery.

Table 2. Estimates for the number of green sea turtles, Kemp’s ridley sea turtles, and Atlantic sturgeon caught incidentally in the small-mesh and large-mesh anchored gill-net fisheries from 2013-2022. A hyphen (-) represents values that could not be calculated based on data provided.

		Green sea turtle discards		Kemp's ridley sea turtle discards		Atlantic Sturgeon discards	
Seasons	MU	Large Mesh	Small Mesh	Large Mesh	Small Mesh	Large Mesh	Small Mesh
Spring	A	17	4	19	-	1805	181
	B	66	125	13	-	18	478
	C	15	5	4	-	93	41
	Core	37	22	-	-	7	114
	D	4	1	1	-	1	1
	E	19	6	7	-	15	15
Summer	A	16	3	19	-	119	11
	B	313	62	66	-	8	64
	C	28	5	8	-	11	5
	Core	121	3	-	-	3	4
	D	21	2	4	-	1	1
	E	121	9	54	-	7	4
Fall	A	63	8	38	-	1773	88
	B	1,050	206	143	-	96	249
	C	55	14	7	-	72	31
	Core	316	81	-	-	26	134
	D	110	24	8	-	5	1
	E	194	58	43	-	37	39
Winter	A	8	3	-	-	722	131
	B	11	30	-	-	4	125
	C	1	3	-	-	3	27
	Core	1	1	-	-	1	5
	D	1	1	-	-	1	1
	E	2	4	-	-	1	9
Total		2,590	680	434	-	4,829	1,759

Recreational Fishery

The Spotted Seatrout fishery in N.C. is predominately a recreational fishery. Since 2012, recreational landings have accounted for approximately 86% of total landings. Recreational harvest, release, and trip data are estimated from the Marine Recreational Information Program (MRIP) which is a series of surveys designed to estimate total recreational catch. Recreational estimates across all years have been updated and are now based on MRIP's new Fishing Effort Survey-based calibrated estimates. For more information on MRIP see NOAA's MRIP informational page.

Annual landings and releases

Landings in 2019 increased sharply and have remained high through 2022 (Figure 88). In recent years (2012 to 2022) landings averaged 2,212,806 pounds, but since 2019 (2019 to 2022) landings averaged 3,339,879 pounds. Landings have been below a million pounds in only two years since 2012 (2015, 339,436 pounds and 2018, 728,411 pounds) and both years follow documented cold stuns including a fishery closure in 2018 (Table 1). Landings from 2019–2022 represent the four highest landings values in this timeframe and four of the five highest landings since 1991.

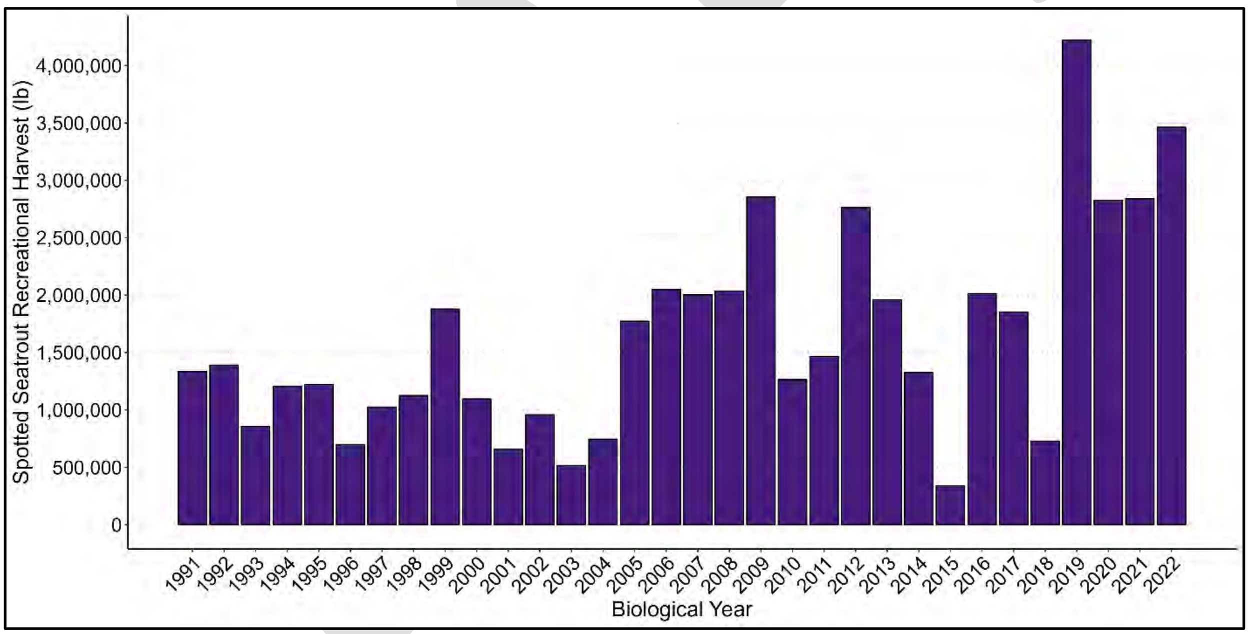

Figure 88. North Carolina Spotted Seatrout recreational landings biological years 1991–2022 (March–February).

There is a dedicated catch and release segment of the recreational fishery, though how anglers participate in this segment varies. Some anglers release all fish, some anglers release all larger fish (e.g., any fish over 20"), and some anglers continue to target Spotted Seatrout for catch and release fishing after harvesting their limit. Recreational releases vary annually and 2018 represents a large outlier for the time series likely due to Hurricane Florence impacting MRIP surveys throughout most of North Carolina in late 2018 but releases have generally increased since 2009 (Figure 99). Recreational releases may change seasonally as well because Spotted Seatrout growth rates and life history can lead to greater numbers of sublegal fish at times. Anglers released an average of 6,150,931 fish annually from 2009–2022 with the 2018 outlier removed which is nearly five times the number of fish harvested.

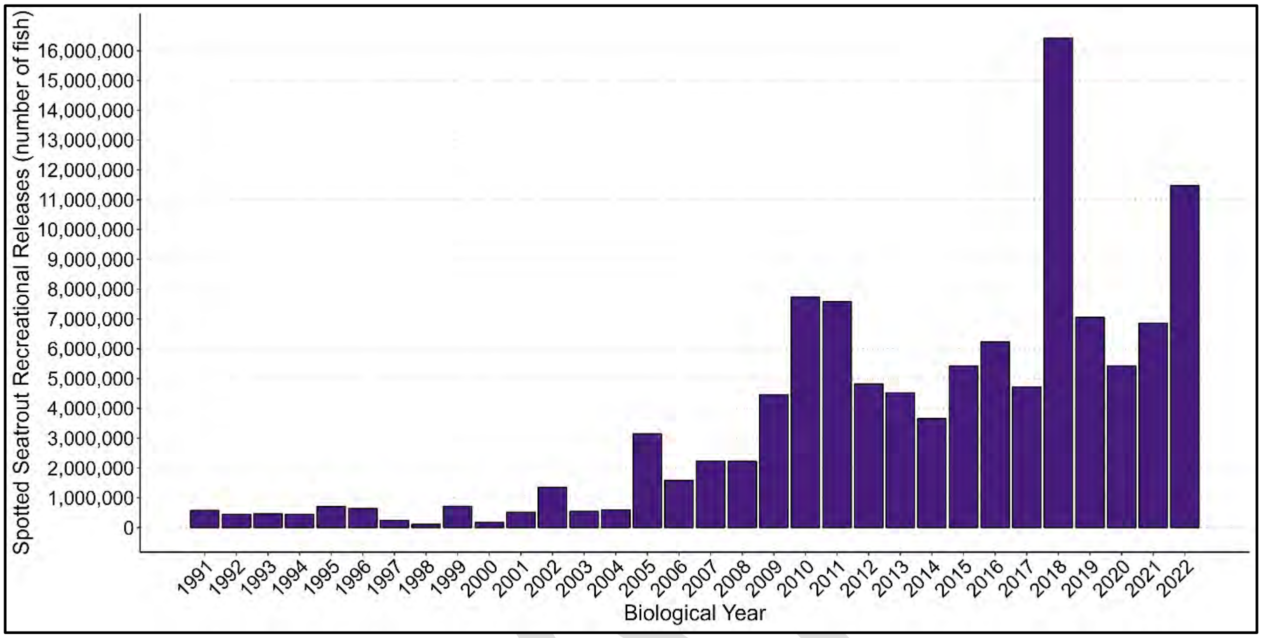

Figure 99. North Carolina Spotted Seatrout recreational releases biological years 1991–2022 (March–February). Hurricane Florence impacted MRIP sampling in most of North Carolina in late 2018. As such recreational releases from 2018 should be viewed with a high degree of caution.

Landings by month

Although recreational harvest occurs throughout the year, most harvest occurs in late fall and early winter. Harvest increases in October, peaks sharply in November, then decreases in winter but remains above average compared to the rest of the year in December, January, and February (Figure 1010). A second, slight increase in landings occurs in June and July, likely driven by tourism. From 1991 to 2022 approximately 63% of harvest occurs during the primary harvest peak (October – February) while the slight increase in June and July encompasses about 11% of harvest. In recent years (2012–2022), the general harvest patterns remain, but winter months make up a larger proportion of harvest (Figure 1111). Though minor regional variation in these seasonal patterns might exist, these patterns are broadly consistent across the state.

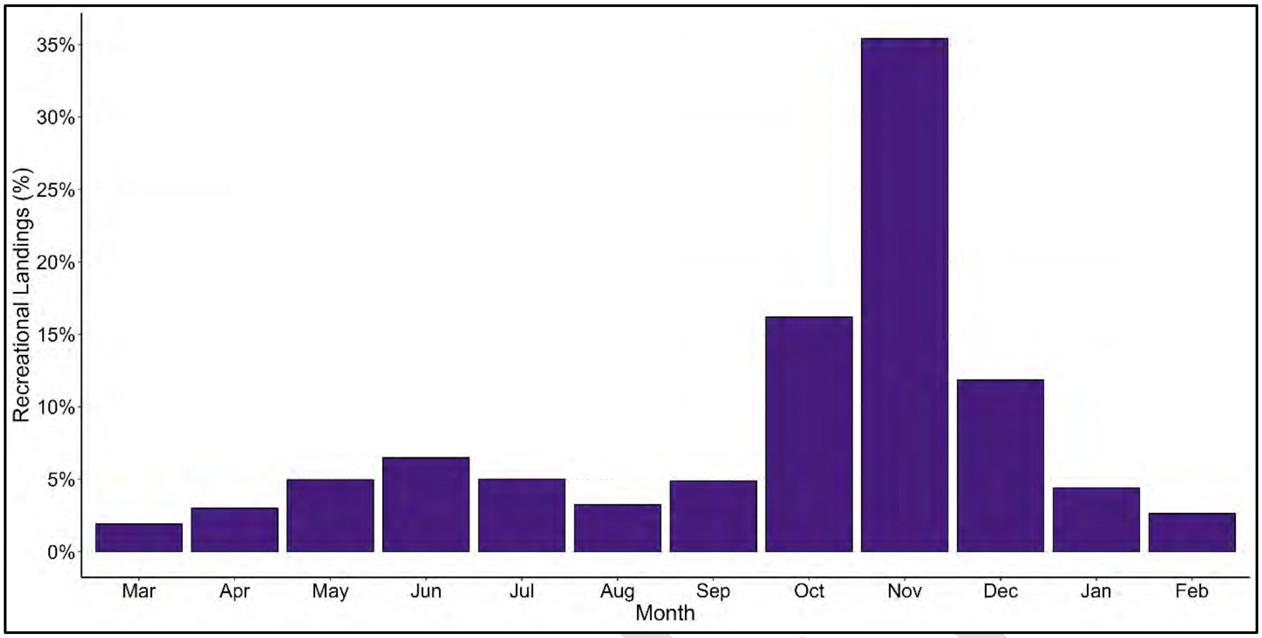

Figure 1010. North Carolina average monthly Spotted Seatrout recreational landings proportion by month, 1991-2022. Months are ordered according to the biological year (March – February).

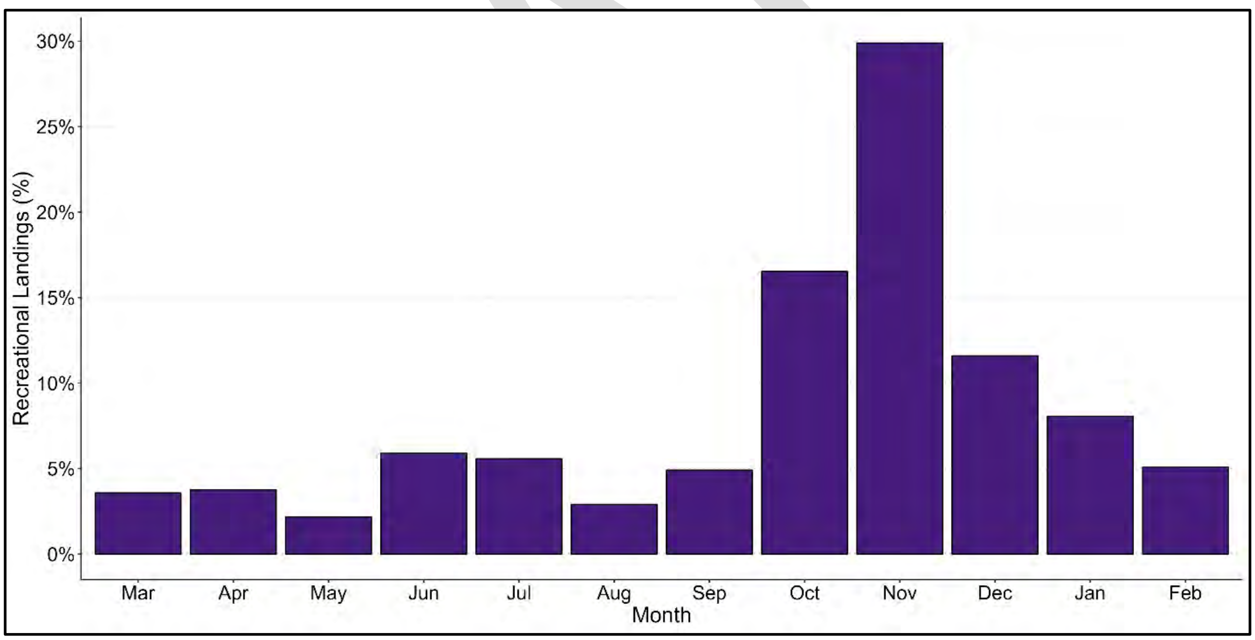

Figure 1111. North Carolina average monthly Spotted Seatrout recreational landings proportion by month, 2012-2022. Months are ordered according to the biological year (March – February).

Recreational releases also occur throughout the year, however; releases are concentrated in October, November, and December. In recent years (2012–2022) a slightly larger proportion of fish are released in January compared to the rest of the year, but releases remain relatively consistent outside October, November, and December (Figure 1212).

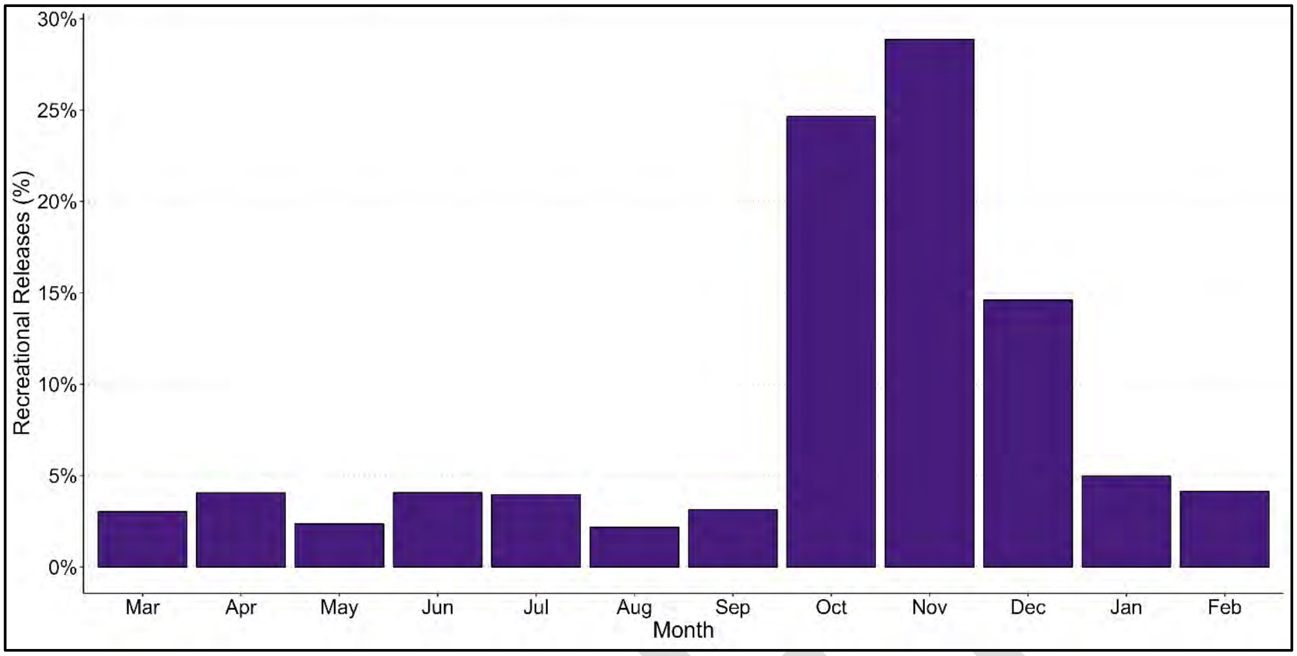

Figure 1212. North Carolina average monthly Spotted Seatrout recreational releases proportion by month, 2012-2022. Months are ordered according to the biological year (March – February).

Summary of Economic Impact

Modeling software, IMPLAN, is used to estimate the economic impacts of an industry to the state at-large, accounting for revenues and participation. For a detailed explanation of the methodology used to estimate the economic impacts please refer to the North Carolina Division of Marine Fisheries (DMF) License and Statistics Section Annual Report. Due to the management options being considered, this analysis includes both the recreational and commercial industries.

Commercial

Commercial landings and effort data collected through the DMF trip ticket program are used to estimate the economic impact of the commercial fishing industry. For commercial fishing output, total impacts are estimated by incorporating modifiers from NOAA's Fisheries Economics of the United States reports from 2012-2020, which account for proportional expenditures and spillover impacts from related industries. By assuming the Spotted Seatrout commercial fishery's economic contribution is a proportion equal to its contribution to total commercial ex-vessel values, we can generate an estimate of the economic contribution of the commercial Spotted Seatrout fishery statewide.

From 2012 to 2022 Spotted Seatrout economic sales impacts have varied from a low of approximately $360,000 in 2015 to a high of $1.5 million dollars in 2022 and supports between 575 and 1,200 jobs annually. Annual sales impacts have varied over the decade but have averaged $5.9 million from 2012 to 2022.

Table 3. Annual economic contributions from the Spotted Seatrout commercial fishery to the state of North Carolina from 2012 to 2022 reported in 2022 dollars.

Year	Pounds Landed	Ex-Vessel Value	Job Impacts	Income Impacts	Value Added Impacts	Sales Impacts
2022	520,994	$1,480,294	834	$3,413,446	$5,432,284	$7,819,923
2021	654,327	$1,833,146	846	$4,305,885	$6,767,404	$9,880,173
2020	653,093	$1,709,539	862	$4,296,534	$6,965,574	$9,646,212
2019	443,629	$1,182,385	822	$2,986,277	$4,369,883	$6,959,060
2018	151,708	$461,888	575	$1,044,323	$1,717,370	$2,371,747
2017	259,432	$810,368	898	$2,100,330	$3,132,230	$4,835,802
2016	273,848	$864,570	775	$2,281,480	$3,515,818	$5,204,455
2015	115,547	$358,921	633	$938,109	$1,450,039	$2,135,390
2014	226,394	$671,553	846	$1,631,567	$2,455,165	$3,761,647
2013	364,123	$1,035,645	1,194	$2,528,888	$3,938,648	$5,769,680
2012	315,128	$811,864	1,081	$2,858,981	$3,908,590	$6,278,522

Recreational

Recreational effort data is provided from the Marine Recreational Information Program, the National Marine Fisheries Service (NMFS) as well as survey responses collected from North Carolina recreational fishing participants administered by the Fisheries Economics Program at DMF. For recreational fishing output, total impacts are estimated by incorporating modifiers from NOAA's Fisheries Economics of the United States reports from 2012 to 2020, which account for proportional recreational expenditures and spillover impacts from related industries. By assuming the Spotted Seatrout recreational fishery's contribution to expenditure categories is at a proportion equal to its contribution to total recreational trips and durable goods expenditure, we can generate an estimate of the total economic contribution of Spotted Seatrout in North Carolina.

From 2012 to 2022 Spotted Seatrout economic sales impacts have varied from a low of about $267 million in 2015 to a high of $581 million dollars in 2020. Similarly, job impacts span from approximately 2,700 to 5,500 jobs annually. Annual sales impacts have varied over the described time horizon but have averaged $438 million from 2012 to 2022.

Table 4. Annual economic contributions of the Spotted Seatrout recreational fishery to the state of North Carolina from 2012 to 2022 reported in 2022 dollars.

Year	Trips	Expenditure	Job Impacts	Income Impacts	Value Added Impacts	Sales Impacts
2022	2952725	$610,166,244	4556	$186,974,466	$287,883,774	$508,297,606
2021	2254224	$527,895,592	4318	$167,784,164	$253,959,746	$455,899,909
2020	2719670	$680,865,862	5486	$231,035,451	$328,868,972	$580,954,157
2019	2528247	$635,730,887	5252	$195,627,253	$296,435,669	$535,753,473
2018	1773091	$439,207,323	3185	$141,032,169	$213,419,087	$380,831,319
2017	1555087	$380,456,082	3573	$117,806,629	$177,609,593	$325,543,922
2016	2091731	$522,385,203	4526	$164,680,710	$244,974,745	$443,331,488
2015	1295843	$321,730,351	2709	$98,681,487	$160,541,925	$267,200,930
2014	1510415	$384,591,773	3635	$116,796,277	$173,912,242	$309,980,126
2013	2065210	$552,161,892	4451	$390,676,333	$248,904,256	$532,736,812
2012	2112138	$587,450,277	4679	$176,846,782	$263,358,908	$473,618,472

ECOSYSTEM PROTECTION AND IMPACT

Coastal Habitat Protection Plan

The Fishery Reform Act statutes require that a Coastal Habitat Protection Plan (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 in developing goals and recommendations for the continued protection and enhancement of fishery habitats in North Carolina. Habitat recommendations related to fishery management can be addressed directly by the North Carolina Marine Fisheries Commission (NCMFC). The NCMFC has passed rules that provide protection for Spotted Seatrout 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).

Spotted seatrout make use of a variety of habitats during their life history with variations in habitat preference due to location, season, and ontogenetic stage. They are found most often in habitats identified in the CHPP including water column, wetlands, submerged aquatic vegetation (SAV), soft bottom, and shell bottom (NCDEQ, 2016). Spotted Seatrout are found throughout estuarine systems and can migrate offshore to deeper marine soft bottom areas and beaches in response to falling temperatures (ASMFC, 1984; Mercer, 1984). Spotted Seatrout do, however, show a strong preference for low-flow areas with SAV or soft bottom (Tabb, 1958; Moulton et al., 2017). Growth and survival of Spotted Seatrout within the habitats they use are maximized when water quality parameters such as temperature, salinity, and dissolved oxygen are within optimal ranges. Maintenance and improvement of suitable estuarine habitat and water quality may be the most important factors in sustaining Spotted Seatrout stocks. Additional information on the habitats discussed below, threats to these habitats, water quality degradation, and how these topics relate to fisheries can be found in the CHPP (NCDEQ, 2016).

Threats and Alterations

Suitable habitat is a critical element in the ecology and productivity of estuarine systems. Degradation or improvement in one aspect of habitat may have a corresponding impact on water quality. All habitats used by Spotted Seatrout are threatened in some way.

Water Column

The water column habitat is defined as “the water covering a submerged surface and its physical, chemical, and biological characteristics” (NCDEQ, 2016). Spotted seatrout spawning is generally limited to estuarine waters in the late summer and early fall in response to temperature and salinity but can also include inlets in North Carolina (ASMFC, 1984; Mercer, 1984; Saucier & Baltz, 1992, 1993; Holt and Holt, 2003; Kupschus, 2004; Stewart & Scharf, 2008; Ricci et al., 2017). Spawning sites have been noted to include tidal passes, channels, river mouths, and waters in the vicinity of inlets (Saucier & Baltz, 1992, 1993; Roumillat et al., 1997; Luczkovich et al., 1999; Stewart & Scharf, 2008; Lowerre-Barbieri et al., 2009; Boucek et al., 2017). For the portion of the Spotted Seatrout population that spawns inshore or offshore of inlets, they are a critical component of water column habitat for Spotted Seatrout and the larvae that must pass through inlets to reach estuarine nursery areas (Churchill et al., 1997; Hare et al., 1999; Luettich et al., 1999). Due to the importance of inlets to the movement of larval Spotted Seatrout into nursery areas and of adult Spotted Seatrout out into to oceanic waters while avoiding lower estuarine temperatures, terminal groins may threaten Spotted Seatrout stocks by impeding recruitment and preventing adults from avoiding cold stuns, since they can obstruct inlet passage (Kapolnai et al., 1996; Churchill et al., 1997; Blanton et al., 1999). Inlets are hydraulically dredged on a regular basis to ensure safe passage for vessels of all sizes. Though DMF recommends an in-water-work moratorium of April 1 to July 30 to minimize impacts during peak biological activity, most projects are given moratorium relief due to public safety. Large hydraulic dredge boats are used inside the inlets and have the highest potential to draw in fishes and invertebrates of all life stages. However, this type of dredge is most impactful to eggs and larval fish, as their reduced swimming ability means they are unable to actively avoid the suction field (Todd et al., 2015).

Soft Bottom

Soft bottom habitat plays an important role in estuarine system function, acting as both a source and sink (storage) for nutrients, chemicals, and microbes. Estuarine soft bottom habitats, especially those adjacent to wetlands, act as Spotted Seatrout nursery areas, provide key food sources for all life stages, and refuge from large predators (Ross & Epperly, 1985; Noble & Monroe, 1991; Powers, 2012). Soft bottom sediments support algae and the benthic invertebrates that eat algae, which are important food sources for juvenile and adult Spotted Seatrout. Spotted Seatrout begin their lives eating primarily copepods and mysid shrimps before transitioning to penaeid and palaemonid shrimps (Peterson and Peterson 1979; Daniel 1988; McMichael and Peters 1989). Soft bottom habitat, along with SAV, are more heavily utilized by Spotted Seatrout than other habitat types (Tabb, 1958; Moulton et al., 2017). Dredging threatens soft bottom habitat, potentially affecting Spotted Seatrout food sources and water quality. Dredging removes all benthic infauna from the affected areas immediately, which reduces food availability temporarily to bottom feeding fish such as the Spotted Seatrout (NCDEQ, 2016).

In addition to estuarine soft bottom habitats, there are also surf zone and deeper marine soft bottom habitats used by adult Spotted Seatrout in North Carolina during late autumn temperature migrations (ASMFC, 1984; Mercer, 1984). The threats to ocean beaches and surf zone include beach nourishment and storm water outfalls.

Submerged Aquatic Vegetation

Submerged Aquatic Vegetation (SAV) is a fish habitat dominated by one or more species of underwater vascular plants and occurs in both subtidal and intertidal zones, sometimes over extensive areas (NCDEQ, 2016). SAV acts as a crucial structured habitat for fishes and invertebrates, providing refuge from predators and food sources such as epiphytic (living on the surface of vegetation) algae and animals. Spotted Seatrout use SAV as spawning sites, nurseries, forage areas, refuge areas, and for feeding on invertebrates on seagrasses and other structures. The Atlantic States Marine Fisheries Commission (ASMFC) lists SAV as a Habitat Area of Particular Concern (HAPC) for Spotted Seatrout (ASMFC, 1984). All life stages of Spotted Seatrout have been documented in mesohaline and polyhaline seagrass beds (Tabb, 1966; ASMFC, 1984; Mercer, 1984; Thayer, Kenworthy & Fonseca, 1984; McMichael & Peters, 1989; Rooker et al., 1998). Spotted Seatrout use SAV habitat as much, if not more, than other spawning sites (Ricci et al., 2017; Boucek et al., 2017). Juvenile Spotted Seatrout are abundant in high salinity SAV in both Pamlico and Core sounds (Purvis, 1976; Wolff, 1976) and juvenile abundances were found to be greater in SAV than soft bottom and oyster reef and were greater than or equivalent to abundances in wetland habitats (Minello, 1999; Minello et al., 2003). Seagrass beds are threatened by physical destruction from bottom disturbing fishing gear, dredging, and damage from boat use, as well as degradation of water quality. Declines in SAV, globally and in North Carolina, due to increased coastal development and decreased water quality, are also altering these ecosystems and their community structure.

Shell Bottom

Shell bottom is defined as estuarine intertidal or subtidal bottom made of surface shell concentrations of living or dead oysters, hard clams, and other shellfish (NCDEQ, 2016). This includes oyster beds and reefs and shell hash (a mixture of sediments and broken shell). Spawning aggregations of Spotted Seatrout have been documented over shell bottom areas in North Carolina including in the Neuse River (Barrios et al., 2006). Shell bottom habitats have been shown to provide an important forage base of invertebrates and small finfish for juvenile and adult Spotted Seatrout (Coen et al. 1999; ASMFC, 2007). Oyster reefs and shell hash areas can be damaged by bottom-disturbing fishing gears, disease, and overfishing.

Wetlands

Wetlands are areas that are inundated or saturated by the accumulation of surface or groundwater, enough to support a prevalence of vegetation typically adapted for life in saturated soil conditions (NCDEQ, 2016). Estuarine wetlands are tidal and are found in bays, sounds, and rivers in brackish waters. Freshwater wetlands include freshwater marshes, bottomland, hardwood forests, and swamp forests in low salinity to freshwater areas of creeks, streams, and rivers. Wetlands are particularly valuable as juvenile Spotted Seatrout appear to use estuarine wetlands, particularly the marsh edge habitat of salt/brackish marshes, as nurseries (Tabb, 1966; ASMFC, 1984; Mercer, 1984; Hettler 1989; Rakocinski et al., 1992; Baltz et al., 1993; Peterson & Turner, 1994). Abundances of juveniles in wetlands were found to be less than or equal to abundances in SAV (Minello, 1999; Minello et al., 2003). Wetlands are threatened by many human activities, including dredging for marinas and channels, filling for development, ditching and draining for agriculture, silviculture, channelization, and shoreline stabilization. Wetland loss and decreasing vegetative buffers can hasten excessive nutrient loading impacts to the surrounding water and other habitat types (NCDWQ, 2000a).

Water Quality Degradation

Good water quality is essential, both for supporting the various life stages of Spotted Seatrout and for maintaining their habitats. Naturally occurring and anthropogenic activities can alter the salinity and temperature conditions or elevate levels of toxins, nutrients, and turbidity, as well as lower dissolved oxygen levels, which can degrade water quality and impact Spotted Seatrout survival. Water quality degradation through stormwater runoff, discharges, toxic chemicals, sedimentation, and changes in turbidity can threaten Spotted Seatrout survival. Salinity particularly affects the eggs of Spotted Seatrout which rely on high spawning salinities to remain positively buoyant allowing for wind and tidally driven distribution throughout the estuary (Churchill et al., 1999; Holt & Holt, 2003); however, sudden salinity reductions cause Spotted Seatrout eggs to sink, thus reducing dispersal and survival (Holt & Holt, 2003).

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 in the NCDWQ guides on the NCDWQ website (NCDWQ, 2000b; NCDWQ, 2008) and in the CHPP (NCDEQ, 2016). More information about the water quality requirements for Spotted Seatrout can be found in the DESCRIPTION OF THE STOCK section of this FMP.

Gear Impacts on Habitat

Bottom disturbing fishing gear can impact ecosystem function through habitat degradation. Static (non-mobile) gears tend to have a lesser impact on habitat compared to mobile gears, as the amount of area affected by static gears tends to be insignificant when compared to that of mobile gears (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 Spotted Seatrout commercial fishery are estuarine gill nets (runaround, strike, or set), long haul seines, beach seines, and ocean gill nets. In the recreational fishery, rod and reel is the primary gear. Other gears that may harvest Spotted Seatrout as incidental catch include pounds nets, crab pots, drift gill nets, and fyke nets. Many gears that interact with Spotted Seatrout are considered static gear (Barnette, 2001; NCDEQ, 2016) and generally have minimal impact on habitat.

Beach seines and runaround gill nets are both mobile and may disturb local habitats. Impacts from mobile bottom-disturbing fishing gears such as seines and runaround gill nets include changes in community composition from the removal of species and physical disruption of the habitat (Barnette, 2001). Gears may damage or uproot SAV as they are dragged across the seafloor, potentially reducing productivity and destroying structures that provide feeding surfaces and shelter for Spotted Seatrout (NCDEQ, 2016). Gears that drag across the seafloor may also suspend sediments, temporarily increasing turbidity (Corbett et al., 2004) and reducing clarity, SAV growth, productivity, and survival (NCDEQ, 2016). Sediment suspended by bottom disturbing fishing gears and boat propeller wash may also bury SAV (Thayer et al., 1984), degrading habitat quality and reducing productivity.

Extreme Weather Events

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, soft bottom, and wetlands, that are critical to Spotted Seatrout throughout their life history. Potential increases in extreme weather events could have an inverse effect on the recruitment and survival of Spotted Seatrout in the estuarine system.

Included in extreme weather events are winter storms. Spotted seatrout display a greater sensitivity to sharp drops in water temperatures than many other species. Throughout their range, Spotted Seatrout are periodically exposed to water temperatures below their thermal tolerance (i.e., below temperatures they can tolerate without experiencing stress) because of prolonged cold air temperatures or from snow and ice melt after a winter storm. For more information on how Spotted Seatrout are affected by winter events, please see the Cold Stun Management issue paper in this FMP.

FINAL AMENDMENT ONE MANAGEMENT STRATEGY

****Section will be completed when the MFC selects preferred management and prior to DEQ secretary and legislative committees review****

The purpose of this section is for readers to see exactly how we are managing this fishery and what constitutes a change in management. It should include an overview and statement of policies, as well as any adaptive management. Present the management strategies in a clear, concise, and precise way.

RESEARCH NEEDS

The research recommendations listed below are offered by the division to improve future management strategies of the Spotted Seatrout fishery. They are considered high priority as they will help to better understand the Spotted Seatrout fishery and meet the goal and objectives of the FMP. A more comprehensive list of research recommendations is provided in the Annual FMP Update and DMF Research Priorities documents.

- Integrate tagging data into stock assessment model so both tagging data and other data sources can work together to give a better picture of the population dynamics including estimates of survival and natural mortality.
- Conduct additional work to evaluate more fully the utility of the Program 120 survey and determine if alternative sampling methodologies or expanded sampling seasonality could provide a more robust index.
- Develop programs to incorporate information on size of recreational releases such as Citizen Science initiatives; Improve estimates of recreational discard mortality.
- Conduct a detailed analysis of the existing data (i.e. Program 915) to determine the extent to which late fall and spring provide insights into overwinter changes in abundance.
- Conduct research to generate accurate fecundity estimates for North Carolina Spotted Seatrout.

APPENDICES

Appendix 1: SMALL-MESH GILL NET CHARACTERIZATION IN THE NORTH CAROLINA SPOTTED SEATROUT FISHERY

ISSUE

The small-mesh gill-net fishery in North Carolina is managed and regulated by species-specific fishery management plans (FMPs), and numerous Marine Fisheries Commission (MFC) rules and Division of Marine Fisheries (DMF) proclamations. However, concerns about biological impacts from the use of small mesh gill nets remain. The primary issues to be addressed concern greater flexibility with constraining harvest in the Spotted Seatrout fishery, reducing bycatch, and to the greatest extent practical reducing conflict between gill-net users and other stakeholders. Specific management options for gill-net regulations can be found in Appendix 2: Sustainable Harvest Issue Paper.

ORIGINATION

The North Carolina Marine Fisheries Commission.

BACKGROUND

At their August 2021 business meeting, the MFC passed a motion to not initiate rulemaking on small-mesh gill nets but refer the issue through the FMP process for each species, and any issues or rules coming out of the species-specific FMP to be addressed at that time. In North Carolina, small-mesh gill nets are the predominant gear used to harvest Spotted Seatrout. Most Spotted Seatrout are harvested commercially using set gill nets or runaround gill nets. Per direction from the MFC, small-mesh gill nets must be addressed during review of the Spotted Seatrout FMP.

North Carolina General Statutes authorize the MFC to adopt rules for the management, protection, preservation, and enhancement of the marine and estuarine resources within its jurisdiction (G.S. 113-134; G.S. 143B-289.52). The MFC has authority to adopt FMPs and the DMF is charged with preparing them (G.S. 113-182.1; G.S. 143B-289.52). Further, the MFC may delegate to the DMF director in its rules the authority to issue proclamations suspending or implementing MFC rules that may be affected by variable conditions (G.S. 113-221.1; G.S. 143B-289.52). Variable conditions include compliance with FMPs, biological impacts, bycatch issues, and user conflict, among others (MFC Rule 15A NCAC 03H .0103). The estuarine gill-net fishery in North Carolina is managed and regulated by FMPs and numerous MFC rules and DMF proclamations. Rules are periodically amended to implement changes in management goals and strategies for various fisheries and are the primary mechanism for implementing FMPs under the Fisheries Reform Act of 1997 (FRA).

In recent years, modifications to gill-net management resulting from the adoption of FMPs or other circumstances have largely been implemented through the DMF director's proclamation authority, not through rulemaking. This is primarily due to the need to implement management changes in a timely fashion and to accommodate variable conditions. Over time, this has resulted in incongruent restrictions between rules and proclamations. Additionally, many of the rules related to small mesh gill nets were first developed prior to the FRA and have not been thoroughly evaluated since the addition of more recent rules developed through the FMP process.

The Spotted Seatrout small-mesh gill-net fishery operates year-round, but the type of gill net used varies by season and area (NCDMF 2018). Multiple species may be landed during a single trip; however, the target species usually dominates the catch (NCDMF 2008). In North Carolina, gill nets are restricted to a minimum mesh size of 2.5 inches stretched mesh [ISM; MFC Rule 15A NCAC 03J .0103(a)]. The DMF categorizes gill nets from 2.5 to less than 5 ISM as small-mesh (Daniel 2013). Although the rule uses "mesh length" and not "mesh size", their meanings are identical for the purpose of this document; this helps to demarcate the discussion of "mesh size" from "net length" throughout the document. Small-mesh gill nets are generally classified into three categories based on how the net is deployed and fished: set gill nets, runaround gill nets, and drift gill nets [Figure 1.1; Table 1.1; (Steve, et al. 2001)]. For the purposes of this document, "set" gill nets, or "set nets", includes anchored, fixed, and stationary gill nets.

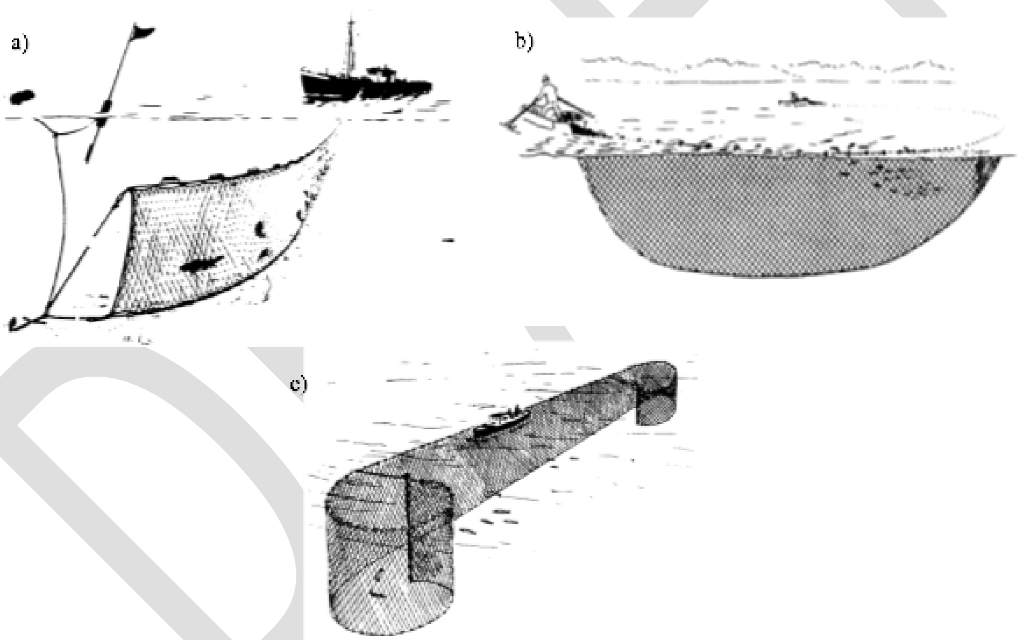

Figure 1. 1 Illustrations of (a) set, (b) runaround, and (c) drift gill nets extracted from Steve et al. (2001).

Set nets (Figure 1.1a) are the second most common gill-net type used for commercial Spotted Seatrout harvest in North Carolina. They are kept stationary with the use of anchors or stakes attached to the bottom or attached to some other structure attached to the bottom, at both ends of the net (MFC Rule 15A NCAC 03I .0101). Set nets can be further classified as sink or float gill nets (Steve et al. 2001). A sink gill-net fishes from the bottom up into the water column a fixed distance by having a lead line (bottom line) heavy enough to sink to the bottom. Depending on the height of the net and the depth of the water, the float line (top line) may or may not be submerged below the surface of the water. A float gill net may fish the entire water column by having the top line with buoys sufficient for floating on the surface of the water, or a portion of the water column depending on the depth of the net (number of meshes deep). Set nets are deployed by dropping one end of the net and running out the rest of the length of net usually in a line. Once deployed, soak times for fishing set nets vary depending on factors such as target species, water temperature, season, waterbody, and regulations (NCDMF 2018).

A runaround gill net is the most common gill-net method used for commercial Spotted Seatrout harvest in North Carolina. It is an actively fished gear used to encircle schools of fish (Figure 1.1b). They are deployed with a weight and a buoy at one end that enables the rest of the net to be fed out, creating a closed circle around the school of fish due to the vessel's path. Runaround gill nets tend to be deep nets capable of fishing the entire water column. Mesh sizes and net lengths vary depending on the target species (Steve et al. 2001). Another form of runaround gill net is the strike net or drop net. Rather than deploying the net in a circle, the net is set parallel to shore, often with one end anchored to the bank. Once the net is set, the boat is driven between the net and the shore to drive fish into the net (NCDMF 2018). Soak times for all types of runaround gill nets are almost always an hour or less.

Table 1. 1 Small-mesh gill net gear categories with descriptions and capture method descriptions.

Small-Mesh Gill Net Gear Categories	Sub-Categories	Gear Description	Capture Method
Anchored, Fixed, Stationary, Set	Sink	Attached to bottom or some other structure by anchors or stakes at both ends. Sink nets are fished from the bottom up into the water column	Passively Fished - For both sink and float set nets the gear is left in place for a period of time. Fish, if appropriately sized, swim into the net and are gilled.
	Float	Attached to bottom or some other structure by anchors or stakes at both ends. Float nets are fished from the top down into the water column. Depending on target species, nets fish part of the water column or the entire water column.	
Runaround	Circle	Attached to the bottom at one end. Once the end is set, the rest of the net is then fed out of a boat creating a circle and meeting back at the original set point. Generally, these nets fish the entire water column.	Actively Fished - Used to encircle a school of fish. Primary target species for this gear is Striped Mullet.

	Strike, Drop	Attached to the bottom at one end. Deployed along shore with the terminal end finishing at another point along the shore. The boat is driven into the blocked section to “drive” the fish into the net and are then retrieved.	Actively Fished - Used to corral or intercept a school of fish and then immediately retrieved. Primary target species for this gear is Striped Mullet, and Spotted Seatrout to a lesser extent.
Drift		Attached to boat or free-floating with close attendance. Lighter lead lines and no anchors allow the net to drift. Depending on target species and water depth, nets fish part of the water column or the entire water column. Primarily used in Pamlico Sound to target Spanish Mackerel and Bluefish.	Actively Fished - Drift with the water current with continuous attendance.

Drift gill nets are unanchored, non-stationary gill nets that are actively attended (i.e., remain attached to the vessel or the fishing operation remains within 100 yards of the gear; Figure 1.1c) and tend to have shorter soak times than set gill nets. They are constructed with lighter lead lines to allow for the net to drift with the current. The small-mesh drift gill nets currently employed in North Carolina estuaries are primarily used to target Spanish Mackerel and Bluefish in Pamlico Sound. This gear can also be used to target Spot (as a sink net) and Striped Mullet (typically fishing the entire water column) in areas primarily from Core Sound and south (Steve et al. 2001). Drift gill nets typically account for less than 0.5% of annual Spotted Seatrout landings. However, from 2019 through 2022 drift gill nets accounted for 2.5% of Spotted Seatrout landings.

METHODS

Information specific to the North Carolina gill net fishery was gathered from the N.C. Trip Ticket Program and two DMF sampling programs briefly described below:

N.C. Trip Ticket Program

The N.C. Trip Ticket Program began in 1994. This program requires licensed commercial fishermen to sell their catch to licensed fish dealers, who are then required to complete a trip ticket for every transaction. Data collected on trip tickets include gear type, area fished, species harvested, and total weights of each species. Information recorded on trip tickets for gear type and characteristics is self-reported by the dealer. This information may be verified by DMF fish house staff after the fact, but the potential exists that some trips may be mischaracterized by dealers. In 2004, trip tickets included mesh size categories for gill nets: small-mesh < 5-inch ISM and large-mesh ≥ 5-inch ISM. However, the use of this new field was not prevalent until about 2008 because dealers were still using old trip tickets they had on hand.

Commercial Fish House Sampling

Commercial fishing activity is monitored through fishery-dependent (fish house) sampling. Sampling occurs dockside as fish are landed. Commercial fishermen and/or dealers are interviewed by DMF staff, and the catch is sampled. Samplers collect data on location fished, effort (soak time, net length, etc.), gear characteristics (net type, net depth, mesh size, etc.), and the size distribution of landed species.

Commercial Observer Program

On board observations of commercial estuarine gill nets, primarily set gill nets, occur through Program 466. Observers collect data on effort (soak time, net length, etc.), location fished, gear characteristics, size, and the fate (harvest, discard, etc.) of captured species. The Observer Program was born out of the need to estimate incidental takes of protected species such as sea turtles and Atlantic sturgeon in estuarine set gill nets per the Endangered Species Act Section 10 Incidental Take Permits (NMFS 2013, 2014). As a result, observations of runaround or drift gill nets are rare.

The following analysis and information presented are used to characterize the Spotted Seatrout small-mesh gill-net fishery in North Carolina relative to time, area, configuration, and species composition of the harvested and discarded catch. Data from biological years 2012 through 2022 for these three programs were used to characterize the current North Carolina Spotted Seatrout small-mesh gill-net fisheries.

Using trip ticket data, trips where Spotted Seatrout were the species of highest abundance in landings or the most abundant finfish species of those species typically targeted with small-mesh gill nets were considered targeted Spotted Seatrout trips. Basing analysis on trips where Spotted Seatrout are the presumed target species allows for results that describe the gear parameters associated with the directed Spotted Seatrout fishery (see NCDMF 2008 for further description of methodology). Once targeted Spotted Seatrout trips were identified, the method of fishing (set gill net or runaround gill net), mesh size, and net length were characterized based on available fish house sampling data from 2012 through 2022. Analysis of fish house sampling data was limited to samples where only one gear was used on the trip.

Regional analysis of the Spotted Seatrout small-mesh gill-net fishery was investigated by waterbody of landing. Waterbodies were grouped into seven regions using distinct area boundaries or clear differences in fishing practices (Figure 1.2).

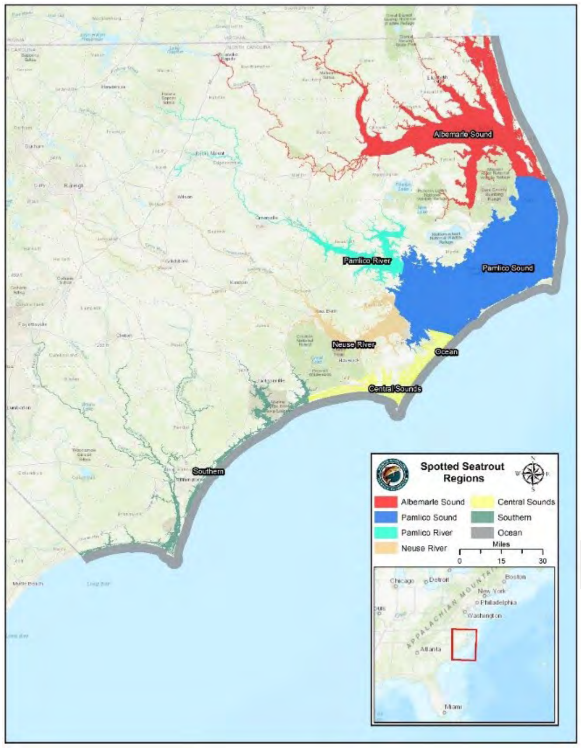

Figure 1. 2. Map of defined regions used for regional characterization of the Spotted Seatrout small-mesh gill-net fishery.

RESULTS

For information regarding characterization of small-mesh gill nets across all fisheries in North Carolina please refer to the Small Mesh Gill Net Rule Modifications Information Paper presented to the MFC at its August 2021 business meeting.

Spotted Seatrout Fishery General Characterization

The commercial Spotted Seatrout fishery is currently managed with a 14” minimum size limit and 75-fish daily trip limit (except for the stop net fishery). Since 2012, runaround gill net has been the primary gear used to harvest Spotted Seatrout in the commercial fishery, followed by small-mesh set gill net (Figures 1.3 and 1.4). From April through October, most Spotted Seatrout harvest comes from small-mesh set gill nets. However, from November through March, commercial landings switch to runaround gill nets as Spotted Seatrout aggregate in the fall and winter and are more easily targeted by commercial fishermen (Figure 1.5).

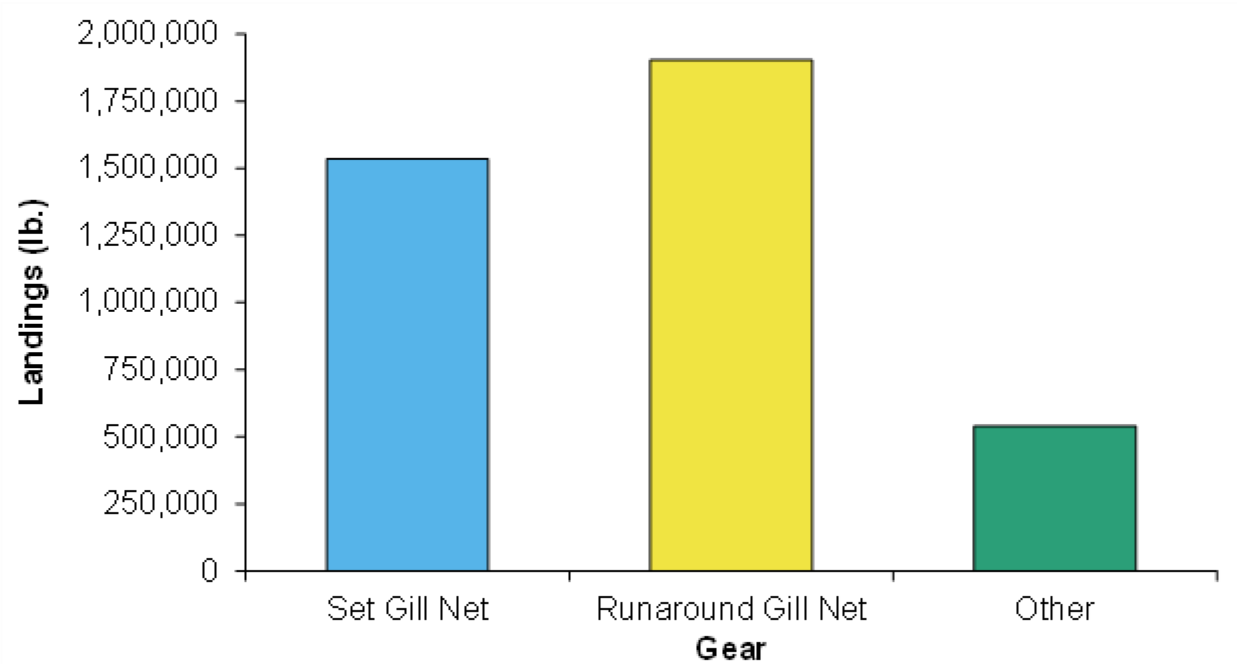

Figure 1. 3. Spotted Seatrout commercial landings by gear reported through the North Carolina Trip Ticket Program, 2012–2022.

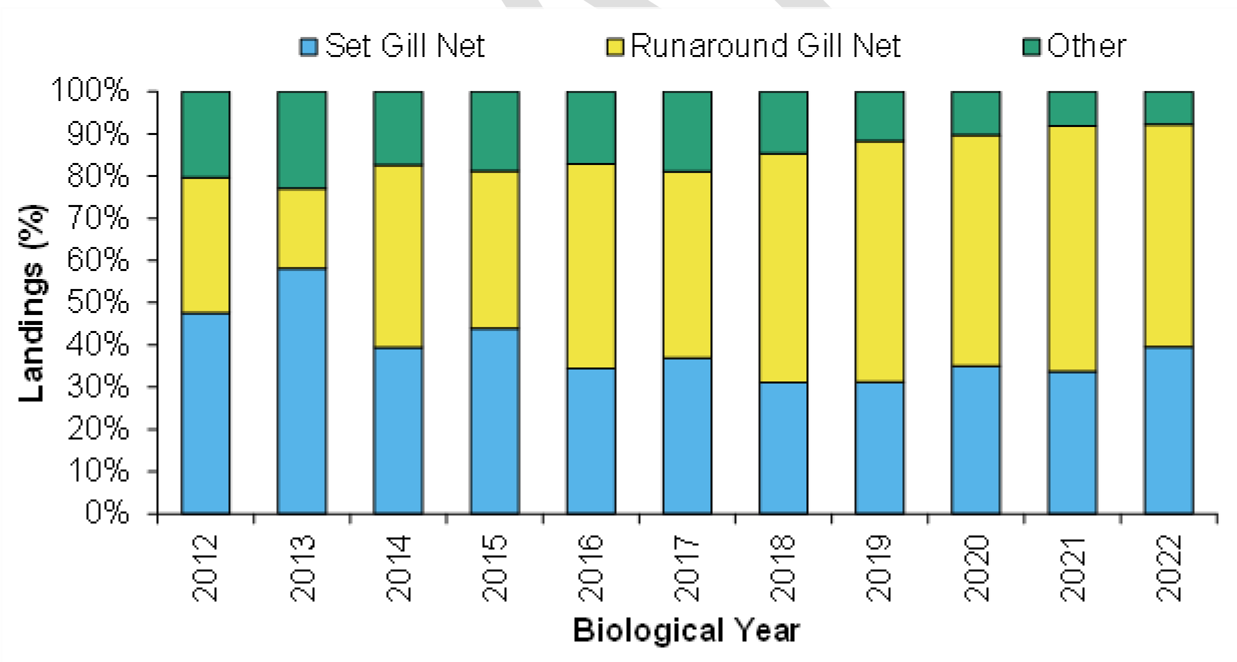

Figure 1. 4. Percent of Spotted Seatrout commercial landings by year and gear reported through the North Carolina Trip Ticket Program, 2012–2022.

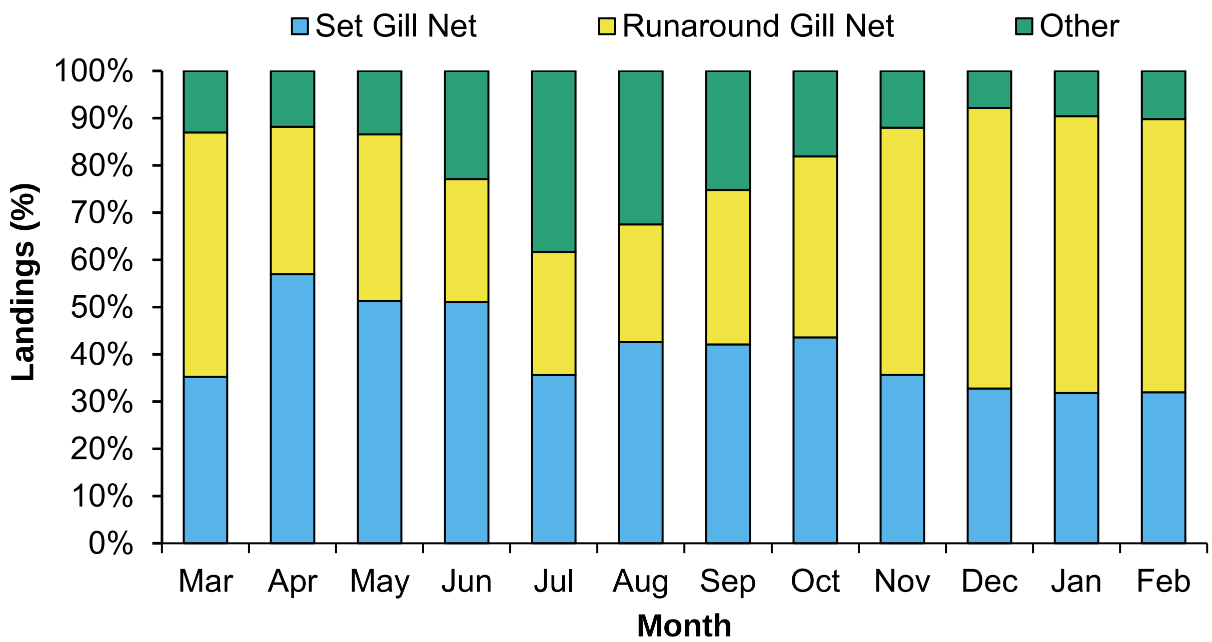

Figure 1. 5. Percent of Spotted Seatrout commercial landings by month and gear reported through the North Carolina Trip Ticket Program, 2012–2022.

Spotted Seatrout are caught in small-mesh gill nets with stretched mesh sizes ranging from 2.5 ISM to 4.88 ISM in North Carolina. Mesh size does not appreciably affect the overall size range of Spotted Seatrout caught in small-mesh gill nets (set and runaround; Figure 1.6). As stretched mesh size increases, the minimum size of Spotted Seatrout harvested increases to some degree but there is a lot of overlap in the size of Spotted Seatrout caught with various mesh sizes. An R^2 value of 0.17 indicates a weak linear relationship between mesh size and the size of Spotted Seatrout harvested. The lack of a strong relationship between mesh size and the size of Spotted Seatrout captured makes it difficult to increase the minimum size limit or implement a slot limit without tight mesh size restrictions to protect or select for specific sizes of Spotted Seatrout. The lack of selectivity is likely due to Spotted Seatrout having a relatively soft body resulting in a wide size range of fish able to become lodged in a particular mesh size. Also, Spotted Seatrout frequently become entangled in gill nets around the mouth area either by their teeth or jaw which results in larger Spotted Seatrout being captured than would typically become caught in the webbing of a gill net.

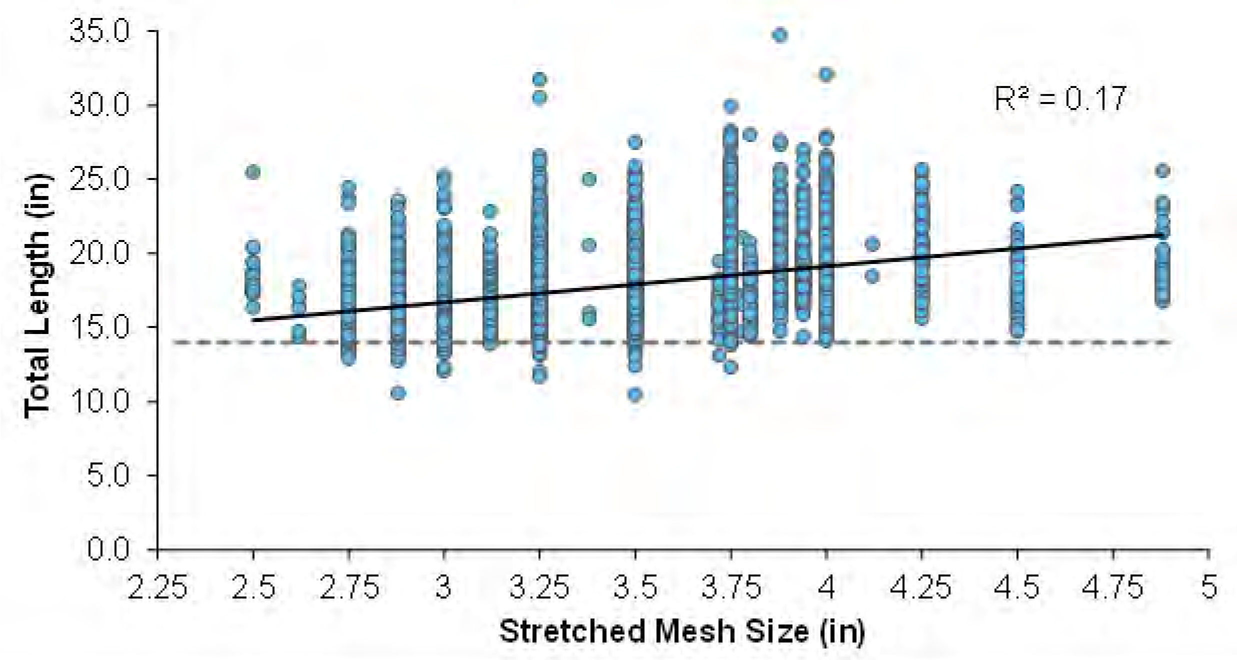

Figure 1. 6. Relationship of stretched mesh size versus total length of Spotted Seatrout sampled from the commercial fish house sampling program (2012-2022). A trendline is provided for reference. The dashed gray line shows the current 14-inch TL minimum size limit.

An example of the impact of increasing the minimum size limit from 14 inches to 15 inches is shown in Figure 1.7. As mesh size increases the percent of Spotted Seatrout under 15 inches (blue bars) that will be discarded decreases. From the Spotted Seatrout measured through division fish house sampling, approximately 22% of fish measured from 3 ISM gill nets are under 15 inches compared to 3% from 3.5 ISM gill nets. In this example, setting the minimum mesh size to harvest Spotted Seatrout at 3.5 ISM will result in a minimal increase in discards of sublegal fish and maximize the realized reduction if the minimum size limit is raised to 15 inches.

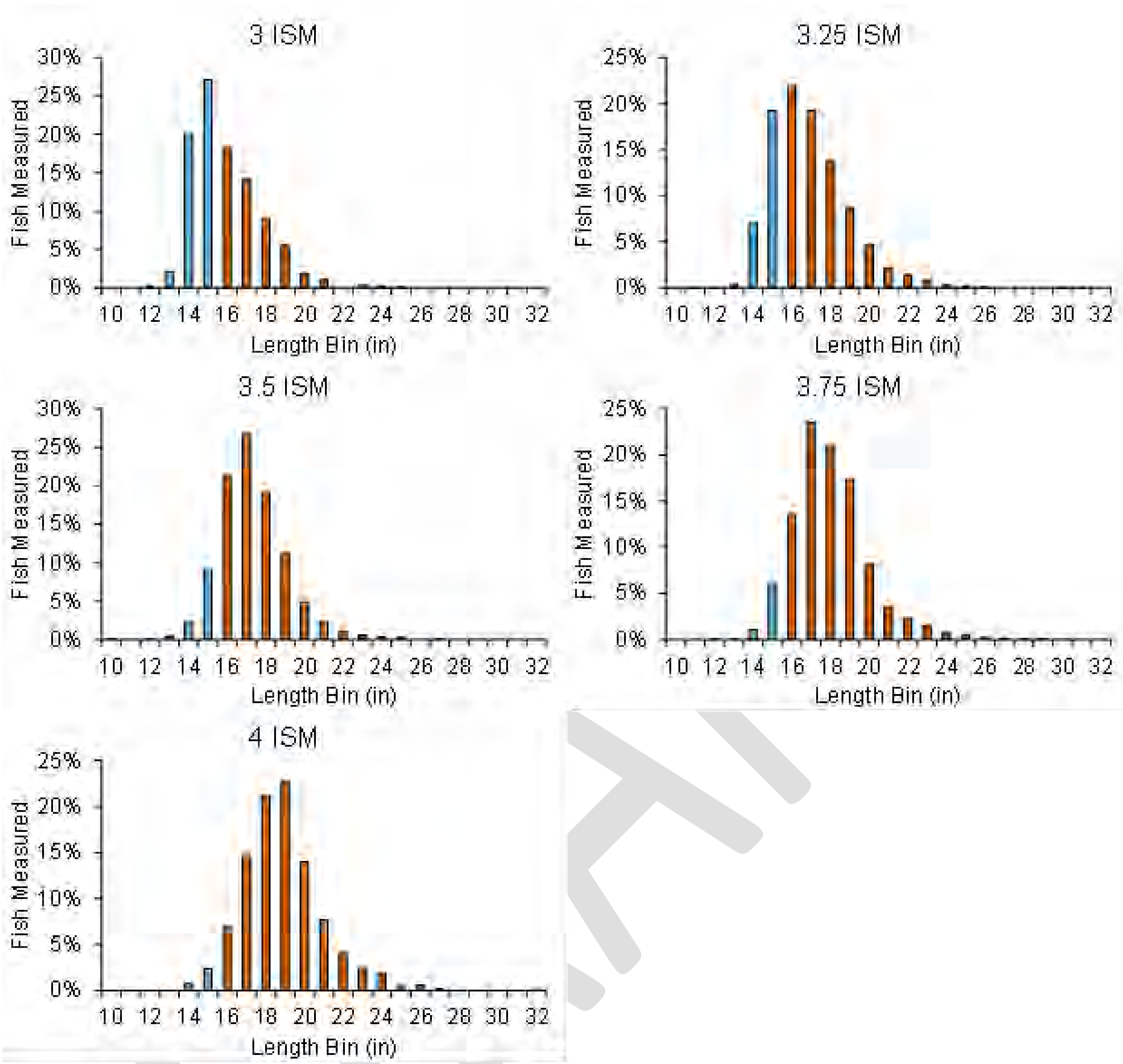

Figure 1. 7. Length distribution of Spotted Seatrout measured from the division's commercial fish house sampling programs by mesh size. Blue bars indicate percent of Spotted Seatrout by size bin below the minimum size limit if it is raised to 15 inches. Orange bars indicate the percent of Spotted Seatrout by size bin above the minimum size limit if it is raised to 15 inches.

When looking at a narrow slot limit, the mesh size restrictions will be more severe. For example, Figure 1.8 shows the impact of a harvest slot limit of 16 inches to 20 inches (fish 20 inches and larger cannot be harvested). The difficulty in implementing mesh size restrictions for a slot limit comes when trying to balance and minimize discards of fish both below slot and above slot size (blue bars). From division fish house sampling, approximately 4% of Spotted Seatrout measured from 3 ISM gill nets are 20 inches or larger but 50% of Spotted Seatrout are below 16 inches. In comparison, approximately 31% of Spotted Seatrout measured from 4 ISM are 20 inches or larger but only 3% are below 16 inches. In this example, limiting the gill net mesh sizes used to harvest Spotted

Seatrout from 3.5 to 3.75 ISM will best minimize discards of below slot and above slot size Spotted Seatrout.

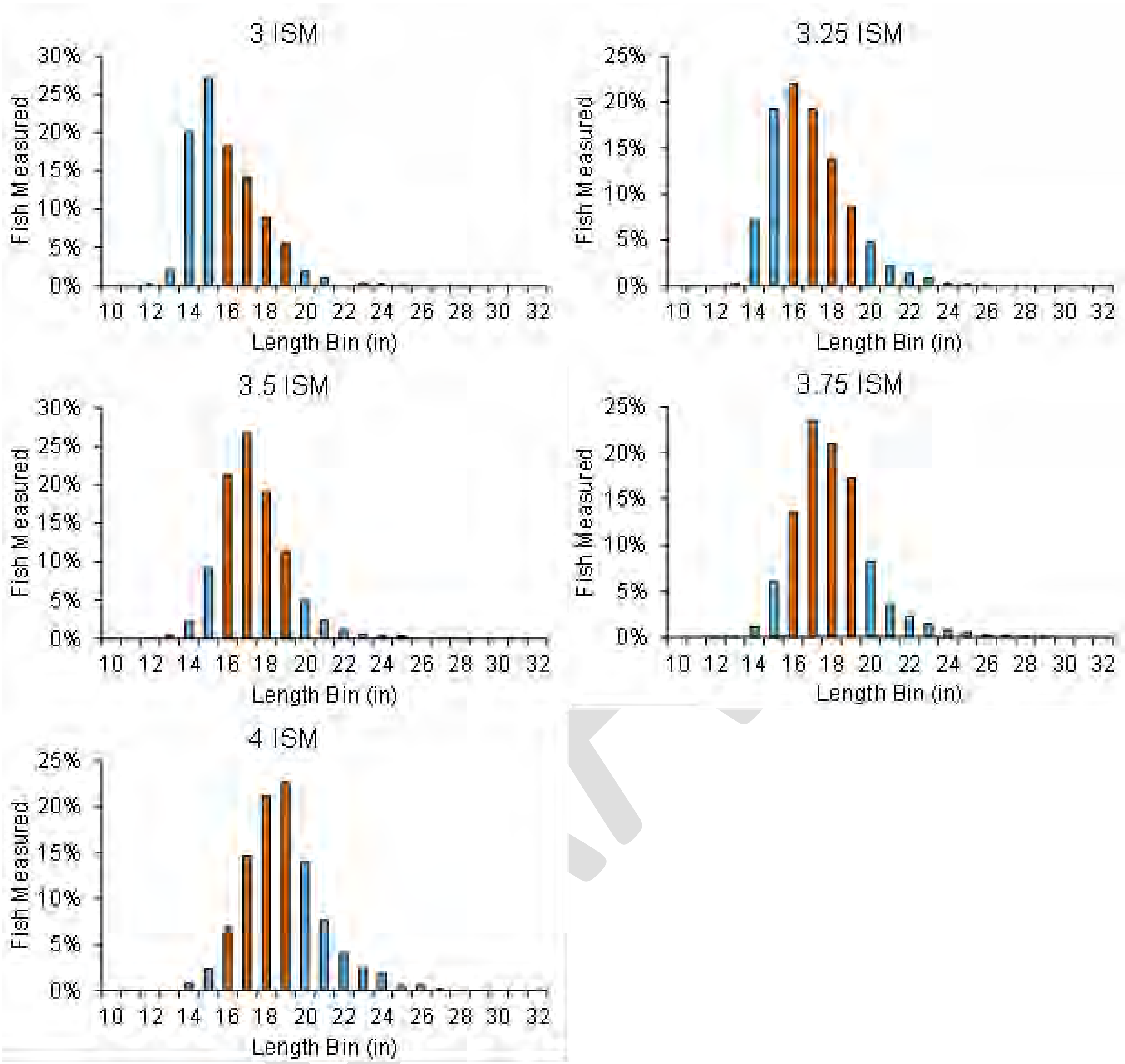

Figure 1. 8. Length distribution of Spotted Seatrout measured from the division's commercial fish house sampling programs by mesh size. Blue bars indicate percent of Spotted Seatrout by size bin below the minimum size limit if it is raised to 16 inches and above the maximum size limit if it is set at 20 inches. Orange bars indicate the percent of Spotted Seatrout by size bin above the minimum size limit if it is raised to 16 inches and below the maximum size limit if it is set at 20 inches (i.e., 16-20 slot limit).

Most Spotted Seatrout harvest occurs in Pamlico Sound (28%) and the Neuse and Bay rivers (24%; Figure 1.9). These areas are followed by the Central Sounds (13%), Southern (13%), Albemarle Sound (11%), and Pamlico and Pungo rivers (9%). Runaround gill net is the primary gear used to harvest Spotted Seatrout in the Neuse and

Bay rivers and Central Sounds regions. Small-mesh set gill net is the dominant gear in the other regions. (Figure 1.10). The increase in commercial landings beginning in 2019 is largely driven by an expansion of the Spotted Seatrout fishery in the Pamlico Sound, Neuse and Bay rivers, and Pamlico and Pungo rivers regions.

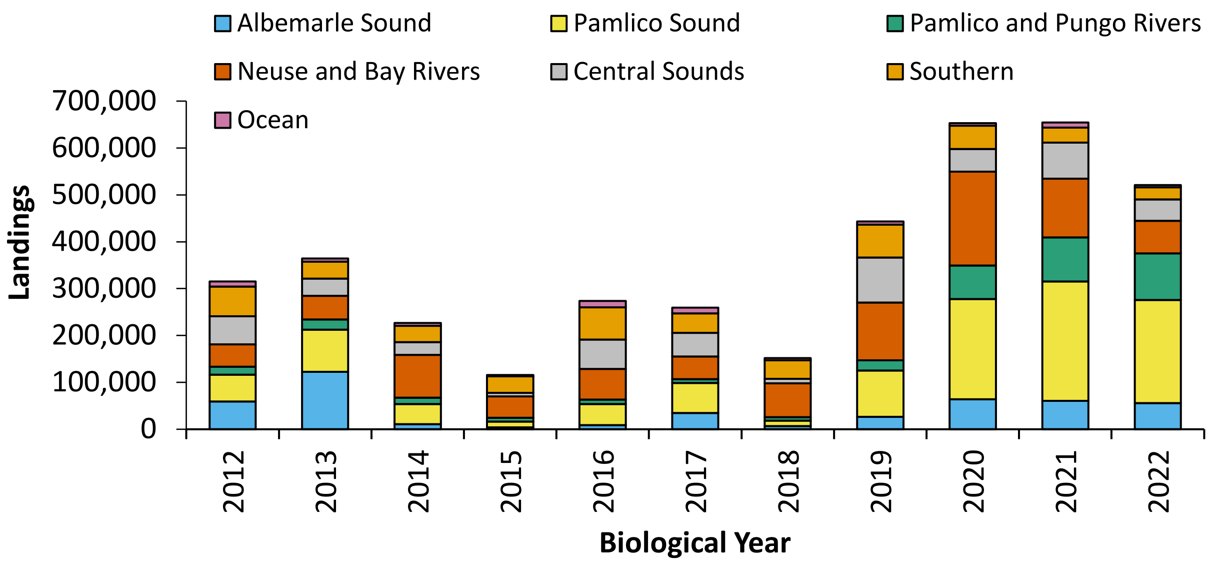

Figure 1. 9. Annual commercial landings of Spotted Seatrout commercial landings by region reported through the North Carolina Trip Ticket Program, 2012–2022.

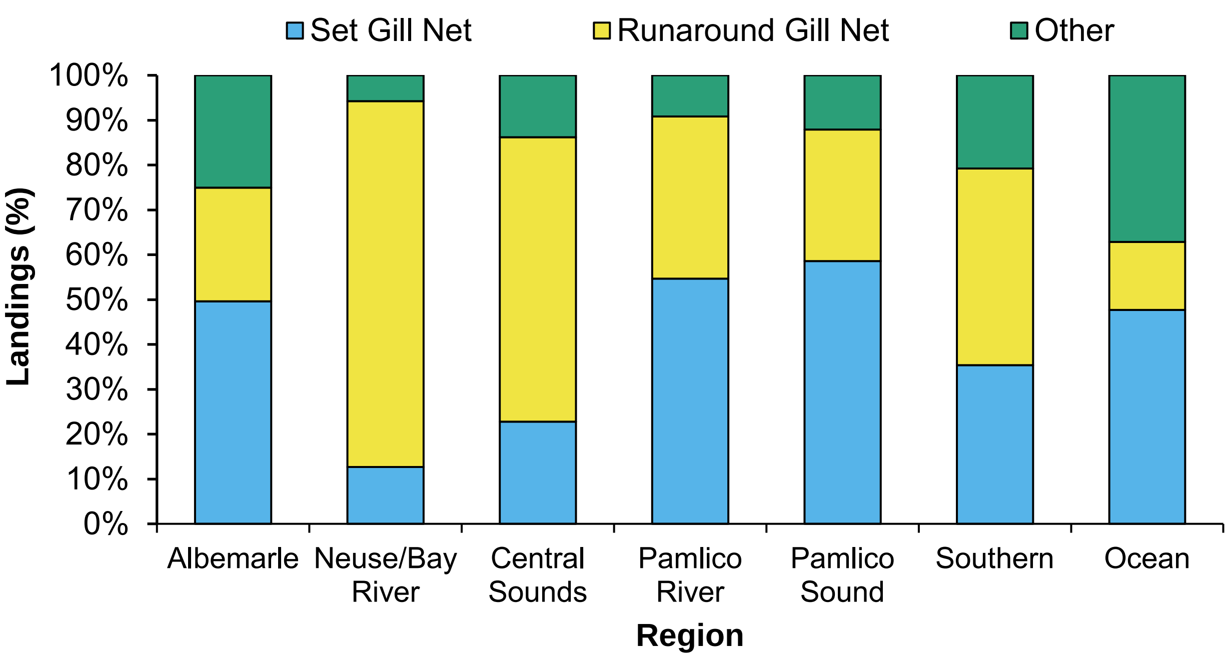

Figure 1. 10. Percent of total Spotted Seatrout commercial landings by gear for each area reported through the North Carolina Trip Ticket Program, 2012–2022.

Due to the low contribution of ocean waters to the Spotted Seatrout small-mesh gill-net fishery (Figure 1.9) it is excluded from the analysis in the following gear-specific sections.

Set Gill Nets

Spotted Seatrout targeted small-mesh set gill-net trips were defined as trips where Spotted Seatrout were the species of highest abundance or the most abundant finfish species. Small-mesh set gill nets are the second most common gear used to capture Spotted Seatrout (Figures 1.3 - 1.4) in North Carolina and are the dominant gear in the Albemarle Sound, Pamlico River, Pamlico Sound, and Ocean regions (Figure 1.10). Spotted Seatrout are the third most important species targeted in the North Carolina small-mesh set gill-net fishery behind Bluefish and Spanish Mackerel (Figure 1.11). They make up the largest proportion of monthly small-mesh set gill-net trips in November, December, and January.

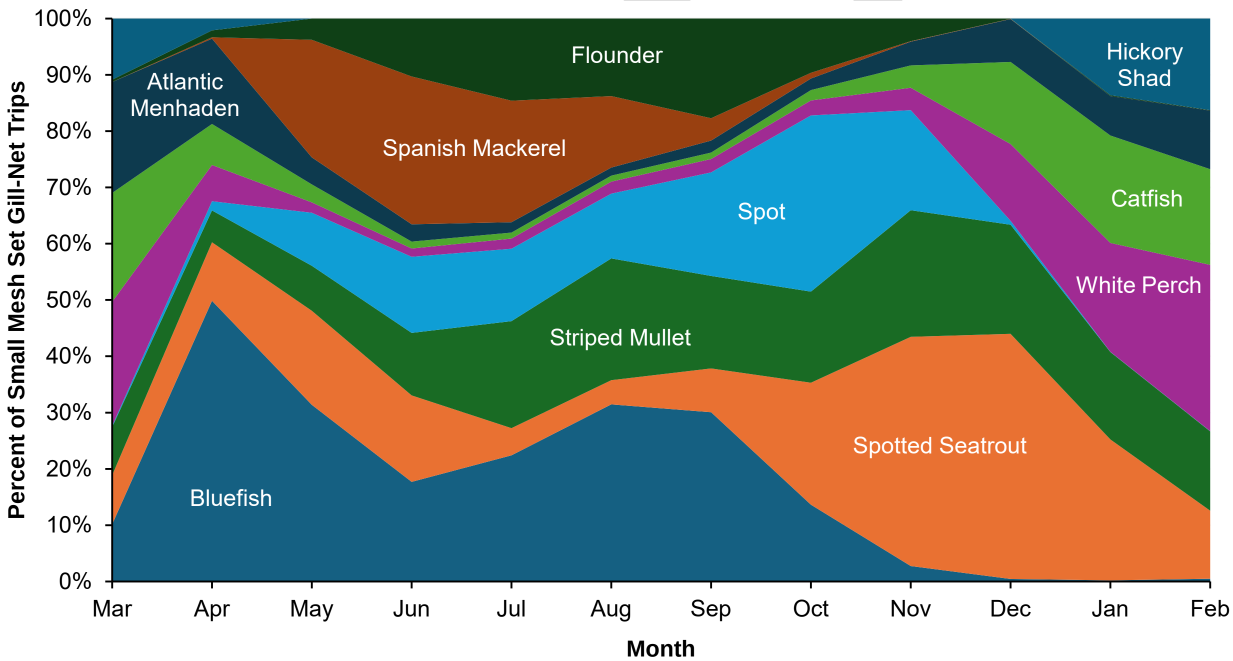

Figure 1. 11. Percentage of total set gill-net trips for each of the 10 primary target species across months in N.C. waters, 2012-2022.

Spotted Seatrout are primarily landed incidentally in the set gill-net fishery during most of the year, however they are targeted more in the fall and winter months as Spotted Seatrout aggregate in smaller waterbodies. From 2012 through 2018, the use of set gill nets to target Spotted Seatrout declined through 2018. Beginning in 2019, the number of trips increased and has remained higher, although the number of participants has remained steady since 2015 (Figure 1.12). This increase in trips matches well with the increase in landings in the Spotted Seatrout fishery over the same period.

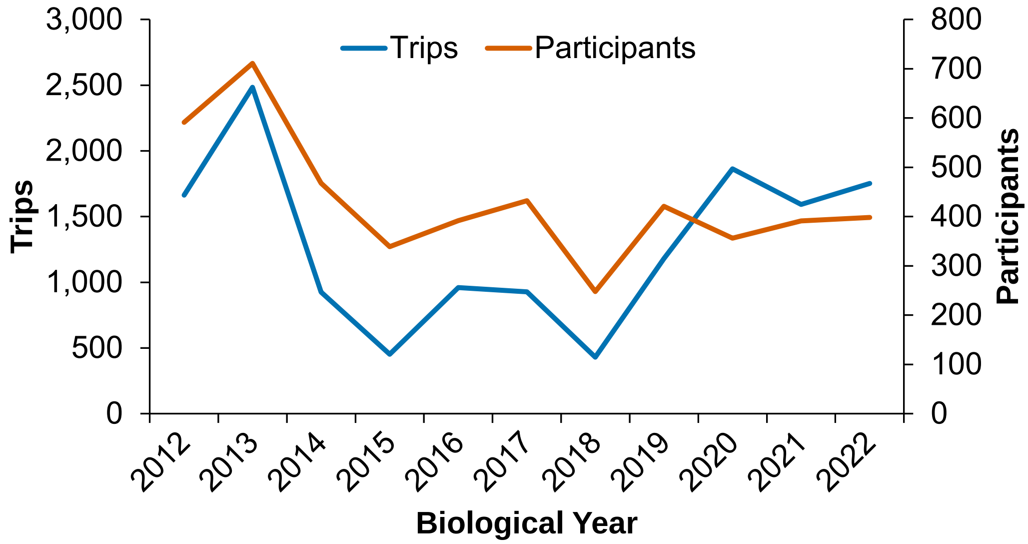

Figure 1. 12 Targeted trips and participants in the set small-mesh gill-net Spotted Seatrout fishery by year reported through the North Carolina Trip Ticket Program, 2012-2022.

