North Carolina
Southern Flounder (*Paralichthys lethostigma*)
Fishery Management Plan

Amendment 1

By

North Carolina Division of Marine Fisheries

North Carolina Department of Environment and Natural Resources
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March 2013

March 2008	Amendment 1 Timeline begins
January 2009	Present stock assessment to NCMFC
June 2009	Develop interim management measures and review by committees
June 2010	Internal review with NCDMF comments
July 2010	Revised with AC Comments
August 2010	Amendment 1 draft approved by NCMFC for public meetings
November 2010	Draft adopted by NCMFC after public meetings and comments
July 2012	Developed additional management strategies
August 2012	Draft approved by NCMFC for public meetings
October 2012	Revised with AC Comments
November 2012	Draft adopted by NCMFC after public meetings and comments
December 2012	Draft FMP Amendment 1 submitted to JLCGO and DENR Secretary
February 2013	FMP Amendment 1 adopted by the NCMFC

1.0 ACKNOWLEDGEMENTS

Amendment 1 to the North Carolina (NC) Southern Flounder Fishery Management Plan (FMP) was developed by the NC Department of Environment and Natural Resources (DENR) North Carolina Division of Marine Fisheries (NCDMF) under the direction of the North Carolina Marine Fisheries Commission (NCMFC) with the advice of the Southern Flounder Advisory Committee (AC). Deserving special recognition are the members of the Southern Flounder AC and the Plan Development Team (PDT) who contributed their time and knowledge to this effort.

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2.0 PRIOR MANAGEMENT MEASURES AND OBJECTIVES

MANAGEMENT STRATEGY	OBJECTIVES	OUTCOME
Fisheries Management		
A 14-inch minimum size limit in estuarine waters	1 and 2	Size limit accomplished by Proclamation (FF-19-2005) April 1, 2005
A closure period for the commerical fishery from December 1 to December 31	1 and 2	Closed season accomplished annually by Proclamation
A minimum mesh size of 5 ½ inch stretched mesh for large mesh gill nets from April 15 through December 15	1, 2, and 3	Rule 03J .0103(i) amended on September 1, 2005
A 3,000 yard limit on large mesh gill nets	1 and 2	Rule 15A NCAC 03J .0103(i)(1) amended on September 1, 2005
The requirement of escape panels of 5 ½ inch stretched mesh in pound nets in Albemarle Sound west of the Alligator River	1, 2, and 3	Rule 15A NCAC 03J .0501(e)(2) amended on September 1, 2005
Minimum distance of 500 yards between pound nets and large mesh gill nets in Albemarle Sound and its tributaries from August 15 through December 1 or until fishery is closed, 200-yard minimum distance in the other estuarine waters	5	Rule 15A NCAC 03J. 0103(d)(1)
Minimum distance of 1,000 yards between new and existing pound nets	5	Rule 15A NCAC 03J. 0103(e)(3)
Maintain a 14-inch minimum size limit and an 8-fish bag limit for the recreational fishery in areas	1 and 2	Accomplished by Proclamation (FF-25-2008) March 1, 2008
Require a RCGL or other appropriate license to use gigs recreationally	8	Accomplished by CRFL January 1, 2007
Recreational Commercial Gear License holders are required to attend their large mesh gill nets at all times from south of the NC Highway 58 bridge at Emerald Isle to the South Carolina state line	3	Accomplished by rule 03O .0302(a)(5)(B)
Establish a stakeholder group(s), similar to the Bottlenose Dolphin Take Reduction Team, to address interactions and management between large mesh estuarine gill nets and high profile species	3	Accomplished by NCMFC Sea Turtle Advisory Committee
Endorse additional research to reduce bycatch in the shrimp trawl fishery, primarily shrimp trawl characterization studies involving at-sea observers and investigations into fish excluder devices with a higher success rate for reducing the harvest and retention of flounder in shrimp trawls	3	Bycatch characterization study of NC commercial shrimp trawl fishery conducted in ocean waters (2007-2008) with a completion report in 2009; characterization study in estuarine waters conducted in 2009 with a completion report due later in 2010
Recommend that the Shrimp FMP address the issue of the discard of sublegal southern flounder in the shrimp trawl fishery	3	Accomplished—see Shrimp FMP for specific management strategies
Implement a 4-inch mesh in crab trawl tailbags in the western side of the sounds and a 3-inch mesh in crab trawl tailbags in the eastern side of the sounds	3	Accomplished by Proclamation (SH-18-2005) October 24, 2005. Will be in rule as part of the Blue Crab FMP Amendment 2.
Endorse research to test the feasibility of using biodegradable panels in crab pots	3	Research complete, report completed in 2008
Do not endorse funding for pilot research on the feasibility of southern flounder stock enhancement at this time	2	Accomplished by not endorsing

MANAGEMENT STRATEGY	OBJECTIVES	OUTCOME
Habitat and Water Quality		
The NCDCM should continue promoting the use of shoreline stabilization alternatives that maintain or enhance fish habitat. That includes using oyster cultch or limestone marl in constructing the sills (granite sills do not attract oyster larvae)	6	Refer to CHPP
To ensure protection of flounder nursery areas, fish-friendly alternatives to vertical stabilization should be required around primary and secondary nursery areas	6	Refer to CHPP
The location and designation of nursery habitats should be continued and expanded by the NCDMF	6	Refer to CHPP
No trawl areas and mechanical harvest prohibited areas should be expanded to include recovery/restoration areas for subtidal oyster beds and SAV	6	Refer to CHPP
Expansion and coordination of habitat monitoring efforts is needed to acquire data for modeling the location of potential recovery/restoration sites for oysters and SAV	6	Refer to CHPP
Any proposed stabilization project threatening the passage of flounder larvae through coastal inlets should be avoided	6	Refer to CHPP
All coastal-draining river basins should be considered for NSW classification because they all deliver excess nutrients to coastal waters, regardless of flushing rate	6	Refer to CHPP
Efforts to implement phase II stormwater rules must be continued	6	Refer to CHPP
The EEP process should be extended to other development projects	6	Refer to CHPP
Reduce sediment and nutrient loading by addressing multiple sources, including: improvement and continuation of urban and agricultural BMPs, more stringent sediment controls on construction projects, and implementation of additional buffers along coastal waters	6	Refer to CHPP

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3.3 LIST OF ACRONYMS

AC – Advisory Committee

AEC – Areas of Environmental Concern

ALDS – Angler License Directory Survey

APAIS – Access-Point Angler Intercept Survey

ASMFC – Atlantic States Marine Fisheries Commission

BMP – Best Management Practices

CAMA – Coastal Area Management Act

CCA— Coastal Conservation Association

CEIP – Coastal Energy Impact Program

CHPP – Coastal Habitat Protection Plan

CHTS – Coastal Household Telephone Survey

CPI – Consumer Price Index

CPUE – Catch Per Unit Effort

CRC – North Carolina Coastal Resources Commission

CRFL – Coastal Recreational Fishing License

DCM – North Carolina Division of Coastal Management

DEHNR - North Carolina Department of Environment, Health and Natural Resources

DENR – North Carolina Department of Environment and Natural Resources

DO – Dissolved Oxygen

DOT – North Carolina Department of Transportation

DWQ- North Carolina Division of Water Quality

EEP – Ecosystem Enhancement Program

EFH – Essential Fish Habitat

EMC – North Carolina Environmental Management Commission

EPA – United States Environmental Protection Administration

ESA - Endangered Species Act

F— Fishing Mortality

FDA – United States Food and Drug Administration

FIN— Fisheries Information Network

FMP – Fishery Management Plan

FRA – Fishery Reform Act

FRG – Fishery Resource Grant

GIS – Geographical Information System

GS – General Statute

HCP— Habitat Conservation Plan

HQW- High Quality Waters

ICW – Intracoastal Waterway

ITP— Incidental Take Permit

JLCSA – Joint Legislative Commission for Seafood and Aquaculture

MAFMC – Mid Atlantic Fisheries Management Council

NCMFC – North Carolina Marine Fisheries Commission

MMPA- Marine Mammal Protection Act

MRFSS - Marine Recreational Fisheries Statistical Survey

MRT - Management Review Team

NC – North Carolina

NCDMF – North Carolina Division of Marine Fisheries

NCSU – North Carolina State University

NCTTP – North Carolina Trip Ticket Program

NEFSC – Northeast Fisheries Science Center

NMFS – National Marine Fisheries Service

NOAA – National Oceanic and Atmospheric Administration

NOI— Notice of Intent

NPDES – National Pollutant Discharge Elimination System

NSW – Nutrient Sensitive Waters

NYDEC – New York Department of Environmental Conservation

ORW – Outstanding Resource Waters

PDT – Plan Development Team

PNA – Primary Nursery Area

PPI – Producer Price Index

PPT – Parts Per Thousand

PSE – Proportional Standard Error

PSGNRA – Pamlico Sound Gill Net Restricted Area

RAT – Rules Advisory Team

RCGL – Recreational Commercial Gear License

RDD – Random Digit Dialing

RSCFL – Retired Standard Commercial Fishing License

SAFMC – South Atlantic Fishery Management Council

SAV – Submerged Aquatic Vegetation

SCFL – Standard Commercial Fishing License

SHA – Strategic Habitat Area

SSB— Spawning Stock Biomass

SSR – Stock Status Report

TED— Turtle Excluder Devices

TL- Total Length

TSS – Total Suspended Solids

TTP – North Carolina Division of Marine Fisheries Trip Ticket Program

UNC – University of North Carolina

UNC-CH – University of North Carolina, Chapel Hill

UNCW – University of North Carolina, Wilmington

URW – Use Restoration Waters

USACE – United States Army Corp of Engineers

USFWS – United States Fish and Wildlife Service

WRC – North Carolina Wildlife Resources Commission

WS – Water Supply

4.0 EXECUTIVE SUMMARY

Goals and Objectives: The goal of Amendment 1 to the North Carolina Southern Flounder Fishery Management Plan (FMP) is to end overfishing and rebuild the spawning stock of southern flounder (*Paralichthys lethostigma*) for long-term sustainable harvest and maintain the integrity of the stock. To achieve this goal, the following objectives must be met:

1. Ensure that the spawning stock biomass of southern flounder is adequate to produce recruitment levels necessary to increase spawning stock biomass and expand age distribution.
2. Implement management measures that will achieve sustainable harvest.
3. Promote harvesting practices that minimize bycatch.
4. Continue to develop an information program to educate the public and elevate their awareness of the causes and nature of problems in the southern flounder stock, its habitat and fisheries, and explain the rationale for management efforts to sustain the stock.
5. Address social and economic concerns of all user groups, including issues such as user conflicts.
6. Promote the protection, restoration, and enhancement of habitats and environmental quality for the conservation of the southern flounder population.
7. Initiate, enhance, and/or continue studies to improve the understanding of southern flounder population ecology and dynamics.
8. Initiate, enhance, and/or continue studies to collect and analyze the socio-economic data needed to properly monitor and manage the southern flounder fishery.

General Problem Statement: The 2005 southern flounder stock assessment determined the stock was overfished and overfishing was occurring. Since the implementation of the 2005 FMP, the stock status of southern flounder has improved with decreases in fishing mortality, increases in spawning stock biomass, and expansion of age classes. However, the 2009 assessment still finds the stock to be overfished and overfishing is still occurring. The purpose of Amendment 1 is to recommend management measures that will restore the North Carolina southern flounder stock to a viable level and ensure production of a long-term sustainable harvest. Areas to be addressed in the management of North Carolina's southern flounder fishery are: 1) achieving sustainable harvest; 2) conflict between fisheries; 3) bycatch of under-sized flounder and protected species; and 4) environmental factors.

Status of the Commercial Fisheries: Southern flounder is the most economically important estuarine finfish species in North Carolina. Commercial landings of southern flounder averaged 3,320,610 pound from 1991 to 2007 with peak landings of 4,878,639 pounds in 1994. Commercial landings accounted for an average of 89% of the total annual harvest of southern flounder in the state from 1991 to 2007 but decreased to 75% of the total annual harvest from 2005 to 2007. Commercial pound nets, estuarine gill nets, and gigs collectively accounted for an average of 86% of the total commercial landings of southern flounder from 1972 to 2007, and 96% from 2000 to 2007. Southern flounder landings from the estuarine gill net fishery have increased from 13% of the commercial harvest in from 1972 to 1979 to 63% of the total southern flounder harvest in the state from 2000 to 2007. Pound net landings showed the opposite trend during the same time periods with landings accounting for 64% of the total southern flounder harvest from 1972 to 1979 and decreasing to 31% of the total southern flounder harvest from 2000 to 2007.

Status of the Recreational Fisheries: Southern flounder are highly targeted recreational fishes by fishermen using hook and line, gigs, and gill nets. The average recreational hook and line harvest from 1991 to 1999 was 112,842 pounds from 1991 to 1999. From 2000 to 2007, the average recreational harvest increased to 308,706 pounds. From 1992 to 1999 the number of trips either catching or targeting southern flounder ranged from 32,000 to 60,000 trips per year. The number of trips in 2000 increased to over 93,000 and peaked in 2004 at over 156,000 trips either targeting or catching southern flounder. The total annual harvest of southern flounder from RCGL gears from 2002 to 2007 was less than the hook and line fishery and has decreased precipitously since 2004. Overall, large mesh gill nets accounted for 74% by number and 73% by weight of the total RCGL harvest of southern flounder from 2002 to 2007. All of the main RCGL gears that land southern flounder showed a declining trend in the number of trips taken from 2002 to 2007.

Socioeconomic Status of the Southern Flounder Fishery: Southern flounder is a relatively high-volume commercial fishery, representing a significant portion of the value of finfish landed overall in the state. In terms of value, the fishery clearly had a high point in the 1990s, with landings sometimes nearing or exceeding $8,000,000 per year. The real price for southern flounder has not moved appreciably over the past 20 years, although it has kept up with inflation and has risen to over $2.00 per pound since 2006. Analysis using the 2006 IMPLAN model for the southern flounder commercial fishery estimated an economic impact from expenditures of $17,691,083. Nearly all commercial fishermen were white males, with an average age of 50 and over 25 years of commercial fishing experience. The economic analysis for the southern flounder hook and line fishery estimated an economic impact from expenditures of $25,390,614, and $2,537,893 for the southern flounder RCGL fishery. Like commercial fishermen, recreational anglers are primarily white males with an average age close to 50.

Environmental Factors: Habitat use patterns of southern flounder vary over time, space and by life stage. These habitats serve as nursery areas, refuge from piscivorous predators, foraging areas, and corridors for passage among different habitats. These habitats are also directly impacted by a number of activities, including, but not limited to estuarine shoreline stabilization, dredging for navigational purposes, fishery harvest (including trawling activities), and inlet stabilization. Protection of each habitat type is critical to the sustainability of the southern flounder stock.

Management Issues and Proposed Actions:

In the development of Amendment 1 to the Southern Flounder FMP, management options were developed for identified principal issues through the FMP process. These issues and options were developed by the NCDMF through the cooperation and advice solicited from the Southern Flounder Advisory Committee, NCMFC, Finfish and Regional Advisory committees, the public, and the scientific community. The NCMFC selected preferred management options for each of the principal issues at their November 4-5, 2010 business meeting. Additional management options addressing sustainable harvest in the commercial fishery were selected at the November 2012 NCMFC meeting. A summary of the principal issues along with the preferred NCMFC management options are listed in the following table.

ISSUE	NCMFC PREFERRED MANAGEMENT STRATEGY	OBJECTIVES ADDRESSED	REGULATORY ACTION
Achieving Sustainable Harvest	Commercial: Accept management measures to reduce protected species interactions as the management strategy for achieving sustainable harvest in the commercial southern flounder fishery. Specific minimum measures for the flounder gill net fishery are provided in Issue Paper 10.1.1 (page 129). Recreational: Increase the minimum size limit to 15 inches and decrease the creel limit to 6 fish--20.2% harvest reduction	1, 2, 4	Commercial: No Action Required Recreational: Proclamation FF-29-2011 (refer to Supplement A to the 2005 FMP)
Ocean Harvest of Southern Flounder	Status quo and address research recommendations	1, 2,4,7	No Action Required
Large Mesh Gill Net Related Conflicts	Status quo (implement mediation and proclamation authority to address user conflicts with large mesh gill nets)	5,8	No Action Required
Minimum Distance Between Pound Nets and Gill Nets in Currituck Sound	Status quo (200-yard minimum distance between pound nets and gill nets)	5,8	No Action Required
Exploring the Elimination of the Recreational Commercial Gear License (RCGL)	Status quo and address research recommendations	5,8	No Action Required
Update on Southern Flounder Bycatch in the Commercial Crab Pot Fishery	Status quo and expand research on flatfish escape devices and degradable panels under commercial conditions to other parts of the state	3	No Action Required

Southern Flounder Discards in the Recreational Hook and Line Fishery	Status quo and expand research on factors impacting the release mortality of southern flounder and on deep hooking events of different hook types and sizes	3	No Action Required
Incidental Capture of Protected Species in Southern Flounder Large Mesh Gill Net and Pound Net Fisheries	• Request funding for state observer program • Apply for Incidental Take Permit for large mesh gill net fishery • Continue gear development research to minimize protected species interactions	3	No Action Required
Gear Requirements in the Flounder Pound Net Fishery	Status quo minimum mesh size for escape panels (5.5-inch stretched mesh) and recommend further research on 5.75-inch stretched mesh escape panels	3	No Action Required
Gear Requirements in the Flounder Gill Net Fishery	Status quo minimum mesh size (5.5 inches stretched mesh)	3	No Action Required

Current rules are listed in Section 5.7.3. Necessary rule changes to implement the current MFC preferred options are provided in Appendix Section 13.4.

5.0 INTRODUCTION

5.1 LEGAL AUTHORITY FOR MANAGEMENT

Fisheries management includes all activities associated with maintenance, improvement, and utilization of the fisheries resources of the coastal area, including research, development, regulation, enhancement, and enforcement.

Many different state laws, known as General Statutes (G.S.), provide the necessary authority for fisheries management in North Carolina. General authority for stewardship of marine and estuarine resources by NCDENR is provided in G.S. 113-131. The branch of the NCDENR that carries out this responsibility is NCDMF. The NCMFC is charged to “manage, restore, develop, cultivate, conserve, protect, and regulate the marine and estuarine resources of the State of North Carolina” (G.S. 143B-289.51). The NCMFC can regulate fishing times, areas, fishing gear, seasons, size limits, and quantities of fish harvested and possessed (G.S. 113-182 and 143B-289.52). General Statute 143B-289.52 allows the NCMFC to delegate the authority to implement its regulations for fisheries “which may be affected by variable conditions" to the Director of the NCDMF who may then issue public notices called "proclamations". Thus, North Carolina has a very powerful and flexible legal basis governing coastal fisheries management. The General Assembly has retained the authority to establish commercial fishing licenses, but has delegated to the NCMFC authority to set individual permit fees for various commercial fishing gears.

The Fisheries Reform Act of 1997 (FRA) establishes a process for preparation of coastal fisheries management plans for North Carolina. The FRA was amended in 1998 and again in 2004. In 1998 the FRA was amended with several changes, that; 1) determine limited entry authority in Federal quota-based fisheries; 2) authorized that FMPs and management measures from FMPs be reviewed by the regional advisory committees; 3) authorized that MFC meetings must have a super quorum; 4) clarified definitions; and 5) clarified licensing provisions for standard commercial fishing licenses (SCFL) and recreational commercial gear licenses (RCGL). The amendment of the Act in 2004 required FMPs to achieve sustainable harvest rather than optimal yield and to specify a time period not to exceed 10 years for ending overfishing and rebuilding a fishery. The FRA states "the goal of the plans shall be to ensure the long-term viability of the state's commercially and recreationally significant species or fisheries. Each plan shall be designed to reflect fishing practices so that one plan may apply to a specific fishery, while other plans may be based on gear or geographic areas. Each plan shall:

a. Contain necessary information pertaining to the fishery or fisheries, including management goals and objectives, status of the relevant fish stocks, stock assessments for multi-year species, fishery habitat and water quality considerations consistent with Coastal Habitat Protection Plans (CHPP) adopted pursuant to G.S. 143B-279.8, social and economic impact of the fishery to the state, and user conflicts.

b. Recommend management actions pertaining to the fishery or fisheries.

c. Include conservation and management measures that will provide the greatest overall benefit to the state, particularly with respect to food production, recreational opportunities, and the protection of marine ecosystems, and that will produce a sustainable harvest.

d. Specify a time period, not to exceed 10 years from the date of the adoption of the plan, for ending overfishing and achieving a sustainable harvest. This subdivision shall only apply to a plan for a fishery that is overfished. This subdivision shall not apply to a plan for a fishery where the biology of the fish or environmental conditions makes ending overfishing and achieving a sustainable harvest within ten years impracticable."

Sustainable harvest is defined in the FRA as "The amount of fish that can be taken from a fishery on a continuing basis without reducing the stock biomass of the fishery or causing the fishery to become overfished."

Overfished is defined 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."

Overfishing is defined as "Fishing that causes a level of mortality that prevents a fishery from producing a sustainable harvest."

5.2 GOALS AND OBJECTIVES

The goal of Amendment 1 to the North Carolina Southern Flounder Fishery Management Plan (FMP) is to end overfishing and rebuild the spawning stock of southern flounder (*Paralichthys lethostigma*) for long-term sustainable harvest and maintain the integrity of the stock. To achieve this goal, the following objectives must be met:

1. Ensure that the spawning stock biomass of southern flounder is adequate to produce recruitment levels necessary to increase spawning stock biomass and expand age distribution.
2. Implement management measures that will achieve sustainable harvest.
3. Promote harvesting practices that minimize bycatch.
4. Continue to develop an information program to educate the public and elevate their awareness of the causes and nature of problems in the southern flounder stock, its habitat and fisheries, and explain the rationale for management efforts to sustain the stock.
5. Address social and economic concerns of all user groups, including issues such as user conflicts.
6. Promote the protection, restoration, and enhancement of habitats and environmental quality for the conservation of the southern flounder population.
7. Initiate, enhance, and/or continue studies to improve the understanding of southern flounder population ecology and dynamics.
8. Initiate, enhance, and/or continue studies to collect and analyze the socio-economic data needed to properly monitor and manage the southern flounder fishery.

5.3 SUSTAINABLE HARVEST

The FRA mandates that fishery stocks be managed to allow for sustainable harvest and prevent overfishing. The 2009 North Carolina Southern Flounder Stock Assessment indicated the stock remains overfished and overfishing is still occurring (Takade-Heumacher and Batsavage 2009). In the terminal year (2007) of the stock assessment, the fishing mortality (F) was 0.7534, the female spawning stock biomass (SSB) was estimated at 4,358,990 pounds, and the spawning potential ratio (SPR) was 19% of a population in which no fishing occurs. The NCDMF position on Amendment 1 of the Southern Flounder FMP sets the threshold at 25% SPR and target at 35% SPR.

5.4 MANAGEMENT UNIT

The management unit for this FMP includes southern flounder and the various fisheries that encounter southern flounder in all coastal and joint waters throughout North Carolina.

5.5 GENERAL PROBLEM STATEMENT

The 2005 southern flounder stock assessment determined the stock was overfished and overfishing was occurring. Since the implementation of the 2005 FMP, the stock status of southern flounder has improved with decreases in F, increases in SSB, and expansion of age classes. However, the 2009 assessment still finds the stock to be overfished and overfishing is still occurring. The purpose of Amendment 1 is to recommend management measures that will restore the North Carolina southern flounder stock to a viable level and ensure production of a long-term sustainable harvest. Areas to be addressed in the management of North Carolina's southern flounder fishery are: 1) achieving sustainable harvest; 2) conflict between fisheries; 3) bycatch of under-sized southern flounder and protected species; and 4) environmental factors.

5.6 INTERIM MEASURES

Session Law 2010-15 modified G.S. 113-182.1 to allow the NCDENR Secretary to authorize the NCMFC to develop interim management measures to supplement an existing FMP if needed for the long-term viability of the fishery. These interim measures are intended to prevent further declines for a stock that is overfished or for a stock that is experiencing overfishing at a level that may jeopardize the long-term sustainable harvest for the fishery. Since the 2009 stock assessment indicated that the stock was overfished and overfishing was occurring, the NCMFC asked the NCDMF at their January 2009 business meeting to evaluate interim management measures to end overfishing in the southern flounder fishery and rebuild the SSB. The NCMFC later requested that the NCDMF present these interim management measures to the Southern Flounder Advisory Committee (AC) before presenting them to the NCMFC. However, the Chair of the NCMFC suspended the discussion of this issue by the AC in November 2009. The NCMFC then voted to table interim management measures for southern flounder due to a lawsuit by the Karen Beasley Sea Turtle Rescue and Rehabilitation Center over sea turtle interactions with large mesh gill nets. In 2010, a settlement was reached between the Karen Beasley Sea Turtle Rescue and Rehabilitation Center and NCDMF which included new regulations for large mesh gill nets.

Proclamation M-8-2010 was implemented on May 15, 2010 to minimize interactions with sea turtles in the large mesh gill net fisheries while the NCDMF applied for a statewide incidental take permit from the National Marine Fisheries Service (NMFS) under Section 10 of the Endangered Species Act. Large mesh gill nets accounted for the greatest proportion of commercial southern flounder fishing effort and landings since 1996, thus these regulations were expected to have an impact on overall southern flounder fishing effort. Interim management measures to achieve sustainable harvest could not be completely evaluated until the result of the lawsuit was certain. The NCMFC also requested that interim management measures designed to alleviate user conflicts associated with the large mesh gill net fishery be evaluated. This issue was addressed by the AC but was also tabled by the NCMFC due to the pending lawsuit by the Karen Beasley Sea Turtle Rescue and Rehabilitation Center over sea turtle interactions with large mesh gill nets.

On February 21, 2011, the NCMFC preferred management strategy of 15 inches minimum size and a six-fish bag limit was implemented for the recreational flounder fishery by Supplement A to the 2005 FMP, under the authority of G.S. 113-182.1. Supplement A expedited the implementation of recreational management measures to end overfishing and achieve sustainable harvest. The management measures implemented in Supplement A were incorporated into FMP Amendment 1 with Issue Paper 10.1.1.

5.7 EXISTING PLANS, STATUTES, AND RULES

5.7.1 EXISTING PLANS

The 2005 Southern Flounder FMP is the only plan that applies specifically to the southern flounder fishery in North Carolina. The 2005 plan implemented several management measures that required changes to existing rules on September 1, 2005 and included:

- a closure period from December 1 to December 31 for the commercial fishery;
- a 14-inch minimum size limit for the commercial fishery;
- a 14-inch minimum size limit and an 8 fish bag limit for the recreational fishery;
- an exemption for flounder aquaculture operations from size and season requirements;
- implementation of a 200-yard limit between gill nets and active pound nets coast wide with the exception of the Albemarle Sound, excluding tributaries, west of a line between Caroon Point and Powell Point, from August 15 to December 31, when the minimum distance will be 500 yards;
- implementation of a 3,000-yard maximum limit coast wide on all large mesh flounder gill nets per fishing operation;
- implementation of a minimum mesh size of 5.5-inch stretched mesh coast wide for all large mesh gill nets from April 15 to December 15;
- the requirement of recreational/commercial gear (RCGL) license holders to attend their large mesh gill nets at all times from south of the NC Highway 58 bridge at Emerald Isle to the South Carolina state line;
- the requirement of escape panels with 5.5-inch stretched mesh in pound nets coast wide; and
- proclamation authority to the Fisheries Director to specify a minimum mesh size of 4-inch stretched mesh for crab trawls in western Pamlico Sound and tributaries and a minimum mesh size of 3-inch stretched mesh for crab trawls on the eastern side of Pamlico Sound (jointly recommended in the 2004 Blue Crab FMP and 2005 Southern Flounder FMP).

The Southern Flounder FMP AC made a recommendation to the Shrimp FMP AC to address the issue of the discard of sublegal southern flounder in the shrimp trawl fishery. This resulted in rule changes on July 1, 2006 through the Shrimp FMP and includes:

- the prohibition of shrimp trawls in the Pungo River above Wades Point and Abel Bay;
- the prohibition of shrimp trawls in the Pamlico River above Goose Bay and Wades Point and;
- the prohibition of shrimp trawls in the Neuse River above Cherry Point and Wilkerson Point.

The summer flounder (*Paralichthys dentatus*) fishery of the Atlantic Coast is managed jointly by the Atlantic States Marine Fisheries Commission (ASMFC) and the Mid-Atlantic Fishery Management Council (MAFMC) FMP, and this FMP has an impact on southern flounder. Due to the difficulty in distinguishing between the two closely related species, flounder in North Carolina are managed by area of occurrence rather than by species. Summer flounder occur primarily in the ocean waters and around the inlets and are commercially harvested almost exclusively with flounder trawls. In contrast, the main commercial fisheries for southern flounder, are from gill nets, pound nets, and gigs, and take place in the sounds and rivers. Therefore, regulations stemming from the federal summer flounder FMP, including harvest limits, size restrictions, and closures, only apply to commercially caught ocean flounder in North Carolina, regardless of the species. However, recreational size limits for summer flounder do affect the southern flounder recreational fishery in certain inshore areas of the state.

5.7.2 STATUTES

All management authority for North Carolina's southern flounder fishery is vested in the State of North Carolina. General authorities that are noted in Section 5.1 provide the NCMFC and the NCDMF with the regulatory powers to manage the southern flounder fishery. Although most southern flounder harvest is taken from coastal and joint waters, the limited harvest from inland waters falls under the jurisdiction of the North Carolina Wildlife Resources Commission (WRC).

Selected North Carolina General Statutes that relate to management and enforcement of regulations relative to southern flounder include:

G.S. 113-168.2	Standard Commercial Fishing License
G.S. 113-168.3	Retired Standard Commercial Fishing License
G.S. 113-168.4	Sale of Fish
G.S. 113-168.6	Commercial fishing vessel registration
G.S. 113-173.	Recreational Commercial Gear License
G.S. 113-174.2	Coastal Recreational Fishing License
G.S. 113-182.	Regulations of fishing and fisheries
G.S. 113-182.1	Fishery Management Plans
G.S. 113-268.	Injuring, destroying, stealing, or stealing from nets, seines, buoys, pots, etc.
G.S. 113-143B-279.8	Coastal Habitat Protection Plans.

5.7.3 RULES

15A NCAC 03J .0101 FIXED OR STATIONARY NETS
It is unlawful to use or set fixed or stationary nets:

(1) In the channel of the Intracoastal Waterway or in any other location where it may constitute a hazard to navigation;
(2) So as to block more than two-thirds of any natural or manmade waterway, sound, bay, creek, inlet or any other body of water;
(3) In the middle third of any marked navigation channel;
(4) In the channel third of the following rivers: Roanoke, Cashie, Middle, Eastmost, Chowan, Little, Perquimans, Pasquotank, North, Alligator, Pungo, Pamlico, and Yeopim.

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;
Eff. January 1, 1991.

15A NCAC 03J .0102 NETS OR NET STAKES

It is unlawful to use nets or net stakes:

(1) Within 150 yards of railroad or highway bridge crossing the Northeast Cape Fear River, New River, White Oak River, Trent River, Neuse River, Pamlico River, Roanoke River, and Alligator River;

(2) Within 300 yards of any highway bridge crossing Albemarle Sound, Chowan River, Croatan Sound, Currituck Sound and Roanoke Sound;

(3) If such net stakes are of metallic material.

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;
Eff. January 1, 1991.

15A NCAC 03J .0103 GILL NETS, SEINES, IDENTIFICATION, RESTRICTIONS

(a) It is unlawful to use gill nets:

(1) With a mesh length less than 2 ½ inches.

(2) In internal waters from April 15 through December 15, with a mesh length 5 inches or greater and less than 5 ½ inches.

(b) The Fisheries Director may, by proclamation, limit or prohibit the use of gill nets or seines in coastal waters, or any portion thereof, or impose any or all of the following restrictions on gill net or seine fishing operations:

(1) Specify area.

(2) Specify season.

(3) Specify gill net mesh length.

(4) Specify means/methods.

(5) Specify net number and length.