Approximately 50% of targeted Spotted Seatrout small-mesh set gill-net trips land 30 or less Spotted Seatrout (Figure 1.13). However, roughly 24% of trips land more than 60 Spotted Seatrout and about 16% of trips land 71-75 Spotted Seatrout per trip. Most of these trips, roughly 70%, occur from October through January (Figure 1.14). Although approximately 20% of the trips occurring each month from November through March land 71-75 Spotted Seatrout per trip (Figure 1.13). Trips landing 71-75 Spotted Seatrout per trip account for approximately 35% of small-mesh set gill-net landings from targeted Spotted Seatrout trips (Figure 1.16).

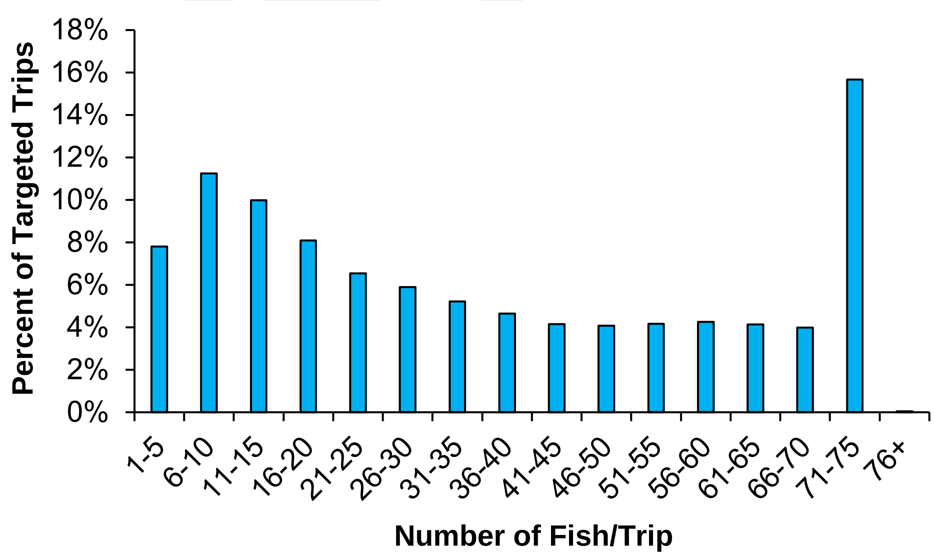

Figure 1. 13. Percent of targeted Spotted Seatrout trips grouped by number of fish landed per trip in the small-mesh set gill-net fishery reported through the North Carolina Trip Ticket Program, 2012–2022.

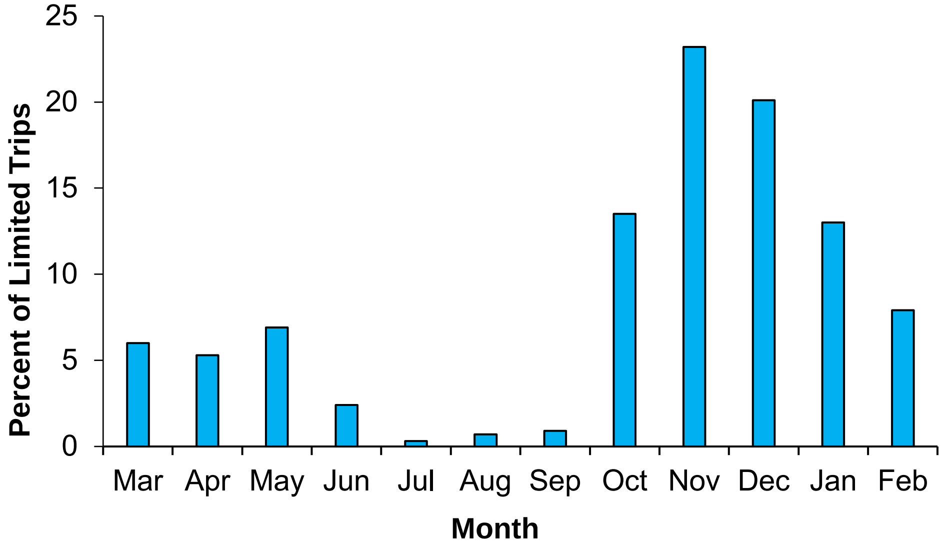

Figure 1. 14. Monthly distribution of total trips reaching the trip limit (71-75 fish estimated to be landed) for targeted Spotted Seatrout trips in the small mesh set gill net fishery reported through the North Carolina Trip Ticket Program, 2012–2022. For example, if there are 100 trips in a year that reached the trip limit and 10 of those trips occurred in March, then the percent of annual trip limit trips in March will be 10%.

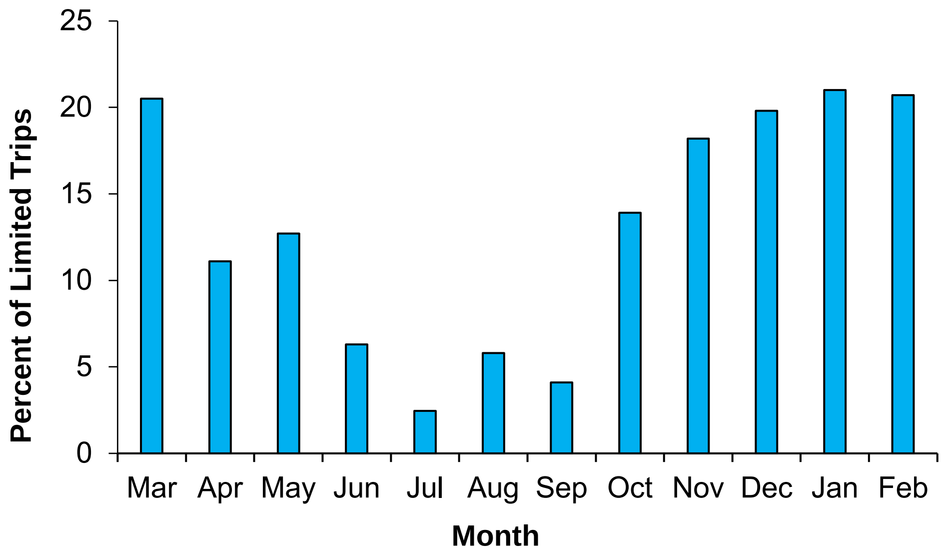

Figure 1. 15. Percent of monthly trips reaching the trip limit (71-75 fish estimated to be landed) for targeted Spotted Seatrout trips in the small mesh set gill net fishery reported through the North Carolina Trip Ticket Program, 2012–2022. For example, if there are 100 trips in March and 10 of those trips reached the trip limit, then the percent of trip limit trips in March will be 10%.

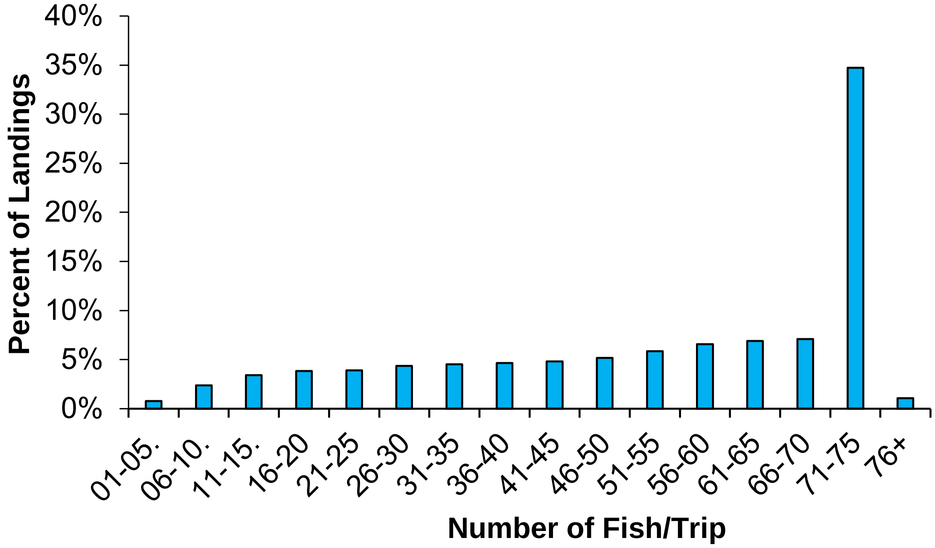

Figure 1. 16. Percent of total pounds landed grouped by number of fish landed per targeted Spotted Seatrout trip in the small mesh set gill net fishery reported through the North Carolina Trip Ticket Program, 2012–2022.

The modal mesh size used to catch Spotted Seatrout in the set gill net fishery was 3.0 ISM (Table 1.2). Average total net length was 691 yards, with a maximum of 3,000 yards. Approximately 42% of all set gill net trips fished 500 yards or less of gill net (Figure 1.17). For reference, small mesh gill nets are currently restricted to a maximum of 800 yards. Reducing the yardage fished could be a means to reduce harvest in this fishery. Yardage restrictions would be best used in conjunction with trip limits to ensure minimal discards. For more information on possible management applications of set gill net yardage restrictions, see Appendix 2.

Table 1. 2. Small mesh (<5 inch ISM) set gill net trips in North Carolina using data from the N.C. Trip Ticket Program with associated gear characteristics from commercial fish house sampling, 2012-2022.

Species	Trips	Avg/Yr.	Modal Mesh	Avg Yds	Max Yds
Spotted seatrout	14,224	1,293	3.0	696	3,000

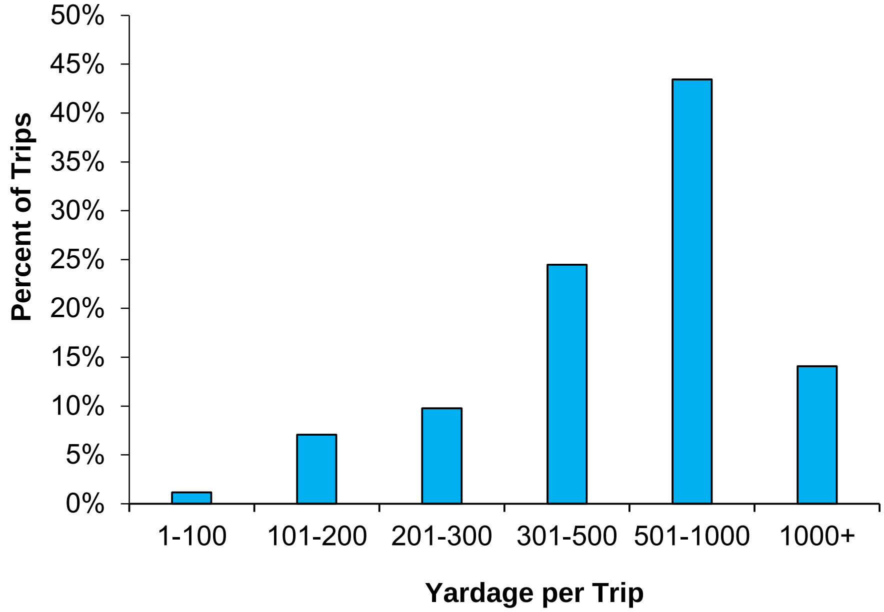

Figure 1. 17. Percent of total trips sampled grouped by yards fished per trip in the Spotted Seatrout small mesh set gill net fishery using data from the commercial fish house sampling program, 2012–2022.

When targeting Spotted Seatrout with small-mesh set gill nets, it is common to catch other species incidentally. The most common species landed incidentally when targeting Spotted Seatrout with set gill nets are Striped Mullet, Bluefish, Red Drum, White Perch, Black Drum, and Spot (Figure 1.18). Conversely, Spotted Seatrout are most commonly caught incidentally when set gill net fishermen are targeting Bluefish, Striped Mullet, and Spot (NC trip ticket data). This overlap between the Spotted Seatrout and Bluefish, Striped Mullet, and Spot set gill net fisheries could have management implications for these fisheries if gear restrictions are put in place to restrict Spotted Seatrout harvest.

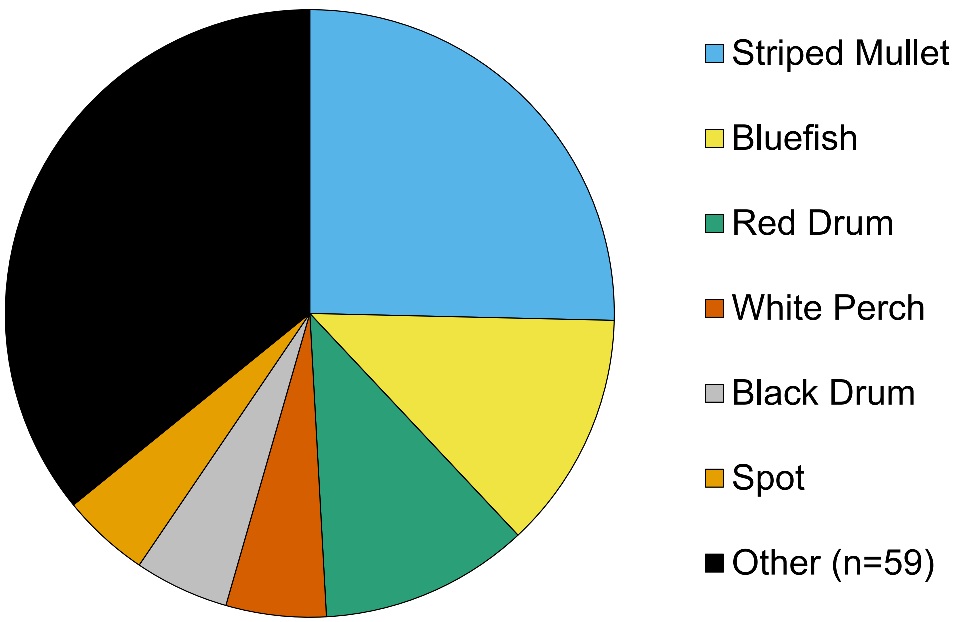

Figure 1. 18. Proportion of incidental catch landed by species in the set small-mesh set gill-net Spotted Seatrout fishery reported through the North Carolina Trip Ticket Program, 2012–2022.

Spotted seatrout discards in the set gill-net fishery are difficult to characterize due to limited data but appear to be minimal based on observations from the commercial observer program. Of the over 3,400 Spotted Seatrout observed in set small-mesh gill nets (2012-2022), 392 fish were discarded. A discard rate of 11.3%. The low rate of Spotted Seatrout discards in the set small-mesh fishery is likely due to there being an adequate trip limit for commercial harvest. Increased restrictions on Spotted Seatrout harvest could increase discards in this fishery. For more information on Spotted Seatrout bycatch in the set gill-net fishery, please refer to the Spotted Seatrout Bycatch section of the FMP.

Discards of other species from Spotted Seatrout targeted small mesh set gill net trips could not be characterized due to limited data. Of the 1,044 observed small mesh set gill net trips observed from the observer program (2012-2022), only 114 Spotted Seatrout targeted trips have been observed. In those trips, 18 managed species were discarded, including Atlantic Menhaden, Red Drum, Black Drum, Blue Crab, and Southern Flounder.

Runaround Gill Nets

Spotted Seatrout targeted runaround gill-net trips were defined as trips where Spotted Seatrout were the species of highest abundance in landings or were the most abundant finfish species. Runaround gill nets are the predominant gear used to catch Spotted Seatrout in North Carolina (Figures 1.3 and 1.4) and the dominant gear in the Neuse and Bay rivers, Central Sounds, and Southern regions (Figure 1.10). The runaround gill-net fishery is more targeted than the set gill-net fishery and is the main gear used to catch Spotted Seatrout when they form aggregations in smaller waterbodies from November through March (Figure 1.5). During this time, catches from runaround gill nets can be higher as fishermen target Spotted Seatrout after the fall Striped Mullet season. Spotted seatrout is the second most targeted species in the North Carolina runaround gill-net fishery (Figure 1.19). Spotted seatrout targeted trips make up the largest proportion of runaround gill-net trips from December through March.

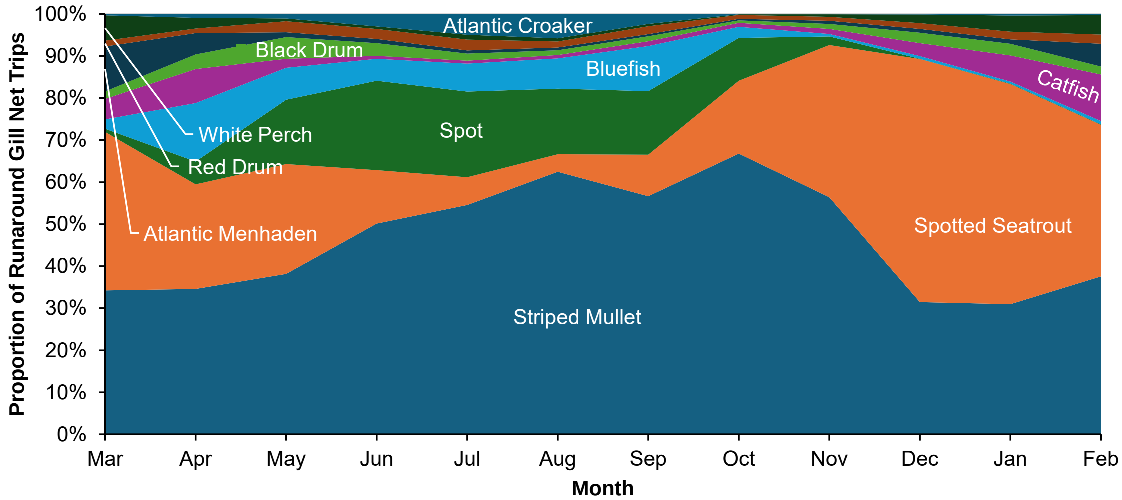

Figure 1. 19. Percent of total runaround gill-net trips for each of the 10 primary target species across months in N.C. waters during 2012-2022.

From 2012 through 2018, effort and participation in this fishery remained relatively consistent, then increased sharply in 2019 and has remained high through 2022 (Figure 1.20). The increase in targeted Spotted Seatrout trips could be due to fishermen shifting to the fishery from other more restricted fisheries.

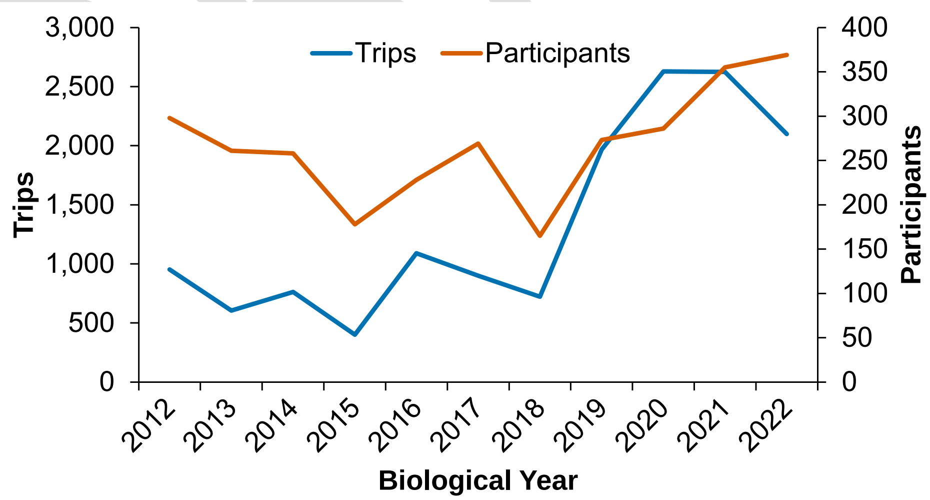

Figure 1. 20. Targeted trips and participants in the runaround gill-net Spotted Seatrout fishery by year reported through the North Carolina Trip Ticket Program, 2012–2022.

Runaround gill nets tend to land more Spotted Seatrout per trip than set gill nets, with roughly 33% of trips landing 30 or less Spotted Seatrout. Approximately 38% of targeted

Spotted Seatrout runaround gill-net trips land more than 60 Spotted Seatrout with 27% of targeted trips landing 71-75 Spotted Seatrout (Figure 1.21). This is likely due to runaround gill nets being able to better target Spotted Seatrout aggregation areas in the fall and winter months. Most of these trips, roughly 73%, occur from October through January (Figure 1.22). Although, approximately 30% of the trips occurring each month from November through March land 71-75 Spotted Seatrout per trip (Figure 1.23). Trips landing 71-75 Spotted Seatrout per trip account for approximately 47% of runaround gill-net landings from targeted Spotted Seatrout trips (Figure 1.24).

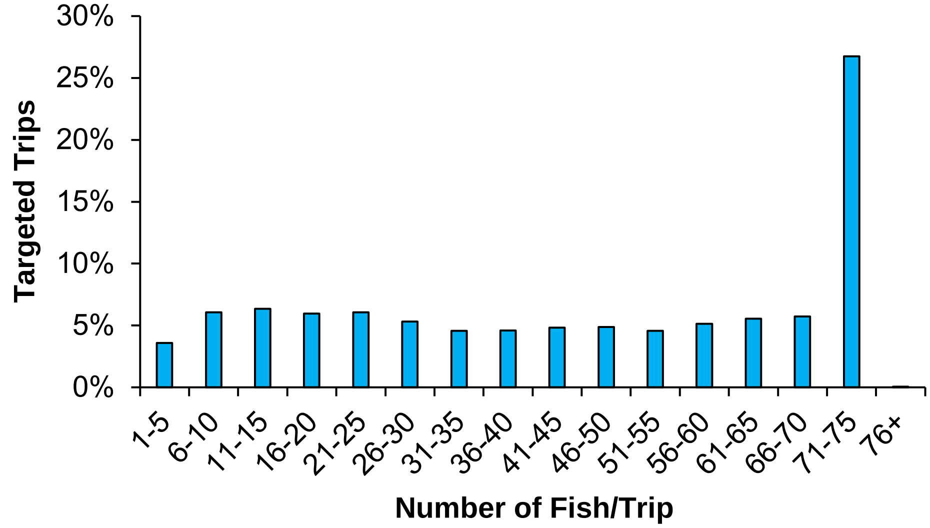

Figure 1. 21. Percent of targeted Spotted Seatrout trips grouped by number of fish landed per trip in the runaround gill-net fishery reported through the North Carolina Trip Ticket Program, 2012–2022.

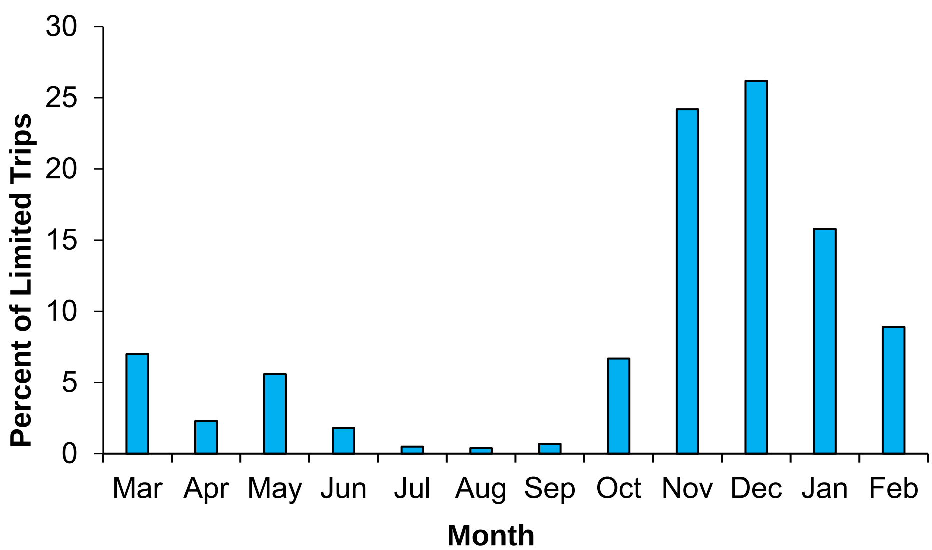

Figure 1. 22. Monthly distribution of total trips reaching the trip limit (71-75 fish estimated to be landed) for targeted Spotted Seatrout trips in the runaround gill-net fishery reported through the North Carolina Trip Ticket Program, 2012–2022. For example, if there are 100 trips in a

year that reached the trip limit and 10 of those trips occurred in March, then the percentage of annual trip limit trips in March will be 10%.

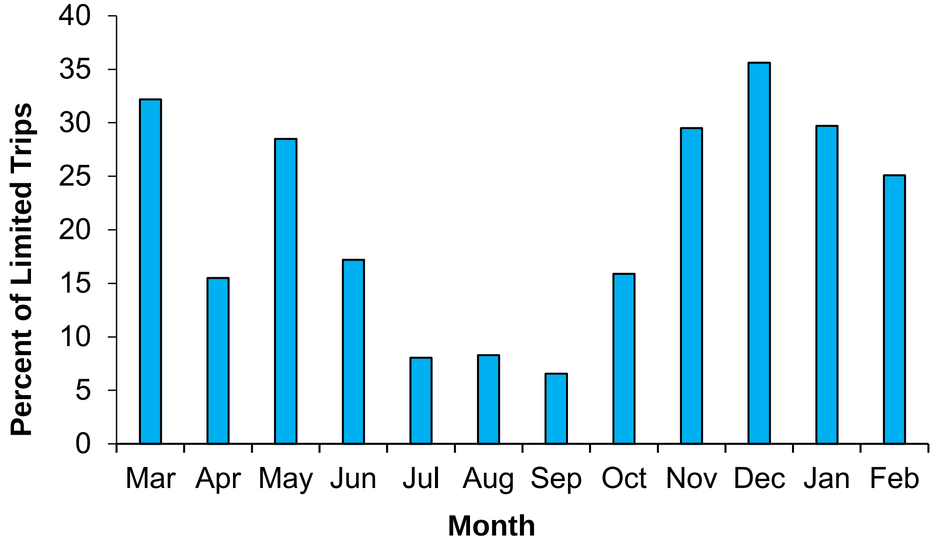

Figure 1. 23. Percent of monthly trips reaching the trip limit (71-75 fish estimated to be landed) for targeted Spotted Seatrout trips in the runaround gill-net fishery reported through the North Carolina Trip Ticket Program, 2012–2022. For example, if there are 100 total trips in March and 10 of those trips reached the trip limit, then the percentage of trip limit trips in March will be 10%.

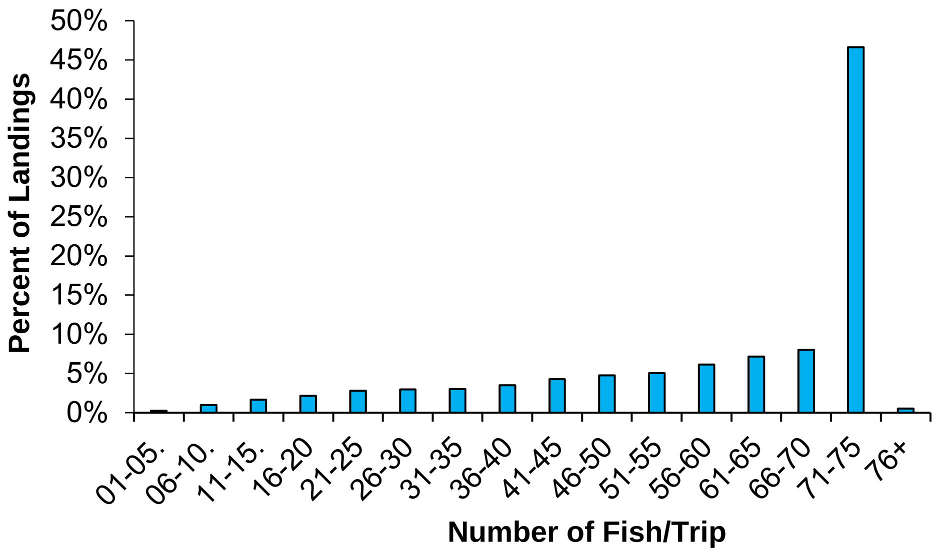

Figure 1. 24. Percent of total pounds landed grouped by number of fish landed per targeted Spotted Seatrout trip in the runaround gill-net fishery reported through the North Carolina Trip Ticket Program, 2012–2022.

Runaround gill nets have a higher modal mesh size (3.75 ISM) than set small-mesh gill nets (3.0 ISM; Table 1.3). The average net length is 430 yards with a maximum of 3,000 yards, with 72% of trips fishing 500 yards (Figure 1.25). Runaround gill nets tend to be shorter than set gill nets because runaround gill nets are actively fished to encircle schools of fish. This allows for less yardage needed to catch the fish than the passively fished set gill nets. Since the runaround gill nets are already significantly shorter, and can be fished several times consecutively, maximum yardage restrictions may not be effective in restricting harvest in this fishery. For more information on possible management applications of runaround gill net yardage restrictions, see Appendix 2.

Table 1. 3. Small-mesh (<5 inch ISM) runaround gill-net trips in North Carolina using data from the N.C. Trip Ticket Program with associated gear characteristics from fish house sampling, 2012-2022.

Species	Trips	Avg/Yr.	Modal Mesh	Avg Yds	Max Yds
Spotted seatrout	14,749	1,340	3.75	430	3,000

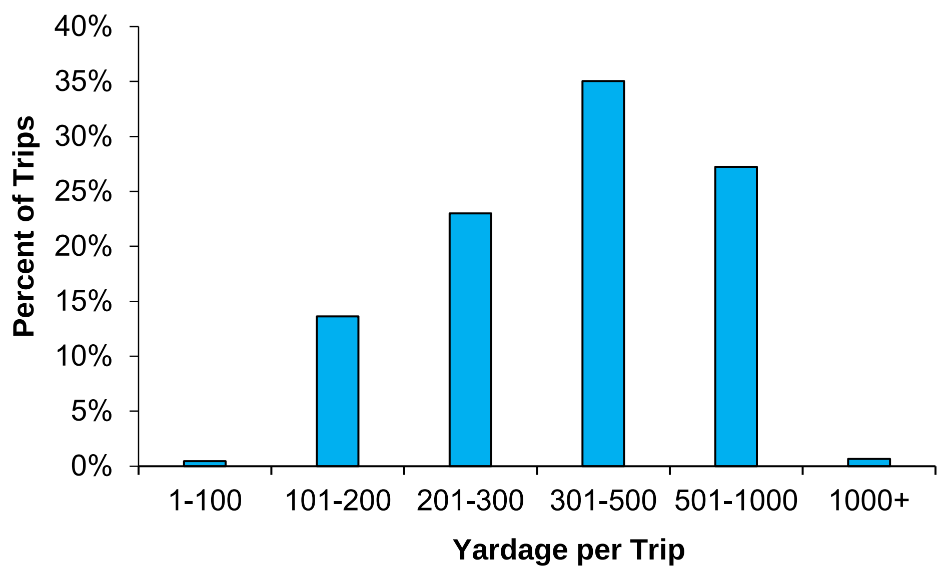

Figure 1. 25. Percent of total trips sampled grouped by yards fished per trip in the Spotted Seatrout runaround gill net fishery using data from the commercial fish house sampling program, 2012–2022.

When targeting Spotted Seatrout with runaround gill nets, it is common to catch other species incidentally. The most common species landed incidentally when targeting Spotted Seatrout with runaround gill nets are Striped Mullet, Red Drum, Black Drum, Bluefish, White Perch, and Spot (Figure 1.26). Conversely, Spotted Seatrout are most commonly caught incidentally when runaround gill-net fishermen are targeting Striped Mullet, Spot, and Bluefish (NC trip ticket data). This overlap between the Spotted Seatrout and Striped Mullet, Spot, and Bluefish runaround gill-net fisheries could have management implications for these fisheries if gear restrictions are put in place to restrict Spotted Seatrout harvest.

No data is available to characterize discards in this fishery because the observer program does not prioritize observing runaround gill-net trips.

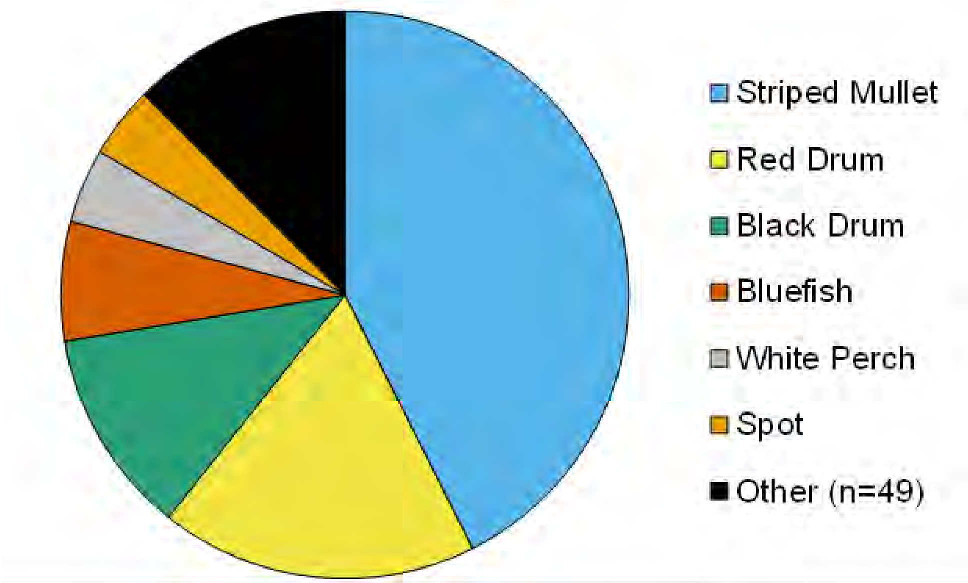

Figure 1. 26. Proportion of incidental catch landed by species in the runaround gill-net Spotted Seatrout fishery reported through the North Carolina Trip Ticket Program, 2012–2022.

Appendix 2: ACHIEVING SUSTAINABLE HARVEST IN THE NORTH CAROLINA SPOTTED SEATROUT FISHERY

ISSUE

Implement management measures to end overfishing and achieve sustainable harvest in the North Carolina Spotted Seatrout fishery.

ORIGINATION

The North Carolina Division of Marine Fisheries (DMF).

BACKGROUND

North Carolina and Virginia tagging studies indicate Spotted Seatrout in North Carolina coastal waters are part of a combined North Carolina and Virginia stock (Ellis 2014). The 2022 North Carolina Spotted Seatrout benchmark stock assessment indicated the Spotted Seatrout stock in North Carolina and Virginia waters is not overfished; however, overfishing is occurring (NCDMF 2022). Reference point thresholds for the Spotted Seatrout stock status are based on a 20% spawning potential ratio which is the comparison of spawning stock biomass (SSB) under a specific fishing regime – i.e., 20% – to a hypothetical unfished SSB. If SSB is below this ratio, the stock is overfished. If fishing mortality (F) is above the level that would lead to this ratio, overfishing is occurring. Due to large uncertainty in the stock assessment terminal year (2019) and based on the recommendation of the external, independent peer review panel, a weighted average of F and SSB from 2017-2019 was used to represent the terminal year and to estimate the threshold and target reference points (NCDMF 2022). The SSB target ($SSB_{30\%}$) and SSB threshold ($SSB_{20\%}$) were estimated at 3,778,723 pounds and 2,519,884 pounds respectively and both were based on 2017-2019 averages. The estimated $SSB_{2019Avg}$ was 4,980,243 pounds which indicates the Spotted Seatrout stock is not overfished (Figure 1). The F target ($F_{30\%}$) and F threshold ($F_{20\%}$) were estimated at 0.38 and 0.60 respectively and were also based on 2017-2019 averages. $F_{2019Avg}$ was estimated at 0.75 which is above the threshold indicating overfishing is occurring (Figure 2.1).

The General Statutes of North Carolina require a Fishery Management Plan to specify a timeframe not to exceed two years from the date of adoption of the plan to end overfishing (G.S. 113-182.1). A harvest reduction of 19.9% is required to reach the $F_{20\%}$ threshold while a harvest reduction of 53.9% will reach the $F_{30\%}$ target. A harvest reduction of at least 19.9% meets the statutory requirement to end overfishing. In developing management measures in Amendment 1 to end overfishing, only harvest reductions from the North Carolina portion of Spotted Seatrout harvest were considered. The original Spotted Seatrout FMP and Supplement A management will remain in place until adoption of Amendment 1 to the Spotted Seatrout Fishery Management Plan.

Discussion of management measures focuses on quantifiable measures that meet the reductions necessary to comply with statutory requirements. Harvest of Spotted Seatrout primarily occurs in the recreational fishery, however; harvest in both the recreational and commercial fisheries increased sharply in 2019 and has remained high through 2022

(Figure 2.1). As such, discussion will focus on both sectors. Management measures considered include seasonal closures, size limits, trip/creel limits, and combinations of these management measures. For an in-depth characterization of the commercial and recreational fisheries as well as management measures intended to support sustainable harvest, please see Appendix 1: Small Mesh Gill Net Characterization in the North Carolina Spotted Seatrout Fishery and Appendix 3: Supplemental Management Options in the North Carolina Spotted Seatrout Fishery. Single solution management measures that do not meet the necessary reductions to comply with statutory requirements will still be discussed here. Such measures may be included in combination management options but will not be presented as single solution management options.

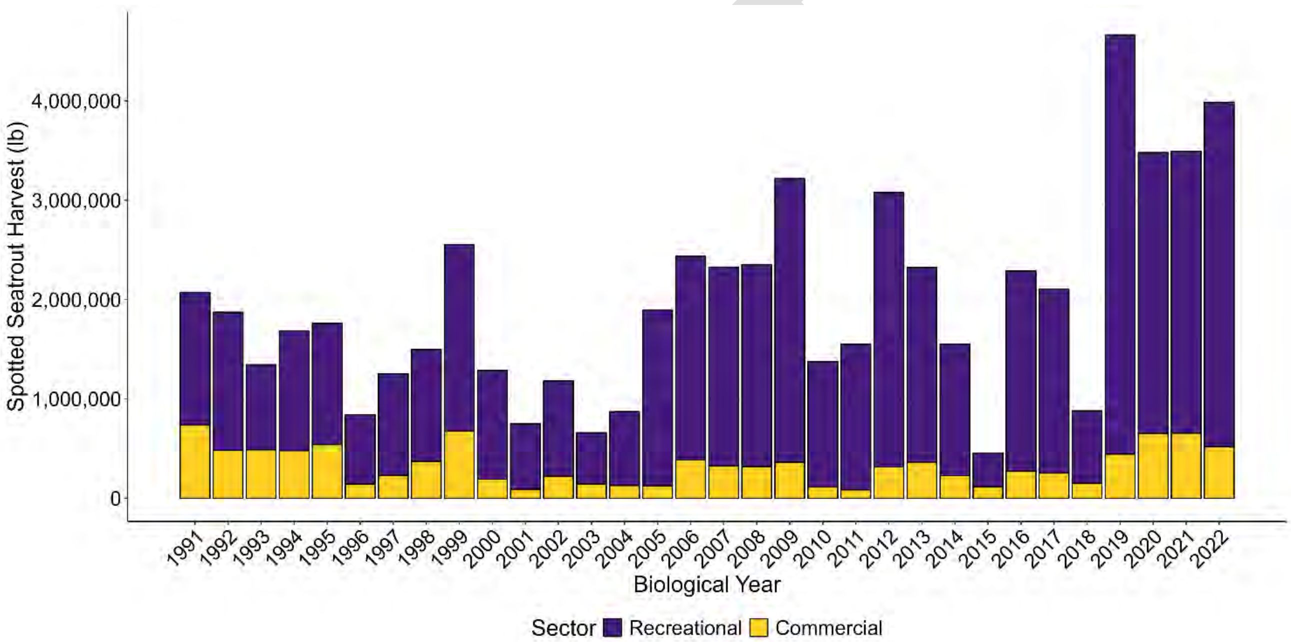

Figure 2.1. Annual harvest of Spotted Seatrout in pounds by biological year (March–February) and sector, 1991–2022. Bars are total annual harvest with commercial harvest as the yellow portion and recreational harvest as the purple portion of the total.

AUTHORITY

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
15A NCAC 03H .0103 PROCLAMATIONS, GENERAL
15A NCAC 03M .0512 COMPLIANCE WITH FISHERY MANAGEMENT PLANS
15A NCAC 03M .0522 SPOTTED SEATROUT

DISCUSSION

Carry Forward Items from Original FMP

The 14” minimum size and 75 fish trip limit for commercial harvest from the original Spotted Seatrout Fishery Management Plan (NCDMF 2012) will be carried forward in Amendment 1.

Size Limits

Throughout this section, unless otherwise specified, all lengths refer to total length (TL) which is a measurement from the tip of the snout to the tip of the compressed tail.

Size limits are a common fisheries management tool designed to protect smaller, juvenile fish from harvest until at least a portion of these fish are large enough to spawn and thus contribute to sustaining the population. Size limits should be set based on management objectives and species life history as these factors influence the effectiveness of the management. For example, setting a size limit below the length at which 50% of females are mature (L_{50}) does not allow most females to be large enough to spawn prior to being harvested. The Atlantic States Marine Fisheries Commission (ASMFC) manages Spotted Seatrout in all Atlantic states who have a declared interest in the species under the Omnibus Amendment to the Interstate Fishery Management Plans for Spanish Mackerel, Spot, and Spotted Seatrout (ASMFC 2012). The Omnibus Amendment sets a minimum size limit of 12 inches. In North Carolina, female Spotted Seatrout L_{50} is estimated at 9.88 inches (NCDMF 2022) with nearly all female Spotted Seatrout mature by the time they are recruited to the fishery at 14 inches (Roumillat and Brouwer 2004; Jensen 2009).

Spotted Seatrout fecundity has been shown to increase with fish size as larger females produce more eggs and spawn more frequently (Brown-Peterson and Warren 2001; Nieland et al. 2002; Roumillat and Brouwer 2004; Murphy et al. 2010). In many species, due to their increased reproductive capacity, large, female fish are expected to have a disproportionately large contribution to populations (Froese 2004; Berkeley et al. 2004; Barneche et al. 2018). More recently however, the general impact of size-specific contributions of individual fish to populations has come into question with some evidence that the collective reproductive output of many, smaller, mature fish may contribute more to populations compared to the reproductive output of fewer, larger fish (Barneche et al. 2018; Lavin et al. 2021) indicating that simply protecting “BOFFFs” (big old fat fecund female fish) may not have the desired conservation effect.

Generally, recreational anglers and commercial fishers in North Carolina target any Spotted Seatrout of legal size. Fish harvested commercially tend to be slightly larger than those harvested recreationally (Table 2.1). There is a dedicated catch and release segment of the recreational fishery (see Recreational Fishery section for more detail). Spotted Seatrout are harvested for consumption regardless of sector.

Slot limits are a specific type of size limit where harvest is restricted to fish above a minimum size but below a maximum size. Sometimes slot limit management will include a trophy limit which allows limited harvest of fish above the maximum size. A slot limit for Spotted Seatrout could protect fish below the minimum size that are not large enough to spawn and fish above the maximum size that may spawn more often and produce more eggs per batch (Brown-Peterson and Warren 2001; Nieland et al. 2002; Roumillat and Brouwer 2004; Murphy et al. 2010). Slot limits can help balance various competing interests that may exist in a fishery and provide a path to achieve management goals (Ahrens et al. 2020). For example, the Spotted Seatrout fishery includes part-time and full-time commercial fishers and part-time and full-time charter guides interested in the economic benefits of the fishery and recreational anglers who may want a robust trophy fishery or to maximize harvest potential, among a variety of other interests (Ahrens et al. 2020).

Table 2.1 Mean, minimum, and maximum lengths (fork length, inches) of Spotted Seatrout measured from the commercial and recreational fisheries, calendar years 2012–2022.

Year	Commercial				Recreational			
	Mean Length	Min Length	Max Length	Total Number Measured	Mean Length	Min Length	Max Length	Total Number Measured
2012	16.5	7.4	31.1	4,822	16.5	13.0	24.1	939
2013	16.7	8.7	28.5	6,144	16.8	10.1	23.5	865
2014	17.3	5.5	28.3	3,321	17.6	13.1	26.0	381
2015	18.3	8.9	30.9	2,676	16.9	12.8	25.0	154
2016	17.3	9.4	31.7	3,025	16.8	13.0	25.2	647
2017	17.6	7.6	32.9	3,066	17.0	11.6	25.8	864
2018	17.2	10.5	28.0	1,180	15.7	9.3	23.3	274
2019	17.3	10.1	28.9	2,622	16.7	10.7	24.6	1,574
2020	17.5	10.9	33.4	2,851	17.0	12.1	26.8	1,119
2021	17.5	10.9	29.9	3,432	17.0	11.1	26.5	1,019
2022	17.9	13.2	28.3	3,314	17.4	12.6	28.0	632

As a standalone management measure, changes to the current Spotted Seatrout minimum size limit are unlikely to reach the necessary harvest reductions to meet statutory requirements. Reductions from increasing the minimum size limit are most likely to be achieved in the short term while long term harvest reductions are lower with some portion of harvest recouped. A delay in harvest could allow more fish to spawn prior to harvest, providing non-quantifiable benefits to the stock. However, Spotted Seatrout growth rates would likely minimize the non-quantifiable benefits from harvest delay as sub-legal fish are recruited to the fishery within a spawning season. Increasing the minimum size limit to 15 inches appears to result in an 8.6% harvest reduction. On average, Spotted Seatrout grow 4.5 inches between year one and year two (Table 2.2) meaning a 14-inch fish at the beginning of the biological year (March) is likely to be well over a 15-inch minimum size during the spawning season (May-August). Most harvest occurs in October, November, and December which means fish well below a 15" minimum size will likely enter the fishery prior to the end of the fishing year but may have a chance to spawn prior to being subject to harvest in the fall. Fish of sub-legal size in the fall would probably not recruit to the fishery until the following spring allowing for some reduction in harvest. As females grow faster than males, sub-legal female fish will recruit to the fishery more rapidly diminishing any potential quantifiable or non-quantifiable benefits from a size limit increase. With the current minimum size at L_{100} and the growth rates of Spotted Seatrout, an increase in the minimum size may be less effective at reducing harvest than anticipated but may have unquantifiable benefits. Increasing the minimum size limit should be considered in conjunction with other measures as means to ensure sustainable harvest.

Table 2.2. Average length at age in inches for female and pooled (male and female) Spotted Seatrout calculated using von Bertalanffy growth parameters from 2022 stock assessment (NCDMF 2022).

Age	Mean Length (female)	Mean Length (pooled)
0	7.6	6.6
1	14.3	12.1
2	19.4	16.6
3	23.1	20.1
4	25.9	23.0
5	28.0	25.3
6	29.6	27.2
7	30.8	28.7
8	31.6	29.9
9	32.8	30.8

Implementing a slot limit alone will not reduce fishing mortality below the threshold unless the size range available for harvest is very limited (Table 2.3), but reductions from a slot limit are more likely to be realized over the long-term than reductions from increasing the minimum size. Rapid growth early in life means Spotted Seatrout recruit to the fishery quickly but will also quickly grow out of a narrow slot limit. The average length of a one-year-old female fish is 14.3 inches and average length increases to 19.4 inches and 23.1 inches by ages two and three respectively (Table 2.2). On average, a female Spotted Seatrout will be recruited to the fishery with a narrow slot range for about one or two years. The probability of a relatively short harvest window of each year class, particularly for female fish, makes a slot limit a potentially useful management measure especially when combined with other measures. Allowing the harvest of a “trophy”, or over slot fish, should be considered with caution. Relatively few Spotted Seatrout over 24” are harvested meaning a trophy allowance of less than 24” will result in a minimal overall harvest reduction. Most of the reduction in harvest gained from a 14”–20” slot limit is from fish between 20” - 22” with almost all the harvest reduction coming from fish less than 26” (Table 2.3). A trophy limit with a higher minimum trophy size (e.g., allowing harvest of one fish over 24” or over 33.5” which is the length of the current state record Spotted Seatrout) would maintain most of the harvest reductions gained from a traditional slot limit while still allowing for the harvest of “a fish of a lifetime” or the setting of a new Spotted Seatrout state record.

Anecdotally, the practice of “high grading” is common in the Spotted Seatrout fishery. High grading is where someone catches a legal limit of fish, keeps that limit in their possession, and continues fishing for larger or higher quality fish. Upon catching such a fish, the smaller or lower quality fish are discarded, and the larger or higher quality fish are kept. These discarded fish have higher than usual mortality rates (Nelson et al. 2021). “Possession” is defined in NCMFC rule as “actual or constructive holding whether under claim of ownership or not” [NCMFC Rule 15A NCAC 03I .0101 (2)(g)] making the practice of high grading illegal as it involves possessing more than a legal limit of Spotted Seatrout. For example, an angler who catches a four fish limit of Spotted Seatrout and keeps those fish in a live well, but continues fishing until catching a larger Spotted Seatrout, then discards one of the fish from the live well has possessed five fish or one fish more than the legal possession limit for Spotted Seatrout, even if only for a short period of time.

Despite the illegality of high grading, enforcement is exceedingly difficult. A traditional slot limit would likely reduce instances of high grading, but a trophy limit could encourage more anglers to participate in this behavior and subsequently decrease potential reductions by increasing dead discards in the fishery though it is impossible to quantify by how much.

Table 2.3. Expected reductions in harvest from various size limits in the North Carolina Spotted Seatrout fishery. The only realistic size limit change that will end overfishing as a standalone measure is a narrow slot limit with no trophy allowance or a trophy allowance of 24” or longer. Rec Reduction (lb) is based on average recreational landings from 2019 to 2022. *Total % Reduction includes a 24,424lb (4.3%) reduction in commercial harvest for 15” minimum size and a 36,921lb (6.5%) reduction in commercial harvest for 16” minimum size based on average commercial landings from 2019 to 2022. Commercial harvest reduction is 0% in all other cases.

Size limit examples (inches Total Length)			
Size Limit	Recreational Reduction (lb)	Recreational Reduction (%)	Total % Reduction
15” minimum	183,693	5.5	5.3*
16” minimum	554,420	16.6	15.1*
14”–20”	617,878	18.5	15.8
14”–22”	240,471	7.2	6.2
14”–24”	106,876	3.2	2.7
14”-20” with one fish over 24”	507,662	15.2	13.0
14”–20” with one fish over 26”	601,178	18.0	15.4
14”–20” with one fish over 30”	617,878	18.5	15.8
15”–20” with one fish over 24”	731,433	21.9	18.7
16”–20” with one fish over 24”	1,102,159	33.0	28.2

A slot limit could be implemented either in the recreational sector or across both the recreational and commercial sectors. A recreational slot limit might lead to increased dead discards. Though the expected discard mortality rate for Spotted Seatrout caught with hook and line is low and the discard mortality rate for larger Spotted Seatrout may be lower than the average rate (Gearhart 2002), the already high number of discarded Spotted Seatrout underscores the importance of considering release mortality when exploring management options. Gear requirements (e.g., circle hooks when fishing live or natural bait) and increased ethical angling education could help minimize dead discards in the recreational fishery. Similarly, a commercial slot limit would likely lead to increased dead discards. North Carolina specific estimates for total mortality (at-net mortality plus delayed mortality) of discarded Spotted Seatrout only exist for the anchored small-mesh gill-net fishery and vary depending on mesh size with an average of 79% (Price and Gearhart 2002). Though anchored small-mesh gill nets have historically been the predominate gear in this fishery, recently runaround gill nets have become increasingly common. Data characterizing dead discards in the commercial fishery are limited though Observer Program data shows limited discards in the anchored gill-net fishery and about 84% of total trips land less than the 75 fish limit (Appendix 1). These data indicate dead discards are likely low under current management. However, it is unclear if dead discards will increase if management changes. Pairing a commercial slot limit with corresponding mesh size changes may not be effective in reducing discards due to the lack of size selectivity across various mesh sizes for Spotted Seatrout (see Appendix 1). Prohibiting commercial gear based on reducing dead discards in the Spotted Seatrout fishery would affect a variety of other fisheries. Since implementing a commercial slot limit would either broadly affect other fisheries or likely increase dead discards, thus reducing the effectiveness of management, a commercial slot limit is not the most effective management option to reduce commercial harvest. Implementing a slot limit for the recreational sector only may simply shift the harvest of large fish to the commercial fishery resulting in the projected harvest reduction not being realized, though quantifying this shift is not possible.

A narrow slot limit with a trophy allowance of one fish over 24” implemented just for the recreational sector could reduce total harvest below the level of harvest that would lead to $F_{Threshold}$ (total harvest reduction of 28.2%, Table 2.3). It is possible that reduction may be less than expected due to increased dead discards in the recreational sector and a portion of that reduction would be recouped by the commercial sector resulting in a realized reduction less than 28.2%. As such, more conservative management measures to buffer overall harvest reductions should be considered if a slot limit is implemented. For example, a recreational slot limit of 16”–20” with an allowance for one fish over 24” paired with a commercial minimum size of 16” would reduce total harvest by 29.1% which would reduce F below the threshold and minimize some of the recoupment potential in the commercial sector. If combined with changes to the allowable stretched mesh size for commercial harvest of Spotted Seatrout, it should be possible to reduce harvest and minimize dead discards in the commercial sector. However, such a measure would not address the potential for increased dead discards from the release of out of slot fish, the high recoupment in the commercial sector if commercial harvest significantly shifted toward larger fish, and the recent trend of increased effort in both sectors.

Option 1: Size Limit Options

a. *Status Quo – no change to commercial size limit. Consider recreational size limit changes as a part of the overall management strategy to achieve sustainable harvest but not as a single solution option.*
b. *Recreational 16”–20” slot limit with allowance for one fish over 24” and commercial 16” minimum size limit*

Seasonal Closures

The Spotted Seatrout fishery in North Carolina predominantly occurs in fall across both the recreational and commercial sectors (Figure 2.2). For a more detailed description of seasonal harvest, see the Commercial and Recreational Fishery sections of Amendment 1. While there might be small regional variations in these seasonal patterns, broadly the patterns are consistent statewide.

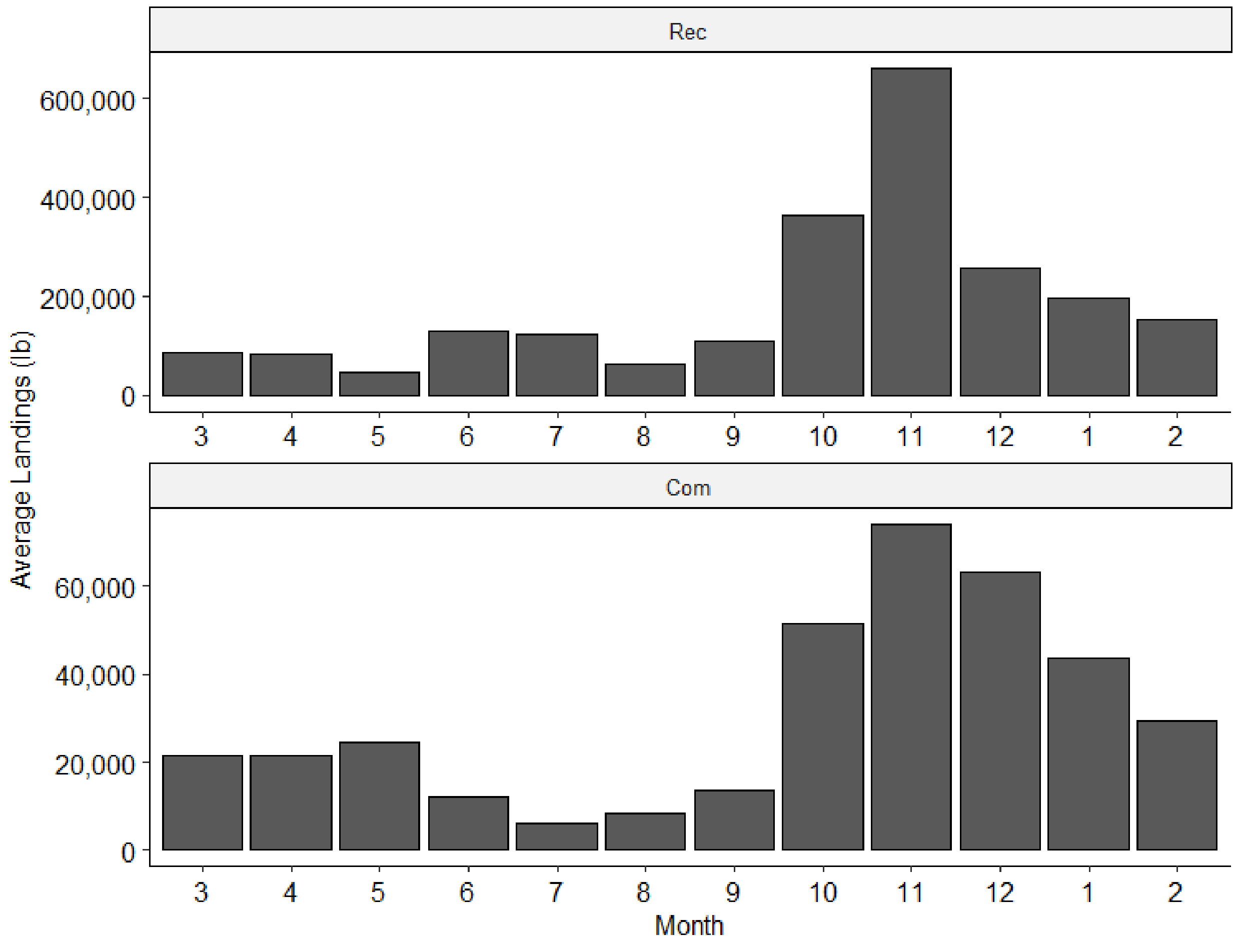

Figure 2.2 Average monthly harvest of Spotted Seatrout in pounds by sector from Biological Year 2012–2022. The top panel is recreational harvest, and the bottom panel is commercial harvest. Note: the vertical axis scale is different between panels to illustrate seasonal variation. The Biological Year is March – February.

Seasonal closures can be an effective way of limiting harvest, especially when closures are at the end of the fishing year to prevent recoupment of harvest. Closures prior to the end of the fishing year should include a buffer above the desired reduction to account for recoupment. It is possible to end overfishing in the Spotted Seatrout fishery through seasonal closures. In theory, a closure that spans the spawning season could reduce overall harvest enough to reach the threshold F (Table 2.4) and provide the added benefit of allowing more Spotted Seatrout to spawn each season. Though 2022 spawning stock biomass does not indicate the need for additional spawning protections, reducing harvest during the spawning season would have non-quantifiable benefits to the Spotted Seatrout stock. A spawning season closure, however, is not at the end of the fishing year therefore it is likely some amount of recoupment would occur after the season closure. A spawning season closure would also have to be longer than a winter closure to reduce harvest to a level that will meet management objectives (Table 2.4). Because recoupment is likely with a spawning season closure or closures that extend past the end of the biological year the closure should be extended, or other management options considered in tandem with the closure to ensure harvest reductions end overfishing. For example, during the AC Workshop there was discussion about a January–March commercial season closure (Table 2.4). While the bulk of reductions from such a closure come from January and February, the reductions gained in March are likely to be recouped throughout the year though some fish are likely to spawn prior to being harvested providing additional benefits to the stock. Extending the January–March closure or including additional management strategies should be considered to increase the likelihood of reaching management objectives. Input received during the public scoping period and from discussions with the Spotted Seatrout FMP Advisory Committee indicate that stakeholders would prefer a shorter season closure if possible. A winter closure at the end of the biological year could reach similar harvest reductions as a spawning season closure over a shorter timeframe with no recoupment of harvest.

Table 2.4. Expected reductions in harvest for each sector from seasonal closures in the North Carolina Spotted Seatrout fishery. Reduction in pounds are based on average harvest from 2019 to 2022. Unless otherwise noted, monthly closures are for the entire month and day of week closures begin at 11:59 p.m. the day prior to the beginning and end at 12:01 a.m. the day after the end (e.g., for a Sat-Sun closure, the fishery will close at 11:59 p.m. Friday and reopen at 12:01 a.m. Monday). A reduction of at least 19.9% (threshold) is needed to end overfishing. *Day of week closures are only calculated for commercial sector. **Reduction for period does not meet the harvest reduction necessary to meet the F threshold or the F target.

Season Closure Examples						
Month Closures	Day of Week Closures*	Recreational Reduction (lb)	Recreational Reduction (%)	Commercial Reduction (lb)	Commercial Reduction (%)	Total Reduction (%)
Jan – Feb			17.4**		21.6	18.0**
Jan-Mar		741,538	22.3	153,363	27.0	23.0
Dec 16 – Feb		738,113	22.1	168,131	29.6	23.2
-	Jan-Sep, Sat-Sun; Oct-Dec, Sat-Mon	0.00**	0.0**	172,107	30.3	4.4**
Jan – Feb	Oct-Dec, Sat-Mon	0.00**	0.0**	228,340	40.2	5.8**
Nov – Feb		1,843,613	55.2	323,198	56.9	55.4
May 16 – Sep		714,734	21.4	80,657	14.2**	20.4

A seasonal closure could be over the same timeframe for the commercial and recreational sectors or could vary depending on sector. A consistent season for both sectors is easier for recreational anglers and commercial fishers to understand, would ease the enforcement burden, and can decrease user group conflict. Ending overfishing in both sectors is more complicated with the same season across sectors as is ensuring a similar reduction for each sector. For example, if the Spotted Seatrout fishery is closed January 1 and does not reopen until the end of February, there would be a 21.6% reduction in commercial harvest (ends overfishing in the commercial sector), but only a 17.4% reduction in recreational harvest (does not end overfishing in the recreational sector). Different seasons for each sector could help ensure parity between sectors and that harvest is reduced to the threshold or target F but could cause confusion for stakeholders though there is precedent for different recreational and commercial seasons in multiple N.C. fisheries (e.g., Southern Flounder and Striped Bass).

It is also important to consider other potential target species during a proposed closed season. The most common species landed on commercial trips that land Spotted Seatrout is Striped Mullet (see Appendix 1). Similarly, Spotted Seatrout is the most common species landed on commercial trips that land Striped Mullet. Fishers in both fisheries use similar gear types with runaround gill nets becoming more common in recent years but anchored small mesh gill nets still common. The overlap in gear types and landings provides strong evidence that the Spotted Seatrout and Striped Mullet commercial fisheries operate alongside each other underscoring the importance of considering how management changes in the recently adopted Amendment 2 to the Striped Mullet FMP might affect Spotted Seatrout harvest and vice versa. The selected sustainable harvest management option in the Striped Mullet FMP is weekend commercial harvest closures on Saturday and Sunday January through September and Saturday through Monday October through December. Mirroring these weekend closures for the Spotted Seatrout commercial fishery would simplify management, could theoretically end overfishing in the commercial sector (Table 2.4), and reduce the potential for dead discards in both fisheries. However, if commercial fishers increase effort during the week to compensate for lost weekend days harvest recoupment is likely. Striped Mullet offshore spawning migrations in the fall largely coincide with wind events providing an opportunity for large numbers of fish to avoid harvest when a “mullet blow” occurs during a closed weekend period. Spotted Seatrout do not have this same migratory behavior. In fact, Spotted Seatrout overwinter in sometimes large aggregations in the upper estuary and begin forming these aggregations in the fall. Such aggregations allow for easier targeting of large numbers of Spotted Seatrout and could lead to a much greater degree of harvest recoupment from a shift in fishing effort compared to Striped Mullet. Day of the week closures could be considered in tandem with other management measures to ensure overfishing is ended. For example, combining the weekend closures adopted in Amendment 2 to the Striped Mullet FMP with a January–February harvest closure would give an on paper commercial harvest reduction of around 47% (46.8%). Even though it is unlikely that full harvest reduction is reached, the January–February harvest closure would provide a buffer and increase the likelihood of ending overfishing. However, if the reduction in recreational harvest were less than 47%, the perception could exist of the commercial sector taking a larger harvest reduction despite the commercial sector accounting for a smaller proportion of overall landings even though the realized reduction would probably fall well below the on-paper reduction. Mirroring a portion of the Striped Mullet regulations could act to balance the benefits of similar management across FMPs and the perception of a lack of parity between sectors. For example, implementing the same management as the Striped Mullet FMP during the peak harvest for both species (Saturday–Monday harvest closure October–December) with an additional Spotted Seatrout harvest closure January–February would match management between FMPs during the timeframe when most harvest occurs and result in a 40.2% on paper reduction in Spotted Seatrout harvest. This would reduce dead discards in both fisheries and decrease possible confusion caused by different management measures for each fishery during peak harvest seasons while still providing additional Spotted Seatrout management beyond weekend closures to account for expected recoupment in that fishery. Even if recreational management is expected to result in a harvest reduction less than 40%, it is likely the realized reduction percentages would be closer offering less of a chance for perceived lack of parity between sectors.

The types of baits and gear used in the recreational fishery are also commonly used when targeting Red Drum, Striped Bass, Southern Flounder, and Black Drum. When open, Striped Bass and Southern Flounder are quota managed species, therefore harvest of these species could not increase if effort shifts occur. If recreational anglers unable to target Spotted Seatrout due to a seasonal closure instead targeted Red Drum or Black Drum, this could lead to an increase in harvest. It is not possible to predict how angler behavior might change when regulations change, however; the seasonality of the Red Drum and Black Drum fisheries could be considered when determining the timeframe for a Spotted Seatrout seasonal closure.

Option 2: Seasonal Closure Options

a. *Status Quo – manage fishery without seasonal harvest closure*
b. *Dec 16 – Feb 28/29 harvest closure (both sectors)*
c. *11:59 p.m. Friday–12:01 a.m. Tuesday commercial harvest closure October 1–December 31 and Jan 1–February commercial harvest closure.* Consider recreational seasonal closures as a part of the overall management strategy to achieve sustainable harvest but not as a single solution option.

d. *Nov 1 – Feb 28/29 harvest closure (both sectors)*

Bag and Trip Limits

The recreational bag limit for Spotted Seatrout is currently 4 fish per person per day. Most recreational anglers, however, harvest less than their limit of Spotted Seatrout. From 2019-2022 – just over 73% of anglers harvested two or fewer Spotted Seatrout and nearly 48% of anglers harvested just one Spotted Seatrout. Harvest reductions needed to reach the F threshold could be achieved in the recreational fishery through bag limit changes, but harvest reductions needed to reach the F target are not possible with bag limit changes as a standalone measure (Table 2.6). Reducing recreational harvest to reach the F threshold would require decreasing the recreational bag limit to two fish per person per day. Reducing the allowable bag limit to meet the minimum reduction necessary to end overfishing in the recreational sector would enact management that is easy to understand, easy to enforce, and straightforward. Even though a two fish bag limit would result in a 27.7% reduction (Table 2.6), the public could potentially conflate the number of fish an angler is theoretically allowed to harvest with the number of fish most anglers actually harvest leading to the misperception that a two fish bag limit is a 50% reduction (Figure 2.3).

Table 2.6. Expected reductions in recreational harvest and total harvest from bag limit changes. Reductions in pounds are based on average recreational harvest from 2019 to 2022. Total harvest reductions assume no other management is implemented. Reductions of at least 19.9% (threshold) up to 53.9% (target) are needed to end overfishing. *Reduction does not meet the 19.9 % threshold harvest reduction (3 fish bag limit) or the 53.9% target harvest reduction (1 fish bag limit).

Bag Limit Reduction Examples			
Bag Limit	Recreational Reduction (lb)	Recreational Reduction (%)	Total Harvest Reduction
3	394,106	11.8*	10.1*
2	925,146	27.7	23.7
1	1,760,116	52.7*	45.0*

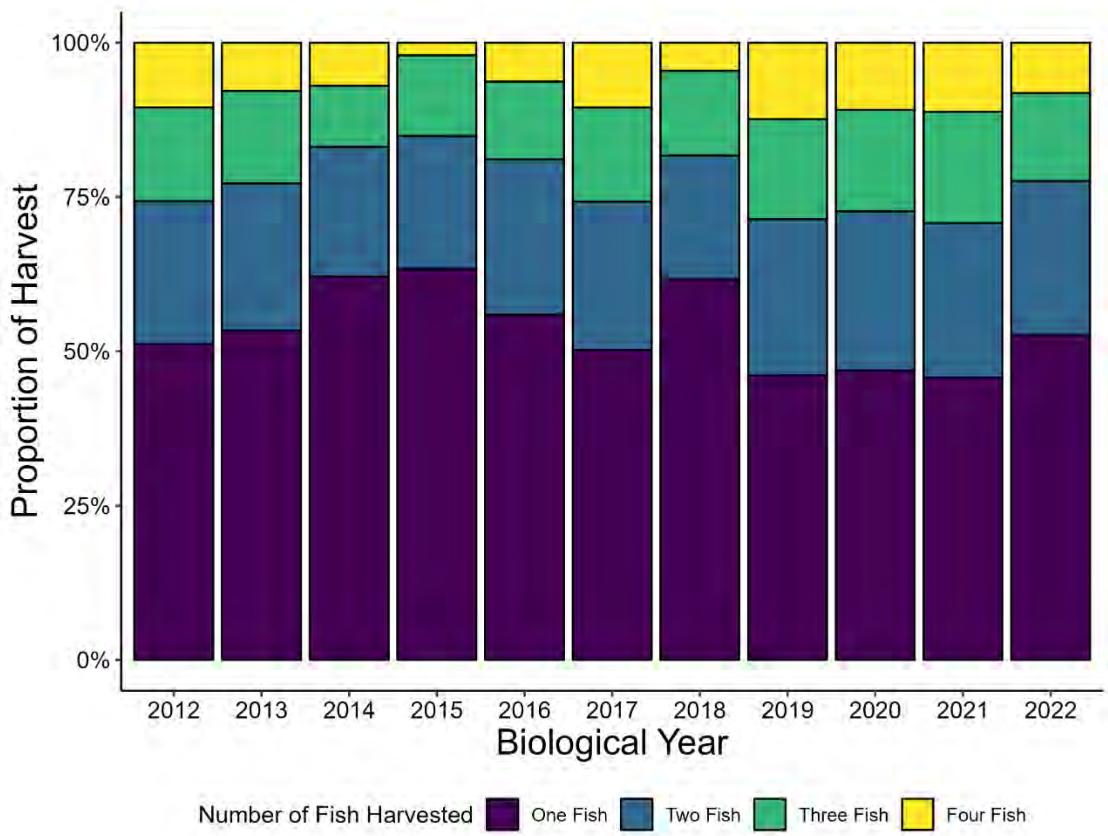

Figure 2.3. The proportion of total recreational Spotted Seatrout harvest where bar color refers to the number of fish harvested. Though the specific proportions of total harvest from each harvest bin vary year to year, approximately 75% of recreational anglers consistently harvest two or fewer Spotted Seatrout.

Currently there is a 75 fish commercial trip limit for Spotted Seatrout. Approximately 16% of commercial trips reach that limit with about half (52%) harvesting 30 or less Spotted Seatrout and over three quarters (84%) harvesting 70 or fewer fish. Reductions to the threshold in the commercial sector could be achieved through lowering the commercial trip limit as a standalone measure but, while technically possible, it is unlikely the necessary trip limit (<20 fish) to approach the target is realistic (Table 2.7). Regardless of whether commercial harvest is reduced to the threshold or the target level, management to reduce commercial harvest would not end overfishing in the combined Spotted Seatrout fishery. Like the recreational sector, there exists the potential for public misperception about harvest reductions stemming from changes to trip limits. For example, reducing the commercial trip limit to 45 fish results in a 21.5% reduction in commercial harvest (Table 2.7) but could be incorrectly perceived as a larger reduction if commercial fishers conflate the actual harvest reduction with the theoretical reduction in allowable harvest (40%).

Table 2.7. Expected reductions in commercial harvest from trip limit changes. Reductions in pounds are based on average commercial harvest from 2019 to 2022. Total harvest reductions assume no other management is implemented. Reductions of at least 19.9% (threshold) up to 53.9% (target) are needed to end overfishing. *Reduction does not meet the 19.9% (55 fish trip limit) or 53.9% (20 fish trip limit) harvest reduction necessary to reach $F_{Threshold}$ or F_{Target}.

Trip Limit Reduction Examples			
Trip Limit	Commercial Reduction (lb)	Commercial Reduction (%)	Total Harvest Reduction (%)
55	70,433	12.4*	1.8
45	122,122	21.5	3.1
20	301,046	53.0*	7.7

Lowering the Spotted Seatrout recreational bag limit or commercial trip limit would probably cause increased dead discards of Spotted Seatrout in both sectors of the fishery which can act to decrease the effectiveness of management changes. Changes to bag limits could be paired with gear requirements (see Appendix 3) and commercial trip limit changes could be accompanied by changes or limits to allowable gear (see Appendix 1) to mitigate dead discards in the fishery.

Option 3: Bag and Trip Limit Options

a. *Status Quo – manage commercial fishery without changes to current trip limit* and consider recreational bag limit changes as a part of the overall management strategy to achieve sustainable harvest but not as a single solution option.
b. *Reduce recreational bag limit to 2 fish and commercial trip limit to 45 fish*

Stop Nets

The stop net fishery is a modification of a traditional beach seine that primarily targets Striped Mullet and is unique to Bogue Banks. This fishery holds historic and cultural value in North Carolina and especially Carteret County (See Striped Mullet FMP and Amendment 1 for review of historical significance of stop net fishery). Where traditional beach seine fisheries involve setting and hauling a net from the beach, the stop net fishery adds a stationary “stop net” set perpendicular to the beach in an L-shape (see Spotted Seatrout FMP for more detail on the execution of the stop net fishery). The 2012 Spotted Seatrout FMP implemented a 75 fish commercial trip limit, but it was noted in the plan there was the potential for dead discards to exceed harvest in high-volume fisheries like the stop net fishery (NCDMF 2012). The MFC tasked the DMF Director with addressing the stop net fishery outside of the 2012 FMP. Since 2013, the stop net fishery has opened and closed by proclamation and operates under an annual Memorandum of Agreement (MOA) signed by a party of the combined fishing operation and the DMF Fisheries Management Section Chief. The MOA sets a 4,595 lb. Spotted Seatrout season quota, requires a party to the stop net fishery to alert DMF prior to fishing the stop nets, and requires reporting of Spotted Seatrout landings in pounds the same day the stop nets are fished. In recent years the stop net fishery has opened around October 15 and closed on December 31. Additionally, stop nets are limited to a maximum of four stop nets between Beaufort Inlet and Bogue Inlet at any one time with each combined fishing operation allowed to set a maximum of two stop nets.

Since implementation of current management in 2013, the stop net fishery has never reached their 4,595 lb. quota. Stop net landings represent a very minor proportion of Spotted Seatrout commercial landings and an even smaller portion of total commercial and recreational landings. For example, the highest stop net landings from 2013 through 2022 were 3,700 lb. which accounted for 1.4% of commercial landings and 0.2% of total landings in that year. Most years the stop net fishery accounts for less than half a percent of commercial landings and less than a tenth of a percent of combined landings. Due to the strict existing management of the stop net fishery, the potential for additional harvest reductions from the recently adopted Amendment 2 to the Striped Mullet FMP, and the low contribution to Spotted Seatrout landings under the current stop net fishery management, additional harvest restrictions may not be necessary in the stop net fishery. However, formalizing current management of the stop net fishery should be considered in this amendment.

Option 4: Stop Net Management Options

a) *Status quo – 4,595 lb. season quota with terms and conditions of stop net fishery and responsibilities of the stop net crew outlined in Memorandum of Agreement.*
b) *Stop nets are restricted to the Atlantic Ocean on Bogue Banks with a 4,595 lb. Spotted Seatrout season quota. A maximum of four stop nets are allowed between Beaufort Inlet and Bogue inlet at any one time and each combined fishing operation is limited to a maximum of two stop nets at any one time. The season will open no sooner than October 15 and close when the Spotted Seatrout quota is reached or no later than December 31. Any weekend closures to commercial harvest implemented in Option 2 will also apply to the Bogue Banks stop net fishery. Stop net crews must contact N.C. DMF Marine Patrol Communication each time a stop net is set and at least two hours prior to each time a stop net is fished. The same day a stop net is fished and the catch is landed at the fish house, a representative of the stop net crew must contact DMF Fisheries Management Section to report the daily total of Spotted Seatrout in pounds as it appears on the trip ticket. Same day reporting is required even if zero Spotted Seatrout are harvested. Failure to follow reporting requirements will result in an immediate closure of the stop net fishery. Additional gear and setback requirements from previous proclamations will continue.*

Combination Management Measures

Combining multiple strategies to achieve management goals is common in fisheries management including in the original Spotted Seatrout Fishery Management Plan which combines size limits with trip and bag limits and weekend prohibitions on commercial harvest or possession of Spotted Seatrout in joint waters. Multiple management measures rather than a single, standalone management measure allow for more specific, targeted management to account for a variety of factors including species life history and biology, differences in the fishery (e.g., industry, regional, etc.), or competing interests in the fishery. As there are few standalone management measures to end overfishing in the Spotted Seatrout fishery, combination measures will help ensure management is realistic and management objectives are more likely to be achieved. Additionally, a management strategy comprised of more than one management measure can allow for increased or more consistent access to the fishery (Tables 2.8 and 2.9). For example, implementing a slot limit along with a seasonal closure in the Spotted Seatrout recreational fishery would allow for a shortened closure period when compared to a seasonal closure as a standalone measure.

Table 2.8. Combination management measures to end overfishing and achieve sustainable harvest. The Total % Reduction column shows the total percent reduction if no changes to commercial management are implemented. Unless otherwise noted, season closures or bag limit reductions include the entirety of the month. *Total reduction does not reduce F to the 19.9% threshold (options 1.a, and 1.b). Harvest reductions in pounds are based on 2019–2022 average recreational harvest.

Option #	Season Closure	Bag Limit (number of fish)	Size Limit	Recreational Reduction (lb)	Recreational Reduction (%)	Total % Reduction
5.a	Jan-Feb	Oct-Dec 3 fish	-	738,113	22.1	18.9*
5.b		Nov-Feb 3fish	16” minimum	741,453	22.2	19.0*
5.c	-	Oct-Feb 3 fish	14-20”, 1 over 26”	824,950	24.7	21.1
5.d	Jan 16-Feb	-	14-20”, 1 over 26”	935,166	28.0	23.9
5.e	Dec 16-Feb	3 fish	-	1,015,323	30.4	26.0
5.f	Jan-Feb	-	14-20”, 1 over 26”	1,078,781	32.3	27.6
5.g	Jan-Feb	Oct-Dec 3 fish	14-20”, 1 over 26”	1,205,696	36.1	30.9
5.h	Jan-Feb	3 fish	14-20”, 1 over 26”	1,319,252	39.5	33.8
5.i	Dec 16-Feb	3 fish	14-20”, 1 over 26”	1,436,148	43.0	36.7
5.j	Dec-Feb	2 fish	14-20”, 1 over 26”	1,923,770	57.6	49.2

Table 2.9 Combination management measures to end overfishing and achieve sustainable harvest. The Total % Reduction column shows the total percent reduction if no recreational management changes are implemented. No management options applied solely to the commercial sector reduce *total* harvest to a level where F meets the 19.9% threshold. Unless otherwise noted, seasonal closures include the entirety of the month. Harvest reductions in pounds are based on 2019–2022 average commercial harvest.

Option #	Season Closure	Trip Limit (number of fish)	Size Limit	Commercial Reduction (lb)	Commercial Reduction (%)	Total % Reduction
6.a	Jan 16-Feb	60	-	131,210	23.1	3.4
6.b	Jan-Feb	65	-	145,979	25.7	3.7
6.c	Jan-Feb	-	16” min	149,955	26.4	3.8
6.d	Feb	45	-	164,155	28.9	4.2
6.e	Jan 16-Feb	45	-	193,124	34.0	4.9
6.f	Jan-Feb	50	-	197,100	34.7	5.0
6.g	Dec 16-Feb	60	-	202,780	35.7	5.2
6.h	Dec-Feb	40	-	314,110	55.3	8.0

Multiple strategies to manage a fishery can be especially helpful when considering different and potentially competing stakeholder objectives as well as ensuring management objectives are realistic for different sectors and therefore more likely to be achieved. However, combining multiple strategies can also lead to more complex management potentially resulting in stakeholder confusion and enforcement difficulties. It is important to balance the increasing complexity of multiple management layers with stakeholder and management objectives.

Options 5/6: Combination Management Options

a) *Option 5.h with commercial management handled through seasonal closures as a standalone measure (see Option 2.c)*

Adaptive Management

The current Spotted Seatrout adaptive management framework needs to be updated. Adaptive management is a structured decision-making process when uncertainty exists, with the objective of reducing uncertainty through time with monitoring. Adaptive management provides flexibility to incorporate new information and accommodate alternative and/or additional actions. The original FMP included adaptive management to “achieve one half of the reductions necessary and to reassess after three years to evaluate the effectiveness of the measures to reduce harvest” and for the Director to “intervene in the event of a catastrophic” cold stun event (NCDMF 2012).

While success or failure of any given management strategy to sustain the stock is best determined through a quantitative stock assessment the ability to adjust management between stock assessments based on evidence of management strategies not sustaining the stock can be an important conservation tool. For example, by itself failure to achieve projected harvest reductions does not necessarily indicate failure of a management measure but could conversely indicate improving stock conditions. However, failure to achieve harvest reductions combined with warning signs in dependent or independent sampling (e.g., a decrease in independent sampling abundance or a truncation of age or length distributions in dependent or independent catch) could indicate a need to adjust management strategies. Peer reviewed stock assessments and stock assessment updates should continue to be used to guide management decisions for the Spotted Seatrout stock. The 2022 peer reviewed stock assessment (NCDMF 2022) should be updated, at least once between full reviews of the plan to gauge success in maintaining sustainable harvest and to monitor changes in *F.* The 2022 stock assessment had a terminal year of 2019 and Amendment 1 management measures will be implemented, at the earliest, in 2025. Given this timeline, the earliest a stock assessment update should be completed is during 2026 with the inclusion of data from 2025. The timing of a stock assessment update is at the discretion of the Division and will consider stock trends and the timing of prior management when determining the appropriate schedule. An assessment update will best determine if management goals are being met, but an adaptive management structure that allows for needed adjustments to management measures between stock assessment updates is an important tool for attaining management goals.

The existing Spotted Seatrout rule, 15A NCAC 03M .0522, provides the Fisheries Director proclamation authority pursuant to 15A NCAC 03H .0103 to impose any of the following restrictions on the taking of Spotted Seatrout:

1) Specify time;
2) Specify area;
3) Specify means and methods;
4) Specify season;
5) Specify size; and
6) Specify quantity.

Upon adoption of Amendment 1, the adaptive management framework will consist of the following:

Option 7: Adaptive Management Framework

1) The adaptive management framework allows for adjusting management measures outside of an updated stock assessment to ensure compliance with and effectiveness of management strategies adopted in Amendment 1 and is a tool to respond to concerns with stock conditions and fishery trends. Upon evaluation by the division, if the management strategy implemented to achieve sustainable harvest (either through Amendment 1 or a subsequent revision) is not achieving the intended purpose, management measures may be revised or removed and replaced using adaptive management; provided it conforms to part 2.
2) Management measures that may be adjusted using adaptive management include:
   a. Season closures
   b. Day of week closures
   c. Trip limits
   d. Size limits
   e. Bag limits
   f. Gear restrictions in support of the measures listed in a-e

MANAGEMENT OPTIONS

Table 2.10. Management options to achieve sustainable harvest in the Spotted Seatrout fishery.

Topic	Option	Description
Size limits	1.a	Status quo – no change to commercial size limit. Consider recreational size limit changes as a part of the overall management strategy to achieve sustainable harvest but not as a single solution option.
	1.b	Recreational 16”–20” slot limit with allowance for one fish over 24” and commercial 16” minimum size limit
Season closure	2.a	Status quo – no season closure as standalone measure
	2.b	Statewide season closure Dec 16 – Feb 28/29 (both sectors)
	2.c	11:59 p.m. Friday-12:01 a.m. Tuesday statewide commercial harvest closure Oct-Dec and Jan-Feb commercial harvest closure. Consider recreational season closures as a part of the overall management strategy to achieve sustainable harvest but not as a single solution option.
	2.d	Statewide season closure Nov 1 – Feb (both sectors)
Bag and trip limits	3.a	Status quo – no change to commercial trip limit. Consider recreational bag limit changes as a part of the overall management strategy to achieve sustainable harvest but not as a single solution option.
	3.b	Reduce recreational bag limit to 2 fish and commercial trip limit to 45 fish
Stop net	4.a	Status quo – no change
	4.b	No change to quota but formalize management in FMP
Combinations	5.a-j & 6.a-h	See tables 2.8 and 2.9
Adaptive management	7	

RECOMMENDATIONS

DMF Initial Recommendation:

The DMF recommends the following options that are projected to end overfishing with a greater than 70% probability of keeping SSB above the target:

Option 2.c Seasonal Closures

- Oct–Dec, 11:59 p.m. Friday to 12:01 a.m. Tuesday statewide commercial harvest closure.
- Jan–Feb statewide commercial harvest closure

Option 4.b Stop Net Management

- *Stop nets are restricted to the Atlantic Ocean on Bogue Banks with a 4,595 lb. Spotted Seatrout season quota.*
- *The season will open no sooner than October 15 and close when the Spotted Seatrout quota is reached or no later than December 31.*
- *Stop net crews must contact N.C. DMF Marine Patrol Communication each time a stop net is set and two hours prior to each time a stop net is fished.*

- *The same day a stop net is fished and the catch is landed at the fish house, a representative of the stop net crew must contact DMF Fisheries Management Section to report the daily total of Spotted Seatrout in pounds as it appears on the trip ticket. Same day reporting is required even if zero Spotted Seatrout are harvested.*
- *Failure to follow reporting requirements will result in an immediate closure of the stop net fishery.*
- *Additional gear and setback requirements from previous proclamations will continue.*

Option 5.h Combination Management Measures

- 3 fish recreational bag limit
- 14”–20” recreational slot limit with allowance for one fish >26”
- Jan–Feb statewide recreational harvest closure

Option 7 Adaptive Management Framework

Appendix 3: SUPPLEMENTAL MANAGEMENT OPTIONS IN THE NORTH CAROLINA SPOTTED SEATROUT FISHERY

ISSUE

The results of qualitative management measures on the North Carolina Spotted Seatrout stock cannot be quantified but implementing these management measures may serve to reduce dead discards, reduce harvest by an unknown amount, and improve the overall Spotted Seatrout stock.

ORIGINATION

The North Carolina Division of Marine Fisheries (DMF).

BACKGROUND

As outlined in Appendix 2, total Spotted Seatrout harvest increased sharply in 2019 and has remained high in the ensuing years through 2022. Most harvest occurs October – December each year. The recreational fishery includes a robust catch and release segment. Since 2012 the recreational sector has accounted for, on average, approximately 85% of Spotted Seatrout harvest (Appendix 2) and the number of recreational trips targeting Spotted Seatrout increased in recent years with biological years 2019 through 2022 representing the four highest numbers of trips since 2012 (Figure 3.1). The proportion of trips that are successful (i.e., anglers are targeting Spotted Seatrout and catch Spotted Seatrout) has remained relatively steady since 2012. The high number of trips targeting Spotted Seatrout has led to not only increased harvest, but also increased dead discards – or fish that are released alive but ultimately die because of the fishing interaction – though on an individual basis discard mortality depends on a variety of factors and is likely low (Gearhart 2002; James et al. 2007; NCDMF 2022). Though the commercial fishery has only accounted for about 15% of total harvest since 2012, commercial landings have also increased in recent years. While commercial dead discards are likely minimal, changes to commercial management (e.g., decreasing trip limits) could cause an unintended increase in dead discards.

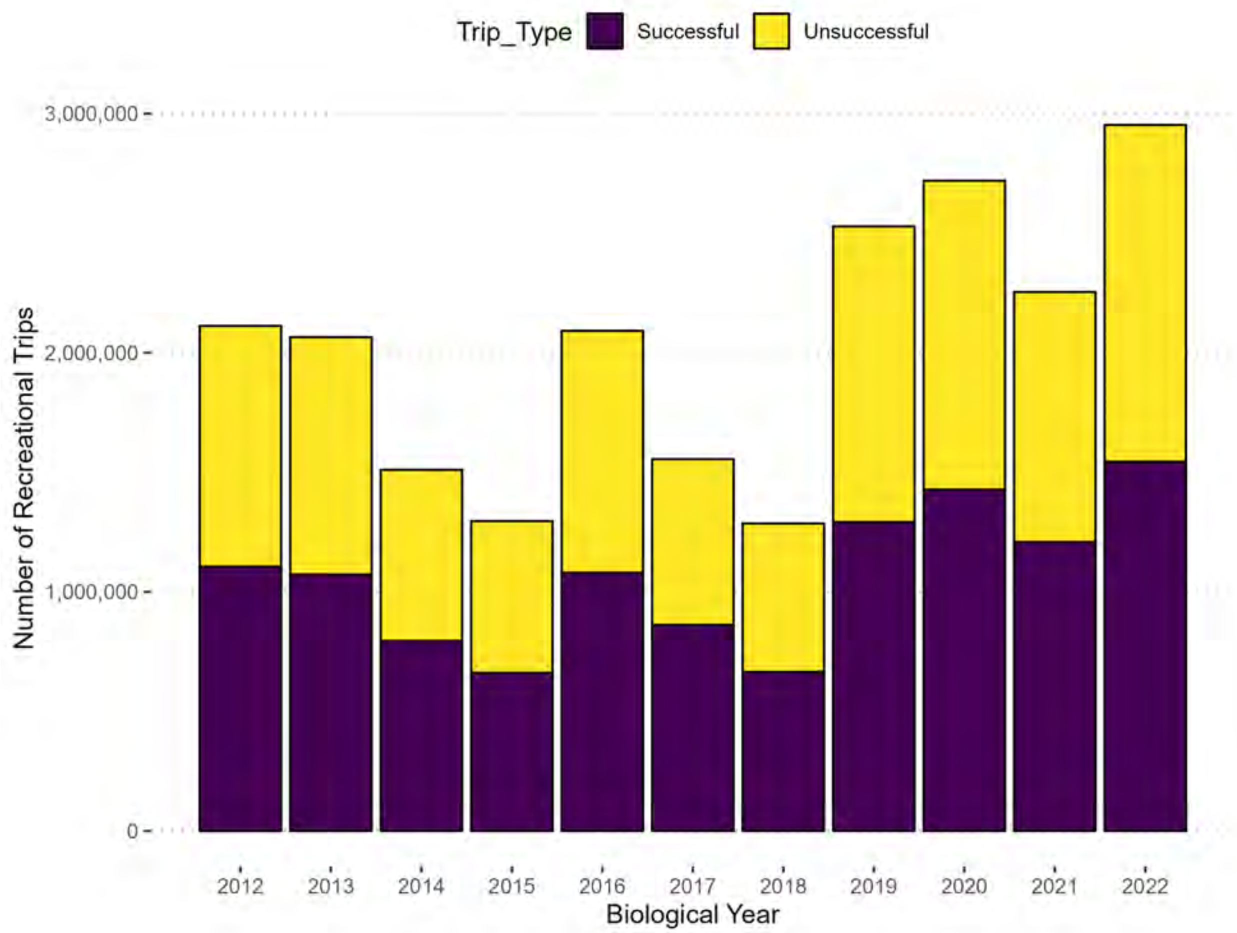

Figure 3.1. Annual MRIP trips where Spotted Seatrout were reported as the primary or secondary target by Biological Year (March–February). Bars are total annual trips with "successful" trips (i.e., a Spotted Seatrout was either harvested or released on the trip) as the purple portion and "unsuccessful" trips (i.e., no Spotted Seatrout were caught) as the yellow portion of the total.

As a result of the popularity of Spotted Seatrout as a targeted species; Marine Fisheries Commission (MFC) commissioners, MFC Advisory Committee members, and the public have mentioned a wide variety of potential recreational and commercial management strategies that could benefit the Spotted Seatrout stock but the scope of which are not immediately quantifiable. The increase in recreational trips targeting Spotted Seatrout and increased total Spotted Seatrout harvest in recent years combined with the presence of a dedicated catch and release segment of the recreational fishery suggest that even management measures lacking immediately quantifiable benefits are worth exploring. Additionally, there are management measures that could provide supplementary benefits when paired with sustainable harvest measures discussed in Appendix 2. For example, gear requirements designed to reduce recreational discard mortality would not provide a quantifiable benefit to the Spotted Seatrout stock, but when paired with a seasonal fishery closure could help prevent an increase in dead discards during the closed season. Discussion will focus on measures specific to the Spotted Seatrout recreational fishery, those more broadly affecting multiple recreational fisheries, and measures specific to the commercial fishery not discussed in Appendix 1.

AUTHORITY

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
15A NCAC 03H .0103 PROCLAMATIONS, GENERAL
15A NCAC 03M .0512 COMPLIANCE WITH FISHERY MANAGEMENT PLANS
15A NCAC 03M .0522 SPOTTED SEATROUT

DISCUSSION

Carry Forward Items from Original FMP

The prohibition on commercial harvest and sale of Spotted Seatrout taken in joint waters on weekends as outlined in the original Spotted Seatrout Fishery Management Plan will carry forward into Amendment 1 to the Spotted Seatrout Fishery Management Plan.

Spotted Seatrout Specific Recreational Management

Vessel limits

Limiting the harvest of fish through a vessel limit less than the sum of individual bag limits when multiple anglers are on a vessel is a common practice in many state and federal fisheries. Spotted seatrout recreational harvest is limited to four fish per person per day. When multiple anglers are fishing from the same vessel, the anglers may keep the individual bag limit for each angler on board. For example, eight anglers fishing from one boat could harvest eight times the individual bag limit or 32 Spotted Seatrout. Similarly, charter captains and any crew are allowed to harvest their own recreational limit of Spotted Seatrout while running charter trips. The prevalence of multiple anglers on private or for-hire boats harvesting multiple individual limits is unknown but implementing a boat limit and/or eliminating the charter captain and crew allowance should aid in meeting sustainability goals. During the Spotted Seatrout public scoping period, Division staff received public comments suggesting vessel limits and suggesting eliminating the captain/crew allowance. Conversely, during the Spotted Seatrout Advisory Committee Workshop, committee members generally spoke out against vessel limits in the fishery but indicated input members had received from the for-hire industry was generally supportive of eliminating the captain/crew allowance for Spotted Seatrout.

There are anecdotal reports of charter captains and crew harvesting multiple bag limits when running more than one trip in a day (DMF Staff, personal communication) though it is not clear how prevalent this behavior is nor is it possible to assess the impact such behavior has on managed fish stocks. Harvesting multiple charter captain/crew allowances in a day is not legal and leads to unreported harvest of managed fish species.

However, enforcement to ensure a single charter captain/crew allowance is difficult as it would require proof that a captain or crew harvested their personal bag limit on a trip previously taken that same day. During the Spotted Seatrout Public Scoping period there was support voiced for eliminating the captain/crew allowance for Spotted Seatrout, but Spotted Seatrout are not the only species in North Carolina where a charter captain/crew allowance is permitted. Changes to the captain/crew allowance in the Spotted Seatrout fishery could lead to confusion about when a captain/crew allowance is permitted, but there is a precedent for eliminating the captain/crew allowance for a single species in other states. The Louisiana Department of Wildlife and Fisheries included a ban on charter captains/crew harvesting Spotted Seatrout while on a for-hire trip in their November 2023 regulation changes. In its most recent Spotted Seatrout regulation changes, the Florida Fish and Wildlife Conservation Commission implemented similar regulations prohibiting captain/crew harvest while engaged in a for-hire trip. Since addressing the charter captain/crew allowance for multiple species is outside the scope of this amendment, management options here will deal specifically with the Spotted Seatrout fishery.

Option 1: Vessel Limit Options

- *a) Status Quo – Manage fishery without changes to vessel limit or for-hire captain/crew allowance*
- *b) Eliminate captain/crew allowance for Spotted Seatrout on for-hire trips with no broader vessel limit*
- *c) Implement 8 fish Spotted Seatrout vessel limit with captain/crew allowance on for-hire trips counted as part of vessel limit.*

<u>Effort Controls</u>

One way to reduce harvest in a fishery is to limit those able to participate in the fishery. There are a multitude of ways to limit entry to a fishery and measures to limit recreational participation in the Spotted Seatrout fishery would reduce harvest pressure and would probably reduce fishing effort. G.S. 113-182.1(g) gives authority to the MFC to limit entry into a fishery, however; the authority granted by this statute is limited only to cases where "the Commission determines that sustainable harvest cannot otherwise be achieved." Participation in the fishery increased markedly in biological year 2019 and has remained high since, but Spotted Seatrout life history allows this species to readily recover from periods of high mortality (e.g., cold stuns). Furthermore, Appendix 2 presents multiple options with an at least 50% chance of ending overfishing within a two-year timeframe of plan implementation (G.S. 113-182 .1). The combination of current stock status, species life history, and other available options expected to end overfishing make the Spotted Seatrout fishery unlikely to meet the level required for the MFC to limit entry.

Recreational management beyond Spotted Seatrout

<u>Gear Requirements</u>

Recreational catch and release fishing for Spotted Seatrout has increased in popularity in recent years whether from anglers switching to catch and release fishing after harvesting their limit or from dedicated catch and release anglers. Released Spotted Seatrout have far outpaced harvested fish. From 2017-2019, recreational anglers released almost six times as many fish as were harvested (Table 3.1). Delayed mortality, or discard mortality, is the measure of how many fish released alive ultimately die because of the fishing interaction and, on an individual basis, is likely low for Spotted Seatrout (Murphy et al. 1995; Gearhart 2002; James et al. 2007). Conversely, delayed mortality for throat or gut hooked fish is quite high. Delayed mortality is also dependent on factors such as salinity, dissolved oxygen levels, and length or health of fish (Gearhart 2002; James et al. 2007). Spotted Seatrout aggregations in the small creeks and bays of the upper estuary during winter months could potentially have a larger than expected impact on dead discards in the fishery as anglers are able to fish more efficiently on schools at smaller spatial scales than other times of the year, though any such effects could be mitigated by lower water temperatures and higher dissolved oxygen levels during the winter months. Even with low individual discard mortality rates, the sheer number of releases in recent years makes the cumulative number of dead discards impactful and management to reduce the delayed mortality rate worth discussing.

Table 3.1. Harvest and releases of Spotted Seatrout in numbers of fish for biological years 2017-2022.

Biological Year	Harvest	Release
2017	1,054,500	4,725,746
2018	499,560	16,426,444
2019	2,415,394	7,050,238
2020	1,605,723	5,428,133
2021	1,495,385	6,859,777
2022	1,852,135	11,468,873

Studies of gear requirements that could reduce recreational discard mortality are severely lacking outside of those studies examining the differences in discard mortality when using circle hooks or “J” hooks. Although there are not specific studies exploring differences in circle and J hook mortality rates for Spotted Seatrout, hooking location and the severity of injuries related to hooking are important factors impacting Spotted Seatrout delayed mortality (Murphy et al. 1995; Gearhart 2002; Stunz and McKee 2006; James et al. 2007) and generally studies show circle hooks reduce hooking injuries compared to J hooks in marine species (Skomal et al. 2002; Cooke et al. 2003; Millard et al. 2005; Vecchio and Wenner 2007). In theory, other gear requirements such as eliminating the use of treble hooks with natural baits, using barbless treble hooks or inline hooks on artificial baits, and requiring rubberized landing nets when handling fish should help reduce discard mortality as well, however; there are few studies that attempt to quantify the benefits of these measures.

Implementing gear requirements in the Spotted Seatrout fishery to reduce mortality of released fish would benefit the stock, but single species gear requirements in multi-species fisheries like the Spotted Seatrout fishery can introduce difficulties in enforcement and decrease compliance with the requirements. Enforcement is difficult because it requires proof of an angler’s intent to fish for Spotted Seatrout and the enforcement difficulty provides a built-in loophole for anglers to avoid gear requirements. For example, requiring circle hooks when fishing with natural or artificial baits in the Spotted Seatrout fishery could also affect other robust recreational fisheries like Sheepshead, Red Drum, Estuarine Striped Bass, Summer Flounder, and Kingfishes regardless of whether anglers in these fisheries target Spotted Seatrout as well. If anglers follow Spotted Seatrout gear requirements when fishing for these other species, there could be decreases in recreational discard mortality across multiple fisheries. However, if anglers use these other fisheries to avoid Spotted Seatrout gear requirements, the discard mortality benefit in the Spotted Seatrout fishery would be reduced. Regardless of angler behavior, enforcement remains difficult. Implementing gear requirements such as requiring circle hooks across multiple fisheries could be a way to improve angler compliance, simplify enforcement, and gain the benefit of reduced discard mortality in these fisheries. Circle hooks could be required when fishing with any natural or artificial bait, when using natural or artificial baits in certain areas (e.g., the sounds or rivers), when using natural or artificial baits in combination with hooks of a certain size, or when using natural or artificial baits where the fishing method is similar. The latter two examples could help provide exceptions for instances where circle hooks could significantly affect angler efficiency such as when anglers are targeting Sheepshead or offshore trolling. Gear requirements are likely better discussed outside of species-specific FMPs because of the wide-ranging effects of requirements across multiple fisheries and species-specific FMPs.

Tournaments

Spotted Seatrout are either directly or indirectly a popular target for many saltwater fishing tournaments in North Carolina. DMF does not formally track or register saltwater fishing tournaments though if tournaments wish to sell their catch – common with billfish or King Mackerel tournaments – they must obtain a license from DMF. Additionally, DMF does obtain age samples from some tournaments, mostly billfish or King Mackerel tournaments. The last time DMF staff attempted to generate a list of saltwater fishing tournaments was 2021 and staff learned of 154 tournaments, however Division staff did not consider the list exhaustive. Of the 154 tournaments, 49 either directly targeted Spotted Seatrout or had categories specifically for Spotted Seatrout and 32 tournaments took place where Spotted Seatrout were likely to be encountered even if it was unclear whether a Spotted Seatrout category existed. In other words, over half of the saltwater tournaments the DMF was aware of in 2021 either targeted or had a high likelihood of encountering Spotted Seatrout.

Understanding the impact of fishing tournaments on Spotted Seatrout or other marine and estuarine fish species would require a catalogue of North Carolina saltwater fishing tournaments that does not exist at this time, an idea of the number of participants in each tournament, information on the type of tournament (e.g., catch and release or harvest), data on the number and species of fish caught in each tournament, and additional research. Most existing research exploring the effects of tournaments on fish populations, fish behavior, immediate mortality, and post release mortality have focused on freshwater systems though there have been some recent attempts to understand the impacts of saltwater tournaments on estuarine fish species. Specifically in Texas and Alabama, studies examining initial and post-release mortality of Spotted Seatrout from live-release tournaments found mortality rates well above recent estimates of recreational release mortality (James et al. 2007; Nelson et al. 2021). The same study in Alabama found similar mortality rates as recent estimates of recreational release mortality for Red Drum (Nelson et al. 2021) implying that the effect of tournaments may vary by species. Requiring a license or some sort of registration process with DMF in order to hold a saltwater fishing tournament in North Carolina could help in gathering these necessary data.

However, the 81 saltwater fishing tournaments known to the Division in 2021 targeting or likely to encounter Spotted Seatrout directly targeted or were also likely to encounter other fish species regularly found in similar habitats such as Red Drum, Striped Bass, Black Drum, flounder, Bluefish, Weakfish, and Sheepshead among many other fish species. The other 73 tournaments were predominately King Mackerel, billfish, or Dolphin/Wahoo tournaments which also target regulated species. The diversity of target species and broad spatial range of saltwater fishing tournaments – from many miles up local creeks to many miles offshore – make the potential effects of these tournaments much further reaching than just the Spotted Seatrout fishery. The effects of any attempt to manage saltwater tournaments based on the Spotted Seatrout fishery could have unforeseen influence on other fisheries. For example, if tournaments could not target Spotted Seatrout as a reward category or had to register to do so, this could potentially cause tournament organizers to focus on a different species thus increasing the impact of saltwater tournaments on that species. In order to better understand the current effect saltwater tournaments have on a variety of North Carolina fishes and to better predict how a system of tournament registration or licensing would affect tournaments, this issue should be examined on a broader basis across multiple fisheries. A separate information paper – rather than this amendment – may be the appropriate place for that exploration.

Spotted Seatrout Specific Commercial Management

<u>Hook and Line Harvest</u>

During the Spotted Seatrout Public Scoping Period recreational anglers and commercial fishers regularly expressed interest in a commercial hook and line fishery. The context of interest in a commercial hook and line fishery varied from making the trip limit the same regardless of gear to making the hook and line trip limit consistent with the broader commercial trip limit but prohibiting gill nets as a legal harvest gear to prohibiting gill nets as a legal harvest gear but keeping the hook and line trip limit consistent with the recreational bag limit and other variations on these ideas. Spotted Seatrout Advisory Committee members also discussed commercial hook and line harvest and generally expressed support for the idea with a similar range of context for that support. There is precedent in other states for allowing increased harvest of Spotted Seatrout by hook and line. Some states combine their hook and line allowance with gill net prohibitions (e.g., Florida and Louisiana) while other states allow both hook and line and gill net harvest (e.g., Mississippi). Commercial harvest in other states is minimal, however, and there does not appear to be a directed Spotted Seatrout fishery outside of North Carolina.

Ultimately, it is unclear how changes to the commercial hook and line trip limit would affect the sustainability of Spotted Seatrout harvest. It is likely the benefits or detriments resulting from changes would largely depend on fisher behavior and the specific implementation of such changes. A decrease to the general trip limit would increase dead discards making management less effective, but if a general trip limit decrease were paired with an exclusively hook and line fishery, the potential increase in dead discards could be greatly mitigated (see Appendix 2 for a more detailed discussion on anchored gill net and hook and line discard mortality). Raising the hook and line trip limit in the absence of other gear limitations should be considered with caution since it is unclear the effect such a change would have on current commercial fisher behavior. In theory, consistent trip limits regardless of gear could increase the number of participants in the fishery as fishers with the expertise to fish gill nets would likely continue doing so, fishers without that expertise would no longer be held to the recreational bag limit when fishing with hook and line, and generally increase the areas accessible for commercial harvest (e.g., areas currently closed to gill net harvest or where fishers cannot set gill nets because of environmental conditions such as heavy tides). A hook and line trip limit consistent with other commercial gears could encourage recreational anglers to obtain a commercial license to keep the commercial limit of Spotted Seatrout. A higher hook and line commercial trip limit could also encourage for-hire captains who currently hold a commercial license to use it to allow their clients to keep a commercial limit. Similarly, for-hire captains who do not currently hold a commercial license could be encouraged to obtain one for the same reasons. These scenarios could increase commercial harvest, though if and how much would depend on other management implemented. For example, a hook and line fishery combined with a decreased trip limit could discourage some of this behavior. Changes to the commercial hook and line limit should be preceded by further outreach and stakeholder engagement to help determine the logistics and sustainability of a commercial hook and line fishery.

The potential issues and benefits of a hook and line commercial fishery are not unique to the Spotted Seatrout fishery. The benefits to other species would likely be similar and, depending on the management conditions (e.g., a mismatch of bag and trip limits or open and closed season between the recreational and commercial sectors), the concerns with developing hook and line fisheries are also the same. There are anecdotal reports of recreational anglers using commercial licenses to harvest commercial limits in the cobia and flounder fisheries though the extent of this practice is unclear. Since the issues surrounding hook and line commercial fisheries are the same across the span of multiple species, it may make more sense to discuss commercial hook and line harvest more broadly outside of species-specific FMPs.

MANAGEMENT OPTIONS

Table 3.2 Supplemental management options for the Spotted Seatrout fishery. Options would likely provide benefits to the stock but are not able to be quantified.

Topic	Option	Description
Boat limits and captain/crew allowance	1.a	Status quo – no boat limit, continue captain/crew allowance
	1.b	Eliminate captain/crew allowance on for-hire trips with no broader vessel limit.
	1.c	Implement 8 fish vessel limit with captain/crew allowance on for-hire trips counted as part of vessel limit.

RECOMMENDATION

Division Recommendation:

Option 1.b Eliminate the captain/crew allowance on for-hire trips with no broader vessel limit.

Appendix 4: COLD STUN MANAGEMENT

ISSUE

Implement additional management measures to protect Spotted Seatrout spawning stock biomass after periodic cold stun events.

ORIGINATION

The North Carolina Division of Marine Fisheries (DMF).

BACKGROUND

Spotted seatrout (*Cynoscion nebulosus)* and other finfish that over-winter in estuarine environments in North Carolina are susceptible to periodic cold stun events. Cold stun events occur when water temperatures drop below a fish's metabolic minimum, impairing their physiological functions and rendering them lethargic or immobile. These events are associated with rapid weather changes that disrupt the thermal balance of coastal waters. In North Carolina, cold stuns can be triggered by snow and ice melt following a winter storm or by sudden and-or prolonged periods of cooler temperatures from cold fronts. Cold stun events can be localized to individual tributaries, or they can be widespread across multiple estuaries. Mass mortality events can occur in these periods of sub-optimal water temperatures because the impaired function of the fish makes them unable to move to warmer waters. Cold stuns are not always lethal, but if water temperatures drop too low or remain low for too long and fish are unable to move to find thermal refuge, they are unlikely to survive. Fish in a stunned state are also easy targets for scavengers, predators, and can be susceptible to harvest with methods like dip nets.

Cold Tolerance

To better understand environmental conditions that lead to Spotted Seatrout cold stuns, several studies have investigated the temperatures at which Spotted Seatrout become stunned and experience mortality. In North Carolina, laboratory experiments suggest the temperatures in which Spotted Seatrout become stunned, or experience a complete loss of equilibrium, range from 2 to 4°C (Ellis et al. 2017). However, Spotted Seatrout begin showing signs of stress at temperatures as high as 7°C. An adult Spotted Seatrout's critical thermal minimum, or the lowest temperature Spotted Seatrout can be exposed to for a short time and still survive, was found to be approximately between 2-3°C. When adult Spotted Seatrout were acclimated and exposed over time to low water temperatures, a water temperature of 3°C was found to be 100% lethal after less than 2 days (Ellis et al. 2017). At 5°C, 93% were still alive after 5 days, but only 15% survived after 10 days. There was high survival (83%) after 10 days at 7°C. Based on this research, we have learned that Spotted Seatrout's survival of cold stun events is not only related to water temperature, but also the length of time they are exposed to these stressful conditions. Similar studies from South Carolina and Texas conducted on Spotted Seatrout saw comparable temperatures leading to Spotted Seatrout loss of equilibrium and mortality (Anweiler et al. 2014; McDonald et al. 2010), although lower temperatures were required to induce mortality in adults (~2°C) than juvenile (~3°C) Spotted Seatrout, indicating the possibility of size-dependent mortality (McDonald et al. 2010).

For Spotted Seatrout, cold water temperatures disrupt cellular processes, making it difficult to maintain osmotic balance of ion concentrations within their body (Hurst 2007). If temperatures drop below a threshold for long enough, and the fish is unable to leave the area, the imbalance will impact their central nervous system and result in loss of equilibrium, causing the "stunned" response where fish float on top of the water or lay along the bottom.

Population Impacts of Cold Stuns

Spotted seatrout mature quickly, with most able to reproduce by age one. Spotted seatrout are also highly fecund, meaning they can produce many offspring within a spawning season and over an individual's lifetime. Females spawn multiple times throughout a season and can produce 3-20 million eggs per year (Murphy et al., 2010; Nieland et al., 2002; Roumillat & Brouwer, 2004). Though Spotted Seatrout have a high capacity to replenish spawning stock biomass (SSB), they are also especially susceptible to cold stuns due to their limited tolerance for abrupt temperature shifts, particularly when these shifts occur outside of their preferred thermal range (Ellis, 2014). North Carolina Spotted Seatrout are more so susceptible to being impacted by cold stuns because they are near the northern extent of their geographical range.

Cold stun mortality has been shown to have population-level effects on Spotted Seatrout in North Carolina (NCDMF 2012; Ellis 2014; Ellis et al. 2018) by reducing stock size and annual cohort strength (Hurst 2007). Overall, the rate of mortality due to fishing activity or natural causes like cold stuns vary seasonally and annually. Using tag return data, Spotted Seatrout natural mortality has been estimated to be higher than fishing mortality during winters in which cold stuns occurred (Ellis et al. 2018; Loeffler et al. 2018; Bauer and Flowers 2019). The division does not have a method to quantify the severity of a cold stun on Spotted Seatrout SSB in real-time, or as the cold temperatures are occurring. However, eliminating or reducing harvest after a cold stun event protects the remaining SSB by ensuring surviving adults have a chance to spawn.

Compared to other commercially and recreationally important fish species in North Carolina, Spotted Seatrout are more likely to experience population-level impacts from cold stun events. Spotted seatrout are a subtropical fish species, with North Carolina being one of the northernmost points of their range. Consequently, Spotted Seatrout are not as well adapted as other species to withstand winters with below average temperatures and winter storms that occur every few years. In addition, Spotted Seatrout in North Carolina overwinter in shallow estuarine creeks and bays which makes them more susceptible to being stunned or dying compared to other species that overwinter offshore, like weakfish, adult Red Drum, and mature southern flounder (Ellis 2014; Ellis et al. 2017b; McGrath and Hilton 2017; Bacheler et al. 2009; Krause et al. 2020). By overwintering in shallow creeks and bays, Spotted Seatrout have an increased risk of exposure to rapid declines in water temperature, usually due to runoff following snow or ice melt from a winter storm. Spotted seatrout can also become trapped in estuarine creeks due to rapid water temperature drops making escape difficult and mortality likely.

North Carolina Cold Stun Response

In 2015, the NCDMF started a comprehensive, statewide water quality monitoring program (Program 909) and deployed an array of continuous water temperature loggers. A total of 80 loggers at 55 stations measure the water temperature every 15 minutes. Station locations are distributed throughout coastal North Carolina with specific locations that staff determined were either representative of the riverine and estuarine systems they were in and-or locations of historic cold stuns (Figure 4.1). At depths greater than 2 meters, two loggers were placed to monitor temperatures at the surface and bottom to help managers identify water column stratification and turnover events.

Combining known Spotted Seatrout temperature tolerances and available water temperature data allows for more quantitative information that can be used in determining the necessity of a potential fishery closure. Quantitative temperature triggers that incorporate estimated probabilities of mortality could inform Spotted Seatrout fishery closure decisions.

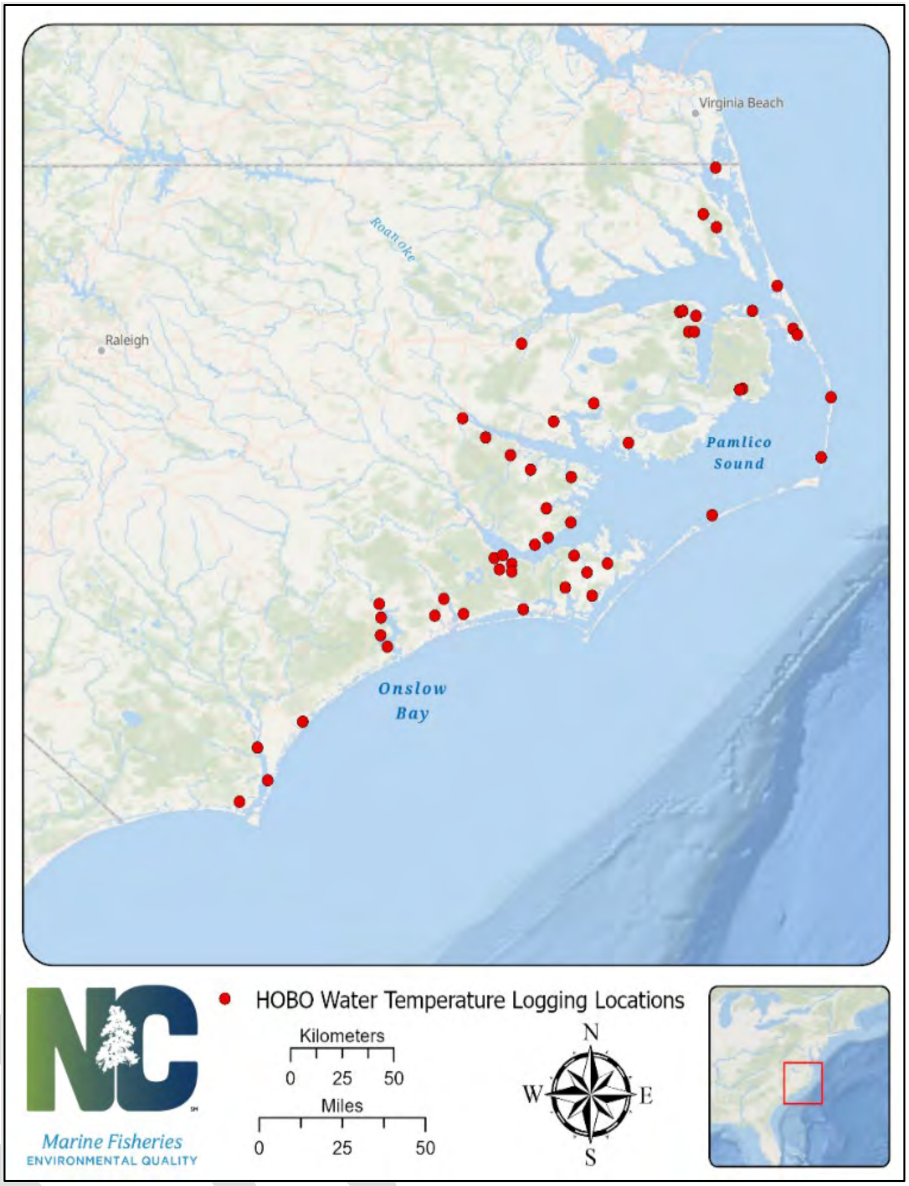

Figure 4.1. Locations of NCDMF water temperature loggers in coastal North Carolina.

Mortality due to cold stuns is recognized in the 2012 Spotted Seatrout Fishery Management Plan (FMP) as a factor impacting the abundance of Spotted Seatrout in North Carolina (NCDMF 2012). At their February 2012 business meeting, the Marine Fisheries Commission (MFC) directed the division to remain status quo regarding Spotted Seatrout management, with the assumption that in the event of a "catastrophic" cold stun the director would use proclamation authority to enact a temporary closure (NCDMF 2012). The objective of a Spotted Seatrout fishery closure after a cold stun event is to allow surviving fish an opportunity to spawn during their spring spawning season, potentially increasing recruitment the following year.

Spotted seatrout have a long history of cold stuns and winter mortality in North Carolina. Spotted seatrout cold stuns have been recorded in North Carolina as far back as over

300 years, and have occurred as recently as the winters of 2000, 2002, 2004, 2009, 2010, 2013, 2014, 2017, and 2022.

AUTHORITY

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
15A NCAC 03H .0103 PROCLAMATIONS, GENERAL
15A NCAC 03M .0512 COMPLIANCE WITH FISHERY MANAGEMENT PLANS
15A NCAC 03M .0522 SPOTTED SEATROUT

DISCUSSION

Several management strategies can be used to further protect Spotted Seatrout SSB after periodic cold stun events. These strategies may include temporary slot limits, fishery closures, spatial (area) closures, or some combination of these options. Management strategies also include the need for the use of adaptive management. Given the inherent difficulty in quantifying the severity of cold stun events as they occur, subsequent management strategies also lack precise quantification methods to determine effectiveness. The proposed management strategies are therefore grounded in a pragmatic, common-sense approach to protect SSB.

Seasonal Closures

The spawning season for Spotted Seatrout varies by location (Brown-Peterson et al., 2002; Nieland et al., 2002; Roumillat & Brouwer, 2004) and can occur with one or two peaks in spawning activity. In North Carolina, Spotted Seatrout have a protracted spawning season, usually lasting from April to October (Burns, 1996). Larger and older females are more developed at the beginning of the spawning season, will spawn sooner than smaller fish, and will spawn for a more protracted season. Smaller fish, that are virgin spawners at the beginning of the season, might enter the spawning stock and spawn later in the year through October.

Following a significant cold stun event, the Spotted Seatrout fishery has historically been closed until June 15th. North Carolina Spotted Seatrout have been observed to have a peak in spawning activity in May and June (Burns, 1996), with some individuals spawning later into the fall months. The option to maintain the status quo would continue to close the fishery until June 15th after a significant cold stun event. However, extending the standard closure to June 30th may ensure that more of the spawning peak is protected and would likely allow most of the larger, older fish to spawn at least once before the chance of significant harvest. Another option would be to extend the standard closure until October 15th, ensuring most surviving fish have the opportunity to spawn during the entire spawning season, but this would result in less fishing opportunities for anglers and likely have a diminishing return for the stock over protection during the peak spawn.

Size Limits

Size and slot limits are a common management strategy to limit harvest of specific size and-or age classes of fish in a stock. By setting a minimum size limit based on length at maturity, management can ensure a portion of the females in the stock have a chance to spawn at least once before harvest. The upper bound of a slot limit likewise helps protect larger females which have a greater reproductive capacity, meaning they can produce more eggs. Estimates of Spotted Seatrout fecundity range from 3 to 20 million eggs per year depending on age, length, and water temperature (Lowerre-Barbieri et al., 2009; Nieland et al., 2002; Roumillat & Brouwer, 2004). Spotted seatrout are batch spawners, meaning they can spawn multiple times in one season. The number of eggs produced within each batch also depends on age and length (Figure 4.2). Spotted seatrout fecundity estimates specific to North Carolina and Virginia are not available at this time.

Theoretically, the ability of the Spotted Seatrout stock to recover faster after significant cold stun event, would be enhanced if larger females are protected. For example, if a slot limit with a trophy fish allowance is adopted for sustainable harvest (Appendix 3, this amendment), the slot limit could be temporarily narrowed and-or the trophy fish allowance could be temporarily removed. Reducing or narrowing the slot limit following a closure, whether by increasing the lower bound or decreasing the upper bound, would ensure more mature fish are available to spawn. Because larger females are more fecund, it may be more important to focus on their protection after a cold stun event. This could be achieved by removing any prospective trophy fish allowance and-or by decreasing the upper bound of the slot limit in response to a severe cold stun event. This temporary slot limit could be put into place until after the peak spawning season (July) or until after most of the spawning season (October).

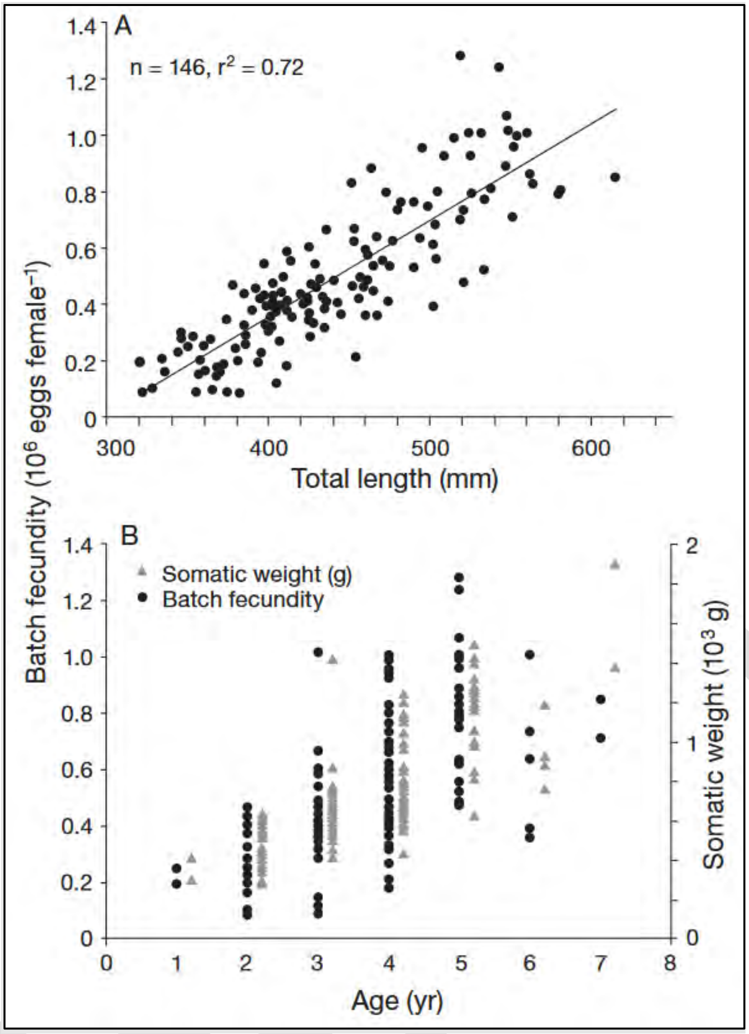

Figure 4.2. Taken from Lowerre-Barbieri et al. (Lowerre-Barbieri et al., 2009). Batch fecundity as it relates to size at age or Spotted Seatrout. (A) Batch fecundity to total length, with the predicted linear relationship, and (B) individual batch fecundities and somatic weights plotted by age.

Bag and Trip Limits

The current Spotted Seatrout daily recreational bag limit is 4 fish, and the daily commercial trip limit is 75 fish. In response to a severe cold stun, temporarily lowering these limits when harvest reopens could potentially reduce overall harvest. This approach aims to increase the Spotted Seatrout spawning stock biomass available through the end of the spawning season. The effectiveness of temporarily reducing bag and trip limits depends on the specific management measures adopted in Amendment 1. For example, if management to extend the cold stun closure through the majority of Spotted Seatrout spawning season is adopted in this Amendment (Appendix 4: Options 1.b or 1.c), temporarily reducing bag and trip limits would likely be less effective in rebuilding the stock as the majority of spawning would occur prior to harvest reopening and a portion of harvest reduced by temporary reductions would likely be recouped prior to the next spawning season. Most recreational and commercial fishers do not harvest their daily bag or trip limit (see Appendix 2) so a modest temporary reduction of bag and trip limits likely would not impact overall harvest. To achieve a reduction in harvest, the temporary reduction in bag and trip limits may need to be more substantial.

Temporary adjustments to bag and trip limits may not be the most effective strategy when applied solely as part of the standard cold stun closure. Instead, they are likely to be more impactful when integrated into an adaptive management framework used in the event of an especially severe cold stun. The adaptive management framework would allow for a more tailored response to address specific conditions that may arise in the event of a severe cold stun.

Area Closures

Historically, cold stun events have varied in their spatial impacts and have ranged from a few isolated creeks in one river system to multiple riverine and estuarine systems. Cold stun events can also occur over large areas of the state, causing more significant losses in all major systems.

Previous cold stun closures have closed the Spotted Seatrout fishery statewide. Tagging and genetics data suggest that Spotted Seatrout exhibit high site fidelity to their natal estuary with periods of greater movement during the spawning season (Ellis, 2014; O’Donnell et al., 2014; Ward et al., 2007). This, coupled with limited movement in the winter months, supports the idea that effects of a cold stun may vary regionally. Using available information about Spotted Seatrout temperature tolerances, mortality probabilities to sub-optimal temperature exposure, and available continuous water temperature monitoring, the division could potentially identify areas of concern when freezing temperatures are predicted to occur. However, the division does not have the ability to quantify or predict the severity of a cold stun event so selecting specific areas for closures would be difficult and may minimize the overall desired impact of maximizing spawning potential following a significant cold stun event.

A statewide closure encompasses all estuarine and riverine systems where Spotted Seatrout overwinter, protecting all Spotted Seatrout in North Carolina from fishing pressure. This ensures areas without documented kills or continuous water temperature monitoring are still protected and that remaining Spotted Seatrout will have the opportunity to spawn before being subject to harvest. However, this strategy will cause fishing opportunities to be lost in areas that may not be affected by cold stun conditions. However, a tradeoff would be that a statewide closure protects fish that may migrate into open areas during more active movement periods during the onset of the spawning period. A statewide closure will also aide Marine Patrol in enforcement of the closure and not burden fisherman with changing boundaries. Further, Spotted Seatrout are assessed and managed as a single stock in North Carolina. Simply closing a small area or region where a cold stun is observed will shift effort to surviving portions of the stock and potentially amplify the negative effects of a cold stun event.

Adaptive Management

The current adaptive management framework for cold stun events allows the Director to close the Spotted Seatrout fishery through June 15th following a significant cold stun event. Since the adoption of the original FMP in 2012 the Spotted Seatrout fishery has been closed twice due to cold stun events (2014 and 2018). The adaptive management framework for cold stun event closures can be refined to further aid in stock recovery following a cold stun event. Adaptive management may be used to temporarily adjust management measures such as size or slot limits, season closures, trip limits, bag limits, and gear requirements if it is determined that additional protections for the stock are needed after a significant cold stun event. Management needed will take into consideration factors such as the size and scope of the cold stun event, the rate of air and water temperature change, and the length of exposure to extreme temperatures. Below is an example of a revised adaptive management framework for cold stun events for consideration.

1) If a significant cold stun event occurs the Director will close the Spotted Seatrout fishery statewide through the date adopted in this amendment.
2) Temporary measures that may be implemented through adaptive management to aid in stock recovery after the standard closure period following a cold stun event include:
    a. recreational bag limit
    b. commercial trip limit
    c. size limit changes
    d. seasonal closure
    e. gill net yardage restrictions
    f. Use of adaptive management to further aid in stock recovery once the fishery reopens following a cold stun event is contingent on approval by the Marine Fisheries Commission.

MANAGEMENT OPTIONS

Table 4.1. Cold stun management options for the Spotted Seatrout fishery. Options would likely provide benefits to the stock but are not able to be quantified.

Topic	Option	Description
Season closure	1.a	Status quo – fishery closed until June 15th following a cold stun
	1.b	Extend fishery closure until June 30th following a cold stun
	1.c	Extend fishery closure until October 15th following a cold stun
Size limits	2.a	Status quo – no size limit change following a cold stun
	2.b	Temporary adjustment of size and or slot limits following a cold stun
Bag and trip limits	3.a	Status quo – no bag/trip limit changes
	3.b	Temporary adjustment of bag and trip limits following a cold stun
Adaptive management	4	

RECOMMENDATIONS

DMF Initial Recommendation:

Option 1.b Extend fishery closure until June 30th following a cold stun

Option 4 Adaptive management

Appendix 5: SPOTTED SEATROUT MANAGEMENT AND STOCK STATUS IN OTHER STATES

Table 5.1 Spotted Seatrout recreational regulations on the Atlantic coast and Gulf of Mexico coast by state as of March 2023. In Florida, Spotted Seatrout are managed separately across five Management Regions (Northeast, Central East, South, Big Bend, and Western Panhandle).

State	Size Limit	Daily Bag Limit	Season	Supplemental Management
VA	14”-24” one >24”	5 fish	Open year round	
SC	14”	10 fish	Open year round	Hook/line & gig only
GA	14”	15 fish	Open year round	
FL				No captain/crew allowance, no trebles w/ live/natural bait
Northeast	15”-19” one >19”	5 fish	Open year round	
Central East	15”-19” one >19”	2 fish	Closed Nov 1-Dec 31	
South	15”-19” one >19”	3 fish	Open year round	
Big Bend	15”-19” one >19”	5 fish	Open year round	
W. Panhandle	15”-19” one >19”	3 fish	Closed Feb	
AL	15”-22” one >22”	6 fish	Open year round	
MS	15”	15 fish	Open year round	
LA	12”-20” two >20”	15 fish	Open year round	No captain/crew allowance
TX	15”-20” one >30”	3 fish	Open year round	

Table 5.2 Spotted Seatrout commercial regulations on the Atlantic coast and Gulf of Mexico coast by state as of March 2023. In Florida, Spotted Seatrout are managed separately across five Management Regions (Northeast, Central East, South, Big Bend, and Western Panhandle).

State	Size Limit	Commercial Trip Limit/Quota	Season	Supplemental Management
VA	14”	51,104 lb annual quota	Sep 1-Aug 31 of following year	A daily incidental catch limit of 50 pounds per licensee aboard a vessel with a max limit of 100 pounds per vessel takes effect once the annual quota is caught.
SC	NA	NA	NA	Closed to commercial harvest
GA	14”	15 fish	Open year round	
FL				
Northeast	15”-24”	50 fish	Open Jun 1-Nov 30	Hook/line or cast net only
Central East	15”-24”	50 fish	Open May 1-Sep 30	Hook/line or cast net only
South	15”-24”	50 fish	Open Jun 1 – Oct 31	Hook/line or cast net only
Big Bend	15”-24”	50 fish	Open Jun 1 – Oct 31	Hook/line or cast net only
W. Panhandle	15”-24”	50 fish	Open Jun 1 – Oct 31	Hook/line or cast net only
AL	NA	NA	NA	Closed to commercial harvest
MS	15”	50,000 lb annual quota	Open year round until quota is met	
LA	14”	15	Jan 2-Dec 31 or until quota is met	No harvest on weekends, hook/line only
TX	NA	NA	NA	Closed to commercial harvest

Table 5.3 The stock status of Spotted Seatrout on the Atlantic coast and Gulf of Mexico coast by state as of March 2023. Not all states manage their Spotted Seatrout stock using stock assessments, therefore a stock status is not available for all states. In FL Spotted Seatrout stocks are assessed separately across five Management Regions (Northeast, Central East, South, Big Bend, and Western Panhandle).

State	Stock Assessment – Year	Stock Status
VA	Yes - 2020	Overfishing occurring, not overfished
SC	No	Unknown
GA	No	Unknown
FL	Yes - 2017	
Northeast		Overfishing occurring, overfished status unclear
Central East		Overfishing occurring, overfished status unclear
South		Not overfishing, not overfished
Big Bend		Overfishing occurring, overfished status unclear
W. Panhandle		Overfishing occurring, overfished status unclear
AL	Yes - 2017	At 20% SPR: overfishing occurring, not overfished At 30% SPR: overfishing occurring, stock overfished
MS	Yes – 2019	Overfishing status unclear, stock overfished
LA	Yes - 2021	Overfishing occurring, stock overfished
TX	No	Stock status unknown but independent sampling indicates depleted stock

Appendix 6: RESEARCH RECOMMENDATIONS

1. Develop a juvenile abundance index to gain a better understanding of a stock recruitment relationship.
2. Research the feasibility of including measures of temperature or salinity into the stock recruitment relationship.
3. Determine batch fecundity estimates for North Carolina Spotted Seatrout.
4. Size specific fecundity estimates for North Carolina Spotted Seatrout.
5. Investigation of the relationship of temperature with both adult and juvenile mortality.
6. Incorporate cold stun event information into the modeling of the population.
7. Estimate or develop a model to predict the impact of cold stun events on local and statewide Spotted Seatrout abundance.
8. Integrate tagging data into stock assessment model so both tagging data and other data sources can work together to give a better picture of the population.
9. Obtain samples (length, age, weight, quantification) of the cold stun events as they occur.
10. Define overwintering habitat requirements of Spotted Seatrout.
11. Determine factors that are most likely to influence the severity of cold stun events in North Carolina and separate into low and high salinity areas.
12. Investigate the distribution of Spotted Seatrout in nursery and non-nursery areas.
13. Further research on the possible influences of salinity on release mortality of Spotted Seatrout.
14. Survey of fishing effort in creeks with conflict complaints.
15. Determine targeted species in nursery areas and creeks with conflict complaints.
16. Microchemistry, genetic, or tagging studies are needed to verify migration patterns, mixing rates, or origins of Spotted Seatrout between North Carolina and Virginia.
17. Tagging studies to verify estimates of natural and fishing mortality.
18. Tagging studies to determine if there are localized populations within the state of North Carolina (e.g., a southern and northern stock).
19. A longer time series and additional sources of fishery-independent information.

20. Increased observer coverage in a variety of commercial fisheries over a wider area.

21. Expand nursery sampling to include SAV bed sampling in high and low salinity areas during the months of July through September.

22. Evaluate the role of shell hash and shell bottom in Spotted Seatrout recruitment and survival, particularly where SAV is absent.

23. Evaluate the role of SAV in the spawning success of Spotted Seatrout.

24. Develop estimates of commercial discards for runaround nets.

25. Conduct a detailed analysis of the existing Program 915 data to determine the extent to which late fall and spring provide insights into overwinter changes in abundance; this analysis could also provide insights into the magnitude of cold-stun events, which could explain differences in the effects observed in tagging and telemetry studies versus survey and fishery monitoring.

26. Improve estimates of recreational discard mortality.

Appendix 7: SPOTTED SEATROUT FISHERY MANAGEMENT PLAN ADVISORY COMMITTEE WORKSHOP SUMMARY

ISSUE

Summarize input received from stakeholders from Spotted Seatrout Fishery Management Plan Advisory Committee Workshop.

ORIGINATION

The North Carolina Division of Marine Fisheries (DMF).

BACKGROUND

The Spotted Seatrout Fishery Management Plan (FMP) Advisory Committee (AC) met for a three-day workshop April 22, 23, and 24 at the N.C. Cooperative Extension – Craven County Center in New Bern. The purpose of the workshop was for the AC to assist DMF staff in evaluating management issues and options included in draft Amendment 1 to the Spotted Seatrout FMP and informing the public on the issues contained in draft Amendment 1, solicit comments from peers and bring comments back to the AC, and evaluate the impacts of management options on the resource and user groups. It is important to note the purpose of the AC Workshop was to receive input from committee members based on their various experiences, expertise, and sector relationships, not to build a consensus among committee members or to recommended specific management strategies.

Division staff presented overviews of the stock assessment, life history, and fishery characterization portions of draft Amendment 1, including the Small Mesh Gill Net Information Paper and the Cold Stun Management, Sustainable Harvest, and Supplemental Management issue papers. Each presentation was followed by an opportunity for the AC to ask clarifying questions and discuss the content and management options included in each paper or section of draft Amendment 1. The AC did not have any suggestions regarding the content or clarity of the informational sections of draft Amendment 1. A summary of the management options and ideas discussed for information and issue papers in draft Amendment 1 are included below. Discussion points are organized by information and issue paper and topic. These points represent the discussion that occurred and the management options or combinations of options the AC suggested the division explore. Division staff explored these options and incorporated them directly into the relevant information and issue paper as appropriate.

DISCUSSION

Small-Mesh Gill-Net Fishery

The AC suggested looking at the data further to see if there is a mesh size(s) that might work with a slot limit in the gill-net fishery. The AC also suggested adding a research recommendation to look at discard mortality from runaround gill nets and other commercial gears.

Sustainable Harvest

Generally, the AC asked the division to prioritize access to the fishery when considering management measures and preferred raising the minimum size limit to reducing the bag/trip limit and season closures. The AC asked the division to consider a 15” or 16” to 20” slot limit, with or without a trophy fish allowance. There was discussion about implementing a commercial harvest cap either at 350,000 or 600,000 lb, similar to how the commercial Red Drum fishery is managed. If a season closure is considered by the division, the AC wanted it to be as short as possible and to consider the number of trips affected by a season closure. The AC gave some ideas for possible winter and spawning season closure options and urged for any closure to be less than 90 days. The AC suggested the division consider several combination options that included raising the minimum size limit, with and without a slot, paired with either a season closure or reducing the bag limit. The AC advised there is a need to build adaptive management into the FMP related to sustainable harvest.

Supplemental Management

The AC did not like the idea of a vessel limit for Spotted Seatrout. AC members relayed there was some support among charter captains to remove the captain and crew limit for Spotted Seatrout but not for species with lower bag limits (e.g., Red Drum, southern flounder).

The AC discussed the possibility of a commercial hook-and-line fishery. Discussion largely centered on the need to limit participation (e.g., exclude recreational fishermen with commercial licenses, commercial fishermen with no history of harvesting Spotted Seatrout) and the need for commercial license reforms prior to allowing a fishery. There was discussion concerning whether the fishery should be allowed with or without gill nets as an allowable gear. They also noted that further outreach and feedback is needed from the public prior to allowing a commercial hook-and-line fishery.

The AC discussed gear requirements in the Spotted Seatrout recreational fishery. Discussion included requiring circle hooks when using natural bait, prohibiting the use of treble hooks when using natural bait, and prohibiting treble hooks on artificial lures. The AC advised that increased outreach regarding ethical angling practices will be needed before any gear changes are required.

The AC brought up the issue of live release fishing tournaments and their potential impact on Spotted Seatrout, particularly the perceived increase in the number of tournaments. There was discussion concerning recent research suggesting the mortality of Spotted Seatrout from live release tournaments is roughly three times higher than recreational release mortality. The AC advised that more information needs to be collected from fishing tournaments.

Cold Stun Management Issue Paper

The AC was receptive to extending the standard cold stun closure period through June 30 (inclusive). The AC did not like the idea of instituting size limit restrictions as part of the standard cold stun management response. Instead, the AC preferred to use adaptive management to implement additional temporary management measures (e.g., size limit, bag limit, trip limit, closed season), with a defined end date, based on the severity of a cold stun. There was a general preference for reducing the bag/trip limit instead of extending the season closure beyond the standard cold stun closure period.

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ROY COOPER
Governor
ELIZABETH S. BISER
Secretary
KATHY B. RAWLS
Director

August 7, 2024

MEMORANDUM

TO:	N.C. Marine Fisheries Commission
FROM:	Anne Markwith and Holly White, southern flounder co-leads, and Tina Moore, southern flounder mentor
SUBJECT:	Results of 2024 Update to the Stock Assessment of Southern Flounder in the South Atlantic and 2023 Landings

Issue

Review the results of the 2024 Update to the Stock Assessment of Southern Flounder in the South Atlantic with the Marine Fisheries Commission (MFC). Update the MFC on the finalized 2023 southern flounder recreational and commercial landings for North Carolina.

Action Needed

For informational purposes only, **no action is needed at this time**.

Supporting Documents

- Stock Assessment of Southern Flounder in the South Atlantic, 1989–2022

Overview

This memo provides an overview of **the results of the 2024 update to the Stock Assessment of Southern Flounder in the South Atlantic**, as well as the **finalized 2023 landings for southern flounder in North Carolina.**

2024 Stock Assessment Update Results

An update to the 2018 benchmark stock assessment for Southern Flounder in the South Atlantic was completed February 2024. This is the second update to the benchmark assessment, with the first update completed in 2019. The update included data from 1989 to 2022, adding 5 years of data to the 2019 update and 7 years to the 2018 benchmark. The assessment covers the Southern Flounder stock from the east coast of Florida through North Carolina. All data sources were updated, including commercial landings and discards (combined), recreational landings and discards (combined), shrimp trawl bycatch, and eight fishery-independent indices.

A few small deviations to the benchmark assessment were needed to improve fit and diagnostics of the model. Deviations included the exclusion of strata in the SEAMAP index not sampled due to the COVID pandemic and changes to catchability, initial recruitment, and population estimates. These changes did not adjust the stock status determination by the model but did improve the diagnostics and overall fit of the model.

The South Atlantic stock of Southern Flounder is overfished and experiencing overfishing. The stock assessment update of Southern Flounder estimated fishing mortality in 2022 at 0.68, higher than the fishing mortality target ($F_{35\%}$) of 0.38 and the fishing mortality threshold ($F_{25\%}$) of 0.57. Fishing mortality was drastically reduced in the last two years of the model, but not enough to end overfishing (Figure 1). The probability of the stock experiencing overfishing was 63.4%.

The spawning stock biomass of Southern Flounder was estimated to be 1,019 mt in 2022, a slight increase over the all-time low of 827 mt in 2021 (Figure 2). The stock is below the estimated threshold ($SSB_{25\%}$) of 4,092 mt and the estimated target ($SSB_{35\%}$) of 5,689 mt. The probability of the stock being overfished was 100%.

Commercial and recreational catch have decreased in recent years (Figure 3) due to restrictions in place for bag and trip limits coast-wide and quotas in North Carolina. However, many indices still show declines in relative abundance while others show no pattern of decline or increase (Figure 4). Poor levels of recruitment are still observed for Southern Flounder, and most of the landings are comprised of smaller, younger fish.

The intent of the 2024 update to the Southern Flounder model was to gauge the effectiveness of management on the status of the stock, particularly since North Carolina implemented strict management strategies to recover the stock. However, determining the effectiveness of management for any one state in a coast-wide stock is not possible with the current model design. An additional limitation with this assessment update is these management strategies have not been implemented long enough to capture whether the management will be effective in rebounding the spawning stock biomass of southern flounder. Due to these limitations, this model should not be used to inform management.

The results of the assessment were presented to the cooperating state partners at the end of April 2024, and it was agreed that a new benchmark assessment is needed. To allow enough time under current management strategies in North Carolina, as well as in the other states, there was general consensus that the earliest terminal year for the new benchmark should be 2026. This would provide four more years of data that would account for one full generation of the species.

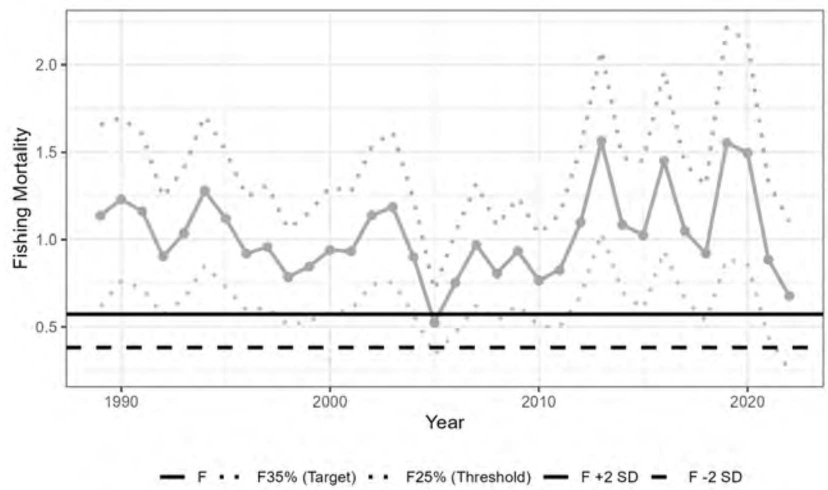

Figure 1. Estimated fishing mortality rates (numbers-weighted, ages 2–4) compared to established reference points, 1989–2022.

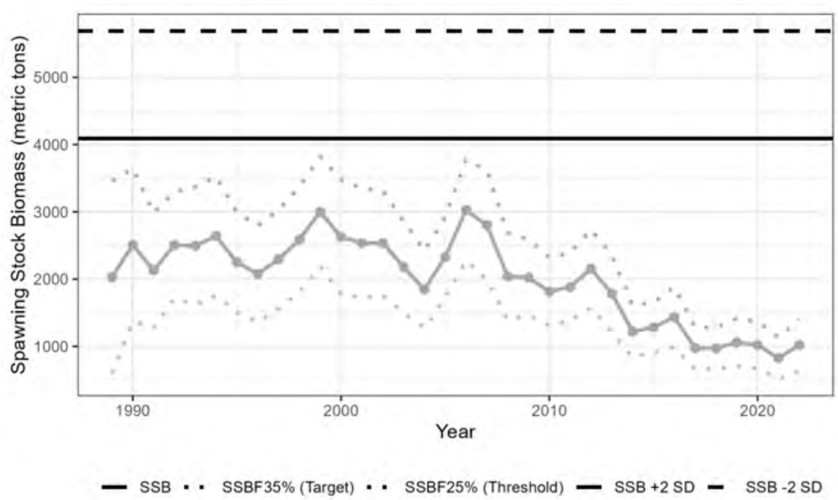

Figure 2. Estimated spawning stock biomass compared to established reference points, 1989–2022.

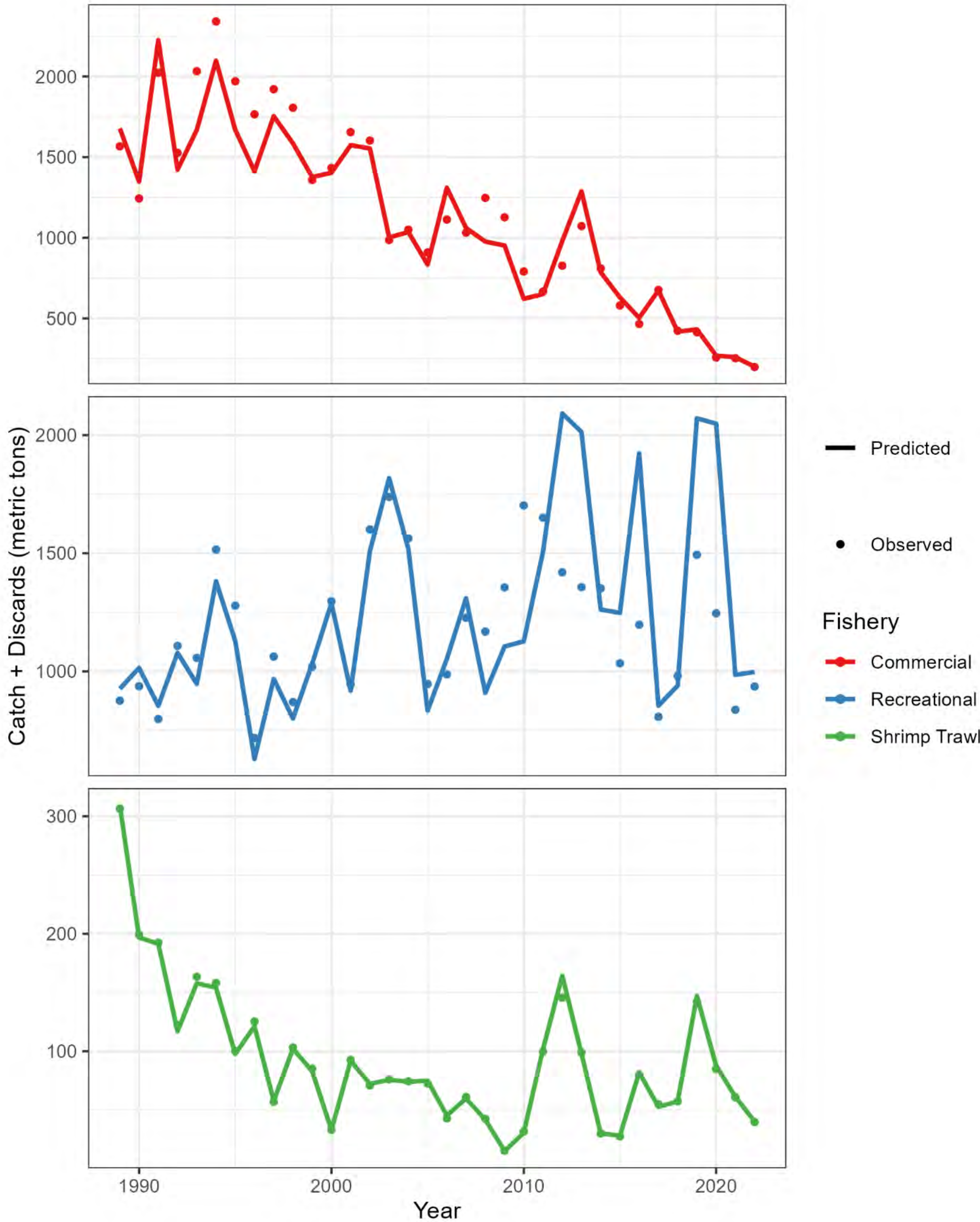

Figure 3. Observed and predicted catch and discards from the commercial fishery, recreational fishery, and shrimp trawl bycatch for the base run of the ASAP model, 1989-2022.

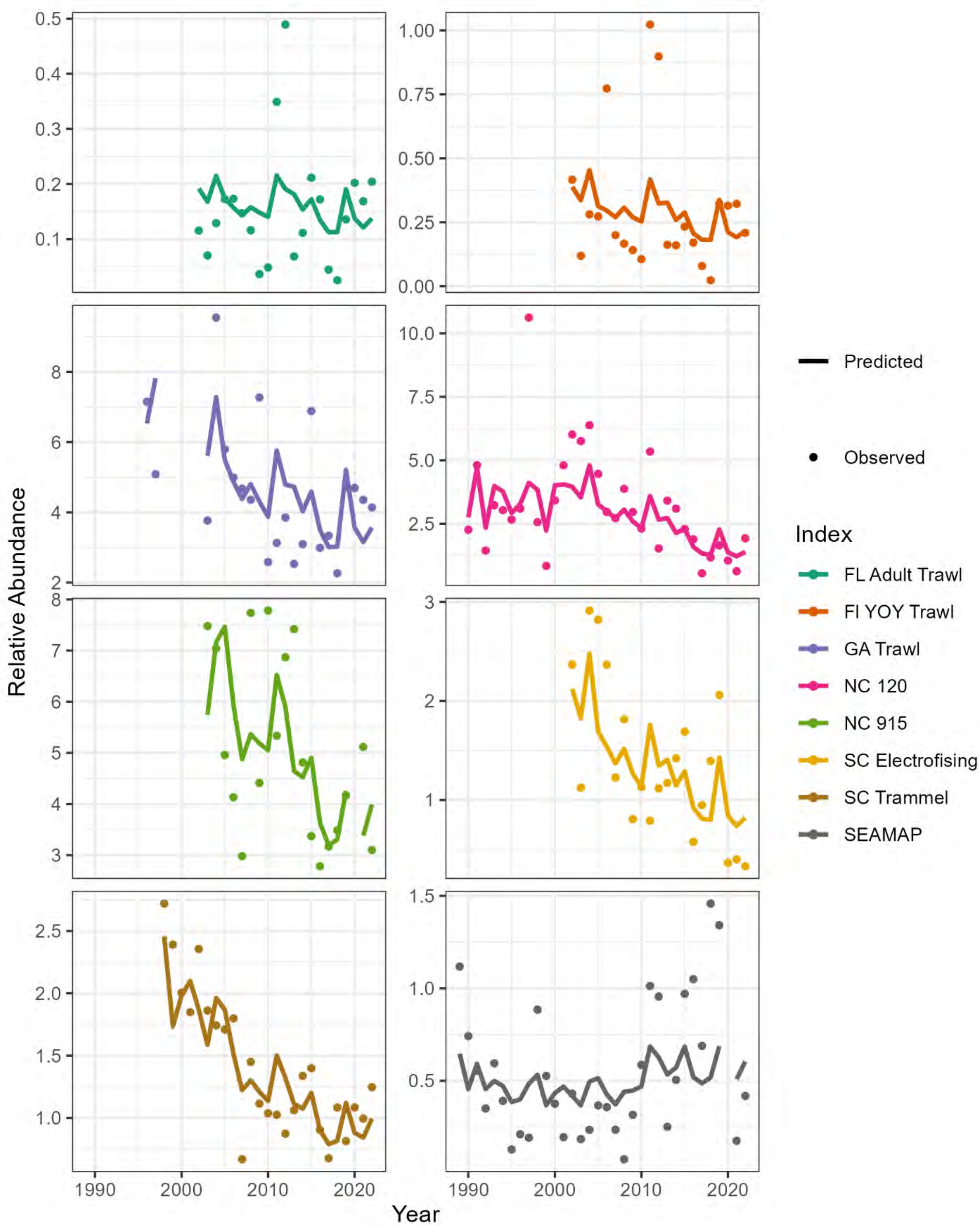

Figure 4. Observed and predicted relative abundance for the fishery-dependent indices from the base run of the ASAP model, 1989-2022.

2023 Southern Flounder Landings
For 2023 and 2024, the commercial fishery was allocated 70% of the overall total allowable catch (TAC), and the recreational fishery was allocated 30% of the TAC. Per Amendment 3, this will shift to a 60% commercial and 40% recreational split in 2025, with 50:50 parity occurring in 2026.

Recreational fishery

- Harvest and discards in 2022 exceeded the recreational TAC requiring a reduction in the 2023 TAC (Table 1).
- Harvest and discards in 2023 exceeded the adjusted recreational TAC by 127,294 pounds.
- After applying pound for pound paybacks, the 2024 quota accounted for the anticipated dead discards from incidental catch and release. There is not enough quota remaining to open the recreational fishery in 2024.

Table 1. Recreational Southern Flounder landings and discards (in pounds) with adjustments for overages for 2022–2024.

Year	Amendment 3 TAC	Adjusted TAC	MRIP Landing	Gig Landings	Total Landings	MRIP Dead Discard	Gig Dead Discard	Total Dead Discard	Total Catch	Overage deducted from next year's TAC
2022	170,655	170,655	166,091	7,882	173,973	52,771	251	53,022	226,995	56,340
2023	170,655	114,315	192,168	*7,882**	200,050	41,308	*251**	41,559	241,609	127,294
2024	**170,655**	**43,361**	TBD							

*Estimated value from previous year

Commercial fishery

- Harvest and discards in 2023 exceeded the overall commercial TAC by 5,550 pounds (Table 2). Adjustments to the TAC and total allowable landings (TAL) are required for the commercial fishery in 2024.
- The northern and central pound net management areas exceeded their quotas, as did the southern mobile gear management area. Paybacks will be applied to these gear management areas (Table 2).
    - The total of the individual gear-area combination overages for northern and central pound nets and southern mobile gears was used to determine the percent contribution of each gear management area to the overall commercial overage in 2023. The central pound net accounted for 69%, northern pound net 7%, and southern mobile 24%.

Table 2. Commercial Southern Flounder TAL and TAC (landings and dead discards), for each Southern Flounder management gear and area, 2023, with adjustments for overages, 2024. Bolded values indicate gear/area overage to TAC.

		2023					2024		
Gear	Area	Allowable Landings	Allowable Catch	Actual Landings*	Dead Discards Gill Net	Actual Catch	Required Paybacks	Allowable Landings	Allowable Catch
Mobile	Northern	123,879	127,028	118,680	4,590	123,270		123,879	127,028
	Southern	62,309	63,893	65,435	2,308	**67,743**	**1,326**	60,983	62,567
Pound Net	Northern	39,700	39,700	40,904		**40,904**	**414**	39,286	39,286
	Central	121,756	121,756	132,826		**132,826**	**3,811**	117,945	117,945
	Southern	25,002	25,002	18,187		18,187		25,002	25,002
	Total	372,646	377,379	376,032		**382,930**	**5,551**	**367,095**	**371,828**

*As of August 6, 2024

Stock Assessment of Southern Flounder (*Paralichthys lethostigma*) in the South Atlantic, 1989–2022

C.J. Carroll Schlick, L.M. Lee, S.D. Allen, A.L. Markwith, and H. White (editors)

May 2024

NCDMF SAP-SAR-2024-01

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We would also like to thank the members of the North Carolina Division of Marine Fisheries Plan Development Team for their review and comments.

[1]North Carolina Division of Marine Fisheries
[2] South Carolina Department of Natural Resources
[3] Georgia Department of Natural Resources, Coastal Resources Division
[4] Florida Fish and Wildlife Conservation Commission
[5] Atlantic States Marine Fisheries Commission

EXECUTIVE SUMMARY

The North Carolina Fisheries Reform Act requires fishery management plans be developed for the state's commercially and recreationally important species to ensure long-term viability of the fisheries. Stock assessments are the primary tools used by managers to assist in determining the status of stocks and developing appropriate management measures to ensure sustainability.

This report presents the stock assessment of Southern Flounder in the South Atlantic for the 1989 through 2022 time period. This stock assessment is the second update to the peer-reviewed and accepted 2018 benchmark stock assessment, first updated in 2019. The stock assessment incorporates data from North Carolina, South Carolina, Georgia, and the east coast of Florida. Data include landings and dead discards from the commercial fishery, recreational fishery, and commercial shrimp trawl fishery. Indices of recruitment and adult relative abundance derived from fisheries-independent surveys were also used. Biological data from all sources were included.

A forward-projecting, statistical catch-at-age model implemented in the Age Structured Assessment Program (ASAP) software was applied to the data to estimate population size, fishing mortality, and reference points. The 2024 update continued to show declining trends in spawning stock biomass (SSB) and recruitment since 2006, also seen in the 2018 benchmark and 2019 update; however, fishing mortality (F) has decreased significantly in the last two years of the assessment.

The fishing mortality (F) target was set at $F_{35\%}$ and the threshold was set at $F_{25\%}$. The stock size reference points are those values that correspond to the fishing mortality target and threshold. The stock size target is $SSB_{35\%}$ and the stock size threshold is $SSB_{25\%}$. The threshold reference points are compared to population estimates in the terminal year (2022) to determine stock status.

The fishing mortality reference points and the compared values of F represent numbers-weighted values for ages 2–4. The ASAP model estimated a value of 0.38 for $F_{35\%}$ (fishing mortality target) and a value of 0.57 for $F_{25\%}$ (fishing mortality threshold). The estimate of F in 2022 is 0.68, which is above the threshold ($F_{25\%}$ = 0.57) and indicates that overfishing is occurring. The probability that the 2022 fishing mortality is above the threshold value of 0.57 is 63.4%.

The SSB threshold and target ($SSB_{25\%}$ and $SSB_{35\%}$, respectively) were estimated using a projection-based approach implemented in the AgePro software. The estimate of $SSB_{35\%}$ (target) was 5,689 metric tons (mt) and the estimate of $SSB_{25\%}$ (threshold) was 4,092 mt. The ASAP model of SSB in 2022 was 1,019 mt, which is below the threshold and indicates the stock is currently overfished. The probability that the 2022 estimate of SSB is below the threshold value of 4,092 mt is 100%.

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1 INTRODUCTION

1.1 The Resource

The Southern Flounder, *Paralichthys lethostigma*, is a demersal species found in the Atlantic Ocean and Gulf of Mexico from northern Mexico to Virginia and is commonly referred to at the genus level (*Paralichthys* spp.) along with Summer Flounder, *P. dentatus*, and Gulf Flounder, *P. albigutta*. The species supports important commercial and recreational fisheries along the U.S. South Atlantic and Gulf coasts and is particularly important to fisheries in North Carolina, South Carolina, Georgia, and Florida.

The biological unit stock for Southern Flounder inhabiting southeast U.S. waters includes waters of North Carolina, South Carolina, Georgia, and the east coast of Florida 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 from North Carolina to Florida.

1.2 Life History

Female Southern Flounder can grow up to 91 cm total length (TL) and males can reach 52 cm TL. The oldest female was nine years old and 81 cm in TL, which is larger and longer than the oldest male aged six years old with a TL of 44 cm (Tables 1.1–1.4). An inverse weighted, least squares approach to the von Bertalanffy growth model was used on all Southern Flounder biological data (male, female, and unsexed) collected during the time series. Additional age-0 (Southern Flounder less than 10 cm) fish inferred from young-of-year (YOY) surveys were included in the model to provide a pooled von Bertalanffy growth model (Table 1.5; Figure 1.1). Similar to the benchmark assessment, an analysis of the residual sum of squares (ARSS) was used to test for differences in growth models between sexes, as well as between seasons (with season 1 defined as January to June and season 2 defined as July to December) for each sex. The ARSS revealed differences in the von Bertalanffy parameters for males and females (ARSS: F=19.2; df=44,558; p<0.001; Table 1.5; Figure 1.1). Additionally, seasonal differences in the von Bertalanffy growth model were significant for females (ARSS: F=4.6; df=33,656; p<0.001) and males (ARSS: F=4.101; df=6,206; p<0.001; Table 1.5).

The standard allometric length-weight model was used to estimate the weight (g) of fish at TL (mm) (Table 1.6; Figure 1.2). An ARSS analysis was completed to compare differences in the length-weight relationship between sexes and between seasons for each sex separately. Results from the ARSS analysis revealed differences in the length-weight relationship between sexes (ARSS: F=106.4; df=11,801; p<0.001) and among seasons for females (ARSS: F=113.9; df=9,951; p<0.001) and males (ARSS: F=28.3; df=1,882; p<0.001; Table 1.6).

Maturity at age was assumed to be the same as used in the 2019 update (Table 1.7). These percentages were based on data and methods outlined in Monaghan and Armstrong (2000), Midway and Scharf (2012), and Midway et al. (2013). Gonads used in the analysis were all collected in the fall months during spawning season (approximately 9–10 months into an age; Frederick Scharf, UNCS, personal communication). The maturity schedules were bumped by one year to account for late in the year spawning, as was done in the benchmark stock assessment in 2018 (Lee et al. 2018).

Natural mortality was estimated using the Lorenzen (1996) method that varied based on age with a maximum age of 9 years used (Table 1.8). Discard mortalities were assumed to be consistent with the benchmark and update assessments (Table 1.9) and were estimated from two previous studies (Montgomery, III 2000; Smith and Scharf 2011).

1.3 The Management

1.3.1 Management Unit Definition

The four states included in this assessment (North Carolina, South Carolina, Georgia, Florida) have management jurisdiction over their own state's waters, but there is currently no organization that coordinates the assessment and management of Southern Flounder at a multi-state scale. Given the biological stock occurs throughout the four states, this update assessment was completed with the collaboration of the four states to better understand the population as a whole stock.

1.4 Previous Assessment

The past two stock assessments of Southern Flounder in the South Atlantic were joint efforts among North Carolina, South Carolina, Georgia, and Florida, led by the North Carolina Division of Marine Fisheries (NCDMF). A benchmark stock assessment (i.e., peer-reviewed by an external panel of experts) was completed in 2018 (Lee et al. 2018) and was updated soon after in 2019 (see below; Flowers et al. 2019). The benchmark and first update were based on a forward-projecting, statistical catch-at-age model. The model was applied to data from three fishing fleets and eight fisheries-independent surveys. Both of these stock assessments concluded the stock was overfished and overfishing was occurring.