(c) It is unlawful to use fixed or stationary gill nets in the Atlantic Ocean, drift gill nets in the Atlantic Ocean for recreational purposes, or any gill nets in internal waters unless nets are marked by attaching to them at each end two separate yellow buoys which shall be of solid foam or other solid buoyant material no less than five inches in diameter and no less than five inches in length. Gill nets, which are not connected together at the top line, are considered as individual nets, requiring two buoys at each end of each individual net. Gill nets connected together at the top line are considered as a continuous net requiring two buoys at each end of the continuous net. Any other marking buoys on gill nets used for recreational purposes shall be yellow except one additional buoy, any shade of hot pink in color, constructed as specified in this Paragraph, shall be added at each end of each individual net. Any other marking buoys on gill nets used in commercial fishing operations shall be yellow except that one additional identification buoy of any color or any combination of colors, except any shade of hot pink, may be used at either or both ends. The owner shall be identified on a buoy on each end either by using engraved buoys or by attaching engraved metal or plastic tags to the buoys. Such identification shall include owner's last name and initials and if a vessel is used, one of the following:

(1) Owner's N.C. motor boat registration number, or

(2) Owner's U.S. vessel documentation name.

(d) It is unlawful to use gill nets:

(1) Within 200 yards of any flounder or other finfish pound net set with lead and either pound or heart in use, except from August 15 through December 31 in all coastal fishing waters of the Albemarle Sound, including its tributaries to the boundaries between coastal and joint fishing waters, west of a line beginning at a point 36° 04.5184' N - 75° 47.9095' W on Powell Point; running southerly to a point 35° 57.2681' N - 75° 48.3999' W on Caroon

Point, it is unlawful to use gill nets within 500 yards of any pound net set with lead and either pound or heart in use;

(2) From March 1 through October 31 in the Intracoastal Waterway within 150 yards of any railroad or highway bridge.

(e) It is unlawful to use gill nets within 100 feet either side of the center line of the Intracoastal Waterway Channel south of the entrance to the Alligator-Pungo River Canal near Beacon "54" in Alligator River to the South Carolina line, unless such net is used in accordance with the following conditions:

(1) No more than two gill nets per vessel may be used at any one time;

(2) Any net used must be attended by the fisherman from a vessel who shall at no time be more than 100 yards from either net; and

(3) Any individual setting such nets shall remove them, when necessary, in sufficient time to permit unrestricted boat navigation.

(f) It is unlawful to use drift gill nets in violation of 15A NCAC 03J .0101(2) and Paragraph (e) of this Rule.

(g) It is unlawful to use unattended gill nets with a mesh length less than five inches in a commercial fishing operation in the gill net attended areas designated in 15A NCAC 03R .0112(a).

(h) It is unlawful to use unattended gill nets with a mesh length less than five inches in a commercial fishing operation from May 1 through November 30 in the internal coastal and joint waters of the state designated in 15A NCAC 03R .0112(b).

(i) For gill nets with a mesh length five inches or greater, it is unlawful:

(1) To use more than 3,000 yards of gill net per vessel in internal waters regardless of the number of individuals involved.

(2) From June through October, for any portion of the net to be within 10 feet of any point on the shoreline while set or deployed, unless the net is attended.

(j) For the purpose of this Rule and 15A NCAC 03R .0112, shoreline is defined as the mean high water line or marsh line, whichever is more seaward.

History Note: *Authority G.S. 113-134; 113-173; 113-182; 113-221; 143B-289.52;*
Eff. January 1, 1991;
Amended Eff. August 1, 1998; March 1, 1996; March 1, 1994; July 1, 1993; September 1, 1991;
Temporary Amendment Eff. October 2, 1999; July 1, 1999; October 22, 1998;
Amended Eff. April 1, 2001;
Temporary Amendment Eff. May 1, 2001;
Amended Eff. April 1, 2009; December 1, 2007; September 1, 2005; August 1, 2004; August 1, 2002.

15A NCAC 03J .0401 FISHING GEAR

(a) The Fisheries Director in order to address issues involving user conflicts may, by proclamation, close the areas described in Paragraph (b) of this Rule to the use of specific fishing gear.

(b) It is unlawful to use fishing gear as specified by proclamation at the time and dates specified in the proclamation between the Friday before Easter through December 31 in the following areas when such areas have been closed by proclamation:

(1) All or part of the Atlantic Ocean, up to one-half mile from the beach;

(2) Up to one-half mile in all directions of Oregon Inlet;

(3) Up to one-half mile in all directions of Hatteras Inlet;

(4) Up to one-half mile in all directions of Ocracoke Inlet;

(5) Up to one-half mile of the Cape Lookout Rock Jetty;

(6) Up to one-half mile in all directions of fishing piers open to the public;

(7) Up to one-half mile in all directions of State Parks;
(8) Up to one-half mile of marinas as defined by the Coastal Resources Commission.

(c) The Fisheries Director shall specify in the proclamation the boundaries of the closure through the use of maps, legal descriptions, prominent landmarks or other permanent type markers.

(d) The Fisheries Director shall hold a public meeting in the affected area before issuance of proclamations authorized by this Rule.

History Note: Authority G.S. 113-133; 113-134; 113-182; 113-221; 143B-289.52;
Eff. July 1, 1993;
Amended Eff. June 1, 1996; March 1, 1995; October 1, 1993.

15A NCAC 03J .0402 FISHING GEAR RESTRICTIONS

(a) It is unlawful to use commercial fishing gear in the following areas during dates and times specified for the identified areas:

(1) Atlantic Ocean - Dare County:
  (A) Nags Head:
    (i) Seines and gill nets may not be used from the North Town Limit of Nags Head at Eight Street southward to Gulf Street:
      (I) From Wednesday through Saturday of the week of the Nags Head Surf Fishing Tournament held during October of each year the week prior to Columbus Day.
      (II) From November 1 through December 15.
    (ii) Commercial fishing gear may not be used within 750 feet of licensed fishing piers when open to the public.
  (B) Oregon Inlet. Seines and gill nets may not be used from the Friday before Easter through December 31:
    (i) Within one-quarter mile of the beach from the National Park Service Ramp #4 (35° 48.2500' N - 75° 32.7000' W) on Bodie Island to the northern terminus of the Bonner Bridge (35° 46.5000' N - 75° 32.3666' W) on Hwy. 12 over Oregon Inlet.
    (ii) Within the area known locally as "The Pond", a body of water generally located to the northeast of the northern terminus of the Bonner Bridge.
  (C) Cape Hatteras (Cape Point). Seines and gill nets may not be used within one-half mile of Cape Point from the Friday before Easter through December 31. The closed area is defined by a circle with a one-half mile radius having the center near Cape Point at a point 35° 12.9000' N - 75° 31.7166' W.

(2) Atlantic Ocean - Onslow and Pender Counties. Commercial fishing gear may not be used during the time specified for the following areas:
  (A) Topsail Beach. From January 1 through December 31, that area around Jolly Roger Fishing Pier bordered on the offshore side by a line 750 feet from the end of the pier and on the northeast and southwest by a line beginning at a point on the beach one-quarter mile from the pier extending seaward to intersect the offshore boundary.
  (B) Surf City:
    (i) From January 1 to June 30, that area around the Surf City Fishing Pier bordered on the offshore side by a line 750 feet

from the end of the pier, on the southwest by a line beginning at a point on the beach one-quarter mile from the pier and on the northeast by a line beginning at a point on the beach 750 feet from the pier extending seaward to intersect the offshore boundaries.

(ii) From July 1 to December 31, those areas around the pier bordered on the offshore side by a line 750 feet from the end of the pier, on the southwest by a line beginning at a point on the beach 750 feet from the pier and on the northeast by a line beginning at a point on the beach one-quarter mile from the pier extending seaward to intersect the offshore boundaries.

(3) Atlantic Ocean - New Hanover County. Carolina Beach Inlet through Kure Beach. Commercial fishing gear may not be used during the times specified for the following areas:

(A) From the Friday before Easter to November 30, within the zones adjacent to the Carolina Beach and Kure Beach Fishing Piers bordered on the offshore side by a line 750 feet from the ends of the piers and on the north and south by a line beginning at a point on the beach one-quarter mile from the pier extending seaward to intersect the offshore boundary, except the southern boundary for Kure Beach Pier is a line beginning on the beach one mile south of the pier to the offshore boundary for the pier.

(B) From May 1 to November 30, within 900 feet of the beach, from Carolina Beach Inlet to the southern end of Kure Beach with the following exceptions:

(i) From one-quarter mile north of Carolina Beach Fishing pier to Carolina Beach Inlet from October 1 to November 30:

(I) Strike nets may be used within 900 feet of the beach;

(II) Attended nets may be used between 900 feet and one-quarter mile of the beach.

(ii) Strike nets and attended gill nets may be used within 900 feet of the beach from October 1 to November 30 in other areas except those described in Part (a)(3)(A) and Subpart (a)(3)(B)(i) of this Rule.

(iii) It is unlawful to use commercial fishing gear within 900 feet of the beach from Carolina Beach Inlet to a point on the beach 33°55.0026' N – 77°56.6630' W near the former location of New Inlet during the October surf fishing tournament in Carolina Beach.

(4) Pamlico River – Beaufort County. Goose Creek State Park. Commercial fishing gear may not be used from the Friday before Easter through December 31 for the following areas:

(A) Within 150 feet of the shoreline within park boundaries;

(B) Within the marked channel from Dinah Landing to the mouth of Upper Goose Creek.

(b) It is unlawful to use gill nets or seines in the following areas during dates and times specified for the identified areas:

(1) Neuse River and South River, Carteret County. No more than 1,200 feet of gill net(s) having a stretched mesh of five inches or larger may be used:

(A) Within one-half mile of the shore from Winthrop Point at Adams Creek to Channel Marker "2" at the mouth of Turnagain Bay.

(B) Within South River.

(2) Cape Lookout, Carteret County:

(A) Gill nets or seines may not be used in the Atlantic Ocean within 300 feet of the Rock Jetty (at Cape Lookout between Power Squadron Spit and Cape Point).

(B) Seines may not be used within one-half mile of the shore from Power Squadron Spit south to Cape Point and northward to Cape Lookout Lighthouse including the area inside the "hook" south of a line from the COLREGS Demarcation Line across Bardens Inlet to the eastern end of Shackleford Banks and then to the northern tip of Power Squadron Spit from 12:01 a.m. Saturdays until 12:01 a.m. Mondays from May 1 through November 30.

(3) State Parks/Recreation Areas:

(A) Gill nets or seines may not be used in the Atlantic Ocean within one-quarter mile of the shore at Fort Macon State Park, Carteret County.

(B) Gill nets or seines may not be used in the Atlantic Ocean within one-quarter mile of the shore at Hammocks Beach State Park, Onslow County, from May 1 through October 1, except strike nets and attended gill nets may be used beginning August 15.

(C) Gill nets or seines may not be used within the boat basin and marked entrance channel at Carolina Beach State Park, New Hanover County.

(4) Mooring Facilities/Marinas. Gill nets or seines may not be used from May 1 through November 30 within:

(A) One-quarter mile of the shore from the east boundary fence to the west boundary fence at U.S. Coast Guard Base Fort Macon at Beaufort Inlet, Carteret County;

(B) Canals within Pine Knoll Shores, Carteret County;

(C) Spooners Creek entrance channel and marina on Bogue Sound, Carteret County; Harbor Village Marina on Topsail Sound, Pender County; and Marina and entrance canal within Carolina Marlin Club property adjacent to Newport River, Carteret County.

(5) Masonboro Inlet. Gill nets and seines may not be used:

(A) Within 300 feet of either rock jetty; and

(B) Within the area beginning 300 feet from the offshore end of the jetties to the Intracoastal Waterway including all the waters of the inlet proper and all the waters of Shinn Creek.

(6) Atlantic Ocean Fishing Piers. At a minimum, gill nets and seines may not be used within 300 feet of ocean fishing piers when open to the public. If a larger closed area has been delineated by the placement of buoys or beach markers as authorized by G.S. 113-185(a), it is unlawful to fish from vessels or with nets within the larger marked zone.

(7) Topsail Beach, Pender County. It is unlawful to use gill nets and seines from 4:00 p.m. Friday until 6:00 a.m. the following Monday in the three finger canals on the south end of Topsail Beach.

(8) Mad Inlet to Tubbs Inlet - Atlantic Ocean, Brunswick County. It is unlawful to use gill nets and seines from September 1 through November 15, except that a maximum of four commercial gill nets per vessel not to exceed 200 yards in length individually or 800 yards in combination may be used.

(9) Spooners Creek, Carteret County. It is unlawful to use gill nets and seines between sunset and sunrise in Spooners Creek entrance channel in Bogue

Sound, all of Spooners Creek proper and the adjoining tributary canals and channels.

History Note: Authority G.S. 113-133; 113-134; 113-182; 113-221; 143B-289.52;
Eff. March 1, 1996;
Amended Eff. October 1, 2004; August 1, 2004; April 1, 2001.

15A NCAC 03J .0501 DEFINITIONS AND STANDARDS FOR POUND NETS AND POUND NET SETS

(a) For the purpose of this Section the following terms are hereby defined:

(1) Pound Net Set Permit. A Division authorization to set and fish a pound net set in a commercial fishing operation in a specified location in a specified fishery.

(2) Permit period. One year from the date of issuance of a new or renewal pound net set permit.

(3) Deployed pound net. Setting of any part of a pound net, except for a location identification stake or for a pound net used in the Atlantic Ocean a location identification buoy placed at each end of a proposed new location.

(4) Operational pound net set. A pound net set as defined in 15A NCAC 03I .0101 and deployed according to rules and permit conditions with net attached to stakes or anchors for the lead and pound, including only a single pound in a multi-pound set, and a non-restricted opening leading into the pound such that the set is able to catch and hold fish.

(5) Flounder pound net. A pound net set that produces a catch consisting of 50 percent or more flounder by weight of the entire landed catch, excluding blue crabs or a pound net set with all pounds (holding pen) constructed of four inch stretch mesh or greater.

(6) Shrimp pound net. A pound net set with all pounds (holding pen) constructed of stretch mesh equal to or greater than one and one-fourth inches and less than or equal to two inches.

(b) It is unlawful for a pound net used in a commercial fishing operation to:

(1) Be deployed on a site without first obtaining a Pound Net Set Permit from the Fisheries Director.

(2) Fail to be operational for a minimum of 30 consecutive days during the pound net set permit period unless a season for the fishery for which the pound net set is permitted is ended earlier due to a quota being met.

(c) It is unlawful for a pound net set in a commercial fishing operation in coastal fishing waters to fail to:

(1) Have the permittee's identification legibly printed on a sign no less than six inches square, securely attached to a stake at the permitted ends of each set at all times. For pound net sets in the Atlantic Ocean using anchors instead of stakes, the set shall be identified with a yellow buoy, which shall be of solid foam or other solid buoyant material no less than five inches in diameter and no less than 11 inches in length. The permittee's identification shall be legibly printed on the buoy. The identification on signs or buoys shall include the Pound Net Set Permit number and the permittee's last name and initials.

(2) Have yellow light reflective tape or yellow light reflective devices on each pound. The yellow light reflective tape or yellow light reflective devices shall be affixed to a stake of at least three inches in diameter on any outside corner of each pound, shall cover a vertical distance of not less than 12 inches, and shall be visible from all directions.

(3) Have a marked navigational opening at least 25 feet wide at the end of every third pound. The opening shall be marked with yellow light reflective tape or yellow light reflective devices on each side of the opening. The yellow light reflective tape or yellow light reflective devices shall be affixed to a stake of at least three inches in diameter, shall cover a vertical distance of not less than 12 inches, and shall be visible from all directions.

If a permittee notified of a violation under this Paragraph fails or refuses to take corrective action sufficient to remedy the violation within 10 days of receiving notice of the violation, the Fisheries Director shall revoke the permit.

(d) It is unlawful to use a Recreational Commercial Gear License (RCGL) shrimp pound net as defined in 15A NCAC 03O .0302 (a)(8) in coastal fishing waters unless the shrimp pound net is:

(1) Marked by attaching to the offshore lead, one floating buoy, any shade of hot pink in color, which is of solid foam or other solid buoyant material no less than five inches in diameter and no less than five inches in length. The owner shall be identified on the buoy by using an engraved buoy or by attaching engraved metal or plastic tags to the buoy. The identification shall include owner's last name and initials and if a vessel is used, one of the following:
   (A) Gear owner's current motor boat registration number; or
   (B) Owner's U.S. vessel documentation name.

(2) Set a minimum of 100 yards from a RCGL shrimp pound net set or 300 yards from an operational permitted shrimp pound net set.

(e) Escape Panels:

(1) The Fisheries Director may, by proclamation, require escape panels in pound net sets and may impose any or all of the following requirements or restrictions on the use of escape panels:
   (A) Specify size, number, and location.
   (B) Specify mesh length, but not more than six inches.
   (C) Specify time or season.
   (D) Specify areas.

(2) It is unlawful to use flounder pound net sets without four unobstructed escape panels in each pound. The escape panels shall be fastened to the bottom and corner ropes on each wall on the side and back of the pound opposite the heart. The escape panels shall be a minimum mesh size of five and one-half inches, hung on the diamond, and shall be at least six meshes high and eight meshes long.

(f) During 1 December through 1 February the Director shall by proclamation establish time periods and areas where it is unlawful to fail to remove all nets from pound net sets in commercial fishing operations in internal coastal waters.

(g) It is unlawful within 30 days of abandonment of a permitted pound net set to fail to remove all stakes and associated gear from coastal fishing waters. The responsible party for abandoned pound net gear may be charged the costs incurred by the Division when the Division undertakes removal of the abandoned pound net gear.

History Note: Authority G.S. 113-134; 113-169.1; 113-182; 143B-289.52;
Eff. April 1, 2009.

15A NCAC 03J .0502 POUND NET SET PERMIT APPLICATION AND PROCESSING

(a) All initial, renewal or transfer applications for Pound Net Set Permits, and the operation of such pound net sets, shall comply with the rules governing all permits as provided in 15A

NCAC 03O .0502. The procedures and requirements for obtaining permits are set forth in 15A NCAC 03O .0501.

(b) Applicants for Pound Net Set permits shall meet the following eligibility requirements as determined by the Fisheries Director:

- (1) Applicant is an individual and not a corporation, partnership, organization or other entity;
- (2) Applicant has in the past complied with fisheries rules and laws and does not have any licenses or privileges under suspension or revocation. In addition, a history of habitual fisheries violations evidenced by eight or more convictions in 10 years shall make an individual ineligible.
- (3) Applicant has in the past complied with all permit conditions, rules and laws related to pound nets.
- (4) Applicant holds proper valid license(s) and permit(s) necessary to fish the type of net indicated in the application.

(c) Applications for Pound Net Set permits shall include the following:

- (1) A base map provided by the Division indicating the proposed set location including an inset vicinity map showing the location of the proposed set with detail sufficient to permit on-site identification and location.
- (2) Declaration of the type of pound net that will be deployed at the site. One of the following pound net fisheries shall be specified:
  - (A) Flounder pound net set;
  - (B) Bait pound net set;
  - (C) Shrimp pound net set;
  - (D) Blue crab pound net set;
  - (E) Other finfish pound net set.

(d) For proposed new location(s), the Fisheries Director shall issue a public notice of intent to consider issuance of a Pound Net Set Permit allowing for public comment for 20 days, and after the comment period, may hold public meetings to take comments on the proposed pound net set. If the Director does not approve or deny the application within 90 days of receipt of a complete and verified application, the application is deemed denied. The applicant shall be notified of denial in writing. Approval is conditional based upon the applicant's continuing compliance with eligibility requirements set out in Paragraph (e) of this Rule and specific conditions contained on the Pound Net Set Permit. The final decision to approve or deny the Pound Net Set Permit application may be appealed by the applicant by filing a petition for a contested case hearing, in writing, within 60 days from the date of mailing notice of such final decision to the applicant, with the Office of Administrative Hearings.

(e) In order for a site to be deemed suitable for a pound net set, the proposed set location shall meet the following criteria as determined by the Fisheries Director:

- (1) The proposed pound net set, either alone or when considered cumulatively with other existing pound net sets in the area, will not interfere with public navigation or with existing, traditional uses of the area other than navigation, and will not violate 15A NCAC 03J .0101 and .0102;
- (2) The proposed pound net set will not interfere with the rights of any riparian or littoral landowner, including the construction or use of piers;
- (3) The proposed pound net set will not, by its proximate location, interfere with existing pound net sets in the area. Flounder or other finfish pound net sets will be a minimum of 1,000 yards, as measured in a perpendicular direction, from any point on a line following the permitted location of existing pound net sets; except
  - (A) in Chowan River as referenced in 15A NCAC 03J .0203; and

(B) for renewal of pound net sets permitted prior to January 1, 2003;

(4) The proposed shrimp or blue crab pound net set will be a minimum of 300 yards, as measured in a perpendicular direction, from any point on a line following the permitted location of existing pound net sets;

(5) The proposed pound net set is not located in Core Sound in areas designated in 15A NCAC 03R .0113 except that only those Pound Net Set Permits valid within the specified area as of March 1, 1994, may be renewed or transferred subject to the requirements of this Rule; and

(6) Issuance of the proposed Pound Net Set Permit is in compliance with management measures adopted in fishery management plans.

History Note: Authority G.S. 113-134; 113-169.1; 113-182; 143B-289.52;
Eff. April 1, 2009.

15A NCAC 03J .0503 POUND NET SET PERMIT RENEWAL

An application for renewal of an existing Pound Net Set Permit shall be filed not less than 30 days prior to the date of expiration of the existing permit, and shall not be processed unless filed by the permittee. The Fisheries Director shall review the renewal application under the criteria for issuance of a new Pound Net Set Permit. The Fisheries Director may hold public meetings and may conduct such investigations necessary to determine if the permit should be renewed.

History Note: Authority G.S. 113-134; 113-169.1; 113-182; 143B-289.52;
Eff. April 1, 2009.

15A NCAC 03J .0504 POUND NET SET PERMIT TRANSFER

It is unlawful to transfer a Pound Net Set Permit without a completed application for transfer being submitted to the Division not less than 45 days before the date of the transfer. The application shall be made by the proposed new permittee in writing and shall be accompanied by a copy of the current permittee's permit and an application for a Pound Net Set Permit in the new permittee's name. The Fisheries Director may hold a public meeting and conduct such investigations necessary to determine if the permit should be transferred. The transferred permit expires on the same date as the initial permit. Upon death of the permittee, the permit may be transferred to the Administrator/Executor of the estate of the permittee if transferred within six months of the Administrator/Executor's qualification in accordance with Chapter 28A of the North Carolina General Statutes. The Administrator/Executor shall provide a copy of the deceased permittee's death certificate, a copy of letters of administration/letters testamentary and a list of eligible immediate family members as defined in G.S. 113-168 to the Morehead City Office of the Division. Once transferred to the Administrator/Executor, the Administrator/Executor may transfer the permit(s) to eligible immediate family members of the deceased permittee. No transfer is effective until approved and processed by the Division.

History Note: Authority G.S. 113-134; 113-169.1; 113-182; 143B-289.52;
Eff. April 1, 2009.

15A NCAC 03J .0505 POUND NET SET PERMIT CONDITIONS

(a) It is unlawful for a permittee:

(1) To fail to notify the Marine Patrol Communications Center within 72 hours by phone:

(A) Of an operational pound net set. Notification shall include the name of permittee, type of net, Pound Net Set Permit number, county where located, a specific location site, and how many pounds are in the set; and

(B) Of a change to the type of net being set at the permitted site.

(2) To make false notifications.

(3) To fail to render the pound net set inoperable during any closed season for the type of fishery for which the pound net is permitted.

Failure to comply with this Paragraph is grounds for the Fisheries Director to revoke any Pound Net Set Permits held by the permittee and for denial of any future applications for Pound Net Set Permits.

(b) Pound net sets are subject to inspection at all times.

(c) Daily reporting may be a condition of the permit for a pound net set for fisheries under a quota.

(d) It is unlawful to fail to remove all pound net stakes and associated gear within 30 days after expiration of the permit or notice by the Fisheries Director that an existing Pound Net Set Permit has been revoked or denied.

History Note: *Authority G.S. 113-134; 113-169.1; 113-182; 143B-289.52;*
Eff. April 1, 2009.

15A NCAC 03M .0503 FLOUNDER

(a) It is unlawful to possess flounder less than 14 inches total length taken from the Atlantic Ocean in a commercial fishing operation.

(b) From October 1 through April 30, it shall be unlawful to use a trawl in the Atlantic Ocean within three miles of the ocean beach from the North Carolina/Virginia state line (36° 33.000'N) to Cape Lookout (34° 36.000'N) unless each trawl has a mesh length of 5 1/2 inches or larger diamond mesh (stretched) or 6 inches or larger square mesh (stretched) applied throughout the body, extension(s) and the cod end (tailbag) of the net except as provided in Paragraphs (g) and (h) of this Rule.

(c) License to Land Flounder from the Atlantic Ocean:

(1) It is unlawful to land more than 100 pounds per trip of flounder taken from the Atlantic Ocean unless the owner of the vessel or in the case of Land or Sell Licenses, the responsible party, has been issued a License to Land Flounder from the Atlantic Ocean and the vessel in use is the vessel specified on the License to Land Flounder from the Atlantic Ocean.

(2) It is unlawful for a fish dealer to purchase or offload more than 100 pounds of flounder taken from the Atlantic Ocean by a vessel whose owner, or in the case of Land or Sell Licenses, the responsible party, has not first procured a valid North Carolina License to Land Flounder from the Atlantic Ocean and the vessel in use is the vessel specified on the License to Land Flounder from the Atlantic Ocean.

(3) It is unlawful for any person to land flounder from the Atlantic Ocean under a License to Land Flounder from the Atlantic Ocean unless that person is the holder of the license or the master designated on the license.

(4) It is unlawful for any individual to land flounder from the Atlantic Ocean without having ready at hand for inspection a valid License to Land Flounder from the Atlantic Ocean, except as specified in Subparagraph (c)(1) of this Rule.

(d) All fish dealer transactions in flounder landed from the Atlantic Ocean must be conducted in accordance with the Atlantic Ocean Flounder Dealer Permits in 15A NCAC 03O .0503 and related rules in 15A NCAC 03O .0500.
(e) It is unlawful to transfer flounder taken from the Atlantic Ocean from one vessel to another.
(f) Tailbag liners of any mesh size, the multiple use of two or more cod ends, or other netting material that in any way could restrict the legal size mesh shall not be used or possessed on the deck of a vessel in the Atlantic Ocean from October 1 through April 30 from the North Carolina/Virginia state line (36° 33.000' N) to Cape Lookout (34° 36.0000'N).
(g) Trawls with a cod end mesh size smaller than described in Paragraph (b) of this Rule may be used or possessed on the deck of a vessel provided not more than 100 pounds of flounder per trip from May 1 through October 31 or more than 200 pounds from November 1 through April 30 is possessed aboard or landed from that vessel.
(h) Flynets are exempt from the flounder trawl mesh requirements if they meet the following definition:

(1) The net has large mesh in the wings that measure 8 inches to 64 inches;
(2) The first body section (belly) of the net has 35 or more meshes that are at least 8 inches; and
(3) The mesh decreases in size throughout the body of the net to as small as 2 inches or smaller towards the terminus of the net.

(i) Commercial Season.

(1) The North Carolina season for landing ocean-caught flounder shall open January 1 each year. If 80 percent of the quota allocated to North Carolina in accordance with the joint Mid-Atlantic Fishery Management Council/Atlantic States Marine Fisheries Commission Fishery Management Plan for Summer Flounder is projected to be taken, the Fisheries Director shall, by proclamation, close North Carolina ports to landing of flounder taken from the ocean.
(2) The season for landing flounder taken in the Atlantic Ocean shall reopen November 1 if any of the quota allocated to North Carolina in accordance with the joint Mid-Atlantic Fishery Management Council/Atlantic States Marine Fisheries Commission Fishery Management Plan for Summer Flounder remains. If after reopening, 100 percent of the quota allocated to North Carolina in accordance with the joint Mid-Atlantic Fishery Management Council/Atlantic States Marine Fisheries Commission Fishery Management Plan for Summer Flounder is projected to be taken prior to the end of the calendar year, the Fisheries Director shall, by proclamation, close North Carolina ports to landing of flounder taken from the ocean.
(3) During any closed season prior to November 1, vessels may land up to 100 pounds of flounder per trip taken from the Atlantic Ocean.

(j) The Fisheries Director may, by proclamation, establish trip limits for the taking of flounder from the Atlantic Ocean to assure that the individual state quota allocated to North Carolina in the joint Mid-Atlantic Fishery Management Council/Atlantic States Marine Fisheries Commission Fishery Management Plan for Summer Flounder is not exceeded.
(k) The Fisheries Director may, by proclamation, based on variability in environmental and local stock conditions, take any or all of the following actions in the flounder fishery:

(1) Specify size;
(2) Specify season;
(3) Specify area;
(4) Specify quantity;
(5) Specify means/methods; and

(6) Require submission of statistical and biological data.

(l) Possession and sale of flounder by a hatchery or flounder aquaculture operation and purchase and possession of flounder from a hatchery or flounder aquaculture operation shall be exempt from season and size limit restrictions set under Paragraph (k) of this Rule. It is unlawful to possess, sell, purchase, or transport such flounder unless they are in compliance with all conditions of the Aquaculture Operations Permit.

History Note: Authority G.S. 113-134; 113-169.5; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. March 1, 1996; February 1, 1992;
Temporary Amendment Eff. November 1, 1995 for a period of 180 days or until the permanent rule becomes effective, whichever is sooner;
Temporary Amendment Eff. December 23, 1996;
Amended Eff. April 1, 1997;
Temporary Amendment Eff. June 1, 1998; August 18, 1997;
Amended Eff. April 1, 1999;
Temporary Amendment Eff. May 1, 2000; July 1, 1999;
Amended Eff. April 1, 2001; August 1, 2000;
Temporary Amendment Eff. September 1, 2004;
Temporary Amendment Expired June 12, 2005;
Amended Eff. September 1, 2005.

15A NCAC 03M .0512 COMPLIANCE WITH FISHERY MANAGEMENT PLANS

(a) In order to comply with management requirements incorporated in Federal Fishery Management Council Management Plans or Atlantic States Marine Fisheries Commission Management Plans or to implement state management measures, the Fisheries Director may, by proclamation, take any or all of the following actions for species listed in the Interjurisdictional Fisheries Management Plan:

(1) Specify size;
(2) Specify seasons;
(3) Specify areas:
(4) Specify quantity;
(5) Specify means and methods; and
(6) Require submission of statistical and biological data.

(b) Proclamations issued under this Rule shall be subject to approval, cancellation, or modification by the Marine Fisheries Commission at its next regularly scheduled meeting or an emergency meeting held pursuant to G.S. 113-221.1.

History Note: Authority G.S. 113-134; 113-182; 113-221; 113-221.1; 143B-289.4;
Eff. March 1, 1996;
Amended Eff. October 1, 2008.