During the external peer review of the 2018 benchmark stock assessment, the external peer reviewers worked with the Southern Flounder Stock Assessment Working Group to develop a model the peer review panel endorsed for management use for at least the next five years (Lee et al. 2018). That endorsement was conditional on the basis that the model would be updated with data through 2017 to provide the best, most up-to-date estimate of stock status for management. That first update was completed in early 2019 (Flowers et al. 2019).

The current stock assessment update follows the methodology of both the 2018 benchmark stock assessment (Lee et al. 2018) and 2019 stock assessment update (Flowers et al. 2019). Any deviations from that methodology are noted in this report.

2 DATA

A complete and detailed description of the data sources used in the benchmark stock assessment can be found in Lee et al. (2018) and details of the previous update can be found in Flowers et al. (2019). Estimates of input values were developed following the same methodology as in the benchmark stock assessment and the previous update, unless otherwise noted.

The occurrence of Hurricane Florence in 2018 and COVID-19 pandemic in 2020–2021 caused disruptions to some of the fisheries-dependent monitoring and fisheries-independent survey programs. Any such disruptions are noted in the text below.

2.1 Fisheries-Dependent

2.1.1 Commercial Fishery Landings

2.1.1.1 Current Regulations Impacting Data Sources

A summary of the major regulations related to fisheries management of southern flounder can be found in Tables 1.10–1.12 in Lee et al. (2018). Changes that occurred between the benchmark and first update to the assessment, which include 2015 through 2017 regulations, are addressed in Flowers et al. (2019). No interruption to reporting of commercial landings or sampling of commercial landings occurred in any of the four states in 2020 or 2021 due to the COVID pandemic.

North Carolina

Current North Carolina commercial fishing regulations for Southern Flounder differ between internal and ocean waters. In internal waters, there is a 15-inch TL minimum size limit for Southern Flounder and a closed season that can only be opened by proclamation. Prior to 2019, regulations limited fishing for Southern Flounder in winter through a December 1 to December 30 closure and gear regulations that varied. More extensive season closures were enacted starting in 2019, and the season could only be opened in internal waters by proclamation. Open seasons occurred between September and November, and the timing and length of the season was dependent on which one of three new management areas was being fished. This changed again in 2022 when a quota was enacted for management. The quota is divided into two gear categories with the mobile gear fishery (all gears but pound nets) split further into two management areas and the pound net fishery split into three management areas. Strict gear restrictions continued to be applied and vary. There are no current trip limits in internal waters, but they can be implemented for pound nets, gigs, and hook and line.

For Southern Flounder targeted in ocean waters, a 14-inch TL minimum size limit and a 100-pound commercial trip limit are enforced, unless an individual has a specific license to land flounder from the Atlantic Ocean. Only trawl gear is allowed in the commercial ocean fishery for flounder.

South Carolina

South Carolina currently manages Southern Flounder through a 16-inch TL minimum size limit and 5 fish per person per day bag limit, not to exceed 10 fish per boat per day bag limit. These management measures were enacted in July of 2021.

Georgia

Fishing regulations in regard to Southern Flounder have not changed in Georgia since 1998, where they are regulated as an aggregate species group with the same management for the commercial and recreational fisheries. Regulations in Georgia include a 12-inch TL minimum size limit and a 15 fish per person per day bag limit.

Florida

Current commercial regulations in Florida require all flounder to be landed whole and be over a 14-inch TL minimum size limit with a maximum harvest of 150 per day from December 1 through October 14, with a reduction to 50 fish per day from October 15 through November 30. Additional bycatch limits are also set (68B-48.006(3), F.A.C.). These regulations were enacted in March 2021.

2.1.1.2 Data Sources

North Carolina

Prior to 1978, North Carolina's commercial landings data were collected by the National Marine Fisheries Service (NMFS). In 1978, the NCDMF entered a cooperative program with the NMFS to maintain and expand the voluntary monthly surveys of North Carolina's major commercial seafood dealers.

On January 1, 1994, the NCDMF initiated a Trip Ticket Program (NCTTP) to obtain complete and more accurate trip-level commercial landings statistics (Lupton and Phalen 1996). Trip ticket forms are used by state-licensed fish dealers to document all transfers of fish from coastal waters sold from the fishermen to the dealer. The data reported on these forms include start and transaction date, area fished, gear used, crew number, landed species and pounds, as well as fishermen and dealer information.

Reported flounder landings in North Carolina are not species specific. To obtain species-specific landings, the NCTTP assumes all flounder landed in estuarine waters are Southern Flounder and all flounder landed in ocean waters are Summer Flounder. Fisheries-dependent sampling of the commercial fisheries that target flounder support this assumption as Southern Flounder comprise more than 95% of all paralichthid flounders sampled from estuarine fisheries and summer flounder comprise approximately 99% of all paralichthid flounders sampled from ocean fisheries (NCDMF, unpublished data).

South Carolina

Commercial landings of Southern Flounder caught in South Carolina state waters must be sold through a licensed commercial dealer, who report landings to the South Carolina Department of Natural Resources (SCDNR). Landings of Southern Flounder caught in federal waters off South Carolina are reported through the Atlantic Coastal Cooperative Statistics Program (ACCSP).

Georgia

Prior to 1989, commercial landings data were collected by the NMFS from monthly dealer reports. The Georgia Department of Natural Resources, Coastal Resources Division (GADNR CRD) began collecting commercial landings in 1989 through monthly dealer reports and fish house visits. Data collected consisted of vessel number, unloading date, days fished, area fished, gear type, species, pounds, and ex-vessel value. In April of 1999, Georgia began their Trip Ticket Program. In order to be in compliance with the ACCSP, additional data categories including trip number, unit of measurement, market grade, quantity of gear, number of crew, fishing time, and number of sets were added (Julie Califf, GADNR CRD, personal communication). The Trip Ticket Program was fully implemented in January of 2000.

Florida

Prior to 1986, commercial landings data were collected by the NMFS from monthly dealer reports. The Florida Marine Information System or Trip Ticket (TTK) System began in 1984, which requires wholesale dealers to report each purchase of saltwater products from licensed commercial fishers monthly (weekly for quota-managed species; Chagaris et al. 2012).

The Florida Fish and Wildlife Conservation Commission (FLFWCC) Fisheries-Dependent Monitoring (FDM) program participates in the trip interview program (TIP), a cooperative effort with the NMFS Southeast Fisheries Science Center, in which field biologists visit docks and fish houses to conduct interviews with commercial fishers. The goal of TIP is to obtain representative samples from targeted fisheries on the level of individual fishing trips. Sampling priority is given to federally managed fisheries and their associated catches. Biologists collect data about the fishing trip such as landings and effort, as well as biological information such as length, weight, otoliths, and spines (for aging), and soft tissues for mercury testing and DNA analysis. These data provide estimates of the age distribution of the commercial landings and can be used to validate the landings, effort, and species identifications in the trip ticket data (Chagaris et al. 2012).

The commercial landings information from the NMFS includes data for the years 1950–1984 and the TTK system includes data for the years 1985–2022. Reported landings of flounder at the species level are available from 1991 and the proportion of species-level classification has increased through time.

Each trip ticket requires the following information: saltwater products license number of the fisher, dealer license number, unloading date, trip duration, county landed, number of sets, traps pulled, soak time, species code, weight of catch, and gear fished (beginning in 1990). Area fished, depth, unit price, and dollar value became mandatory fields in 1995 (Chagaris et al. 2012).

For more information on specific gears used in other states please refer to the benchmark stock assessment (Lee et al. 2018).

2.1.1.3 Development of Estimates

Commercial landings were pooled over the entire stock range, east coast of Florida to North Carolina, by year for 1989-2022.

Biological data were only available from commercial fisheries in North Carolina and Florida (Table 2.1). Length frequencies were developed separately for each state by season using the methods outlined in the 2019 update (Flowers et al. 2019), and then combined by year and season to represent the length distribution of Southern Flounder commercially landed in the South Atlantic. Seasonal port-release mortality rates of 0.12 for season 1 and 0.335 for season 2 were multiplied by the estimates of live commercial gill-net discards to capture the discards that did not survive capture, as outlined in the benchmark assessment and 2019 update (Lee et al. 2018; Flowers et al. 2019).

2.1.1.4 Estimates of Commercial Fishery Landings Statistics

Commercial landings averaged 1,173 mt from 1989 to 2022 with a decreasing trend throughout the time series (Table 2.2; Figure 2.1). Over the assessment period, the highest commercial landings occurred in 1994 with 2,355 mt and the lowest landings occurred in 2022 with 199 mt.

Annual length frequencies of Southern Flounder observed in the commercial landings did not demonstrate any changing trend throughout the time series (Figure 2.2); however, commercial landings were regulated with a minimum allowable size throughout most of the timeseries. The size limits increased throughout most of the stock range in later years of the time series (2017-2021, depending on the state).

2.1.2 Commercial Gill-Net Discards

2.1.2.1 Data Source

Data used to estimate gill-net discards for the commercial estuarine anchored gill-net fishery were obtained from the NCDMF's Onboard Observer Monitoring Program (NC466). This program did not operate from March 2020 through 2021 due to COVID-19 pandemic precautions. Lengths were available to calculate the length composition data for gill-net discards (Table 2.3).

2.1.2.2 Development of Estimates

Southern Flounder discards in the North Carolina estuarine anchored gill-net fishery were calculated using a GLM framework based on data collected from 2004 to 2022, similar to the 2018 benchmark and 2019 update. The same hindcast approach used in the 2018 benchmark and 2019 update was applied for all years prior to 2004 in this update. Due to sampling interruptions through the COVID-19 pandemic, discards were estimated for 2020 and 2021 based on the average discard catch from 2019 and 2022. The GLM framework was used to estimate live and dead discards separately. The variables considered in the model included year, season, and mesh category (small: <5 inches and large: ≥5 inches). Effort differing among sampling events was taken into consideration using an offset variable in the model and makes the assumption that discards are proportional to fishing effort (Crawley 2007; Zuur et al. 2009, 2012). As seen in the 2019 update, a score test confirmed the discard data were still zero-inflated, thus zero-inflated models were used. Both zero-altered and zero-inflated models were considered to determine the best fit.

2.1.2.3 Estimates of Commercial Gill-Net Discard Statistics

The best fit GLM for commercial gill-net live discards used a zero-inflated negative binomial distribution (dispersion=1.4) with covariates of year, season, area, and mesh size significant in the count and binary portions of the model. The best fit GLM for dead discards was a zero-inflated negative binomial distribution (dispersion=1.4), and significant covariates were year, season, area, and mesh within the count and binary portions of the model.

Commercial dead discards decreased (through 2021) from an all-time high of over 92,000 fish in 2008 (Table 2.2; Figure 2.3). In 2022, dead discards increased to over 10,000 fish, as compared to a low of roughly 6,800 fish in 2021; however, this was still lower than the assessment period annual average of over 38,000 Southern Flounder. The length frequencies of commercial dead discards did not change through the time series, other than to be more dispersed through the length bins (12–50 cm) rather than dominated by sizes in the 30–36 cm range (Figure 2.4).

Commercial live discards declined since 2008, when 110,530 fish were discarded, to a low in the timeseries of 11,840 in 2021 (Table 2.2; Figure 2.3).

2.1.3 Commercial Shrimp Trawl Bycatch

2.1.3.1 Data Source(s)

A voluntary shrimp trawl bycatch observer program was implemented in the South Atlantic (North Carolina–Florida) through a cooperative agreement between NOAA Fisheries, the Gulf and South Atlantic Fishery Management Councils, and the Gulf and South Atlantic Fisheries Foundation, Inc. to characterize catch, as well as evaluate bycatch reduction devices (BRDs). Total catch, total shrimp catch, and a subsample (one basket per net, or approximately 32 kg) for species composition is taken from each observed net. Beginning in 2008, the program became mandatory in the South Atlantic and NMFS-approved observers were placed on randomly selected shrimp vessels. The voluntary component of the observer program also continued. Penaeid shrimp (primarily inshore) and rock shrimp (primarily offshore) fisheries in the South Atlantic are covered by the observer program. The total number of trips are also reported.

Observer coverage is allocated by previous effort or shrimp landings when effort data are not available. Based on nominal industry sea days, observer coverage of South Atlantic shrimp trawl fisheries ranged from 0.2 to 1.4% and totaled 0.9% from 2007 to 2010 (see Table 1 in Scott-Denton et al. 2012). See Scott-Denton (2007) for more details on the voluntary component of the Shrimp Trawl Observer Program and Scott-Denton et al. (2012) for more details on the mandatory Shrimp Trawl Observer Program.

Due to the small sample size of lengths provided by the voluntary shrimp trawl observer program, data used to develop length frequencies of Southern Flounder captured as bycatch across all states were obtained from the NC Commercial Shrimp Trawl Characterization Study (NC570). The study included data collection on shrimp trawl vessels fishing in all state waters (inshore estuarine and nearshore ocean 0–3 miles). Though no longer active, the study occurred from 2007 to 2009 and from 2012 to 2017 (Table 2.4). Lengths from 2016 were applied to 2018–2022. Years with missing length estimates prior to 2018 were filled with data from available years using the same method applied in the last update (Flowers et al. 2019).

2.1.3.2 Development of Estimates

The bycatch rates of Southern Flounder from shrimp trawl fisheries (in numbers of fish) were modelled with a negative binomial GLM based on methods outlined in the 2018 update. Covariates considered in the model were year, data set, depth zone, state, and season. All data exclusions from the 2018 update were maintained in this update. Seasons were January through June (off season, season 1) and July through December (peak season, season 2). Depth zones were less than or equal to 30 meters (≤30m), 30 meters to 80 meters (30–80m), 80 meters to 150 meters (80–150m), and greater than 150 meters (>150m). Consistent with the benchmark, the season covariate was the only covariate excluded from the final model through stepwise AIC model selection.

In this assessment, there was a change to the measure of effort data used to extrapolate bycatch rates to total discards. Average hours fished per tow were calculated directly from the trip data set for this update and differ from the average hours fished per tow derived from commercial fishing reporting programs (i.e., Trip Ticket Programs) in past assessments (SEDARs) that were used in the benchmark (NMFS Sustainable Fisheries Branch 2012). The trip data set was only available back to 2001, so 2001–2003 average hours fished were used for years prior to 2001. Comparison of effort between assessments was examined before the new measure of effort was used and deemed appropriate (Figure 2.5). The updated analysis indicated higher effort, but a similar trend in the data was observed in the benchmark.

2.1.3.3 Estimates of Commercial Shrimp Trawl Bycatch Statistics

Estimates of Southern Flounder bycatch in the South Atlantic shrimp trawl fisheries have shown a general decline over time (Table 2.5; Figure 2.6). Since the last update, estimates did increase in 2019 but have since declined to the lowest value in the time series for 2022. Annual length frequencies of Southern Flounder bycatch observed in the shrimp trawl fishery show some variation in size from year to year with most occurring in the 30-cm length bin but proportions changing to more length bins in 2016 through 2022 (Figure 2.7). Please note that only four

Southern Flounder were captured in 2017; thus, these data were excluded from use in the length frequencies.

2.1.4 Recreational Hook-and-Line Catch

A summary of the major regulations related to fisheries management of southern flounder can be found in Tables 1.10–1.12 in Lee et al. (2018). Changes that occurred between the benchmark and first update to the assessment, which include 2015 through 2107 regulations, are addressed in Flowers et al. 2019.

2.1.4.1 Current Regulations Impacting Data Sources

North Carolina

Prior to 2019, the recreational fishery operated year round. Starting in 2019, closed seasons were implemented, and the seasons could only be opened by proclamation. The seasons varied in duration but occurred during a window from August 15 to September 30 each year; during these seasons there was a four fish per day bag limit and a 15-inch TL minimum size. Since 2022, North Carolina has regulated Southern Flounder recreational fishing through a quota, one fish per day bag limit, and a 15-inch TL minimum size limit. The season is only opened by proclamation and has varied in timing and duration. Southern Flounder can no longer be recreationally harvested under a Recreational Commercial Gear License (RCGL).

South Carolina

Current recreational regulations in South Carolina include a 16-inch TL minimum size limit for Southern Flounder, as well as a five fish per person bag limit not to exceed 10 fish per boat vessel limit. These regulations were enacted in July 2021.

Georgia

The state of Georgia has not changed any regulations regarding recreational flounder fishing since the last update. See section 2.1.1.1 for description of recreational harvest restrictions.

Florida

Recreational regulations in Florida include a 14-inch TL minimum size limit, five fish per person per day bag limit, and a season closure from October 15 through November 30 each year. These regulations were enacted in March 2021.

2.1.4.2 Data Source

MRIP Estimates

Data characterizing the recreational hook-and-line fishery for Southern Flounder were provided by the Marine Recreational Information Program (MRIP). No notable changes have been made to MRIP since the 2019 update.

Length data were available from the MRIP intercept survey, as well as the SCDNR Volunteer Angler Tagging Program to characterize the length composition of the recreational harvest and discards. The SCDNR Volunteer Angler Tagging Program has tagged Southern Flounder since 1981 with the help of volunteer anglers. The instructions given to anglers varied from year to year (Robert Wiggers, SCDNR, personal communication), as well as the number of participants in the program and the successful number of Southern Flounder tagged (Table 2.6; Table 2.7). Volunteer anglers would measure each tagged fish before release, which were used to calculate the length frequencies of the recreational discards.

Additional biological data were provided from multiple recreational carcass collection programs where recreational fishermen can donate their catch to each respective state for use in management, research, and stock assessments (Table 2.8).

2.1.4.3 Development of Estimates

The recreational hook-and-line estimates across all states were calculated based on the methods outlined in the 2018 update, using the updated MRIP procedures set forth in the 2012 MRFSS/MRIP calibration workshop (Salz et al. 2011).

The MRIP estimates were impacted by the COVID-19 pandemic due to lack of sampling in Wave 2 (March–April) and Wave 3 (May–June) of 2020. NOAA calculated the 2020 estimates using data from 2018 and 2019. Other Waves in 2020 and all of 2021, samples collected by MRIP were deemed sufficient to proceed as normal, with the exception of headboat sampling. Headboat sampling was suspended from March 2020 through 2021. Data from 2018 and 2019 were used by NOAA to fill headboat data gaps caused by the pandemic. Methods completed by state partners have not changed since the 2019 update.

2.1.4.4 Estimates of Recreational Hook-and-Line Catch Statistics

The recreational harvest of Southern Flounder was without trend through most of the time series with a low of 868,299 fish (2017) to a high of 2,003,753 fish (2003; Table 2.9; Figure 2.8). Southern Flounder released alive have increased throughout the time series, with an all-time high occurring in 2022 with 6.8 million fish released alive (Table 2.9; Figure 2.8). Annual length frequencies of recreational harvests show little change in size distribution after 2001 (Figure 2.9). Recreational discards have always been dominated by the 30-cm TL size bin (Figure 2.10).

2.1.5 Recreational Gig Catch

2.1.5.1 Data Source

Recreational gigging occurs in all four states and harvest regulations mirror those set for the recreational hook-and-line fishery. The MRIP survey does not frequently intercept recreational gig fishermen; therefore, it was necessary to separately estimate recreational gig harvest and discards. Estimates of recreational gig catches were developed based on the NCDMF recreational flounder gigging mail survey, as used in the 2018 benchmark assessment (Lee et al. 2018).

2.1.5.2 Development of Estimates

The recreational Southern Flounder season in North Carolina was shortened to only occur in a small window of time during the fall months, beginning in 2020. Flounder data from the gig fishery were not available for season 1 from 2020 to 2022 and are limited in season 2 due to the short recreational fishing season.

Estimates of harvest and discards for the recreational gig fishery were only available from 2010 to 2022, so the same hindcasting approach used in the 2018 benchmark and 2019 update was again employed to develop estimates for the entire assessment time series. The ratio of recreational gig harvest to total MRIP harvest for each season, as well as gig discards to total MRIP released, were developed (Figures 2.11 and 2.12). The medians of these ratios were applied to the MRIP data from 1989 to 2009 (Table 2.10).

2.1.5.3 Estimates of Recreational Gig Catch Statistics

Estimates of Southern Flounder harvest by gig have dramatically declined since the last stock assessment update, especially since the implementation of the stricter recreational harvest regulations in North Carolina (Table 2.10; Figure 2.13). Discards from the recreational gig fishery were much lower than harvest over the assessment time series with steep declines after the stricter recreational harvest regulations were implemented (Table 2.10; Figure 2.14).

2.1.6 Total Recreational Catch

2.1.6.1 Data Sources

Total recreational catch (e.g., hook and line and gigs) was derived by combining estimates from MRIP (section 2.1.4) and the recreational gig survey (section 2.1.5).

2.1.6.2 Development of Estimates

The MRIP survey and recreational gig harvest were combined to estimate the total recreational harvest of Southern Flounder. The post-release mortality rate for MRIP type B2 estimates was assumed to be 0.07 for season 1 and 0.11 for season 2. Recreational gig post-release mortality was assumed to be 100%. The sum of the MRIP and recreational gig post release mortalities were combined to estimate discards that died after catch and release (recreational dead discards).

2.1.6.3 Estimates of Total Recreational Catch Statistics

Estimates of total recreational catch do not exhibit a trend through the assessment time series (Table 2.11; Figure 2.15), but the numbers of Southern Flounder released alive have increased in recent years due to changes in management (Figure 2.8). The number of dead discards also increased since the 2017 terminal year in the 2019 update (Table 2.11; Figure 2.15); however, these estimates were not as high as the mid-1990s and 2000s.

2.2 Fisheries-Independent

2.2.1 North Carolina Estuarine Trawl Survey

2.2.1.1 Development of Estimates

No major changes occurred in the NC120 Trawl Survey since the 2019 update, except sampling could not occur in May 2020 due to the COVID-19 pandemic. An age-0 relative abundance index was developed using a generalized linear model (GLM) based on the data from the NC120 Trawl Survey. Data were collected from May and June 1989–2022. Poisson and negative binomial error distributions were examined, and the negative binomial was selected due to the lowest estimate of dispersion (ratio of variance to the mean; Zuur et al. 2009).

2.2.1.2 Estimates of North Carolina Estuarine Trawl Survey Statistics

The best-fit negative binomial error distribution included year, stratum (or sampling region), temperature, and salinity as significant covariates (Table 2.12). The index still had an overall decrease in abundance since 2003 (Table 2.13; Figure 2.16). The last strong year class occurred in 1996 and moderate increases in abundance occurred in 2003 and 2010. Samples from the estuarine trawl survey are collected to provide lengths for age-0 fish collected in North Carolina (Table 2.14).

2.2.2 North Carolina Pamlico Sound & Rivers Fisheries-Independent Gill-Net Survey

2.2.2.1 Development of Estimates

The Pamlico Sound and River Fisheries-Independent Gill-Net Survey (NC915) was still conducted with no major changes since the 2019 update, except that sampling could not occur in 2020 due to COVID restrictions. Data were available from 2003 to 2022 (with the exception of 2020) collected in August and September each year from shallow water samples (quad 1). Poisson and negative binomial error distributions of the GLM were considered and the negative binomial had the lowest estimate of dispersion.

The survey collects lengths of the captured Southern Flounder, which are used to generate annual length frequencies for the survey (Table 2.15).

2.2.2.2 Estimates of North Carolina Fisheries-Independent Gill-Net Survey Statistics

The significant covariates used for the NC915 Gill-Net Survey were year, stratum (or sampling area), depth, temperature, and DO (Table 2.12). The index has been highly variable since 2017 (terminal year of the 2019 update; Table 2.16; Figure 2.17); however, the terminal year had the third lowest relative abundance in the index time series. Annual length frequencies developed from the NC915 Survey depict that size classes between 24 cm and 36 cm were usually the dominant size classes in each year of the survey (Figure. 2.18).

2.2.3 South Carolina Electrofishing Survey

2.2.3.1 Development of Estimates

The South Carolina Electrofishing Survey was conducted from 2001 to 2022 with no major alterations. The index was developed using data from July to November, and strata AR and EW were excluded due to low sample size. Additionally, there were no samples collected during the late-flood tidal stage (Tide=3), so samples attempted during the late-flood tidal stage were excluded. Age-0 fish were identified using size frequency plots. Using the GLM approach, Poisson and negative binomial error distributions were considered.

Sizes were collected during the survey to provide lengths of age-0 fish (Table 2.14).

2.2.3.2 Estimates of South Carolina Electrofishing Survey Statistics

The best fit GLM was a negative binomial distribution with year, stratum, temperature, salinity, DO, tide, and depth as significant covariates (Table 2.12). The index had an overall decreasing trend since 2001; however, the 2022 index was higher than 2020 and 2021 (Table 2.13; Figure 2.19).

2.2.4 South Carolina Trammel Net Survey

2.2.4.1 Development of Estimates

The South Carolina Trammel Net Survey was conducted from 1996 to 2022 with no major alterations, except that DO was added in 1998. Using data from July through October, the index was developed from 1998 to 2022 to include DO as a covariate. Poisson and negative binomial error distributions were considered with a GLM approach.

Biological data were also collected during the Trammel Net Survey, which included length, weight, age, and sex (Table 2.15).

2.2.4.2 Estimates of South Carolina Trammel Net Survey Statistics

A negative binomial distribution was the best fit GLM with year, stratum, depth, temperature, salinity, DO, and tide as significant covariates (Table 2.12). The index was highly variable with an overall decreasing trend until 2017 when an increasing trend began; however, the index still remains low in the terminal year when compared to the full time series (Table 2.16; Figure 2.20). Annual length frequencies had some variability from year to year, with the dominant size occurring between 18 cm and 30 cm TL (Figure 2.21).

2.2.5 Georgia Trawl Survey

2.2.5.1 Development of Estimates

The Georgia Trawl Survey occurred from 1996 to 1998 and again from 2003 to 2022, with only one alteration: sampling did not occur in April 2020 due to COVID restrictions. The index was created with data from January to March using a GLM approach. The Poisson and negative binomial distributions were considered in the GLM approach.

Lengths were collected during the Georgia Trawl Survey from January to March (Table 2.15).

2.2.5.2 Estimates of Georgia Trawl Survey Statistics

The best fit GLM was the negative binomial distribution with year, station, temperature, depth, and salinity as significant covariates (Table 2.12). The index was variable and without trend over time (Table 2.16; Figure 2.22). Size classes between 18 and 24 cm TL were the dominant lengths collected by the Georgia Trawl Survey (Figure 2.23).

2.2.6 Florida Trawl Survey

2.2.6.1 Development of Estimates

The Florida Trawl Survey was conducted from 2001 to 2022, which sampled young-of-year (YOY), juvenile, and adult Southern Flounder. No major alterations occurred during the survey. The age-0 index used samples of hypothesized age-0 fish, as defined by individuals less than the maximum standard length (SL) calculated in the benchmark stock assessment (Table 2.17). Only surveys from February to June were used for the age-0 index. For the adult index, samples above the predetermined length cutoff were used. A GLM approach with Poisson and negative binomial distributions was used to calculate both the Florida Trawl age-0 index and the Florida trawl adult index.

Length frequencies were generated from the length data available in the adult Florida Trawl Survey from January through March (Table 2.14).

2.2.6.2 Estimates of Florida Trawl Survey Statistics

The Florida Trawl age-0 index had a best fit GLM with a negative binomial distribution and significant covariates of year, stratum, depth, temperature, and salinity (Table 2.12). The index indicated strong year classes in 2005, 2010, and 2011 with much lower levels of recruitment in the last five years (Table 2.13; Figure 2.24).

The best fit GLM model for the Florida Trawl adult index used a negative binomial distribution with year, stratum, depth, temperature, and salinity as significant covariates (Table 2.12). The index showed a relatively high peak of abundance in 2011 and 2012, with more moderate highs in abundance occurring in 2015, 2020, and 2022 (Table 2.16; Figure 2.25). Annual length frequencies developed from the Florida Trawl adult index showed smaller size classes were commonly the dominant lengths (Figure 2.26).

2.2.7 SEAMAP Trawl Survey

2.2.7.1 Development of Estimates

Samples for the SEAMAP Trawl Survey are taken by trawl from the coastal zone of the South Atlantic Bight between Cape Hatteras, North Carolina, and Cape Canaveral, Florida. Data from the SEAMAP Trawl Survey during 1989 through 2022 were used; however, data were not available in 2020 due to an interruption in sampling protocols from the COVID pandemic. Additionally, SEAMAP changed the protocols of the Trawl Survey in 2021 to only sample one net on the port side of the vessel rather than both sides. The effort data provided by SEAMAP did reflect this change and therefore the data could be appropriately used in the model. An additional change to the SEAMAP Trawl Survey reduced the number of stations sampled on particular trips, but all stations would be sampled each year; however, this impacted the seasonal coverage, which differed among years with many strata not sampled during fall in some years. It was necessary to correct for this change in the survey because the index developed from this survey only uses data collected in the fall months (September through November). Therefore, strata that were not sampled every fall throughout the entirety of the time-series (nine strata, which covered all of Florida and most of North Carolina) were removed from analysis in the development of this index. A GLM model with Poisson and negative binomial distributions, as well as zero-inflated Poisson and negative binomial distributions were considered.

Biological data collected in the SEAMAP Trawl Survey during the fall cruise provided annual length frequencies of Southern Flounder (Table. 2.15).

2.2.7.2 Estimates of SEAMAP Trawl Survey Statistics

The SEAMAP Trawl index used a negative binomial distribution with year, stratum, and salinity as significant covariates (Table 2.12). The index was highly variable with low estimates in 2021 and 2022 compared to the previous five years (Table 2.16; Figure 2.27). Annual length frequencies developed from the SEAMAP Trawl Survey showed some variation from year to year, but size classes between 24 cm and 30 cm TL were usually dominant (Figure 2.28).

3 ASSESSMENT

3.1 Method

3.1.1 Description

This is the second update to the benchmark stock assessment completed in early 2018 (Lee et al. 2018). The first stock assessment update was completed in early 2019 (Flowers et al. 2019). All assumptions and model decisions made in the benchmark stock assessment and first update are repeated here to the extent possible. Any exceptions have been noted.

The assessment is based on a forward-projecting, statistical catch-at-age model that was modeled using ASAP3 software (version 3.0.17; NOAA Fisheries Toolbox 2014). ASAP3 is written in AD Model Builder (Fournier et al. 2012) and uses a graphical interface to facilitate data entry and presentation of model results. The model allows for age- and year-specific values for natural mortality rates and multiple weights by age and year such as average spawning weights, catch weights by fleet, and average stock weight at the beginning of the year. Further, it accommodates multiple fleets with one or more selectivity blocks within the fleets, incomplete age-composition to accommodate fisheries and/or surveys that are not sampled every year, and indices of abundance in either numbers or biomass that are offset by month. Discards can be linked to their fleet as can fishery-dependent indices and they are related to the specific fleet by the applicable selectivity block. Fishery-independent indices are linked to the total population and are applied to specific ages with selectivity curves or by age-specific values. Age-based selectivity options include single logistic (two parameters) or double logistic (four parameters) curves and age-specific parameters. ASAP is constrained to represent either a single sex or combined sexes on an annual time scale. Recruitment for this model occurs at age-1 and, therefore, does not incorporate catch and indices of age-0 fish. The timing of the age-0 indices was advanced to the following January as to be representative of age-1 fish in January.

3.1.2 Dimensions

An assessment model with an annual time step was applied to data collected from within the range of the assumed biological stock unit (North Carolina through the east coast of Florida). The time period was 1989 through 2022, spawning was modeled to occur on January 1, and ages 1 to 4+ were explicitly represented in the age compositions and ages 4 through 9 were treated as a plus group. Sexes were combined but female-only spawning stock biomass was estimated.

3.1.3 Structure & Configuration

3.1.3.1 Catch

Landings and dead discards were incorporated from three fishing fleets: commercial fishery (excluding the shrimp trawl fishery), recreational fishery, and the commercial shrimp trawl fishery. Dead discards refer to fish that either died prior to release or were released alive and subsequently died due to release mortality. Landings plus dead discards of ages 1+ were entered in weight (mt) for each of these fleets. Dead discards and the retained catch were combined and, therefore, not entered separately, as per the peer review panel’s recommendations (Lee et al. 2018). The shrimp trawl fishery was modeled as a bycatch-only fleet and the input removals included only dead discards.

3.1.3.2 Survey Indices

Eight indices of relative abundance were selected for input into the model. All indices were derived from fisheries-independent surveys. Data from the NC915 Gill-Net, South Carolina Trammel Net, Georgia Trawl, Florida Trawl (adult component), and SEAMAP Trawl surveys were used to generate indices of relative adult abundance (number per effort). Age-specific adult indices were generated by using length compositions and an age-length key (section 3.1.3.4). The NC120 Trawl, South Carolina Electrofishing, and Florida Trawl (age-0 component) survey data were used to compute indices of relative age-0 abundance (numbers per effort). The timing of the age-0 indices were advanced to the following January as to be representative of age-1 fish in January. All the fisheries-independent survey indices were assumed to be proportional to stock size.

Inter-annual changes in relative abundance indices can occur due to factors other than changes in abundance, such as spatial-temporal environmental changes; the fisheries-independent indices were standardized using a GLM approach to attempt to remove the impact of some of these factors (Maunder and Punt 2004; see section 2.2). Catchability (q) was estimated for each fisheries-independent survey index and allowed to vary over time via a random walk (see Wilberg et al. 2010). Time-varying catchability is especially likely for fisheries-independent data when the survey does not cover the full area in which the stock occurs, as is the case for the fisheries-independent surveys incorporated into this stock assessment. Initial values of the parameters for the deviations in random walk of $\log_e(q)$ were treated as priors for each of the fisheries-independent surveys. These priors were assumed to follow a lognormal distribution with a prior or 0.001 for each index and the prior coefficient of variation (CV) was set equal to 0.9. The CV of the catchability varying through time was decreased from 0.1, which was used in the benchmark model and the previous update, to a CV of 0.05. This change reduced the chance the catchability could increase by more than one order of magnitude and reduce the occurrence of unobserved misspecification in the model (Somerton 1999; Cadrin et al. 2016).

3.1.3.3 Length Composition

Weight, length, and age composition data were used to estimate proportion caught and discarded at age, average weight at age for each fleet, and average weight for the overall population and female-only spawning population.

Commercial and recreational catch at length by year (sexes pooled) were developed as in the previous stock assessment update (Flowers et al. 2019). Sampled length frequencies were also provided for indices of abundance, the shrimp trawl fishery dead discards, commercial live and dead discards, and recreational live discards. Sampled lengths were expanded to catch at length in numbers for live and dead discards by multiplying the proportion sampled by the total number of live or dead discards. It was necessary to assume length frequencies for some years when few or no fish were sampled. Weight caught per length bin by year (sexes pooled) was then estimated using a time-invariant length-weight relationship.

Landings for the commercial fishery were reported in weight (mt), necessitating alternative methods of calculating catch and weight at length. Estimates of weight caught per length bin were not available and therefore were inferred by applying the proportion caught at length to the annual commercial landings in weight to obtain the weight caught per length bin (sexes pooled). Catch at length (in numbers) was derived by dividing weight at length by the average weight per length bin.

Indices at length were estimated similarly by applying the proportion sampled at length to each yearly index.

3.1.3.4 Age Matrices

<u>Overview</u>

Age data from both data types (i.e., fisheries-independent and fisheries-dependent sources) were used to develop age-length keys by year and data type (methods detailed below). Age-length keys were then applied to fleet- and index-specific catch-at-length matrices to estimate fleet- and index-specific catch at age.

<u>Age-Length Keys</u>

Ideally, age-length keys would be fleet and survey specific, but as shown in Tables 3.1 and 3.2, sample sizes per year for the fleets and surveys included in the model were insufficient. Therefore, the number of fish sampled per length and age bin within a data type (i.e., fisheries-independent or fisheries-dependent sources) were aggregated across states and all fleets/surveys. Ages were not randomly sampled from length composition, potentially leading to biased catch-at-age estimates.

The level of sampling per length bin and year was considered to be adequate if the number of fish aged per length bin was at least ten. Length bins highlighted in Tables 3.3 and 3.4 required some level of smoothing and the conventions and assumptions were as follows: when sample sizes in a length bin are less than ten, the proportion at age per length bin was estimated by fitting a multinomial GLM with the vglm function in R's VGAM package (Yee and Wild 1996; Stari et al. 2010; Yee 2015; R Development Core Team 2023). Covariates used in addition to length bins were year and data type (fisheries-dependent/independent). Including an additive effect of data type accounts for differences in sampled lengths for a given age in fishery-dependent data sources due to minimum size limits and spatial differences.

Because this method treats length bins, years, and data types as fixed effects for each age, it requires that at least one age was sampled per length bin for each year and at least one age was sampled per year and data type. When this was not the case, information was inferred according to an overall age-length key that was aggregated over years and data types. Cells in Tables 3.3 and 3.4 with no ages sampled were filled using expected ages shown in Table 3.5 and the sample size was set to one.

After length bin and age cells with less than ten fish aged for each data type were replaced with estimates from the multinomial GLM model, years with little or no sampling were replaced with averages from previous or subsequent years. No age sampling occurred in 1989, thus age-length keys were inferred by assuming the average of 1990–1991; however, inferred age data were only used to inform catch and discards of age-0 fish (which were subsequently removed from all model inputs) and average weights at age. The first year of catch-at-age information specified in the ASAP model is 1991.

<u>Catch & Discards at Age</u>

Year- and type-specific catch-at-length matrices were multiplied by year- and type-specific age-length keys to obtain the proportion caught and discarded at age. The discard-at-age matrices were developed by applying release mortality rates to live discards at age. Release mortality rates were assumed to be 0.23 for the commercial fishery, 0.09 for the recreational fishery, and 1.0 for the shrimp bycatch fishery. To arrive at annual release mortality rates for the commercial fishery, post-release survival rates for large mesh gill nets in season 2 were averaged over the two data sources. Then, for each gear type (i.e., fishery) post-release survival rates were transformed to post-release mortality rates and averaged over seasons. The ASAP model does not explicitly account for catch of age-0 fish, therefore age-0 catch and discards at age were subtracted from total catch and discards (mt). Catch- and discards-at-age matrices were combined, and the overall proportions were used as inputs (Figures 3.1–3.3).

In addition, mean weights of landings and discards at age were also obtained (Figures 3.4–3.6). Mean weight of Southern Flounder caught and discarded by age for the recreational and commercial fisheries increased gradually over the time series, particularly for ages 1 and 2 (Figures 3.4 and 3.5). This may have been due to increasing minimum size limits over the time period.

<u>Survey Indices at Age</u>

Index-at-age matrices were obtained in a similar manner. Catch-at-length matrices were multiplied by fisheries-independent age-length keys to obtain proportion index-at-age matrices (Figure 3.7-3.11).

Average weights at age for the unit stock on January 1 were assumed to be equal to average weight at age from fisheries-independent data sources from October to December (Figure 3.12). Weight-at-age matrices for January were time invariant with age 1 = 0.280 kg, age 2 = 0.716 kg, age 3 = 1.235 kg, and age 4 = 2.033 kg. Weight-at-age matrices for the spawning stock biomass (SSB) component were reflective of the female-only portion of the stock on January 1. Average weights at age for females were calculated from fisheries-independent data sources from October to December (age 1 = 0.307 kg, age 2 = 0.769 kg, age 3 = 1.320 kg, and age 4 = 2.130 kg; Figure 3.13).

3.1.3.5 Biological Parameters

Natural Mortality

Natural mortality (M) is not estimated in ASAP, so Lorenzen's (1996) method was used to estimate M (Table 3.6). Natural mortality was assumed to be time-invariant.

Maturity & Reproduction

ASAP requires maturity to be specified by age. Maturity at age was not estimated in Midway et al. (2013), only maturity at length; however, since maturity at length in Midway and Scharf (2012) was nearly identical to estimates in Midway et al. (2013), maturity at age was assumed to be time-invariant according to Midway and Scharf (2012; Table 3.7). To estimate female only SSB from January 1 biomass of combined sexes, maturity was entered as the maturity at age multiplied by the proportion female at age (Table 3.8).

Fecundity

Fecundity options in ASAP included either setting fecundity equal to maturity multiplied by SSB weight at age or equal to maturity values. Fecundity was assumed to be equal to maturity multiplied by the proportion female at age and SSB weight at age.

3.1.3.6 Stock-Recruitment

A Beverton-Holt stock-recruitment relationship was assumed, and recruitment varied log-normally about the curve. Virgin recruitment (R_0) and steepness (h) were estimated within the model. The standard deviation of log(recruitment), σ_R, is not estimated in ASAP; therefore, the coefficient of variation on the log-scale was fixed at 0.658. ASAP estimates recruitment residuals on the log scale but does not allow for bias corrections in expected recruitment, potentially leading to conservative estimates of average recruitment.

3.1.3.7 Fishing Mortality & Selectivity

Fishing mortality by fleet, in the absence of discards, was considered to be the product of selectivity at age and the annual fishing mortality for fully-recruited fish ($Fmult_{f,y}$, selectivity = 1.0; Doubleday 1975). The annual fishing mortality deviations were multiplicative meaning that the fishing mortality multiplier for a given year depended upon the prior year's fishing mortality multiplier, i.e., $Fmult_{f,y} = Fmult_{f,y-1} * Fmult\_dev_{f,y}$. The equation for the fishing mortality for fleet, f, at age, a, in year, y, was:

$$F_{f,a,y} = Sel_{f,a} Fmult_{f,y} \tag{3.3.1}$$

where $Sel_{f,a}$ was the selectivity for age, a, in that fleet. A single selectivity pattern per fleet was used; flat-topped selectivity was assumed in the recreational fleets with logistic curves (Eq. 3.3.2 in Quinn, II and Deriso 1999), and dome-shaped selectivity curves (double logistics curves, Eq. 3.3.3) were applied to the commercial fishery, as it is dominated by gill nets throughout most of the time series (Millar and Fryer 1999).

$$Sel_{f,a} = \left[\frac{1}{1+e^{-(a-\alpha)/\beta}} \right] \frac{1}{x} \tag{3.3.2}$$

$$Sel_{f,a} = \left[\frac{1}{1+e^{-(a-\alpha 1)/\beta 1}} \right] \left[1 - \frac{1}{1+e^{-(a-\alpha 2)/\beta 2}} \right] \frac{1}{x} \tag{3.3.3}$$

The term, $\frac{1}{x}$, in Equations 3.3.2 and 3.3.3 normalizes the selectivity values ensuring that at least one age is fully selected ($Sel_{f,a}$ = 1.0). *F* values reported here (unless otherwise noted) represent a real annual *F* calculated as a numbers-weighted *F* for ages 2–4+, the age range that comprises most of the targeted catch.

Selectivity of surveys of ages 1+ was assumed to be dome shaped and allowed to be freely estimated by age. Fully selected ages were chosen iteratively based upon improved model fit.

3.1.4 Optimization

ASAP assumes an error distribution for each data component. The commercial and recreational harvest were fit in the model assuming a lognormal error structure. The lognormal model fits all contain a weighting (lambda) value that allows emphasis of that particular component in the objective function along with an input coefficient of variation (CV) that is used to constrain a particular deviation. Commercial landings were assigned a constant CV equal to 0.25. This value was chosen to account for the added uncertainty when estimating the age-1+ catch and because commercial discards were hindcast prior to 2004.

The observation error for the recreational harvest (Type A+B1, landings + dead releases) and discards (Type B2, live releases) were set to a value of 0.30. The MRIP statistics were used in the 2018 benchmark and 2019 update; however, recent updates from MRIP have questioned the measurement error in these estimates (Andrews et al. 2018; Andrews 2022) thus an increase in the uncertainty of the estimate is warranted for this update. A constant CV of 0.30 was applied to the shrimp trawl bycatch dead discards. Survey indices were fit assuming a lognormal error distribution with variance estimated from the GLM standardization (Table 3.9).

Age composition information was fit assuming a multinomial error structure with variance described by the effective sample size (ESS). There are differing recommendations on constructing ESS from sample data. Most analysts use the number of trips on which sampling occurred or the number of aged specimens (less often preferred if specimens came from few sampling events), but most advise capping ESS at 200. Small values for ESS indicate higher variances of data for an age composition which the model will place little emphasis on in the fitting process, while an ESS of 200 indicates virtually no variation in the observed age composition and the model will attempt to fit those data exactly; however, the square root of the original sample sizes was used rather than caps to avoid overemphasizing large sample sizes while maintaining the relative magnitudes of ESS for placing emphasis in the model fitting process. For each fleet and survey, the ESS was the square root of the number of sampled trips (Tables 3.10 and 3.11). Adjusted effective sample sizes (Stage 2 weights *sensu* Francis 2011) were not applied to reweight the age composition data in the base run.

The objective function is the sum of the negative log-likelihood contributions from various model components. Lambda weighting values are presented in Table 3.12.

CVs for fitted model components such as deviations from initial steepness and virgin recruitment, R_0, are presented in Table 3.12. CVs for deviations from model starting values are very high (= 0.90), allowing the model to essentially be unconstrained when solving for these values (Table 3.13).

3.1.5 Diagnostics

Several approaches were used to assess model convergence. First, the Hessian matrix must be invertible (i.e., there is a unique solution for all the parameters in the model). Next, the maximum gradient component (a measure of the degree to which the model converged to a solution) was compared to the final convergence criteria (0.0001, common default value). Ideally, the maximum gradient component will be less than the criterion. Additionally, model fits to landings (including dead discards), indices, and age compositions were evaluated via visual inspection and an evaluation of standardized residuals.

To further evaluate the fits to the indices, the criteria set forth in Francis (2011) was used. That is, the standardized residuals were calculated and compared to $\sqrt{\chi^2_{0.95,m-1}/(m-1)}$, where $\chi^2_{0.95,m-1}$ is the 95th percentile of a χ^2 distribution with m – 1 degrees of freedom, and m is the number of years in the data set. Francis (2011) suggests that the standard deviation of the standardized residuals be less than this value.

3.1.6 Uncertainty & Sensitivity Analyses

3.1.6.1 Retrospective Analysis

A retrospective analysis was performed by removing up to five years of data to examine the consistency of estimates over time (Mohn 1999). This type of analysis gives an indication of how much recent data have changed our perspective of the past (Harley and Maunder 2003). The analysis is run by removing one year of data from the end of the time series, evaluating results, removing two years of data from the end of the time series, evaluating results, and so on. Ideally, retrospective patterns are random and do not show a clear bias in any direction. The degree of retrospectivity for a given variable can be described by the Mohn's ρ metric (Mohn 1999). Here, a modified Mohn's ρ (Hurtado-Ferro et al. 2015) was calculated for estimated female SSB and *F*. Based on results of simulation studies, Hurtado-Ferro et al. (2015) suggested values of the modified Mohn's ρ lower than -0.22 or higher than 0.30 for shorter-lived species are indicators of retrospective patterns and should be cause for concern. Results of their work also suggested that positive values of the modified Mohn's ρ for biomass and negative values for fishing mortality imply consistent overestimation of biomass and the highest risk for overfishing.

3.1.6.2 Evaluate Data Sources & Select Parameters

The contribution of the different surveys from the various states to the model performance was explored by removing the survey indices and associated biological data from each individual state in a series of model runs. In each of these sensitivity runs, all fisheries-independent indices from a particular state were removed. In addition, a sensitivity run was performed that removed the index associated with the SEAMAP survey. Annual estimates of female spawning stock biomass and *F* were compared to the base run results for this analysis.

Natural mortality estimates can dramatically impact a model. Multiple new methods for estimating natural mortality have been published in recent years, including a generalized length-inverse mortality model using a scaling factor developed from the median prior of M rather than a mean to provide a more representative estimate of M for the entire population (Hamel and Cope 2022; Lorenzen 2022). Underestimation of natural mortality can lead to an underestimation of recruitment and an underestimation of SSB in many modeling scenarios (Catalano and Allen 2010; Punt et al. 2021). The natural mortality estimates provided by this new study are higher than the estimates from the 1996 method (Table 3.14). A sensitivity analysis was completed to determine the impacts of the new natural mortality estimates on the outcome of the model.

To further test model stability, a series of models were run in which steepness (h) and virgin recruitment ($\log(R_0)$) were fixed at a range of values below and above that estimated within the model. Additionally, model sensitivity to the assumption of time-varying catchability was assessed by turning the time varying catchability off, as well as by constraining further with a CV = 0.01 and a CV = 0.001.

Time-varying catchability was used in the benchmark model, as well as the 2019 update; however, initial diagnostics for the current model revealed that catchability would climb unrealistically high, particularly for NC915 and SEAMAP indices. Thus, catchability was constrained with a CV=0.05 so it could not change more than one order of magnitude. To examine the impacts of constraining catchability further a sensitivity analysis was conducted by turning time-varying catchability off.

The fishing effort survey (FES) was implemented by MRIP in 2015 but continuous pilot studies and data analyses have been conducted to better understand the non-sampling errors that could occur in the survey design (Andrews et al. 2018; Andrews 2022). Based on these efforts, MRIP FES estimates have been determined to potentially be skewed based on the way questions were asked during the interview process. MRIP estimates in North Carolina could be anywhere from 32% lower to 40% higher than estimated through FES. Florida estimates ranged from 32% lower to 20% higher (Andrews 2022). Andrews (2022) reported that these estimates would be altered in magnitude but not in overall trends. Based on these results, a sensitivity analysis was completed to determine how the model would be impacted by these varying levels of magnitude by running the model with the MRIP estimates being increased by 10%, 20%, 30%, and 40% for each year, as well as decreasing the MRIP estimates by 10%, 20%, and 30% in each year. Additionally, a second sensitivity analysis was completed based on the MRIP uncertainty value by adjusting the CV value for the catch from the MRIP percent standard error estimates used in the benchmark, to the CV=0.3 used in this update, to CV=0.4, and CV=0.5.

Models are extremely sensitive to the selectivity of a fishery or index used within the model. Problems in selectivity can result in biased estimates and relate to unrealistic estimates of catchability (Cadrin et al. 2016). The benchmark model estimated selectivity using a logistic regression for the recreational fleet and a double logistic regression was used for the commercial fleet (Lee et al. 2018). These regressions are based on a relationship between the four age classes, which could create mathematical problems in regression estimation. A sensitivity analysis was completed to estimate selectivity for both fleets using age-specified starting values that were allowed to vary based on the data sources to determine how the model responded to the change in estimation procedures.

3.1.6.3 MCMC Analysis

Monte Carlo Markov Chain (MCMC) is a method of generating posterior distributions of model parameters and was used in this analysis to estimate uncertainty in fishing mortality and spawning stock biomass. A total of 5,000,000 MCMC iterations were performed but only one out of every

5,000 were saved, resulting in 1,000 iterations used to generate uncertainty estimates in estimates of fishing mortality and spawning stock biomass. Convergence of the MCMC chains was assessed by using Geweke's diagnostic (Cowles and Carlin 1996) implemented in the boa package in R (Smith 2007; R Development Core Team 2023) and by visual inspection.

3.1.7 Results

3.1.7.1 Base Run—Diagnostics

The model base run had an invertible Hessian, and the maximum gradient component was 2.6E-05, smaller than the recommended maximum value of 0.0001. With 355 estimated parameters, the model obtained an objective function of 2,867. Age compositions from the catch and indices contributed most to the magnitude of the likelihood function (Figure 3.14). The root mean squared error (RMSE) values for the fleets were acceptable (≤ 1) with a total catch RMSE= 0.48, where the recreational catch had the largest RMSE at 0.682 and the commercial catch with the lowest at 0.465 (Table 3.15). The model fit well to the commercial catch with low residuals from year to year, but some temporal trends may be occurring (Figure 3.15). The model commonly underestimated the catch prior to 2012 with few exceptions and commonly overestimated the catch after 2012 (Figure 3.16). The same temporal trends were documented in the recreational catch; however, the magnitude of the residuals is higher than the commercial catch (Figure 3.15 and 3.16). The model fit exceptionally well to the shrimp trawl bycatch, where residuals were an order of magnitude lower than the other fleets (Figure 3.15 and 3.16). This could be due to the shrimp trawl fleet being a significantly small component of the entire catch.

The root mean squared errors for the fits to the fishery-independent indices were higher than the fleets, ranging from 0.804 for the South Carolina electrofishing index to 1.97 for the Florida young-of-year trawl index (Table 3.15). Six of the eight indices had RMSE higher than the suggested maximum of 1 (Francis 2011; Table 3.15).

Model predicted indices were loosely tracked overall with general decreasing trends captured in many of the indices (Figure 3.17); however, the inter-annual variability seen in the observed data was not captured by the model (Figure. 3.18). Catchability was allowed to vary through time, but with a constraint on the uncertainty of the estimate. This allowed the catchability for the models to vary but not widely enough that would cause misspecification of the model to be absorbed by catchability and thus not be detectible in model diagnostics. Most indices have an increase in catchability over the entire time series, except for the South Carolina electrofishing index and the two Florida indices (Figure 3.19). While some deviations in catchability occur through time, large fluctuations in catchability should be a concern in model performance. Catchability was constrained in this model to control these fluctuations, but more research into these surveys and the impact of these fluctuations is needed.

The model had variable fits to the age compositions of the fleets (Figure 3.20–3.22). The commercial fleet had variable fits to the age composition for age one, with the opposite fit to ages two and three. In other words, the model would overestimate one age and underestimate the other ages in the same year or vice versa. This could be caused by the use of a dome shaped selectivity (double logistic), which requires four parameters to estimate and there was only four age classes in the model. Age compositions for older ages were overestimated in many years, particularly for the recreational fleet. Overestimation in older ages can commonly be caused by modeling a logistic (flat top) selectivity rather than a dome shaped selectivity.

The fits of the age compositions in each of the indices was much more variable than seen in the commercial fleets. Residuals of the age compositions for the fishery-independent indices were low through most of the time series (Figure 3.23–3.27). Many of the highest residuals were seen in age one and two, where one age would be underestimated and the other overestimated in the same year. There was no distinguishable pattern between when over or underestimation occurred throughout most of the indices. One exception is the overestimation of age one and age two Southern Flounder in 2006 in every index. This indicates that a strong year class occurred in 2003 and the model anticipated a strong year class would occur again in 2004 and 2005; however, that was not the case.

3.1.7.2 Base Run— Selectivity & Population Estimates

A double logistic selectivity was used for the commercial fishery with age two being fully selected and age four selectivity being less than age three (Figure 3.28). The recreational fishery selectivity was based on a logistic function with ages three and four being fully selected (Figure 3.29). Selectivity for the shrimp trawl bycatch fleet was set with age-specific parameters with a maximum selectivity at age one and declining for older ages (Figure 3.30). Selectivity parameters for indices of abundance were all estimated independently by age (Figure 3.31) and the age of full selectivity was specified based on improved fits to the age compositions. The Georgia Trawl and Florida Trawl surveys fully selected for age one individuals with a decline to barely any age four fish selected (Figure 3.31). The North Carolina P915 survey, South Carolina trammel net survey, and SEAMAP surveys had maximum selectivity at age two (Figure 3.31).

Predicted annual recruitment decreased over the time series but was highly variable overall (Table 3.16; Figure 3.32). Temporal patterns were exhibited by the model with recruitment underestimated early in the time series and overestimated later in the time series. This could indicate misspecification within the model that could be addressed by a shift in population dynamics in the 2000s. Spawning stock biomass was highly variable among years but appeared stable in trends through the early 2000s (Table 3.16; Figure 3.33). A strong peak was observed in 1999 and a second in 2006. After 2006, the population continued to decline through the end of the time series. The lowest estimated spawning stock biomass of 827 mt occurred in 2021.

The predicted stock-recruitment relationship was based on an estimated steepness value of 0.74 and $\log(R_0)$ of 9.6 (Figure 3.34). Predicted values of spawner potential ratio (SPR) were fairly variable among years and did not demonstrate an overall trend over time (Table 3.17; Figure 3.35). The highest observed peak occurred in 2005, with the value of 0.27 and a second peak occurred in 2022, the terminal year, with a value of 0.21.

Model predictions of annual *F* (numbers-weighted, ages 2–4) remained mostly stable over the time series (Table 3.18; Figure 3.36); however, three high peaks were observed in 2013, 2016, and 2019. Predicted *F* values ranged from a low of 0.52 in 2005 to a high of 1.56 in 2013. There is an indication of a strong decline in *F* in the last two years of the time series, with values of 0.88 in 2021 and 0.68 in 2022 following a high value of 1.49 in 2020.

Predicted stock numbers were very low for ages 3 and 4 over the time series (Figure 3.37). Overall, there was no clear indication of truncation or expansion of the age structure over time.

3.1.7.3 Retrospective Analysis

Retrospective patterns were observed using a five-year analysis (Figure 3.38). As the model was rerun with terminal years removed, the estimate of SSB increased from the prior estimate for 2018 and 2020 only. For *F*, the estimate decreased from the prior estimate in every year of the retrospective analysis except 2017. The calculated values for Mohn's ρ for SSB (ρ=0.10) was within the bounds for "acceptable" range for shorter-lived species, but Mohn's ρ for *F* (ρ=-0.23) was on the bounds. This indicates the model is underestimating *F*, impacting the ability to gauge the impact on rebuilding the stock.

3.1.7.4 Evaluate Data Sources & Select Parameters

A series of sensitivity analyses were completed to examine the robustness of the model. First, fishery-independent surveys were removed based on the state they were from or coast-wide index (SEAMAP) by deselecting the surveys and corresponding proportion-at-age matrix. This was also completed in the benchmark and previous update. The indices had more impact in this update than in previous models (Figure 3.39). The SSB varied by 20.4% and *F* only varied by 16.4% between the different scenarios. Removing the SEAMAP index increased the SSB estimate after 1994 and reduced the *F* estimate. Removing North Carolina, South Carolina, or Georgia indices had the opposite, but negligible, effect as the SEAMAP index. Removing the Florida indices did not have consistent results through the time series. By including only one location of indices at a time, resulted varied more but not considerably for either the SSB or *F* (Figure 3.40). Using only indices with similar trends (*i.e.*, Florida and SEAMAP surveys as a run versus North Carolina, South Carolina, and Georgia as a run) resulted in the most deviation from the base model, but all runs resulted in similar terminal estimates (Figure 3.41). More research is needed to examine the impact of the indices on the model to develop the best configuration that captures the stock on a coast-wide scale. Additional runs with indices combined or another look at potential data sources since the 2018 benchmark assessment would be beneficial to examine the best combination of indices needed to understand this stock.

Changing natural mortality with updated estimates from Lorenzen (2022) resulted in the biggest impact to the model performance (Figure 3.42). Using the scaled Lorenzen (2022) natural mortality estimates increased the model predictions of SSB by 27% to 46% and reduced the estimates of *F* by 26% to 43% throughout the time series. The Lorenzen (2022) calculated natural mortality using a reference age of 2 provided a more moderate estimate and resulted in a more moderate estimate between the other 2 scenarios. More research into the natural mortality estimates experienced by Southern Flounder throughout the stock range are needed.

The influence of important model parameters (steepness, *h*, and virgin recruitment, R_0) was evaluated by fixing each parameter at different values. For the base run, the estimated steepness value was 0.74 and log(R_0) was 9.6. Steepness was iteratively fixed at 0.7, 0.8, 0.85, and 0.90 by setting the phase to negative. Similarly, log(R_0) was fixed at 9.0, 9.5, 10.0, and 10.5. The ASAP model was generally robust to varying assumptions about steepness (Figure 3.43) and log(R_0) (Figure 3.44).

Results with different levels of constraint on the time-varying catchability values were unpredictable (Figure 3.45). More constraint in the time-varying catchability values resulted in lower estimates of SSB and higher estimates of *F* in the early part of the time series. Then around 2002 the trend flips with higher estimates of SSB and lower estimates of *F* in the later part of the time series. The opposite occurs with less constraint in the catchability values, with patterns changing drastically for the run with no time-varying catchability values.

The magnitude of the recreational catch resulted in higher spawning stock biomass estimates with increasing recreational catch but had little impact on the impact of the overall *F* (Figure 3.46). This is likely due to the recreational catch affecting the modeled scale of the population. For example, when the recreational catch was increased, the total size of the population increased. Thus, SSB increased, and *F* did not vary significantly with increasing recreational catch. The uncertainty in the recreational catch (measured as CV in the model) had a bigger impact on the later part of the time series for both SSB and *F* (Figure 3.47). This is likely due to the early part of the time series being dominated by the commercial fishery then changing to a recreationally dominant fishery around the early to mid-2000s (Figure 3.48). Within the later part of the time series, increasing the recreational fleet uncertainty (CV) resulted in higher SSB and lower *F*.

The selectivity of each fleet was changed to direct estimates of selectivity at age rather than using a functional form, i.e., logistic (recreational fleet) or double logistic (commercial fleet). Selectivity for the shrimp trawl bycatch fleet was set up to directly estimate selectivity at each age. The estimates were set at values that the base model was previously using but allowed to vary for each age as needed. The SSB estimate from the resulting scenario was higher than the base model for the whole time series, while the estimate of *F* from the resulting scenario was lower than the base model (Figure 3.49). This indicates more research is needed to better support estimation of the selectivity of each fleet.

3.1.7.5 MCMC Analysis

Geweke's diagnostic and visual inspection of the MCMC chains for fishing mortality and spawning stock biomass in 2022 suggested that convergence was achieved (all $p>0.1$; Figure 3.50; Cowles and Carlin 1996; Smith 2007). By examining the posterior distributions for fishing mortality and spawning stock biomass, the model estimates for the terminal year were within the 95% credible interval (Figure 3.51).

3.2 Discussion of Results

The stock assessment results indicate recruitment dropping from 14 million recruits in 1989 to four million recruits in 2022 (Figure 3.32). Recruitment did increase from four million recruits in 2017, as the 2019 update showed, to seven million recruits in 2019, then dropped again to four million recruits in 2020 where recruitment has remained. The model also predicted a decline in female SSB beginning in 2007 (Figure 3.33), which corresponds with an increase in fishing mortality beginning in 2007 with a time-series high in 2013 (Figure 3.36).

Model estimates of *F* for the U.S. South Atlantic coast were largely a function of the commercial fishery operating prior to 2002, which generated considerable landings for nearly three decades (1,000–2,000 mt annually). Recreational harvest prior to 2002 varied between 700 and 1,500 mt but constituted less than 50% of the total catch in any given year. Between 2002 and 2009, landings were approximately 50-50 between commercial and recreational catches. Between 2010 and 2019, total landings remained high but were dominated by the recreational catch (53%–73% from recreational harvest). The total catch started to decline quickly in 2020, but harvest was more than 70% from the recreational fishery. In the terminal year of the model, the 2022 commercial landings were 199 mt, while the recreational harvest was 936 mt.

While no previous coast-wide estimates of *F* are available for comparison outside of the benchmark or update that use the same modeling methods, the model estimates are intermediate between estimates of *F* generated from tag-return studies conducted during 2005–2006 and, more recently, during 2014–2017 (Smith et al. 2009; Scharf et al. 2017; Scheffel 2017). Estimates of *F* for the New River and Neuse River commercial gill-net fisheries in North Carolina during 2005 and 2006 ranged between 1.4 and 2.0, depending on the river system and year (Smith et al. 2009; Scharf et al. 2017). In the most recent study, Scheffel (2017) estimated *F* at the estuarine scale (New River) and state-wide using a combination of telemetry and conventional tag-return approaches. For the 2014–2016 fishing seasons, combined telemetry/tag-return models estimated *F* in the New River to range between 0.50 and 1.6 and there was considerable inter-annual variation in the estimates. Statewide, the models predicted *F* values ranging between 0.35 and 0.72 and there was less year-to-year variation. Coast-wide predictions of *F* from the ASAP model ranged between 0.98 and 1.2 from 2014 to 2016 and were similar in magnitude to the estimated harvest rates in North Carolina for those years. While estuarine-specific estimates of *F* tend to be more variable both among systems and years and often higher in magnitude, they reflect the unique contributions of specific systems at finer spatial scales to the broader levels of *F* occurring across the state. While tag return studies can provide reliable information about *F*, these studies are often temporally and spatially limited and rely on tag retention and tag returns.

The 2019 update discussed the lack of a comprehensive fisheries-independent index as causing difficulties in assessing the Southern Flounder South Atlantic stock (Flowers et al. 2019). The SEAMAP Trawl Survey was the only coast-wide index used in the model, but it only covers nearshore ocean habitats, and overall catches of Southern Flounder were lower than in any other fishery-independent surveys. The SEAMAP Trawl Survey also went through a series of changes due to the COVID pandemic and budgetary constraints beginning in 2019. This caused several strata in North Carolina and all strata in Florida to not be sampled in the fall for one or more years between 2019 and 2022 (SEAMAP 2021). The strata that were not sampled through the entirety of the time series could not be used in development of the index; thus, the coast-wide survey SEAMAP represented before now only reflects samples from the southern strata of North Carolina to the Georgia-Florida state line.

Given the potential for important levels of spatial variation (among states) in fishery selectivity and fleet behavior in the Southern Flounder fisheries, future assessment efforts may benefit from the application of areas-as-fleets selectivity (Waterhouse et al. 2014). In addition, the current model configuration is not equipped to model varying selectivity estimates due to differing management strategies among the participating states. This could cause misspecification in the model given the continued but varied changes in management since the benchmark stock assessment.

A point of concern was the model fit better to the Shrimp Trawl Bycatch fleet then the commercial or recreational fleets. The uncertainty around the Shrimp Trawl fisheries were set higher or equal to the other fleets, but the model still fit better to the Shrimp Trawl Bycatch. One suggestion for why the model struggled was due to using consistent selectivities within each fleet. While changes occurred throughout the entire time series and vary from state to state, these changes were more pronounced in the commercial and recreational fisheries. The current model configuration assumes that selectivity for the fleets is the same over time. This is not realistic given that management changes over the time series have likely affected gear selectivity. Models are extremely vulnerable to the selectivity assumed for each fishing fleet and stock assessments perform better overall when selectivity is allowed to vary over time (Cadrin et al. 2016). Given the change in SSB estimates and *F* from changing the selectivity from a double logistic function to directly estimating selectivity at age (Figure 3.49), reconstructing the model to allow for time-varying selectivity to reflect changes in management would likely help with model performance.

Strong patterns in the model residuals can be a symptom of problematic selectivity functions (Punt et al. 2014; Cadrin et al. 2016). Research shows that reference points are more susceptible to selectivity assumptions than abundance or fishing mortality estimates (Butterworth et al. 2014; Cadrin et al. 2016). Using the four-parameter double logistic function to estimate selectivity may not be supported by the data. More research is needed to determine how the assumed functional form of selectivity impacts the results of the Southern Flounder stock assessment model.

Many of the management actions taken in recent years cannot be captured by this model adequately. Several trends and diagnostics from the model, such as a high Mohn's rho on *F*, high residuals on catch at age with temporal trends, poor fits to indices, and a better fit to shrimp trawl fisheries rather than commercial or recreational fisheries, are all indicators of potential model misspecification. A benchmark assessment is needed to address recent changes in management actions that the current model cannot consider. In order to assess the effectiveness of management strategies that have occurred over the last five years, the assessment should be completed no sooner than 2026.

4 STATUS DETERMINATION CRITERIA

The Southern Flounder working group used the NCDMF General Statutes as a guide in developing criteria for determining stock status. The General Statutes of North Carolina define overfished as "the condition of a fishery that occurs when the spawning stock biomass of the fishery is below the level that is adequate for the recruitment class of a fishery to replace the spawning class of the fishery" (NCGS § 113-129). The General Statutes define overfishing as "fishing that causes a level of mortality that prevents a fishery from producing a sustainable harvest."

Amendment 1 to the NCDMF FMP for Southern Flounder set the stock threshold at $SPR_{25\%}$ (0.25) and the stock target at $SPR_{35\%}$ (0.35; NCDMF 2013). The fishing mortality reference points are those values of F that correspond to the stock threshold ($F_{25\%}$) and target ($F_{35\%}$). The working group selected $SSB_{25\%}$ as the stock threshold and $SSB_{35\%}$ as the stock target. SSB values below the stock threshold ($SSB_{25\%}$) would indicate the stock is overfished and values of F above the fishing mortality threshold ($F_{25\%}$) would suggest that overfishing is occurring.

The fishing mortality reference points and the values of F that are compared to them represent numbers-weighted values for ages 2 to 4. The ASAP model estimated a value of 0.38 for $F_{35\%}$ (fishing mortality target) and a value of 0.57 for $F_{25\%}$ (fishing mortality threshold). Estimated fishing mortality in 2022 is 0.68, which is higher than the threshold ($F_{25\%}$=0.57) and so indicates that overfishing is occurring (Figure 4.1).

The minimum stock size threshold and target ($SSB_{25\%}$ SPR and $SSB_{35\%}$SPR, respectively) were based on a projection-based approach implemented in the AgePro software version 4.2.2 (Brodziak et al. 1998). This approach determined the level of spawning stock biomass expected under equilibrium conditions when fishing at $F_{25\%}$ and $F_{35\%}$. This approach does not assume a stock-recruitment relationship but instead draws levels of recruitment from an empirical distribution. The AgePro model estimated a value of 5,689 mt for $SSB_{35\%}$ (SSB target) and a value of 4,092 mt for $SSB_{25\%}$ (SSB threshold; Figure 4.2). The estimate of SSB in 2022 is 1,019 mt, which is lower than the SSB threshold ($SSB_{25\%}$=4,092 mt) and so indicates that the stock is overfished.

As recommended by the review panel (Lee et al. 2018), the final year (terminal year) posterior distributions of fishing mortality and spawning stock biomass from the MCMC analysis are compared to the respective reference points (Figures 4.1 and 4.2). This allows probabilistic reporting of the uncertainty associated with the estimated values. Estimates of population values in the terminal year of the stock assessment are often the least informed, and therefore most uncertain. Assuming the MCMC posterior distributions provide reliable estimates of model uncertainty, the probability that the estimated terminal year value is above or below the overfished/overfishing reference points can be calculated. In this way, a level of risk associated with failing to reach the reference points can be quantitatively specified.

For this assessment, the probability the fishing mortality in 2022 is above the threshold value of 0.57 is 63.4%, whereas there is a 95.9% chance the fishing mortality in 2022 is above the target value of 0.38. The probability that the SSB in 2022 is below the threshold or target value (4,092 and 5,689 mt, respectively) is 100%.

5 RESEARCH RECOMMENDATIONS

The research recommendations listed below (in no particular order) are offered by the working group to improve future stock assessments of the South Atlantic Southern Flounder stock. Those recommendations followed by an asterisk (*) were identified as high priority research recommendations, in terms of improving the reliability of future stock assessments, by the peer review panel of the benchmark assessment (Lee et al. 2018).

- Examine the use of current indices in the model and appropriate weighting or combination methods to compare multiple states and a coastwide survey on appropriate spatial and temporal scales
- Explore appropriate time blocks within the model to capture management changes throughout the time series, particularly the implementation of quotas Explore use of appropriate age-specified selectivities to use with Southern Flounder given it is a short-lived species with only 4 age groups modeled
- Continuing a tagging study to estimate emigration, movement rates, and mortality rates throughout the stock's range
- Improve estimates of the B2 component (catches, lengths, and ages) for Southern Flounder from the MRIP *
- Complete an age validation study using known age fish *
- Expand, improve, or add fisheries-independent surveys of the ocean component of the stock *
- Determine locations of spawning aggregations of Southern Flounder *
- Investigate how environmental factors (wind, salinity, temperatures, or oscillations) may be driving the stock-recruitment dynamics for Southern Flounder *
- Develop a survey that will provide estimates of harvest and discards for the recreational gig fisheries in North Carolina, South Carolina, Georgia, and Florida
- Conduct sampling of the commercial and recreational ocean spear fishery harvest and discards
- Develop a survey that will estimate harvest and discards from commercial gears used for recreational purposes

- Develop a survey that will provide estimates of harvest and discards from gears used to capture Southern Flounder for personal consumption
- Collect additional discard data (ages, species ratio, lengths, fates) from other gears (in addition to gill nets) targeting Southern Flounder (pound net, gigs, hook-and-line, trawls)
- Develop and implement consistent strategies for collecting age and sex samples from commercial and recreational fisheries and fisheries-independent surveys to achieve desired precision for stock assessments
- Expand, improve, or add inshore and offshore surveys of Southern Flounder to develop indices for future stock assessments
- Collect age and maturity data from the fisheries-independent SEAMAP Trawl Survey given its broad spatial scale and potential to characterize offshore fish
- Conduct studies to better understand ocean residency of Southern Flounder
- Develop protocol for archiving and sharing data on gonads for microscopic observation of maturity stage of Southern Flounder for North Carolina, South Carolina, Georgia, and Florida
- Examine the variability of Southern Flounder maturity across its range and the effects this may have on the assessment model
- Promote data sharing and research cooperation across the South Atlantic Southern Flounder range (North Carolina, South Carolina, Georgia, and Florida)
- Consider the application of areas-as-fleets models in future stock assessments given the potential spatial variation (among states) in fishery selectivity and fleet behavior in the Southern Flounder fishery
- Consider the application of a spatial model to account for inshore and ocean components of the stock as well as movements among states

In addition to identifying some research needs as high priority, the peer review panel of the benchmark assessment offered the following additional research recommendations (Lee et al. 2018):

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

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7 TABLES

Table 1.1 Average length in centimeters and associated sample size (n), coefficient of variation (CV), minimum length observed (Min), and maximum length observed (Max) by sex and age calculated from North Carolina's available biological data.

Sex	Age	n	Average	CV	Min	Max
Female	0	1,625	29.3	16.6	12.9	41.3
	1	9,078	37.2	15.1	14.5	58.7
	2	7,270	43.0	13.8	14.8	65.2
	3	1,758	48.9	15.7	25.4	74.4
	4	489	55.2	15.4	32.7	78.7
	5	153	60.7	16.3	37.0	83.0
	6	32	64.6	13.4	48.1	83.5
	7	10	71.8	9.7	56.8	79.2
	8	3	61.5	7.7	56.0	64.3
	9	1	81.0		81.0	81.0
Male	0	195	25.9	18.8	12.7	36.8
	1	1,412	29.5	14.5	13.8	48.2
	2	1,174	33.5	11.1	15.9	51.9
	3	114	34.5	12.5	25.5	46.7
	4	7	36.7	9.1	31.9	42.0
	5	4	42.1	6.1	40.0	45.7
	6	3	40.8	9.2	36.7	44.0

Table 1.2 Average length in centimeters and associated sample size (n), coefficient of variation (CV), minimum length observed (Min), and maximum length observed (Max) by sex and age calculated from South Carolina's available biological data.

Sex	Age	n	Average	CV	Min	Max
Female	0	1,213	21.3	20.4	10.6	45.3
	1	4,568	33.4	16.3	12.4	57.2
	2	6,141	41.1	11.0	18.8	59.8
	3	1,712	46.5	11.2	32.8	65.2
	4	463	50.1	12.3	33.1	69.6
	5	85	55.6	11.6	43.5	68.5
	6	22	56.8	12.3	45.7	68.7
	7	2	45.8		45.8	45.8
Male	0	459	19.1	16.9	10.8	29.6
	1	1,721	25.2	17.7	13.6	39.7
	2	845	32.0	11.7	16.4	47.6
	3	124	35.3	8.3	19.5	44.5
	4	30	35.9	7.9	30.8	40.5
	5	3	38.3	3.3	36.8	39.0
	6	4	38.4	2.1	37.7	39.1

Table 1.3 Average length in centimeters and associated sample size (n), coefficient of variation (CV), minimum length observed (Min), and maximum length observed (Max) by sex and age calculated from Georgia's available biological data.

Sex	Age	n	Average	CV	Min	Max
Female	0	7	31.2	6.3	28.0	34.3
	1	351	36.2	10.1	27.5	51.7
	2	447	41.2	11.0	27.7	60.2
	3	137	44.1	13.1	33.7	62.7
	4	20	44.1	13.9	33.9	58.3
	5	2	43.1	6.9	41.0	45.2
	6	0				
	7	1	51.0		51.0	51.0
Male	0					
	1	34	32.8	9.0	27.3	38.8
	2	25	35.7	15.0	27.5	46.4
	3	9	37.7	6.9	35.3	42.6

Table 1.4 Average length in centimeters and associated sample size (n), coefficient of variation (CV), minimum length observed (Min), and maximum length observed (Max) by sex and age calculated from Florida's available biological data.

Sex	Age	n	Average	CV	Min	Max
Female	0	15	28.7	19.4	19.5	37.5
	1	186	33.3	17.5	23.0	52.4
	2	170	40.9	17.4	24.8	57.6
	3	56	46.5	15.5	31.0	62.6
	4	15	53	13.7	40.1	65.5
	5	2	51.5	2.7	50.5	52.5
	6	0	0			
	7	1	52.6		52.6	52.6
Male	0	2	25.3	32.4	195	31.1
	1	38	30.0	12.3	21.6	37.7
	2	24	32.4	15.1	25.3	39.7
	3	3	38.0	8.1	36.0	41.6

Table 1.5 Parameter estimates of the von Bertalanffy age-length growth curve. Values of L_∞ represent total length in millimeters.

Sex	Season	n	L_∞		*K*		t_0	
Pooled	Pooled	43,581	793	(4.3)	0.21	(0.0031)	-0.87	(0.020)
Female	Pooled	33,659	817	(19.7)	0.21	(0.013)	-1.03	(0.090)
Male	Pooled	6,212	387	(6.3)	0.71	(0.066)	0.35	(0.089)
Female	1	10,302	720	(4.0)	0.27	(0.0046)	-0.69	(0.021)
Female	2	23,357	1,044	(17.1)	0.12	(0.0041)	1.78	(0.049)
Male	1	2,557	384	(2.1)	0.76	(0.019)	-0.17	(0.018)
Male	2	3,655	400	(2.7)	0.50	(0.021)	1.03	(0.066)

Table 1.6 Parameter estimates of the length-weight function. The function was fit to total length in millimeters and weight in grams.

Sex	Season	n	*a*		*b*	
Pooled	Pooled	62,816	5.51E-06	(1.13E-07)	3.13	(0.0033)
Female	Pooled	9,919	2.32E-06	(7.88E-08)	3.26	(0.0054)
Male	Pooled	1,886	6.98E-06	(5.16E-07)	3.08	(0.013)
Female	1	2,876	4.04E-06	(2.72E-07)	3.17	(0.011)
Female	2	7,043	1.97E-06	(7.61E-08)	3.29	(0.0062)
Male	1	399	1.28E-05	(2.16E-06)	2.97	(0.029)
Male	2	1,487	6.01E-06	(4.86E-07)	3.11	(0.014)

Table 1.7 Percent (%) maturity at age estimated by two studies of Southern Flounder reproductive maturation in North Carolina.

Age	Monaghan and Armstrong (2000)	Midway and Scharf (2012)
0	18	3
1	74	44
2	91	76
3	99	
4	100	
5	100	
6	100	

Table 1.8 Estimates of age-specific natural mortality (*M*) for Southern Flounder based on Lorenzen's (1996) method.

Age	*M*
0	1.199
1	0.658
2	0.488
3	0.405
4	0.357
5	0.326
6	0.305
7	0.289
8	0.278
9	0.270

Table 1.9 Results of the reanalysis of studies of gill-net and hook-and-line post-release survival and mortality for Southern Flounder in North Carolina.

Gear	Salinity (ppt)	n	Post-Release Survival Rate		Source
			Season 1	Season2	
Large mesh gill net	24	246		0.71	Montgomery (2000)
Large mesh gill net	11-26	268	0.88	0.62	Smith and Scharf (2011)
Hook and line	8-29	316	0.93	0.89	Gearhart (2002)

Table 2.1 Summary of the biological data (number of fish) available from sampling of commercial fisheries landings in the South Atlantic, 1989–2022.

Year	Lengths	Ages
1989	1,874	0
1990	3,012	0
1991	6,911	532
1992	8,166	370
1993	7,363	217
1994	5,768	197
1995	10,596	224
1996	10,049	401
1997	9,127	312
1998	9,555	487
1999	10,529	206
2000	13,133	279
2001	12,792	304
2002	13,726	151
2003	10,792	73
2004	14,533	599
2005	12,991	169
2006	17,105	133
2007	16,494	23
2008	24,467	107
2009	20,037	47
2010	17,584	22
2011	17,405	131
2012	16,745	183
2013	19,128	399
2014	13,865	550
2015	11,904	455
2016	10,319	262
2017	8,978	377
2018	6,606	415
2019	6,977	1,067
2020	4,268	803
2021	4,850	818
2022	3,829	550

Table 2.2 Annual commercial landings, commercial gill-net dead discards, and commercial gill-net live discards of Southern Flounder in the South Atlantic, 1989–2022.

	Landings	Dead Discards	Live Discards
Year	mt	000s of fish	000s of fish
1989	1,607	28.58	39.01
1990	1,304	18.65	25.35
1991	2,031	43.23	60.28
1992	1,550	26.52	37.50
1993	2,055	50.17	63.19
1994	2,355	69.46	88.25
1995	2,002	62.77	81.34
1996	1,788	55.31	71.10
1997	1,927	63.41	84.61
1998	1,856	66.00	84.53
1999	1,440	48.65	67.10
2000	1,541	62.40	80.48
2001	1,661	56.02	73.64
2002	1,629	46.77	65.63
2003	1,047	39.00	56.21
2004	1,187	39.14	55.23
2005	914.6	61.91	75.33
2006	1,113	50.70	65.12
2007	1,017	48.17	81.14
2008	1,232	92.36	110.53
2009	1,125	51.33	64.75
2010	805	25.67	27.73
2011	665	9.65	14.45
2012	848	19.68	35.91
2013	1,061	43.58	87.71
2014	822	25.22	34.65
2015	585	16.52	28.48
2016	461	15.51	23.47
2017	674	17.25	33.16
2018	440	16.14	27.70
2019	413	8.60	14.13
2020	259	7.18	12.69
2021	257	6.83	11.84
2022	199	10.85	21.24

Table 2.3 Summary of the biological data (number of fish) available from sampling of commercial fisheries dead discards, 2013–2022. Samples from the commercial fishery were not available (n/a) from March 2020 through 2021 due to COVID-19.

Year	Lengths
2001	240
2002	200
2003	110
2004	1,559
2005	1,475
2006	1,701
2007	456
2008	1,280
2009	798
2010	435
2011	505
2012	1,360
2013	2,893
2014	1,968
2015	1,263
2016	1,153
2017	1,180
2018	732
2019	348
2020	16
2021	n/a
2022	110

Table 2.4 Summary of the biological data (number of fish) available from sampling of shrimp trawl bycatch from NC Program 570, 2007–2016. Program was not continued after 2016.

Age	Lengths
2007	87
2008	160
2009	55
2010	0
2011	0
2012	64
2013	238
2014	480
2015	193
2016	26

Table 2.5 Annual bycatch (numbers of fish) of Southern Flounder in the South Atlantic shrimp trawl fishery, 1989–2022.

Year	Bycatch
1989	2,166,028
1990	1,445,232
1991	1,203,629
1992	791,302
1993	1,019,723
1994	1,091,200
1995	648,018
1996	837,412
1997	339,590
1998	741,092
1999	778,844
2000	286,358
2001	637,487
2002	534,684
2003	632,549
2004	593,644
2005	510,125
2006	324,600
2007	338,058
2008	396,293
2009	294,223
2010	228,374
2011	697,337
2012	1,014,900
2013	689,502
2014	348,153
2015	278,420
2016	466,164
2017	519,434
2018	448,580
2019	797,933
2020	644,622
2021	361,814
2022	224,706

Table 2.6 Number of volunteer anglers that tagged flounder in the SCDNR Volunteer Angler Tagging Program, 1981–2022. Average values across all years were used as the effective sample size in the stock assessment model.

Year	Season		Annual (Unique Anglers)
	Jan-Jun	Jul-Dec	
1989	22	31	44
1990	27	72	85
1991	53	81	116
1992	72	150	191
1993	95	107	168
1994	66	83	124
1995	61	65	99
1996	49	70	98
1997	45	71	97
1998	46	91	113
1999	42	31	59
2000	35	21	51
2001	8	14	19
2002	4	4	8
2003	1	2	3
2004	4	1	5
2005	16	14	23
2006	14	13	23
2007	12	13	17
2008	7	5	9
2009	2	2	4
2010	1	1	2
2011	0	2	2
2012	3	9	11
2013	9	16	20
2014	18	25	29
2015	20	19	30
2016	20	30	36
2017	25	39	44
2018	29	42	54
2019	29	37	43
2020	28	24	36
2021	26	36	45
2022	34	36	51
Mean	**27**	**37**	**52**

Table 2.7 Number of Southern Flounder tagged in the SCDNR Volunteer Angler Tagging Program, 1989–2022.

Length Bin (cm)	Season 1 Jan-Jun	Season 2 Jul-Dec	Annual
10	1	1	2
12	1	7	8
14	6	12	18
16	14	10	24
18	6	15	21
20	58	81	139
22	65	99	164
24	290	353	643
26	465	696	1,161
28	322	377	699
30	865	1,021	1,886
32	511	694	1,205
34	451	726	1,177
36	128	210	338
38	213	315	528
40	167	226	393
42	87	83	170
44	67	86	153
46	24	16	40
48	33	37	70
50	18	22	40
52	16	16	32
54	6	14	20
56	2	2	4
58	5	7	12
60	1	6	7
62	5	1	6
64	0	0	0
66	1	0	1
68	1	0	1
70	1	0	1
72	0	0	0
74	1	0	1
76	0	3	3
Total	3,831	5,136	8,967

Table 2.8 Summary of the age data (number of fish) available from state (non-MRIP) sampling of recreational catches, 1989–2022.

Year	Lengths	Ages
1989	72	1
1990	99	85
1991	118	105
1992	140	137
1993	114	108
1994	148	148
1995	295	292
1996	281	273
1997	294	290
1998	635	626
1999	734	728
2000	1,039	1,031
2001	745	741
2002	755	726
2003	858	798
2004	464	441
2005	654	640
2006	693	679
2007	424	423
2008	487	480
2009	488	465
2010	480	459
2011	517	496
2012	447	443
2013	388	377
2014	210	200
2015	131	129
2016	399	347
2017	277	253
2018	128	124
2019	161	153
2020	238	225
2021	484	332
2022	613	525

Table 2.9 Annual recreational catch statistics for Southern Flounder in the South Atlantic, 1989–2022. These values do not include estimates from the recreational gig fishery.

Year	Harvest (A+B1)		Released Alive (B2)	
	Num	PSE[NUM]	Num	PSE[NUM]
1989	1,264,576	24.6	331,674	19.2
1990	1,207,333	27.9	368,300	9.7
1991	1,051,890	13.7	987,687	19.2
1992	1,317,885	13.3	653,454	30.1
1993	1,294,224	11.9	768,621	19.3
1994	1,993,498	9.1	1,100,701	12.1
1995	1,464,981	15.8	1,246,790	13.5
1996	889,935	13.0	1,308,061	8.3
1997	1,081,362	13.8	1,733,917	16.3
1998	993,967	12.6	1,521,768	12.9
1999	1,145,359	13.2	1,072,162	16.3
2000	1,431,782	12.1	1,827,518	17.1
2001	1,107,942	9.9	1,765,229	11.6
2002	1,809,714	14.5	2,207,234	14.3
2003	2,003,753	20.0	2,385,976	39.6
2004	1,626,982	20.0	2,359,092	26.6
2005	1,031,773	15.5	1,747,508	15.5
2006	1,011,036	10.6	2,435,607	13.7
2007	1,288,574	14.0	2,348,591	15.7
2008	1,185,203	11.9	3,442,306	14.0
2009	1,440,530	20.6	3,429,532	40.5
2010	1,656,340	10.9	5,119,663	12.0
2011	1,573,009	11.3	3,497,275	14.8
2012	1,359,914	10.5	3,987,712	11.7
2013	1,286,090	18.3	4,005,154	52.7
2014	1,456,136	24.0	4,080,512	32.4
2015	1,227,358	18.4	3,177,056	16.6
2016	1,287,494	15.2	3,779,029	71.2
2017	868,299	16.5	3,585,743	6.9
2018	1,014,160	22.9	2,692,966	13.3
2019	1,667,968	20.9	4,363,754	26.5
2020	1,288,980	19.6	3,137,358	32.8
2021	911,677	14.8	4,798,727	14.8
2022	939,956	20.2	6,843,028	24.3

Table 2.10 Annual recreational gig harvest and discards (number of fish) for Southern Flounder landed in North Carolina, 1989–2022. Note that values prior to 2010 were estimated using a hindcasting approach.

Year	Harvest	Dead Discards
1989	34,722	200
1990	31,878	220
1991	29,073	658
1992	33,968	406
1993	35,725	465
1994	51,888	679
1995	37,148	771
1996	24,197	790
1997	29,130	1,062
1998	25,673	934.0
1999	29,167	714
2000	37,543	1,135
2001	28,941	1,113
2002	47,868	1,397
2003	47,026	1,570
2004	40,400	1,462
2005	28,850	1,069
2006	27,158	1,558
2007	34,620	1,446
2008	31,887	2,112
2009	36,254	2,166
2010	18,079	3,051
2011	51,954	9,726
2012	46,338	2,674
2013	54,419	2,759
2014	42,306	2,715
2015	28,707	2,356
2016	29,642	3,737
2017	24,136	655
2018	23,243	525
2019	20,179	1,042
2020	11,511	90
2021	11,338	926
2022	3,422	109

Table 2.11 Annual recreational catches (numbers of fish) of Southern Flounder in the South Atlantic, 1989–2022. These values include estimates from both the recreational hook-and-line and recreational gig fisheries.

Year	Harvest 000s of fish	Dead Discards 000s of fish
1989	1,299	20.0
1990	1,239	30.1
1991	1,081	21.2
1992	1,352	29.6
1993	1,330	36.6
1994	2,045	39.0
1995	1,502	78.7
1996	914	84.9
1997	1,110	72.1
1998	1,020	66.0
1999	1,175	33.3
2000	1,469	17.8
2001	1,137	15.6
2002	1,858	33.6
2003	2,051	72.8
2004	1,667	41.5
2005	1,061	36.5
2006	1,038	56.7
2007	1,323	32.1
2008	1,217	25.0
2009	1,477	53.7
2010	1,674	6.8
2011	1,625	21.2
2012	1,406	12.2
2013	1,341	8.9
2014	1,498	5.0
2015	1,256	14.7
2016	1,317	13.4
2017	892	9.0
2018	1,037	2.4
2019	1,688	7.7
2020	1,300	17.3
2021	923	7.8
2022	943	6.7

Table 2.12 Summary of the GLM-standardizations applied to the fisheries-independent survey data (nb = negative binomial).

Program	Subset	Model	Significant Covariates	Dispersion
NC 120	May-June; core stations	nb	year, stratum, temp, salinity	1.3
NC 915	Aug–Sep; Pamlico Sound and Rivers; quad 1	nb	year, sediment size, depth, temp, salinity	1.3
SC Electrofishing	Jul–Nov; age-0; no strata; no AR & EW; no late-flood tidal stage	nb	year, stratum, depth, temp, salinity, tide	1.1
SC Trammel Net	Jul–Oct	nb	year, stratum, depth, temp, salinity, DO, tide	1.1
GA Trawl	Jan–Mar	nb	year, station, temp, depth, salinity	1.3
FL Trawl (age 0)	Feb–Jun	nb	year, stratum, depth, temp, salinity	1.4
FL Trawl (adult)	Jan–Mar	nb	year, stratum, depth, temp, salinity	1.1
SEAMAP	Fall (Sep–Nov); no strata from FL and only 1 from NC	nb	year, stratum, salinity	1.1

Table 2.13 GLM-standardized indices of age-1 relative abundance and associated standard errors, 1989–2022. Indices of young-of-year are age-0 values that have been bumped by 1 year and 1 age to become age-1 relative indices.

	NC120		SC Electrofishing		FL Trawl (age 0)	
Year	**Index**	**SE [Index]**	**Index**	**SE [Index]**	**Index**	**SE [Index]**
1989						
1990	2.26	0.318				
1991	4.81	0.633				
1992	1.44	0.212				
1993	3.23	0.436				
1994	3.04	0.417				
1995	2.66	0.396				
1996	3.09	0.482				
1997	10.62	1.465				
1998	2.56	0.339				
1999	0.84	0.126				
2000	3.42	0.451				
2001	4.80	0.634				
2002	6.02	0.766	2.37	0.412	0.42	0.172
2003	5.76	0.719	1.13	0.195	0.12	0.051
2004	6.38	0.833	2.91	0.456	0.28	0.074
2005	4.46	0.569	2.82	0.427	0.27	0.087
2006	2.96	0.385	2.37	0.397	0.77	0.181
2007	2.72	0.349	1.23	0.227	0.20	0.048
2008	3.87	0.498	1.82	0.301	0.17	0.048
2009	2.96	0.383	0.81	0.174	0.14	0.040
2010	2.31	0.303	1.13	0.203	0.11	0.031
2011	5.34	0.669	0.79	0.164	1.02	0.191
2012	1.53	0.218	1.12	0.218	0.90	0.173
2013	3.41	0.429	1.17	0.228	0.16	0.046
2014	3.09	0.396	1.42	0.273	0.16	0.044
2015	2.29	0.308	1.69	0.308	0.23	0.053
2016	1.89	0.257	0.58	0.135	0.17	0.043
2017	0.55	0.087	0.95	0.185	0.08	0.026
2018	1.17	0.165	1.40	0.249	0.02	0.013
2019	1.64	0.226	2.06	0.320	0.32	0.070
2020	1.05	0.149	0.37	0.089	0.31	0.071
2021	0.63	0.097	0.40	0.100	0.32	0.081
2022	1.93	0.259	0.33	0.091	0.21	0.051

Table 2.14 Summary of the biological data (number of fish) available from sampling of the age-0 fish independent surveys, 1989–2022.

	Length		
Year	NC120	SC Electrofishing	FL Trawl YOY
1989	429		
1990	855		
1991	209		
1992	452		
1993	504		
1994	343		
1995	329		
1996	1,113		
1997	496		
1998	180		
1999	447		
2000	626		
2001	769		15
2002	711	1	8
2003	908		42
2004	671	2	21
2005	555		61
2006	470	2	37
2007	692		23
2008	433	1	24
2009	366		21
2010	770		195
2011	210		120
2012	557		24
2013	548		25
2014	380		50
2015	348		36
2016	105		14
2017	213		4
2018	282		70
2019	214		54
2020	127	1	44
2021	494	2	40
2022	172	2	31

Table 2.15 Summary of the biological data (number of fish) available from sampling of the adult independent surveys, 1989–2022. Samples from the NC915 and SEAMAP surveys were not available (n/a) from March 2020 through 2021 due to COVID-19.

	Length				
Year	**NC915**	**SC Trammel Net**	**GA Trawl**	**FL Trawl (adult)**	**SEAMAP**
1989					29
1990					33
1991					20
1992					21
1993					22
1994					28
1995					9
1996			225		26
1997			125		13
1998		753	364		27
1999		659			36
2000		451			12
2001		523			11
2002		644		21	17
2003	376	620	46	16	10
2004	360	547	468	12	14
2005	206	611	419	24	9
2006	241	514	330	39	10
2007	166	306	201	25	5
2008	503	383	296	21	9
2009	240	292	264	7	13
2010	399	356	231	32	26
2011	259	380	163	61	38
2012	305	367	87	73	67
2013	367	393	83	12	18
2014	232	372	241	23	18
2015	161	344	542	57	63
2016	133	335	218	35	55
2017	167	158	131	6	28
2018	209	272	60	8	44
2019	211	217	362	27	41
2020	n/a	200	203	30	n/a
2021	295	158	191	32	34
2022	162	196	202	34	22

Table 2.16 GLM-standardized indices of adult relative abundance and associated standard errors, 1989–2022. Samples from the NC915 and SEAMAP surveys were not available (n/a) from March 2020 through 2021 due to COVID-19.

	NC915		SC Trammel Net		GA Trawl		FL Trawl (adult)		SEAMAP	
Year	**Index**	**SE [Index]**	**Index**	**SE [Index]**	**Index**	**SE [Index]**	**Index**	**SE [Index]**	**Index**	**SE [Index]**
1989									1.12	0.446
1990									0.74	0.252
1991									0.55	0.203
1992									0.35	0.136
1993									0.59	0.217
1994									0.39	0.147
1995									0.13	0.064
1996					7.15	1.134			0.21	0.090
1997					5.08	0.865			0.19	0.090
1998			2.72	0.284	4.25	0.539			0.88	0.276
1999			2.39	0.277					0.53	0.197
2000			2.00	0.280					0.38	0.153
2001			1.85	0.203					0.20	0.105
2002			2.36	0.252			0.12	0.043	0.43	0.165
2003	7.48	1.045	1.86	0.226	3.77	1.059	0.07	0.027	0.19	0.083
2004	7.04	0.980	1.74	0.199	9.55	1.103	0.13	0.045	0.23	0.092
2005	4.96	0.829	1.71	0.199	5.80	0.636	0.17	0.052	0.37	0.144
2006	4.13	0.617	1.80	0.193	4.99	0.584	0.17	0.042	0.36	0.154
2007	2.98	0.446	0.67	0.084	4.68	0.621	0.15	0.038	0.24	0.112
2008	7.74	1.039	1.45	0.164	4.36	0.525	0.12	0.032	0.08	0.049
2009	4.41	0.661	1.11	0.133	7.27	0.967	0.04	0.016	0.32	0.135
2010	7.78	1.151	1.04	0.121	2.58	0.387	0.05	0.016	0.59	0.210
2011	5.33	0.780	1.03	0.123	3.13	0.435	0.35	0.069	1.01	0.359
2012	6.87	0.939	0.87	0.107	3.85	0.719	0.49	0.093	0.96	0.320
2013	7.42	1.047	1.06	0.145	2.53	0.437	0.07	0.024	0.25	0.109
2014	4.81	0.717	1.34	0.159	3.10	0.398	0.11	0.031	0.51	0.188
2015	3.37	0.538	1.40	0.168	6.88	0.695	0.21	0.048	0.97	0.323
2016	2.78	0.445	0.90	0.120	2.99	0.389	0.17	0.042	1.05	0.341
2017	3.17	0.480	0.68	0.108	3.33	0.520	0.04	0.019	0.69	0.252
2018	3.49	0.518	1.08	0.140	2.26	0.437	0.03	0.012	1.46	0.513
2019	4.17	0.615	0.81	0.113	4.71	0.559	0.14	0.036	1.34	0.445
2020	n/a	n/a	1.08	0.160	4.69	0.648	0.20	0.051	n/a	n/a
2021	5.12	0.774	0.99	0.162	4.36	0.601	0.17	0.041	0.18	0.085
2022	3.10	0.471	1.25	0.199	4.14	0.535	0.20	0.048	0.42	0.173

Table 2.17 Monthly cutoff lengths used for delineating age-0 fish in the FL Trawl survey.

Month	SL (mm)
Jan	26
Feb	44
Mar	70
Apr	105
May	147
Jun	196
Jul	196
Aug	196
Sep	196
Oct	196
Nov	196
Dec	196

Table 3.1 Summary of available age data (number of fish) from fisheries-independent data sources that were the basis of inputs entered into the ASAP model, 1989–2022.

Year	FL	NC	SC
1989			28
1990			513
1991		19	738
1992		95	592
1993		56	332
1994			219
1995		45	35
1996		47	7
1997		142	
1998	3	198	130
1999	1	142	140
2000		139	116
2001	44	119	104
2002	32	195	119
2003	136	140	142
2004	93	216	111
2005	148	511	95
2006	111	529	131
2007	98	499	93
2008	89	795	89
2009	121	414	62
2010	410	1,067	73
2011	233	710	105
2012	94	971	75
2013	109	617	78
2014	141	811	63
2015	135	462	29
2016	44	431	48
2017	31	670	32
2018	129	576	40
2019	99	1053	65
2020	76	225	13
2021	100	645	25
2022	51	491	48

Table 3.2 Summary of available age data (number of fish) from fisheries-dependent data sources that were the basis of inputs entered into the ASAP model, 1989–2022.

Year	NC Comm	FL Comm	NC Rec	SC Rec	GA Rec	FL Rec
1989				1		
1990				85		
1991	532		8	97		
1992	370		12	125		
1993	217			108		
1994	197		20	128		
1995	224		27	265		
1996	294		22	251		
1997	312		48	242		
1998	487		97	498	31	
1999	206		165	539	24	
2000	279		251	772	8	
2001	304		238	486	17	
2002	136	15	108	551	60	9
2003	73		81	604	87	33
2004	599		70	324	21	26
2005	169		117	483	26	17
2006	133		200	376	93	13
2007	23		218	184	20	4
2008	107		200	232	48	
2009	32	15	45	330	90	2
2010	22		134	204	120	1
2011	68	63	127	306	63	
2012	163	20	60	338	45	
2013	346	53	2	260	115	1
2014	463	87		166	26	8
2015	332	123	28	54	46	1
2016	201	61	140	154	53	
2017	359	18	149	65	39	
2018	310	105	78	46		
2019	993	74	73	80		1
2020	763	40	222	3		
2021	766	52	328	4		9
2022	498	52	484	41		19

Table 3.3 Number of fish aged per length bin from fisheries-independent data sources, 1989–2022. Dark grey highlighted cells indicate no age sampling and light grey highlighted cells identify length bins with less than 10 aged fish.

	Length Bin																																
Year	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**	**32**	**34**	**36**	**38**	**40**	**42**	**44**	**46**	**48**	**50**	**52**	**54**	**56**	**58**	**60**	**62**	**64**	**66**	**68**	**70**
1989	0	0	0	0	0	0	0	0	1	1	0	2	3	1	0	3	5	3	4	2	0	0	0	1	0	1	0	0	0	0	1	0	0
1990	0	0	0	4	6	12	20	45	43	43	34	36	29	27	29	23	10	27	21	22	28	21	15	6	7	3	1	0	0	0	1	0	0
1991	1	1	4	13	22	38	53	68	73	72	45	32	37	33	47	49	52	28	24	17	16	10	5	8	4	3	1	1	0	0	0	0	0
1992	0	0	0	32	52	61	45	42	44	37	49	59	59	38	29	23	14	16	20	21	13	11	8	9	2	2	0	1	0	0	0	0	0
1993	0	0	1	1	15	14	20	30	27	39	31	35	40	18	21	18	11	11	8	6	11	6	9	8	3	3	0	0	1	0	1	0	0
1994	0	0	0	4	5	6	24	22	11	20	13	15	17	14	9	12	12	12	8	5	6	1	0	2	1	0	0	0	0	0	0	0	0
1995	0	0	0	1	3	7	16	15	13	5	7	3	2	1	0	1	0	1	0	0	0	1	2	0	0	1	1	0	0	0	0	0	0
1996	0	0	0	0	4	11	2	5	4	4	2	7	6	3	1	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	1	3	13	21	6	5	11	12	6	4	2	14	10	12	2	6	5	4	1	1	1	0	0	0	0	1	0	1	0	0	0
1998	0	1	1	4	1	6	14	34	33	33	37	30	14	26	16	16	12	12	10	8	3	8	3	1	1	4	2	1	0	0	0	0	0
1999	0	0	1	3	5	17	22	13	13	17	17	20	23	19	27	14	19	14	14	7	9	1	4	1	1	0	0	1	0	1	0	0	0
2000	0	0	0	0	0	9	8	9	17	12	18	22	30	22	18	15	14	20	10	12	5	2	1	2	6	2	1	0	0	0	0	0	0
2001	11	4	8	6	8	9	14	9	8	16	11	10	18	18	18	8	19	21	15	9	9	3	2	3	0	1	0	0	0	1	0	0	0
2002	3	0	6	1	0	10	10	11	15	14	15	21	25	40	30	25	18	23	19	16	8	7	2	6	1	3	0	1	0	0	0	0	0
2003	10	16	9	4	6	11	9	12	13	8	15	11	19	26	32	35	24	16	10	17	13	7	9	3	3	4	0	0	0	1	0	0	0
2004	11	8	8	11	6	6	12	8	20	14	16	24	34	24	31	21	28	31	33	17	19	2	7	3	3	1	1	1	1	0	0	1	0
2005	25	17	11	2	4	8	11	12	12	19	34	36	50	75	73	62	57	71	39	22	18	9	2	1	0	0	2	1	0	0	0	0	0
2006	22	6	10	8	4	9	11	21	15	19	27	42	54	67	75	69	70	57	51	42	20	12	11	6	1	1	1	0	0	1	0	0	0
2007	8	5	5	11	3	8	16	16	21	30	35	53	51	76	73	70	48	50	25	18	17	5	7	3	2	1	0	0	0	0	0	0	0
2008	6	6	4	4	4	8	10	26	31	42	50	54	71	95	115	107	85	82	60	36	14	12	8	4	1	2	0	0	1	0	0	1	0
2009	7	10	10	19	15	17	5	10	18	17	22	23	47	41	43	52	48	51	47	35	17	12	7	3	2	1	2	0	1	0	0	1	0
2010	46	23	17	9	5	8	8	9	19	28	50	71	100	135	146	140	122	121	91	52	26	25	7	6	3	2	0	0	0	0	0	0	0
2011	17	23	28	11	4	20	13	19	22	25	22	40	59	96	128	127	81	82	60	34	23	8	7	3	1	1	0	0	0	0	0	1	0
2012	3	3	12	7	3	10	16	30	40	63	86	97	158	126	104	83	71	53	56	37	20	19	16	7	8	1	0	0	0	1	0	1	0
2013	9	7	13	17	6	10	11	15	29	38	48	69	72	91	89	67	75	41	36	16	10	5	6	1	3	1	1	1	0	0	0	1	0
2014	18	10	43	21	6	9	9	17	23	37	58	65	79	88	79	80	70	76	54	41	28	21	7	4	2	1	1	0	1	0	0	0	0
2015	15	14	17	8	7	6	6	13	16	27	25	30	46	43	51	70	51	45	34	28	14	9	3	0	1	0	0	0	0	0	0	0	0
2016	2	6	2	3	5	3	4	8	16	24	26	50	50	46	41	47	46	41	31	25	16	11	10	3	0	1	0	0	1	0	0	0	0
2017	4	1	2	6	4	7	12	7	17	22	31	60	58	88	70	77	85	62	34	38	15	13	7	3	3	3	0	0	0	0	0	0	0
2018	16	16	14	25	26	9	14	16	32	33	52	55	45	58	52	44	46	45	32	28	15	12	5	2	0	1	1	1	0	0	0	0	0
2019	13	14	15	12	12	18	16	20	21	34	59	69	61	76	113	129	118	129	101	74	39	16	13	2	5	0	2	0	0	0	0	0	0
2020	8	5	17	10	7	4	2	3	7	13	20	27	26	16	6	21	22	18	8	8	12	12	8	4	1	2	2	0	0	0	0	0	0
2021	14	9	13	11	6	8	7	12	17	24	24	51	42	45	62	78	74	82	48	47	26	13	12	6	2	4	4	1	0	1	0	0	0
2022	5	5	9	10	7	9	9	9	15	24	29	38	41	42	44	52	57	50	38	31	17	13	10	4	2	2	2	0	0	0	0	0	0

Table 3.4 Number of fish aged per length bin from fisheries-dependent data sources, 1989–2022. Dark grey highlighted cells indicate no age sampling and light grey highlighted cells identify length bins with less than 10 aged fish.

Year	Length Bin																																
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	2	11	9	11	10	8	6	8	8	2	2	2	0	0	0	0	0	0
1991	0	0	1	4	17	22	13	10	8	16	29	38	24	45	45	61	60	49	48	29	30	27	34	10	6	2	2	1	3	2	0	0	0
1992	0	0	0	0	1	2	5	2	7	6	9	24	81	54	45	53	51	29	20	24	25	21	12	18	9	4	5	0	0	0	0	0	0
1993	0	0	0	1	7	3	9	1	7	7	11	22	29	23	33	21	34	32	25	22	11	9	7	5	0	3	2	1	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	4	17	33	31	54	44	45	34	34	19	18	7	3	0	1	1	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	1	3	5	31	50	55	57	44	41	61	39	35	26	18	21	11	8	4	3	1	2	0	0	0
1996	0	0	1	3	7	0	3	5	0	4	7	16	31	74	67	82	74	50	39	19	22	7	13	15	7	5	2	3	3	3	2	2	1
1997	0	0	0	0	1	0	0	3	4	9	7	6	20	24	69	74	64	56	49	51	36	34	38	20	9	8	7	3	0	2	3	1	2
1998	0	0	0	0	0	1	3	6	10	7	12	20	63	113	128	126	145	105	86	82	49	41	27	26	14	20	8	6	5	4	2	1	1
1999	0	0	0	0	0	0	0	0	2	3	6	4	51	87	128	116	120	95	80	73	48	28	29	20	11	20	5	2	2	0	0	2	1
2000	0	0	0	0	0	6	3	10	7	9	18	13	45	91	124	147	148	141	131	98	63	62	50	33	31	26	15	4	10	9	2	10	2
2001	0	0	0	0	0	0	0	1	4	6	6	22	49	105	119	142	131	90	99	71	61	42	28	10	21	10	3	5	3	2	5	2	3
2002	0	0	0	0	0	0	4	4	5	1	6	15	50	92	82	109	121	87	83	61	51	36	26	5	9	6	3	5	4	4	2	3	0
2003	0	0	0	0	1	0	0	1	2	5	4	2	35	73	122	122	109	112	82	57	33	16	15	20	25	17	10	4	4	2	1	1	0
2004	0	0	0	0	0	2	11	3	5	7	10	20	37	87	114	121	138	124	67	77	41	45	28	34	21	14	6	8	6	1	2	2	1
2005	0	0	0	1	0	0	6	4	0	5	8	7	45	58	72	97	93	93	88	51	39	32	27	20	20	7	10	13	2	2	1	4	1
2006	0	0	0	0	0	0	0	1	3	3	3	3	15	52	55	65	94	118	124	81	75	44	22	13	12	10	2	6	3	5	2	2	0
2007	0	0	0	0	0	0	0	0	0	0	0	0	2	9	25	50	51	49	45	55	41	28	34	15	13	10	8	2	5	2	1	2	1
2008	0	0	0	0	0	0	0	0	10	10	6	5	6	10	33	56	70	79	54	56	40	32	28	17	22	13	8	11	13	2	4	1	0
2009	0	0	0	0	0	0	0	0	0	0	0	0	3	9	27	41	62	72	64	67	49	32	16	18	16	14	8	7	3	0	1	1	2
2010	0	0	0	0	0	0	0	0	0	0	0	0	4	8	15	42	54	89	55	52	40	27	20	17	16	15	8	6	6	3	1	1	0
2011	0	0	0	0	0	0	0	0	0	0	0	0	3	12	43	80	84	96	63	61	48	28	22	13	14	12	10	7	6	9	4	5	2
2012	0	0	0	0	0	0	0	0	0	0	3	5	15	18	42	91	87	88	74	70	25	23	22	13	9	13	10	4	3	4	3	1	1
2013	0	0	0	0	0	0	0	1	0	0	5	14	18	27	56	95	98	80	84	62	51	43	34	28	29	19	13	8	6	2	1	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	2	10	29	64	76	85	96	100	75	43	35	41	28	24	14	8	6	3	2	4	1	2
2015	0	0	0	0	0	0	0	0	0	0	0	1	0	7	45	46	98	110	91	47	39	19	23	19	17	13	5	0	2	1	1	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	2	10	11	28	23	94	105	91	73	50	41	27	15	17	6	8	3	2	2	1	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	5	7	26	129	123	86	63	39	46	29	17	24	11	9	7	3	2	1	2	0
2018	0	0	0	0	0	0	0	0	0	0	1	0	0	4	4	19	99	99	84	53	37	38	24	23	13	18	9	3	4	4	1	2	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	8	13	10	56	326	275	167	115	74	66	38	22	18	14	4	7	3	3	2	0	0
2020	0	0	0	0	0	0	0	0	0	0	2	2	3	4	7	54	191	179	117	115	116	81	59	53	25	9	3	3	1	2	0	0	2
2021	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	44	197	248	228	183	94	56	23	21	14	11	14	9	3	3	2	2	1
2022	0	0	0	0	0	0	0	1	1	1	2	0	2	2	7	59	155	190	167	143	85	83	51	41	18	20	17	23	12	3	6	2	1

Table 3.5 Ages assumed for length bins (cm) with zero fish aged.

Age	Min Length	Max Length
0	2	24
1	26	34
2	36	40
3	42	46
4	48	52
5	54	58
6	60	64
7	66	70
8	72	78
9	80	90

Table 3.6 Natural mortality at age assumed for the ASAP model.

Age	M
1	0.66
2	0.49
3	0.41
4+	0.36

Table 3.7 Maturity at age assumed for the ASAP model.

Age	Maturity
1	0.030
2	0.44
3	0.76
4+	1.0

Table 3.8 Sex ratio at age assumed for the ASAP model.

Age	Proportion Female
1	0.79
2	0.84
3	0.93
4+	0.96

Table 3.9 Coefficient of variation (CV) values assumed for the fisheries-independent indices, 1989-2022.

	YOY Indices			Adult Indices				
Year	**NC120**	**SCElectro**	**FLTrawl**	**NC915**	**SCTrammel**	**GATrawl**	**FLTrawl**	**SEAMAP**
1989	0.141							0.320
1990	0.132							0.272
1991	0.147							0.292
1992	0.135							0.312
1993	0.137							0.292
1994	0.149							0.301
1995	0.156							0.396
1996	0.138					0.159		0.340
1997	0.132					0.170		0.374
1998	0.150				0.104	0.127		0.250
1999	0.132				0.116			0.300
2000	0.132				0.140			0.326
2001	0.127	0.179	0.413		0.110			0.431
2002	0.125	0.177	0.430		0.107		0.373	0.307
2003	0.130	0.164	0.265	0.140	0.122	0.281	0.387	0.358
2004	0.128	0.156	0.317	0.139	0.114	0.116	0.348	0.315
2005	0.130	0.171	0.234	0.167	0.116	0.110	0.299	0.314
2006	0.128	0.187	0.243	0.149	0.107	0.117	0.240	0.345
2007	0.129	0.171	0.289	0.149	0.125	0.133	0.256	0.382
2008	0.129	0.218	0.282	0.134	0.113	0.121	0.272	0.516
2009	0.131	0.184	0.290	0.150	0.119	0.133	0.437	0.341
2010	0.125	0.212	0.187	0.148	0.117	0.150	0.334	0.287
2011	0.143	0.198	0.193	0.146	0.120	0.139	0.196	0.284
2012	0.126	0.197	0.286	0.137	0.123	0.187	0.191	0.268
2013	0.128	0.197	0.276	0.141	0.137	0.172	0.352	0.345
2014	0.134	0.184	0.227	0.149	0.119	0.128	0.279	0.299
2015	0.136	0.237	0.253	0.159	0.120	0.101	0.227	0.267
2016	0.159	0.197	0.329	0.160	0.132	0.130	0.243	0.260
2017	0.141	0.181	0.540	0.151	0.159	0.156	0.436	0.293
2018	0.137	0.157	0.218	0.149	0.129	0.193	0.478	0.282
2019	0.142	0.245	0.226	0.148	0.139	0.119	0.263	0.266
2020	0.154	0.250	0.252		0.147	0.138	0.254	
2021	0.134	0.275	0.243	0.151	0.163	0.138	0.241	0.386
2022	0.149	0.248	0.265	0.152	0.159	0.129	0.233	0.331

Table 3.10 Effective sample sizes applied to the commercial, recreational, and shrimp trawl bycatch catch and discards, 1989-2022.

Year	Commercial	Recreational	Shrimp Trawl
1989	0.00	0.00	0.00
1990	0.00	0.00	0.00
1991	14.25	27.62	0.00
1992	15.23	30.53	0.00
1993	16.85	32.56	0.00
1994	17.58	33.08	0.00
1995	19.10	33.33	0.00
1996	17.29	28.25	0.00
1997	21.26	31.29	0.00
1998	28.27	32.02	0.00
1999	30.72	24.76	0.00
2000	25.24	25.36	0.00
2001	28.34	25.26	0.00
2002	25.12	24.90	0.00
2003	21.70	23.15	0.00
2004	21.02	24.19	0.00
2005	21.68	22.87	0.00
2006	27.95	26.08	0.00
2007	27.86	27.09	0.00
2008	29.80	26.23	12.65
2009	32.71	24.35	0.00
2010	38.73	33.30	0.00
2011	41.09	29.39	0.00
2012	47.52	27.75	0.00
2013	68.30	26.78	15.43
2014	58.17	30.00	21.91
2015	49.82	27.84	13.89
2016	51.36	31.27	0.00
2017	50.65	30.46	0.00
2018	35.03	32.45	0.00
2019	33.87	32.71	0.00
2020	18.22	31.83	0.00
2021	17.12	34.26	0.00
2022	18.89	33.08	0.00

Table 3.11 Effective sample sizes applied to fisheries-independent indices of adult abundance, 1989-2022.

Year	NC915	SCTrammel	GATrawl	FLTrawl	SEAMAP
1989	0.00	0.00	0.00	0.00	5.39
1990	0.00	0.00	0.00	0.00	5.74
1991	0.00	0.00	0.00	0.00	4.47
1992	0.00	0.00	0.00	0.00	4.58
1993	0.00	0.00	0.00	0.00	4.69
1994	0.00	0.00	0.00	0.00	5.29
1995	0.00	0.00	0.00	0.00	3.00
1996	0.00	0.00	15.00	0.00	5.10
1997	0.00	0.00	11.18	0.00	3.61
1998	0.00	0.00	19.08	0.00	5.20
1999	0.00	25.67	0.00	0.00	6.00
2000	0.00	21.24	0.00	0.00	3.46
2001	0.00	22.87	0.00	0.00	3.32
2002	0.00	25.40	0.00	3.16	4.12
2003	19.39	24.90	6.78	3.32	3.16
2004	18.97	23.41	21.63	3.46	3.74
2005	14.35	24.80	20.47	4.58	3.00
2006	15.52	22.67	18.17	6.16	3.16
2007	12.88	17.52	14.18	4.90	2.24
2008	22.43	19.57	17.20	4.58	3.00
2009	15.49	17.09	16.25	2.45	3.61
2010	19.97	18.89	15.20	3.74	5.10
2011	16.09	19.49	12.77	7.75	6.16
2012	17.46	19.16	9.33	8.54	8.19
2013	19.16	19.85	9.11	3.16	4.24
2014	15.23	19.29	15.52	4.69	4.24
2015	12.69	18.60	23.28	6.71	7.94
2016	11.53	18.33	14.76	5.66	7.42
2017	12.92	12.61	11.45	2.45	5.29
2018	14.46	16.49	7.75	2.24	6.63
2019	14.53	14.76	19.03	5.00	6.40
2020	0.00	14.14	14.25	5.29	0.00
2021	17.18	12.57	13.82	5.57	5.83
2022	12.73	14.00	14.21	5.74	4.69

Table 3.12 Coefficient of variation (CV) and lambda weighting values applied to various likelihood components in the ASAP model.

Source	Parameter	Lambda	CV
Commercial	Total catch in weight	1.0	
	Total discards in weight	0.0	
	F-mult in first year	0.0	0.9
	F-mult deviations	0.0	0.9
Recreational	Total catch in weight	1.0	
	Total discards in weight	0.0	
	F-mult in first year	0.0	0.9
	F-mult deviations	0.0	0.9
Shrimp Trawl	Total catch in weight	1.0	
	Total discards in weight	0.0	
	F-mult in first year	0.0	0.9
	F-mult deviations	0.0	0.9
Surveys	Index	1.0	
	Catchability	0.0	0.9
	Catchability deviations	1.0	0.05
Other	N in first year deviation	0.5	0.9
	Deviation from initial steepness	0.0	0.9
	Deviation from initial SR scalar	0.0	0.9
	Recruitment deviations	0.6	0.7

Table 3.13 Initial starting values specified in the ASAP model.

Source	Parameter	Start Value
Numbers at age	Age 1	15,000
	Age 2	7,500
	Age 3	4,500
	Age 4	1,500
Stock-Recruitment	Virgin recruitment	15,000
	Steepness	0.85
	Maximum *F*	4
F-mult	Commercial	0.7
	Recreational	0.4
	Shrimp Trawl	0.01
Surveys	Catchability	0.0001

Table 3.14 Estimates of age-specific natural mortality (*M*) for Southern Flounder based on Lorenzen's (2022) method. Only mortalities for age 1 through age 4 were used in the model due to the constraints of ASAP and the use of a 4 plus age.

Age	*M*	*M* (scaled)
0	1.627	2.425
1	0.836	1.247
2	0.600	0.895
3	0.488	0.728
4	0.424	0.632
5	0.383	0.572
6	0.356	0.530
7	0.336	0.501
8	0.322	0.479
9	0.311	0.463

Table 3.15 Root mean squared error (RMSE) computed from standardized residuals and maximum RMSE computed from Francis (2011).

Component	# Residuals	RMSE	MaxRMSE
Commercial Catch	34	0.465	
Recreational Catch	34	0.682	
Shrimp Trawl Bycatch	34	0.108	
Total Catch	102	0.48	
NC 120 Trawl Survey	33	1.44	1.20
NC 915 Gill-Net Survey	19	1.1	1.27
SC Electrofishing Survey	21	1.37	1.25
SC Trammel Net Survey	25	0.804	1.23
GA Trawl Survey	22	0.922	1.25
FL Trawl Survey-- YOY	21	1.97	1.25
FL Trawl Survey-- Adult	21	1.7	1.25
SEAMAP Trawl Survey	33	1.87	1.20
Total Survey Indices	195	1.47	
Stock numbers in 1st year	0	0.398	
Recruit Deviations	34	0.472	
Fleet Selectivity Parameters	7	0.539	
Survey Selectivity Parameters	14	0.571	
Catchability Deviations	0	0.529	

Table 3.16 Predicted recruitment and female spawning stock biomass (SSB) and associated standard deviations from the base run of the ASAP model, 1989–2022.

	Recruits (000s of fish)		SSB (metric tons)	
Year	Value	SD	Value	SD
1989	14,431	3,061	2,029	715
1990	8,751	1,460	2,509	569
1991	14,865	1,779	2,130	426
1992	7,333	1,103	2,507	396
1993	12,252	1,525	2,496	438
1994	11,261	1,400	2,642	442
1995	8,440	1,123	2,249	373
1996	9,099	1,109	2,078	358
1997	10,982	1,278	2,297	366
1998	10,172	1,151	2,587	391
1999	5,794	765	3,001	410
2000	9,884	1,120	2,626	425
2001	9,435	1,087	2,535	405
2002	8,771	919	2,536	389
2003	7,579	756	2,184	343
2004	10,154	878	1,847	287
2005	6,882	648	2,327	302
2006	6,362	601	3,028	374
2007	5,838	558	2,802	407
2008	6,632	612	2,041	324
2009	5,733	555	2,023	283
2010	5,254	514	1,815	253
2011	8,330	747	1,883	253
2012	6,417	610	2,156	289
2013	6,708	620	1,786	287
2014	5,440	512	1,221	192
2015	6,128	584	1,283	184
2016	4,429	434	1,437	224
2017	3,901	397	974	155
2018	3,864	427	971	154
2019	7,052	696	1,060	177
2020	4,303	480	1,020	176
2021	3,858	431	827	154
2022	4,348	578	1,019	192

Table 3.17 Predicted spawner potential ratio (SPR) from the base run of the ASAP model, 1989–2022.

Year	SPR
1989	0.11
1990	0.1
1991	0.1
1992	0.15
1993	0.12
1994	0.09
1995	0.11
1996	0.14
1997	0.14
1998	0.18
1999	0.16
2000	0.14
2001	0.14
2002	0.11
2003	0.11
2004	0.15
2005	0.27
2006	0.18
2007	0.13
2008	0.17
2009	0.15
2010	0.18
2011	0.17
2012	0.12
2013	0.08
2014	0.13
2015	0.13
2016	0.09
2017	0.13
2018	0.15
2019	0.08
2020	0.08
2021	0.15
2022	0.21

Table 3.18 Predicted fishing mortality (numbers-weighted, ages 2–4) and associated standard deviations from the base run of the ASAP model, 1989–2022.

Year	Value	SD
1989	1.14	0.26
1990	1.23	0.23
1991	1.16	0.22
1992	0.9	0.17
1993	1.03	0.19
1994	1.28	0.22
1995	1.12	0.19
1996	0.92	0.16
1997	0.96	0.18
1998	0.78	0.14
1999	0.84	0.16
2000	0.94	0.18
2001	0.93	0.17
2002	1.14	0.2
2003	1.19	0.21
2004	0.9	0.17
2005	0.52	0.09
2006	0.75	0.14
2007	0.97	0.17
2008	0.8	0.14
2009	0.93	0.15
2010	0.76	0.13
2011	0.82	0.16
2012	1.1	0.21
2013	1.56	0.26
2014	1.08	0.19
2015	1.02	0.21
2016	1.45	0.26
2017	1.05	0.19
2018	0.92	0.19
2019	1.55	0.33
2020	1.49	0.32
2021	0.88	0.22
2022	0.68	0.21

8 FIGURES

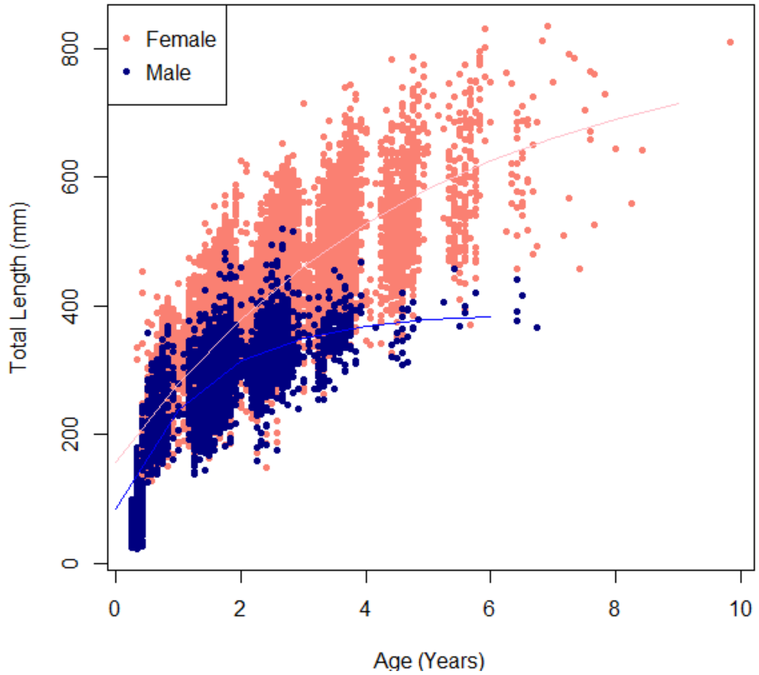


Figure 1.1. Fit of the von Bertalanffy age-length model to available biological data for Southern Flounder.

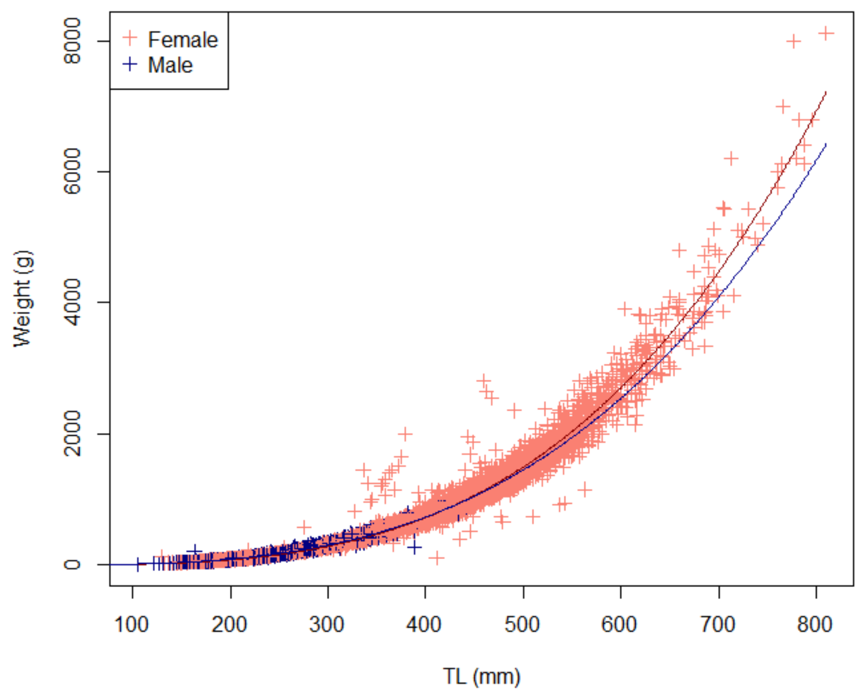


Figure 1.2. Fit of the length-weight function to available biological data for Southern Flounder.

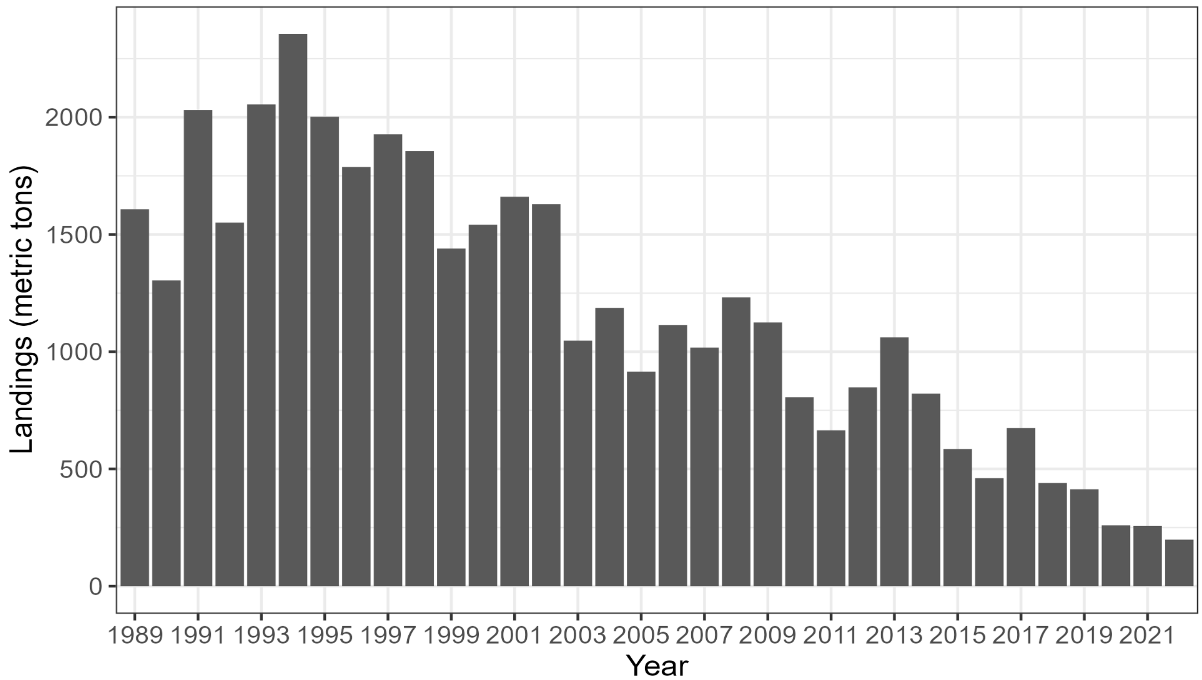


Figure 2.1. Annual commercial landings of Southern Flounder in the South Atlantic, 1989–2022.

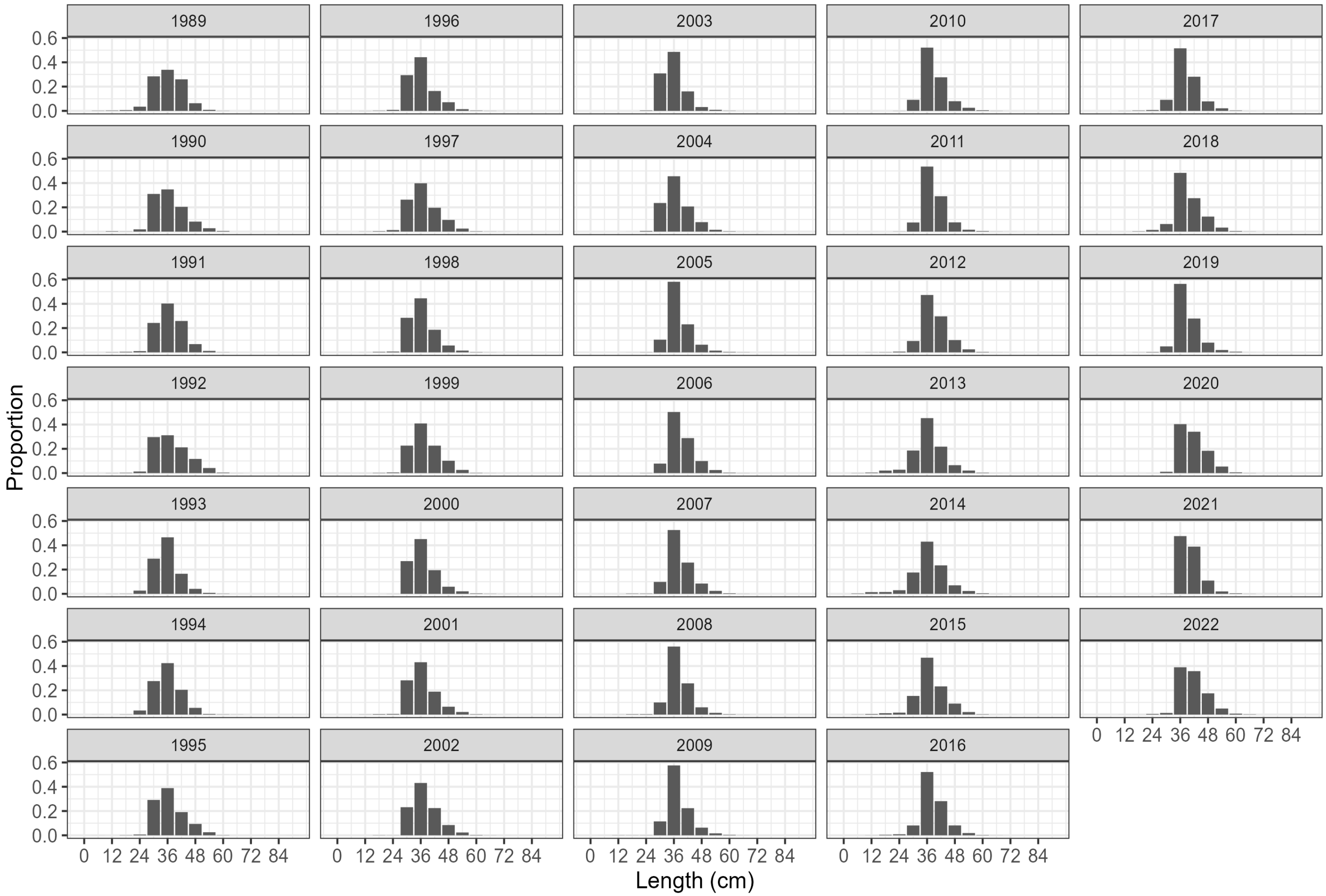


Figure 2.2. Annual length frequencies of Southern Flounder commercially landed in the South Atlantic, 1989–2022.

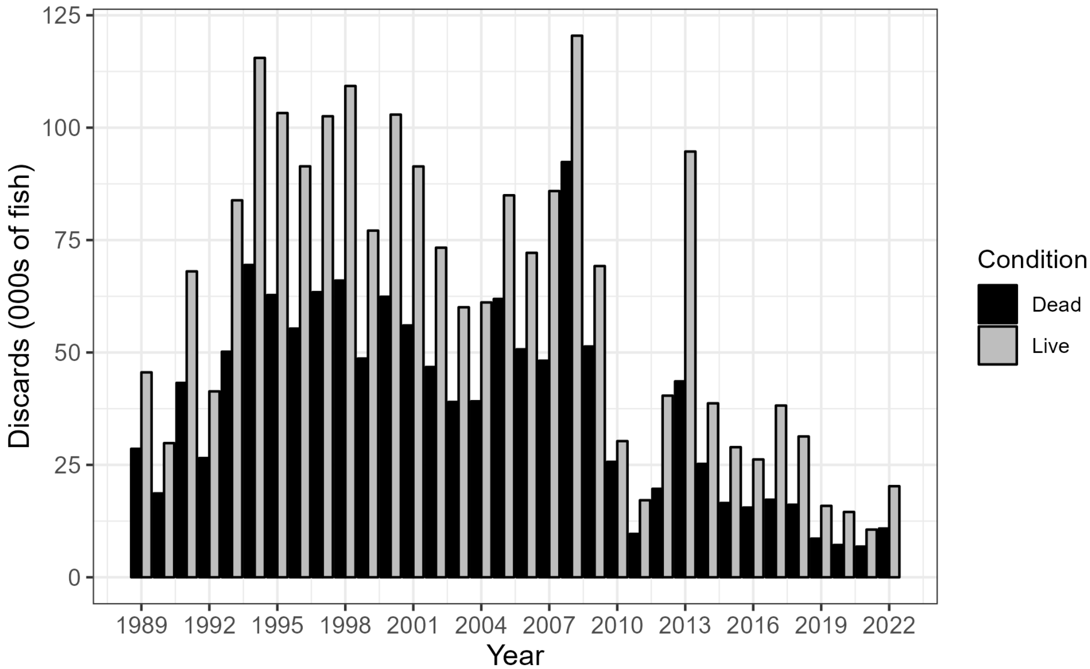


Figure 2.3. Annual commercial gill-net fishery discards of Southern Flounder in the South Atlantic, 1989–2022. Note that values prior to 2004 were estimated using a hindcasting approach.

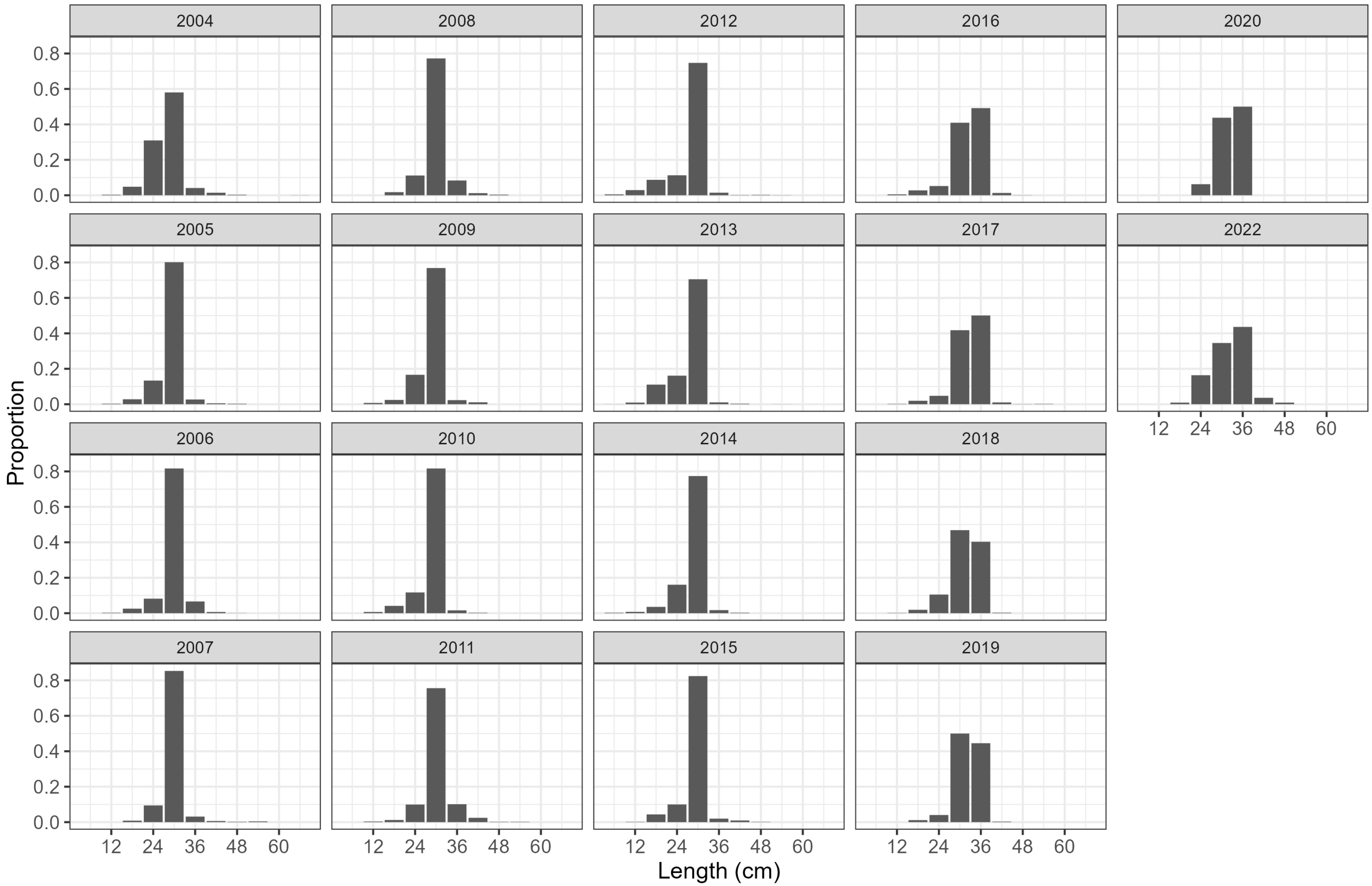


Figure 2.4. Annual length frequencies of Southern Flounder commercial gill-net dead discards in the South Atlantic, 2004–2022.

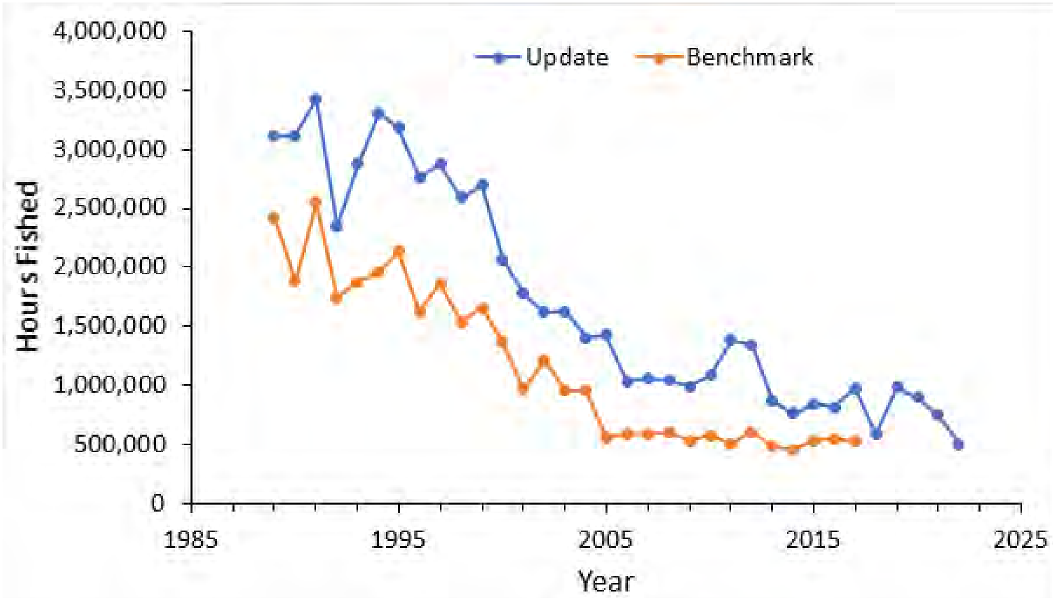


Figure 2.5. Comparison of effort data between the benchmark (Flowers et al. 2018) and update assessment (current report) collected from 1989-2017 and 1989-2022, respectively.

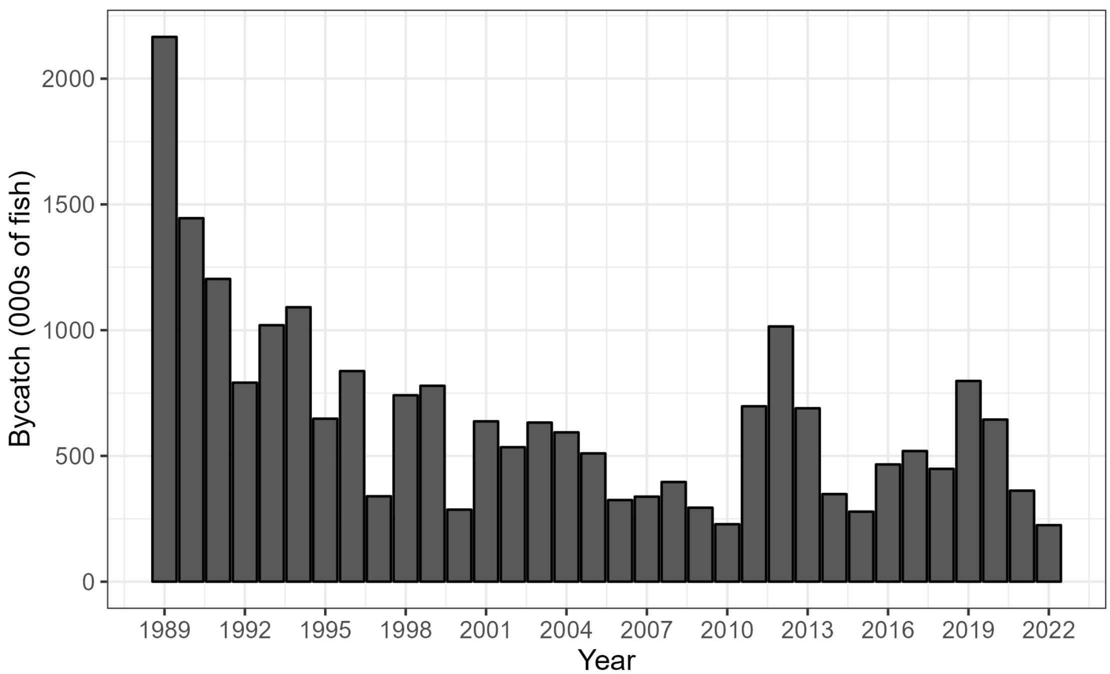


Figure 2.6. Annual shrimp trawl bycatch of Southern Flounder in the South Atlantic, 1989–2022.

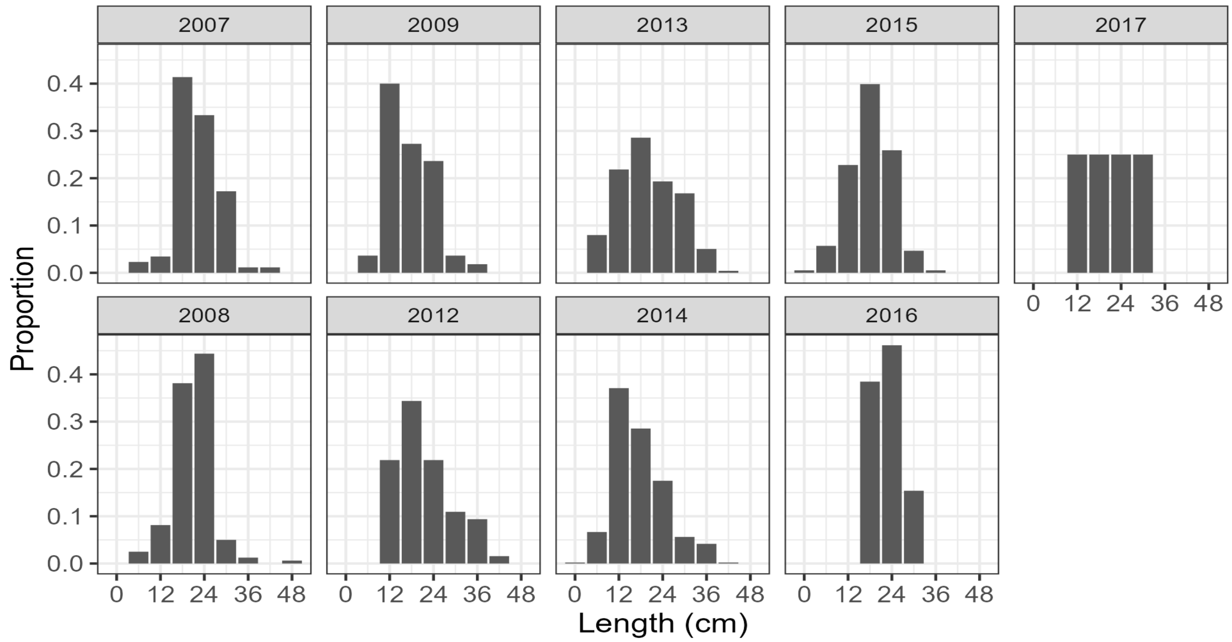


Figure 2.7. Annual length frequencies of Southern Flounder shrimp trawl bycatch in the South Atlantic, 2007–2017. Survey was not conducted from 2017-2022.

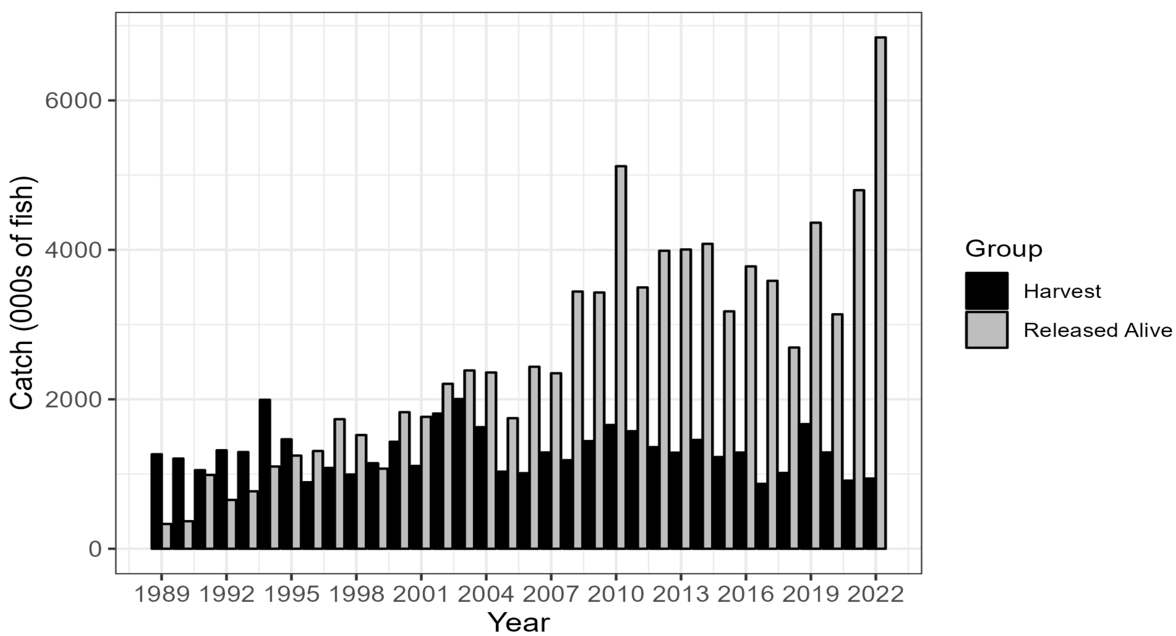


Figure 2.8. Annual recreational catches of Southern Flounder in the South Atlantic, 1989–2022. These values do not include estimates from the recreational gig fishery.

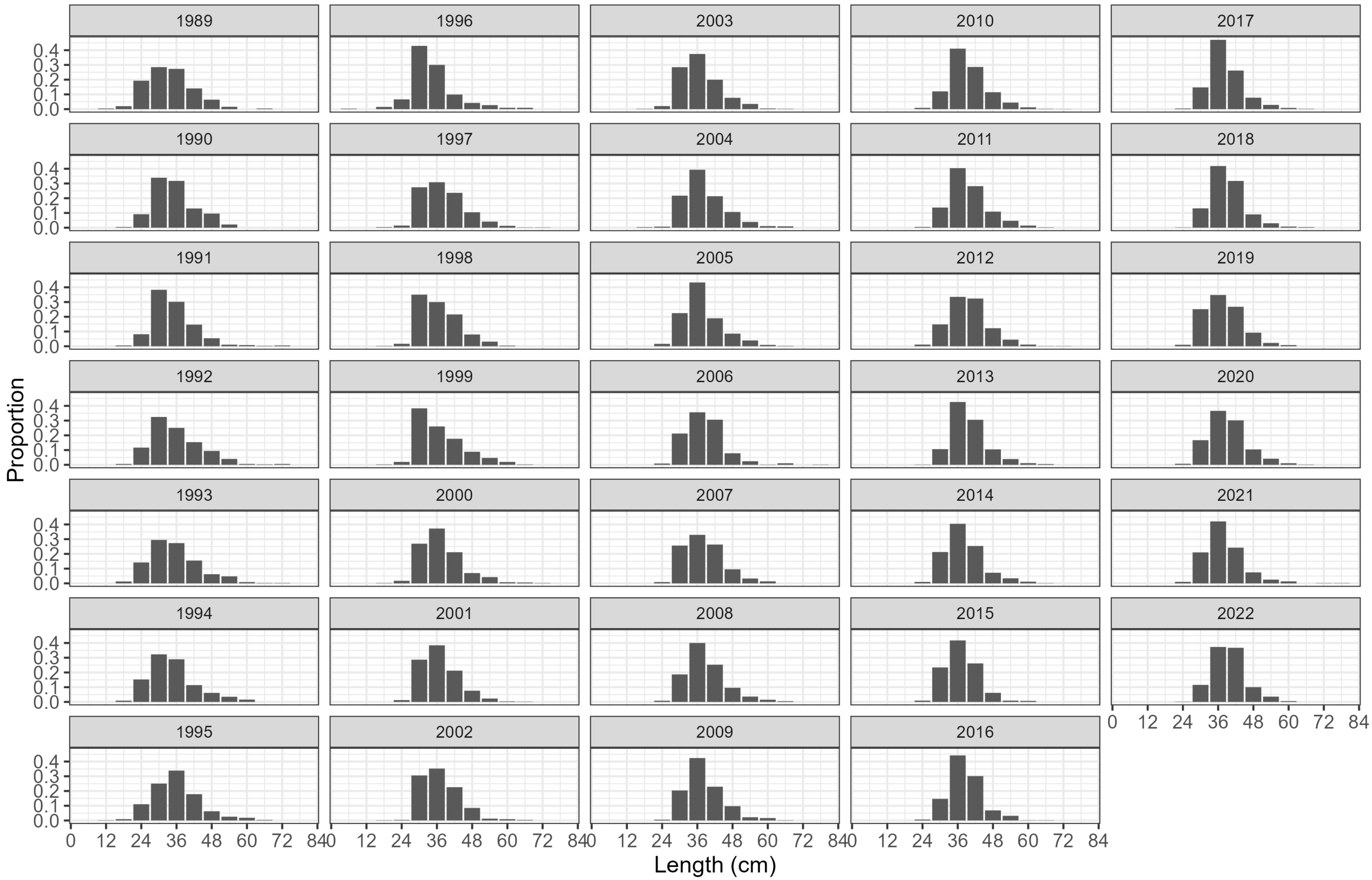


Figure 2.9. Annual length frequencies of Southern Flounder recreational harvest in the South Atlantic, 1989–2022.

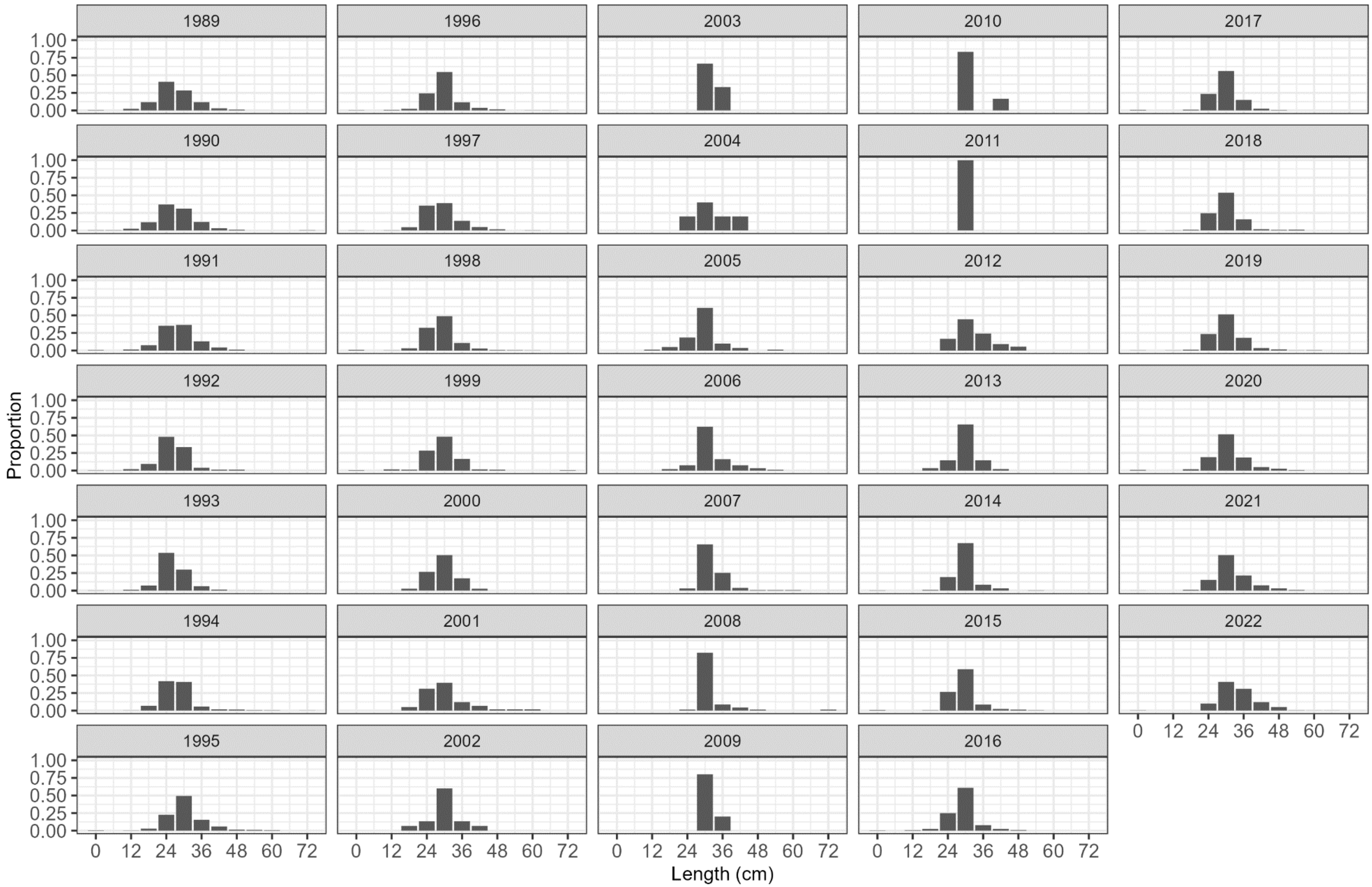


Figure 2.10. Annual length frequencies of Southern Flounder recreational discards in the South Atlantic, 1989–2022.

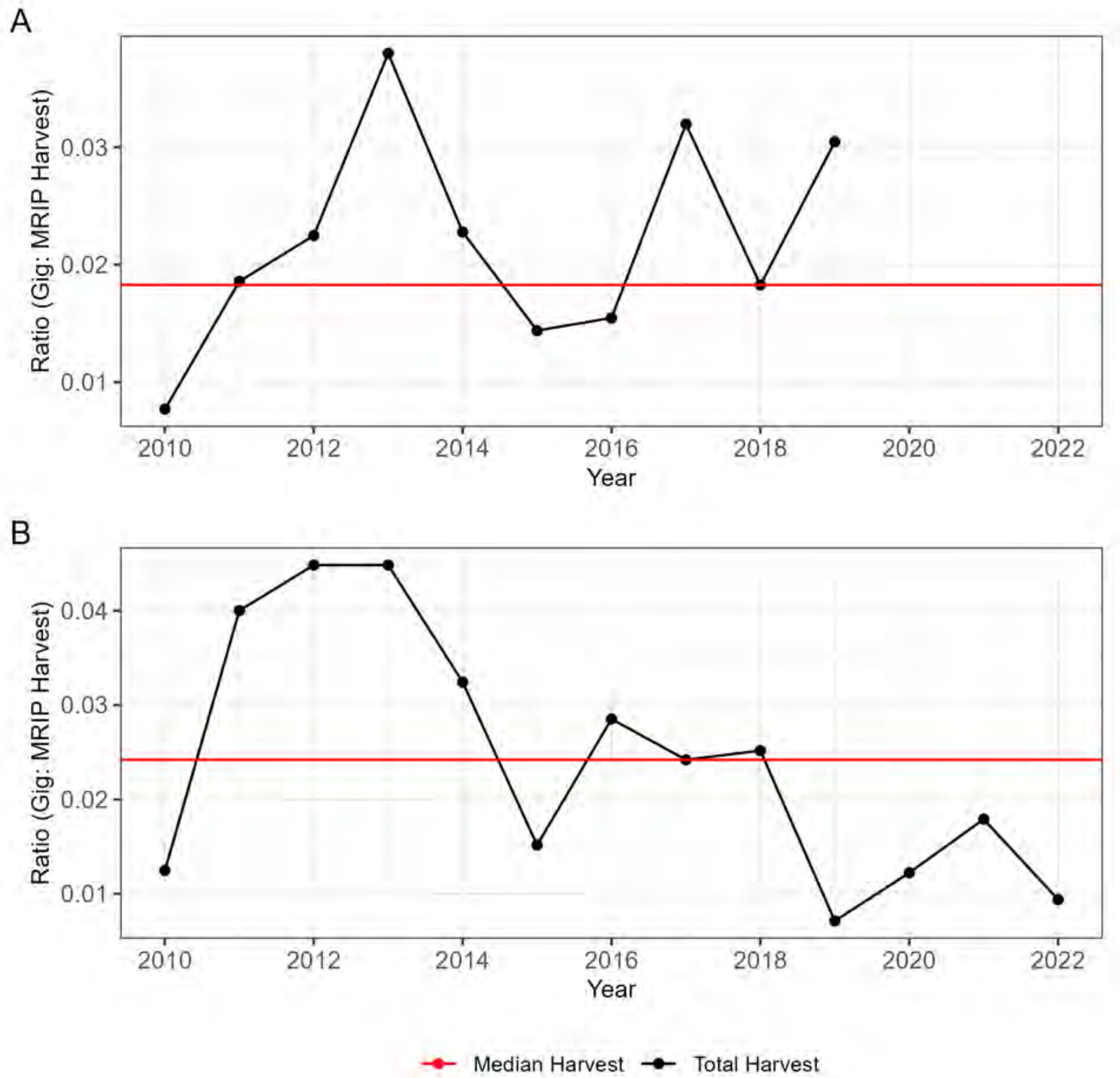


Figure 2.11. Ratio of North Carolina recreational gig harvest to total recreational harvest for the South Atlantic in (A) season 1 and (B) season 2, 2010–2022.

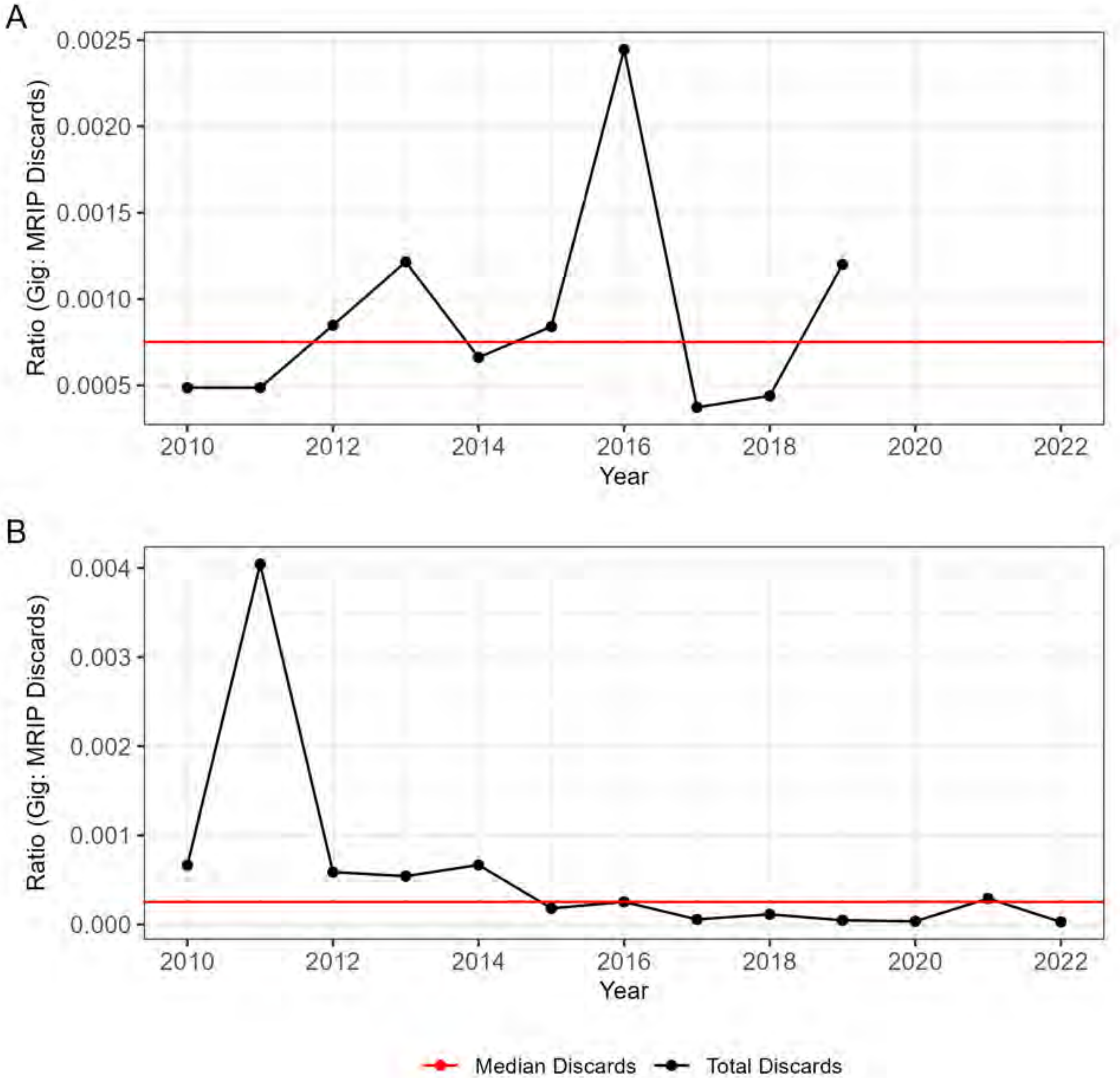


Figure 2.12. Ratio of North Carolina recreational gig discards to total recreational releases for the South Atlantic in (A) season 1 and (B) season 2, 2010–2022.