15A NCAC 03R .0113 POUND NET SET PROHIBITED AREAS

The pound net set prohibited areas referenced in 15A NCAC 03J .0502 are delineated in the following coastal water areas of Core Sound:

(1) The area described by a line beginning at a point 34° 58.9130' N - 76° 15.0878' W on the shoreline north of Great Ditch; running southwesterly to a point 34° 58.6399' N - 76° 15.3694' W on the south shore of Great Ditch; following the shoreline to a point 34° 58.4957' N - 76° 15.8093' W on Hog Island Point; running southwesterly to a point 34° 58.2318' N - 76° 16.0913' W near Marker "3"; running southeasterly to a point 34° 58.0773' N - 76° 15.6134' W near Beacon "2"; running southeasterly to a point 34° 57.3120' N

- 76° 13.7113' W near Beacon "13"; running northeasterly to a point 34° 58.5157' N - 76° 13.2389' W near Beacon "11"; running northwesterly to the point of beginning;

(2) The area described by a line beginning in Cedar Island Bay at a point 34° 58.2318' N - 76° 16.0913' W near Marker "3"; running southwesterly to a point 34° 57.4914' N - 76° 16.5861' W on Cedar Island Point; running southeasterly to a point 34° 56.3436' N - 76° 15.6069' W near Beacon "18"; running northerly to a point 34° 58.0773' N - 76° 15.6134' W near Beacon "2"; running northwesterly to the point of beginning; and

(3) The area described by a line beginning on the north shore of Lewis Creek at a point 34° 56.9654' N - 76° 16.7395' W; running easterly to a point 34° 56.3436' N - 76° 15.6069' W near Beacon "18"; running southwesterly to a point 34° 54.9904' N - 76° 16.5888' W near Beacon "19"; running southwesterly following the six foot contour to a point 34° 53.7599' N - 76° 18.1613' W; running southwesterly to a point 34° 50.6266' N - 76° 22.0449' W near Beacon "27"; running westerly to a point 34° 50.5496' N - 76° 22.9284' W near Beacon "28"; running southwesterly to a point 34° 49.1889' N - 76° 24.2010' W near Beacon "29"; running westerly to a point 34° 48.9514' N - 76° 24.8780' W near Beacon "31"; running southwesterly to a point 34° 45.0942' N - 76° 27.9533' W near Beacon "35"; running southwesterly to a point 34° 43.4896' N - 76° 28.9411' W near Beacon "37A"; running westerly to a point 34° 43.7782' N - 76° 30.0187' W on Bells Point; running northerly along the shoreline of Bells Island to a point 34° 44.2190' N - 76° 30.1336' W; running northerly to a point 34° 44.2568' N - 76° 30.1419' W; running northerly along the shoreline to a point 34° 44.6759' N - 76° 30.1712' W; running northeasterly to a point 34° 45.2824' N - 76° 29.1636' W on Davis Island; running northeasterly to a point 34° 45.8196' N - 76° 28.7530' W on the north side of Spit Bay; running northeasterly along the shoreline to a point 34° 48.7982' N - 76° 26.9741' W on the south shore of Oyster Creek; running northeasterly to a point 34° 48.9701' N - 76° 26.6299' W on the north shore of Oyster Creek; running northeasterly along the shoreline to a point 34° 50.4311' N - 76° 24.9934' W on the south shore of Fulcher Creek; running northeasterly to point 34° 50.4911' N - 76° 24.9540' W on the north shore of Fulcher Creek; running northeasterly along the shoreline to a point 34° 50.9934' N - 76° 24.7727' W on the south shore of Willis Creek; running northeasterly to a point 34° 51.1866' N - 76° 24.5416' W on the south shore of Nelson Bay; running easterly to a point 34° 51.4437' N - 76° 23.6151' W on Drum Point; running easterly along the shoreline to a point 34° 51.4462' N - 76° 22.9669' W at Mill Point; running northeasterly to a point 34° 52.4143' N - 76° 20.8557' W on Steep Point; running northeasterly along the shoreline to a point 34° 54.3782' N - 76° 18.8575' W on Hall Point; running northeasterly to a point 34° 55.4257' N - 76° 17.8541' W on Lookout Point; running northeasterly along the shoreline to a point 34° 55.7679' N - 76° 17.7021' W on the south shore of Rumley Bay; running northeasterly to a point 34° 56.2513' N - 76° 17.1858' W on the north shore of Rumley Bay; running northeasterly along the shoreline to the point of beginning.

History Note: Authority G.S. 113-134; 113-181; 113-182; 143B-289.52;
Eff. August 1, 2004; Amended Eff. April 1, 2009.

6.0 STATUS OF THE STOCK

6.1 LIFE HISTORY

Southern flounder are members of the family Bothidae (lefteye flounders), and as such, have both of their eyes on the left side of their body. Southern flounder are closely related and appear very similar to their congeners (summer flounder and Gulf flounder (*Paralichthys albigutta*)). All three co-occur in the waters of North Carolina. Upon close examination, it is possible to distinguish between the three species based on physical characteristics (Figure 6.1). The southern flounder is typically dark in color with either lighter or darker blotches. Unlike either the summer or the Gulf flounder, the southern flounder has no ocellated spots (dark spots ringed with a lighter color) (Ginsburg 1952).

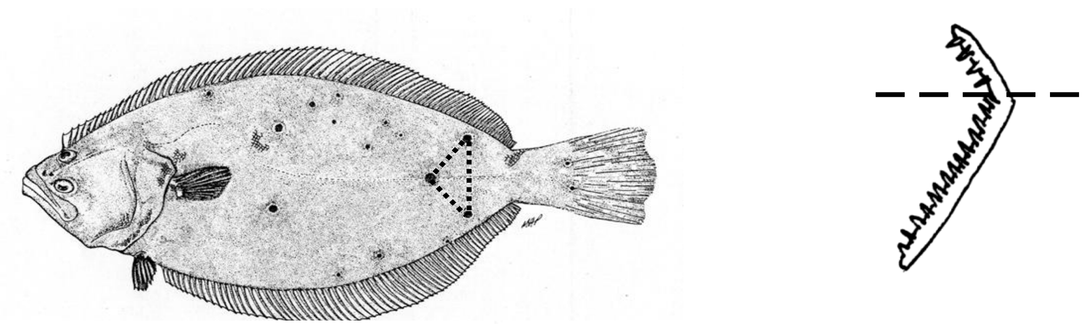
Flounder have a compressed body and spend much of their life lying on the bottom on their side, rather than swimming in the water column like other fish. Southern flounder lie on the right side of their body, which usually lacks pigmentation. The exposed left side of their body is dark and blotchy enabling the flounder to blend in with its surroundings. Both eyes and nostrils are located on the left or upper side of the head enabling the flounder to see and breathe uninhibited while lying on its side. When a flounder swims, it remains on its side rather than righting itself in the water column like most fish.

6.1.1 RANGE AND DISTRIBUTION

Southern flounder inhabit the riverine, estuarine, and coastal waters along the East Coast of North America from Virginia south to the Loxahatchee River on the Atlantic Coast of Florida. They are also common along the Gulf of Mexico coastline from the Caloosahatchee River estuary in Florida west to Texas and south into northern Mexico. However, this species has yet to be found in waters surrounding the southern tip of Florida (Gilbert 1986). Blandon et al. (2001) found that the South Atlantic population and the Gulf of Mexico population of southern flounder are not genetically distinct from one another based on samples tested from North Carolina, Florida, Alabama, Mississippi, Texas.

6.1.2 REPRODUCTION

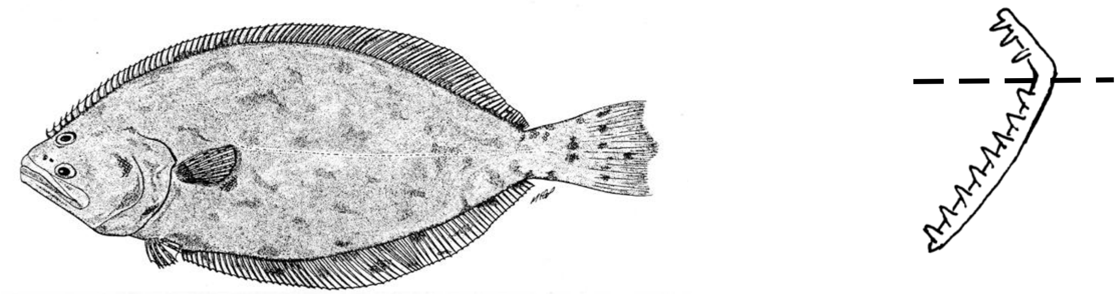
Adult southern flounder migrate out of the rivers and estuaries in the late fall to spawn offshore in the warmer waters of the Gulf Stream between November and February (Reagan and Wingo 1985; Gilbert 1986; Daniels 2000). Southern flounder reach sexual maturity at ages 1 and 2, the males as small as 230 mm (9.1 inches) in length and weighing about 0.1 kg (0.3 pounds) and the females as small as 320 mm (12.6 inches) and weighing approximately 0.4 kg (0.8 pounds) (Wenner et al. 1990; Safrit and Schwartz 1998; Daniels 2000; Monaghan and Armstrong 2000). Fertilization occurs externally, the milt (sperm) and roe (unfertilized eggs) being broadcast into the water column (Pattillo et al. 1997).



Summer flounder

1. Ocellated spots form triangle near tail that points forward.

2. Gill rakers on lower portion of first gill arch number 13 to 18.

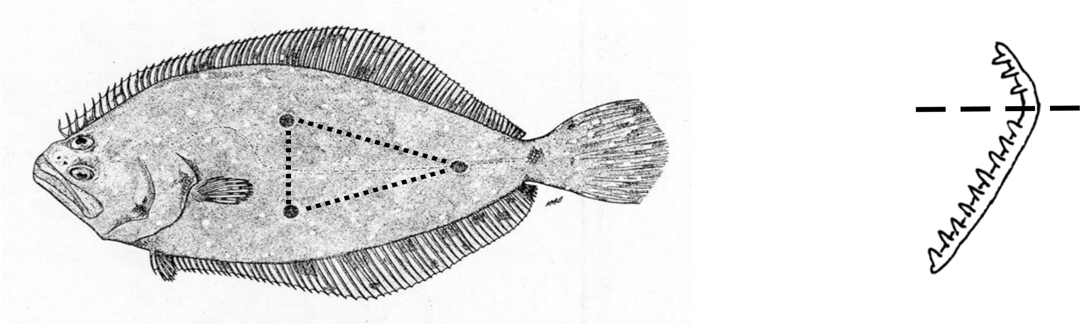


Southern flounder

1. No ocellated spots. Dark and light blotches on dark background.

2. Gill rakers on lower portion of first gill arch number 8 to 11.

3. 63 to 74 anal rays.



Gulf flounder

1. Ocellated spots form triangle pointing towards tail.

2. Gill rakers on lower portion of first gill arch number 9 to 12.

3. 53 to 63 anal rays.

Figure 6.1 Physical characteristics of summer, southern, and Gulf flounder that can be used to distinguish between the three species

6.1.3 GROWTH AND DEVELOPMENT

6.1.3.1 EMBRYOS

Southern flounder eggs have a diameter of approximately 1.0 mm, are nearly transparent, and contain a single oil droplet about 0.2 mm (0.008 inches) in diameter (Henderson-Arzapalo et al. 1988; Powell and Henley 1995; Daniels 2000). As a result, the eggs are highly buoyant, floating at or near the water surface (Arnold et al. 1977; Gilbert 1986). In the laboratory, eggs hatched following a 55-hour incubation period at 63° F (17° C) and 33 ppt salinity (Daniels 2000).

6.1.3.2 LARVAE

Newly hatched larvae are about 2.1 mm (0.08 inches) notochord length (Powell and Henley 1995) and lack fins, eyes, and mouth, but develop these features during the five-day period between hatching and first-feeding (Daniels 2000). At the time of first-feeding, the yolk is completely absorbed. The oil droplet, however, is retained for several days longer (Daniels 2000). Metamorphosis into the post-larval stage occurs around day 30 at 63° F (17° C) in the laboratory, or between 30 to 70 days in the wild under variable conditions, when the larvae are approximately 8 to 11 mm (0.31 to 0.43 inches) total length (TL) (Arnold et al. 1977; Miller et al. 1991; Daniels 2000). During the metamorphosis process, the skull rotates as the eye on the right side of the head moves to the other side of the body to join the left eye and generally takes two weeks to complete. Based on laboratory results, cooler waters around 63° F (17° C) are optimal conditions for egg hatching and larval survival and development. Conversely, temperature conditions for survival of the larvae through the metamorphosis process are optimum in warmer waters closer to 70° F (21° C) (Daniels 2000). Newly metamorphosed southern flounder are highly tolerant to low salinity. Twelve-week studies have shown that growth rates are not significantly different for southern flounder in water of 0 ppt versus 20 ppt up to a size of 60 g (2 oz) (Daniels 2000). As with other flatfish, the sex of the flounder is not determined until after metamorphosis occurs (Daniels 2000).

6.1.3.3 JUVENILES

The minimum size of settled juvenile southern flounder, 10 to 15 mm (0.39 to 0.59 inches), overlaps that of the post-larvae for some fish (Pattillo et al. 1997). Following metamorphosis, female southern flounder grow approximately three times faster than males (Daniels 2000). Stokes (1977) estimated that the average size of southern flounder following the first and second year of growth was between 201 and 250 mm (7.91 to 9.84 inches) TL for males, and between 225 and 364 mm (8.86 to 14.33 inches) TL for females. In addition to sex-related size differences, size-at-age has also been found to be highly variable for southern flounder within each sex. According to Fitzhugh et al. (1996), southern flounder display a bimodal length-frequency distribution during the first year of growth that is independent of the sex of the fish. It is hypothesized that this divergence in growth rates, which generally occurs when the fish are between 75 to 100 mm (2.95 to 3.94 inches) TL, may be the result of variation in the onset of piscivory (the shift from eating primarily crustaceans to a diet consisting primarily of small fish) (Fitzhugh et al. 1996).

6.1.3.4 ADULTS

In North Carolina, the oldest female southern flounder collected was age-9, and the oldest male was age-6 (Takade-Heumacher and Batsavage 2009). Wenner and Archambault (2005) reported maximum ages for female and male southern flounder from South Carolina at ages 7 and 5, respectively. The maximum age of southern flounder from the Louisiana coast of the Gulf of Mexico was age-8 for females and age-4 for males (Fischer and Thompson 2004). Nall (1979) reported age-10 as the maximum age for southern flounder from Florida, but subsequent studies have determined the age and growth estimates from this study to be very questionable (Wenner et al. 1990; GSMFC 2000).

Southern flounder typically range from 305 to 508 mm (12 to 20 inches) and 1 to 4 pounds, although fish much larger are not uncommon (Wenner and Archambault 2005; NCDMF 2007). Female southern flounder grow larger and at a faster rate than male southern flounder (Wenner et al. 1990; Fischer and Thompson 2004; Wenner and Archambault 2005; Takade-Heumacher and Batsavage 2009). The largest female southern flounder collected in North Carolina was 835 mm (32.9 inches) and 9.3 kg (20.5 pounds) (Takade-Heumacher and Batsavage 2009). Males exceeding 330 mm (13 inches) and 0.5 kg (1 pound) are uncommon (Wenner et al. 1990; Fischer and Thompson 2004, Takade-Heumacher and Batsavage 2009).

6.1.4 DIET AND FOOD HABITS

While still in the marine environment, larval southern flounder are found throughout the water column and feed on zooplankton prior to metamorphosis (Daniels 2000). In contrast, juvenile and adult southern flounder are demersal, lie-in-wait predators (Burke 1995). They feed by camouflaging themselves on the bottom and ambushing their prey. Southern flounder ambush the prey with a quick upward lunge and inhale it by creating a vacuum action with its mouth. As juveniles, a portion of their diet consists of epifaunal prey including mysids, amphipods, and calanoid copepods (Powell and Schwartz 1979; Burke 1995). Southern flounder switch to piscivory when they are between 75 to 100 mm (2.95 to 3.94 inches) TL (Fitzhugh et al. 1996). Adult southern flounder feed almost exclusively on other fish, but will consume shrimp as well (Powell and Schwartz 1979).

6.1.5 MIGRATION AND MOVEMENT PATTERNS

In North Carolina, adult southern flounder inhabit estuarine waters during the spring and summer, preferring the lower salinity portions of the sounds, rivers, and bays. In the fall, the adult southern flounder move out through the inlets into the ocean waters to spawn (Wenner and Archambault 2005). These migrations coincide with falling water temperatures (Shepard 1986; Pattillo et al. 1997). This seasonal migration offshore, from September to November, is when the majority of the southern flounder are landed in the pound net, gill net, and gig fisheries. Juvenile and young, sexually immature adult flounder overwinter in the low salinity waters of the rivers and bays for the first two years of their life rather than migrating offshore (Powell and Schwartz 1979; Daniels 2000), as evident from crab trawl catches during the winter months in the Neuse, Pamlico, and Bay rivers (McKenna and Camp 1992; Lupton 1996; Hannah and Hannah 2000) and from winter catches in the gig fishery between the White Oak River and the South Carolina state line (Watterson 2003).

Following the spawning period offshore, which extends from December to March (Monaghan and Armstrong 2000), the adult flounder return through the inlets to the estuaries and rivers. Some adult southern flounder remain in the ocean after spawning instead of returning to the estuaries (Watterson and Alexander 2004; Taylor et al. 2008). The proportion of the adult southern flounder remaining in the ocean and the annual variation of southern flounder remaining in the ocean is unknown.

Developing larval flounder remain in the offshore waters for between 30 to 60 days (Miller et al. 1991; Daniels 2000). Around the time of metamorphosis, the larval flounder are carried through the inlets into the estuaries during nighttime flood tides (Warlen and Burke 1990; Burke et al. 1991; Burke et al. 1998). Following metamorphosis, the juvenile flounder settle on tidal flats towards the head of the estuaries and move upstream to lower salinity riverine habitats (Burke et al. 1991).

6.2 PRESENT STOCK STATUS

Southern flounder support substantial commercial and recreational fisheries in North Carolina. Increased fishing effort and concern for the southern flounder stock resulted in a stock assessment in 2004 and a FMP in 2005. The 2009 stock assessment updates the status of the southern flounder stock, using fishery dependent and fishery independent data from 1991 to 2007. Southern flounder in North Carolina were considered a unit stock based on previous tagging studies (Wenner et al. (1990); Monaghan (1992); Scharf et al. 2008). There is also evidence of adult southern flounder returning to the estuaries in the spring and summer subsequent to spawning offshore (Monaghan 1992), and the presence of adult southern flounder remaining in the ocean off North Carolina after spawning (Watterson and Alexander 2004; Taylor et al. 2008).

Data available for southern flounder included commercial and recreational landings, length frequencies from the commercial and recreational fisheries, age, growth and maturity data, and indices of abundance from fishery dependent (commercial gill net and recreational hook and line fishery) and fishery independent (Albemarle Sound Independent Gill Net, Pamlico Sound Independent Gill Net, Pamlico Sound Trawl, Estuarine Trawl, and Beaufort Inlet Ichthyoplankton Sampling Program) surveys. The model selected to estimate mortality and abundance for this assessment is a forward projecting statistical catch-at-age model called ASAP2. Yield per recruit and biomass per recruit models were used to identify levels of fishing mortality (F) and spawning stock biomass (SSB) for the determination whether or not the stock is overfished and whether or not overfishing is occurring.

The terminal year number-adjusted F was estimated at 0.7534 (Table 6.1), and the estimated terminal year SSB was 4,358,990 pounds of female fish (Table 6.2). Based on the range of possible reference fishing mortality rates from $F_{25\%}$ to $F_{40\%}$, F thresholds and targets for this stock are between F=0.5937 and F=0.3445 (Table 6.3). The average fishing mortality rate (F=1.1631) over the 1991 – 2007 time period is above the upper bound of the reference mortality rates. Based on the reference SSB levels associated with the range of fishing mortality thresholds from $F_{25\%}$ to $F_{40\%}$, SSB thresholds and targets for this stock are between 5,903,817 pounds and 9,446,797 pounds, which exceeds the 2007 terminal year SSB estimate. The threshold reference point chosen for Amendment 1 to the Southern Flounder FMP is $F_{25\%}$, which corresponds to an F=0.5937 and a SSB=5,903,817 pounds. The target reference point chosen for Amendment 1 to the Southern Flounder FMP is $F_{35\%}$, which corresponds to an F=0.4081 and a SSB=8,265,162 pounds. The 2007 terminal year F was expected to retain about 19% of the maximum SSB.

Table 6.1 ASAP2 estimates of fishing mortality for all ages and average fishing mortality for ages 2-5 female southern flounder, 1991-2007.

	Age							Fishing
Year	0	1	2	3	4	5	6+	mortality
1991	0.0058	0.3731	1.2335	1.2666	1.2549	1.1117	0.8980	1.2361
1992	0.0044	0.2803	0.9256	0.9505	0.9415	0.8310	0.6661	0.9300
1993	0.0062	0.4001	1.3075	1.3415	1.3270	1.1515	0.8896	1.3175
1994	0.0075	0.4873	1.5674	1.6068	1.5854	1.3275	0.9426	1.5693
1995	0.0062	0.4038	1.2934	1.3260	1.3071	1.0795	0.7399	1.2967
1996	0.0056	0.3621	1.1655	1.1955	1.1790	0.9806	0.6843	1.1690
1997	0.0065	0.4205	1.3299	1.3626	1.3401	1.0707	0.6686	1.3354
1998	0.0062	0.4053	1.2744	1.3051	1.2826	1.0134	0.6116	1.2771
1999	0.0061	0.3701	1.1642	1.2010	1.1803	0.9249	0.5437	1.1687
2000	0.0064	0.3644	1.1686	1.2143	1.1957	0.9594	0.6067	1.1802
2001	0.0068	0.3747	1.2201	1.2706	1.2536	1.0357	0.7104	1.2235
2002	0.0091	0.5038	1.6375	1.7051	1.6820	1.3845	0.9404	1.6511
2003	0.0072	0.3657	1.1998	1.2609	1.2435	1.0124	0.6674	1.2090
2004	0.0063	0.2934	0.9849	1.0454	1.0328	0.8559	0.5918	0.9947
2005	0.0045	0.2140	0.6858	0.6639	0.5966	0.5406	0.4987	0.6813
2006	0.0048	0.2572	0.8072	0.7601	0.6720	0.6001	0.5463	0.7795
2007	0.0047	0.2479	0.7799	0.7366	0.6521	0.5830	0.5313	0.7534

Table 6.2 ASAP2 estimates of spawning stock biomass for female southern flounder in pounds and +/- one standard deviation, 1991-2007.

Year	-1 Standard deviation	SSB	+1 Standard deviation
1991	3,845,100	4,080,760	4,316,420
1992	4,038,050	4,268,640	4,499,230
1993	3,438,990	3,680,830	3,922,670
1994	3,551,440	3,779,450	4,007,460
1995	2,857,360	3,010,600	3,163,840
1996	3,397,890	3,568,220	3,738,550
1997	3,136,080	3,290,670	3,445,260
1998	3,021,720	3,213,780	3,405,840
1999	2,874,530	3,055,970	3,237,410
2000	2,070,910	2,202,480	2,334,050
2001	3,324,490	3,487,050	3,649,610
2002	2,995,300	3,136,260	3,277,220
2003	2,099,600	2,218,950	2,338,300
2004	2,224,030	2,352,340	2,480,650
2005	4,168,400	4,381,680	4,594,960
2006	4,043,490	4,304,930	4,566,370
2007	3,978,570	4,358,990	4,739,410

Table 6.3 Estimated F and SSB thresholds and targets for female southern flounder.

	Fishing mortality	SSB
$F_{0.1}$	0.3570	9,188,593
$F_{25\%}$	0.5937	5,903,817
$F_{30\%}$	0.4880	7,084,845
$F_{35\%}$	0.4081	8,265,162
$F_{40\%}$	0.3445	9,446,797

The stock status of southern flounder has improved since the earlier portion of the time series with decreases in F, increases in SSB and age class expansion in recent years. However, this assessment finds that the stock is still overfished and overfishing is occurring. The commercial and recreational fisheries heavily rely on the harvest of age-1 and age-2 fish, which are the ages when female southern flounder begin to sexually mature. Based on the selectivity patterns of the fisheries, consecutive years of low recruitment can result in decreased SSB and increased F in subsequent years. For more information on the stock status of southern flounder, see Appendix 13.5 Stock Status of North Carolina Southern Flounder (*Paralichthys lethostigma*).

7.0 STATUS OF THE FISHERIES

7.1 COMMERCIAL FISHERY

7.1.1 COLLECTION OF COMMERCIAL STATISTICS

Annual North Carolina landings data were collected by the Division of Commercial Fisheries (U.S. Fish and Wildlife Service, Department of the Interior) from 1880 to 1974 (Chestnut and Davis 1975). The collection methods of landings statistics were standardized by NMFS for U.S. south Atlantic fishery species in 1972. Landings were collected monthly from major seafood dealers, although reporting was not mandatory. The NCDMF and NMFS began a cooperative commercial fishery data collection program in 1978, maintaining the same methodology established in 1972. However, NCDMF assumed the primary role of data collection for the state and further improved data collection coverage with additional staff. Under-reported landings, however, were a growing concern due to the reliance on voluntary program cooperation from seafood dealers. The rising perception of deteriorating attitudes towards fisheries management by North Carolina fishermen in the late 1980s and early 1990s contributed to the reform of the NCDMF/NMFS cooperative statistics program (Lupton and Phalen 1996). With the support of the commercial fishing industry, NCDMF instituted a mandatory, dealer-based, trip-level, reporting system for all commercial species in 1994, which greatly improved reporting compliance. Improved collection methods that began in 1994 should be considered when comparing pre-1994 landings with post-1994 landings. This reporting system is still currently in place and is known as the North Carolina Trip Ticket Program (NCTTP).

Flounder landings reported through the NCTTP are not tabulated by species. To determine the commercial landings of each species, it is assumed that all flounder harvested from internal waters are southern flounder, while all flounder taken from the ocean are summer flounder. According to dependent sampling efforts of the commercial fish houses by the NCDMF, it has been determined that southern flounder make up less than one percent of the catch from ocean waters, while summer flounder and Gulf flounder account for approximately two percent or less of the total flounder harvested from internal waters (NCDMF unpublished data).

7.1.2 HISTORY

Southern flounder is the most economically important estuarine finfish species in North Carolina. Historically, summer flounder (*Paralichthys dentatus*) was the primary flounder species landed in the state. However, due to a decline in the fishery since the mid-1980s, followed by federal restrictions on harvest implemented in 1993, summer flounder landings have been reduced from historical levels (Figure 7.1). As the availability of summer flounder began to decline in the late 1980s, both the demand and value for flounder increased, resulting in an increase in southern flounder landings (Figure 7.1). In addition, the early 1990s saw the beginning of the sushi and sashimi market, which substantially increased the value of live and bled jumbo flounder (Figure 7.2), as well as the development of a deepwater large mesh gill net fishery for flounder in Pamlico Sound. More information on the social and economic factors for southern flounder is available in Section 8.0 – Socioeconomic Characteristics of the Fisheries. Subsequently, landings in both the pound net and the estuarine gill net fisheries increased considerably (Figure 7.2). In 1993, a federal quota was established for summer flounder, which not only put a cap on the total pounds of summer flounder that could be landed in the state, but also resulted in an increase in both the ex-vessel value for all flounder and the amount of pressure being placed on the southern flounder stocks. Due to the culmination of these factors, southern flounder became the primary flounder species harvested in North Carolina in the 1990s, both in landings and value. An increase in the annual quota for summer flounder has allowed this species again to surpass southern flounder landings in more recent years in North Carolina (Figure 7.1)

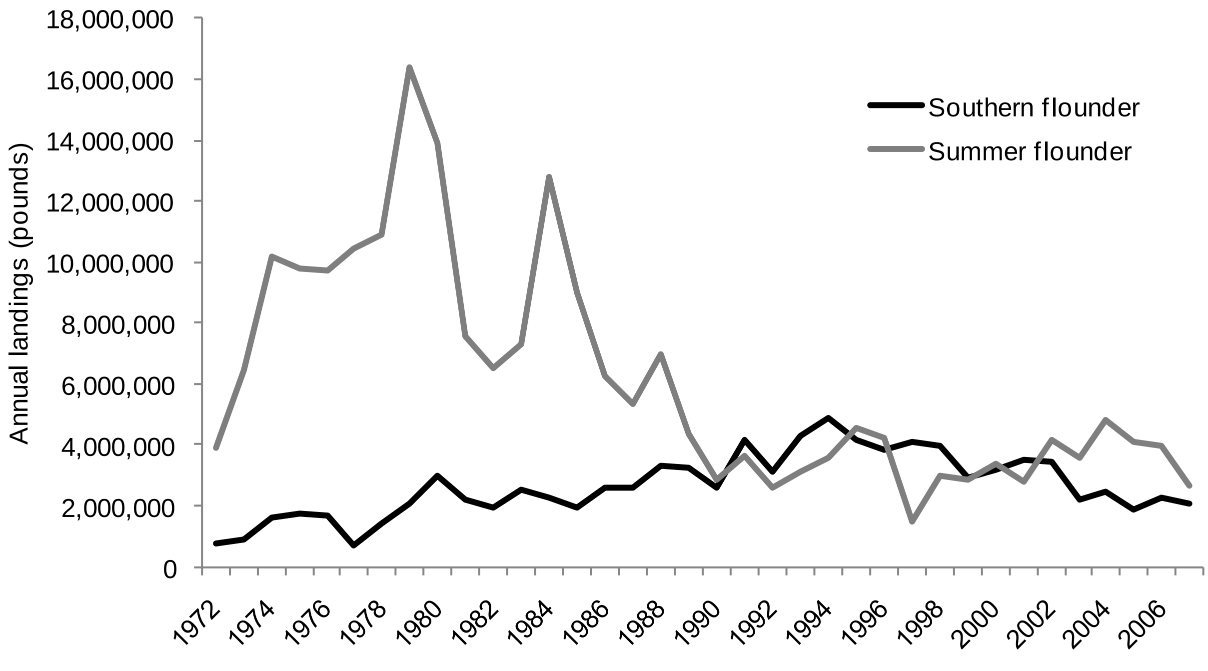


Figure 7.1 Annual commercial landings of southern and summer flounder, 1972-2007 (NCDMF Trip Ticket Program).

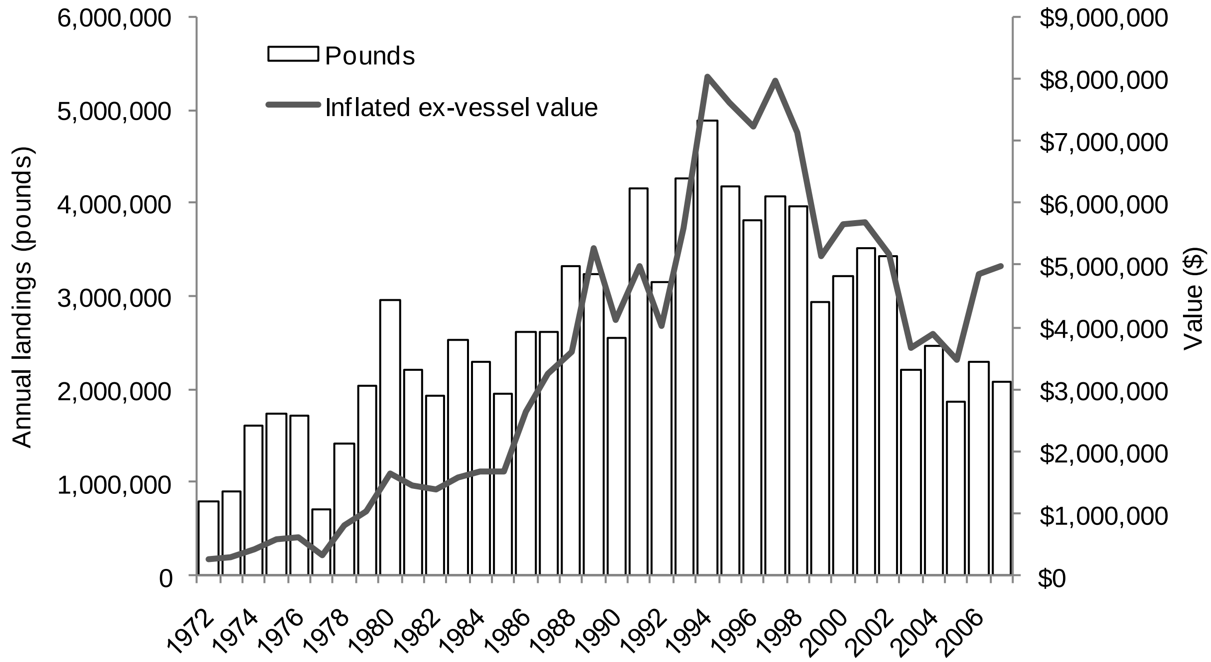


Figure 7.2 Annual commercial landings (pounds) and inflated ex-vessel value of southern flounder in North Carolina, 1972-2007 (NCDMF Trip Ticket Program).

Many of the regulations for commercial flounder fisheries prior to 2005 were imposed for the summer flounder fishery in the ocean and had very little impact on the southern flounder fishery in the estuaries (Takade-Heumacher and Batsavage 2009). On September 1, 1988, the minimum size limit for the commercial harvest of flounder in estuarine and ocean waters increased from 11 in to 13 inches. Escape panels of 5 ½ inch stretched mesh were required for flounder pound nets on October 2, 1998. Flounder pound nets in Albemarle Sound west of the Alligator River were exempt from this regulation. The 2005 Southern Flounder FMP implemented several regulations to prevent overfishing of southern flounder in North Carolina as means to produce long-term sustainable harvest of this species (NCDMF 2005). The target southern flounder commercial fishery regulations included the following:

- a 14-inch minimum size limit in estuarine waters, which began on April 1, 2005 through proclamation FF-19-2005;
- a closure period from December 1 to December 31, through a proclamation issued each year usually in November;
- a minimum mesh size of 5.5- inch stretched mesh for large mesh gill nets from April 15 through December 15, rule 15A NCAC 03J. 0103(a)(2) amended on September 1, 2005;
- a 3,000-yard limit on large mesh gill nets, rule 15A NCAC 03J .0103(i)(1) amended on September 1, 2005;
- the requirement of escape panels of 5.5-inch stretched mesh in pound nets in Albemarle Sound west of the Alligator River, rule 15A NCAC 03J .0501(e)(2) amended on September 1, 2005;
- a minimum distance between pound nets and gill nets, rule 15A NCAC 03J. 0103(d)(1); and
- a minimum distance between new and existing pound nets, rule 15A NCAC 03J. 0103(e)(3).

The 2005 Southern Flounder FMP also implemented a minimum tailbag mesh size of 4-inch stretched mesh in crab trawls in western Pamlico Sound to minimize bycatch of undersized southern flounder issued by proclamation SH-18-2005 on October 24, 2005. Additionally, the 2006 NCDMF Shrimp FMP closed upper portions of the Neuse, Pamlico and Pungo rivers to shrimp trawling to minimize southern flounder bycatch in this fishery and implemented a maximum combined 90 foot headrope length in the mouths of the Pamlico and Neuse rivers and all of the Bay River (Rules 15A NCAC 03R .0114 and 15A NCAC 03L .0102(c)(2)(3) amended July 1, 2006) (NCDMF 2006a).

7.1.3 ANNUAL LANDINGS AND VESSELS

Southern flounder are harvested year-round in the estuaries with peak landings from September to November (NCDMF 2005). Commercial landings of southern flounder averaged 3,320,610 pound from 1991 to 2007 with peak landings of 4,878,639 pounds in 1994 (Table 7.1 and Figure 7.2). Average commercial landings from 2003 to 2007 decreased to 2,177,891 pounds. Annual landings decreased to a low of 1,870,754 pounds in 2005. The number of vessels landing southern flounder from 1994 to 2007 has been in decline (Figure 7.3). Commercial landings accounted for an average of 89% of the total annual harvest of southern flounder in the state from 1991 to 2007 (Table 7.1).

Table 7.1 Annual proportions of commercial and recreational harvest (pounds) of southern flounder in North Carolina, 1991-2007.

Year	Commercial harvest	Percent total harvest	Recreational harvest	Percent total harvest	Total harvest
1991	4,163,374	93.83	273,674	6.17	4,437,048
1992	3,145,020	95.49	148,618	4.51	3,293,638
1993	4,272,368	97.43	112,812	2.57	4,385,180
1994	4,878,639	94.87	263,612	5.13	5,142,251
1995	4,166,966	94.70	233,238	5.30	4,400,204
1996	3,807,009	94.29	230,674	5.71	4,037,683
1997	4,076,793	90.31	437,234	9.69	4,514,027
1998	3,952,729	95.73	176,292	4.27	4,129,021
1999	2,933,331	94.98	155,010	5.02	3,088,341
2000	3,205,792	85.53	542,476	14.47	3,748,268
2001	3,522,136	89.17	427,822	10.83	3,949,958
2002	3,436,753	87.90	473,300	12.10	3,910,053
2003	2,198,503	83.21	443,614	16.79	2,642,117
2004	2,454,577	74.27	850,450	25.73	3,305,027
2005	1,870,754	71.76	736,202	28.24	2,606,956
2006	2,287,823	75.74	732,808	24.26	3,020,631
2007	2,077,798	73.93	732,618	26.07	2,810,416
Average	3,320,610	89.01	410,027	10.99	3,730,636

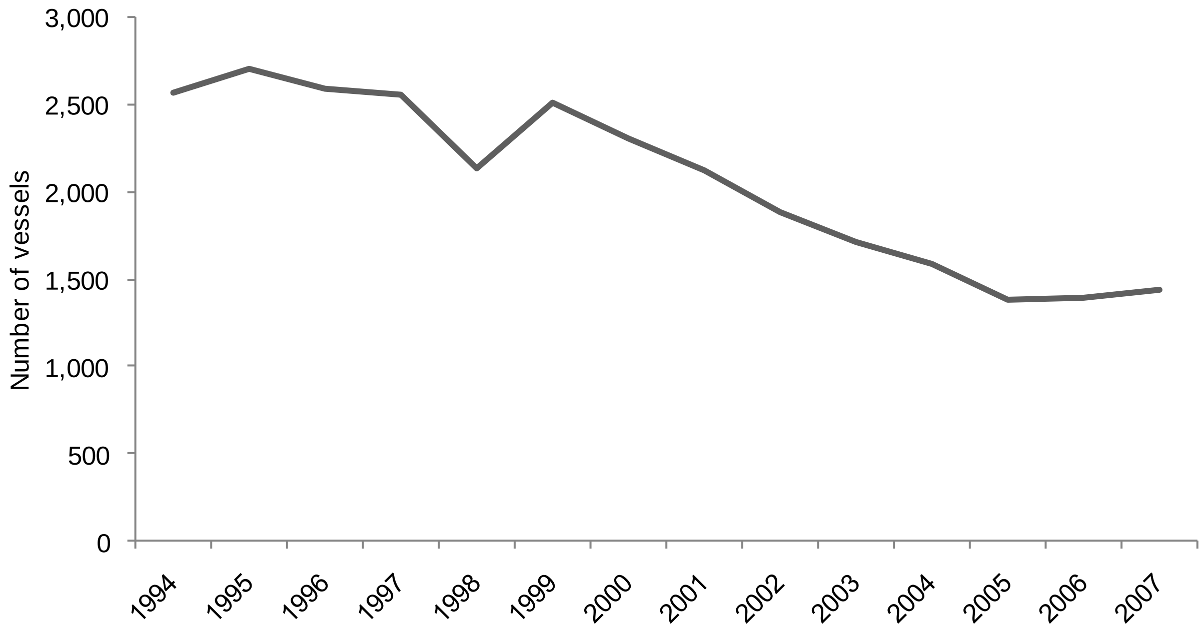


Figure 7.3 Number of vessels landing southern flounder in North Carolina by year, 1994-2007 (NCDMF Trip Ticket Program).

7.1.4 PRIMARY AREAS OF LANDINGS

The regional break down of the five main harvest areas for southern flounder include: Albemarle, Pamlico Sound, Rivers, Core Sound, and Southern (Table 7.2). The majority of the commercial landings of southern flounder in North Carolina have historically come from Pamlico Sound, Albemarle, and Core Sound areas (Figure 7.4). Across each decade Pamlico Sound accounted for 35% to 48% of the total landings (Figure 7.4). On average from 1972 to 2007, 43% of the total state landings of southern flounder came from Pamlico Sound. Core Sound accounted for 17%, Albemarle made up approximately 25%, the Rivers accounted for 8% and the Southern area accounted for the remaining 7% of the total landings for all years combined. The harvest of southern flounder from the Albemarle area increased in the last 18 years, accounting for 32% to 36% from 1990 to 1999 and from 2000 to 2007, respectively, whereas in 1972 to 1979 the Albemarle region only accounted for 8% of the total commercial harvest of southern flounder in the entire state (Figure 7.4). In the 1970s time period Core Sound accounted for 38% of the entire state landings, but from 2000 to 2007 comprised only 11% of the total landings in the state.

Table 7.2 Water bodies considered within each region designation (NCDMF Trip Ticket Program).

Areas	Included water bodies
Albemarle	Albemarle Sound, Alligator River, Chowan River, Croatan Sound, Currituck Sound, Pasquotank River, Perquimans River, Roanoke River, and Roanoke Sound
Pamlico Sound	Pamlico Sound
Rivers	Bay River, Neuse River, Pamlico River, and Pungo River
Core Sound	Core Sound
Southern	Bogue Sound, Cape Fear River, Inland Waterway, Inland Waterway (Brunswick), Inland Waterway (Onslow), Lockwood Folly River, Masonboro Sound, New River, Newport River, North River/Back Sound, Shallotte River, Stump Sound, and Topsail Sound

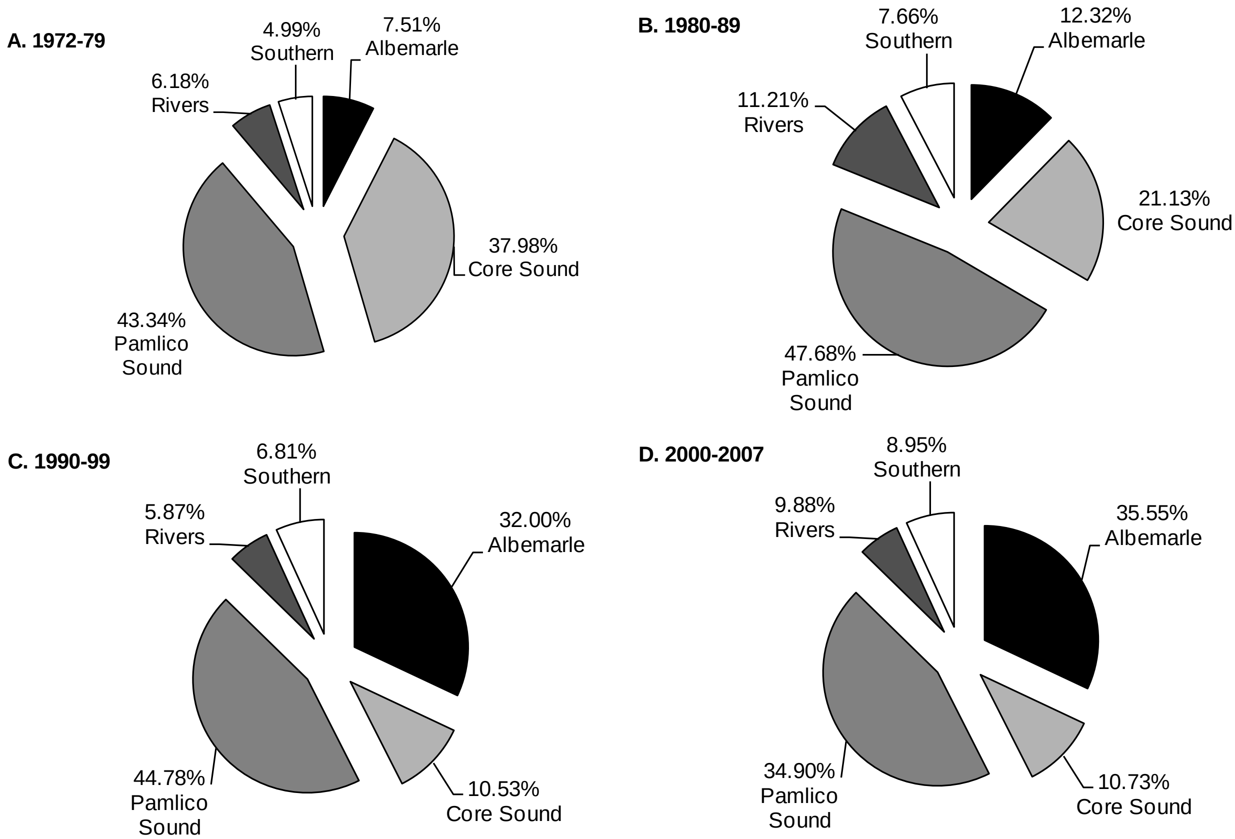


Figure 7.4 Percentage of southern flounder total landings by area for each decade. A. 1972-1979, B. 1980-1989, C. 1990-1999, and D. 2000-2007 (NCDMF Trip Ticket Program).

7.1.5 SEASONAL HARVEST AND EFFORT

The majority of the harvest and effort in the commercial southern flounder fishery in North Carolina begins around March or April, as the fish are moving into the sounds and estuaries from offshore, and remain moderate throughout the summer months (Figure 7.5). During September through November landings and effort peak, particularly in the pound net and gill net fisheries as the fish start to migrate through the sounds and estuaries to spawn offshore. On average from 1994 to 2007, 5% of the commercial landings of southern flounder have occurred in June, 6% in July, 8% in August, 18% in September, 33% in October, 19% in November, and 11% during the remaining months combined (January through May, and December).

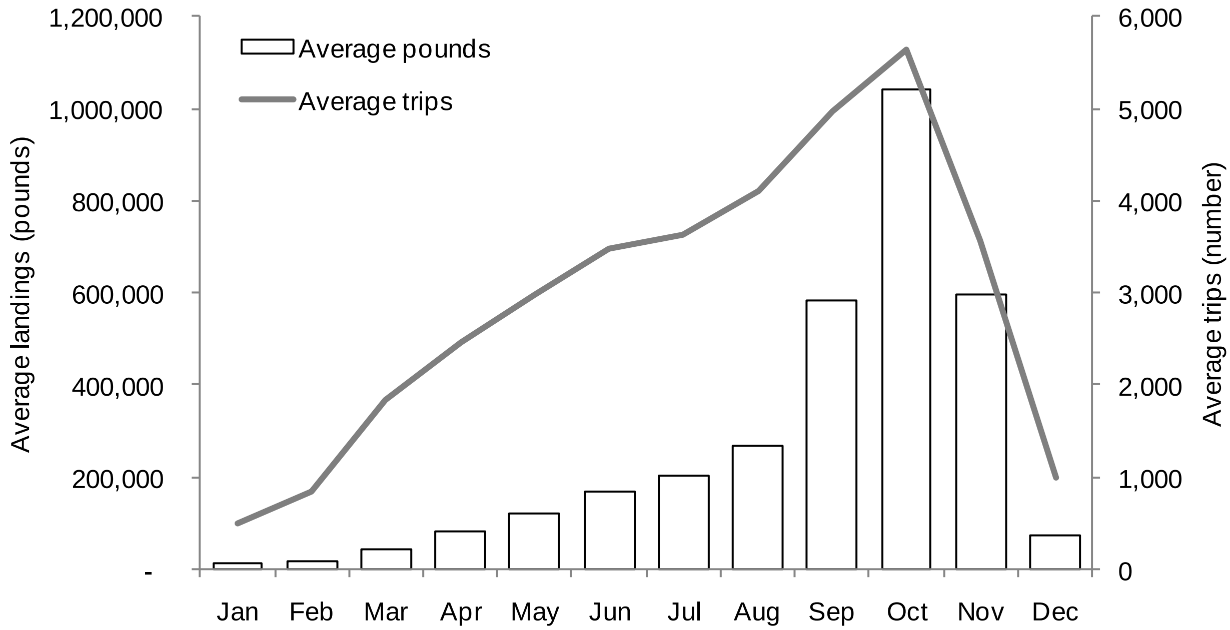


Figure 7.5 Average monthly commercial landings and number of southern flounder trips in North Carolina, 1994-2007 (NCDMF Trip Ticket Program).

7.1.6 INCIDENTAL AND DISCARDED CATCH IN THE COMMERCIAL FISHERY

Characterizing the nature and extent of bycatch has proven difficult. The North Carolina Marine Fisheries Commission adopted a policy in November 1991 directing the NCDMF to establish the goal of reducing bycatch to the absolute minimum and incorporates that goal into actions. Bycatch is defined as “the portion of a catch taken incidentally to the targeted catch because of non-selectivity of the fishing gear to either species or size differences” [Atlantic States Marine Fisheries Commission (ASMFC) 1994]. Bycatch can be divided into two components: incidental catch and discarded catch. Incidental catch refers to retained catch of non-targeted species. Discarded catch is that portion of the catch returned to the sea as a result of economic, legal, or personal considerations.

The difficulties in estimating bycatch are generally attributed to inadequate monitoring of actual bycatch levels, effort of the directed fishery, distribution of the bycatch species, and the mortality rate of the discarded species. The problem is exacerbated by the patchy distribution of effort and species abundance in both time and space. Additionally, available effort data are often inadequate. Although research indicates that tow duration or soak time is often a significant factor when estimating bycatch losses, the NCDMF Trip Ticket Program records effort data by trip without any accompanying information on tow duration, soak time, or the number of tows or sets made during a trip. Mortality of bycatch captured in commercial gear varies by species, in addition to tow time or soak time, water temperature, fishing location, and gear configuration.

The lack of reliable discard estimates has not stopped researchers from investigating impacts on fish stocks, but it has prevented increased precision. Most stock assessments address the range of bycatch through sensitivity analyses by comparing basic assessment results over the range of bycatch estimates and assumptions. If none of the results seems plausible, the assessment may proceed without the bycatch estimates included but with the caveat that results may be biased or contain additional uncertainties due to unknown levels of missing catch.

The 2009 southern flounder stock assessment estimated an annual discard mortality rate of 17.3% for regulatory discarded southern flounder in the commercial estuarine gill net fishery (Takade-Heumacher 2009). Discard estimates were calculated in the commercial estuarine gill net fishery from the NCDMF gill net observer data based on at sea sampling. The underlying assumptions are that the observer data is representative of the commercial estuarine gill net fishery, all marketable, legal sized southern flounder were kept, and the discard mortality rates remained constant. There was insufficient data for estimating southern flounder regulatory discards in other fisheries such as the pound net, gig, crab pot, and shrimp trawl fisheries for the 2009 stock assessment. Further calculation and discussion of the 2009 stock assessment estimates are described in Appendix 13.5: Stock Status of North Carolina Southern Flounder (*Paralichthys lethostigma*).

Incidental bycatch of other species, such as striped bass and red drum, in the target southern flounder fisheries has been addressed in other FMPs by gear type (NCDMF 2004b; NCDMF 2008b). Non-target southern flounder fisheries, such as shrimp trawls and crab trawls have had rule changes from the 2006 Shrimp FMP and 2005 Southern Flounder FMP, respectively to minimize bycatch of undersized southern flounder. Crab trawls are required to have a minimum tailbag mesh size of 4-inch stretched mesh in western Pamlico Sound (NCDMF 2005). Shrimp trawls are no longer allowed in the upper portions of the Neuse, Pamlico and Pungo rivers and shrimp trawls are also limited to a maximum combined 90-foot headrope length in the mouths of the Pamlico and Neuse rivers and all of Bay River (NCDMF 2006a).

7.1.7 MAJOR GEARS USED IN THE COMMERCIAL FISHERY

In North Carolina, commercial pound nets, estuarine gill nets, and gigs collectively account for an average of 86% of the total commercial landings of southern flounder from 1972 to 2007, and 96% during the last eight years of the time series (Figure 7.6). Due to the magnitude of the influence of these three gears on the commercial harvest of the species, each fishery will be examined in detail. The gears that contribute to the remainder of the commercial landings from 1972 to 2007 primarily include: crab trawls, haul seines, crab pots, and shrimp trawls (Figure 7.6).

Southern flounder landings from the estuarine gill net fishery have increased from 13% of the commercial harvest in from 1972 to 1979 to 63% of the total southern flounder harvest in the state from 2000 to 2007 (Figure 7.6). Pound net landings showed the opposite trend during the same time periods with landings accounting for 64% of the total southern flounder harvest from

1972 to 1979 and decreasing to 31% of the total southern flounder harvest during the 2000 to 2007 time series (Figure 7.6). In the 1980s crab trawls and shrimp trawls accounted for a combined 27% of all the southern flounder landings in the state, but due to regulatory changes in the more recent years (2000 to 2007), crab trawls and shrimp trawls combined accounted for less than 2% of the total southern flounder landings in the state (Figure 7.6). Southern flounder are also incidentally landed by a variety of other commercial gears.

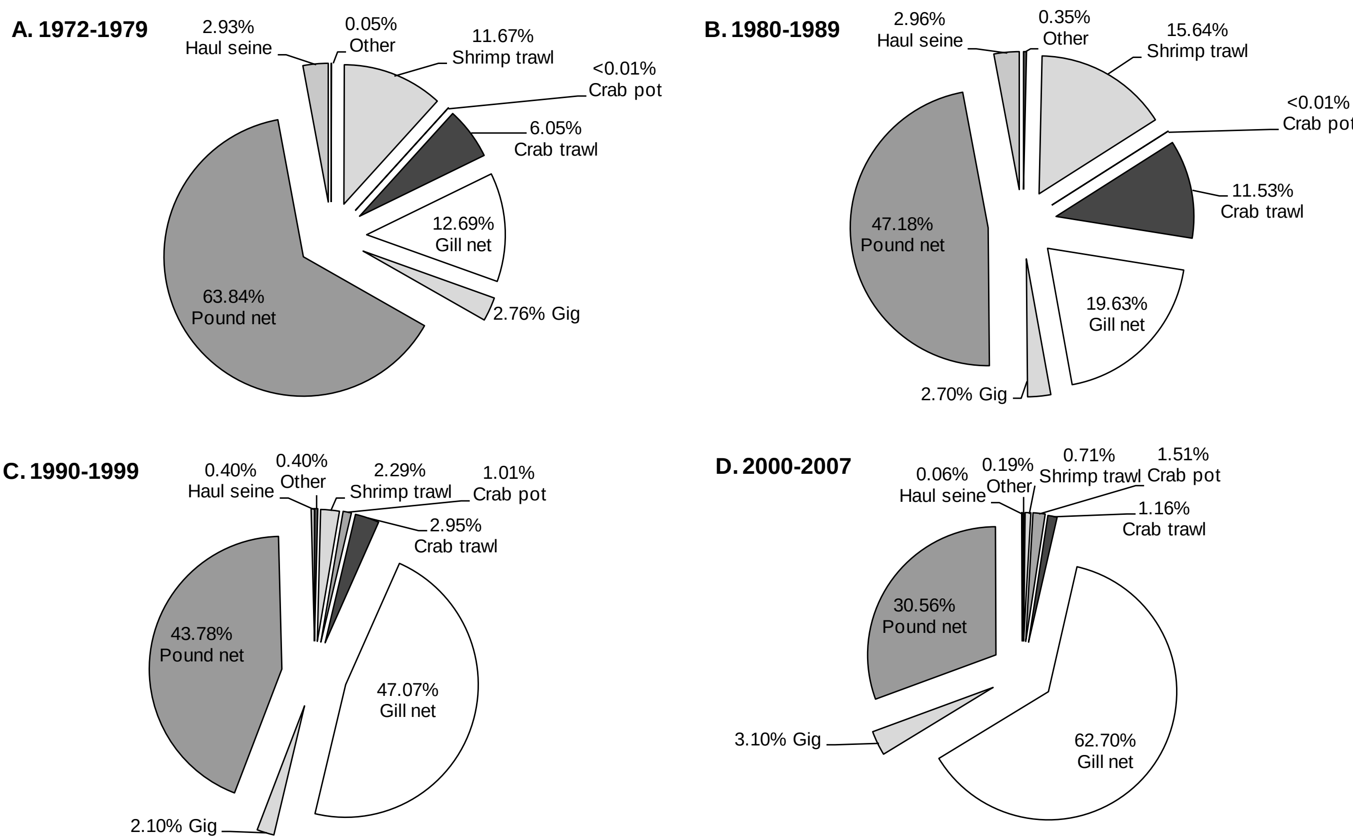


Figure 7.6 Commercial gears used to catch southern flounder in North Carolina by decade. A. 1972-1979, B. 1980-1989, C. 1990-1999, and D. 2000-2007. (NCDMF Trip Ticket Program).

Several different pound net fisheries occur in North Carolina including the bait (Atlantic menhaden (*Brevoortia tyrannus*)) and sciaenid (weakfish (*Cynoscion regalis*) and Atlantic croaker (*Micropogonias undulatus*)) and flounder pound net fisheries. Of these, the flounder pound net fishery accounts for the vast majority of the southern flounder landings from pound nets (Batsavage 2007). Southern flounder pound net landings are the total southern flounder harvested from the combined pound net fisheries. Flounder pound nets are set in the late summer and fall to target paralichthid flounders as they migrate from the estuaries to the ocean. The pound net fishery harvested the majority of southern flounder until 1995 when the estuarine gill net fishery became the predominant fishery (Figure 7.7) (NCDMF 2005).

7.1.7.1 POUND NETS

The pound net fishery in North Carolina was historically the predominate fishery for catching southern flounder, reaching its peak in pounds landed between 1988 and 1996 (Figure 7.7). However, landings of flounder within the commercial estuarine gill net fishery began to rise in the late 1980s and early 1990s, and as of 1995, commercial estuarine gill nets have surpassed pound nets for yielding the highest annual landings of the species (Figure 7.7).

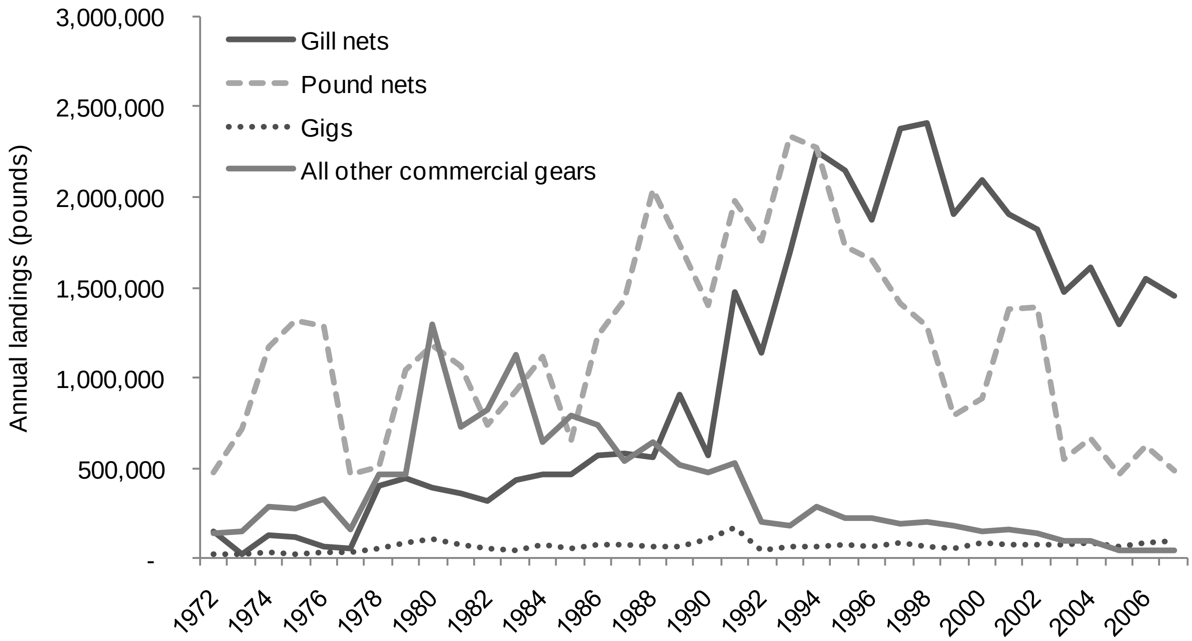


Figure 7.7 Annual commercial landings of southern flounder in North Carolina by pound nets, estuarine gill nets, gigs and all other gears combined, 1972-2007 (NCDMF Trip Ticket Program).

Participation in the pound net fishery has been in decline since the mid-1990s (Table 7.3). Table 7.3 takes numbers for 1995 to 2003 directly from the 2005 Southern Flounder FMP because of inaccuracies within the database to replicate these numbers. The numbers generated for the table from 2004 to 2007 were taken directly from the Fisheries Information Network (FIN) database removing duplicates caused by transfers to a new permit holder and duplicates showing one permit holder with two net types (Flounder and Flounder/Bait) within the same year. As of 1995, there were approximately 394 active flounder pound net permits. By 2007, this number had decreased to 145, the lowest in the recorded data time series. Both Carteret and Dare counties hold the most active pound net permits in the state. Both counties have shown a decline in the most recent year to about 38% of the original number of active pound net permits in 1995. The same trend can be seen in the number of trips made within the fishery. In 1994, there were 4,596 trips made by pound netters landing southern flounder (Figure 7.8). The number of trips has declined since then to as low as 1,219 trips in 2003. This decline was due in part to the expenses required to purchase and maintain a pound net, which can be fished in only one location, verses an estuarine gill net which can be moved to areas of high flounder concentration and are comparably less expensive. Also in more recent years, the December closure, from the 2005 Southern Flounder FMP and hurricanes have likely added to the reduction in trips from the pound net fishery. However, 2001 and 2002 saw a slight resurgence in the pound net fishery with 2,345 and 2,484 trips made, respectively (Figure 7.8).

Table 7.3 The number of active flounder commercial pound net permits within each county, 1995-2007. Data directly reported from 1995-2003 from the Southern Flounder 2005 FMP and 2004-2007 from the FIN database.

County	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Beaufort		1	2	2	2	2	3	2	2	2	1	1	
Camden	3	3	2	2	2	2	2	2	1	1	2	2	1
Carteret	238	224	220	216	215	197	163	145	140	115	108	98	90
Craven	1	1	1	1	1	1	1		1				
Currituck	12	11	11	10	11	10	7	9	9	9	9	9	10
Dare	75	73	70	69	70	72	70	64	59	36	27	25	28
Hyde	50	52	55	53	54	53	51	44	44	22	23	15	14
Pasquotank	2	2											
Perquimans	1	1			1	3	3	2	2				
Tyrell	12	12	12	11	11	11	12	11	11	8	7	4	2
Total	394	380	373	364	367	351	312	279	269	193	177	154	145

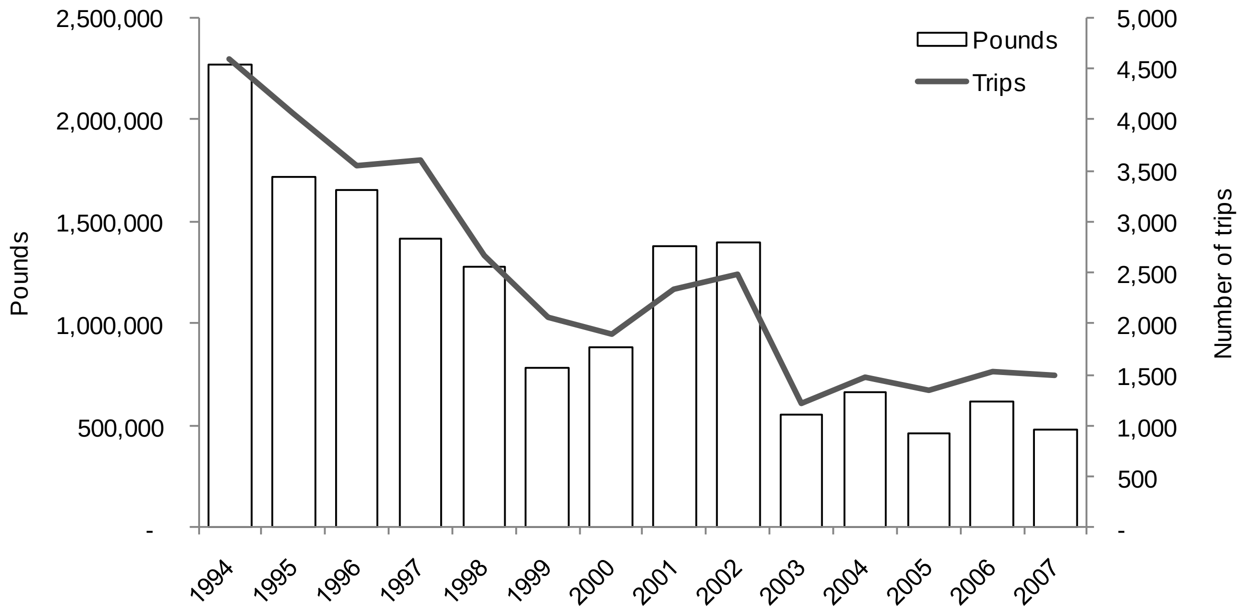


Figure 7.8 Annual commercial pound net landings and trips, 1994-2007 (NCDMF Trip Ticket Program).

The flounder pound net fishery in North Carolina occurs primarily during September through November, with October being the peak month of the fishery (Figure 7.9). Pound nets typically catch the flounder as they are migrating out of the estuaries to spawn offshore, and the higher catches usually occur following periods of high winds or storm events.