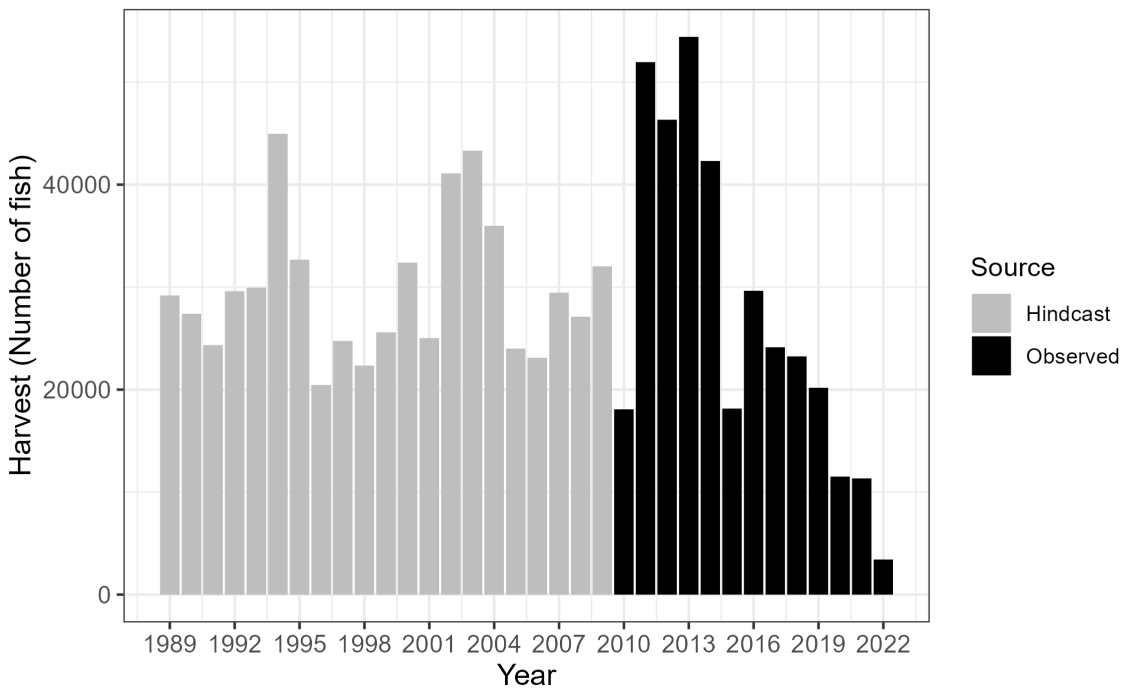


Figure 2.13 Annual recreational gig harvest of Southern Flounder in the South Atlantic, 1989–2022. Note that values prior to 2010 were estimated using a hindcasting approach.

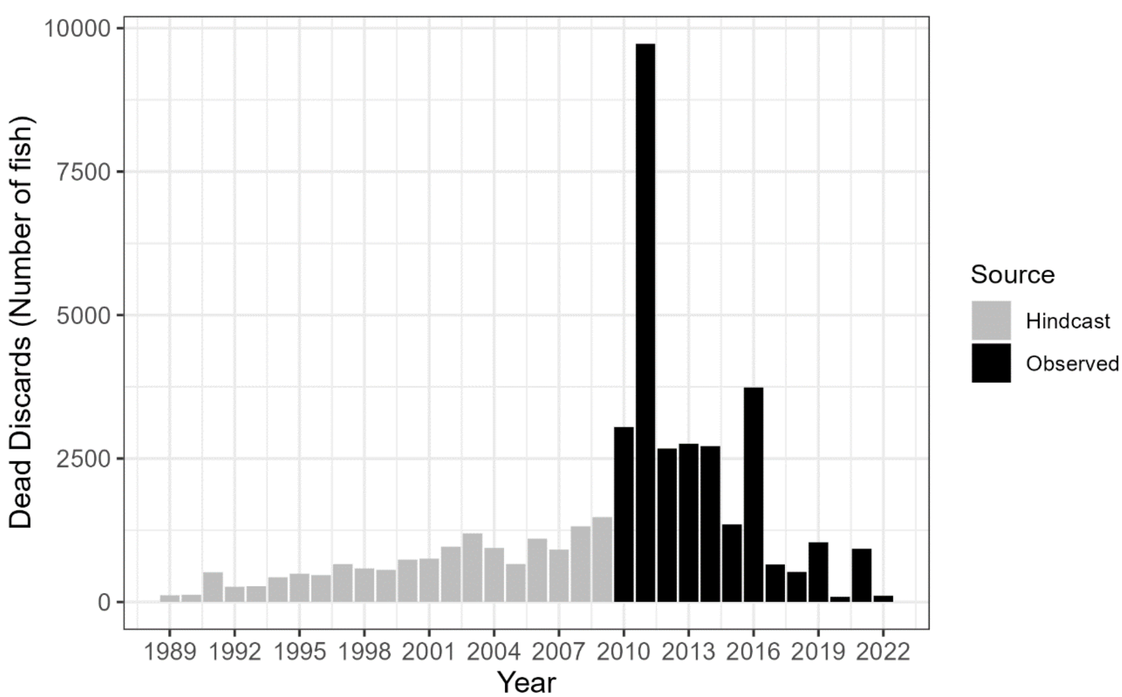


Figure 2.14. Annual recreational gig discards of Southern Flounder in the South Atlantic, 1989–2022. Note that values prior to 2010 were estimated using a hindcasting approach.

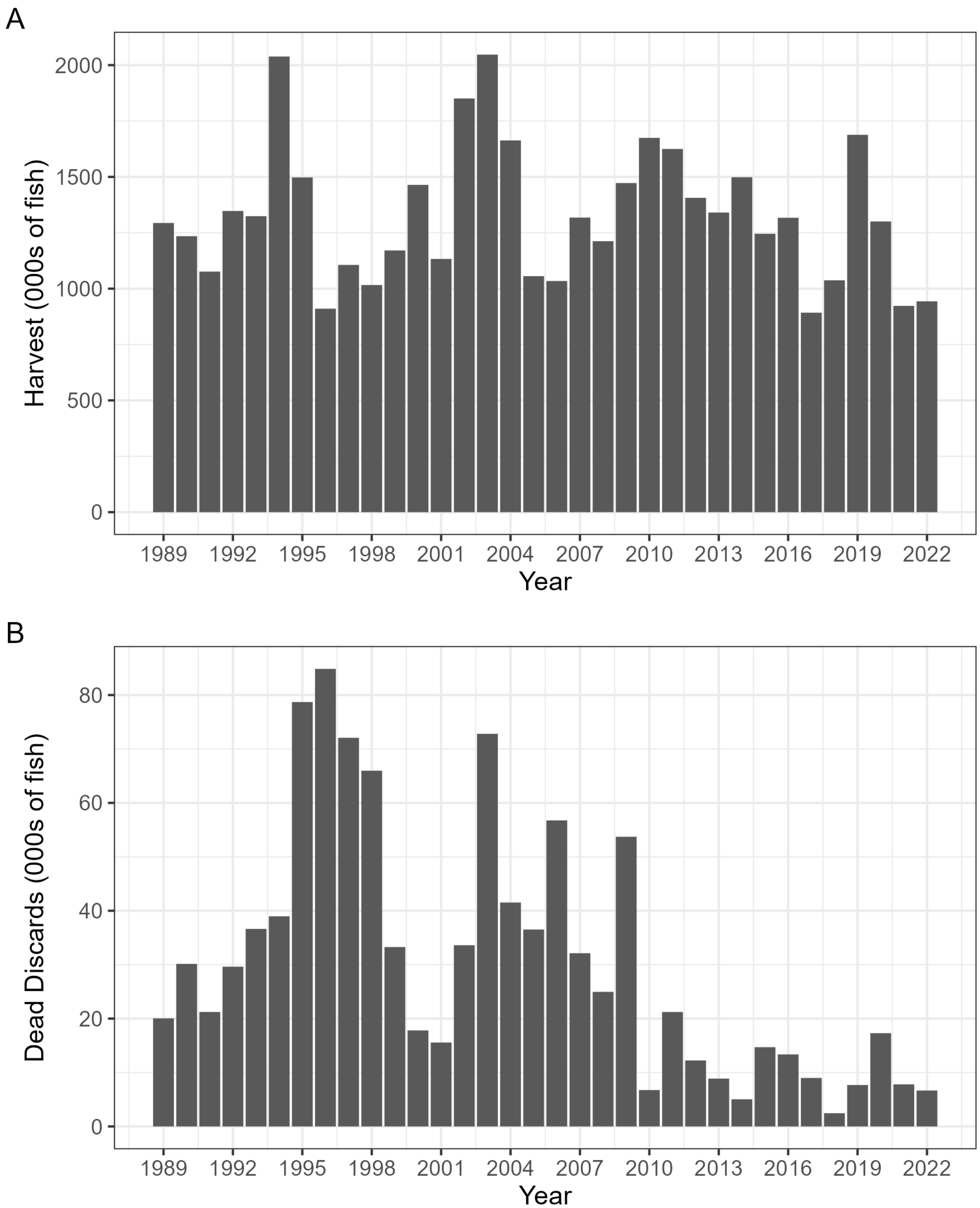


Figure 2.15. Annual total recreational (hook-and-line plus gig) catches of Southern Flounder in the South Atlantic, 1989–2022.

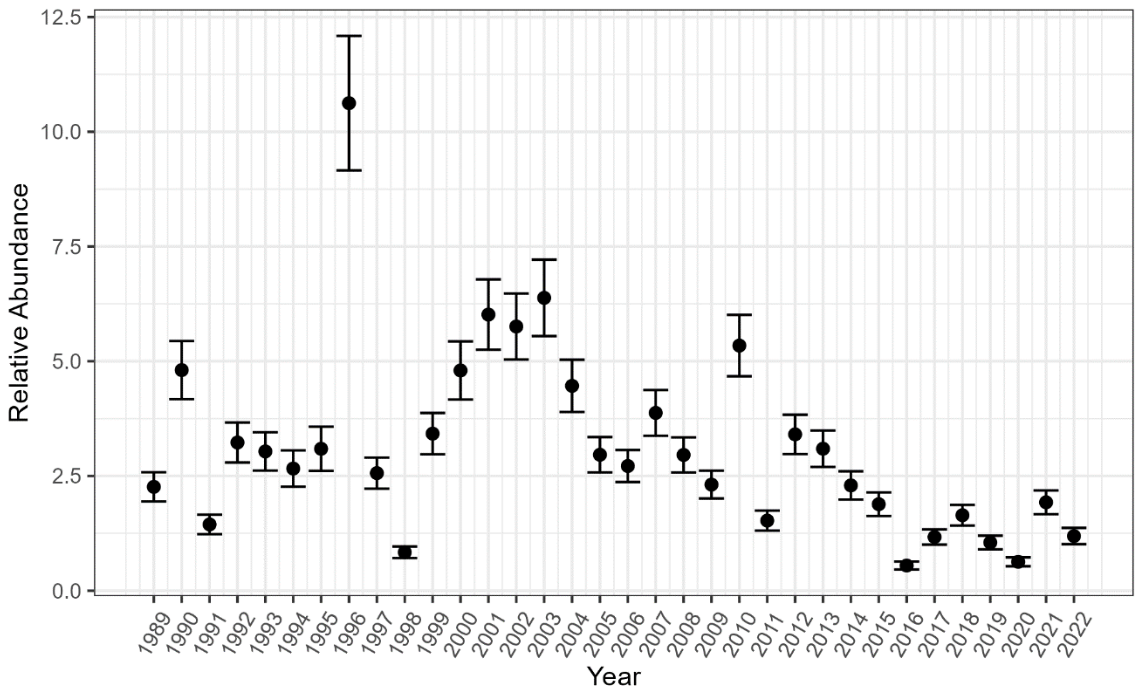


Figure 2.16. GLM-standardized index of age-0 relative abundance derived from the NCDMF NC120 Trawl Survey, 1989–2022. Error bars represent ± standard errors.

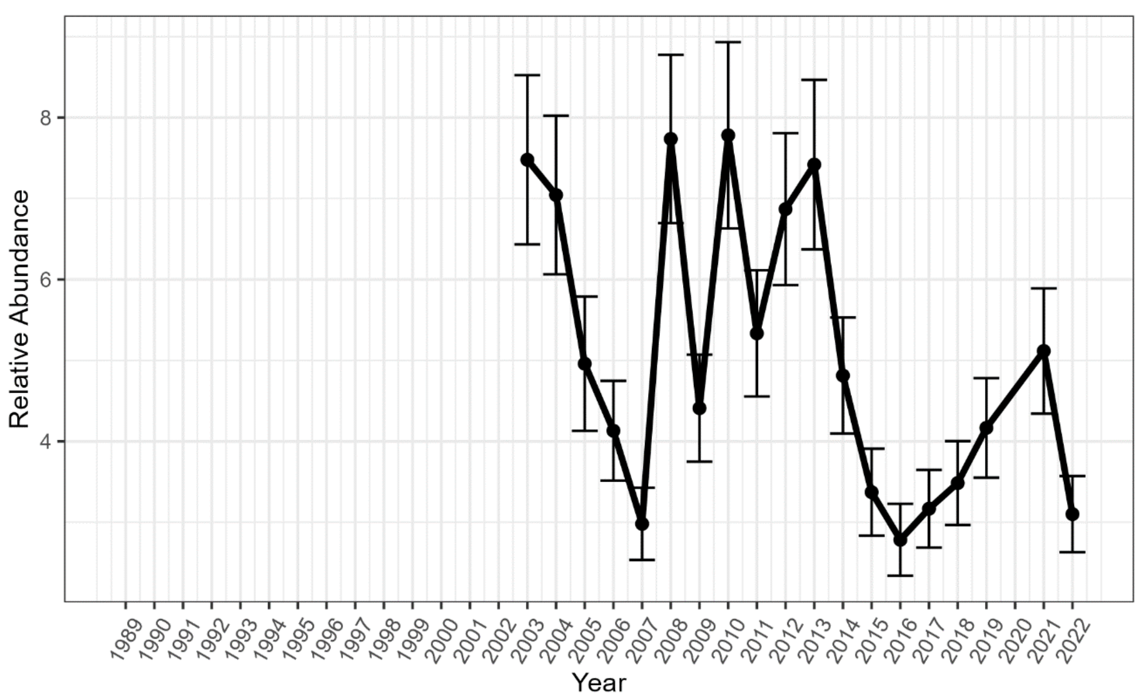


Figure 2.17. GLM-standardized index of relative abundance derived from the NCDMF NC915 Gill-Net Survey, 2003–2022. Error bars represent ± standard errors.

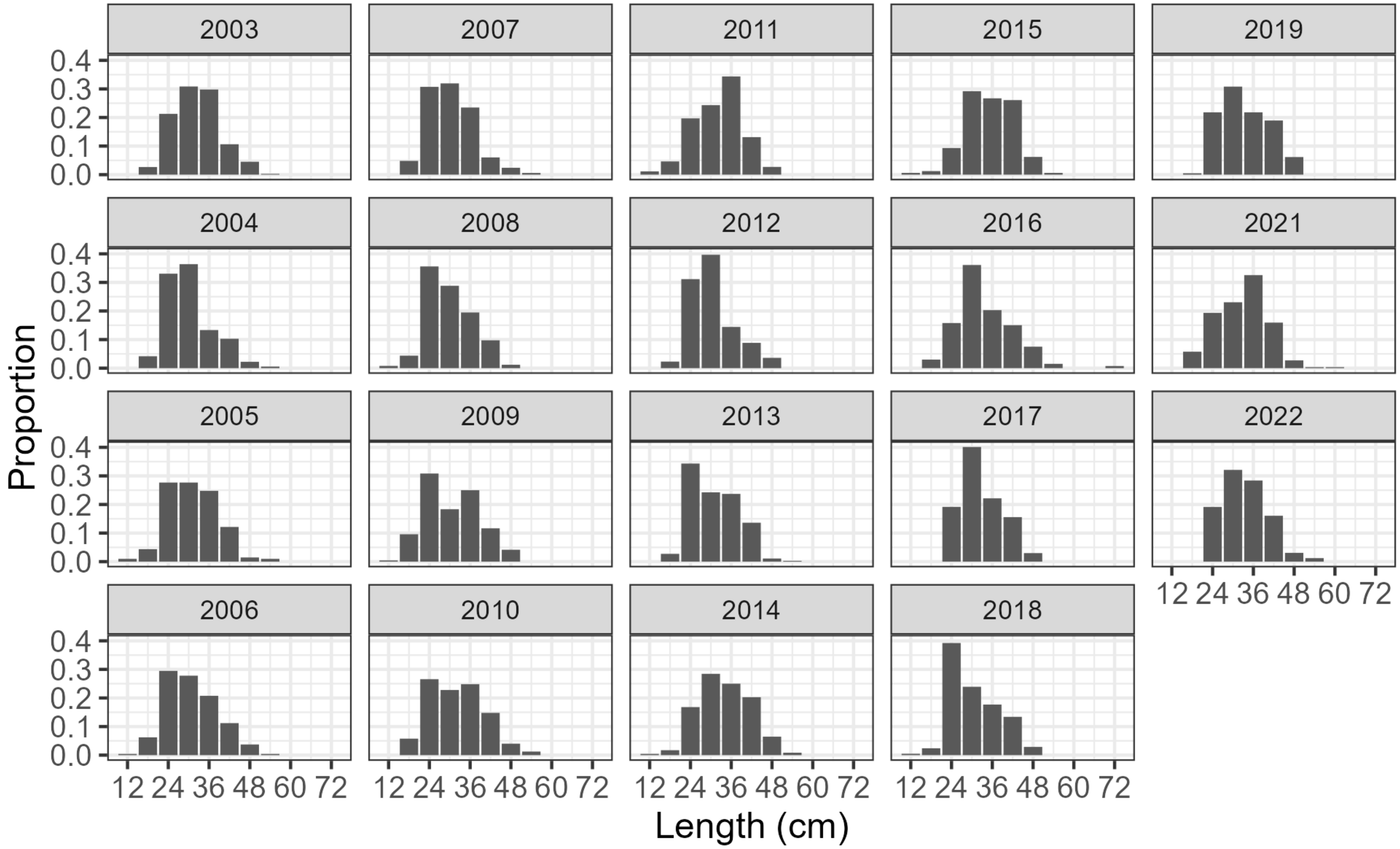


Figure 2.18. Annual length frequencies of Southern Flounder occurring in the NCDMF NC915 Gill-Net Survey, 1989–2022.

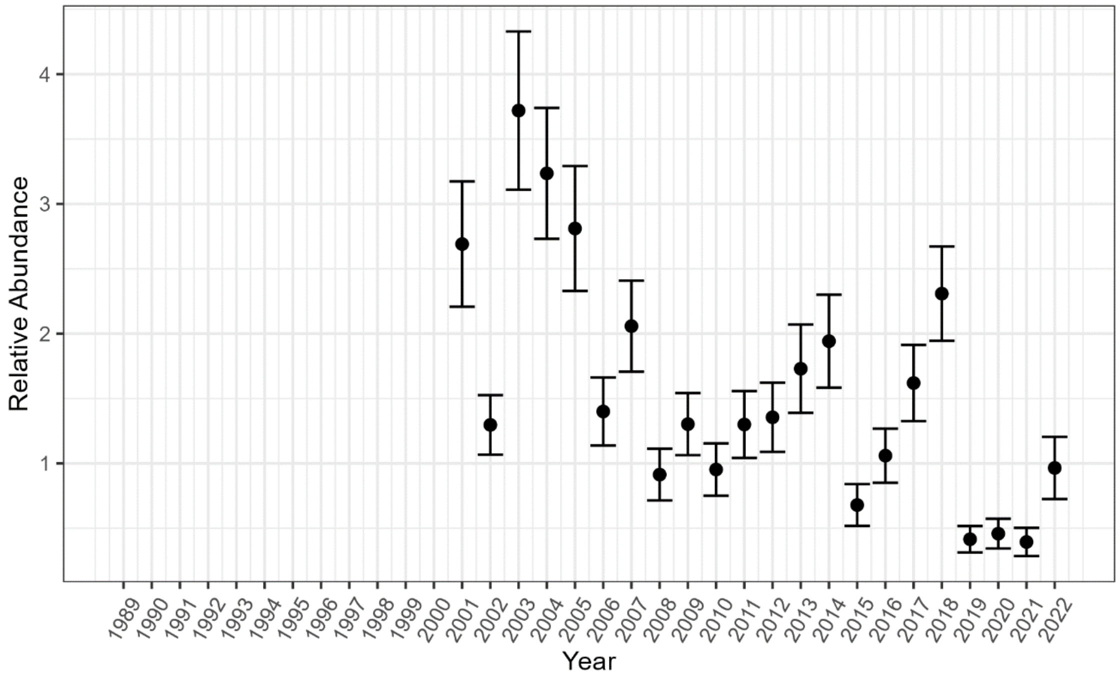


Figure 2.19. GLM-standardized index of age-0 relative abundance derived from the SC Electrofishing Survey, 2001–2022. Error bars represent ± standard errors.

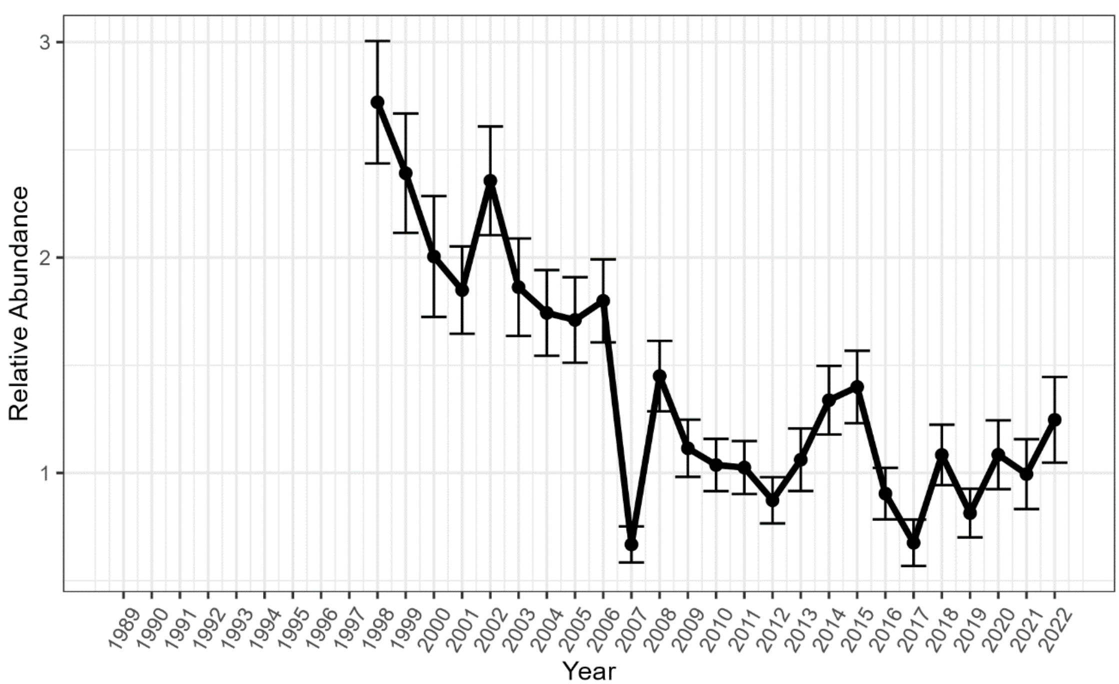


Figure 2.20. GLM-standardized index of relative abundance derived from the SC Trammel Net Survey, 1994–2022. Error bars represent ± standard errors.

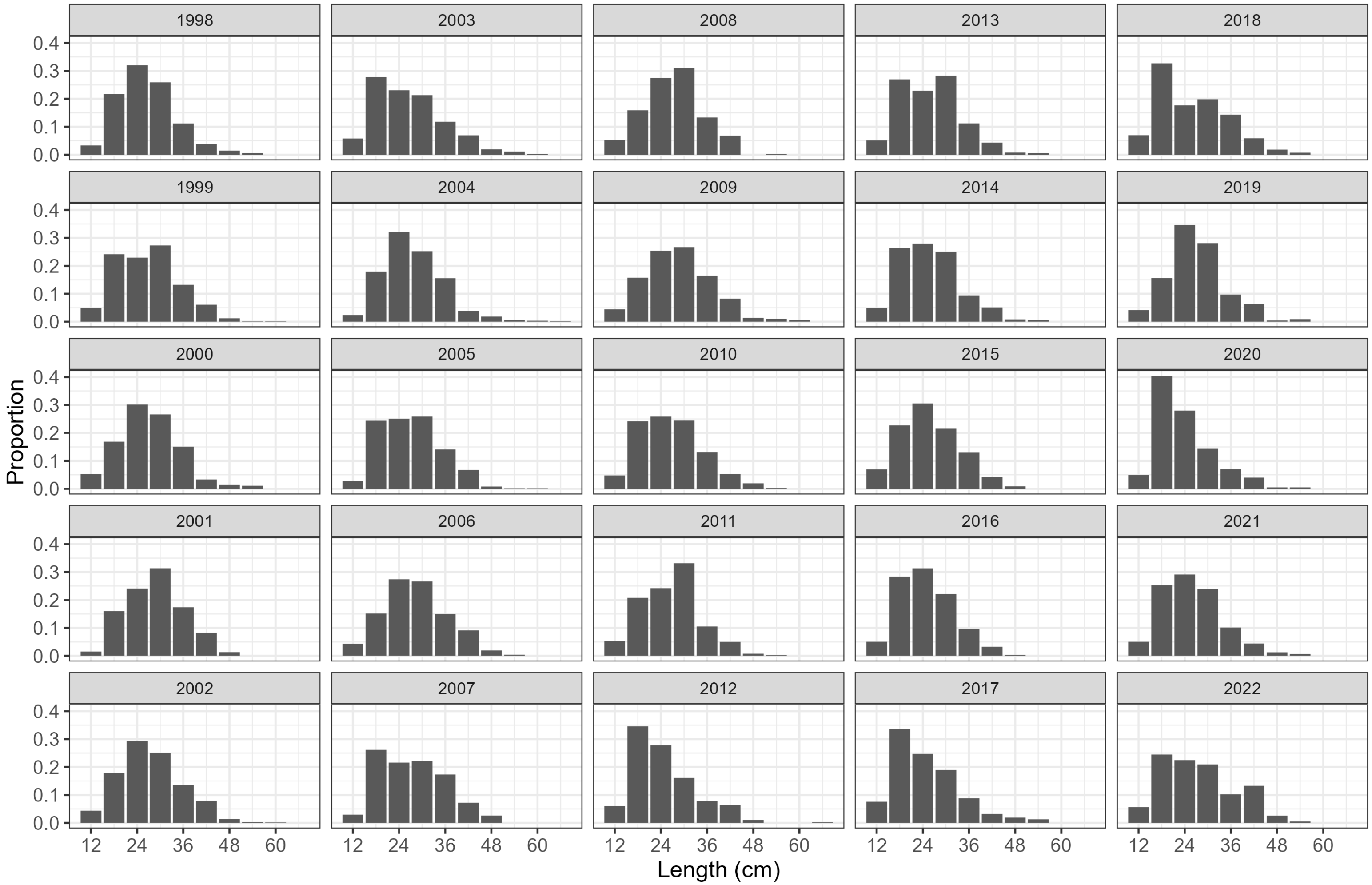


Figure 2.21. Annual length frequencies of Southern Flounder occurring in the SC Trammel Net Survey, 1989–2022.

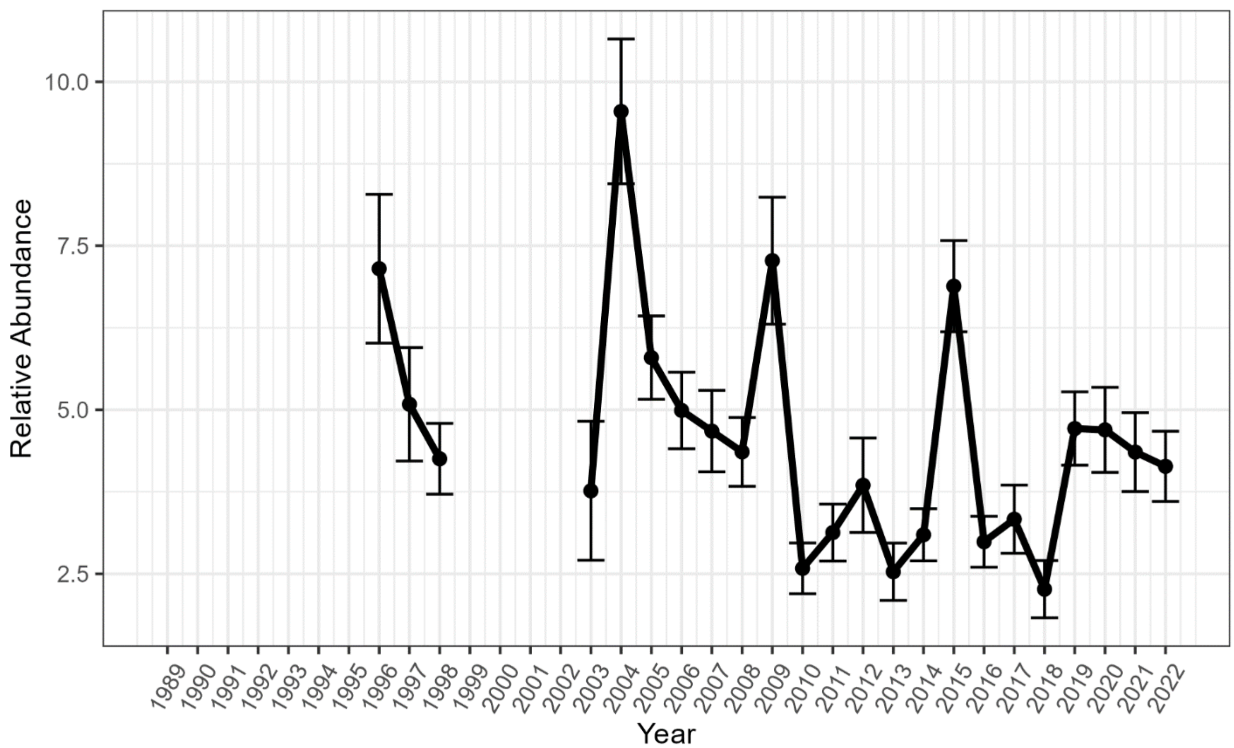


Figure 2.22. GLM-standardized index of relative abundance derived from the GA Trawl Survey, 1996–2022. Error bars represent ± standard errors.

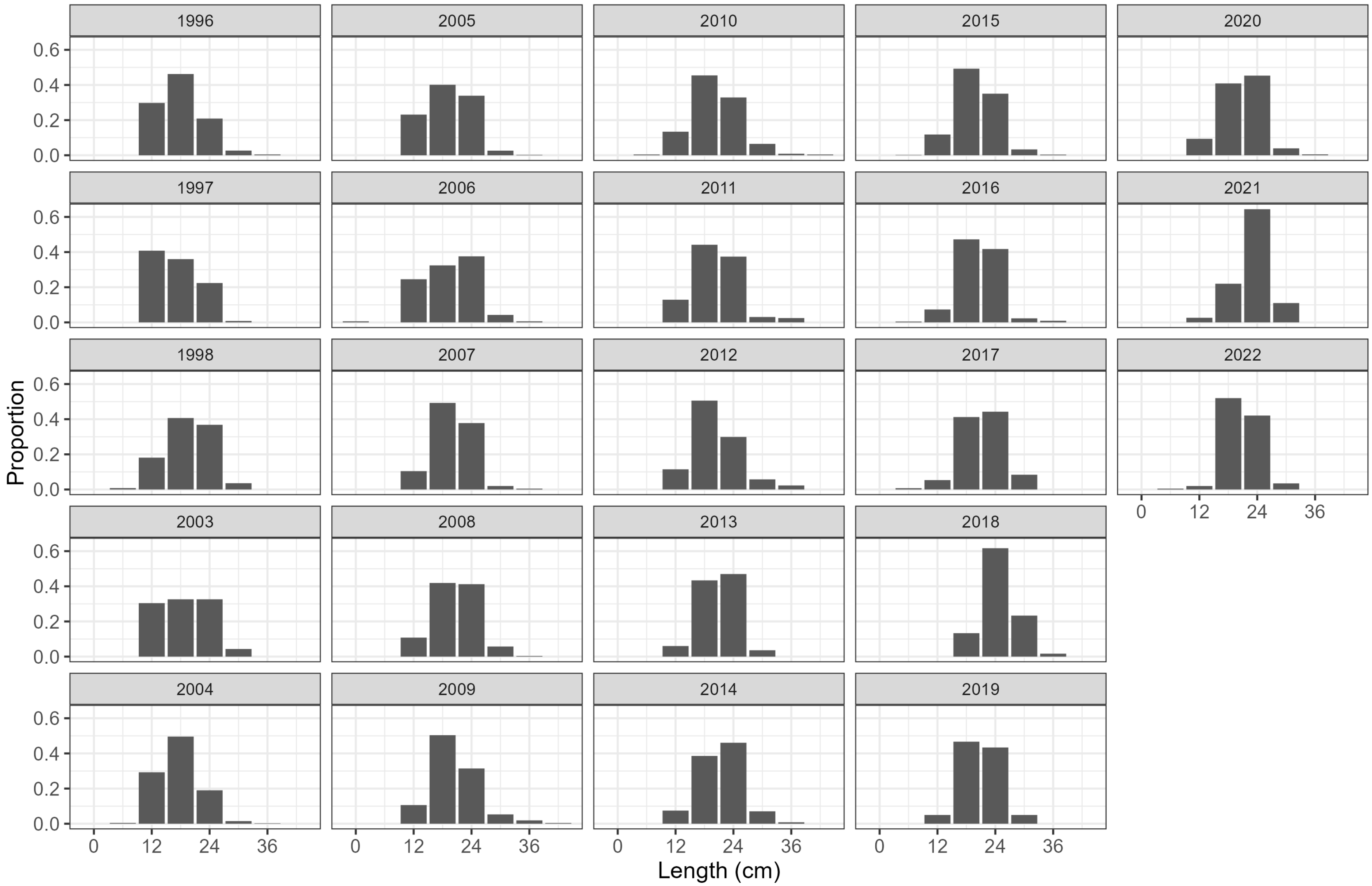


Figure 2.23. Annual length frequencies of Southern Flounder occurring in the GA Trawl Survey, 1989–2022.

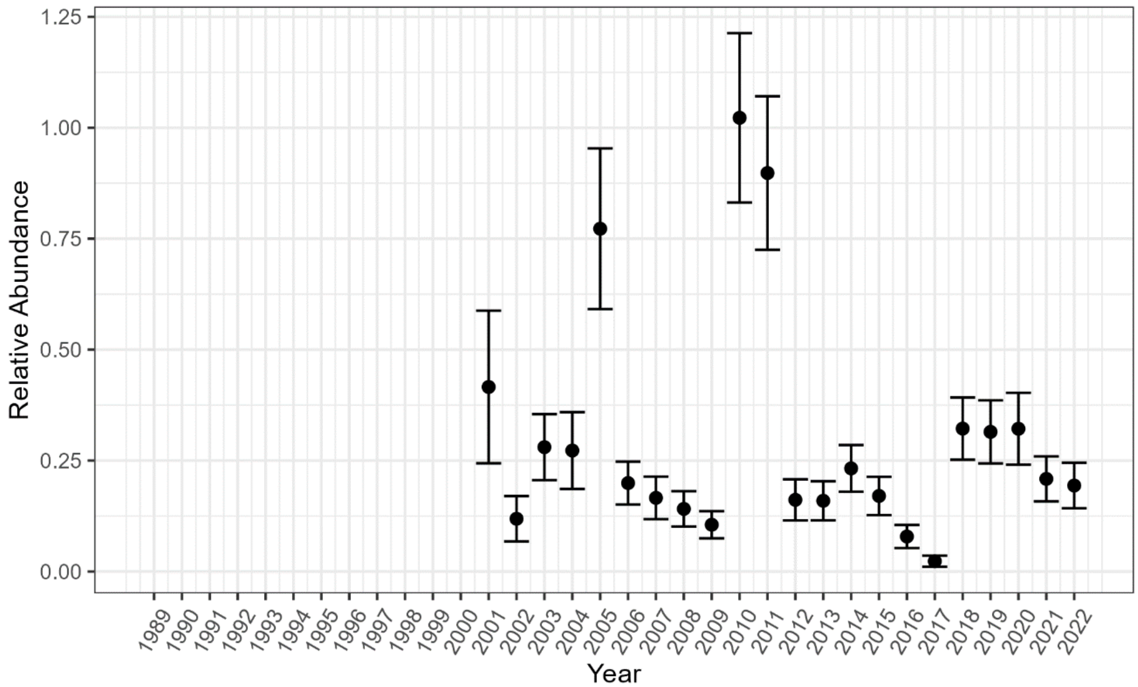


Figure 2.24. GLM-standardized index of age-0 relative abundance derived from the FL Trawl Survey, 2001–2022. Error bars represent ± standard errors.

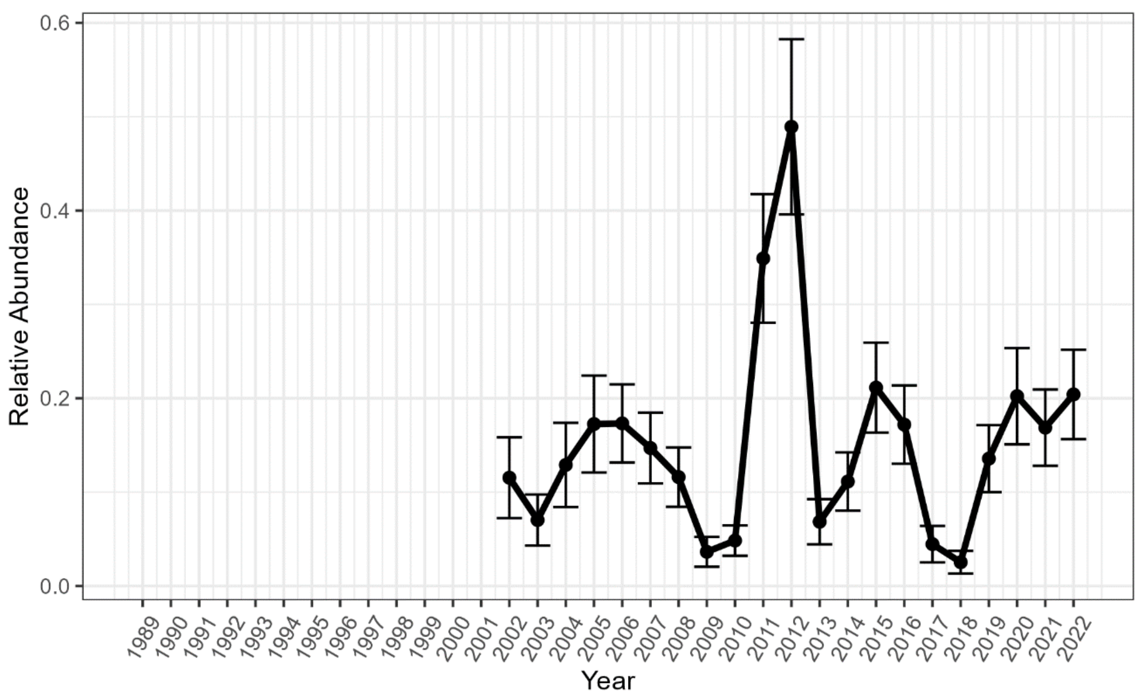


Figure 2.25. GLM-standardized index of adult relative abundance derived from the FL Trawl Survey, 2002–2022. Error bars represent ± standard errors.

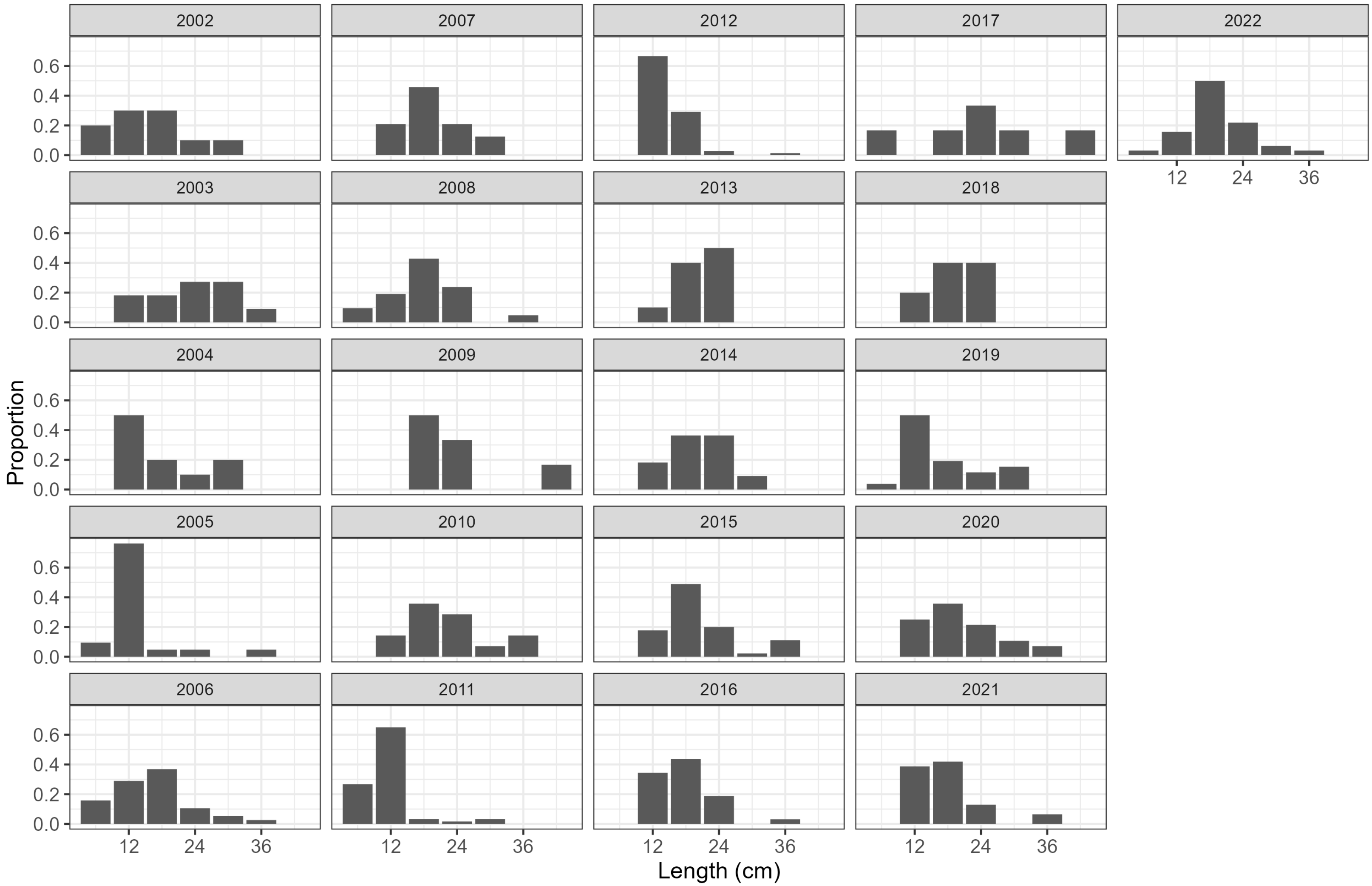


Figure 2.26. Annual length frequencies of adult Southern Flounder occurring in the FL Trawl survey, 1989–2022.

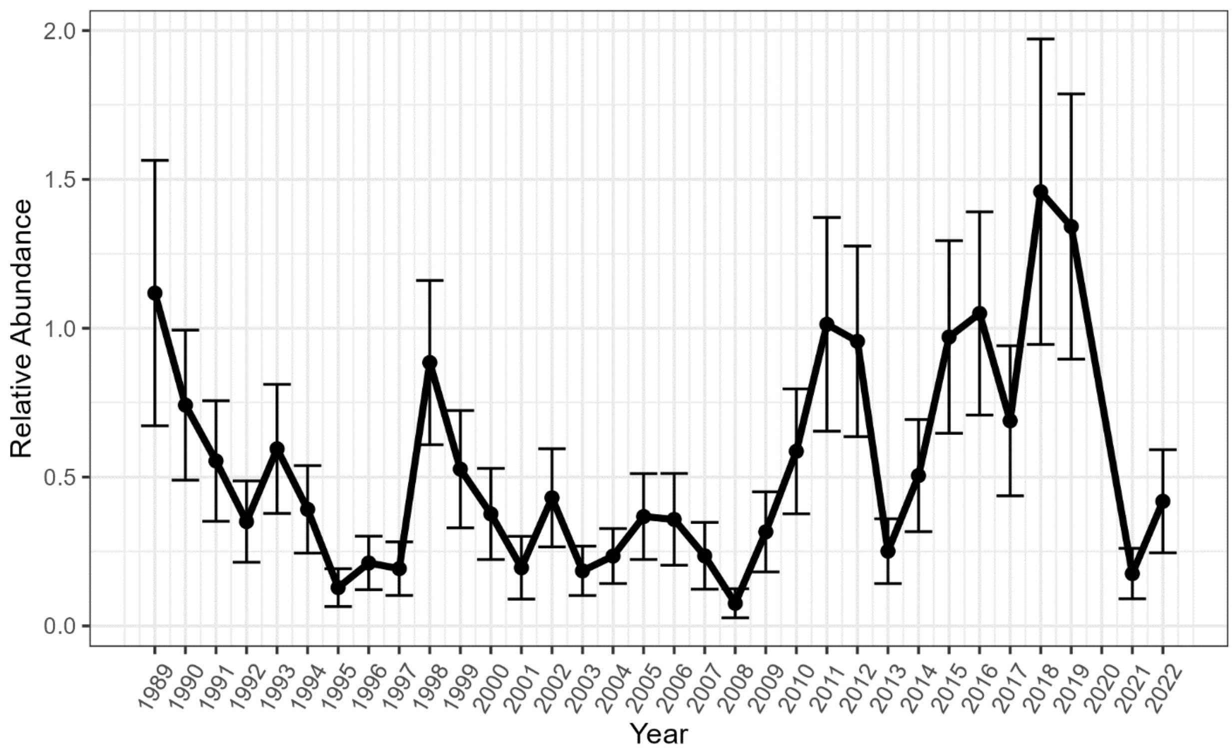


Figure 2.27. GLM-standardized index of relative abundance derived from the SEAMAP Trawl Survey, 1989–2022. Error bars represent ± standard errors.

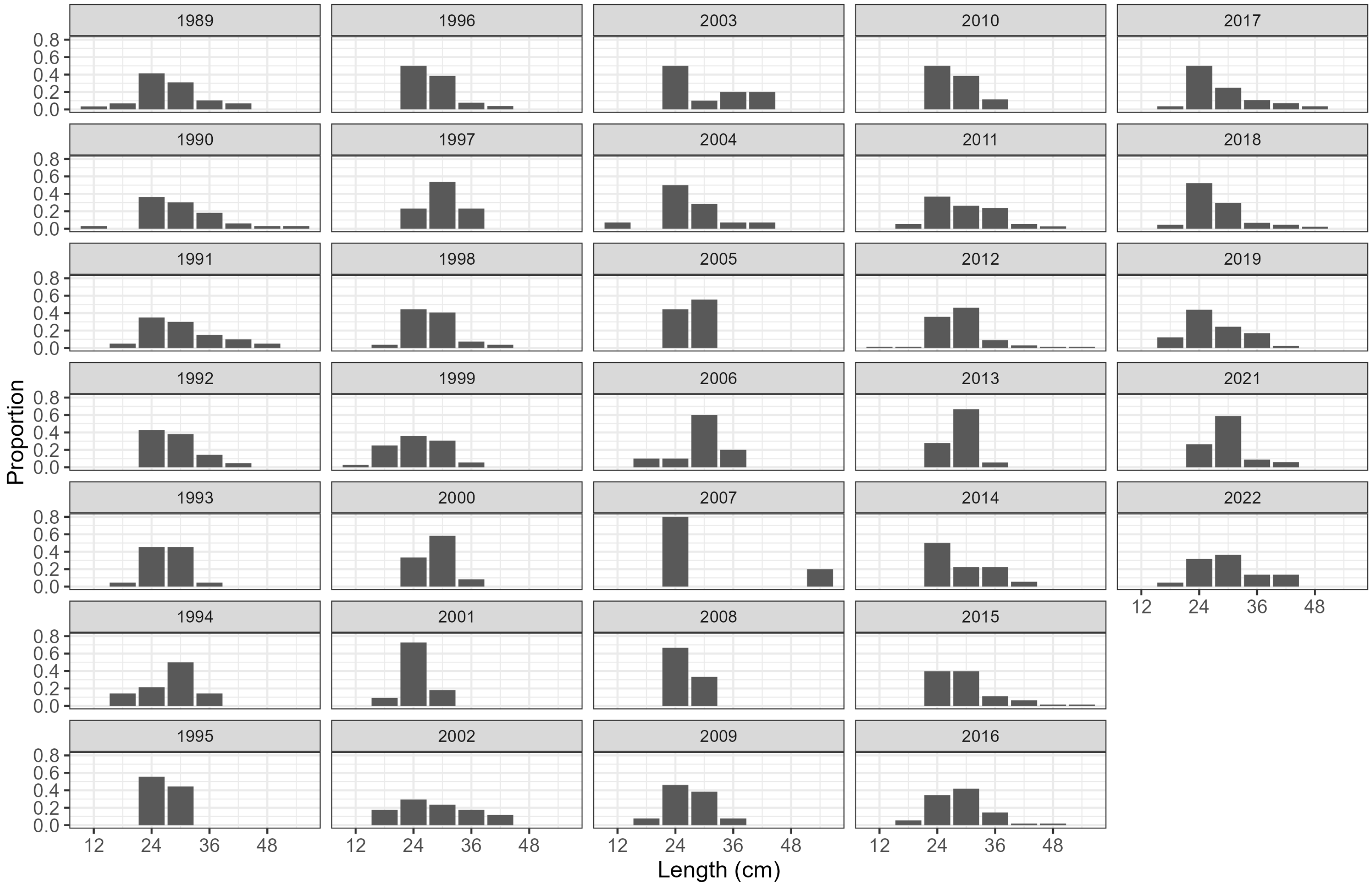


Figure 2.28. Annual length frequencies of adult Southern Flounder occurring in the SEAMAP Trawl Survey, 1989–2022.

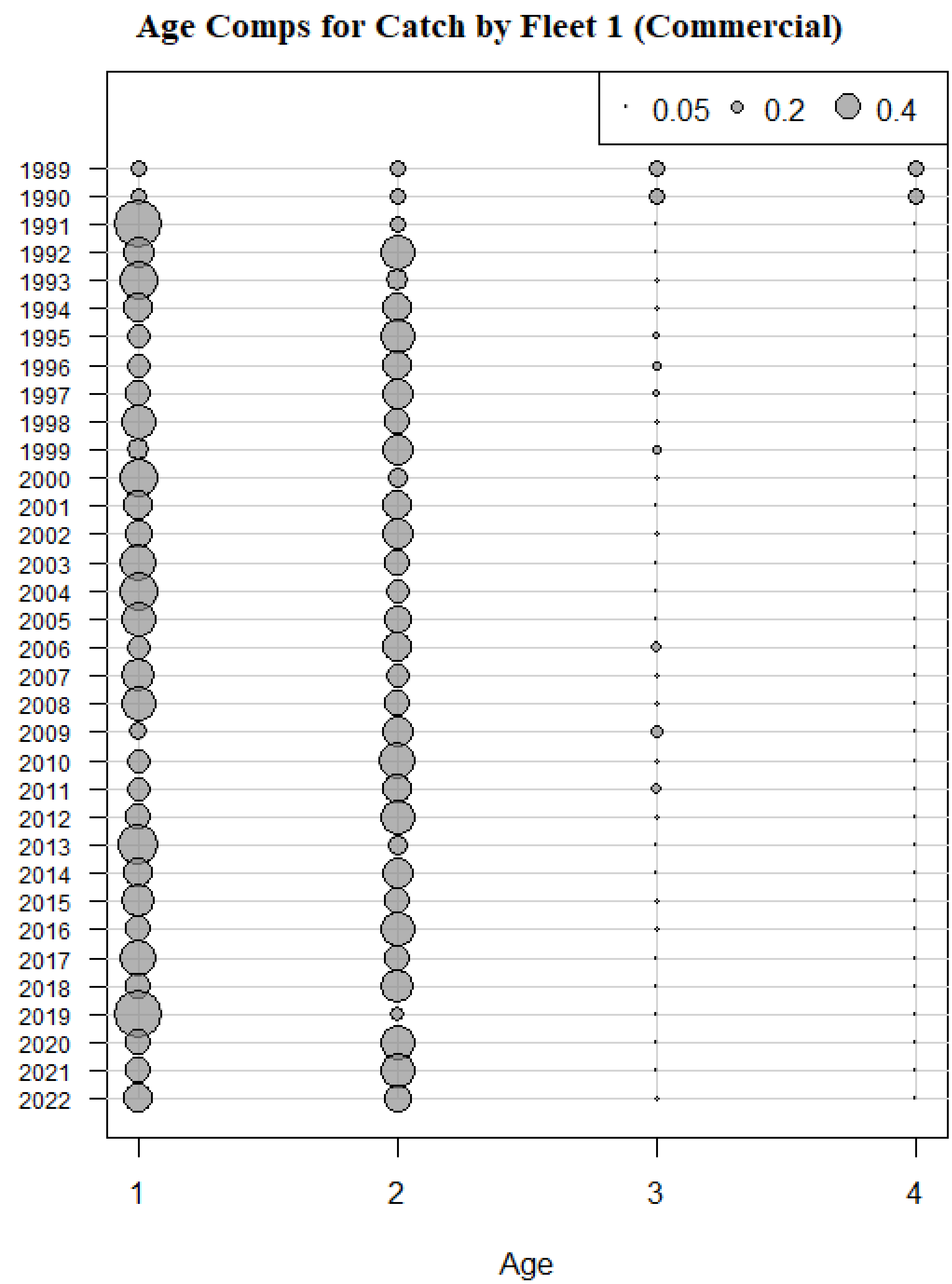


Figure 3.1. Estimated proportion at age for the commercial catch (including discards), 1991-2022. Equal proportions across ages were assumed in ASAP when age data were unavailable (prior to 1991).

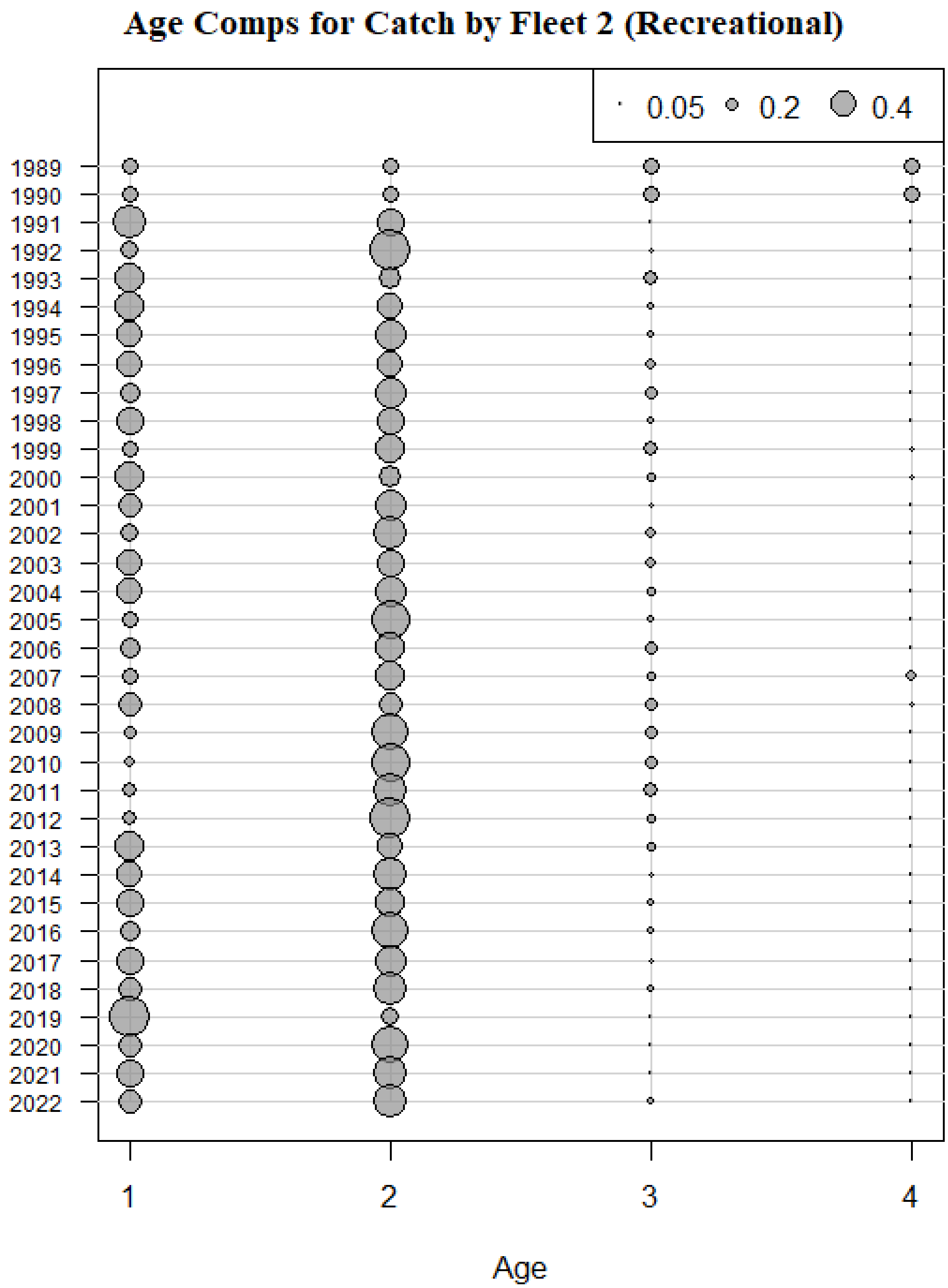


Figure 3.2. Estimated proportion at age for the recreational catch (including discards), 1991-2022. Equal proportions across ages were assumed in ASAP when age data were unavailable (prior to 1991).

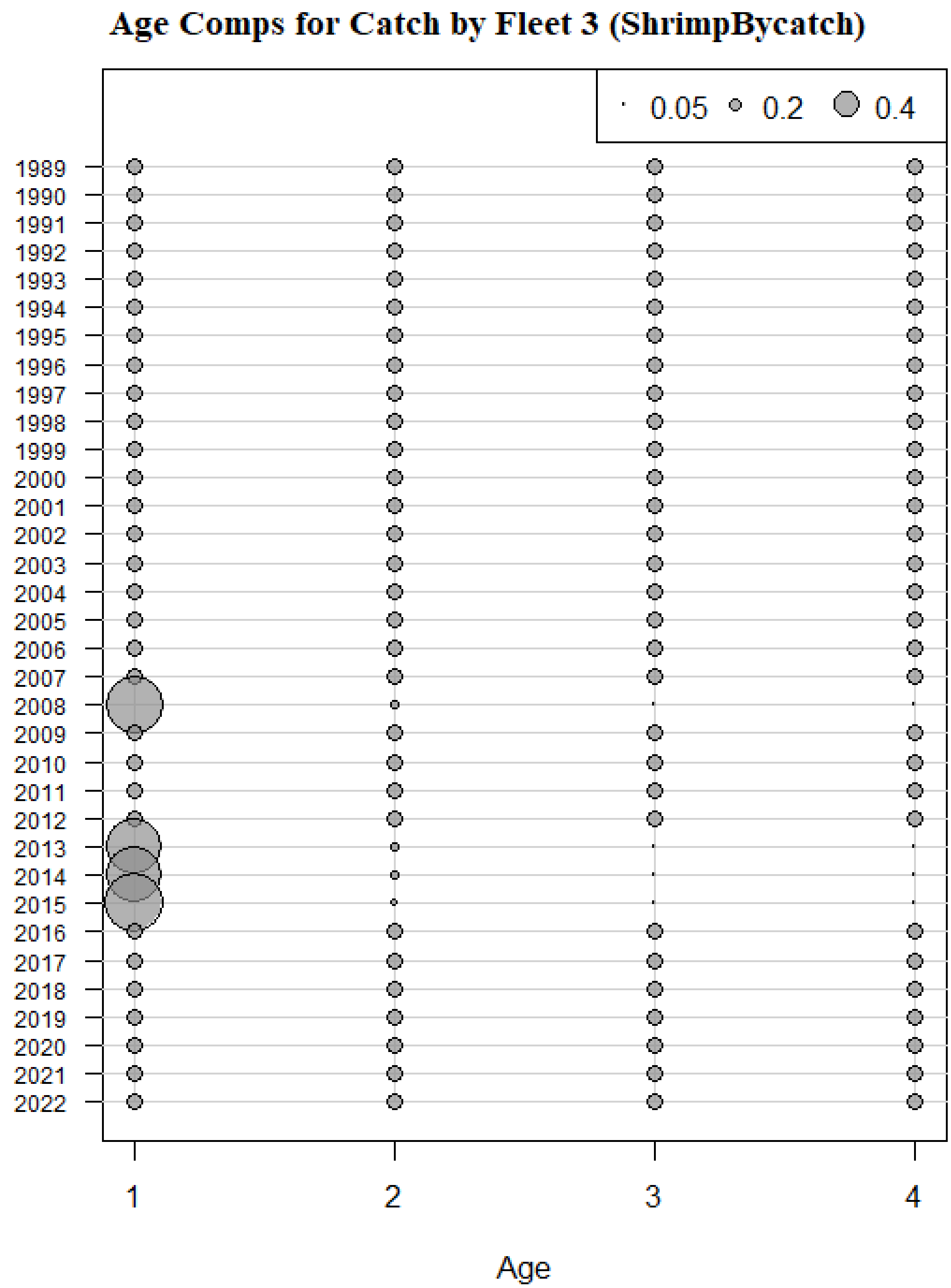


Figure 3.3. Estimated proportion discarded at age for the shrimp trawl fleet. Equal proportions across ages were assumed in ASAP when age or length data were unavailable (prior to 2007, 2010, 2011, and after 2017).

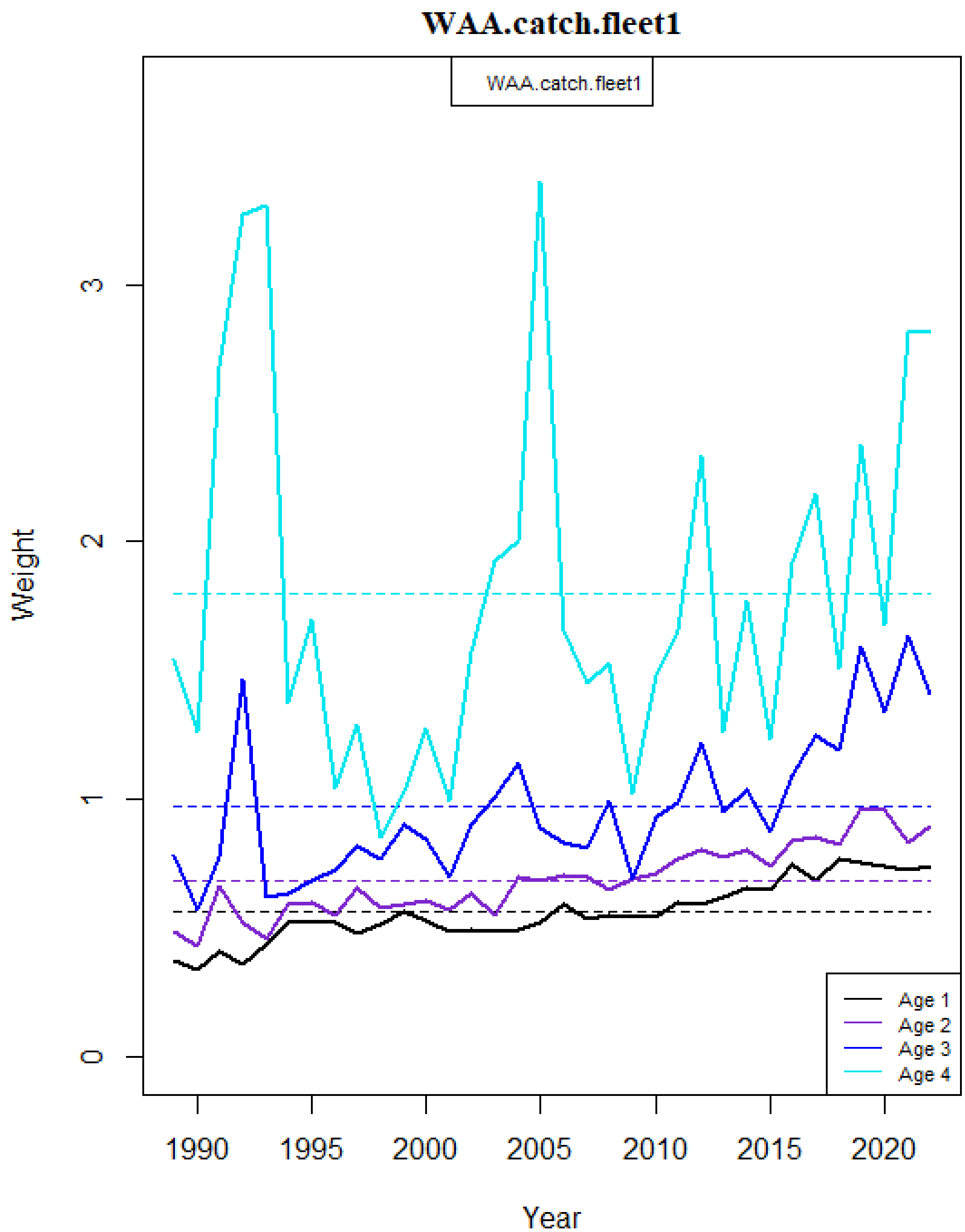


Figure 3.4. Estimated weight (kg) caught at age for the commercial catch (including discards).

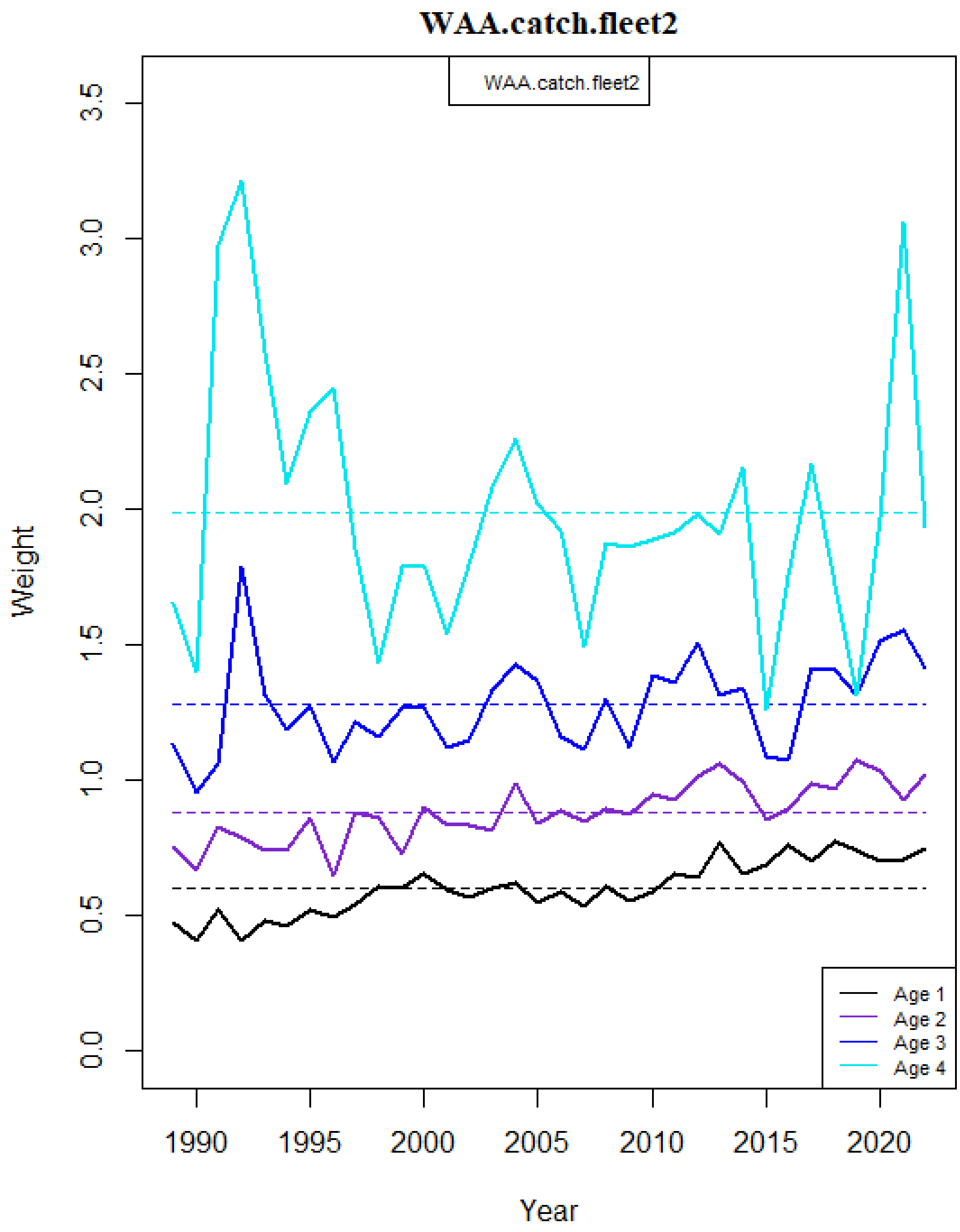


Figure 3.5. Estimated weight (kg) caught at age for the recreational catch (including discards).

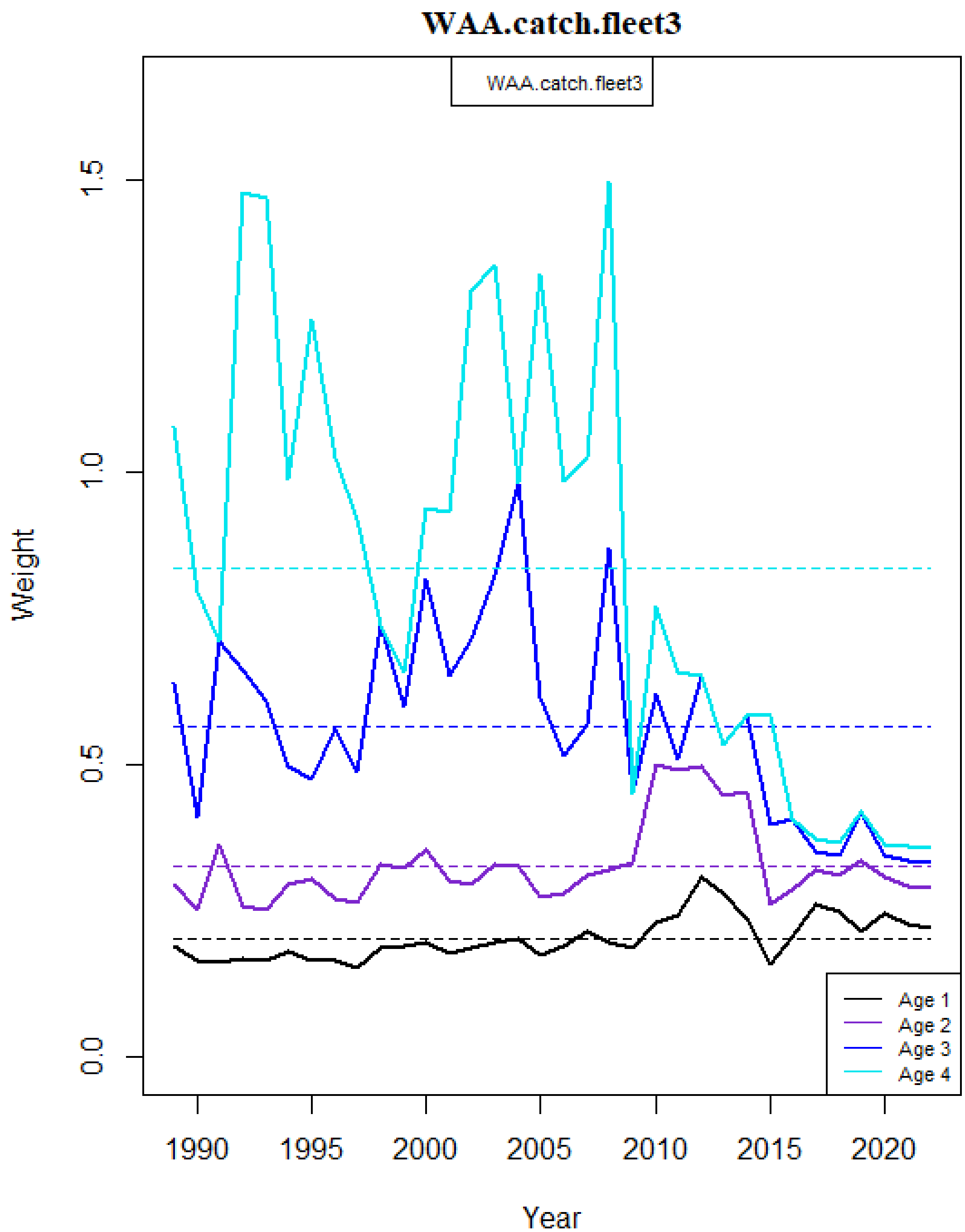


Figure 3.6. Estimated weight (kg) caught at age for the shrimp trawl fleet.

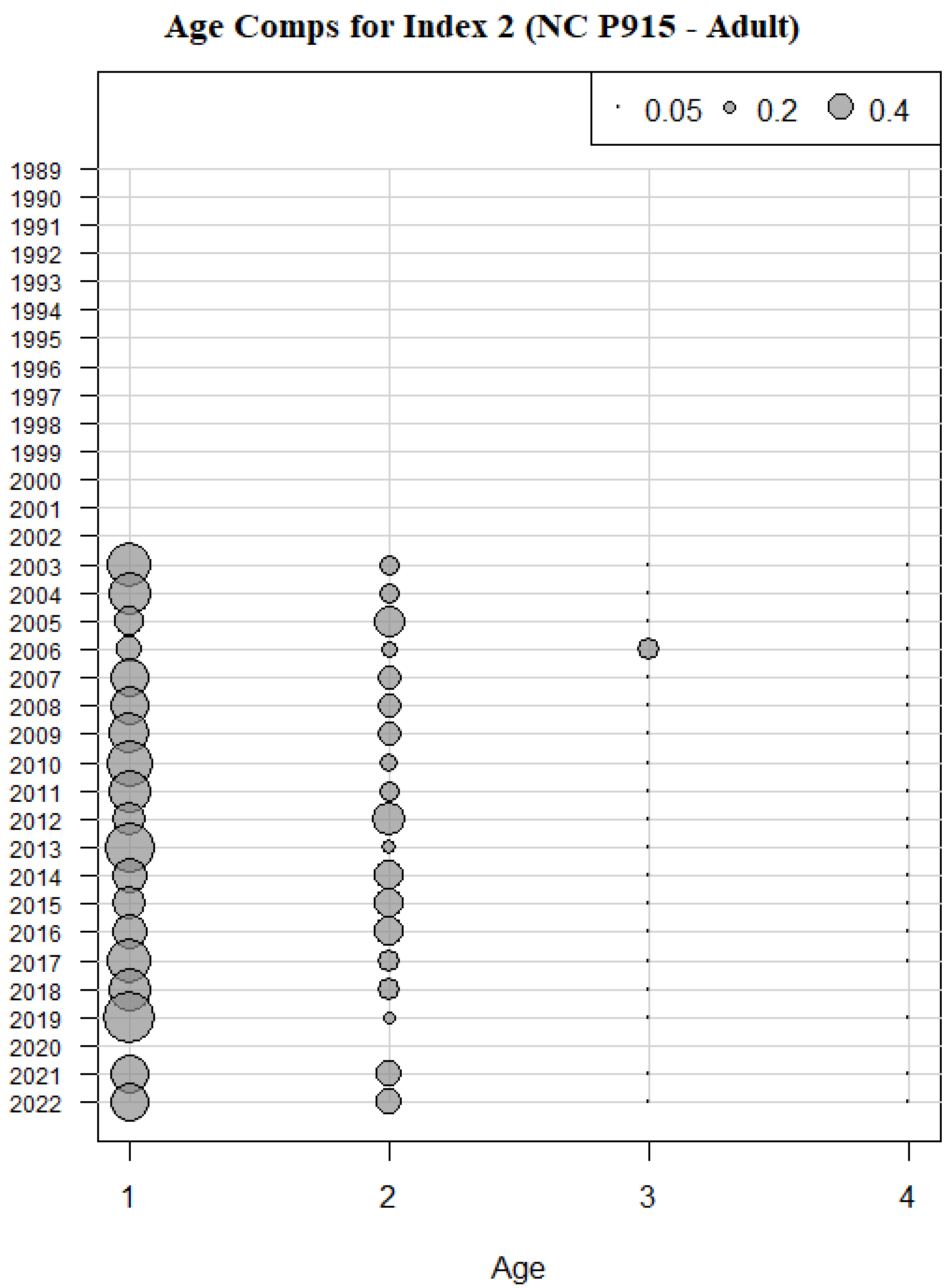


Figure 3.7. Estimated proportion sampled at age for the NC915 Gill-Net index of abundance, 2003-2022 (excluding 2020 where sampling could not occur due to COVID).

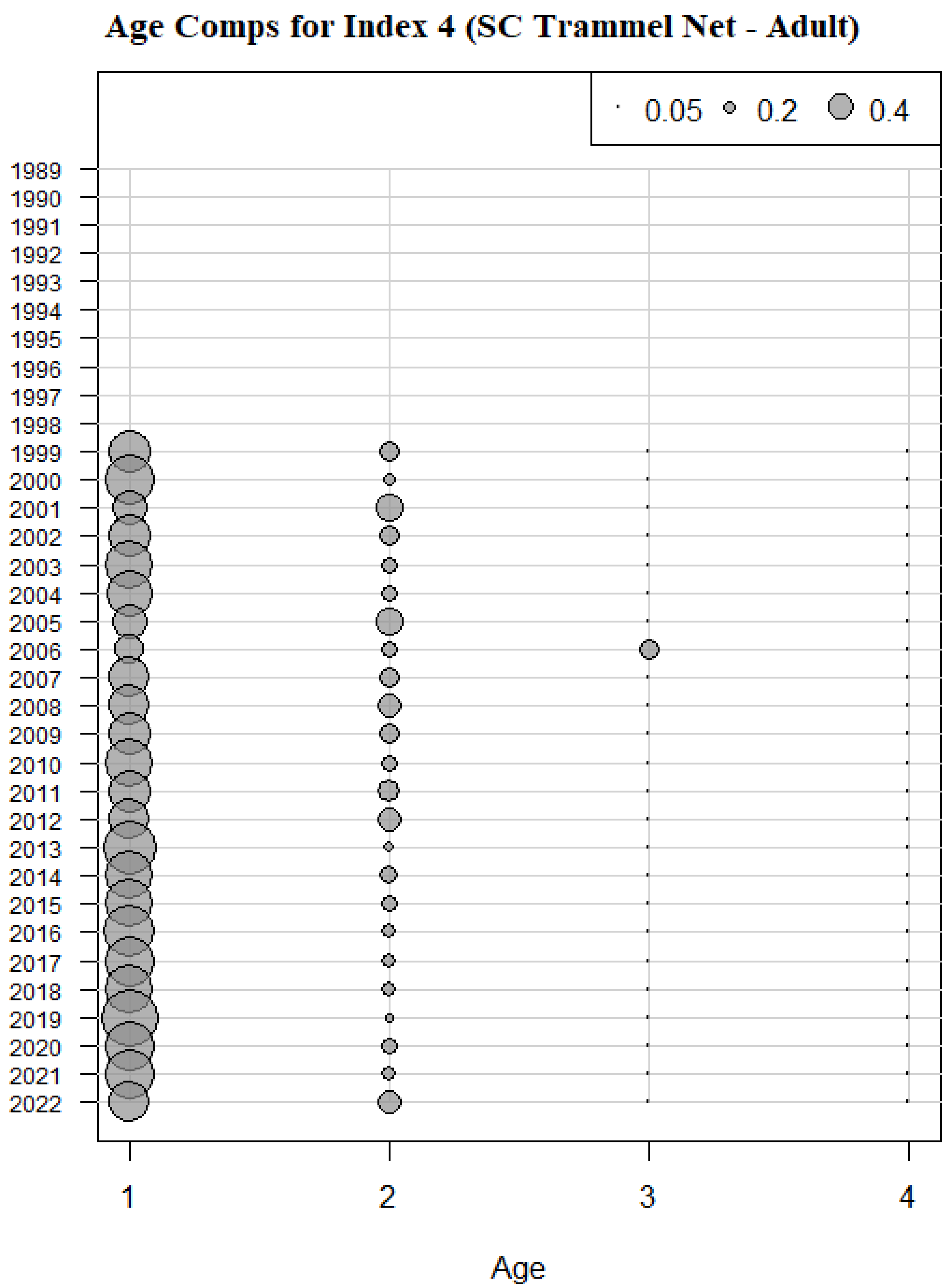


Figure 3.8. Estimated proportion sampled at age for the SC Trammel Net index of abundance, 1999-2022.