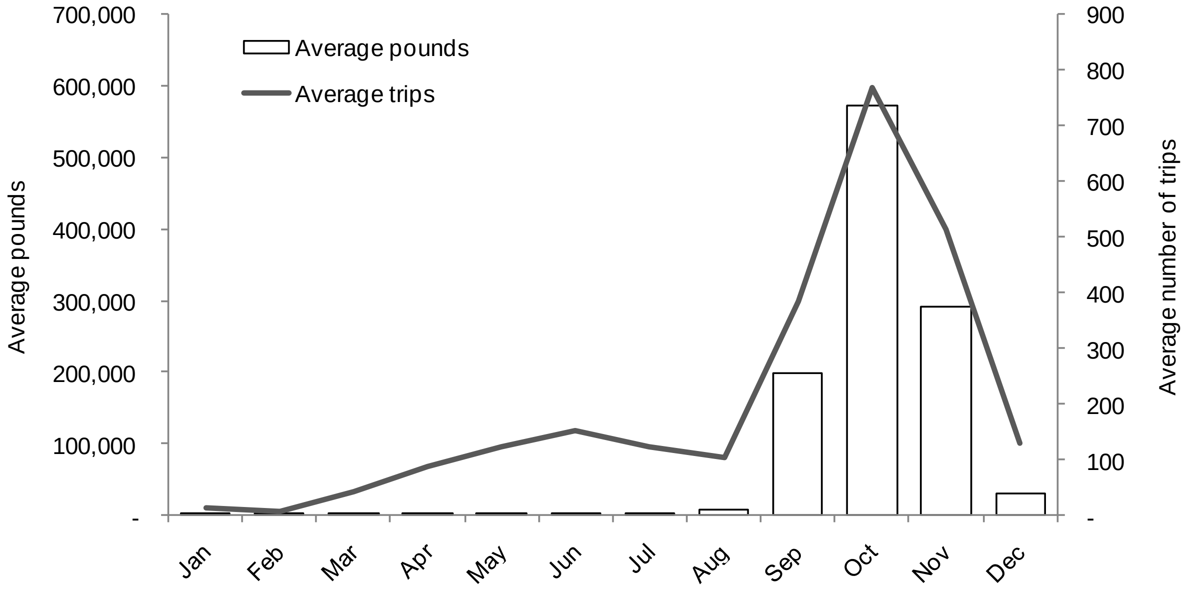


Figure 7.9 Average southern flounder landings (pounds) and average number of trips by month in commercial pound nets, 1994-2007 (NCDMF Trip Ticket Program).

During the 1970s, the landings of southern flounder from pound nets were split between Core and Pamlico sounds, at 47% and 41%, respectively (Figure 7.10). However, in the 1980s to the present, Pamlico Sound (51% to 64%) has accounted for the majority of the landings. During that same period, landings from the Albemarle Sound area pound nets also increased to levels rivaling that of Core Sound.

With the majority of the pound net landings of southern flounder coming from Core and Pamlico sounds, it follows that on average 54% (annual average 1972 to 2007) of these fish are sold in Carteret County, which is bordered by both bodies of water. The remaining landings in the fishery are primarily split between Dare (26%, annual average 1972 to 2007) and Hyde (12% annual average 1972 to 2007) counties.

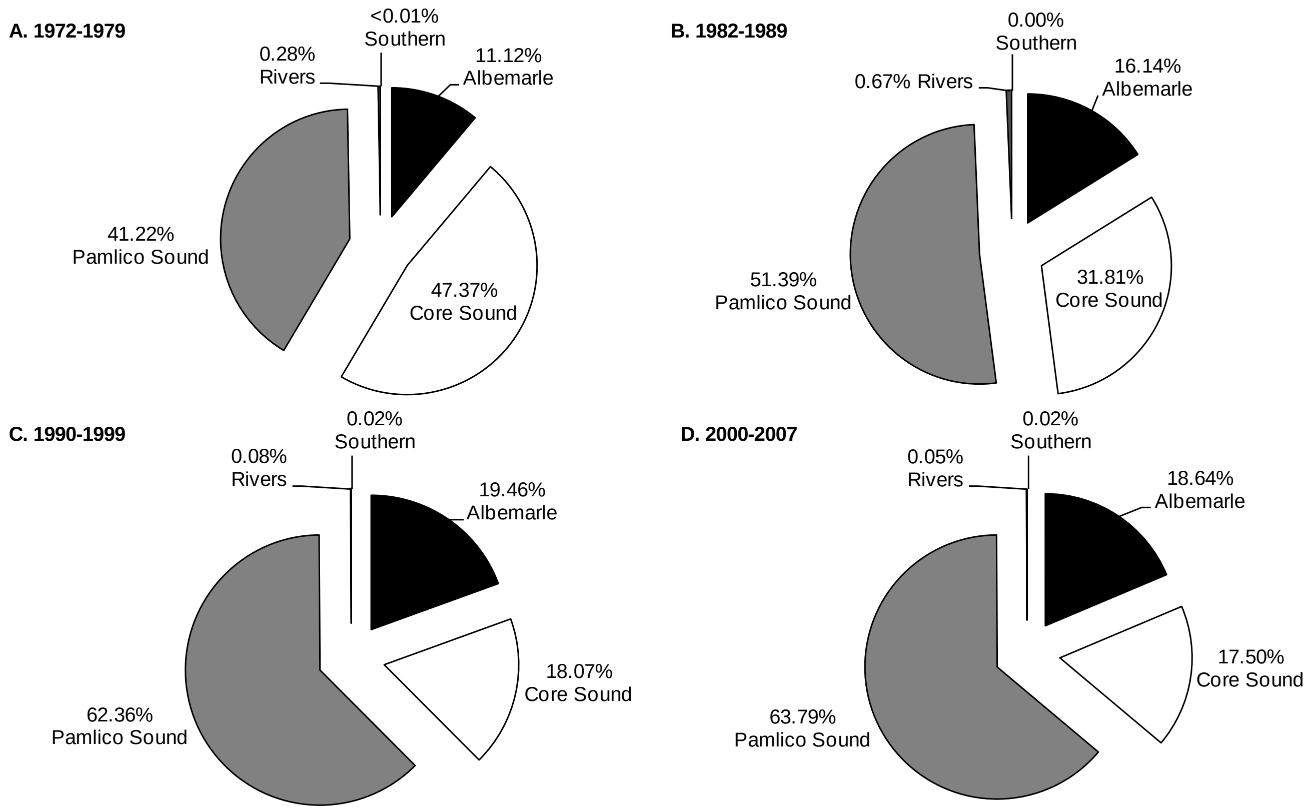


Figure 7.10 Percentage of southern flounder total landings in commercial pound nets by area for each decade. A. 1972-1979, B. 1980-1989, C. 1990-1999, and D. 2000-2007 (NCDMF Trip Ticket Program).

Comprehensive biological sampling of the flounder pound net fishery by intercepting the fishermen as they unload their catch at the dock began in 1989. Area designation for the biological samples was separated in the same manner as in the trip ticket program (Table 7.2).

Flounder pound net sampling occurs primarily from September to December and catches are sampled throughout the range of the fishery from Albemarle Sound to Core Sound. The annual number of southern flounder measured from the flounder pound net fishery ranged from 2,639 fish in 2003 to 8,198 fish in 1992 (Takade-Heumacher and Batsavage 2009). The length frequency distributions are shown for the period from 1991 to 2004 when the minimum size limit for southern flounder remained at 13 inches. In April 2005, the minimum size limit for southern flounder was changed to 14 inches in conjunction with the 2005 Southern Flounder FMP. This fishery catches a wide size range of southern flounder (Figure 7.11). Modal size classes vary by year and by area, which are partly a result of dominant year classes and spatial distribution of southern flounder during different life history stages. The number of samples collected and size ranges of fish sampled per year has fluctuated due to varying sampling intensity and fishing effort.

Undersized flounder were seen during both time periods in pound nets before and after the size limit increase in all areas, but comprised a greater proportion of the catches from 2005 to 2007 (Figure 7.11). The undersized southern flounder in the pound net fishery could be the result of inadequate gear modifications for the minimum size limit, insufficient enforcement of the minimum size limit, strong year classes entering the fishery or a combination of these factors. The dominant size class for Core Sound and the Albemarle area from 1991 to 2004 was right at the 13-inch minimum size limit and at 16-inches in Pamlico Sound. The maximum sizes of southern flounder were as large as 29 inches in the Albemarle area and 30 inches in Pamlico and Core sounds from 1991 to 2004 (Figure 7.11). The dominant size class for southern flounder in the 2005 to 2007 time period in the Albemarle area and Pamlico Sound was 15-inches with a maximum length at 25 inches and 23 inches, respectively (Figure 7.11). The dominant size class for southern flounder in Core Sound was at the minimum size limit of 14 inches for the 2005 to 2007 time period (Figure 7.11).

Bycatch in the pound net fishery was addressed in the 2005 Southern Flounder FMP in the issue paper titled, 13.1.18 Bycatch in the Flounder Pound Net Fishery (NCDMF 2005). Non-marketable bycatch in flounder pound nets is rarely seen because it is typically discarded at sea. The 2005 Southern Flounder FMP recommended to implement a minimum 5½-inch stretched mesh on escape panels in flounder pound nets coast wide to decrease the number of undersized flounder and other species of fish in the nets.

Sea turtles are usually caught alive in pound nets and in the past this gear has been used by the National Marine Fisheries Service to conduct tagging studies and capture valuable biological data (NCDMF 2005). Sea turtles in pound nets will be discussed further in the issue paper "10.8 Incidental Capture of Protected Species in the Southern Flounder Large Mesh Gill Net and Pound Net Fisheries".

Marine mammals have not been documented in pound nets in the U.S. Mid-Atlantic multispecies pound net fishery (Federal Register 2008). Each year under section 118 of the Marine Mammal Protection Act (MMPA) the NMFS must publish, at least annually, a List of Fisheries that places U.S. commercial fisheries into categories based on the level of incidental serious injury and mortality of marine mammals that occur in each fishery (NCDMF 2005). Pound nets in 2009 are listed as a Tier 2, Category III fishery, which includes fisheries that have an annual mortality and serious injury impact to a marine mammal stock less than or equal to 1 percent of the Potential Biological Removal level (Federal Register 2008). This issue was discussed further in the 2005 Southern Flounder FMP in the issue paper titled, "13.1.8 Bycatch in the Flounder Pound Net Fishery" and there is no new information to add at this time.

Although little research has documented the subject, shore birds can get caught in the webbing of flounder pound net stands. Brown pelicans like to perch on the top lines of the nets, and can be seen diving on fish within the pound. Double crested cormorants, common and red throated loons, and pied-billed grebe, are all non-endangered species that occur in inshore waters and have been captured in gill nets (Darna 2000; Rose 2000). It is possible that flounder pound nets could catch these same species.

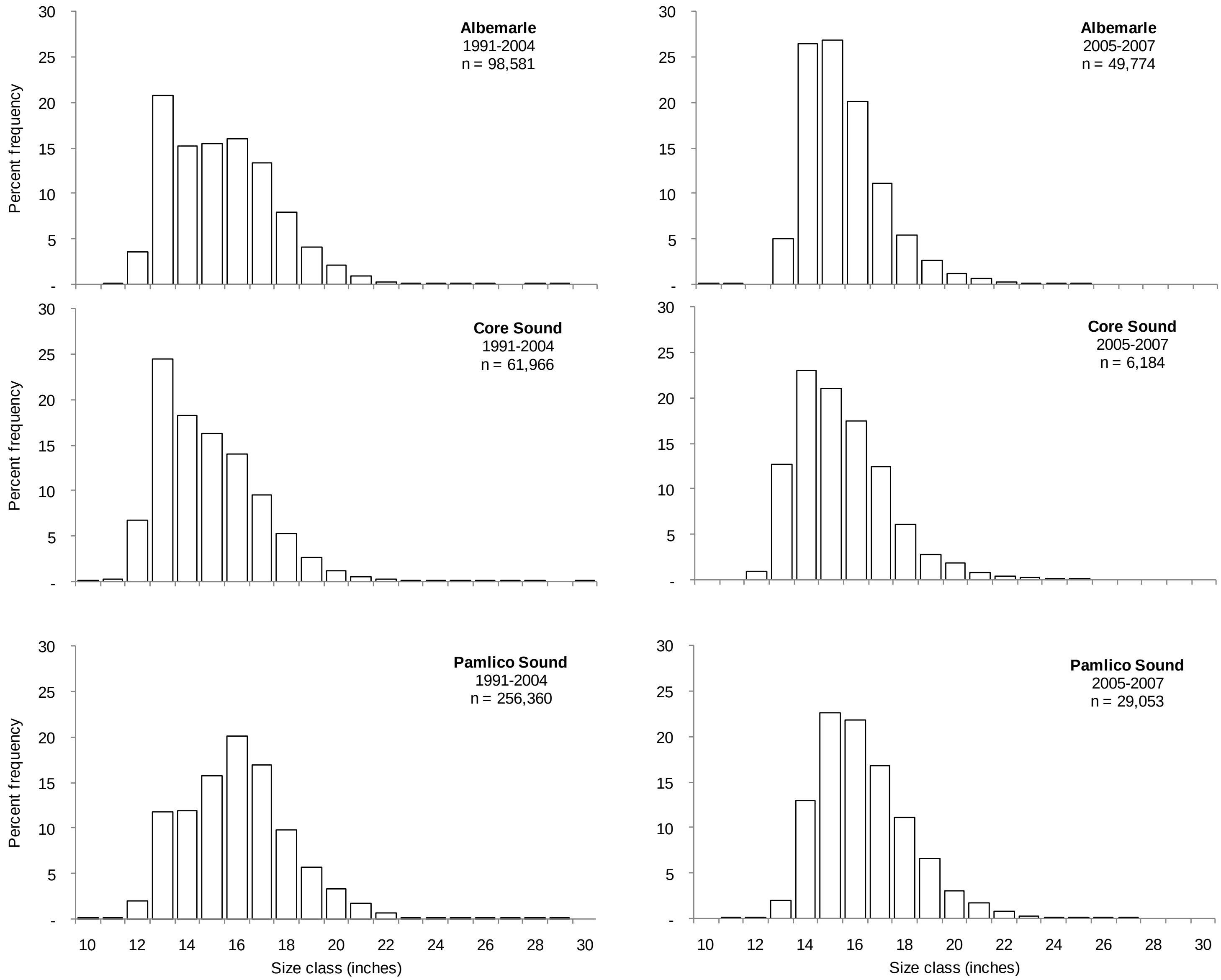


Figure 7.11 Percent size class frequency (inches) of southern flounder in commercial pound nets by area. Left side graphs from 1991 to 2004 during the 13-inch minimum size limit and right side graphs from 2005 to 2007 during 14-inch minimum size limit (NCDMF Biological Database).

7.1.7.2 GILL NETS

Landings of southern flounder in the commercial estuarine gill net fishery in North Carolina were historically low until the early 1990s when the summer flounder fishery began to decline and demand increased for southern flounder (Figure 7.1). During this time, anecdotal reports from fishermen and dealers indicated an influx of commercial gill net fishermen from Florida following the prohibition of gill nets in 1995 in their waters. Commercial estuarine gill nets quickly became the dominant gear landing southern flounder, surpassing all other gears, including pound nets (Figure 7.7). Since 1998 both landings and number of trips in the commercial estuarine gill net fishery have declined (Figure 7.12).

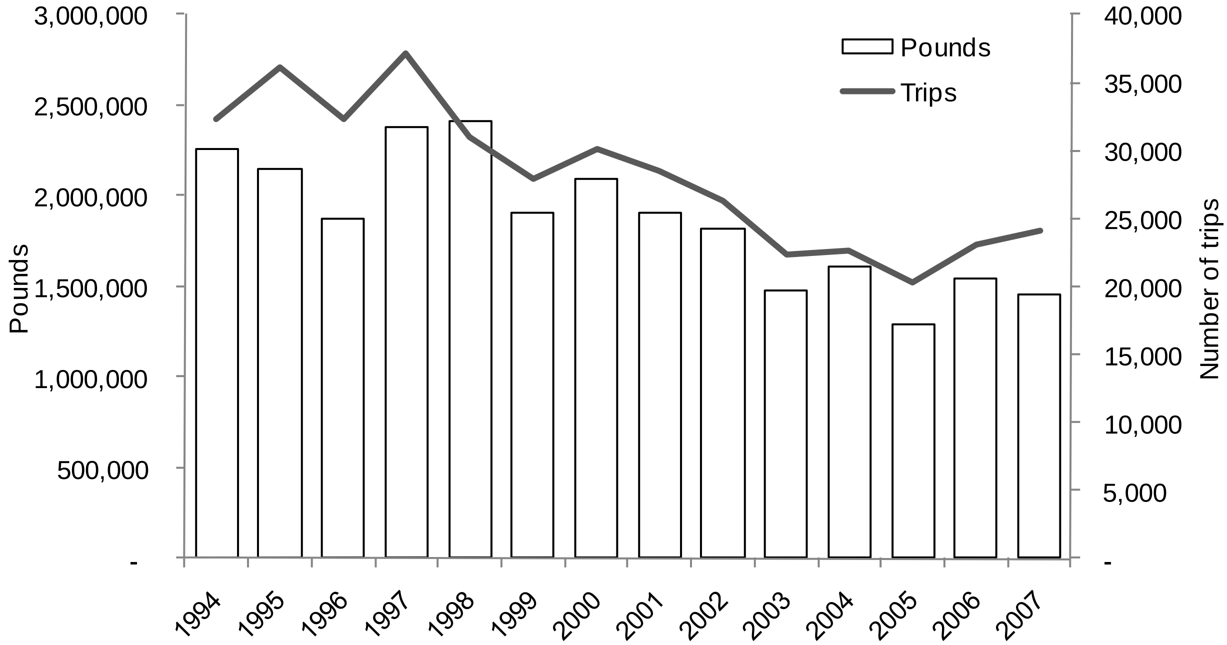


Figure 7.12 Annual commercial estuarine gill net landings and trips, 1994-2007 (NCDMF Trip Ticket Program).

Sea turtle strandings in the southeastern portion of Pamlico Sound increased significantly in November 1999. Deep-water large mesh gill nets were suspected of being responsible for most of the strandings. The National Marine Fisheries Service (NMFS) issued an emergency rule closing that portion of Pamlico Sound to the use of commercial gill nets larger than five-inch stretched mesh to protect endangered and threatened sea turtles. In 2000, the NCDMF required permits for all fishermen who participated in this fishery and allowed them to set a maximum of 2,000 yd of large ($\geq$ 5 ½ inch stretch) mesh gill net in what is now known as the Pamlico Sound Gill Net Restricted Area (PSGNRA). This restriction represented a 37% reduction in the amount of gill net set by fishermen in this area (NCDMF 2004a). In 2007, NCDMF closed deepwater areas of Pamlico Sound on September 1, 2007 through December 15, 2007 and areas of the PSGNRA were closed because of excessive green sea turtle takes from November 15, 2007 to December 15, 2007. Sea turtles in gill nets will be discussed further in the issue paper "10.8 Incidental Capture of Protected Species in the Southern Flounder Large Mesh Gill Net and Pound Net Fisheries".

Effort and southern flounder landings within the commercial estuarine gill net fishery begins to intensify around April (Figure 7.13). As with the flounder pound net fishery, landings and effort in the gill net fishery peak from September to October as the fish are migrating to ocean waters to spawn. Participation in the gill net fishery increases toward the peak of the season, as well, with more vessels becoming involved in the fishery (Figure 7.14). Following the peak, both landings and effort decline rapidly as the fish move offshore and are no longer available to the fishery.

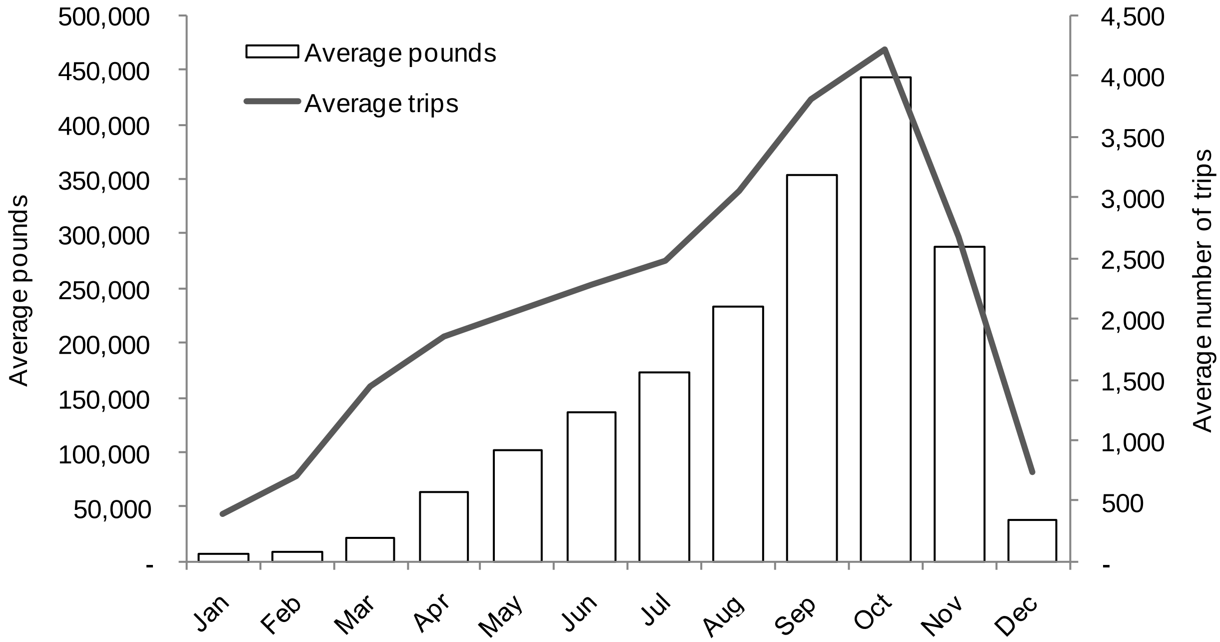


Figure 7.13 Average southern flounder landings (pounds) and average number of trips by month in commercial estuarine gill nets, 1994-2007 (NCDMF Trip Ticket Program).

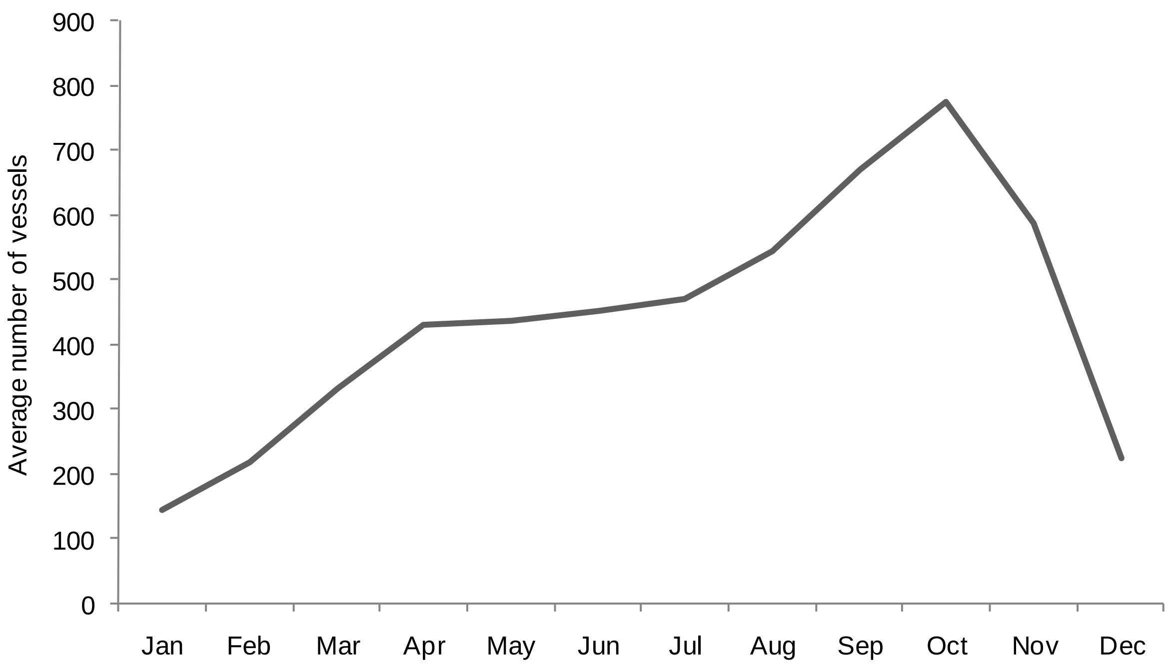


Figure 7.14 Average number of vessels with catches of southern flounder in the commercial estuarine gill net fishery by month, 1994-2007 (NCDMF Trip Ticket Program).

During the 1970s, landings of southern flounder from commercial estuarine gill nets were evenly split between Core Sound and the Southern area of the state and Pamlico Sound and the Rivers (Figure 7.15). However, in the 1980s there was a shift in landings to the Albemarle area and Pamlico Sound with 21% and 27% of the total landings coming from each of these two regions. Since the 1990s the Albemarle area is the dominant area of landings for southern flounder from estuarine gill nets (Figure 7.15).

Most of the southern flounder caught in gill nets are sold in Dare, Pasquotank and Carteret counties (52% combined average from 1972-2007). Dare County exhibited the highest landings of southern flounder across the time series (25%) with an increase occurring in the mid-1990s and remaining steady in more recent years. Pasquotank County exhibited a sharp rise in landings between 1991 and 1994, but has had declined in landings since then. Other counties contributing significantly to the landings include Hyde, Pamlico, Beaufort, and Onslow counties.

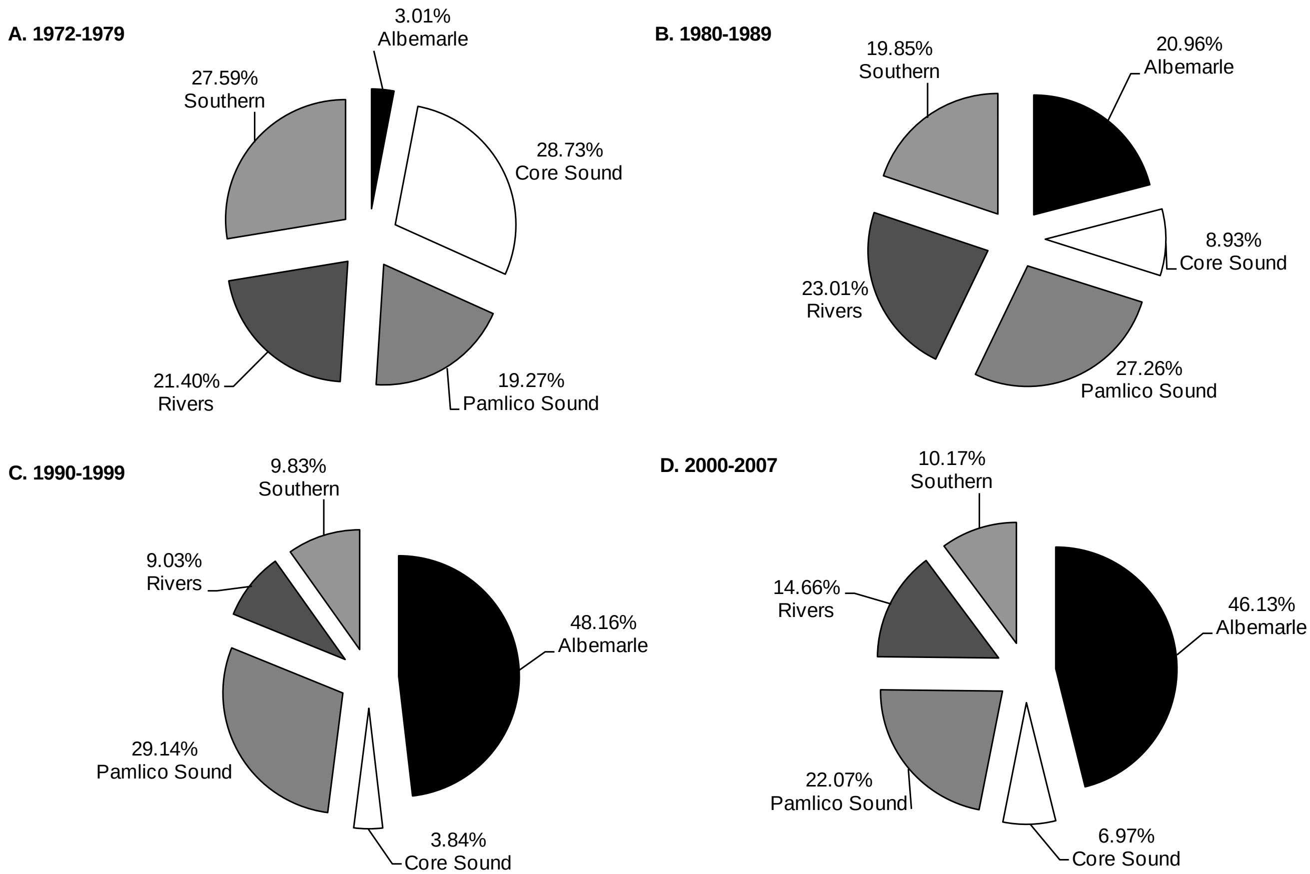
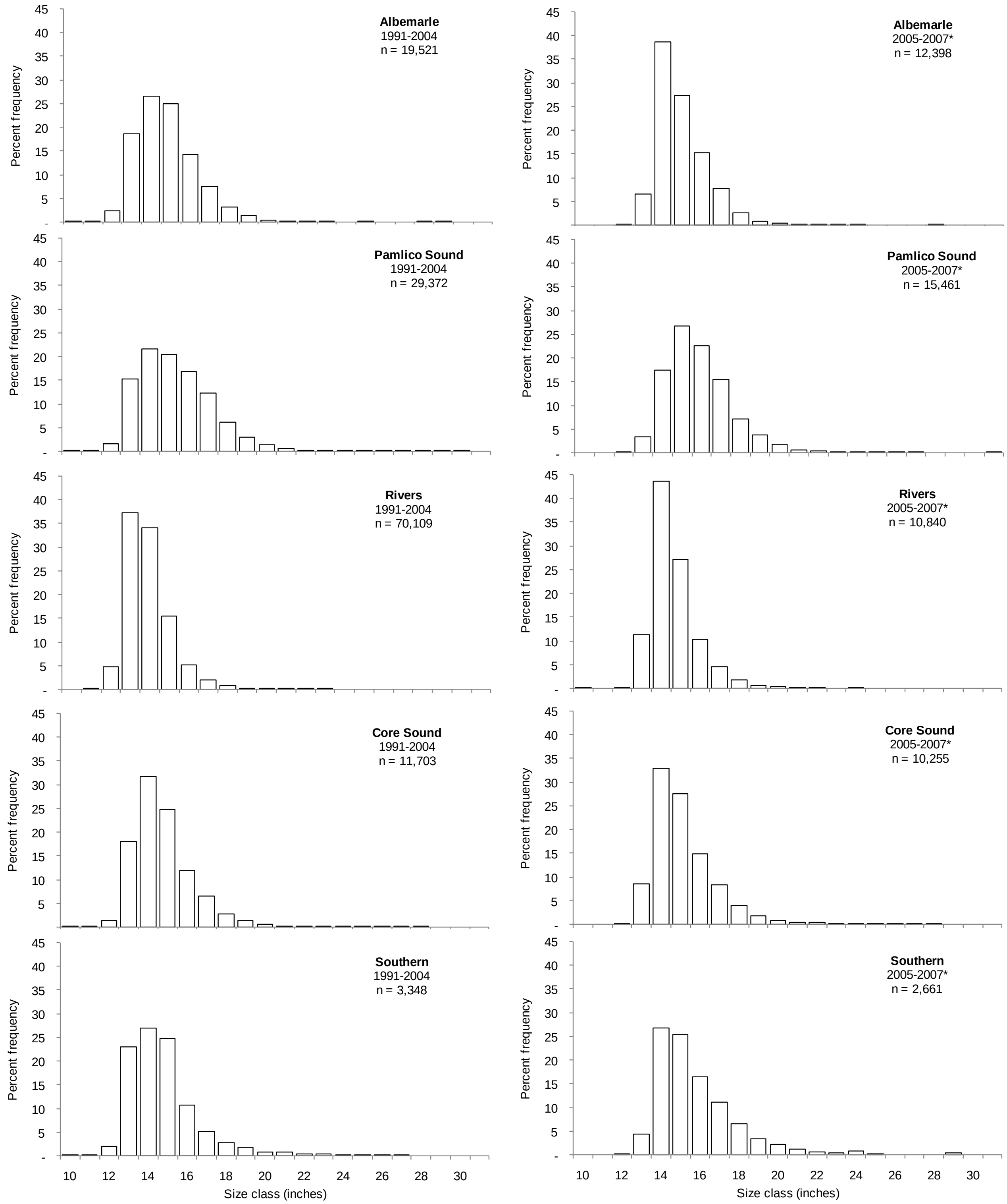


Figure 7.15 Percentage of southern flounder total landings in commercial estuarine gill nets by area for each decade. A. 1972-1979, B. 1980-1989, C. 1990-1999, and D. 2000-2007 (NCDMF Trip Ticket Program).