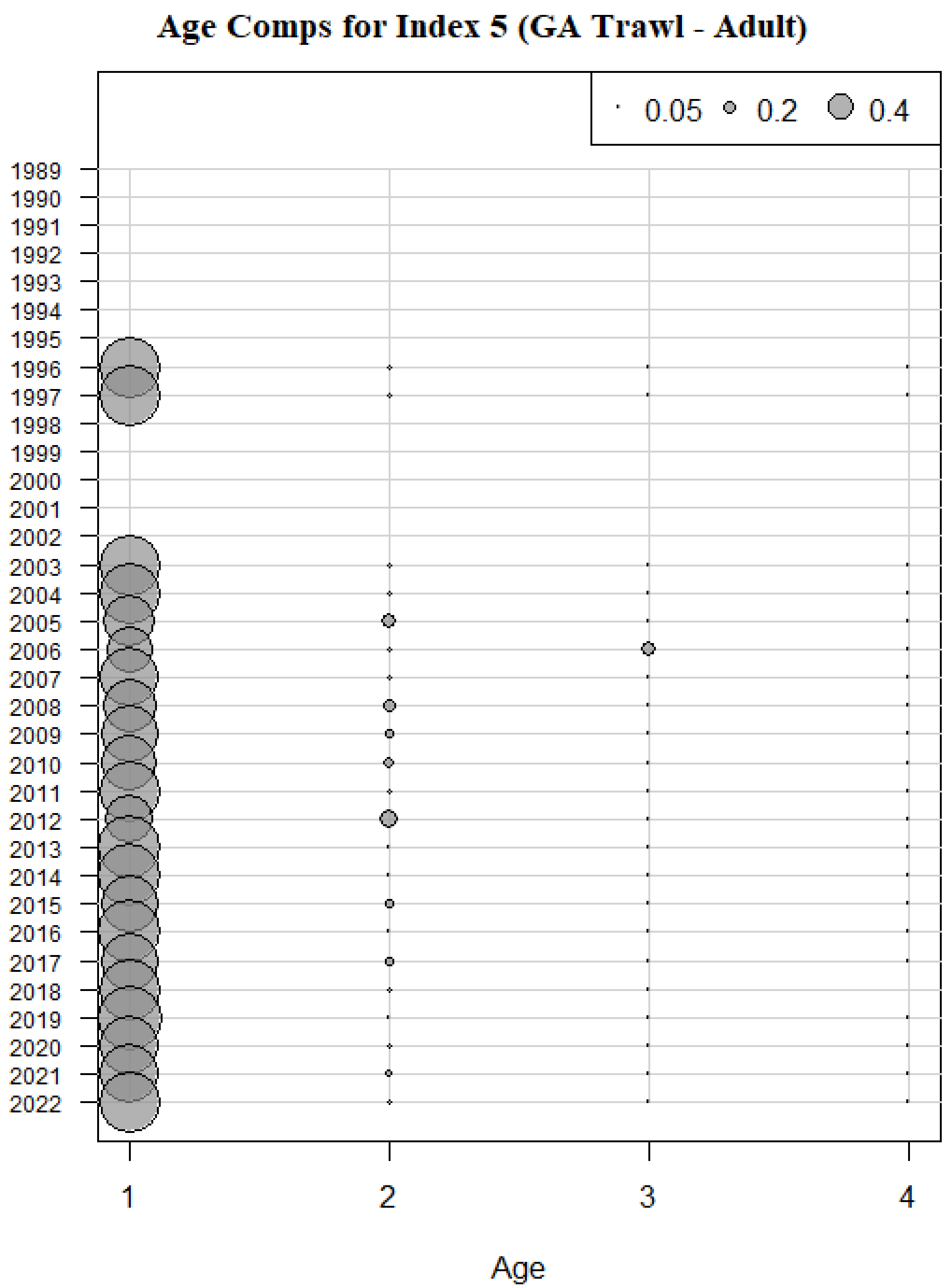


Figure 3.9. Estimated proportion sampled at age for the GA Trawl index of abundance, 1996-1997 and 2003-2022.

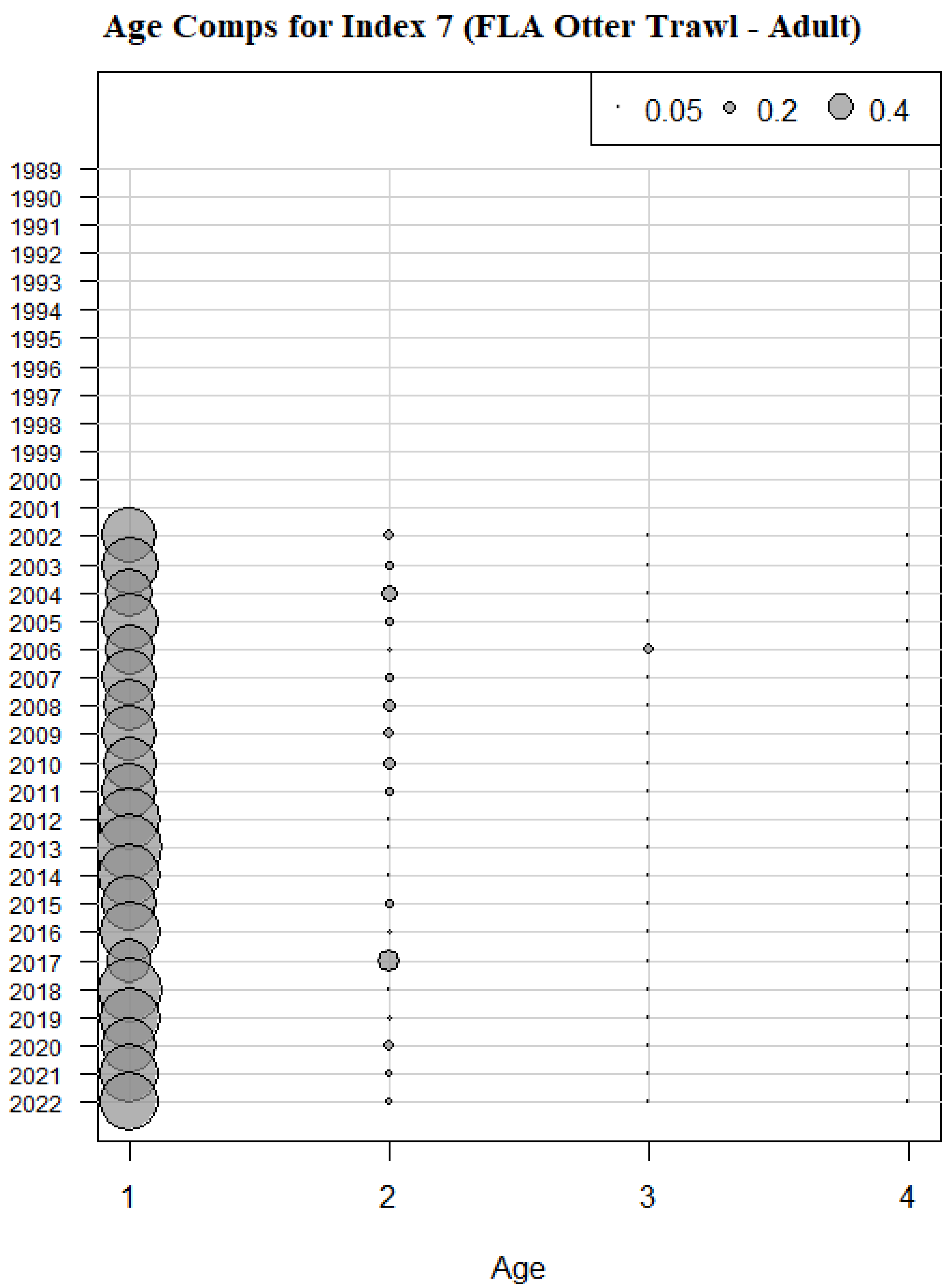


Figure 3.10. Estimated proportion sampled at age for the FL Trawl index of abundance, 2002-2022.

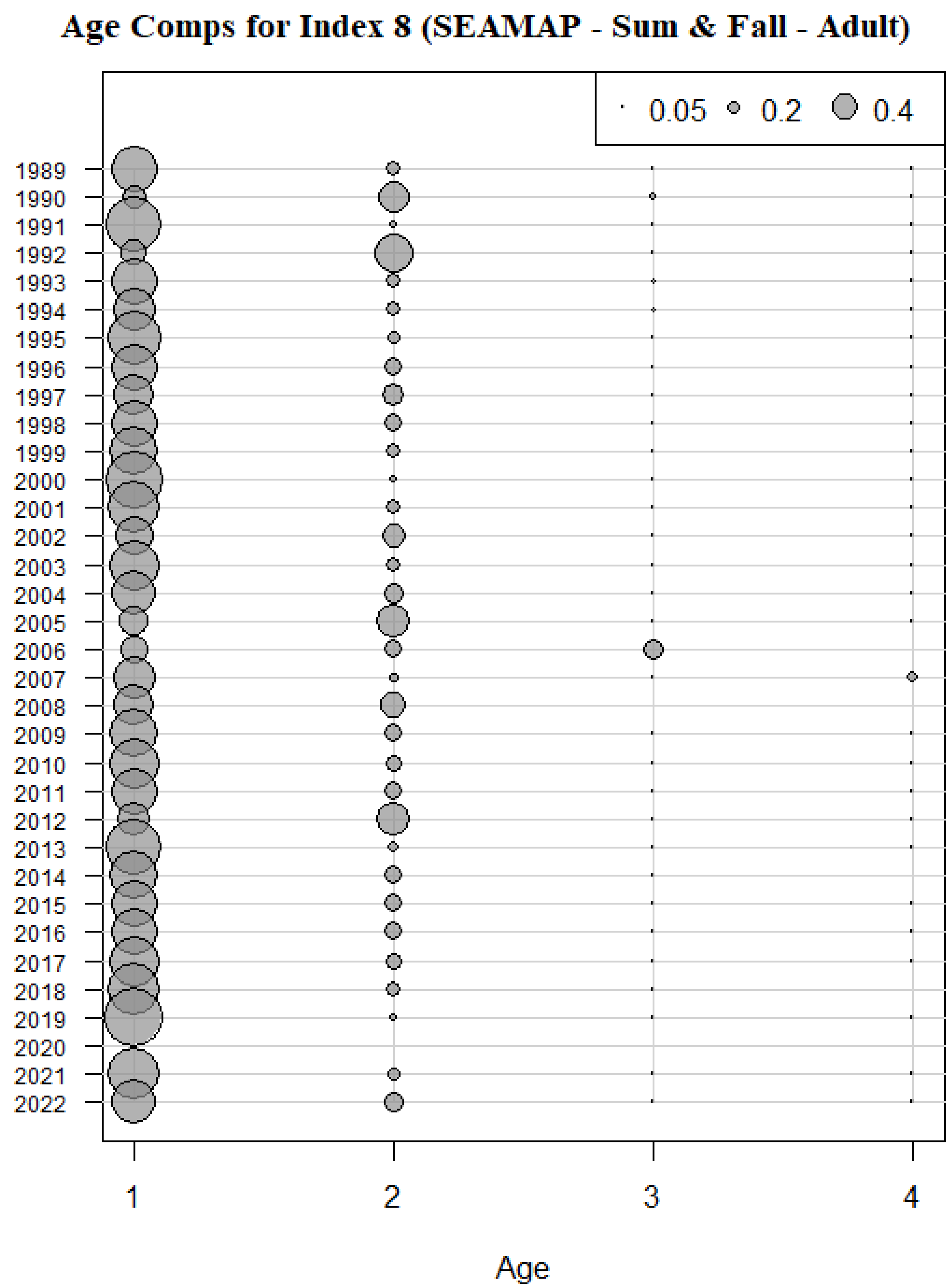


Figure 3.11. Estimated proportion sampled at age for the SEAMAP Trawl index of abundance, 1989-2022 (excluding 2020 where sampling could not occur due to COVID).

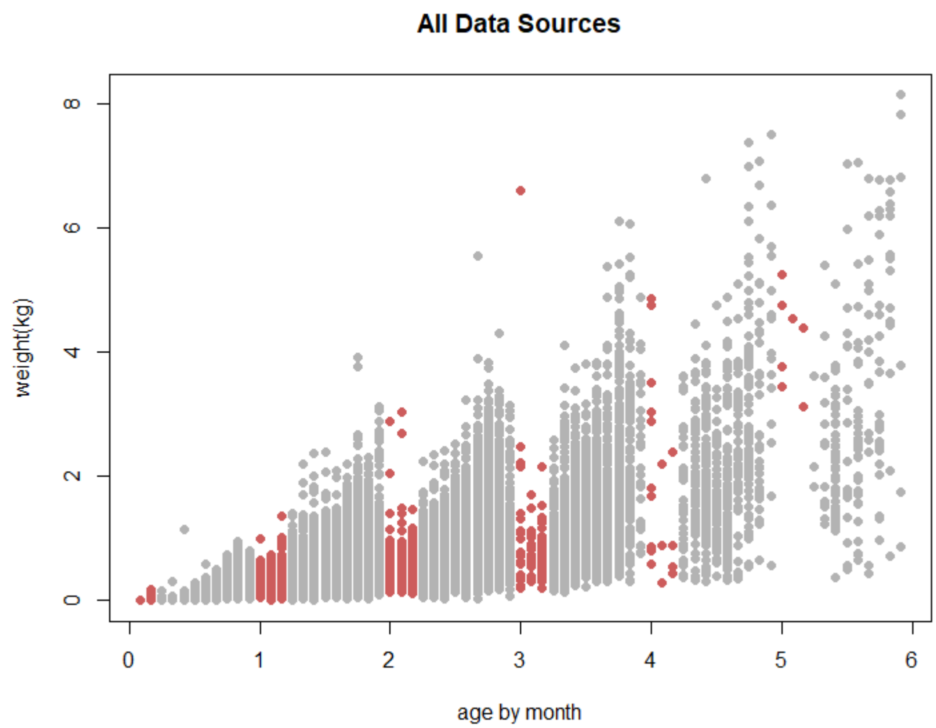


Figure 3.12. Weights by age and month from all data sources. Grey dots indicate January–March weights and red dots indicate October–December weights.

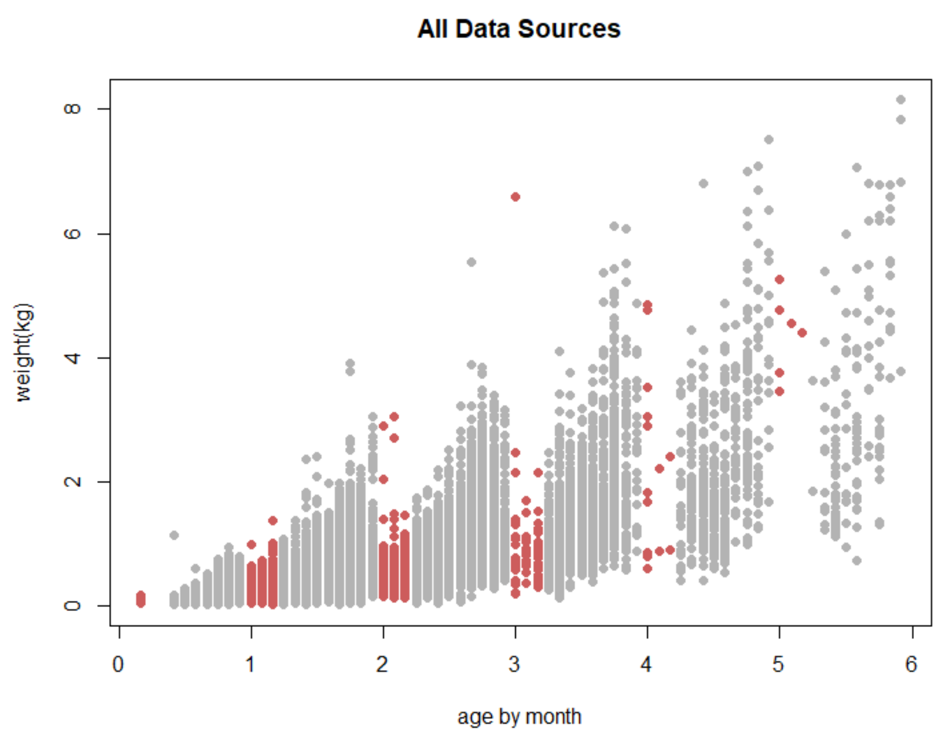


Figure 3.13. Female-only weights by age and month from all data sources. Grey dots indicate January–March weights and red dots indicate October–December weights.

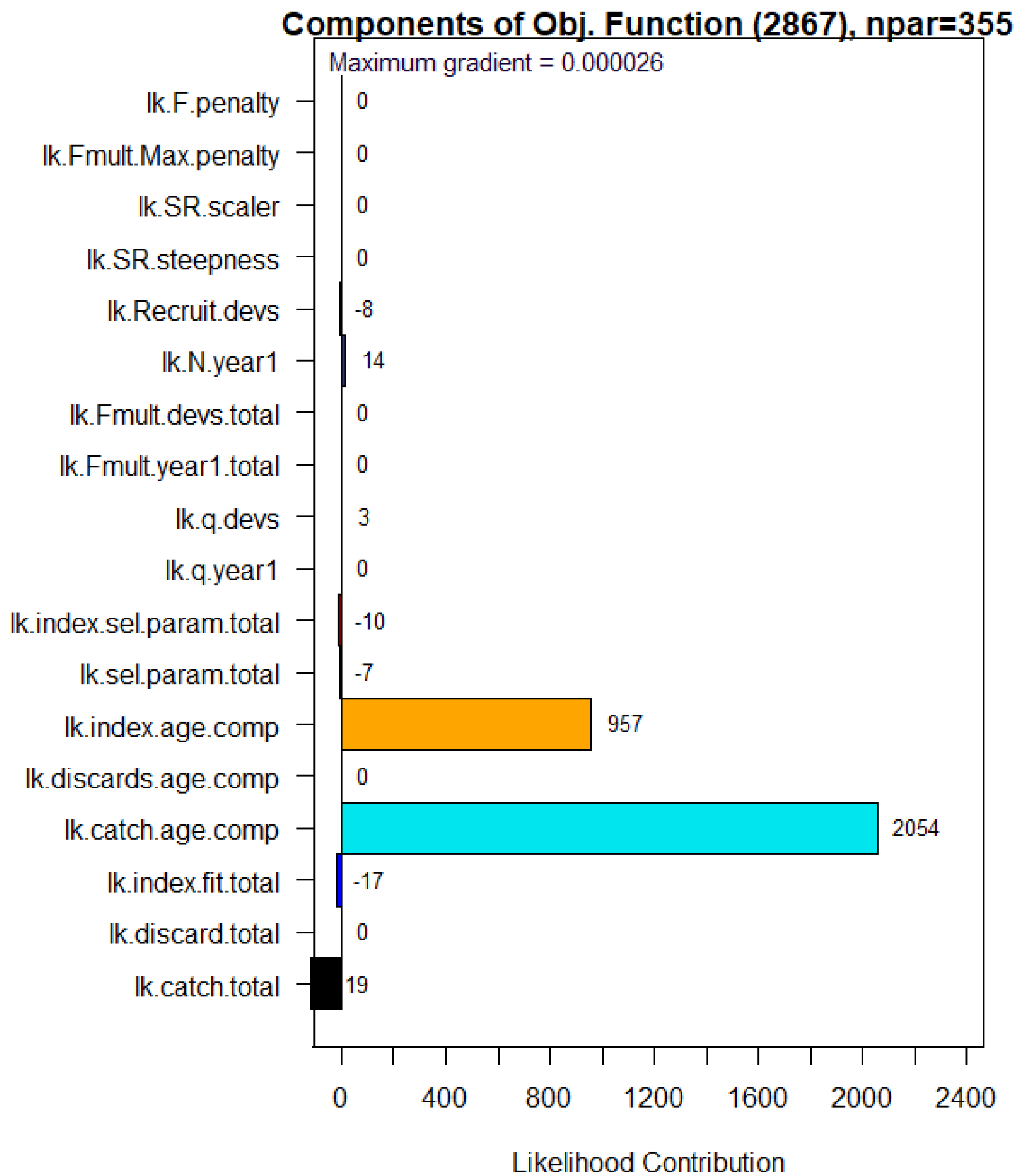


Figure 3.14. Magnitude of the components of the likelihood function for the ASAP model.

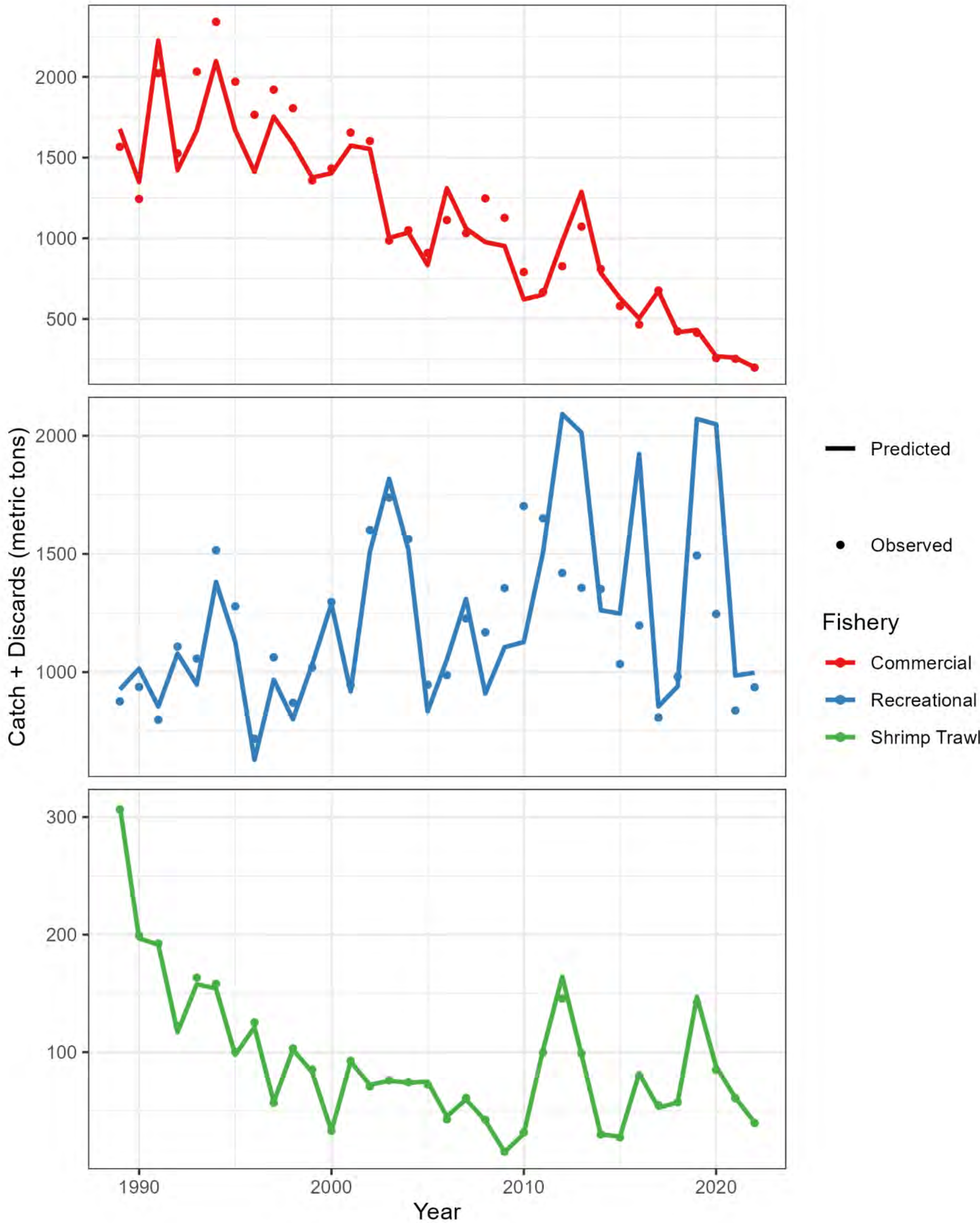


Figure 3.15. Observed and predicted catch and discards from the commercial fishery, recreational fishery, and shrimp trawl bycatch for the base run of the ASAP model.

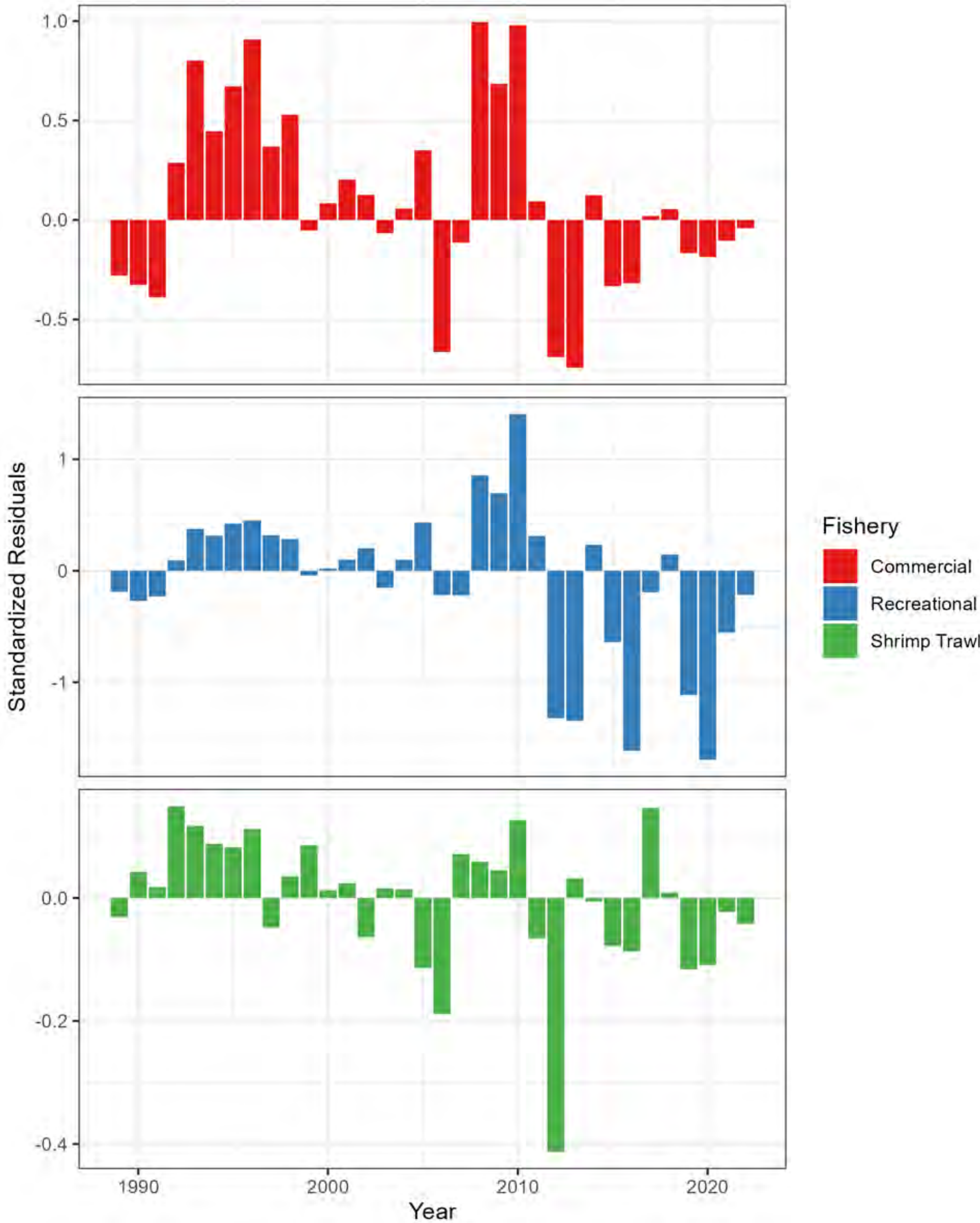


Figure 3.16. Standardized residuals for the commercial catch, recreational catch, and shrimp trawl bycatch from the base run of the ASAP model.

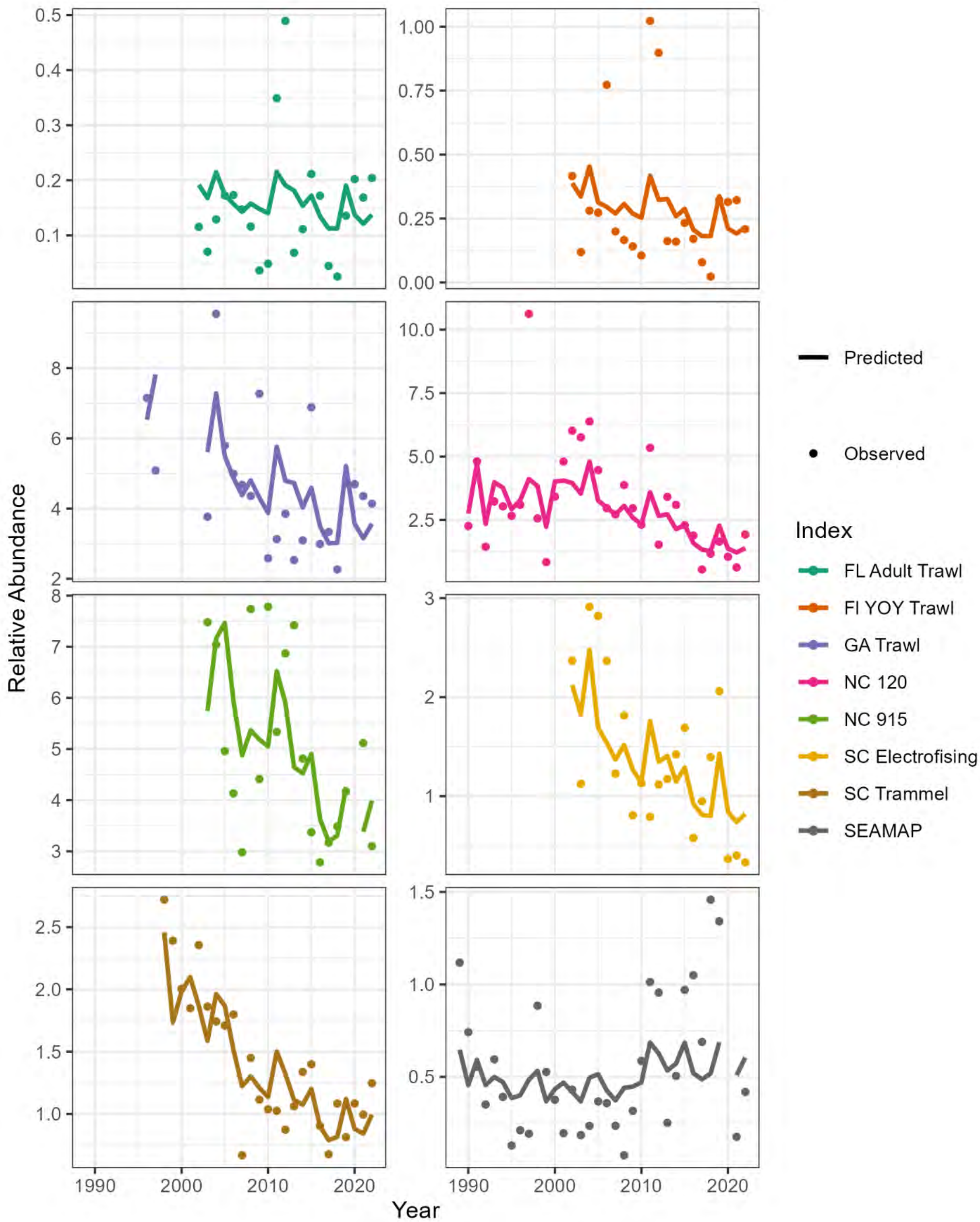


Figure 3.17. Observed and predicted relative abundance for the fishery-independent indices from the base run of the ASAP model.

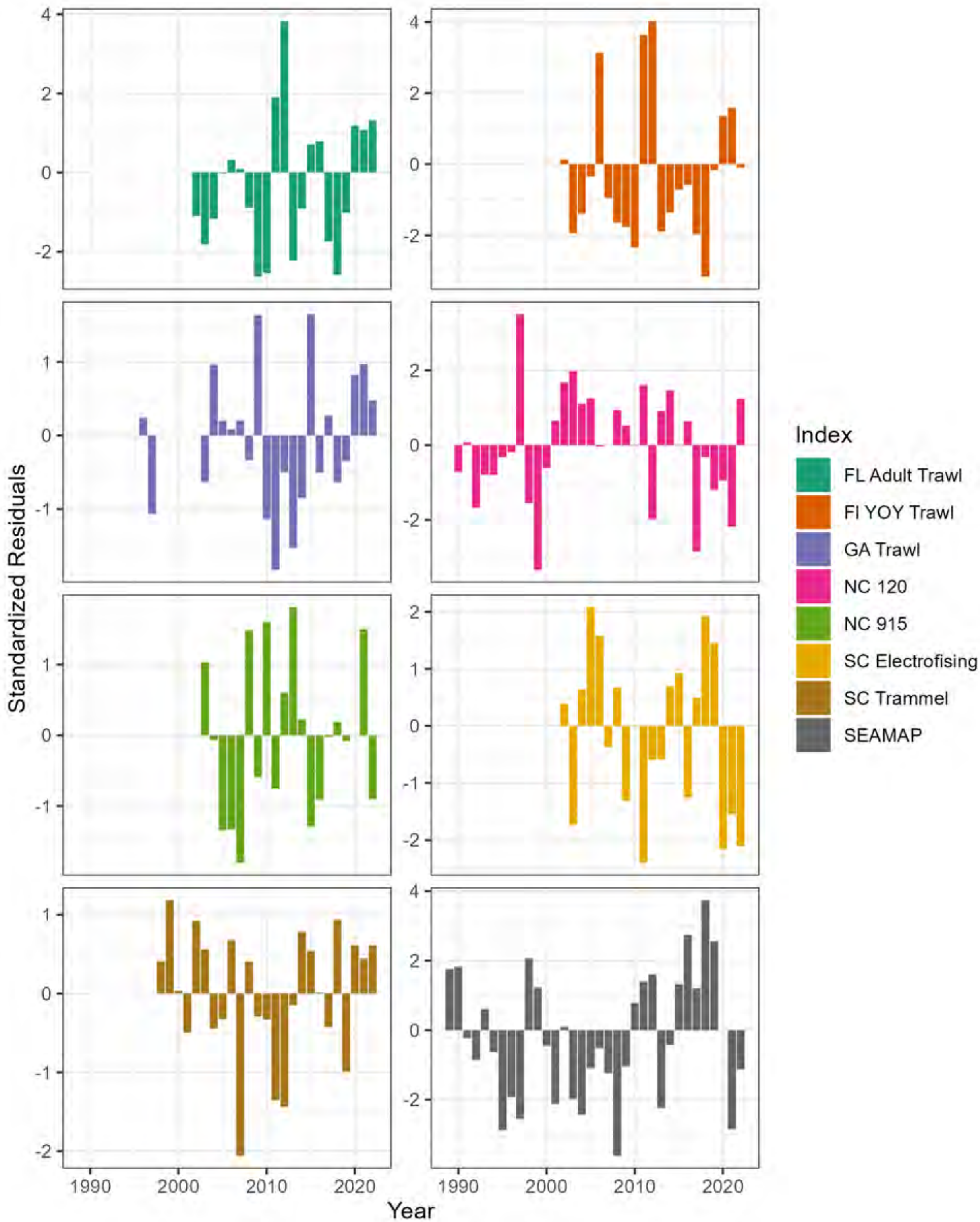


Figure 3.18. Standardized residuals for the fishery-dependent indices from the base run of the ASAP model.

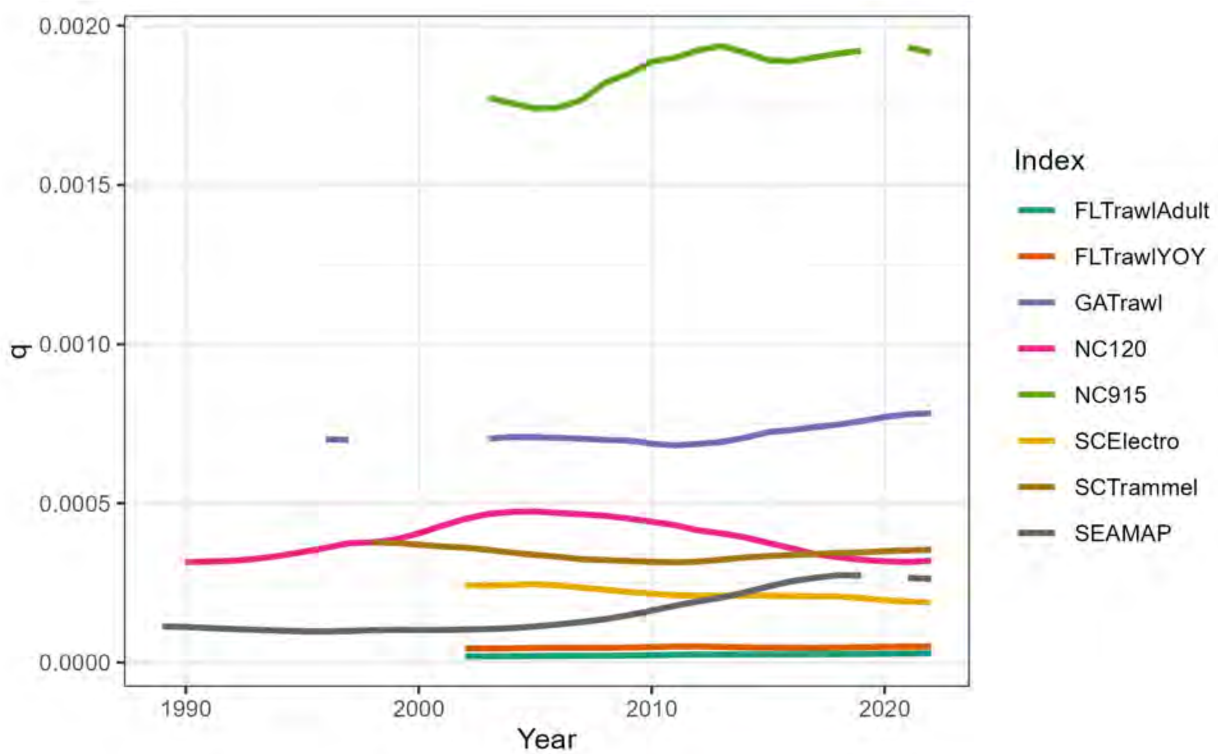


Figure 3.19. Predicted catchability (q) for the fishery-dependent indices from the base run of the ASAP model.

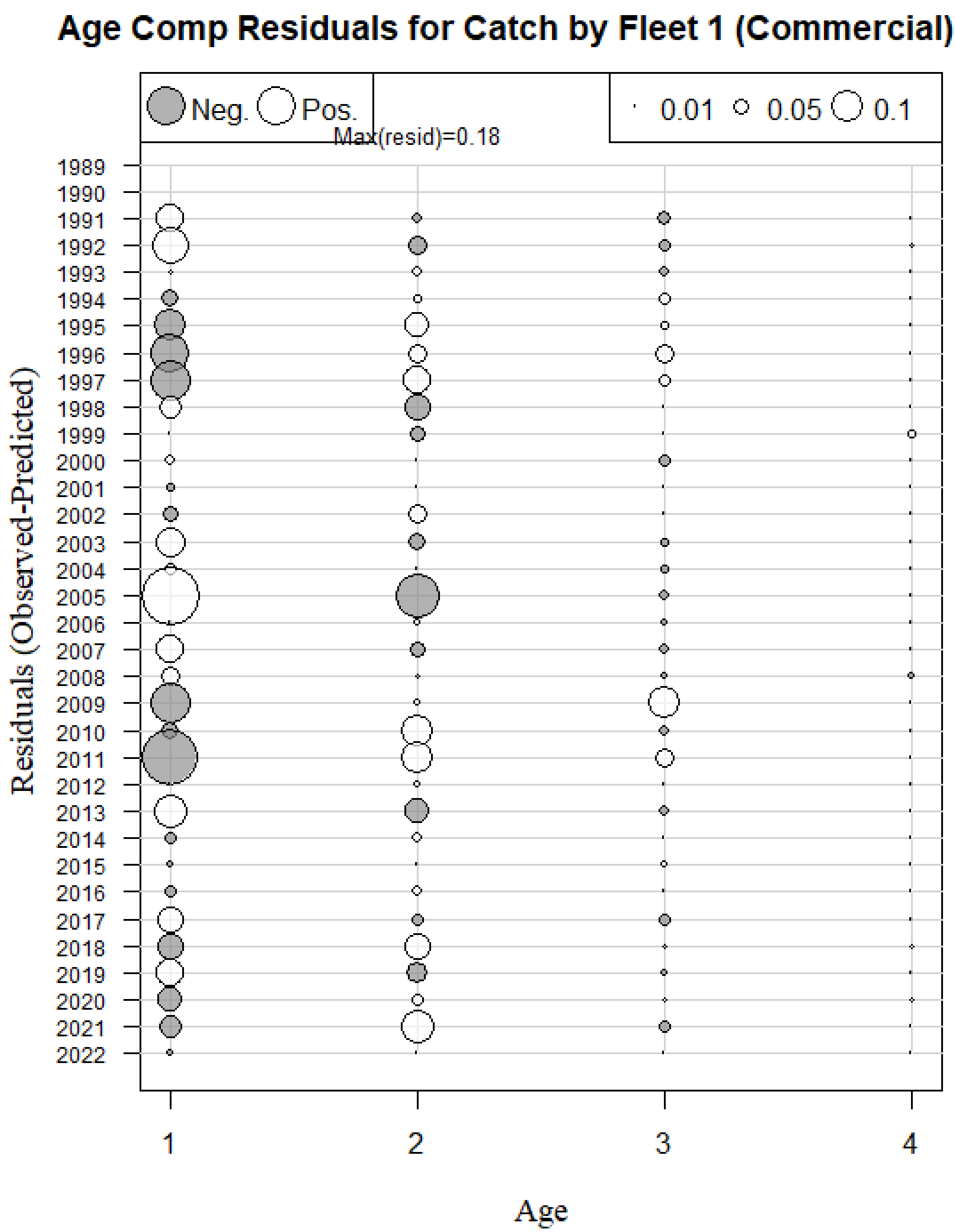


Figure 3.20. Standardized residuals for the commercial catch age composition data from the base run of the ASAP model, 1989–2022. Gray circles represent negative residuals while white circles represent positive residuals. The area of the circles is proportional to the size of the residuals.

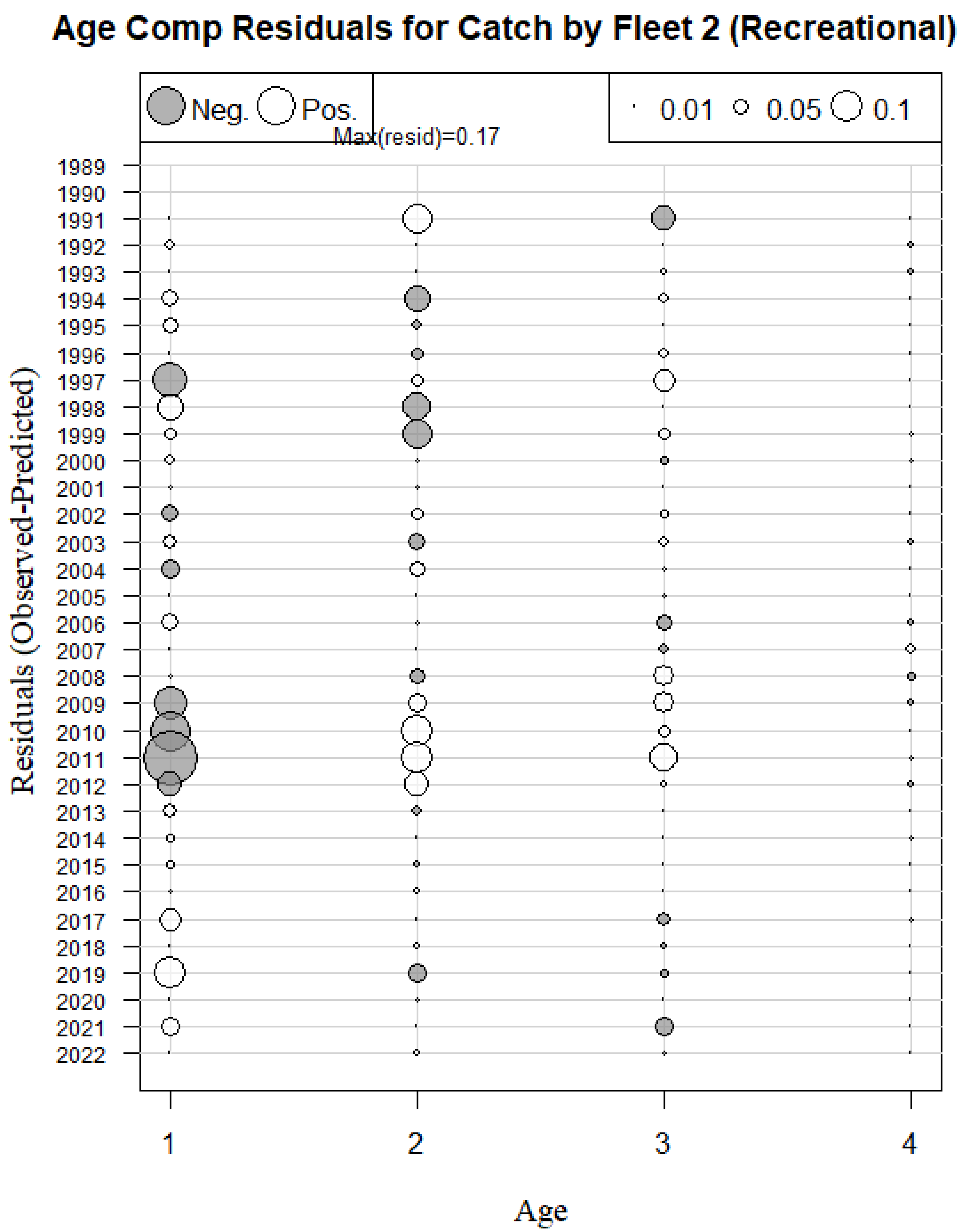


Figure 3.21. Standardized residuals for the recreational catch age composition data from the base run of the ASAP model, 1989–2022. Gray circles represent negative residuals while white circles represent positive residuals. The area of the circles is proportional to the size of the residuals.

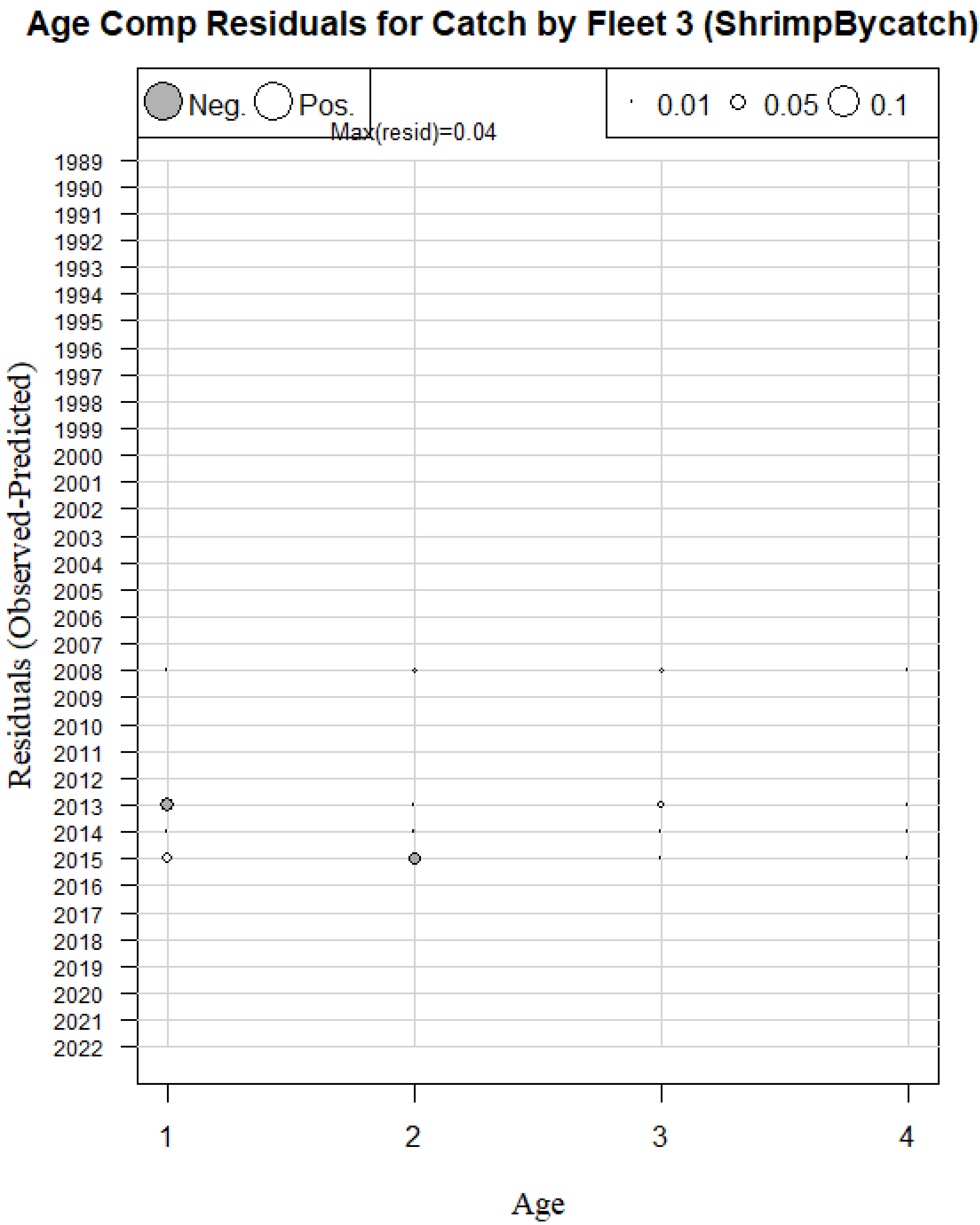


Figure 3.22. Standardized residuals for the shrimp trawl bycatch age composition data from the base run of the ASAP model, 1989–2022. Gray circles represent negative residuals while white circles represent positive residuals. The area of the circles is proportional to the size of the residuals.

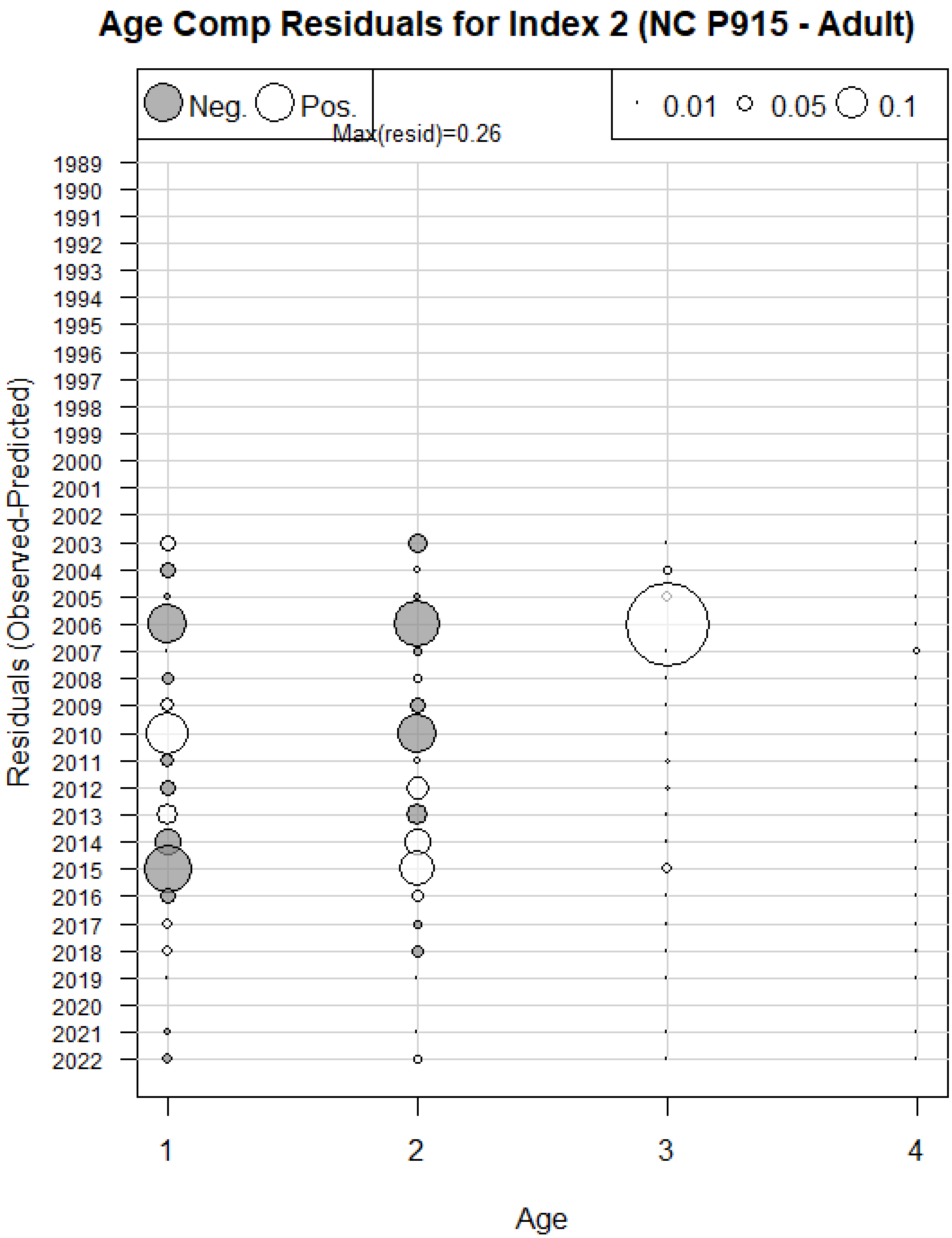


Figure 3.23. Standardized residuals for the NC915 Gill-Net Survey age composition data from the base run of the ASAP model, 1989–2022. Gray circles represent negative residuals while white circles represent positive residuals. The area of the circles is proportional to the size of the residuals.

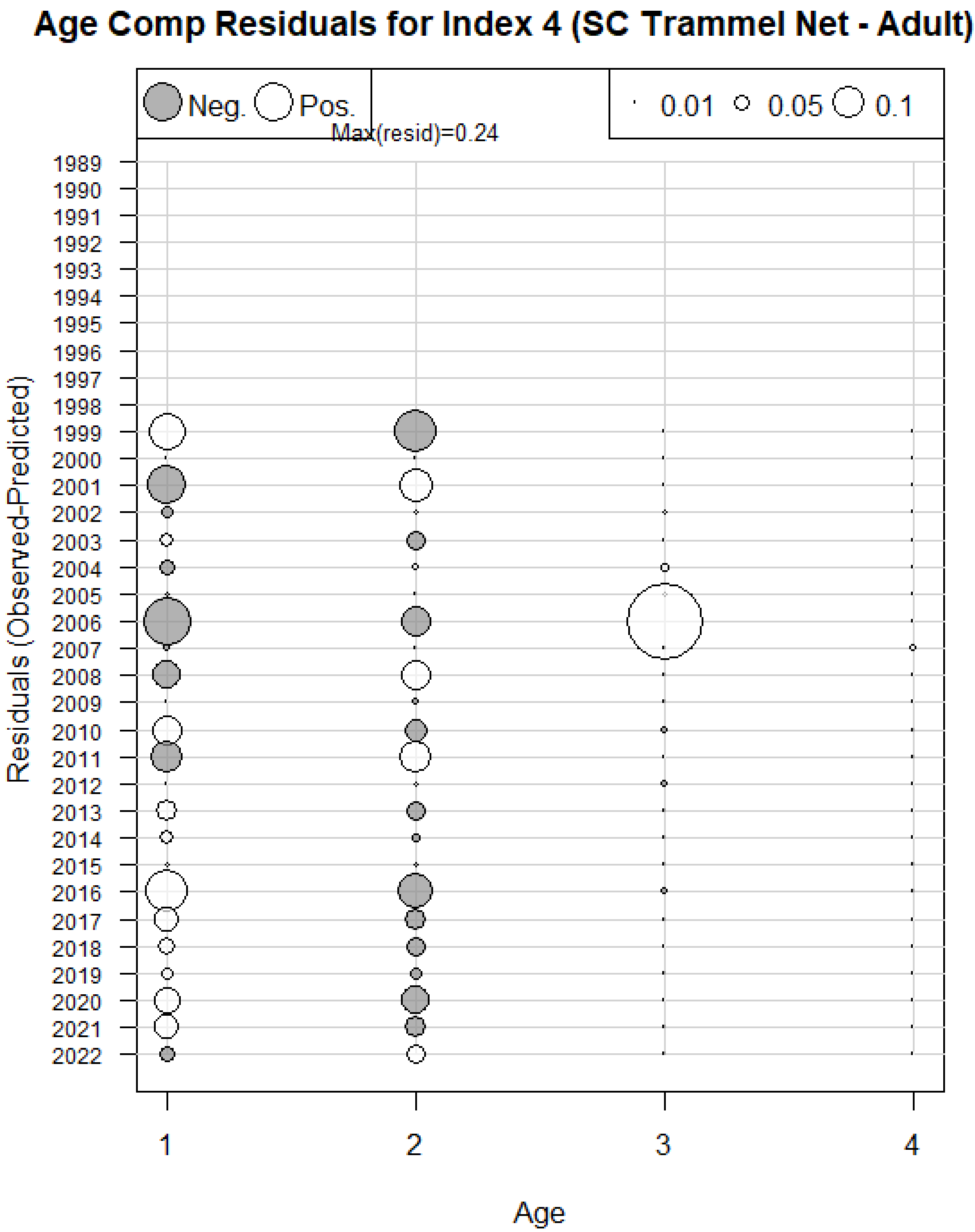


Figure 3.24. Standardized residuals for the SC Trammel Net Survey age composition data from the base run of the ASAP model, 1989–2022. Gray circles represent negative residuals while white circles represent positive residuals. The area of the circles is proportional to the size of the residuals.

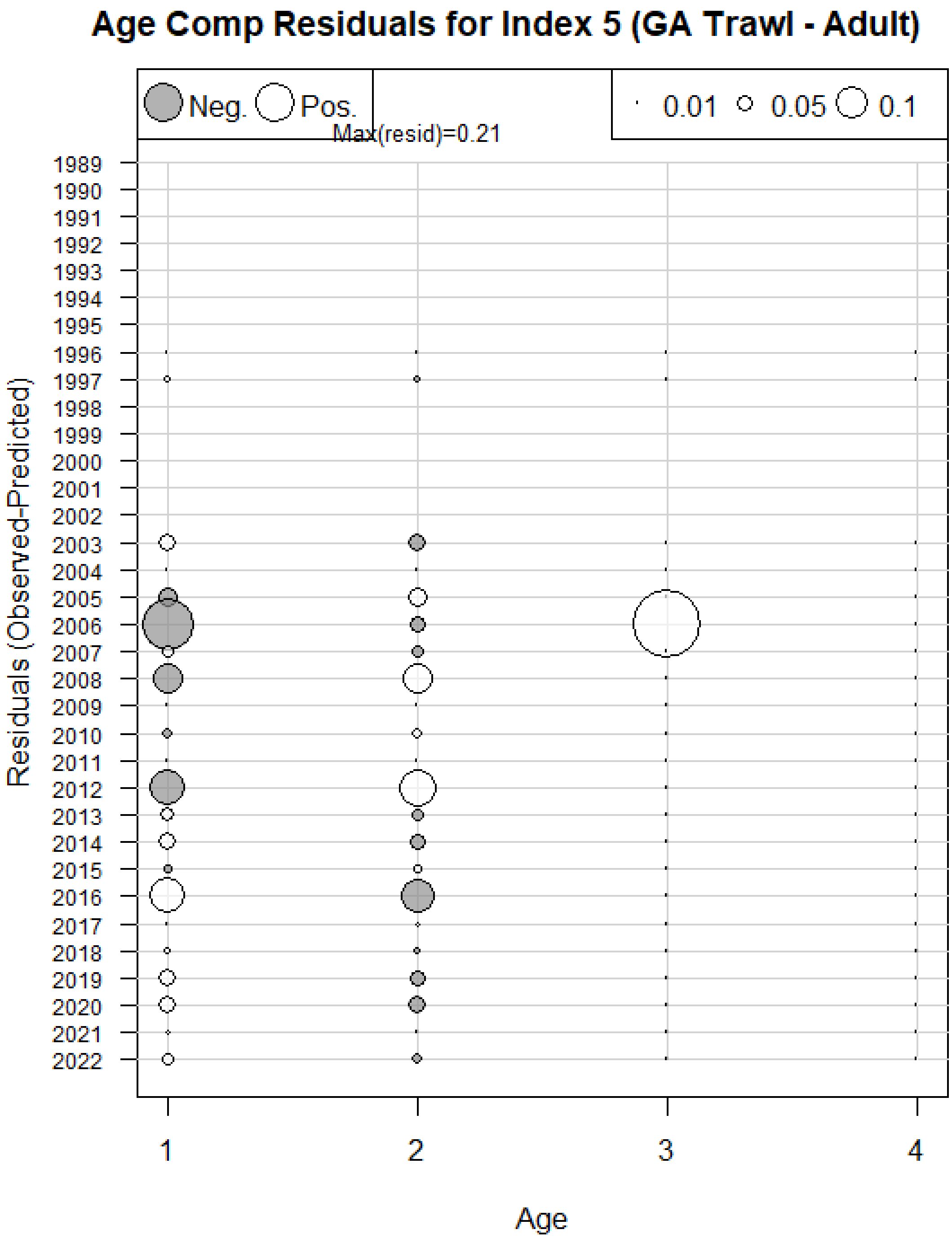


Figure 3.25. Standardized residuals for the GA Trawl Survey age composition data from the base run of the ASAP model, 1989–2022. Gray circles represent negative residuals while white circles represent positive residuals. The area of the circles is proportional to the size of the residuals.

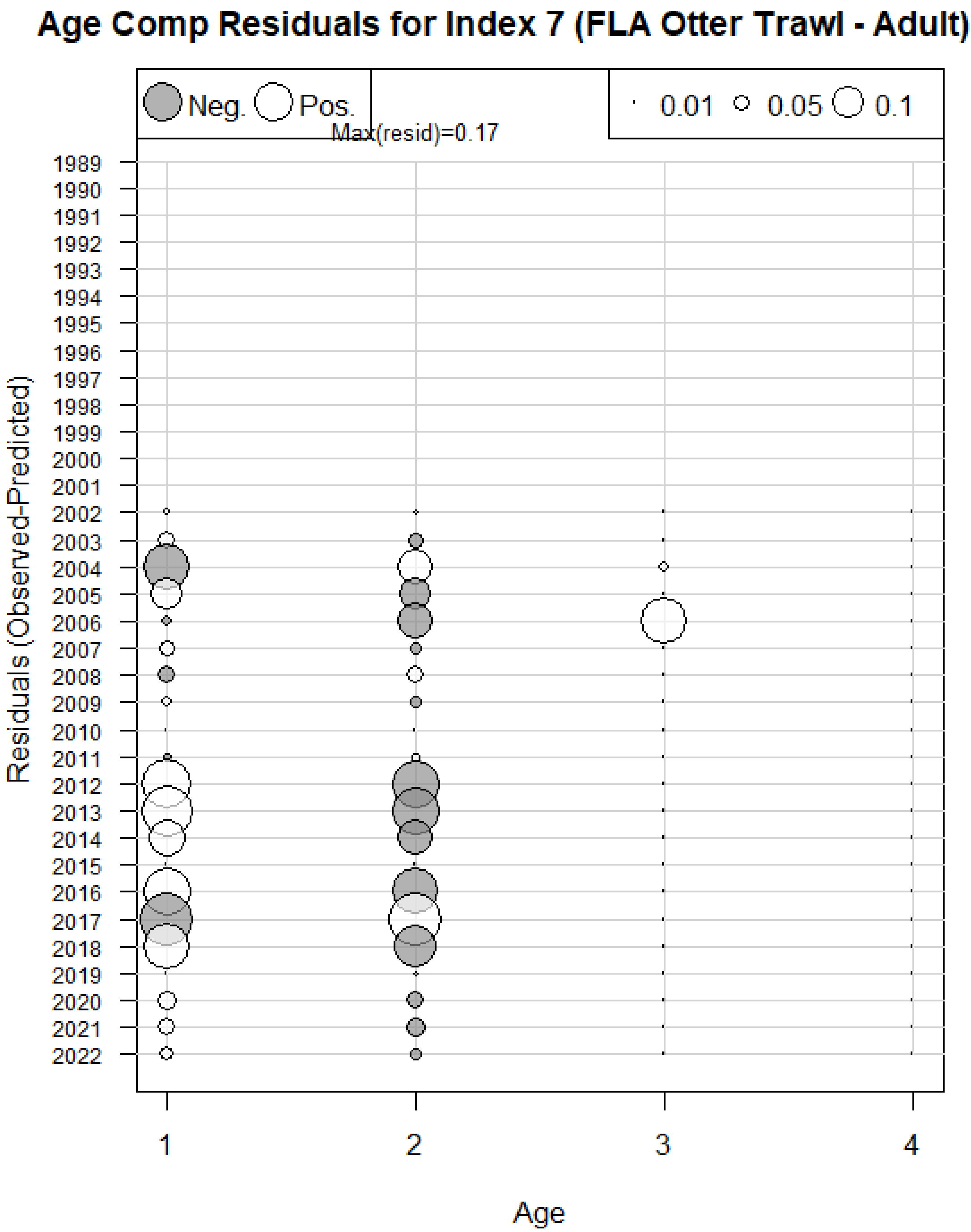


Figure 3.26. Standardized residuals for the FL Trawl Survey (adult component) age composition data from the base run of the ASAP model, 1989–2022. Gray circles represent negative residuals while white circles represent positive residuals. The area of the circles is proportional to the size of the residuals.

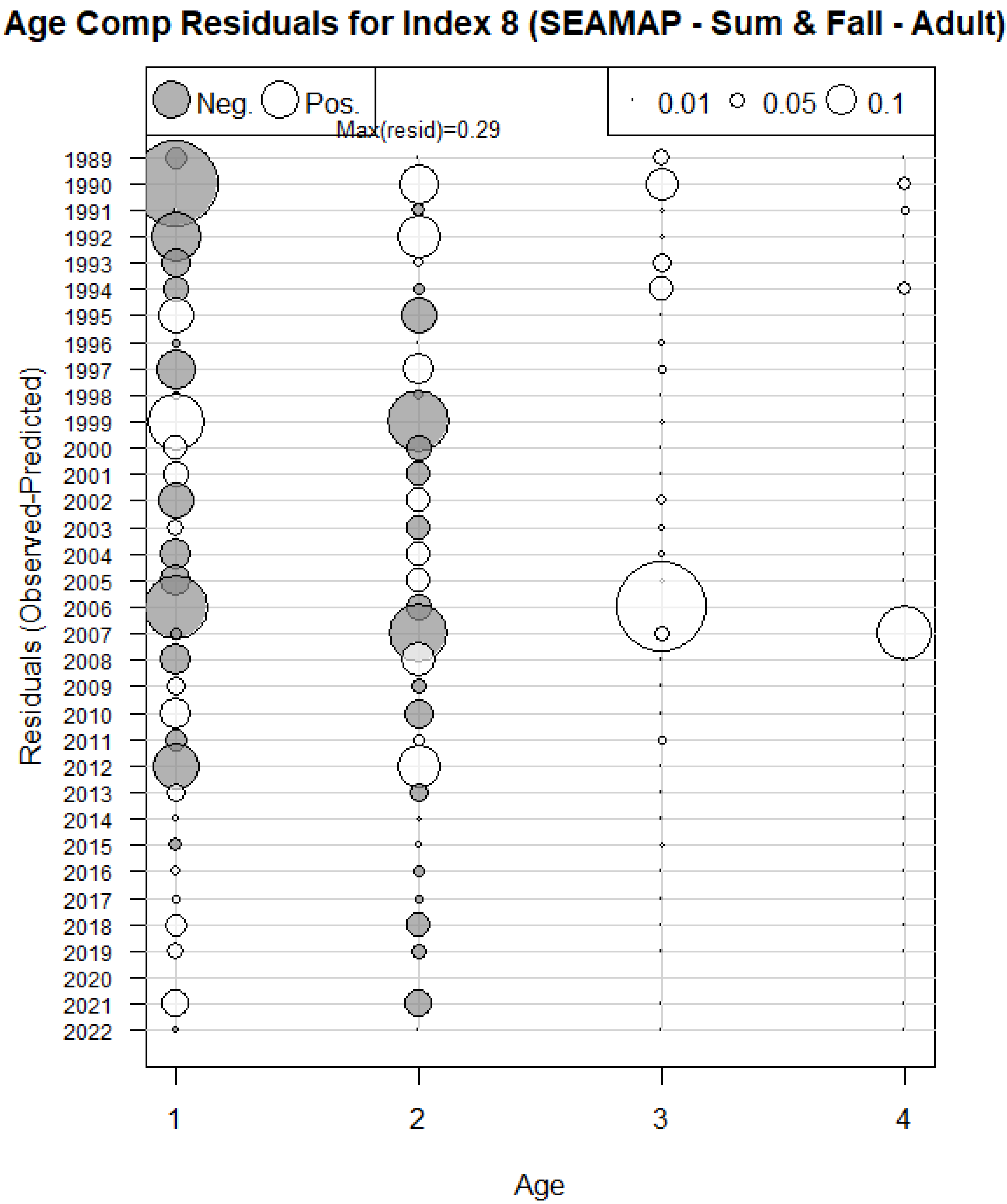


Figure 3.27. Standardized residuals for the SEAMAP Trawl Survey age composition data from the base run of the ASAP model, 1989–2022. Gray circles represent negative residuals while white circles represent positive residuals. The area of the circles is proportional to the size of the residuals.

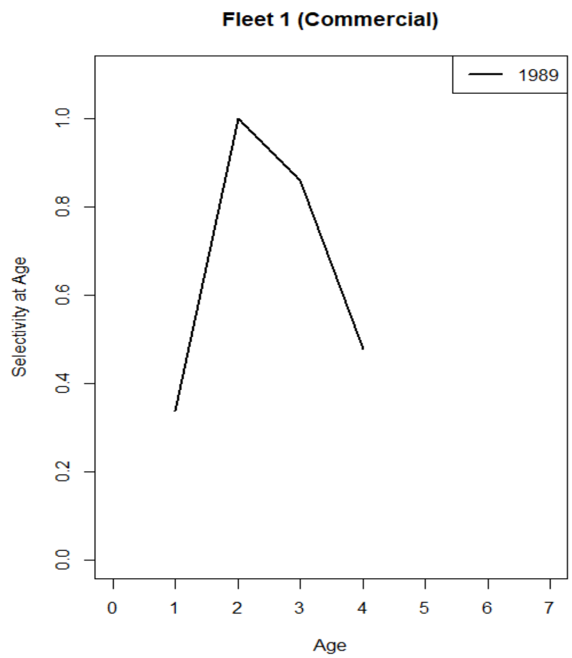


Figure 3.28. Predicted age-based selectivity for the commercial fishery from the base run of the ASAP model.

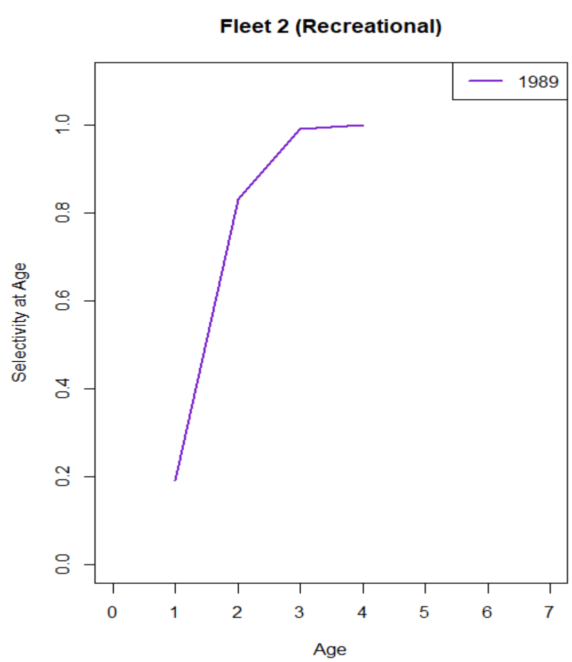


Figure 3.29. Predicted age-based selectivity for the recreational fishery from the base run of the ASAP model.

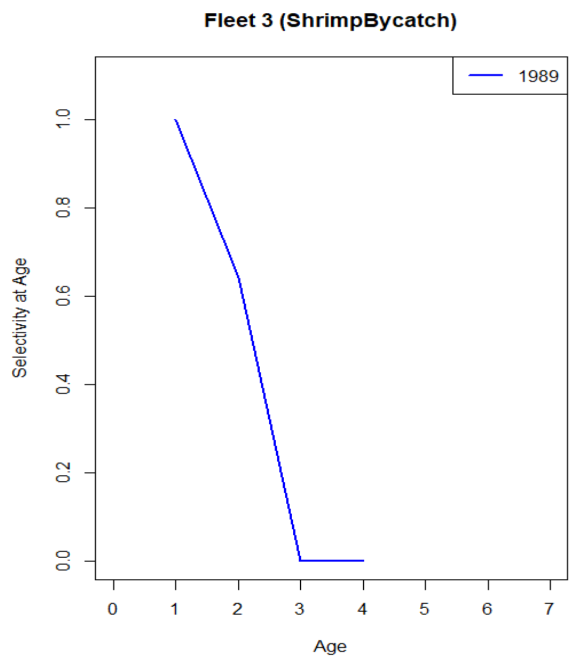


Figure 3.30. Predicted age-based selectivity for the shrimp trawl fishery from the base run of the ASAP model.

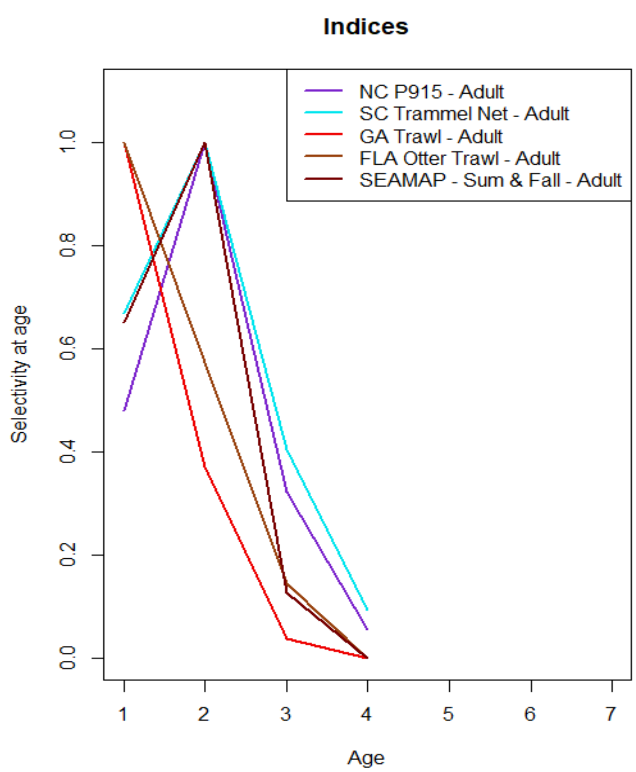


Figure 3.31. Predicted age-based selectivity for the age-1+ surveys from the base run of the ASAP model.

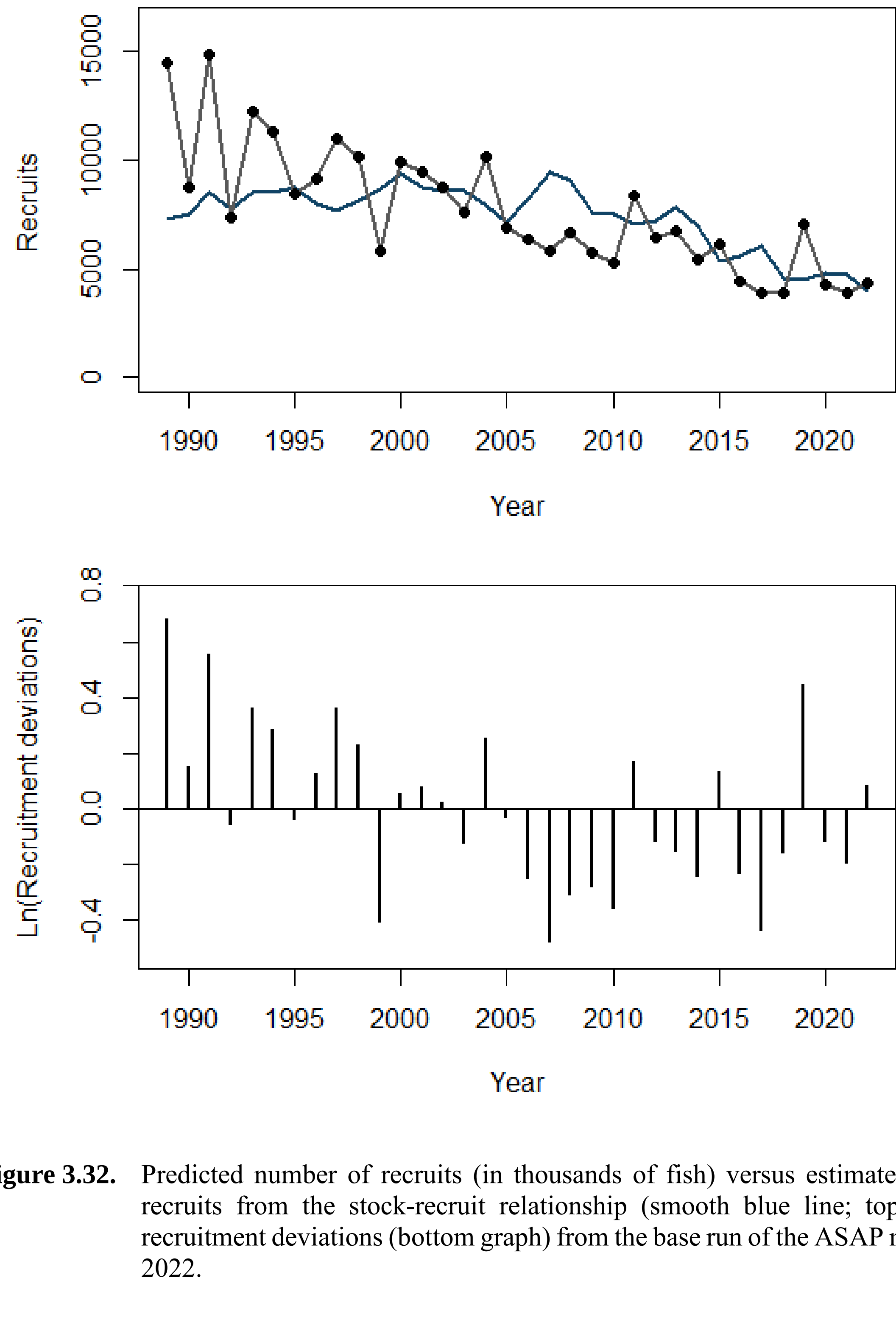


Figure 3.32. Predicted number of recruits (in thousands of fish) versus estimated number of recruits from the stock-recruit relationship (smooth blue line; top graph) and recruitment deviations (bottom graph) from the base run of the ASAP model, 1989–2022.

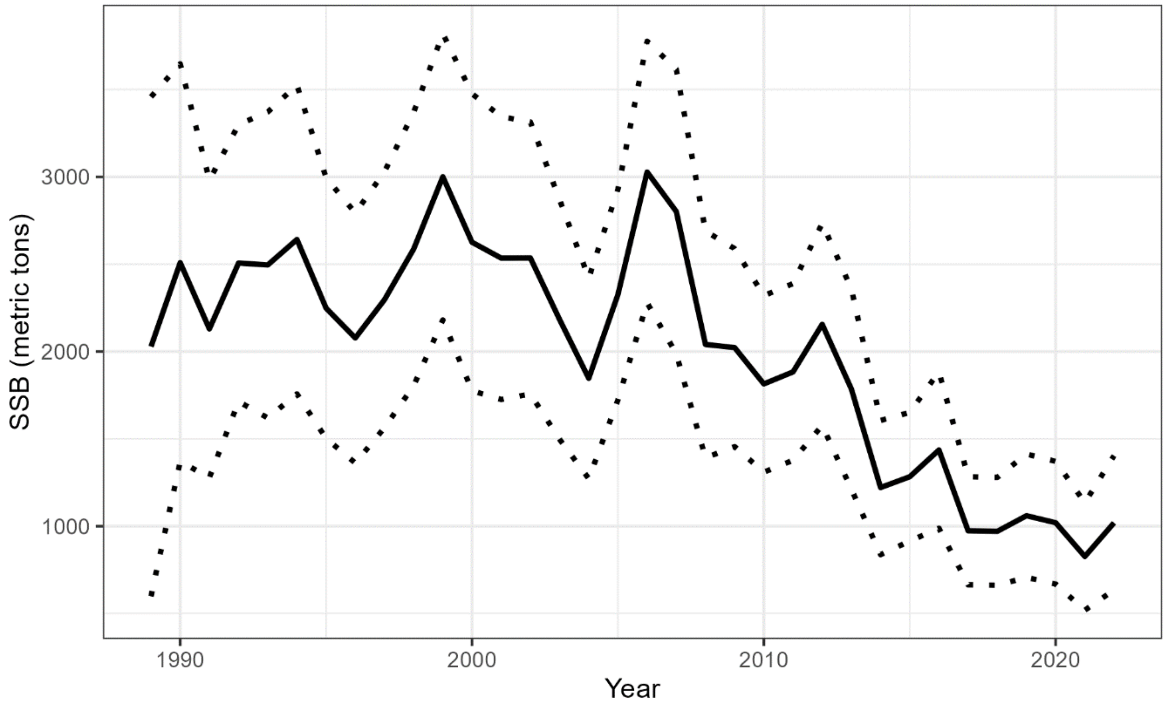


Figure 3.33. Predicted female spawning stock biomass (SSB) from the base run of the ASAP model, 1989–2022. Dotted lines represent ± 2 standard deviations of the predicted values.