The commercial estuarine gill net sampling program began in 1991 and occurs year-round throughout the state with variable degrees of sampling intensity in different areas and times of the year. Samples of southern flounder come from both small (less than 5-inch stretched mesh) and large mesh (5-inch stretched mesh and greater) catches, but the majority of the samples come from large mesh catches (target fishery). The number of southern flounder samples is higher during the latter part of the year (July-December) when the fishery is more active. The annual number of southern flounder measured from the commercial estuarine gill net fishery ranged from 2,673 fish in 1992 to 12,611 fish in 2007 (Takade-Heumacher and Batsavage 2009).

The majority of the southern flounder in commercial estuarine gill net samples from 1991 to 1994 were from western Pamlico Sound and the Pamlico River catches. The size ranges of fish sampled were not as broad during these years because the catches from these areas were mostly comprised of younger, smaller southern flounder. Sampling intensity in other areas of the state increased during the late 1990s. Sampling in Core Sound began in 1996, and catches were sampled more frequently after 1998. The collection of samples from the southern counties (Onslow, Pender, New Hanover, and Brunswick) began in 1998.

The dominant modal size class was 14 inches in all areas except the Rivers, which was 13 inches, during the 1991 to 2004 time period when the minimum size limit for southern flounder was 13 inches (Figure 7.16). The dominant modal size class for the April 2005 through 2007 time period when the minimum size was increased to 14 inches, was 14 inches in all areas except in Pamlico Sound where the dominant modal size class was 15 inches (Figure 7.16). Undersized flounder were seen during both time periods in commercial estuarine gill nets before and after the size limit increase in all areas but comprised a greater proportion of the catches from 2005 to 2007 (Figure 7.16). The undersized southern flounder in the commercial estuarine gill net fishery could be the result of inadequate gear modifications for the minimum size limit, insufficient enforcement of the minimum size limit, strong year classes entering the fishery or a combination of these factors. The start date for the size limit increase on southern flounder from 13 inches to 14 inches began on April 1, 2005 from recommendations in the 2005 Southern Flounder FMP (NCDMF 2005).



*2005 began in April at the start date of the increase in the minimum size limit from 13" to 14".

Figure 7.16 Percent size class frequency (inches) of southern flounder in commercial estuarine gill nets by area. Left side graphs from 1991-2004 during the 13-inch minimum size limit and right side graphs from 2005-2007 during 14-inch minimum size limit (NCDMF Biological Database).

Undersized southern flounder bycatch was addressed in the 2005 Southern Flounder FMP in the issue paper titled, 13.1.3 Gear Requirements in the Flounder Gill Net Fishery (NCDMF 2005). The 2005 Southern Flounder FMP recommended to implement a minimum mesh size of 5½-inch stretched mesh on large mesh gill nets to reduce discarded catch by going from a 13-inch to a 14-inch minimum size limit. Specifically, the use of large mesh nets between 5-inches and 5 ½-inch stretched mesh length are prohibited in internal waters from April 15 through December 15 [Rule: 15A NCAC 03J .0102(a)(2)] with the intent to reduce the catch of undersized flounder in large mesh gill nets and went into effect in late 2005. Further management options will be explored to reduce undersized flounder discards in the issue paper, 10.1 Achieving Sustainable Harvest.

The incidental take of other finfish species in the commercial gill net fishery was addressed in the 2005 Southern Flounder FMP in the issue paper titled "13.1.4 Bycatch in the Commercial Flounder Gill Net Fishery" (NCDMF 2005). The bycatch of red drum and striped bass in commercial estuarine flounder gill nets was further addressed in the 2008 Amendment I to the Red Drum FMP and for the Central/Southern striped bass stock in the 2004 Striped Bass FMP (NCDMF 2004b; NCDMF 2008b).

The 2008 Amendment I to the Red Drum FMP included a management recommendation for unattended large mesh nets (greater than 5-inch stretch mesh) to be set a minimum of 10 feet from any shoreline from June through October [Rule: 15A NCAC 03J .0102(i)(2)] to reduce the bycatch of red drum in large mesh gill nets.

The Albemarle Sound Management Area in the 2004 Striped Bass FMP recommended status quo, which maintains proclamation authority for gill nets with a mesh length of 5½ inches or larger to have tie downs or floats so that the nets will fish on the bottom with a vertical height that does not exceed 48 inches (Proclamation M-26-2008). Management recommendations for the Central/Southern management area for striped bass include requiring tie-downs after the quota is reached in the Rivers (Neuse, Pamlico, Pungo, and Bay rivers) and gill nets with stretched mesh greater than 6-inches in the Pamlico Sound are prohibited during the striped bass open harvest season (NCDMF 2004b). In 2008, a proclamation (M-9-2008) was issued after a study was conducted in the Pamlico, Neuse, Pungo and Bay rivers and approved by the NCMFC in 2007 to extend tie-down use from April 15 through December 15 to restrict the vertical height of the net to 36-inches or less from the bottom. Also the large mesh gill nets must be at least 50 yards from the shore in the upper portions of the rivers only. This proclamation is re-issued each year and will remain in proclamation to allow NCDMF the flexibility to adjust the gill net modifications at anytime with the intent to reduce the capture of striped bass in commercial estuarine flounder gill nets.

Some of the general public's negative perception of the gill net fisheries stems from the incidental capture of non-target species of concern, particularly marine mammals, birds, and sea turtles (NCDMF 2005). Environmental, conservation, and sportfishing organizations have cited these catches to support the ban of any and all commercial gill net fishing operations. The controversy has intensified recently because of increased incidences of sea turtle interactions with commercial gill nets in North Carolina estuarine waters. Anglers and conservation groups have lobbied a number of state legislatures to eliminate the use of gill nets. Gill nets have been banned in other states, which add pressure to states that still allow this gear.

The issue paper titled "13.1.5 Incidental Capture of Non-Target Species of Concern in the Commercial Large Mesh Estuarine Flounder Gill Net Fishery" in the 2005 Southern Flounder FMP discussed the listed endangered and threatened species and non-listed species that could potentially be captured in commercial estuarine flounder gill nets (NCDMF 2005). The only change that has occurred to listed endangered or threatened species in the original table since 2005 is that bald eagles are now considered de-listed (Table 7.4). Shortnose sturgeon (*Acipenser brevirostrum*), roseate terns (*Sterna dougalli dougalli*), piping plovers (*Charadrius melodus*), and the West Indian manatee (*Trichechus manatus*) still maintain a threatened or endangered status. The manatee is proposed to be reduced to a threatened status from an endangered status, but has not been finalized at this time (Table 7.4). For more information on the listed endangered and threatened species please visit the United States Fish and Wildlife Service website and link to endangered species at: http://ecos.fws.gov/tess_public/pub/stateListingIndividual.jsp?state=NC&status=listed, which will give more information on each of these species.

Table 7.4 Species listed as either endangered or threatened in North Carolina with the potential to become entangled in estuarine gill nets (USFWS 2009).

Common name	Species name	Endangered=E Threatened=T	Listed since
FISH			
Shortnose sturgeon	*Acipenser brevirostrum*	E	1967
BIRDS			
Piping plover	*Charadrius melodus*	T	1985
Roseate tern	*Sterna dougallii dougallii*	T	1987
MAMMALS			
West Indian manatee	*Trichechus manatus*	E; Latest update proposed listing as threatened	1967

The number of non-listed species that could potentially be captured has grown some since the 2005 Southern Flounder FMP (NCDMF 2005) (Table 7.5). Input for this list is a compilation of the previous list and any additional interactions that have occurred in both NCDMF fishery independent gill net sampling programs and the commercial fishery at sea sampling program used to observe catches in the PSGNRA and other areas of the North Carolina coast (Table 7.5). Sea turtles are not included in this list because they will be addressed in more detail in the issue paper “10.8 Incidental Capture of Protected Species in the Southern Flounder Large Mesh Gill Net and Pound Net Fisheries”.

Table 7.5 Non-listed species that can potentially become entangled in estuarine gill nets.

Common name	Species name
FISH	
Atlantic sturgeon	*Acipenser oxyrhyncus*
BIRDS	
American black duck	*Anas rubripes*
Bald eagle; delisted in 2007	*Haliaeetus leucoceohalus*
Brown pelican	*Pelecanus occidentalis*
Bufflehead	*Bucephala albeola*
Canvasback	*Aythya valisineria*
Common loon	*Gavia immer*
Double crested cormorant	*Phalacrocorax auritus*
Greater scaup	*Aythya marila*
Herring gull	*Larus argentatus*
Hooded merganser	*Lophodytes cucullatus*
Laughing gull	*Larus atricilla*
Lesser scaup	*Aythya affinis*
Pied-billed grebe	*Podilymbus podiceps*
Redhead	*Athya americana*
Red-breasted merganser	*Mergus serrator*
Ringneck duck	*Aythya collaris*
Ruddy	*Oxyura jamaicensis*
Surf scoter	*Melanitta perspicillata*
MAMMALS	
Bottlenose dolphins	*Tursiops truncatus*
Nutria	*Myocastor coypus*
River otter	*Lutra canadensis*

Bottlenose dolphins have been documented in commercial estuarine gill nets in North Carolina and are considered part of the Western North Atlantic coastal stock which are listed under the MMPA as depleted (NCDMF 2005; NOAA 2009). In 2006, NMFS implemented the Bottlenose Dolphin Take Reduction Plan (BNDTRP) to reduce the serious injury and mortality of the Western North Atlantic coastal bottlenose dolphins taken incidentally in several U.S. fisheries (Federal Register 2006; NOAA 2009). Fisheries in North Carolina affected by the BNDTRP recommendations include gill net fisheries in ocean waters but not the commercial southern flounder gill net fishery that occurs in estuarine waters. The latest stock assessment report on bottlenose dolphins indicates that there is evidence to support demographic separation between dolphins residing within estuaries along the Atlantic coast and there are possibly three separate stocks that occur in North Carolina coastal ocean waters (NOAA 2008). The study further states that there is a possibility of a resident group of bottlenose dolphins in Pamlico Sound based on satellite telemetry and photo-identification that move to nearshore ocean waters in the winter months. This further breakdown into multiple stocks makes it even more problematic to estimate mortality to the appropriate stock for categorizing the Potential Biological Removals (NOAA 2008).

7.1.7.3 GIGS

Commercial landings of southern flounder from gigs in North Carolina have always been less than 5% of the total landings for any given year, but are considered an important gear because it targets southern flounder and has not seen the drop in the overall landings like many of the other gears (Figure 7.7). Since 1994 both landings and number of trips in the commercial gig fishery have remained steady and shown some increase in the last few years (Figure 7.17).

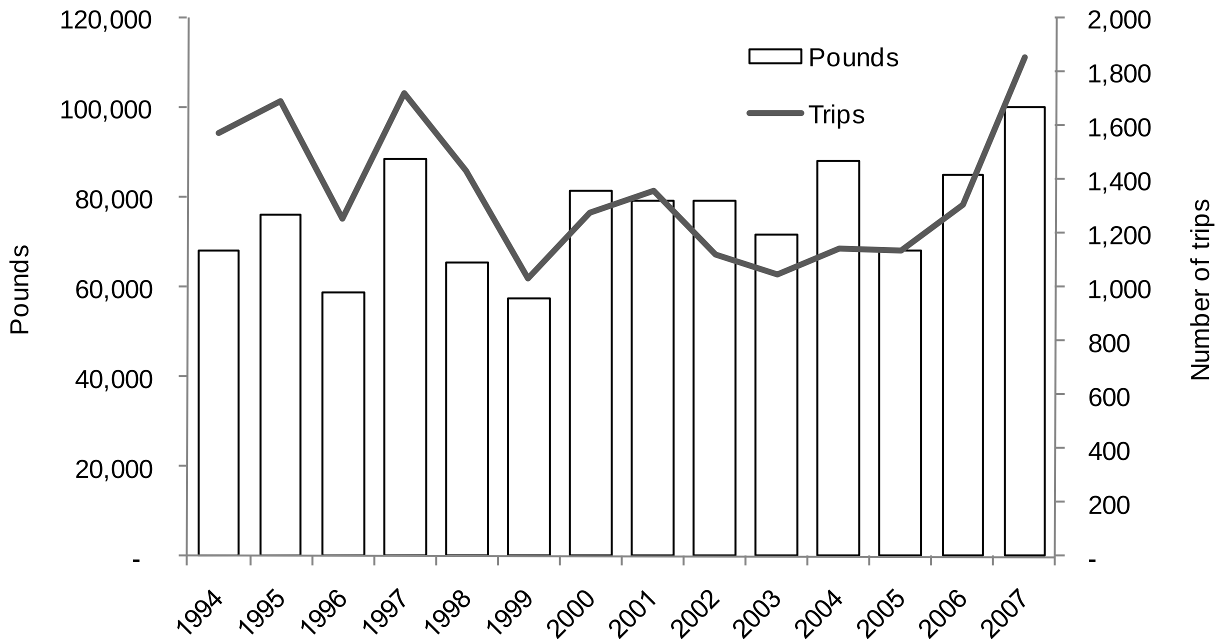


Figure 7.17 Annual commercial gig landings and trips, 1994-2007 (NCDMF Trip Ticket Program).

Effort and southern flounder landings within the commercial gig fishery increases around May and continues through until August (Figure 7.18). Southern flounder feed in the shallower waters near the ocean inlets as they follow aggregations of bait fish. Following the peak, both landings and effort decline as the fish migrate out of the inlets into ocean waters and are not as easily available to the fishery.

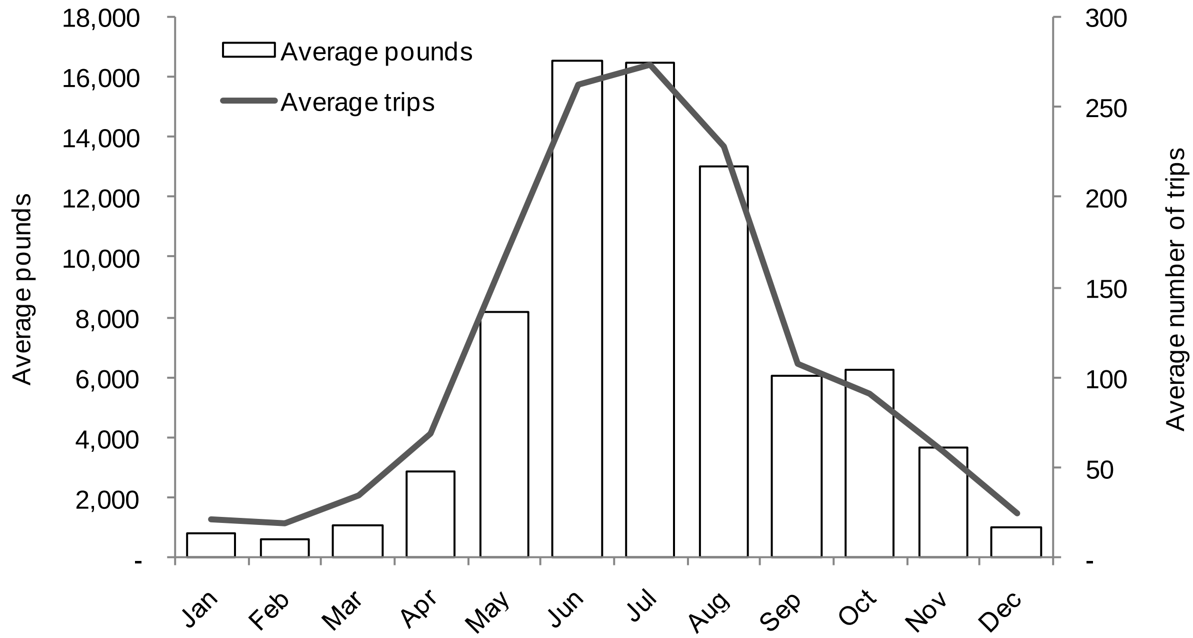


Figure 7.18 Average southern flounder landings (pounds) and average number of trips by month in commercial gigs, 1994-2007 (NCDMF Trip Ticket Program).

Throughout the entire time series the Southern area and Core Sound have dominated the landings in the commercial gig fishery (Figure 7.19). Dominant landings from this gear in these two regions are due to the more favorable conditions presented by the water bodies, with plenty of inlets where the fish are migrating in and out of during the different seasons. Gigging requires shallow, clear waters to see and gig the fish during the night time hours. Southern flounder in the summer months tend to aggregate in areas near grass beds and sandy shoals to feed on bait fish present in these areas. During the 1970s, 98% of the southern flounder landings from commercial gigs came from Core Sound (61%) and areas in the Southern (37%) part of the coast (Figure 7.19). However, in the 1980s there was a shift in landings to these same regions but with the Southern area (North River/Back Sound and all areas south) contributing 64% of the total southern flounder landings and Core Sound contributing 33% to the total southern flounder landings in commercial gigs (Figure 7.19). This same trend was seen in the 1990s and 2000 to 2007 time periods with the Southern area of the coast having the most landings and Core Sound second in the commercial gig fishery (Figure 7.19).

Most of the southern flounder caught in commercial gigs are sold in Carteret, New Hanover, Onslow, and Brunswick counties (92% combined average from 1972 to 2007). Carteret County exhibited the highest landings of southern flounder across the time series (54%) with a shift in landings to account for only 35% of the entire landings during the 1994 to 2007 time period. New Hanover and Brunswick counties have experienced an increase in landings in more recent years (1994-2007) and accounted for 31% and 15%, respectively of the total commercial gig harvest (1972-2007).

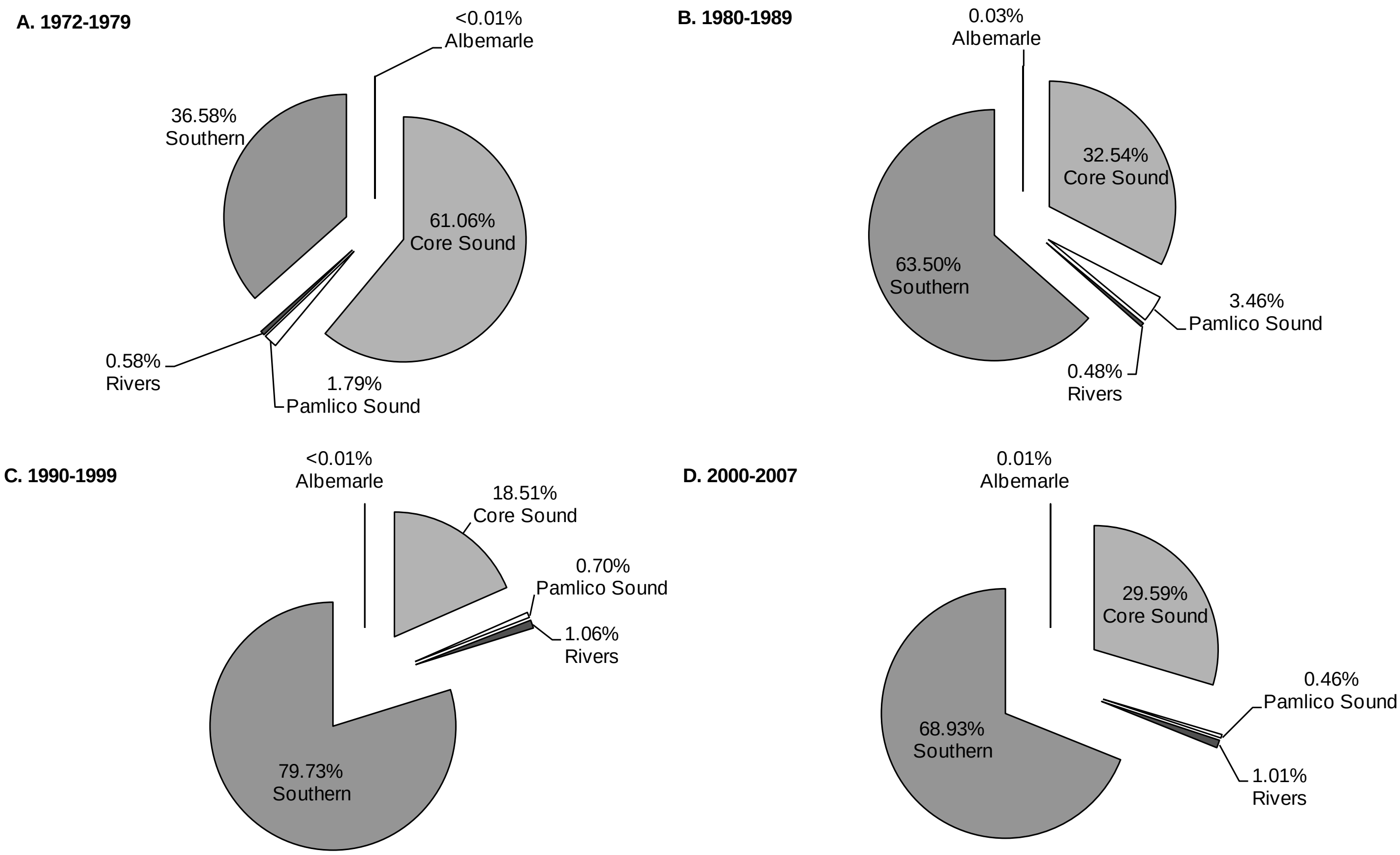


Figure 7.19 Percentage of southern flounder total landings in commercial gigs by area for each decade. A. 1972-1979, B. 1980-1989, C. 1990-1999, and D. 2000-2007 (NCDMF Trip Ticket Program).

The sampling of commercial gig catches began in September 2004 and during the 13-inch minimum size limit only in the Southern area; therefore it does not provide useful information for discussion. The catches sampled from April 2005 to 2007 ranged from southern Pamlico Sound to Lockwood Folly River with the majority from Core and Back sounds. The number of gig fishery samples collected per year was lower than in the commercial estuarine gill net and pound net fisheries, but the effort and landings of southern flounder in this fishery were much lower (NCDMF 2008a).

The dominant modal size class for the April 2005 through 2007 time period when the minimum size was increased to 14 inches was 15 inches in the Rivers and Southern area of the coast and 16 inches in the Pamlico Sound (Figure 7.20). There were two dominant modal size classes in Core Sound at 15 and 17 inches total length from April 2005 through 2007 (Figure 7.20). Undersized southern flounder were sampled in commercial gigs after the size limit increase but comprised a smaller proportion of the catch than in the pound net and gill net fisheries (Figure 7.16).

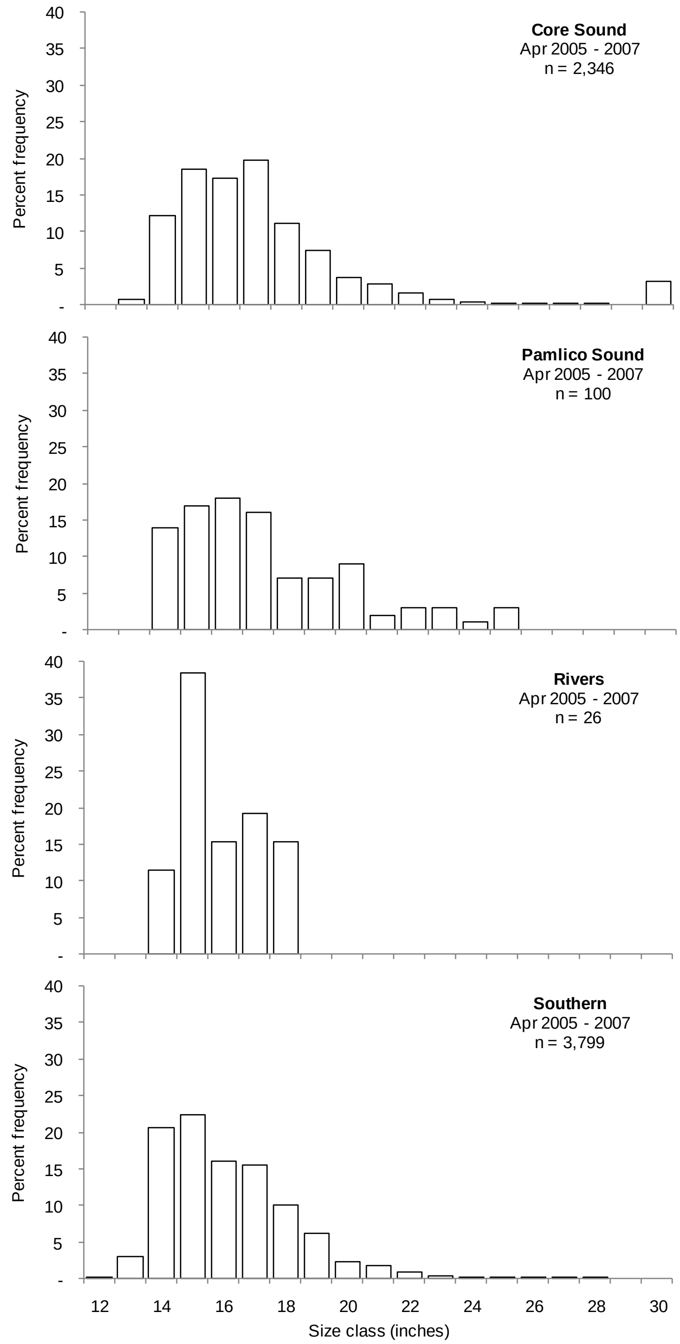


Figure 7.20 Percent size class frequency (inches) of southern flounder in commercial gigs by area. From April 2005-2007 during 14-inch minimum size limit. Sampling only began in this fishery in September 2004 in the Southern area and does not provide enough useful information during the 13-inch minimum size limit (NCDMF Biological Database).

7.2 RECREATIONAL FISHERY

Southern flounder are highly targeted recreational fishes along the southeast Atlantic Coast and Gulf of Mexico. Its table fare and willingness to take natural and artificial baits make the species popular with recreational fishermen. The primary gears used to recreationally harvest southern flounder are hook and line, gigs, and gill nets and are harvested year round in the ocean and estuarine waters of North Carolina. Popular fishing locations include the inlets, piers and jetties, bays and rivers, surf and ocean artificial reefs. Anglers generally catch southern flounder using a variety of natural and artificial baits. The preferred natural baits include live mullet [striped (*Mugil cephalus*) and white (*Mugil curema*)], Atlantic menhaden (*Brevoortia tyrannus*), and killifish (*Fundulus* spp.) while preferred artificial baits include soft bodied jigs and bucktails.

7.2.1 RECREATIONAL FISHING DATA COLLECTION

North Carolina currently conducts three surveys that collect data on the recreational finfish harvest. The Marine Recreational Fishery Statistics Survey (MRFSS) is the primary survey used to collect data on angler harvest from ocean and estuarine waters along the entire North Carolina coast. In 2002, NCDMF began collecting data from recreational fishermen who are allowed to harvest recreational limits of finfish and crustaceans while using limited amounts of commercial gear if they possess a Recreational Commercial Gear License (RCGL). In 2004 NCDMF initiated the Central and Southern Management Area (CSMA) striped bass survey, an upper estuarine creel survey conducted in the Neuse, Pamlico and Pungo rivers developed to provide recreational hook and line estimates of anadromous fishes including striped bass, American shad, and hickory shad for use in the North Carolina State and Federal Cooperative Striped Bass Management Plan. While originally designed to provide estimates of striped bass catch, other species are often encountered in the survey. The widespread distribution of southern flounder in the estuarine waters of the state will make results from this survey a useful addition in future assessment of the overall harvest of this species. The recreational gig fishery harvests a significant number of southern flounder, but there is no annual sampling program for this fishery, and therefore, no direct annual harvest estimates. The NCDMF conducted a recreational gig survey from July 2000 to January 2003 to characterize the fishery and the catch, and to obtain an estimate of southern flounder harvest by gigs from the estuarine waters of North Carolina (Watterson 2003). This survey generated an estimate of the recreational gig harvest of southern flounder in 2002. The 2002 recreational southern flounder gig harvest estimates and the 2002 MRFSS southern flounder hook and line harvest estimate were similar so the 2009 southern flounder stock assessment assumed the annual recreational gig harvest was equal the annual recreational hook and line harvest for the entire time series covered in the stock assessment (Takade-Heumacher and Batsavage 2009). Due to the lack of comprehensive recreational gig harvest data, only the hook and line and RCGL fisheries will be discussed in more detail.

7.2.2 MARINE RECREATIONAL FISHERIES STATISTICS SURVEY

The MRFSS provides the primary data that are used to estimate the impact of marine recreational fishing on marine resources (NCDMF 2008a). MRFSS was initiated in 1979 by the National Marine Fisheries Service to gather information from the recreational fishing community to provide estimates of catch and effort at a regional level. MRFSS consists of two components, the Access-Point Angler Intercept Survey (APAIS) and the Coastal Household Telephone Survey (CHTS). The CHTS utilizes a random digit dialing (RDD) telephone survey approach to collect marine recreational fishing effort information from residential households located in coastal counties. The APAIS, an onsite intercept survey conducted at fishing access-sites, is used for collection of individual catch and discard data for calculation of catch rate at the species level. Creel clerks collect intercept data from January through December (in two-month waves) by interviewing anglers completing fishing trips in one of the four fishing modes (man-made structures, beaches, private boats, and for-hire vessels (charter boat and headboat)). Results from both component surveys are combined at the state, area, fishing mode and wave level to provide estimates of the total number of fish caught, released, and harvested, the weight of the harvest, the total number of trips, and total participation in marine recreational fishing. All estimates generated through MRFSS include the proportional standard error (PSE), which is a measure of the precision of the estimate. The PSE is calculated by dividing the standard error of the estimate by the estimate to express the standard error as a percentage allowing the reader to make quick comparisons of precision among surveys. Small PSEs indicate precise estimates while high PSEs are less reliable. Estimates with a PSE of 20 or less are considered reliable while PSEs greater than 20 are less reliable (NCDMF 2008a).

In 2008 NCDMF along with the National Oceanic and Atmospheric Administration (NOAA) began a pilot survey project using the North Carolina Coastal Recreational Fishing License (CRFL) list in a new program, the Angler License Directory Survey (ALDS) to parallel the CHTS in a dual frame survey approach to improve the efficiency in collecting effort information. NCDMFs' efforts in securing this pilot project were to fulfill the obligation to use the CRFL data to better estimate impacts from recreational anglers.

7.2.3 RECREATIONAL COMMERCIAL GEAR LICENSE SURVEY

Fishermen who hold a RCGL must abide by the same size and creel limits as other recreational fishermen and are not allowed to sell their catch. This license was implemented in July 1999, and a monthly mail survey was initiated in March 2002 to gather catch and effort data from RCGL holders. Questionnaires were mailed to randomly selected individuals from the RCGL population at a sampling rate of 30% of the total RCGL holders. Approximately 45% of questionnaires distributed were completed and returned to the NCDMF. Types of information collected through the survey include gears and quantity used, number of trips, estimates of the number and poundage of each species harvested, and estimated numbers of each species discarded. Total effort and catch were computed for the subsample and extrapolated to the entire RCGL population. This survey does not capture individual lengths or weights of fish reported. This survey also did not collect species specific flounder harvest estimates. The NCDMF fishery dependent sampling of the commercial estuarine gill net fishery provided annual proportions of southern flounder from the catches; these proportions were applied to the RCGL flounder harvest and discard estimates to get southern flounder harvest and discard estimates for the RCGL fishery. Reliable RCGL harvest estimates prior to 2002 were unavailable because of considerable changes in the behavior of RCGL fishermen over the years (C. Wilson, NCDMF, personal communication). Because reliable RCGL harvest estimates were unavailable for the entire time series and because RCGL harvest of southern flounder was minimal compared to the total annual harvest, RCGL harvest was not included in the 2009 stock assessment (Takade-Heumacher and Batsavage 2009).

7.2.4 REGULATORY AND MANAGEMENT HISTORY

Many of the regulations for the recreational fishery have been the result of summer flounder management, but these regulations have had some impact on the southern flounder recreational fishery. An 11-inch minimum size limit with no creel limit was implemented for the recreational fishery on January 1, 1979. The minimum size limit for the recreational harvest of flounder in estuarine and ocean waters increased from 11 inches to 13 inches on September 1, 1988 with no creel limit. This regulation for estuarine waters remained in effect through September 30, 2002. The minimum size limits, creel limits, and seasons changed on a nearly annual basis in the ocean because of Amendment 2 of the Mid Atlantic Fishery Management Council's Summer Flounder FMP (ASMFC 2006). These regulations were designed to constrain the recreational harvest of summer flounder to end overfishing and rebuild the spawning stock. Minimum size limits ranged from 14 inches to 15 ½ inches and creel limits ranged from six to 10 fish per person per day from 1994 to 2007 (Table 7.6). Closed seasons for the ocean were implemented in 2001 and 2002 to meet required recreational harvest reductions for summer flounder. The minimum size limit for flounder in internal waters increased to 14 inches on October 1, 2002 with the exception of the western Pamlico Sound and its tributaries, where the minimum size limit remained 13 inches. The 2005 Southern Flounder FMP implemented a 14-inch minimum size limit for recreationally caught flounder and implemented an eight fish per person per day creel limit throughout the estuaries (NCDMF 2005). The FMP also required that participants in the recreational gig fishery be licensed, which occurred when the CRFL was implemented on January 1, 2007. In addition, RCGL holders were required to attend their large mesh gill nets (5 ½ inches stretched mesh and greater) at all times from the NC Highway 58 bridge at Emerald Isle south to the South Carolina state line to minimize bycatch (NCDMF 2005).

Table 7.6 Recreational flounder regulations in North Carolina, 1993-2007.

	Estuarine Waters			Ocean Waters		
Year	Size Limit	Bag Limit	Closed Season	Size Limit (TL)	Bag Limit	Closed Season
1993	13"	----	----	13"	----	----
1994	13"	----	----	14"	8 (1/1-10/31)/ 6 (11/1-12/31)	----
1995	13"	----	----	14"	8	----
1996	13"	----	----	14"	8	----
1997	13"	----	----	14" (1/1-3/31)/ 14.5" (4/1-12/31)	8 (1/1-3/31)/ 10 (4/1-12/31)	----
1998	13"	----	----	14.5" (1/1-6/6)/ 15" (6/7-12/31)	10 (1/1-6/6)/ 8 (6/7-12/31)	----
1999	13"	----	----	15"	8	----
2000	13"	----	----	15"	8	----
2001	13"	----	----	15.5"	8	5/1-5/14
2002	13" (1/1-9/30)/ 14" (10/1-12/31)*	----	----	15.5"	8	4/3-7/4
2003	14"	----	----	15"	8	----
2004	14"	----	----	14"	8	----
2005	14"	8 (4/1-12/31)	----	14"	8	----
2006	14"	8	----	14"	8	----
2007	14"	8	----	14.5"	8	----

* 13-inch minimum size limit in western Pamlico Sound and tributaries until April 1, 2005

7.2.5 HOOK AND LINE FISHERY

7.2.5.1 MRFSS HARVEST ESTIMATES

Southern flounder are harvested in the recreational hook and line fishery along the Atlantic coast of the United States from Virginia to Florida (Table 7.7). Overall, the east coast of Florida had the highest harvest in the time series followed by North Carolina, South Carolina, and Georgia. Virginia is the northernmost range of southern flounder and are not commonly found there, which is why harvest estimates were low and sporadic from this state. Hook and line harvest in North Carolina have increased in recent years. The average recreational harvest from 1991 to 1999 was 56,186 fish and 112,842 pounds from 1991 to 1999. From 2000 to 2007, the average recreational harvest increased to 148,076 fish and 308,706 pounds (Table 7.8). The peak harvest of 196,906 fish and 425,221 pounds occurred in 2004. Since 2005, the harvest has averaged 162,619 fish and 366,938 pounds.

Table 7.7 East Coast recreational hook and line harvest in pounds of southern flounder, 1991-2007 (MRFSS Survey).

	State				
Year	Virginia	North Carolina	South Carolina	Georgia	Florida East Coast
1991	2,372	136,835	142,018	84,652	281,843
1992	4,048	74,308	79,119	119,670	545,387
1993		56,405	117,329	58,060	461,619
1994		131,804	217,019	108,378	675,247
1995		116,617	264,030	59,154	479,617
1996	646	115,336	90,896	40,256	248,447
1997	18,543	218,615	189,798	24,019	370,920
1998	13,801	88,147	166,948	19,242	366,091
1999		77,505	67,243	23,415	441,352
2000		271,234	157,649	34,983	347,668
2001		213,908	109,386	74,207	232,753
2002	1,138	236,648	164,889	36,713	255,253
2003		221,805	226,415	126,127	304,973
2004		425,221	360,895	69,956	365,800
2005		368,098	152,563	61,996	234,243
2006	27,765	366,400	270,515	44,449	177,618
2007		366,305	203,992	157,653	308,410
Average	9,759	205,011	175,336	67,231	358,661

Table 7.8 North Carolina recreational hook and line harvest (number and weight) and number of releases of southern flounder, 1991-2007 (MRFSS Survey).

Year	Harvest (Number)	PSE	Weight (lb)	PSE	Released (Number)
1991	80,540	9.6	136,835	10.7	33,635
1992	38,892	14.6	74,308	16.5	83,025
1993	34,588	14.4	56,405	14.9	156,167
1994	72,124	11.9	131,804	12.6	257,032
1995	54,495	12.3	116,617	13.2	269,350
1996	67,416	13.8	115,336	16.4	178,354
1997	79,719	15.3	218,615	16.3	336,756
1998	42,727	16.1	88,147	17.1	197,069
1999	35,171	21.6	77,505	23.7	73,085
2000	150,315	15.0	271,234	14.6	454,862
2001	115,477	11.4	213,908	11.9	404,319
2002	115,154	13.8	236,648	15.5	515,374
2003	118,898	15.6	221,805	15.6	382,084
2004	196,906	11.1	425,221	11.6	879,373
2005	161,292	13.6	368,098	14.4	514,799
2006	172,136	12.5	366,400	12.8	566,653
2007	154,429	13.3	366,305	13.8	599,786

The MRFSS estimates the number of southern flounder released alive by anglers, but the estimates are not species specific because the MRFSS clerks do not observe the released flounder. In order to develop release estimates for the three predominant flounder species (summer, southern and Gulf flounder) in the state, the proportion of flounder species harvested in a particular wave, mode, and area was applied to the number of released flounder from the same wave, mode, and area. This method assumes that the species proportion of released flounder is the same as the kept flounder. A greater number of fish were released than were kept, but the trend in southern flounder released from the hook and line fishery in North Carolina was similar to the trend in harvest (Table 7.8).

7.2.5.3 MRFSS FISHING EFFORT AND CATCH RATES

The number of hook and line fishing trips either targeting or catching southern flounder has generally increased from 1991 to 2007 (Figure 7.21). From 1992 to 1999 the number of trips ranged from 32,000 to 60,000 trips per year. The number of trips in 2000 increased to over 93,000 and peaked in 2004 at over 156,000 trips either targeting or catching southern flounder. Since 2005, the annual number of trips has ranged from 121,000 to 133,000 trips.

The number of southern flounder harvested by hook and line fishing trips from 1991 to 2007 ranged from less than one fish per angler to as many as 30 fish per angler (Table 7.9). However, approximately 94% of the trips sampled harvested 3 or less fish per angler and only 0.4% of the trips harvested the current creel limit of 8 southern flounder per angler.

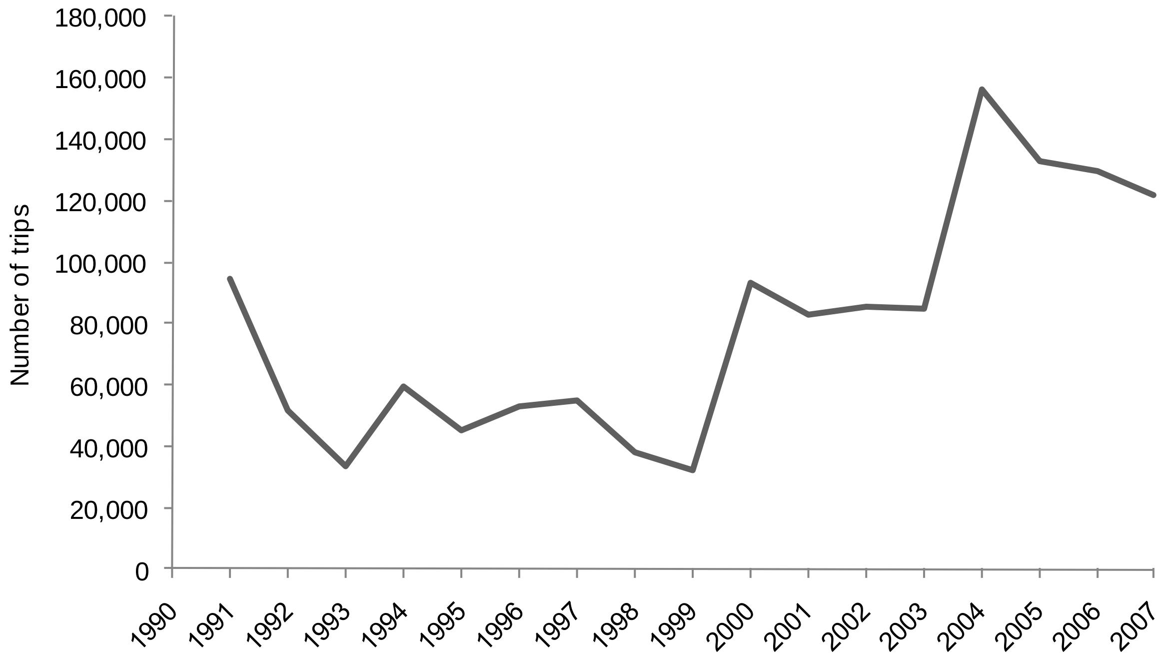


Figure 7.21 Number of recreational hook and line trips targeting or catching southern flounder in North Carolina, 1991-2007 (MRFSS Survey).

Table 7.9 Number and proportion of southern flounder harvested per angler, per trip, 1991-2007 (MRFSS Survey).

Fish per angler	Number of samples	Percent	Cumulative percent
<1	413	11.4%	11.4%
1	2,222	61.4%	72.9%
2	579	16.0%	88.9%
3	199	5.5%	94.4%
4	101	2.8%	97.2%
5	46	1.3%	98.4%
6	13	0.4%	98.8%
7	12	0.3%	99.1%
8	14	0.4%	99.5%
9	5	0.1%	99.6%
10	2	0.1%	99.7%
11	2	0.1%	99.8%
12	4	0.1%	99.9%
13	2	0.1%	99.9%
15	1	0.0%	99.9%
16	1	0.0%	100.0%
30	1	0.0%	100.0%
Total	3,617	100.0%	

7.2.5.4 MRFSS SEASONALITY OF HARVEST

MRFSS samples recreational angler catches in six two-month periods called waves beginning in January and ending in December. This allows managers to examine the seasonality of catches. Southern flounder harvest in the hook and line fishery is very low in Waves 1 (January-February) and 2 (March-April) (Figure 7.22). Harvest increases in Wave 3 (May-June) and peaks in Wave 4 (July-August), representing approximately 40% of the annual harvest. Wave 5 (September-October) accounts for approximately 35% of the annual harvest, while Wave 6 (November-December) accounts for only 5% of the annual harvest.

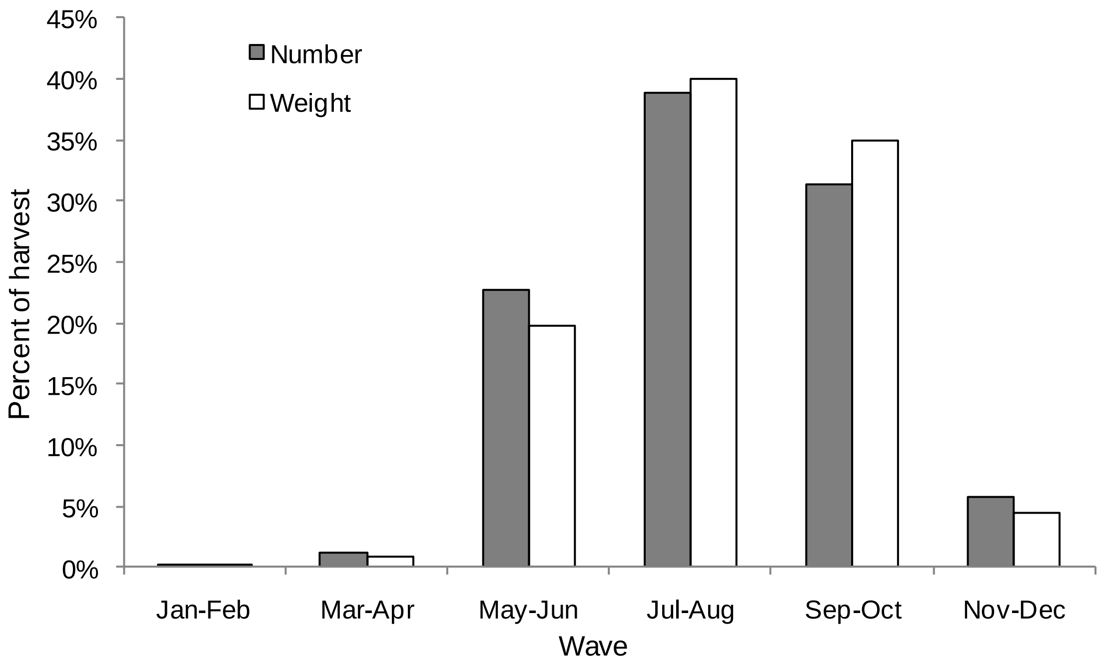


Figure 7.22 Proportion of harvest by wave in numbers and weight (pounds) of southern flounder in the recreational hook and line fishery, 1991-2007 (MRFSS Survey).

7.2.5.5 MRFSS HARVEST BY AREA

MRFSS provides estimates based on estuarine or oceanic waters. Approximately 72% of southern flounder by number and 70% by weight were harvested in the estuarine waters of the state from 1991 to 2007 (Table 7.10). Standard MRFSS estimates of catch and effort are not available at the county and specific water body levels. However, the unexpanded MRFSS intercept data can be summarized at many levels including county of landing and water body of catch. MRFSS intercept data by county show that Brunswick and New Hanover counties accounted for approximately 68% of the southern flounder intercepts (estuarine and ocean combined) from 2002 to 2007 (Table 7.11).

Table 7.10 Recreational hook and line harvest of southern flounder by numbers and weight (pounds) from estuarine and ocean waters, 1991-2007 (MRFSS Survey).

	Harvest (numbers)				Harvest (lb)			
Year	Estuarine	Percent	Ocean	Percent	Estuarine	Percent	Ocean	Percent
1991	38,966	48.4%	41,575	51.6%	66,403	48.5%	70,433	51.5%
1992	27,874	71.7%	11,018	28.3%	52,148	70.2%	22,160	29.8%
1993	14,491	41.9%	20,097	58.1%	27,438	48.6%	28,966	51.4%
1994	46,713	64.8%	25,411	35.2%	73,367	55.7%	58,438	44.3%
1995	23,761	43.6%	30,734	56.4%	42,666	36.6%	73,954	63.4%
1996	50,617	75.1%	16,799	24.9%	80,025	69.4%	35,311	30.6%
1997	52,856	66.3%	26,863	33.7%	137,318	62.8%	81,297	37.2%
1998	34,728	81.3%	8,000	18.7%	65,514	74.3%	22,630	25.7%
1999	23,411	66.6%	11,760	33.4%	43,420	56.0%	34,085	44.0%
2000	119,714	79.6%	30,601	20.4%	213,687	78.8%	57,549	21.2%
2001	94,785	82.1%	20,692	17.9%	167,838	78.5%	46,072	21.5%
2002	104,064	90.4%	11,090	9.6%	213,128	90.1%	23,519	9.9%
2003	110,179	92.7%	8,719	7.3%	202,409	91.3%	19,394	8.7%
2004	113,852	57.8%	83,053	42.2%	230,061	54.1%	195,160	45.9%
2005	114,977	71.3%	46,315	28.7%	262,949	71.4%	105,147	28.6%
2006	114,608	66.6%	57,528	33.4%	250,674	68.4%	115,724	31.6%
2007	100,148	64.9%	54,281	35.1%	233,064	63.6%	133,241	36.4%
Average	69,750	68.5%	29,679	31.5%	138,948	65.8%	66,064	34.2%

Table 7.11 Proportion of southern flounder intercepts by county in the recreational hook and line fishery, 2002-2007 (MRFSS Survey).

County	Percent of southern flounder
New Hanover	36.6%
Brunswick	31.0%
Hyde	14.0%
Carteret	8.2%
Onslow	6.3%
Dare	2.1%
Beaufort	0.8%
Pamlico	0.5%
Pender	0.4%
Craven	0.1%

7.2.5.6 MRFSS HARVEST BY MODE

Much of the hook and line harvest of southern flounder in North Carolina comes from the private/rental boat mode, which on average accounted for approximately 85% of the annual harvest from 1991 to 2007 (Table 7.12). The beach and man-made structure modes accounted for a greater amount of the annual harvest in the early and mid 1990s, but the proportion of harvest from these modes has decreased in recent years. The harvest estimates from the charter boat and head boat modes are too imprecise to report as stand-alone estimates. However, these modes accounted for a very minimal proportion of the total annual harvest.

Table 7.12 Recreational hook and line harvest (pounds) of southern flounder for the beach, man-made structure and private/rental boat modes, 1991-2007. Note: the harvest estimates from the charter and head boat modes are not sufficiently precise as stand-alone estimates (MRFSS Survey).

	Beach		Man-Made		Private/Rental Boat		Total
Year	Harvest (lb)	Percent	Harvest (lb)	Percent	Harvest (lb)	Percent	Harvest (lb)
1991	38,774	28.3%	29,047	21.2%	69,017	50.4%	136,838
1992	7,398	10.0%	15,990	21.5%	50,875	68.5%	74,309
1993	5,207	9.2%	14,008	24.8%	37,118	65.8%	56,406
1994	25,639	19.5%	31,607	24.0%	74,289	56.4%	131,806
1995	23,192	19.9%	9,427	8.1%	83,777	71.8%	116,620
1996	10,942	9.5%	10,816	9.4%	93,110	80.7%	115,337
1997	6,224	2.8%	40,641	18.6%	171,753	78.6%	218,618
1998	757	0.9%	12,578	14.3%	74,811	84.9%	88,146
1999	1,405	1.8%	679	0.9%	75,421	97.3%	77,505
2000	2,729	1.0%	13,728	5.1%	254,782	93.9%	271,239
2001	8,937	4.2%	8,902	4.2%	196,072	91.7%	213,911
2002	7,721	3.3%	12,857	5.4%	214,125	90.5%	236,650
2003	3,622	1.6%	16,146	7.3%	201,730	90.9%	221,807
2004	25,286	5.9%	39,984	9.4%	359,139	84.5%	425,225
2005	11,083	3.0%	20,010	5.4%	335,922	91.3%	368,100
2006	12,339	3.4%	13,861	3.8%	330,138	90.1%	366,404
2007	4,571	1.2%	28,668	7.8%	332,504	90.8%	366,308
Average	11,519	5.6%	18,762	9.2%	173,799	84.8%	205,013

The length frequency of southern flounder harvested from the hook and line fishery was examined for two different time periods (1991-2002 and 2003-2007) because of the minimum size limit increase from 13 inches to 14 inches for most of the estuarine waters in late 2002 (Table 7.6). The modal size for both time periods was 14 inches, accounting for 19%-20% of the harvest (Figure 7.23). Southern flounder in the 13-inch size class were an important component of the hook and line fishery from 1991 to 2002, accounting for approximately 17% of the harvest. Anglers harvested southern flounder as large as 31 inches, but fish greater than 19 inches comprised a small proportion of the harvest.

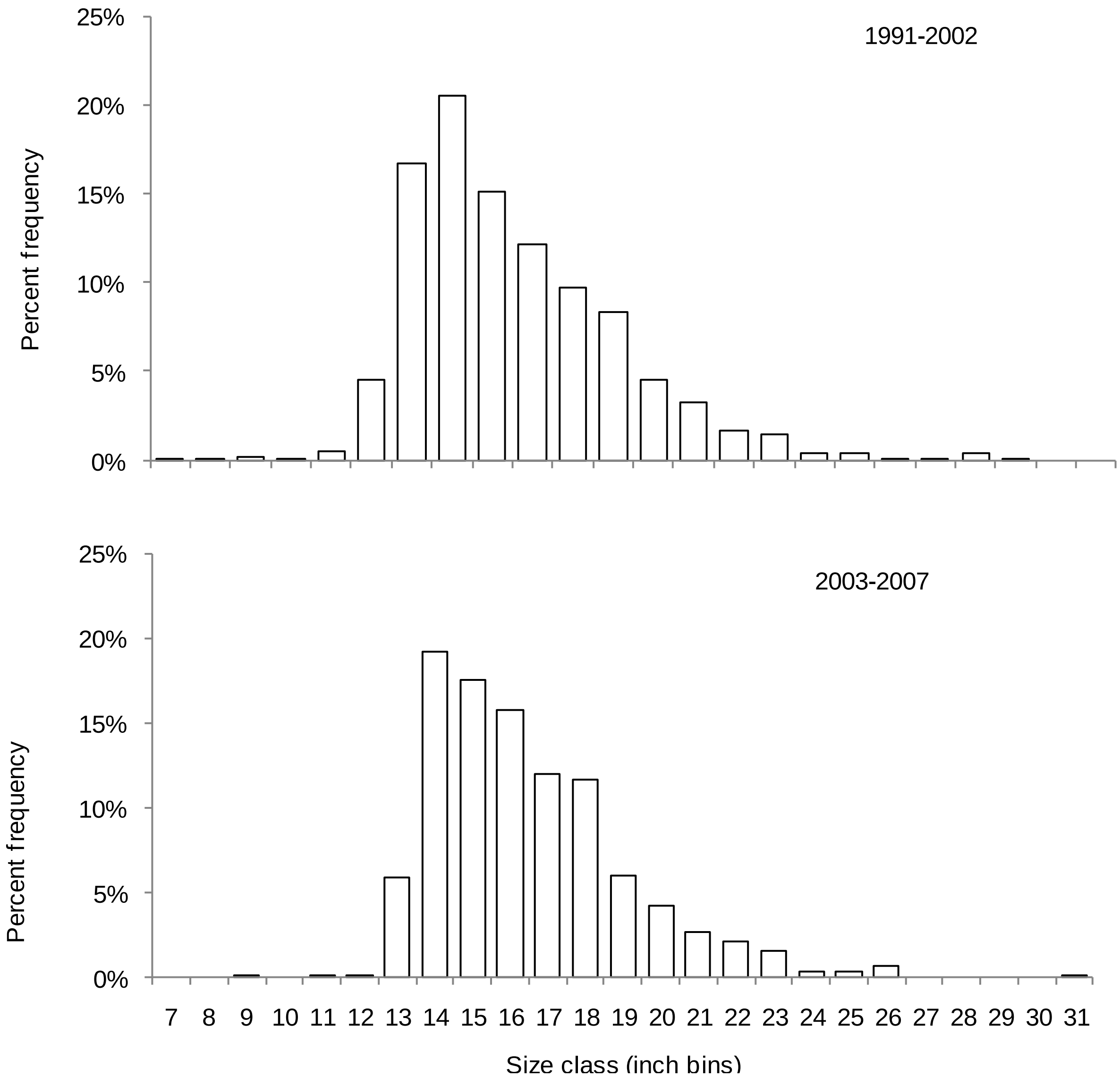


Figure 7.23 Length frequency distributions of southern flounder from the hook and line fishery, 1991-2002 and 2003-2007 (MRFSS Survey).

7.2.6 RCGL FISHERY

7.2.6.1 RCGL HARVEST ESTIMATES

The total annual harvest of southern flounder from RCGL gears from 2002 to 2007 was less than the hook and line fishery (Figure 7.24; Table 7.8). Peak harvest of southern flounder occurred in 2002 but has decreased precipitously since 2004. Southern flounder were harvested by a number of gears including gill nets [large mesh ($\geq$ 5.5 inches stretched mesh) and small mesh (< 5.5 inches stretched mesh)], shrimp trawls, crab pots, and trotlines (Table 7.13). Overall, large mesh gill nets accounted for 74% by number and 73% by weight of the total RCGL harvest of southern flounder from 2002 to 2007. Small mesh gill nets accounted for 21% by number and 22% by weight of the harvest.

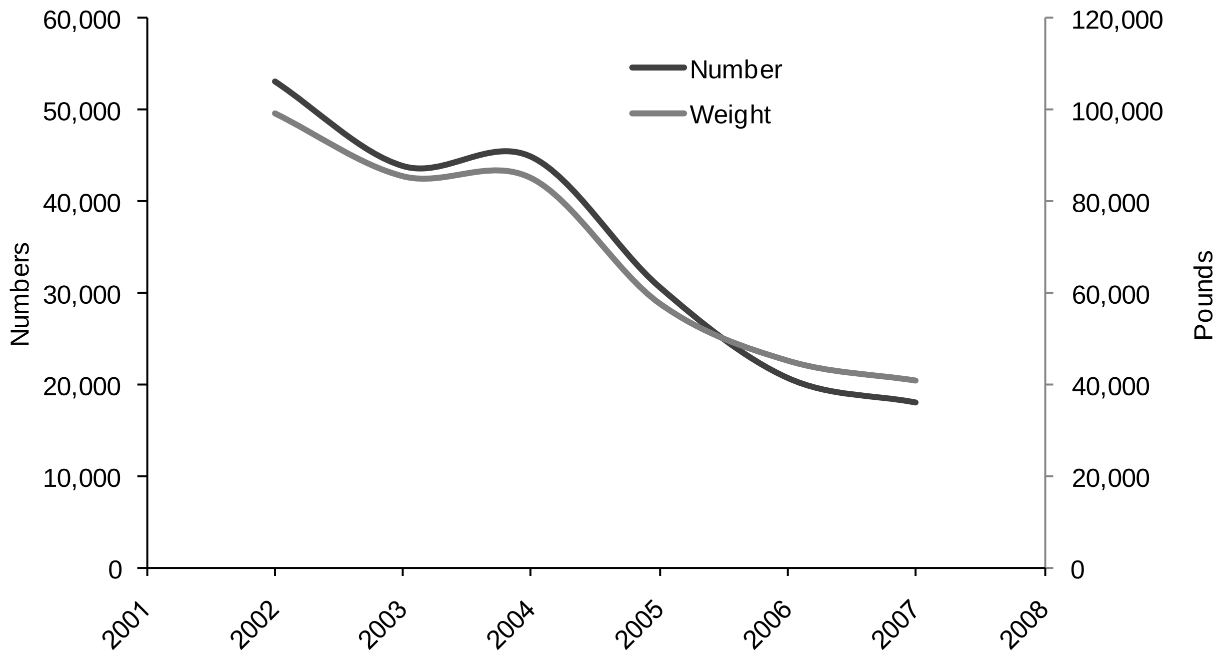


Figure 7.24 RCGL harvest (number and weight) of southern flounder, 2002-2007 (NCDMF RCGL Survey).

7.2.6.2 RCGL DISCARD ESTIMATES

Large mesh gill nets and shrimp trawls accounted for the majority of southern flounder discards over the time series (38% and 32%, respectively), while small mesh gill nets accounted for 21% of the discards over the time series (Table 7.13). The annual proportions of discards by gear varied. Shrimp trawl discards ranged from 15% of the total southern flounder discards in 2004 to 52% of the total discards in 2002. Small mesh gill net discards ranged from 7% in 2002 to 30% in 2004. The annual proportion of southern flounder discards from large mesh gill nets was more consistent over the time series, ranging from 31% in 2006 to 47% in 2004.

Table 7.13 RCGL southern flounder harvest (number and weight) and discards by gear, 2002-2007 (NCDMF RCGL Survey).

		Trips		Harvest		Harvest		Discard	
Year	Gear	Number	Percent	Number	Percent	Pounds	Percent	Number	Percent
2002	Crab pot	8,729	31.1	2,996	5.6	4,602	4.6	4,295	8.2
	Large mesh gill nets	14,394	51.4	44,456	83.8	83,136	83.9	16,915	32.4
	Small mesh gill nets	2,895	10.3	4,788	9.0	9,825	9.9	3,769	7.2
	Shrimp trawl	2,011	7.2	793	1.5	1,543	1.6	27,182	52.1
	All	28,029	100.0	53,032	100.0	99,107	100.0	52,161	100.0
2003	Crab pot	4,328	22.0	1,135	2.6	2,252	2.6	1,661	7.5
	Large mesh gill nets	9,129	46.3	29,769	67.9	55,856	65.4	9,830	44.4
	Small mesh gill nets	5,240	26.6	12,702	29.0	26,644	31.2	6,568	29.7
	Trotline (unspecified)	17	0.1	17	0.0	51	0.1	0	0.0
	Shrimp trawl	1,000	5.1	202	0.5	568	0.7	4,075	18.4
	All	19,714	100.0	43,826	100.0	85,371	100.0	22,134	100.0
2004	Crab pot	5,080	24.6	1,192	2.7	2,453	2.9	2,148	8.4
	Large mesh gill nets	9,590	46.4	33,680	75.1	62,833	73.9	11,821	46.5
	Small mesh gill nets	5,002	24.2	9,070	20.2	17,823	21.0	7,629	30.0
	Shrimp trawl	996	4.8	892	2.0	1,862	2.2	3,837	15.1
	All	20,668	100.0	44,835	100.0	84,970	100.0	25,435	100.0
2005	Crab pot	3,624	23.2	849	2.8	1,832	3.2	1,422	7.9
	Large mesh gill nets	7,576	48.5	22,201	72.4	42,361	73.5	7,781	43.2
	Small mesh gill nets	4,036	25.8	7,113	23.2	12,257	21.3	5,255	29.2
	Shrimp trawl	396	2.5	516	1.7	1,182	2.1	3,565	19.8
	All	15,632	100.0	30,679	100.0	57,634	100.0	18,023	100.0
2006	Crab pot	3,775	27.1	868	4.2	1,754	3.9	1,870	10.4
	Large mesh gill nets	5,631	40.4	15,045	72.4	30,871	68.4	5,543	30.7
	Small mesh gill nets	3,909	28.1	4,751	22.9	12,215	27.1	4,105	22.8
	Shrimp trawl	605	4.3	115	0.6	279	0.6	6,518	36.1
	All	13,921	100.0	20,779	100.0	45,120	100.0	18,036	100.0
2007	Crab pot	3,255	27.6	586	3.2	1,353	3.3	1,933	13.2
	Large mesh gill nets	4,439	37.6	12,024	66.5	26,047	63.9	5,383	36.9
	Small mesh gill nets	3,746	31.7	5,300	29.3	12,948	31.8	4,122	28.2
	Shrimp trawl	372	3.2	181	1.0	405	1.0	3,155	21.6
	All	11,812	100.0	18,092	100.0	40,753	100.0	14,591	100.0
Total	Crab pot	28,792	26.2	7,627	3.6	14,246	3.5	13,328	8.9
	Large mesh gill nets	50,758	46.2	157,175	74.4	301,103	72.9	57,272	38.1
	Small mesh gill nets	24,828	22.6	43,724	20.7	91,713	22.2	31,449	20.9
	Trotline (unspecified)	17	0.0	17	0.0	51	0.0	0	0.0
	Shrimp trawl	5,380	4.9	2,698	1.3	5,840	1.4	48,332	32.2
	Total	109,776	100.0	211,242	100.0	412,955	100.0	150,381	100.0

7.2.6.3 RCGL FISHING EFFORT AND CATCH RATES

All of the main RCGL gears that land southern flounder showed a declining trend in the number of trips taken from 2002 to 2007 (Figure 7.25). The decline in RCGL trips by all gears was largely responsible for the declining harvest of southern flounder over the time series. The harvest of many other species by RCGL gears also showed a similar decline as the number of trips declined (NCDMF 2008a). Large mesh gill nets, the RCGL gear that harvested the greatest proportion of southern flounder, showed the greatest decline in trips from over 14,000 trips in 2002 to less than 4,500 trips in 2007. The marked decrease in effort from this gear was

likely the result of the required full time attendance of large mesh RCGL gill nets from the NC Highway 58 bridge at Emerald Isle south to the South Carolina state line.
The number of southern flounder harvested by RCGL gill net trips (large and small mesh) from 2002 to 2007 ranged from less than one fish per angler to as many as 30 fish per trip (Table 7.14). However, approximately 94% of the large mesh gill net trips and 96% of the small mesh gill net trips harvested 8 or less southern flounder per trip.