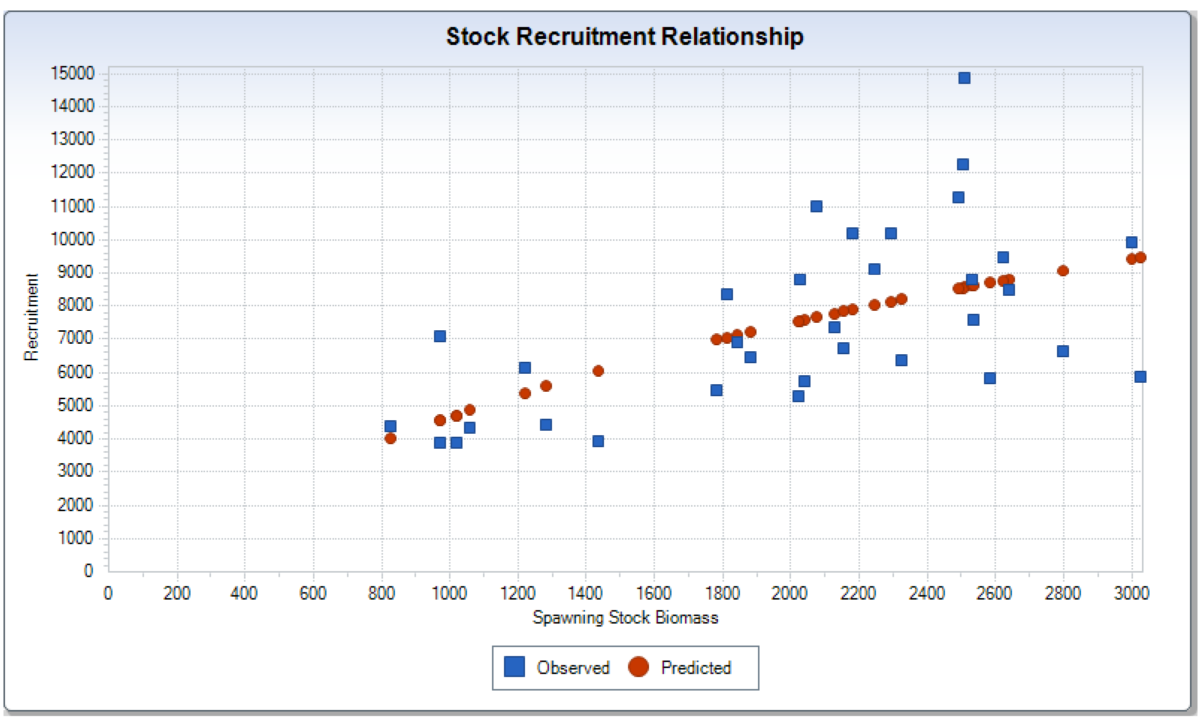


Figure 3.34. Predicted Beverton-Holt stock-recruitment relationship from the base run of the ASAP model.

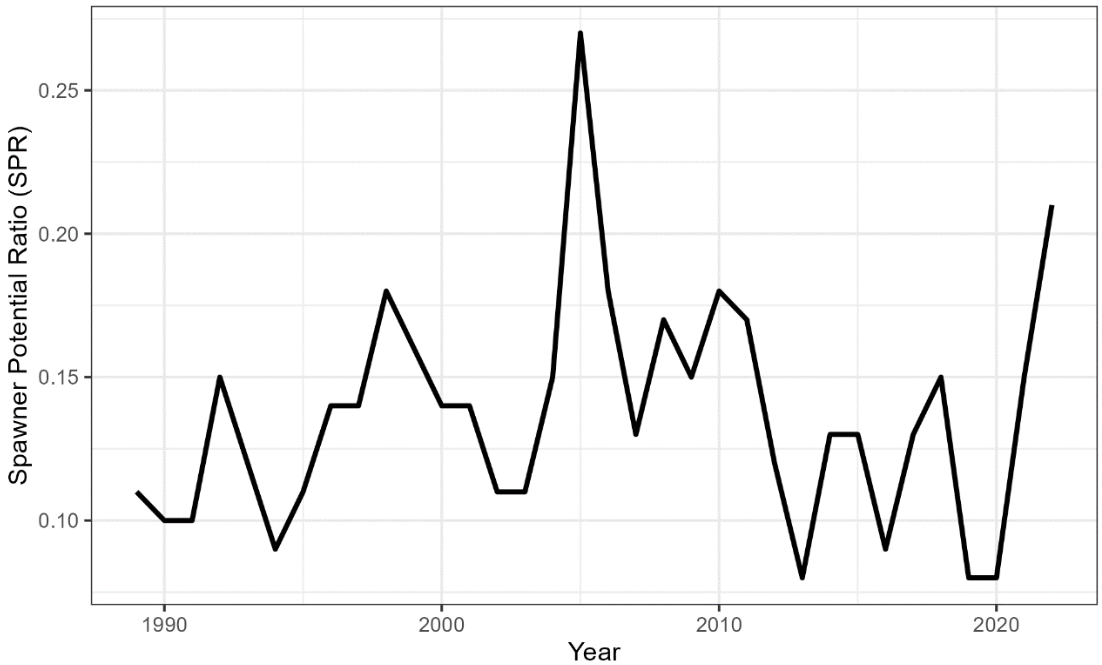


Figure 3.35. Predicted spawner potential ratio (SPR) from the base run of the ASAP model, 1989–2022.

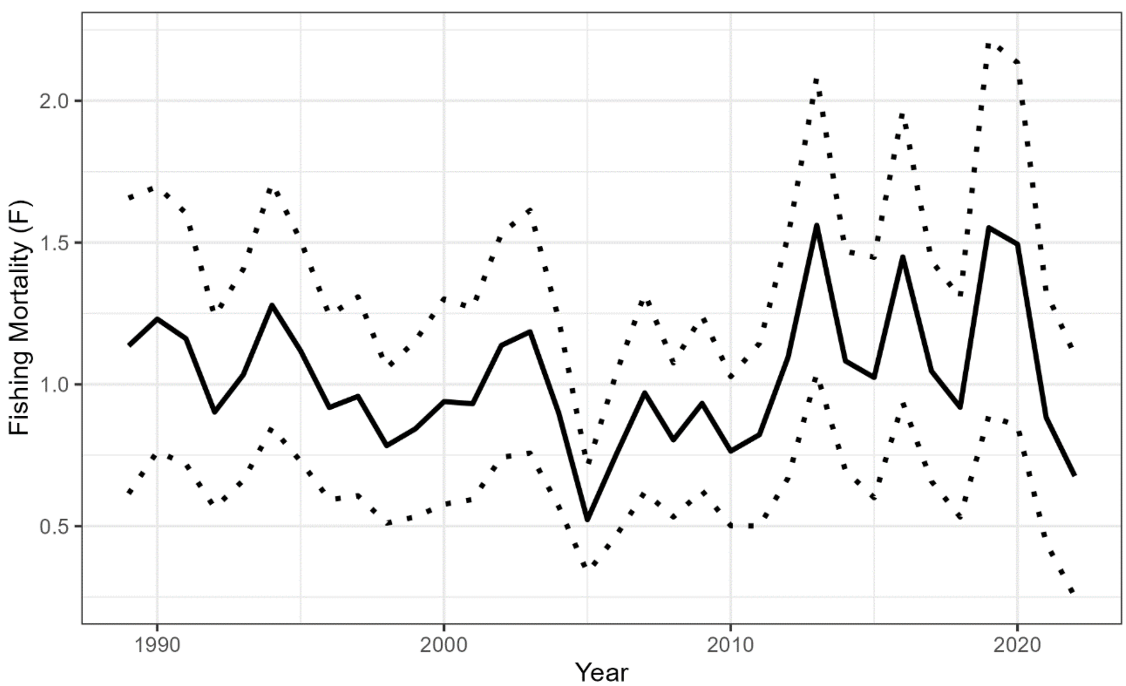


Figure 3.36. Predicted fishing mortality rates (numbers-weighted, ages 2–4) from the base run of the ASAP model, 1989–2022. Dotted lines represent ± 2 standard deviations of the predicted values.

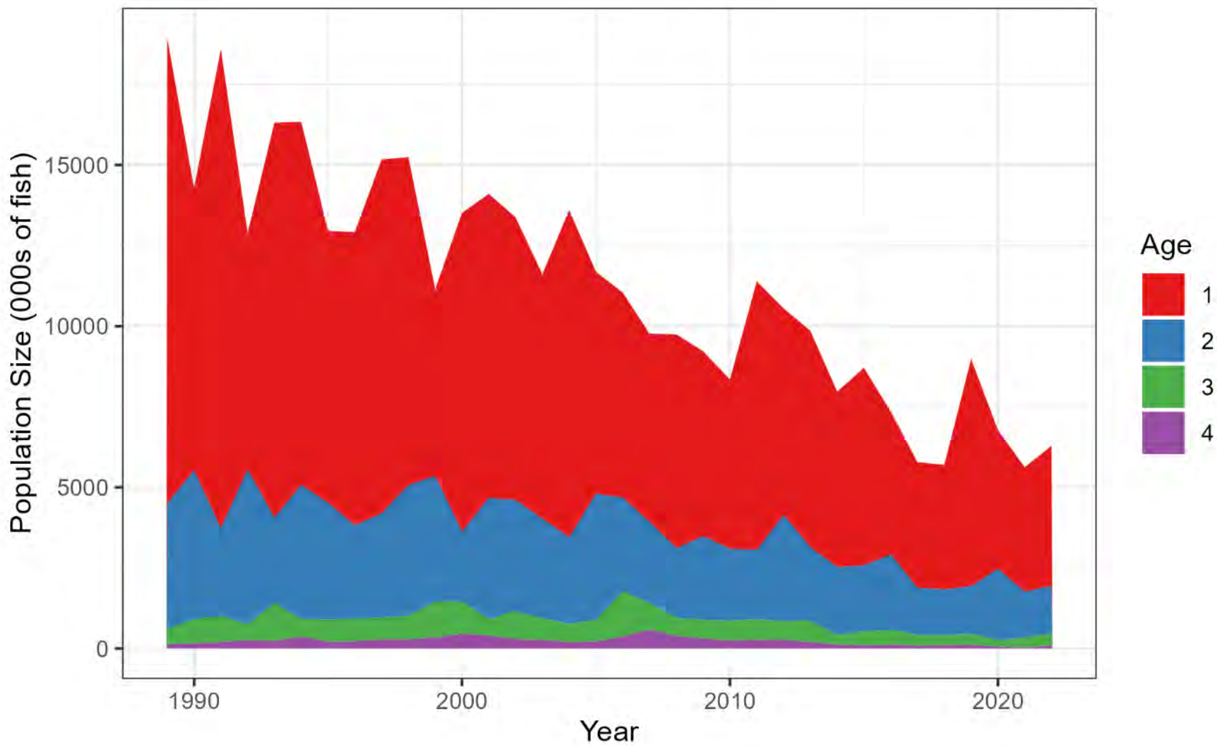
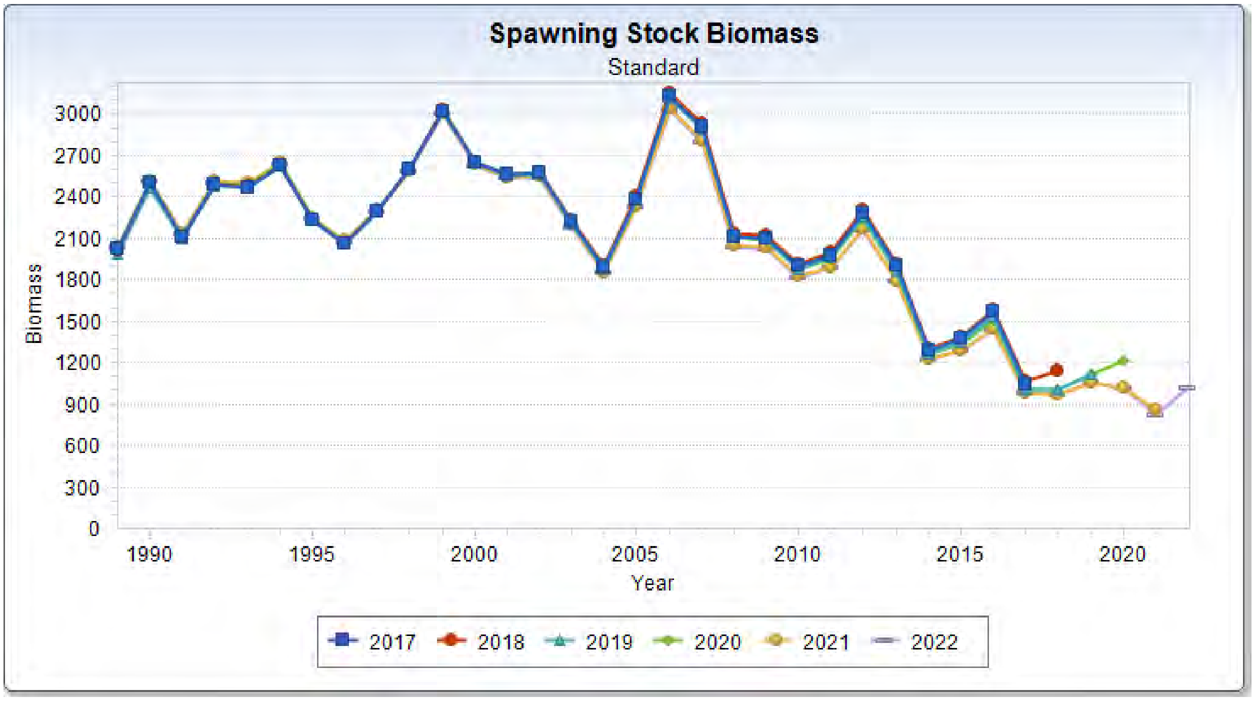


Figure 3.37. Predicted stock numbers at age from the base run of the ASAP model, 1989–2022.



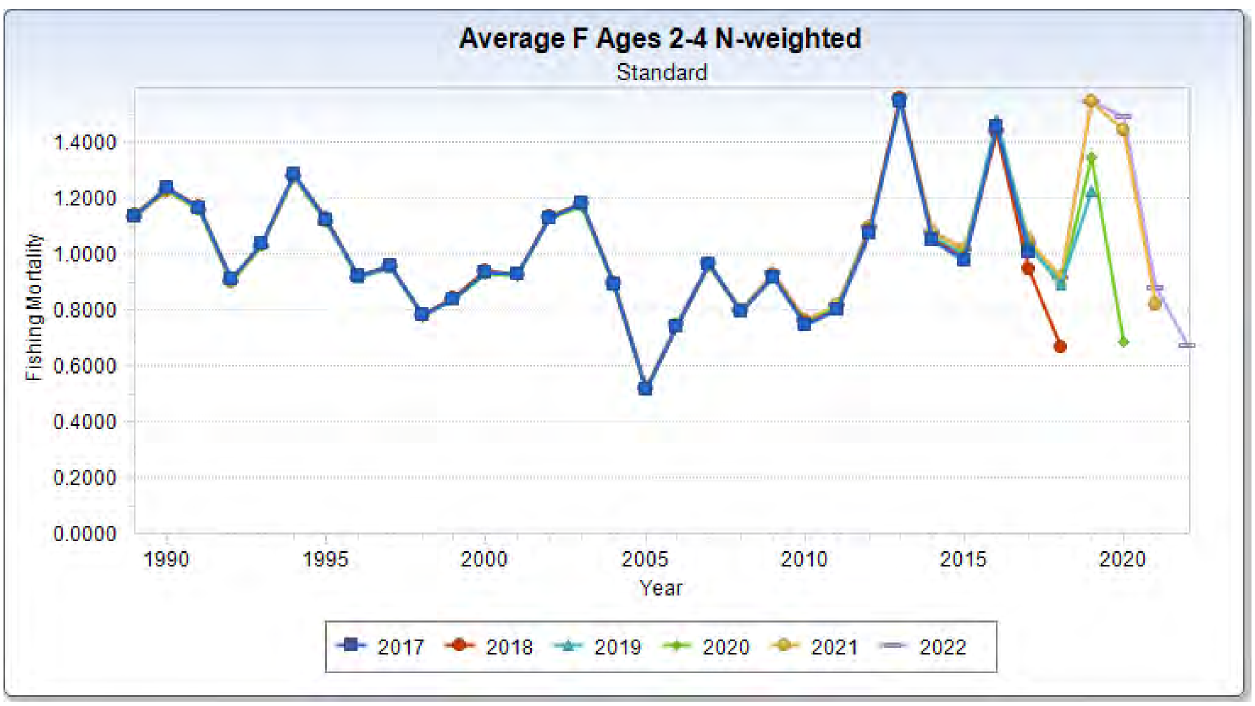


Figure 3.38. Predicted female spawning stock biomass (SSB; top graph) and fishing mortality rates (numbers-weighted, ages 2–4; bottom graph) from a retrospective analysis of the base run of the ASAP model, 1989–2022.

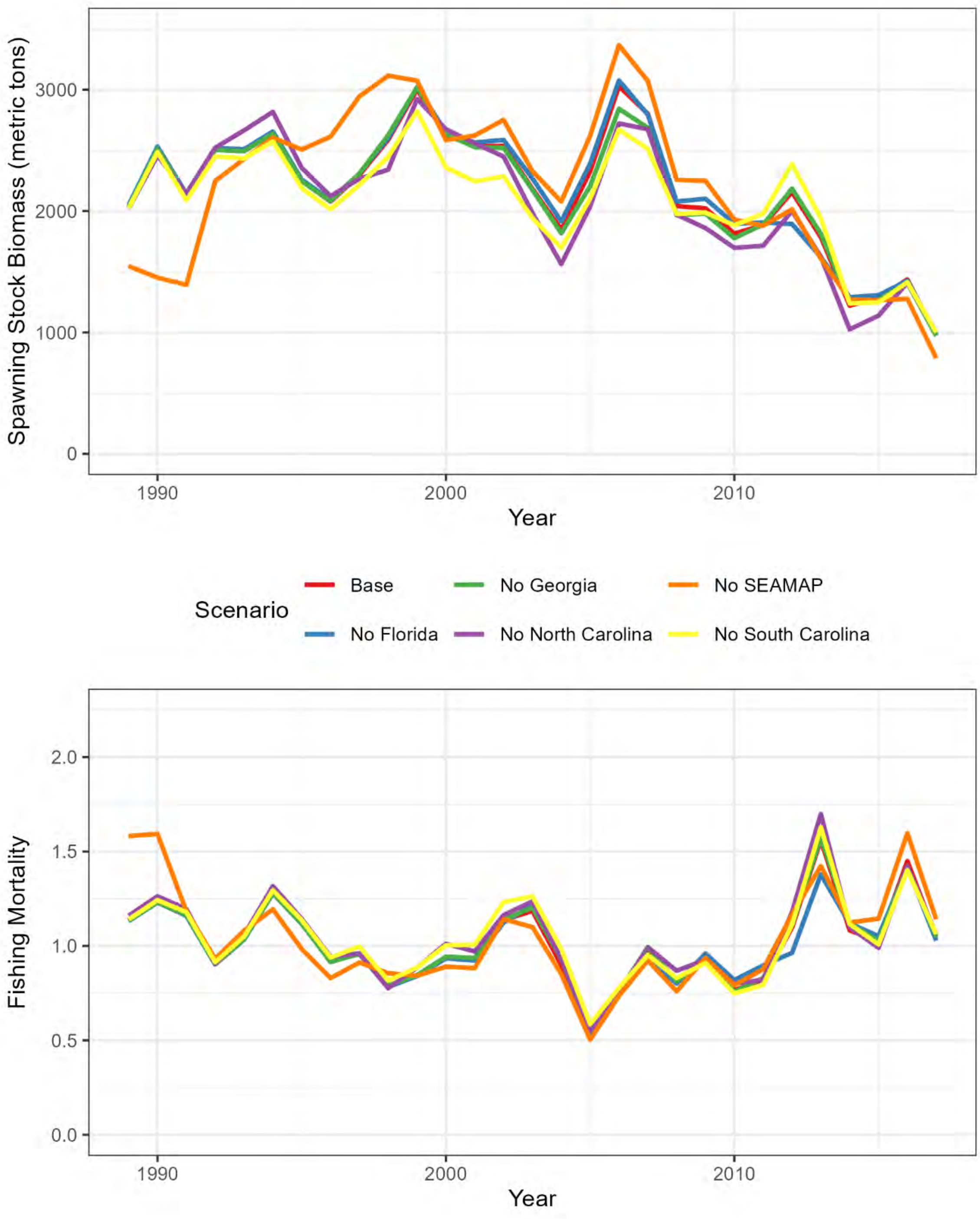


Figure 3.39. Sensitivity of model-predicted female spawning stock biomass (SSB; top graph) and fishing mortality rates (numbers-weighted, ages 2–4; bottom graph) to removal of different fisheries-independent survey data from the base run of the ASAP model, 1989–2022.

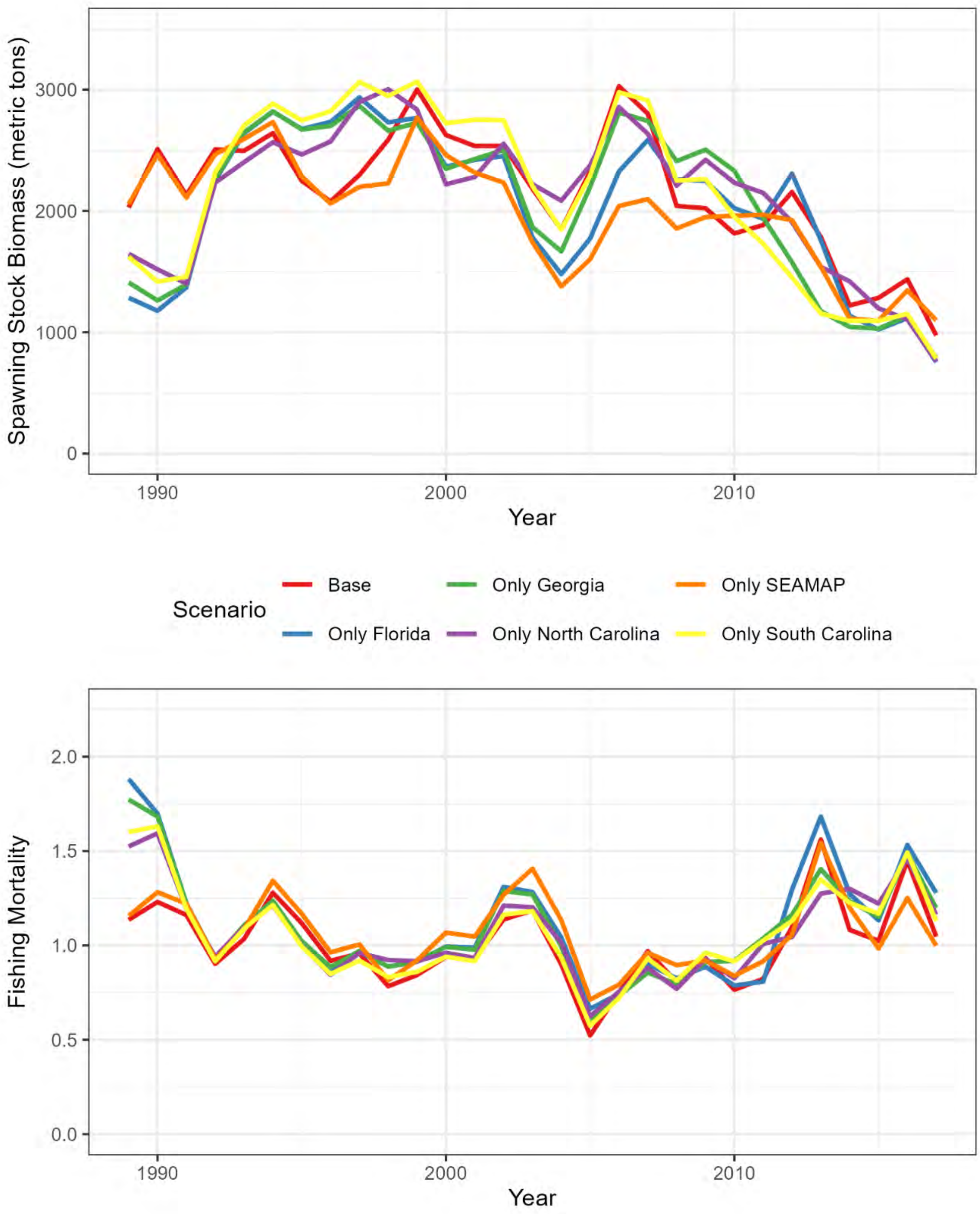


Figure 3.40. Sensitivity of model-predicted female spawning stock biomass (SSB; top graph) and fishing mortality rates (numbers-weighted, ages 2–4; bottom graph) to the inclusion of fisheries-independent survey data from each state independently compared to the base run of the ASAP model, 1989–2022.

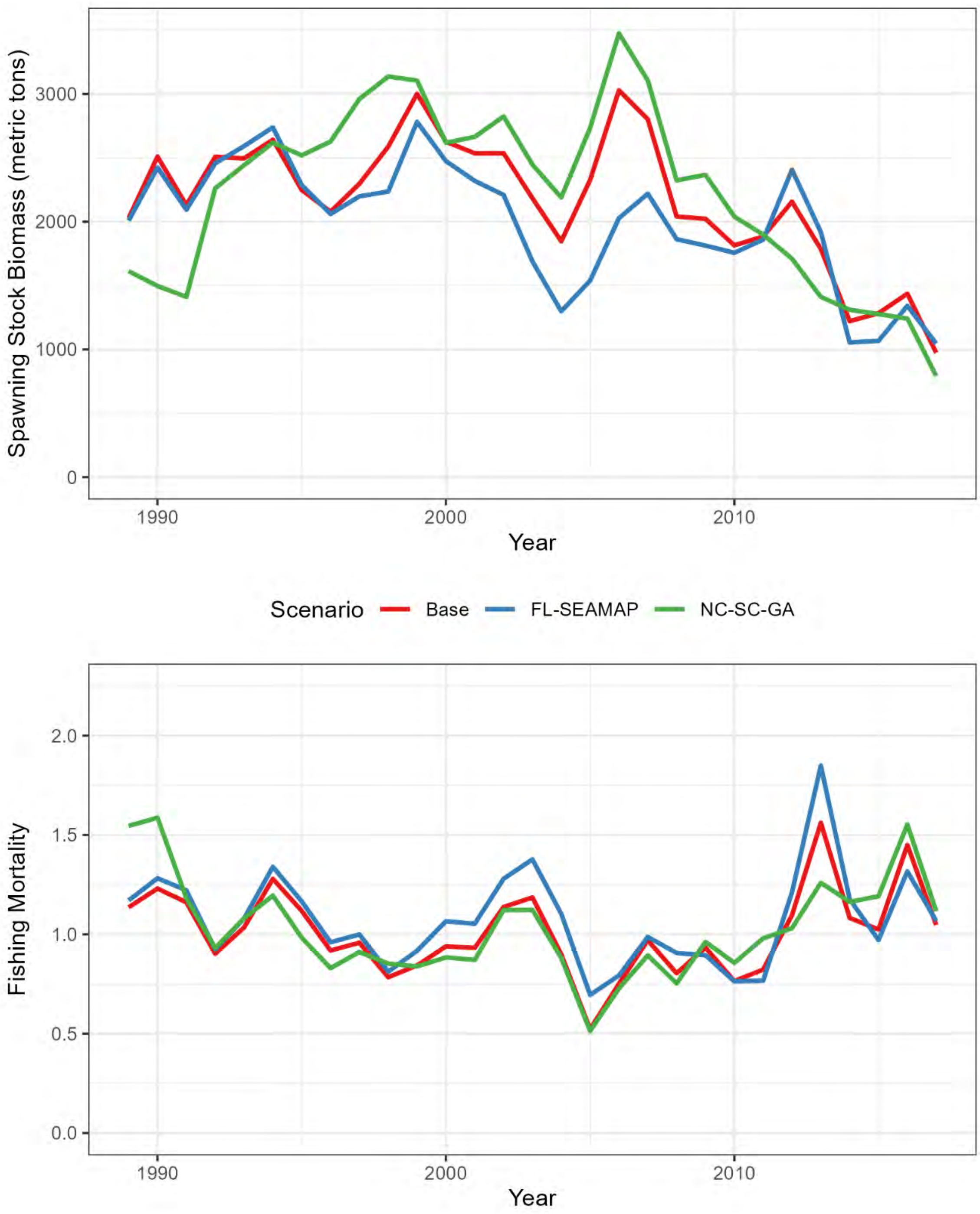


Figure 3.41. Sensitivity of model-predicted female spawning stock biomass (SSB; top graph) and fishing mortality rates (numbers-weighted, ages 2–4; bottom graph) to removal of fisheries-independent survey data with similar trends (NC-SC-GA run uses indices with a declining trend in abundance through time and FL-SEAMAP run uses indices with no trend) compared to the base run of the ASAP model, 1989–2022.

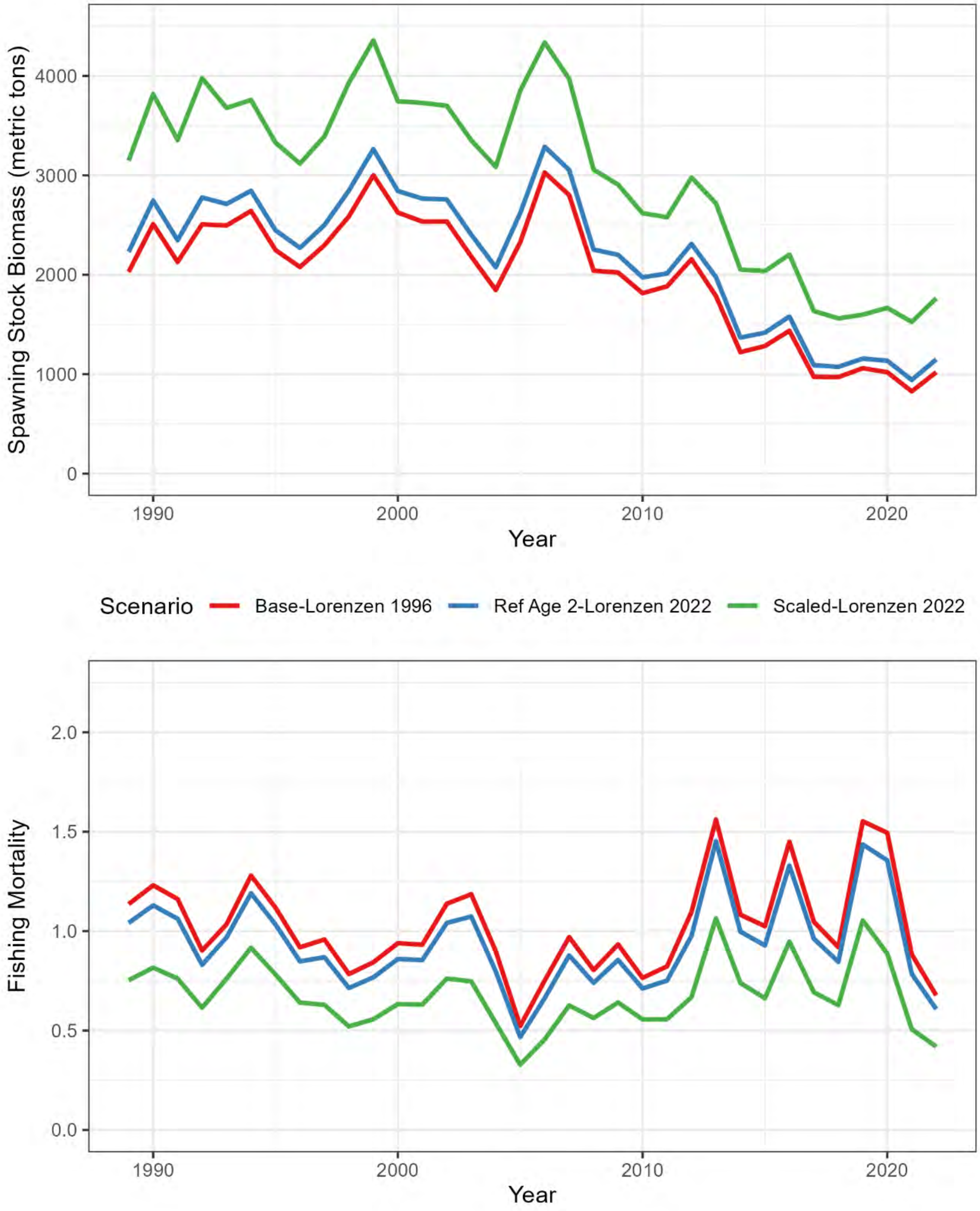


Figure 3.42. Sensitivity of model-predicted female spawning stock biomass (SSB; top graph) and fishing mortality rates (numbers-weighted, ages 2–4; bottom graph) to different natural mortality estimates based on methods from Lorenzen (1996, 2022) compared to the base run of the ASAP model, 1989–2022. Please note that spawning stock biomass increased for the scaled-Lorenzen 2022 model, thus increasing the scale of the entire figure (y-axis differs from other SSB figures).

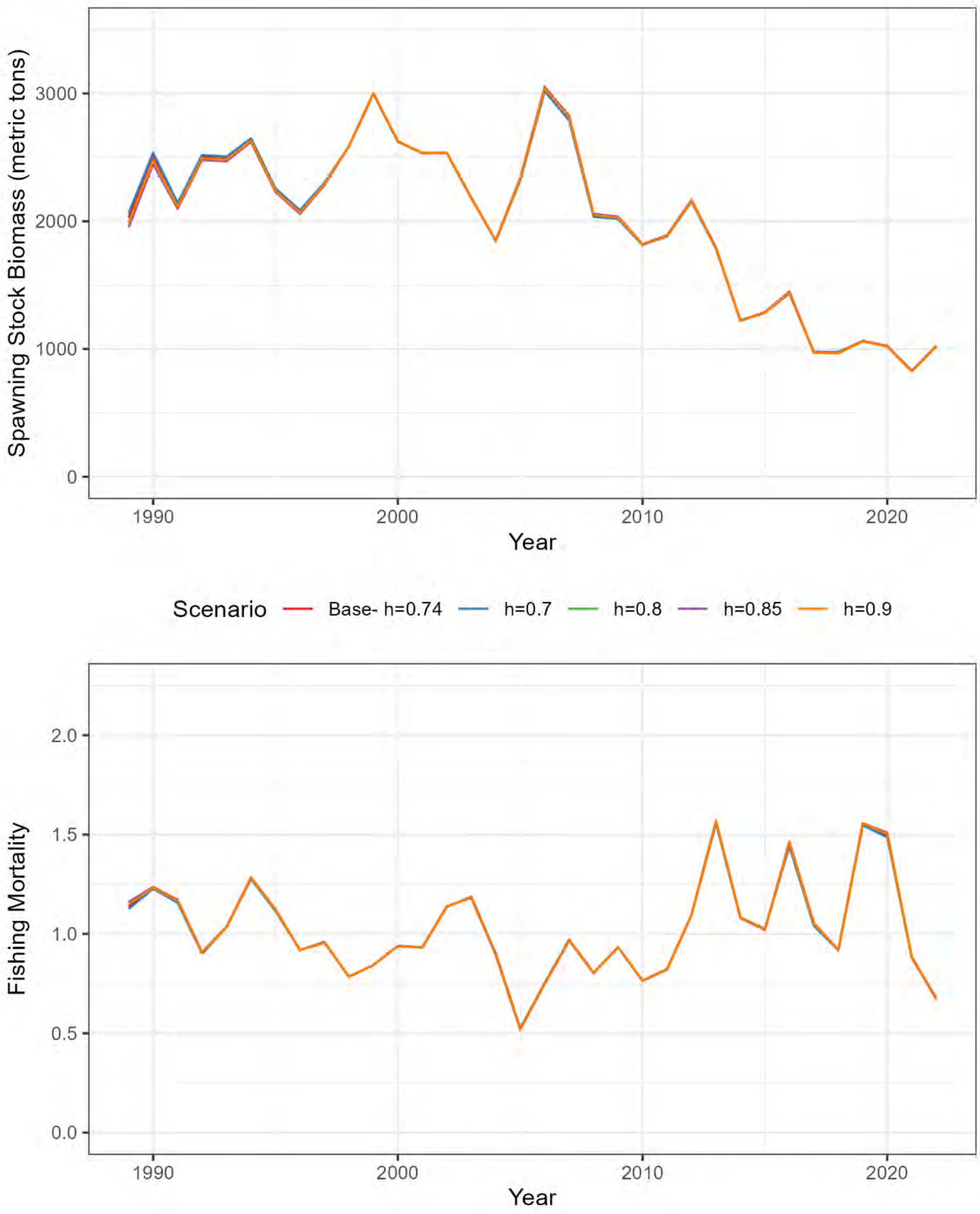


Figure 3.43. Sensitivity of model-predicted female spawning stock biomass (SSB; top graph) and fishing mortality rates (numbers-weighted, ages 2–4; bottom graph) to varying levels of steepness from the base run of the ASAP model, 1989–2022.

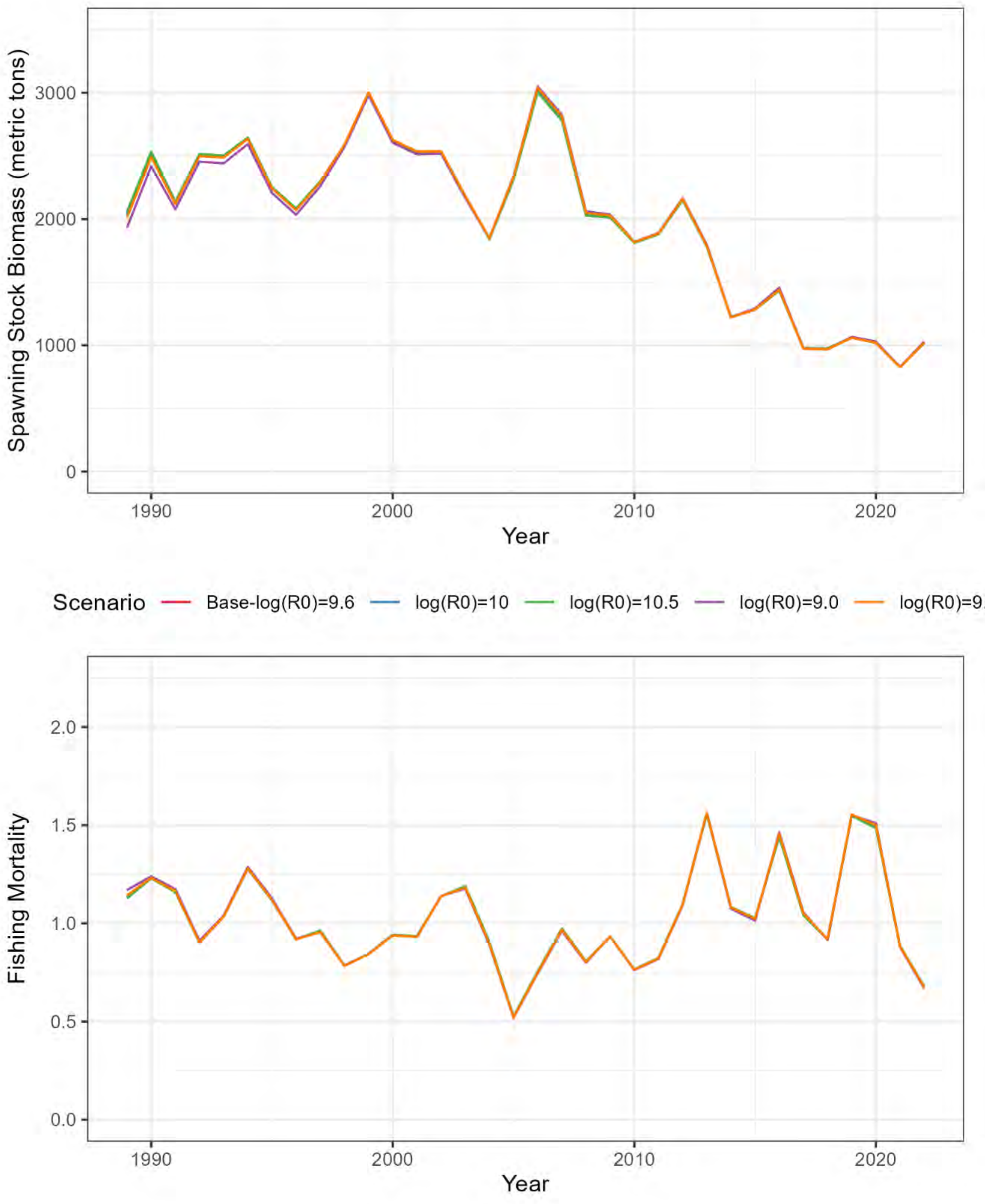


Figure 3.44. Sensitivity of model-predicted female spawning stock biomass (SSB; top graph) and fishing mortality rates (numbers-weighted, ages 2–4; bottom graph) to different assumed values for log(R0) from the base run of the ASAP model, 1989–2022.

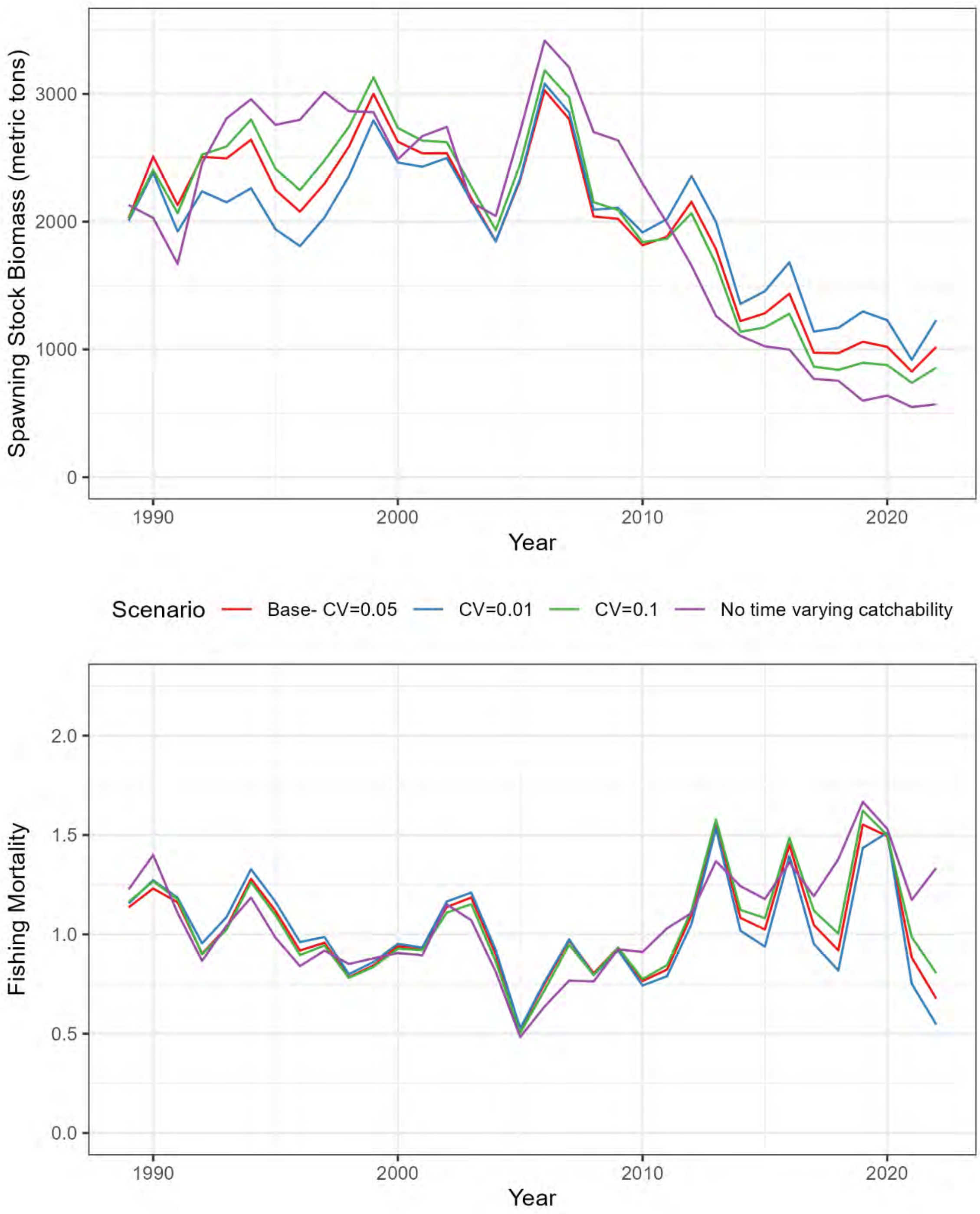


Figure 3.45. Sensitivity of model-predicted female spawning stock biomass (SSB; top graph) and fishing mortality rates (numbers-weighted, ages 2–4; bottom graph) to varying levels of constraint on time varying index catchability from the base run of the ASAP model, 1989–2022.

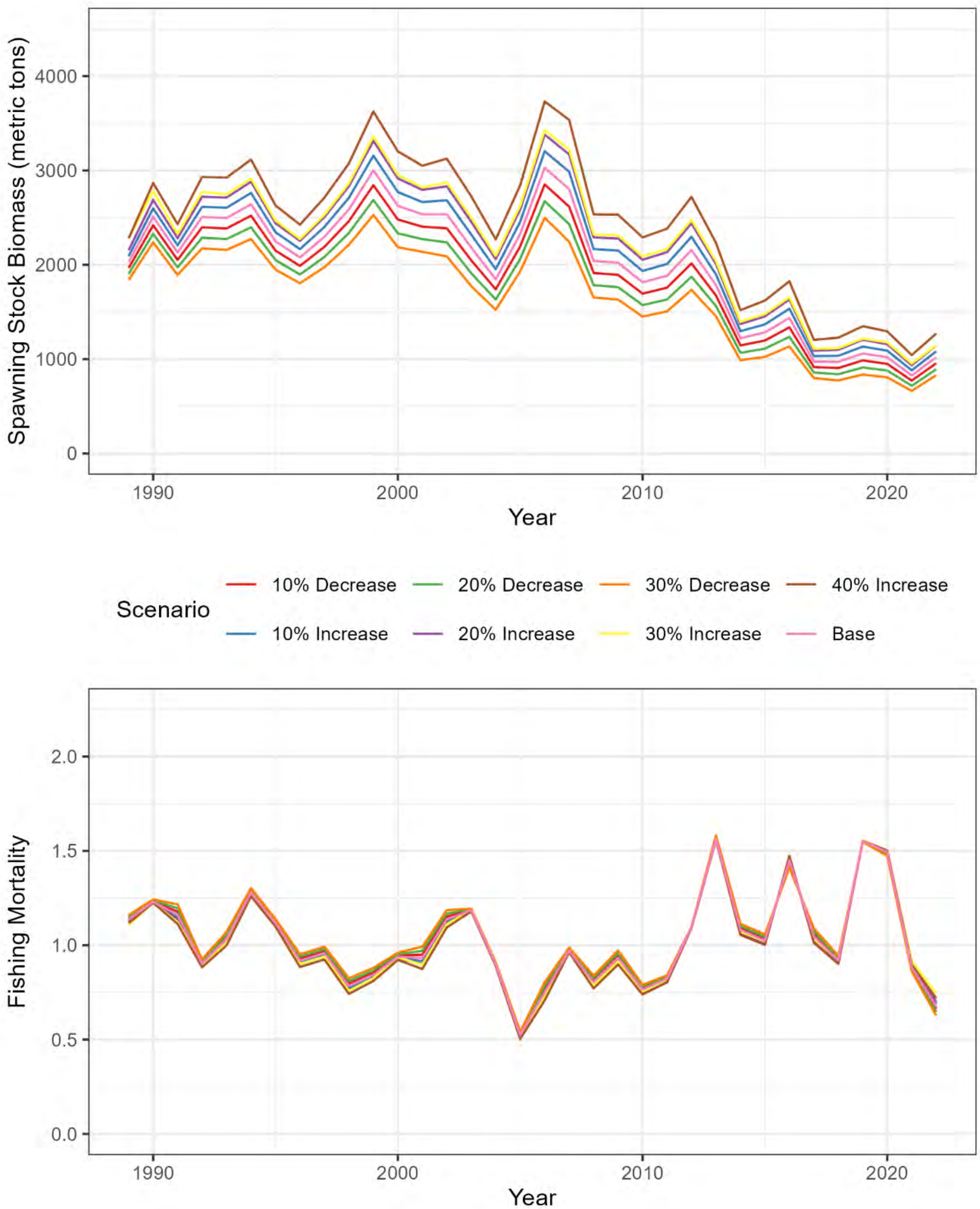


Figure 3.46. Sensitivity of model-predicted female spawning stock biomass (SSB; top graph) and fishing mortality rates (numbers-weighted, ages 2–4; bottom graph) to varying magnitudes of recreational fishing catch from the base run of the ASAP model, 1989–2022. Changes in fishing mortality are based on uncertainty values published in Andrews (2022).

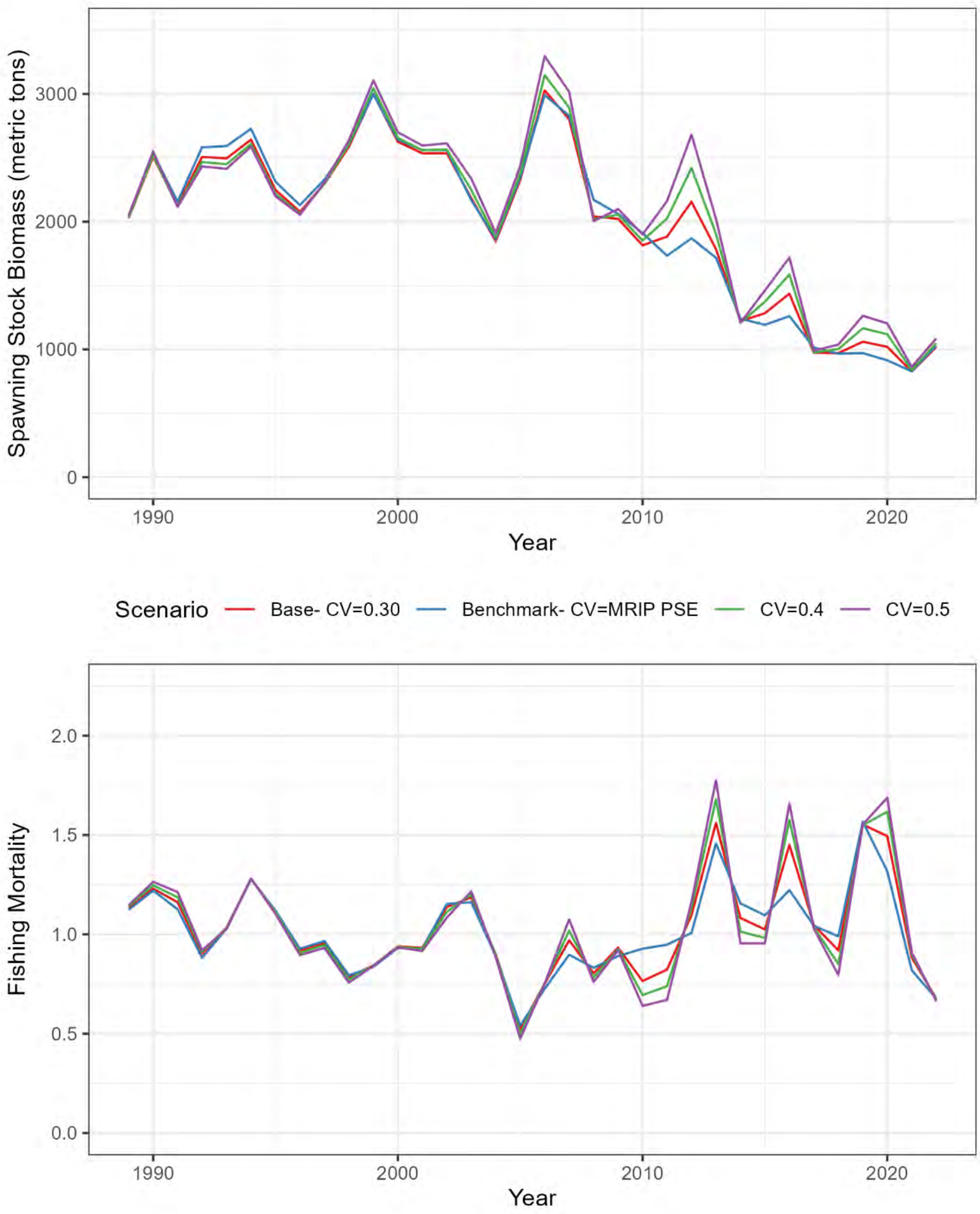


Figure 3.47. Sensitivity of model-predicted female spawning stock biomass (SSB; top graph) and fishing mortality rates (numbers-weighted, ages 2–4; bottom graph) to varying levels of uncertainty around the MRIP estimates for the recreational statistics compared to the base run of the ASAP model, 1989–2022.

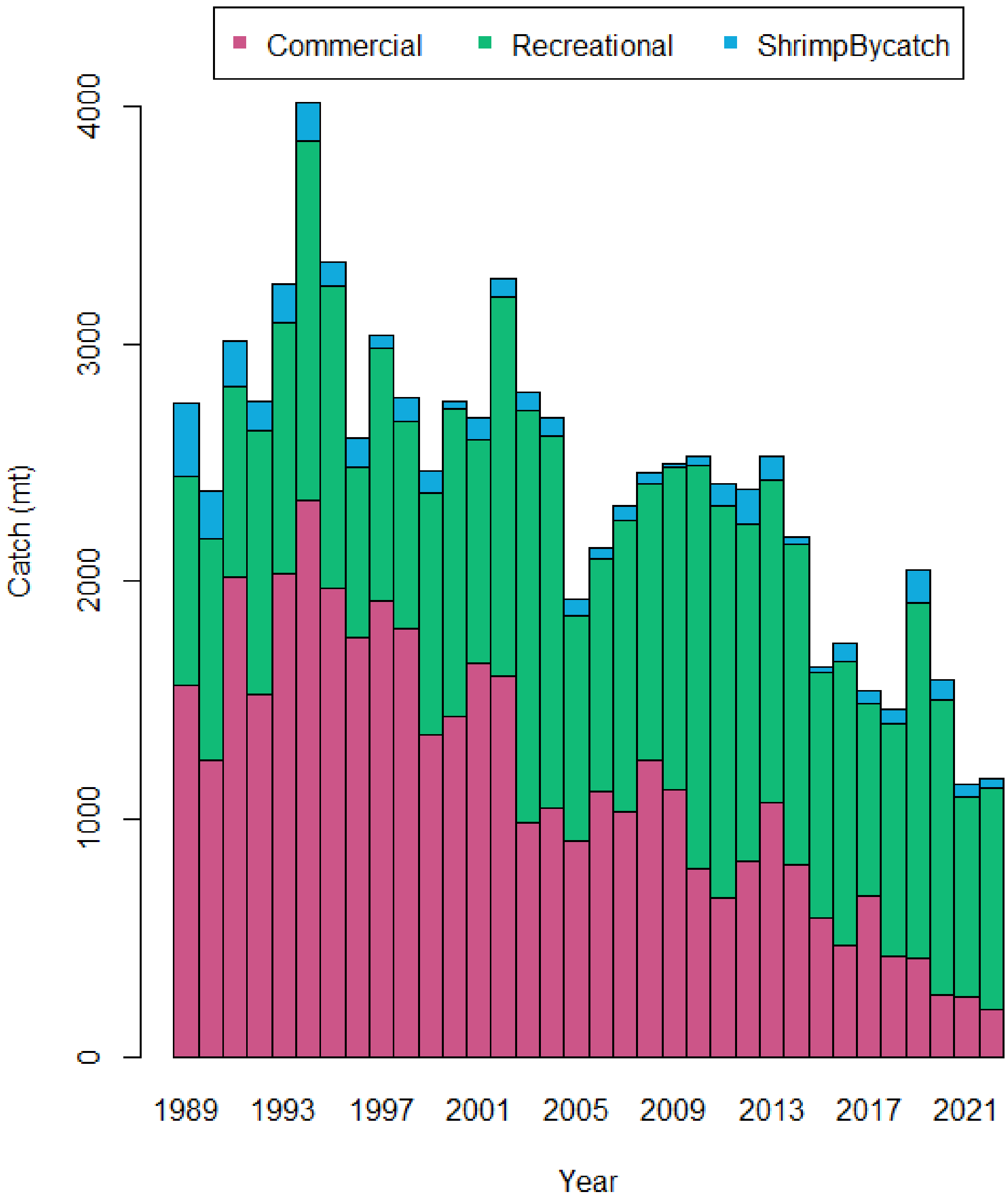


Figure 3.48. Estimated total catch of the three fishing fleets (commercial=pink, recreational=green, shrimp trawl bycatch=blue) from the base run of the ASAP model, 1989–2022.

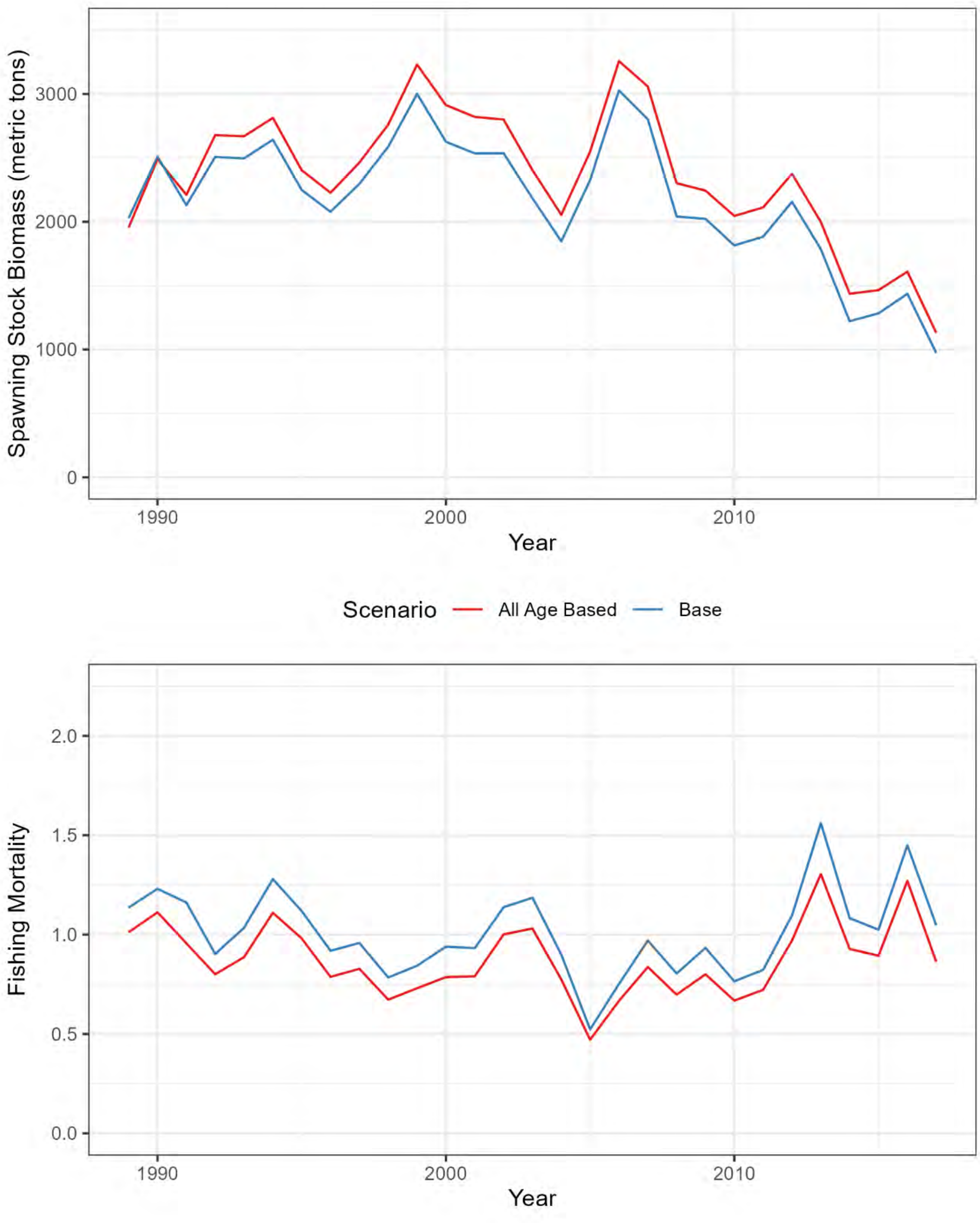


Figure 3.49. Sensitivity of model-predicted female spawning stock biomass (SSB; top graph) and fishing mortality rates (numbers-weighted, ages 2–4; bottom graph) with age-specified selectivity used in the commercial and recreational fleets compared to the use of double logistic and logistic estimates for the the base run of the ASAP model, 1989–2022.

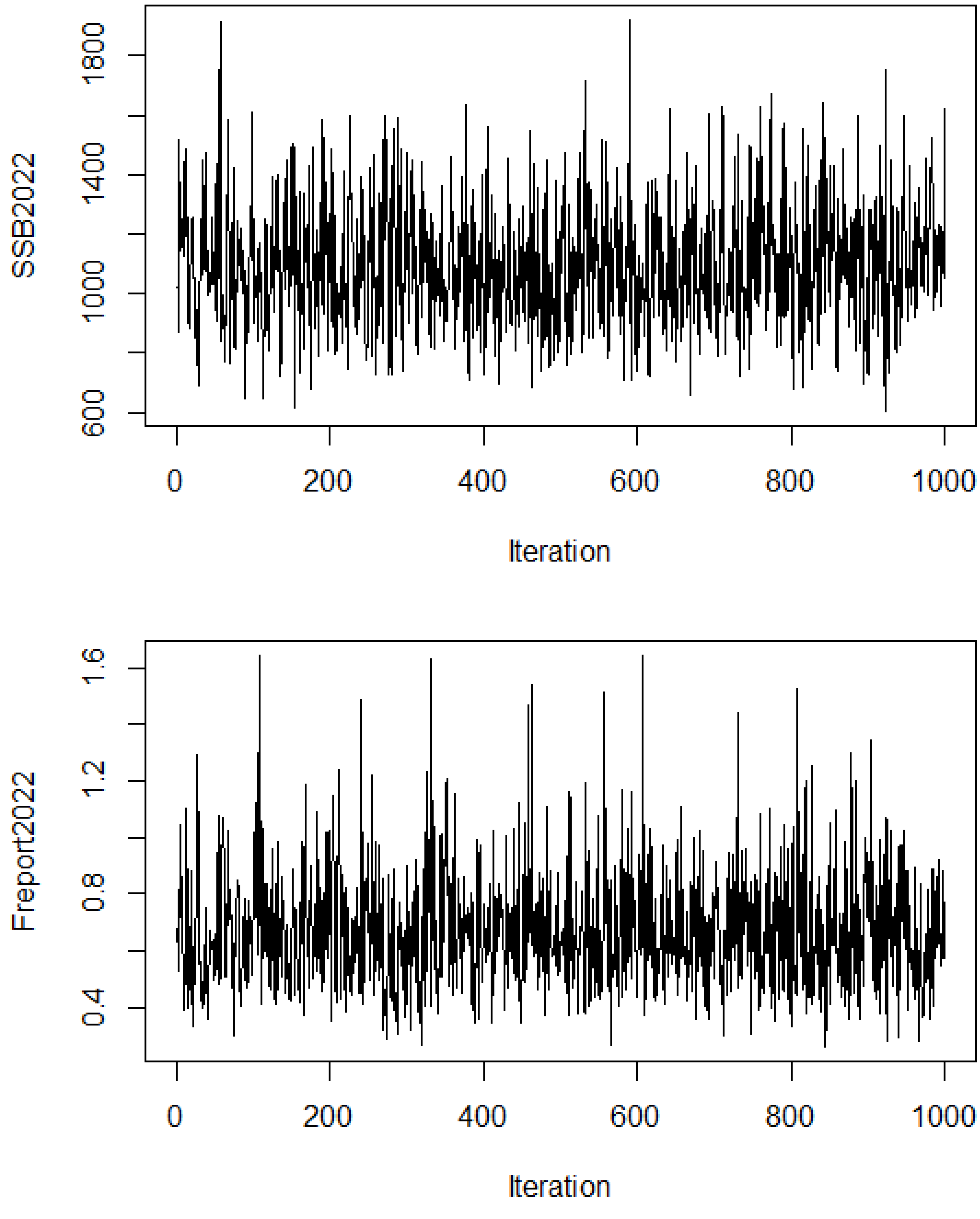


Figure 3.50. Trace plot of MCMC iterations of spawning stock biomass (top graph) and fishing mortality (bottom graph) in 2022 from the base run of the ASAP model, 1989–2022.

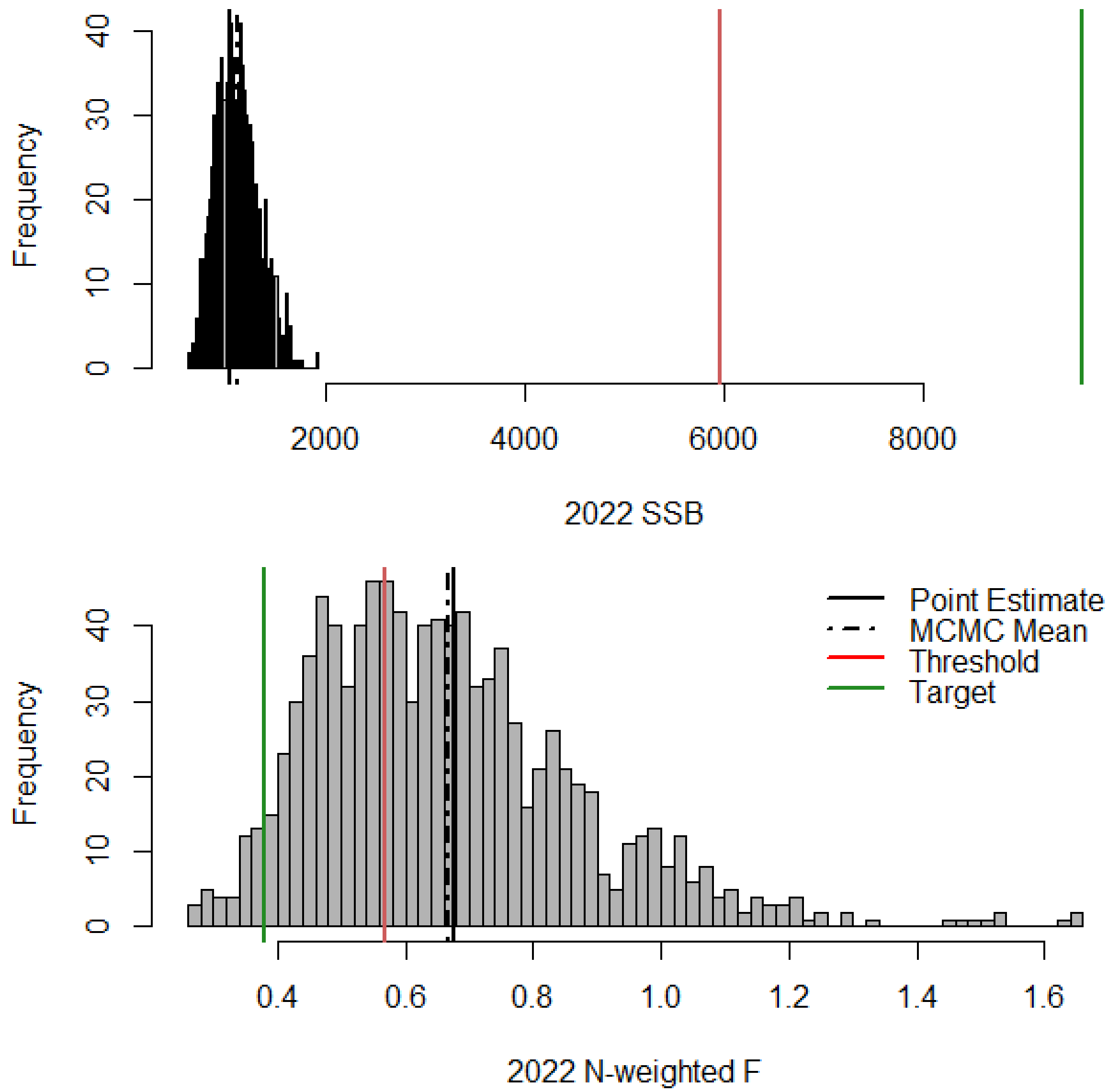


Figure 3.51. Posterior distributions of spawning stock biomass (top graph) and fishing mortality (bottom graph) in 2022 from the base run of the ASAP model compared to established reference points, 1989–2022.

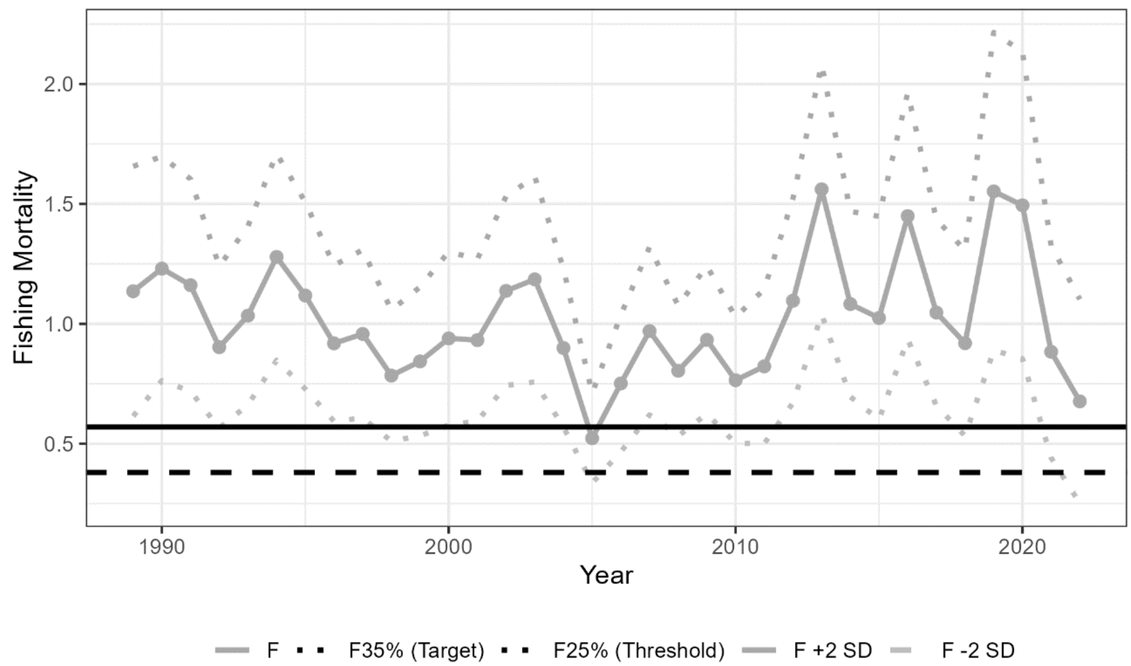


Figure 4.1. Estimated fishing mortality rates (numbers-weighted, ages 2–4) compared to established reference points, 1989–2022.

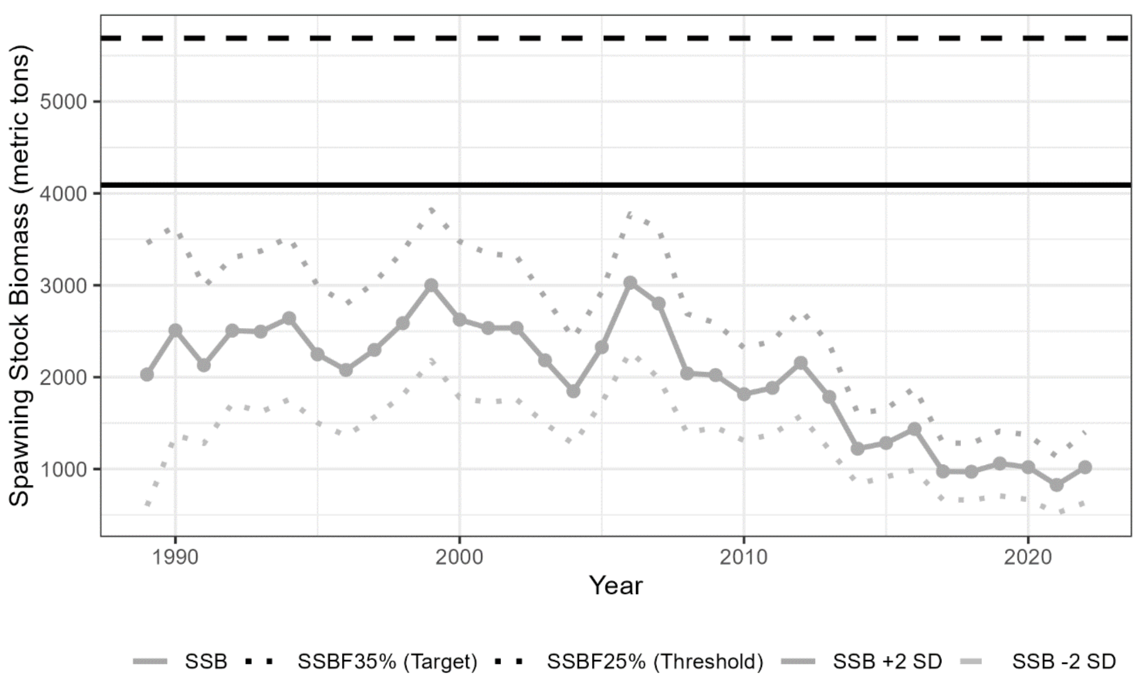


Figure 4.2. Estimated spawning stock biomass compared to established reference points, 1989–2022.

Annual Fishery Management Plan Update
Division of Marine Fisheries and Marine Fisheries Commission
August 2, 2024

Authority and Process

The Fisheries Reform Act of 1997 and its amendments established the requirement to create fishery management plans (FMPs) for all of North Carolina's commercially and recreationally significant species or fisheries. Plan contents are specified, advisory committees are required, and oversight by the Department of Environmental Quality (DEQ) secretary, Joint Legislative Oversight Committee on Agriculture and Natural and Economic Resources (AgNER), and legislative Fiscal Research Division are mandated.

Annually, the division reviews all State, Federal (Fishery Management Councils), and Atlantic States Marine Fisheries Commission (ASMFC) managed FMPs where North Carolina is directly involved. Stock conditions and management are monitored and reported through annual FMP updates. Upon review, the annual State FMP Schedule is confirmed or revised.

Status of State FMPs

Review is underway for three of the 13 State FMPs: Spotted Seatrout, Eastern Oyster, and Hard Clam.

The 2022 Stock Assessment for the **Spotted Seatrout FMP** was completed with data through February 2020. The division and a peer review team deemed the assessment suitable for management use. The stock assessment indicated the stock was not overfished; however, overfishing was occurring. The division held public scoping in March 2023 and held the Spotted Seatrout FMP Advisory Committee Workshop in April 2024. With scoping comments and Advisory Committee discussions in mind, the division is completing the first draft of the Spotted Seatrout FMP Amendment 1. At their August 2024 business meeting the MFC is scheduled to vote on sending the DRAFT Amendment 1 out for public comment and MFC Advisory Committee review.

The **Eastern Oyster FMP** Amendment 5 and the **Hard Clam FMP** Amendment 3 are under development for their scheduled five-year review. With changes in shellfish leases, aquaculture, and franchises being addressed by the Shellfish Lease and Aquaculture program, the amendments under development will focus only on wild harvest. Additionally, stock assessments have not been completed for these species due to data limitations, therefore population size and the rate of removals are unknown. A public scoping period was held in September 2023 and the MFC gave scoping input at its November 2023 business meeting and approved the Goal and Objectives to both amendments. The DMF held the Oyster and Hard Clam FMP Advisory Committee Workshop in July 2024 to inform development of the plan and the division is completing the first draft of both amendments. The MFC is scheduled to vote on sending both draft amendments out for public comment and MFC Advisory Committee review at their November 2024 business meeting.

The **Red Drum FMP** management continues to meet its targets. Any changes to the state FMP must consider compliance requirements of the ASMFC plan. The next red drum stock assessment through ASMFC is scheduled for completion late in 2024. The division recommends delaying the next review of the Red Drum FMP until 2025, one year later than previously planned. This will provide time for completion of the ASMFC red drum stock assessment, which will inform management.

The **Kingfishes FMP** management has resulted in a stock that has met ongoing management targets. Therefore, the MFC approved the 2020 annual FMP update to fulfill the scheduled review of the Kingfishes FMP. Management strategies continue to be maintained as outlined in the State FMP. Stock conditions are monitored and reported through the annual FMP update. The next scheduled review of this plan will begin in 2025.

The **Blue Crab FMP** Amendment 3 was adopted in February 2020 to address the overfished status and end overfishing, indicated by the 2018 stock assessment. An update to the 2018 stock assessment was completed in 2023, but concerns raised by external peer reviewers lead to the updated stock assessment not being approved for management purposes. All available information suggests the blue crab stock has continued to decline since the adoption of Amendment 3. The division is developing management recommendations, based on results of the 2018 stock assessment, that can be implemented through adaptive management. The Amendment 3 adaptive management framework allows any quantifiable management measure to be considered. Prior to implementation, the division will consult with the Northern, Southern, and Shellfish/Crustacean advisory committees and management recommendations will be brought to the MFC for approval. The division recommends the next review of the Blue Crab FMP begin in 2026, one year later than previously planned to afford time to implement new management measures adopted under adaptive management in 2025 prior to beginning the next benchmark stock assessment.

The **Bay Scallop FMP** 2020 annual FMP update fulfilled the scheduled review of the plan. Management continues to be maintained as outlined in the State FMP. Stock conditions are monitored and reported through the annual FMP update. After many years of low abundance, the season was opened in specific regions in 2021, 2022, and 2023 at the lowest allowed harvest levels. The division recommends delaying until 2026 the next review of the Bay Scallop FMP since DMF has identified no immediate need for management changes and to reduce overlap in ongoing FMP reviews.

The **Shrimp FMP** Amendment 2 was adopted by the MFC at its February 2022 business meeting. Amendment 2 management has been implemented through proclamations. The May 2024 Revision to Amendment 2 documents the supporting data and rationale of the MFC for concluding further action to address SAV protection under the Shrimp FMP Amendment 2. The division is continuing to test gear combinations that reduce finfish bycatch in shrimp trawls and work with the MFC to seek additional funding and methods for a long-term shrimp observer program. The next scheduled review of the plan will begin in 2027.

The **Southern Flounder FMP** Amendment 3 was adopted by the MFC at its May 2022 business meeting. Amendment 3 addresses long-term, comprehensive management for the flounder fishery. Amendment 3 management was implemented through proclamations. An update to the 2019 stock assessment was completed in 2024, but concerns raised by the division and state partners lead to the updated stock assessment not being approved for management purposes. In 2023, the recreational and commercial fisheries exceeded their total allowable catch, and paybacks have been applied towards the 2024 seasons. The next scheduled review of the plan will begin in 2027.

The **River Herring FMP** 2022 Annual FMP Review fulfilled the scheduled five-year review of the plan. The 2017 Atlantic coast-wide stock assessment update indicated river herring remain depleted and at near historic lows on a coast-wide basis. All management strategies will be maintained as outlined in the State and ASMFC FMPs. Results from the 2024 benchmark Atlantic coast-wide stock assessment are expected to be presented to the ASMFC River Herring Management Board at their August 2024 business meeting. The next scheduled review of the plan will begin in 2027.

The **Estuarine Striped Bass FMP** Amendment 2 is jointly developed with the Wildlife Resources Commission and was adopted by the MFC at its November 2022 business meeting. The 2022 Albemarle-Roanoke (A-R) stock assessment update indicated the stock continued to decline since the previous assessment and remains overfished with overfishing occurring. Amendment 2 adaptive management allows flexibility in management based on results of the stock assessment update. Based on the stock assessment results, the 2024 Revision to Amendment 2 implemented a harvest moratorium in the Albemarle Sound and Roanoke River Management Areas. In addition, we are in year two of a three-year hatchery stocking plan to increase the abundance of the A-R striped bass stock. No stock status is available for the Central Southern Management Area; however, a population model indicates the stock is depressed to a level where sustainability is unlikely. In 2025, data through 2024 from the Tar-Pamlico and Neuse rivers will be reviewed to determine if populations are self-sustaining and if sustainable harvest can be determined. The review will also allow for the assessment of the gill net prohibition. The next scheduled full review of the plan will begin in 2027.

The 2022 information update for the **North Carolina FMP for Interjurisdictional Fisheries** was adopted by the MFC at its May 2022 business meeting. The goal of the FMP for Interjurisdictional Fisheries is to adopt FMPs, consistent with law, approved by the federal Councils or the ASMFC by reference and implement corresponding fishery regulations in North Carolina to provide compliance or compatibility with approved FMPs and amendments, now and in the future. The division recommends delaying the next review of the plan to 2028 to reduce overlap in ongoing FMP reviews.

The **Striped Mullet FMP** Amendment 2 was adopted by the MFC at its May 2024 business meeting. The MFC adopted regulations intended to reduce striped mullet harvest with a goal of ending overfishing and to rebuild the stock to a level that provides a sustainable harvest. The regulations included commercial day of week harvest closures and recreational possession limits. Adaptive management allows for adjustment to season closures, day of week closures, trip limits, and gill net yardage and mesh size restrictions to ensure management targets are being met, based on results of stock assessment updates, concerning stock conditions or fishery trends. Adaptive management allows restrictions to be relaxed once the stock recovers with consultation with the MFC Northern, Southern, and Finfish Advisory Committees and approval by the MFC. The next scheduled review of this plan will begin in 2029.

DRAFT FOR DEQ SECRETARIAL REVIEW

DRAFT N.C. FISHERY MANAGEMENT PLAN REVIEW SCHEDULE (July 2024–June 2029) Revised August 13, 2024					
SPECIES (Date of Last Action)	2024–2025	2025–2026	2026–2027	2027–2028	2028–2029
SPOTTED SEATROUT (2/12)*					
EASTERN OYSTER (2/17)^					
HARD CLAM (2/17)^					
RED DRUM (8/17)					
KINGFISHES (8/20)					
BLUE CRAB (2/20)					
BAY SCALLOP (8/20)					
SHRIMP (2/22)					
SOUTHERN FLOUNDER (5/22)					
RIVER HERRING (8/22)					
ESTUARINE STRIPED BASS (11/22)					
INTERJURISDICTIONAL (5/22)					
STRIPED MULLET (5/24)					

*FMP review began in 2021.

^FMP review began in 2023.

This schedule assumes no rulemaking is required to implement plan amendments.