Southern flounder are harvested by RCGL gears year round with much of the harvest occurring from May through November (Figure 7.26). Harvest was fairly consistent from June through September before peaking in October. The majority of southern flounder discards also occurred from May through November (Figure 7.27). However, peak discards occurred in July and August before declining in September. The peak in southern flounder discards coincided with the peak in shrimp trawl trips, which accounted for 32% of the southern flounder discards (NCDMF 2008a).

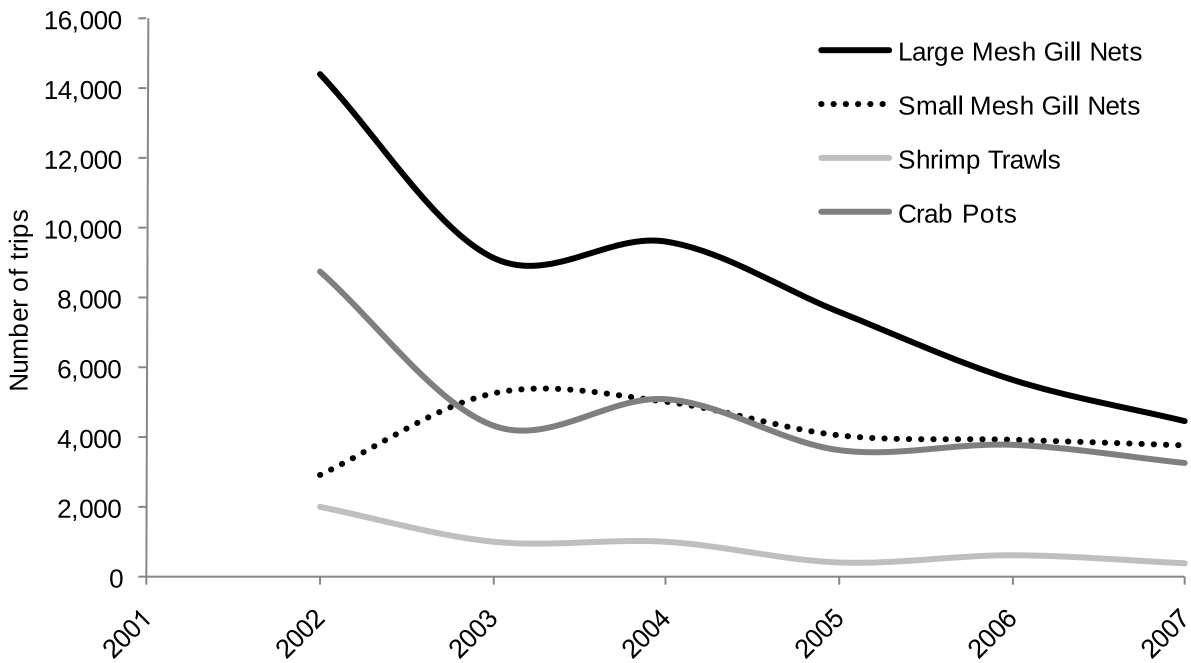


Figure 7.25 Number of RCGL trips by gear, 2002-2007 (NCDMF RCGL Survey).

Table 7.14 Number of southern flounder harvested per trip for large mesh and small mesh RCGL gill nets, 2002-2007 (NCDMF RCGL Survey).

	Large mesh gill nets		Small mesh gill nets	
Fish per trip	Percent	Cumulative percent	Percent	Cumulative percent
0	6.5	6.5	27.2	27.2
1	23.4	29.9	26.0	53.2
2	21.2	51.1	15.3	68.4
3	17.0	68.2	8.7	77.1
4	9.7	77.8	5.6	82.7
5	7.4	85.2	5.5	88.2
6	4.5	89.7	4.6	92.8
7	2.8	92.5	1.9	94.6
8	1.8	94.2	1.6	96.3
9	0.8	95.1	0.7	96.9
10	2.0	97.1	1.1	98.0
11	0.2	97.2	0.0	98.0
12	0.9	98.2	0.4	98.4
13	0.2	98.3	0.3	98.7
14	0.2	98.5	0.0	98.7
15	0.5	99.0	0.1	98.8
16	0.1	99.0	0.3	99.1
17	0.1	99.1	0.1	99.2
18	0.2	99.3	0.0	99.2
19	0.1	99.4	0.1	99.3
20	0.2	99.5	0.1	99.5
21	0.1	99.6	0.0	99.5
25	0.0	99.6	0.3	99.7
26	0.1	99.7	0.0	99.7
27	0.1	99.8	0.0	99.7
28	0.0	99.8	0.1	99.9
29	0.2	99.9	0.0	99.9
30	0.1	100.0	0.1	100.0
Total	100.0		100.0	

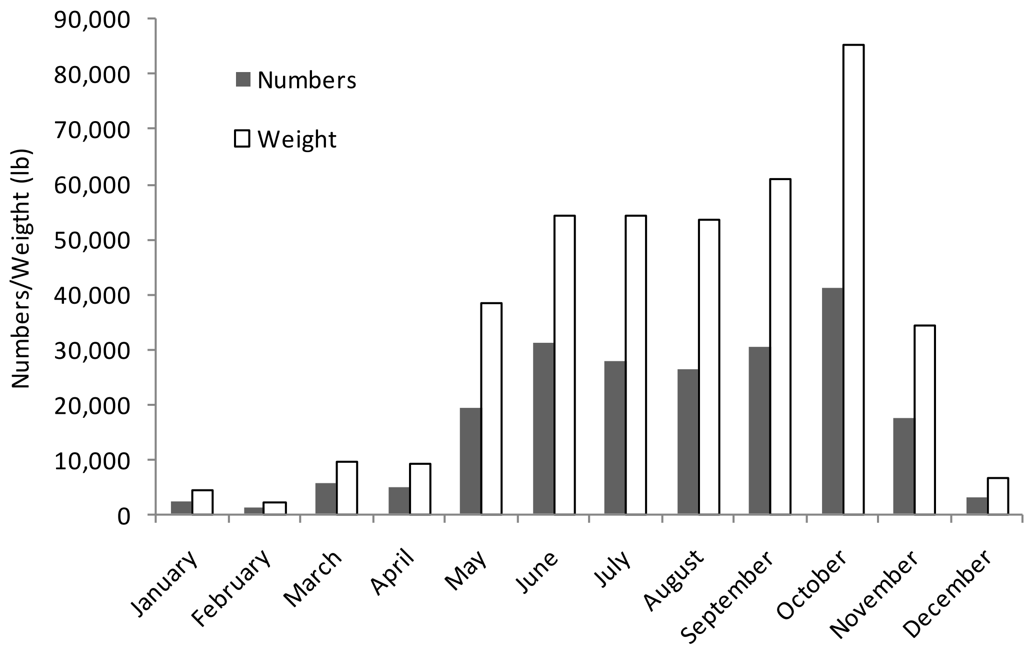


Figure 7.26 Monthly harvest (numbers and weight) of southern flounder in the RCGL fishery, 2002-2007 (NCDMF RCGL Survey).

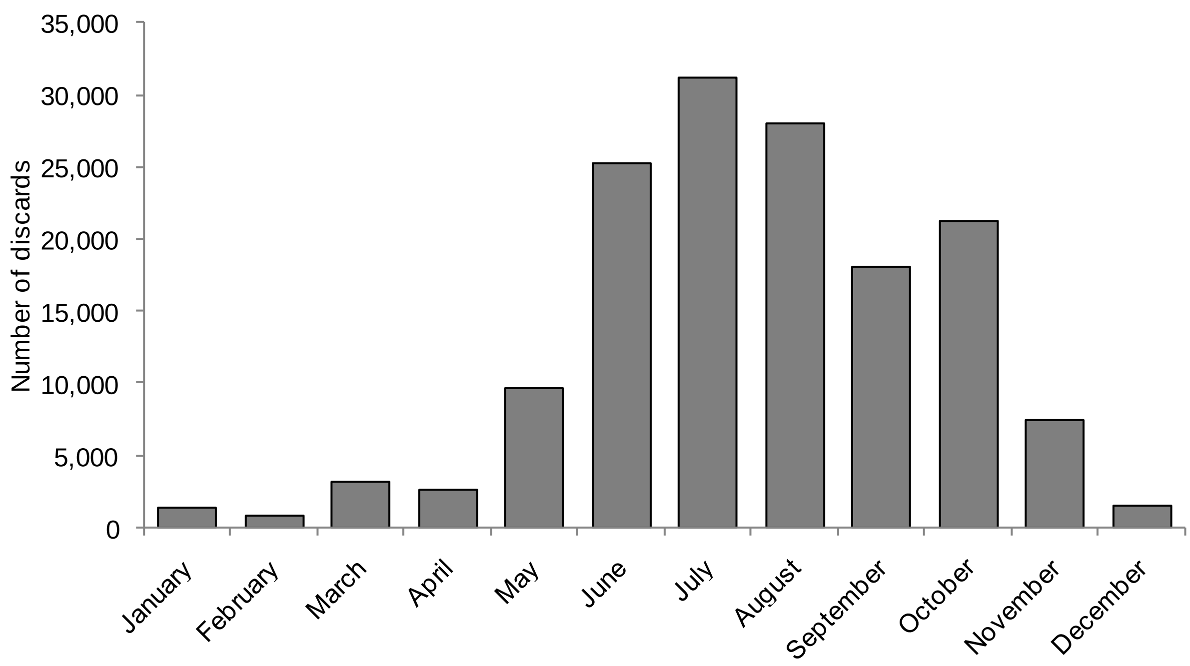


Figure 7.27 Monthly discards of southern flounder in the RCGL fishery, 2002-2007 (NCDMF RCGL Survey).

7.2.6.4 RCGL CATCH BY AREA

To more easily describe the spatial distribution of RCGL southern flounder harvest, the coast was divide into four regions, Northern, Pamlico, Central, and Southern (Figure 7.28). The contributions from each region to the total poundage of southern flounder harvested by weight were approximately 32%, 30%, 25% and 11%, respectively for the Pamlico, Southern, Central, and Northern regions (Table 7.15). The contributions from each region to the total numbers of trips and discards showed similar proportions.

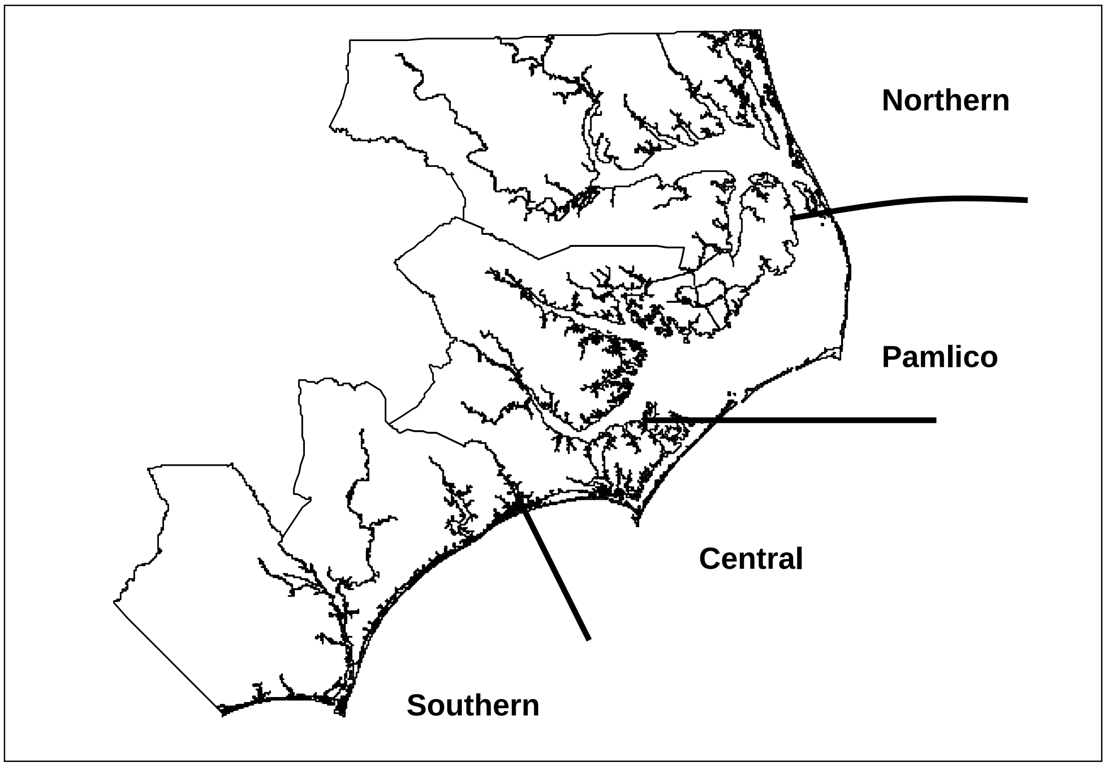


Figure 7.28 Regions used to describe the spatial distribution of southern flounder harvest from RCGL gears.

Table 7.15 Trips, harvest (numbers and weight), and discards of southern flounder by area in the RCGL fishery, 2002-2007 (NCDMF RCGL Survey).

		Trips		Harvest				Discard	
Year	Region	Number	Percent	Number	Percent	Pounds	Percent	Number	Percent
2002	Central	6,288	22.4	11,968	22.6	23,308	23.5	10,334	19.8
	Northern	5,376	19.2	7,854	14.8	15,568	15.7	4,748	9.1
	Pamlico	10,835	38.7	19,700	37.1	34,244	34.6	27,320	52.4
	Southern	5,530	19.7	13,509	25.5	25,986	26.2	9,759	18.7
	All	28,029	100.0	53,032	100.0	99,107	100.0	52,161	100.0
2003	Central	5,531	28.1	12,135	27.7	25,784	30.2	6,501	29.4
	Northern	1,664	8.4	2,479	5.7	4,723	5.5	2,207	10.0
	Pamlico	6,111	31.0	15,105	34.5	26,002	30.5	6,397	28.9
	Southern	6,181	31.4	13,819	31.5	28,243	33.1	6,895	31.2
	Unknown	227	1.1	289	0.7	619	0.7	133	0.6
	All	19,714	100.0	43,826	100.0	85,371	100.0	22,134	100.0
2004	Central	6,029	29.2	10,271	22.9	22,577	26.6	4,738	18.6
	Northern	1,701	8.2	8,168	18.2	12,087	14.2	3,360	13.2
	Pamlico	6,658	32.2	12,041	26.9	22,652	26.7	7,490	29.4
	Southern	5,522	26.7	12,454	27.8	23,887	28.1	8,856	34.8
	Unknown	758	3.7	1,901	4.2	3,767	4.4	992	3.9
	All	20,668	100.0	44,835	100.0	84,970	100.0	25,435	100.0
2005	Central	3,781	24.2	5,442	17.8	11,725	20.4	2,590	14.4
	Northern	887	5.7	1,132	3.7	2,177	3.8	2,145	11.9
	Pamlico	5,299	34.0	15,047	49.3	25,636	44.7	5,884	32.7
	Southern	5,210	33.4	7,730	25.3	15,551	27.1	6,963	38.7
	Unknown	422	2.7	1,199	3.9	2,270	4.0	401	2.2
	All	15,599	100.0	30,550	100.0	57,360	100.0	17,982	100.0
2006	Central	2,825	20.3	3,131	15.1	6,683	14.8	2,958	16.4
	Northern	1,498	10.8	1,904	9.2	4,053	9.0	1,006	5.6
	Pamlico	4,503	32.3	7,286	35.1	14,283	31.7	8,564	47.5
	Southern	4,776	34.3	7,836	37.7	19,068	42.3	5,201	28.8
	Unknown	319	2.3	623	3.0	1,034	2.3	307	1.7
	All	13,921	100.0	20,779	100.0	45,120	100.0	18,036	100.0
2007	Central	2,964	25.1	4,569	25.3	10,984	27.0	2,548	17.5
	Northern	1,486	12.6	2,351	13.0	5,433	13.3	1,455	10.0
	Pamlico	4,070	34.5	5,831	32.2	10,892	26.7	5,643	38.7
	Southern	2,839	24.0	4,727	26.1	12,094	29.7	4,328	29.7
	Unknown	454	3.8	613	3.4	1,350	3.3	619	4.2
	All	11,812	100.0	18,092	100.0	40,753	100.0	14,591	100.0
All	Central	27,418	25.0	47,515	22.5	101,061	24.5	29,669	19.7
	Northern	12,613	11.5	23,889	11.3	44,040	10.7	14,920	9.9
	Pamlico	37,476	34.1	75,010	35.5	133,709	32.4	61,297	40.8
	Southern	30,058	27.4	60,076	28.5	124,829	30.2	42,002	27.9
	Unknown	2,179	2.0	4,626	2.2	9,040	2.2	2,452	1.6
	All	109,743	100.0	211,113	100.0	412,681	100.0	150,340	100.0

8.0 SOCIOECONOMIC STATUS OF THE SOUTHERN FLOUNDER FISHERY

8.1 COMMERCIAL SOUTHERN FLOUNDER FISHERY

8.1.1 EX-VESSEL VALUE AND PRICE

Southern flounder is a relatively high-volume commercial fishery in North Carolina, representing a significant portion of the value of finfish landed overall in the state. In terms of value, the fishery clearly had a high point in the 1990s, with landings sometimes nearing or exceeding $8,000,000 per year (Figure 8.1, Table 8.1).

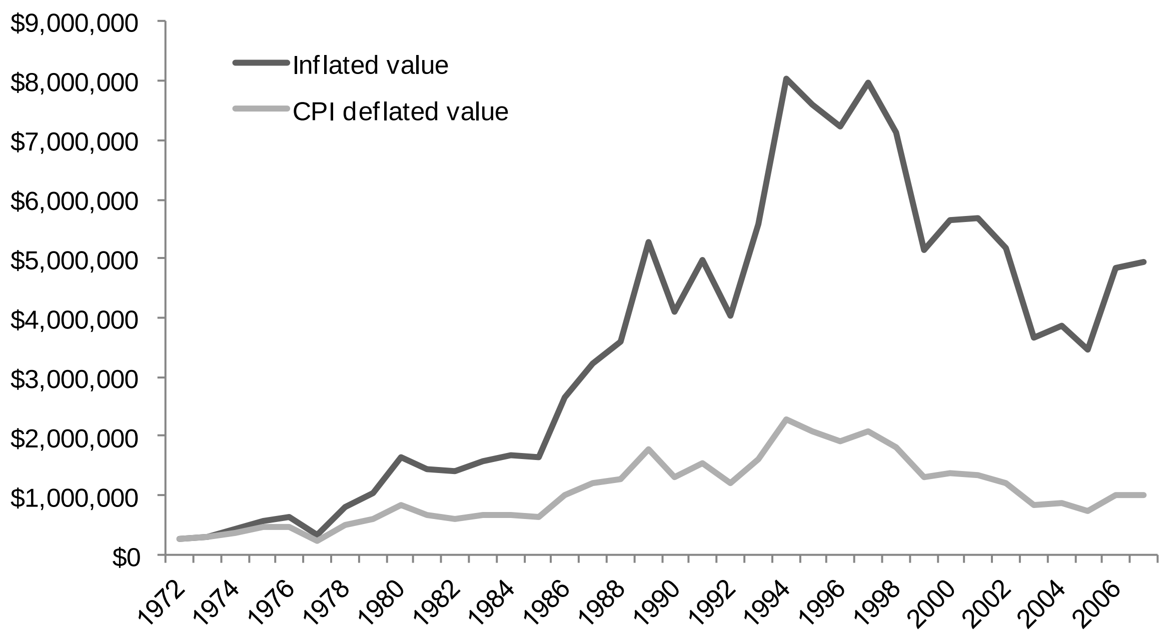


Figure 8.1 Value of southern flounder landings in North Carolina, 1972 – 2007 (NCDMF Trip Ticket Program).

The real price for southern flounder has not moved appreciably over the past 20 years, although it has kept up with inflation and has risen to over $2.00 since 2006 (Figure 8.2). The consistent ex-vessel price of the fish, when compared to the drastic swings in the supply over the decades, indicates a relatively inelastic demand curve and the likely presence of acceptable substitutes to consumers such as summer flounder. If southern flounder is not readily available to a customer, in other words, the customer is more likely to buy another type of fish than to tolerate a higher price from the supplier. This is in contrast to some other North Carolina species such as red drum that have seen steady price increases in recent years as commercial supplies have been increasingly restricted (NCDMF 2008b). The price of southern flounder is highly dependent on the supply and demand of summer flounder, as dealers pay the same price regardless of species.

Table 8.1 Detail values of southern flounder landed, total value, deflated value, price per pound, and percent change from year to year for landings in North Carolina, 1972—2007 (NCDMF Trip Ticket Program).

Year	Pounds landed	Inflated value	Conversion	CPI deflated value	Inflated price per pound	CPI price per pound
1972	785,348	$277,446	1.0000	$277,446	$0.35	$0.35
1973	904,700	$309,569	0.9414	$291,441	$0.34	$0.32
1974	1,617,306	$434,365	0.8479	$368,285	$0.27	$0.23
1975	1,730,809	$580,701	0.7770	$451,177	$0.34	$0.26
1976	1,706,267	$622,423	0.7346	$457,246	$0.36	$0.27
1977	704,212	$318,829	0.6898	$219,918	$0.45	$0.31
1978	1,407,847	$796,438	0.6411	$510,600	$0.57	$0.36
1979	2,043,142	$1,037,799	0.5758	$597,521	$0.51	$0.29
1980	2,965,023	$1,629,142	0.5073	$826,434	$0.55	$0.28
1981	2,212,948	$1,438,282	0.4598	$661,388	$0.65	$0.30
1982	1,940,195	$1,393,349	0.4332	$603,544	$0.72	$0.31
1983	2,533,417	$1,586,072	0.4197	$665,641	$0.63	$0.26
1984	2,294,059	$1,689,008	0.4023	$679,505	$0.74	$0.30
1985	1,960,200	$1,661,321	0.3885	$645,383	$0.85	$0.33
1986	2,613,970	$2,650,535	0.3814	$1,010,879	$1.01	$0.39
1987	2,621,651	$3,238,358	0.3680	$1,191,579	$1.24	$0.45
1988	3,314,027	$3,584,908	0.3533	$1,266,688	$1.08	$0.38
1989	3,225,955	$5,267,360	0.3371	$1,775,610	$1.63	$0.55
1990	2,560,459	$4,105,161	0.3198	$1,312,898	$1.60	$0.51
1991	4,163,374	$4,978,710	0.3069	$1,527,974	$1.20	$0.37
1992	3,145,020	$4,026,402	0.2979	$1,199,598	$1.28	$0.38
1993	4,272,368	$5,596,669	0.2893	$1,618,967	$1.31	$0.38
1994	4,878,639	$8,044,887	0.2821	$2,269,071	$1.65	$0.47
1995	4,166,966	$7,611,408	0.2743	$2,087,643	$1.83	$0.50
1996	3,807,009	$7,235,817	0.2664	$1,927,706	$1.90	$0.51
1997	4,076,793	$7,981,377	0.2604	$2,078,639	$1.96	$0.51
1998	3,952,729	$7,118,989	0.2564	$1,825,606	$1.80	$0.46
1999	2,933,331	$5,154,205	0.2509	$1,293,192	$1.76	$0.44
2000	3,205,792	$5,660,767	0.2427	$1,374,100	$1.77	$0.43
2001	3,522,136	$5,690,481	0.2360	$1,343,095	$1.62	$0.38
2002	3,436,753	$5,165,017	0.2324	$1,200,098	$1.50	$0.35
2003	2,198,503	$3,661,597	0.2272	$831,819	$1.67	$0.38
2004	2,454,577	$3,880,410	0.2213	$858,661	$1.58	$0.35
2005	1,870,754	$3,462,308	0.2140	$741,037	$1.85	$0.40
2006	2,287,823	$4,850,300	0.2100	$1,018,563	$2.12	$0.45
2007	2,077,798	$4,958,108	0.2016	$999,555	$2.39	$0.48

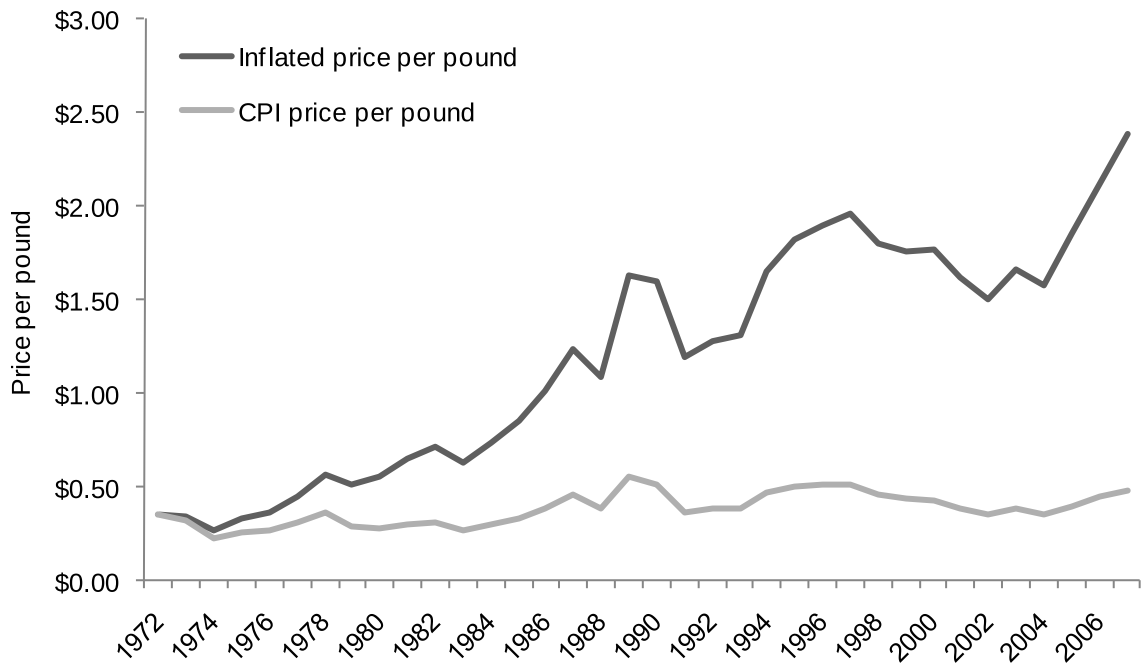


Figure 8.2 Average price per pound of southern flounder landings in North Carolina, 1972—2007 (NCDMF Trip Ticket Program).

8.1.2 PARTICIPANTS AND TRIPS

The North Carolina Division of Marine Fisheries keeps rigorous track of the commercial catch levels of all fishermen in the state. Information is captured at the point at which catch is sold to the commercial dealer for every trip. This information can be broken down and categorized for a closer look at the patterns of behavior of fishermen in any particular fishery.

The number of fishermen involved with the fishery since 1999 is reported in Table 8.2, broken down by the number of individual trips that resulted in catching southern flounder in each year. Note that the number of participants has diminished by approximately one-third since the turn of the millennium. This drop in effort has not been restricted to the commercial southern flounder fishery; efforts to catch other fish commonly pursued by southern flounder fishermen (such as spotted sea trout) have also decreased by a similar proportion.

Table 8.2 Number of participants and the number of trips taken that landed southern flounder in North Carolina, 1999—2007 (NCDMF Trip Ticket Program).

	1999	2000	2001	2002	2003	2004	2005	2006	2007
1 Trip	267	261	241	207	221	196	174	148	184
% within Year	15%	14%	14%	13%	15%	14%	15%	13%	15%
2 - 10 Trips	641	668	623	551	524	504	411	390	403
% within Year	36%	35%	36%	35%	36%	37%	35%	33%	32%
11 - 20 Trips	250	243	212	216	181	164	144	163	156
% within Year	14%	13%	12%	14%	13%	12%	12%	14%	13%
21 - 50 Trips	285	310	292	262	247	217	191	191	193
% within Year	16%	16%	17%	17%	17%	16%	16%	16%	16%
51 - 100 Trips	186	231	189	182	148	136	140	140	173
% within Year	10%	12%	11%	12%	10%	10%	12%	12%	14%
More than 100 Trips	166	175	177	166	117	140	117	150	137
% within Year	9%	9%	10%	11%	8%	10%	10%	13%	11%
Total	1,795	1,888	1,734	1,584	1,438	1,357	1,177	1,182	1,246

Participants in this fishery, by annual income from southern flounder, are presented in Table 8.3. There has been a significant increase in the amount of money earned from southern flounder by the average participating fisherman, as the proportion of fishermen with over $1,000 in landings has increased from 32% in 1999 to 41% in 2007.

Table 8.3 Number of participants in the southern flounder fishery by value of landings and year in North Carolina, 1999—2007 (NCDMF Trip Ticket Program).

	1999	2000	2001	2002	2003	2004	2005	2006	2007
<$100	654	667	620	567	507	463	386	316	372
% within year	36%	35%	36%	36%	35%	34%	33%	27%	30%
$101 - $500	410	407	383	338	287	296	253	245	251
% within year	23%	22%	22%	21%	20%	22%	22%	21%	20%
$501 - $1000	158	142	135	128	148	123	98	100	111
% within year	9%	8%	8%	8%	10%	9%	8%	9%	9%
> $1000	573	672	596	551	496	475	440	521	512
% within year	32%	36%	34%	35%	35%	35%	37%	44%	41%
Total	1,795	1,888	1,734	1,584	1,438	1,357	1,177	1,182	1,246

As with any commercial fishery in the state, fishermen who land southern flounder may only sell their catch to licensed dealers. The number of dealers who handled southern flounder has dropped over the past decade, perhaps reflecting a drop in the number of fish houses in the state (Garrity-Blake and Nash 2006).

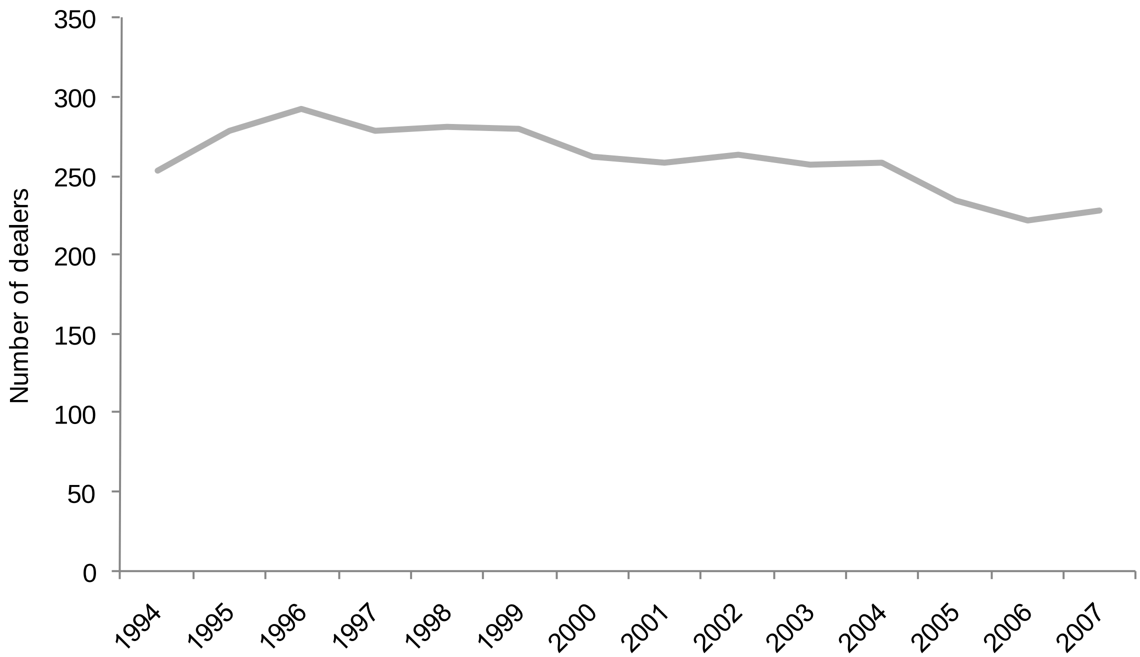


Figure 8.3 Number of dealers who purchased southern flounder from 1994—2008 (NCDMF Trip Ticket Program).

Table 8.4 shows the dependence on various dealers on southern flounder. The average and median values are for the dealer's overall business, not just southern flounder purchases. For 62% of dealers, southern flounder purchases make up less than a fifth of their total commercial value totals, but 11% of dealers rely almost entirely (>80%) on southern flounder for their business models. The sharp difference between the average and median values indicates the presence of several "highliners" in each category (businesses who deal in much larger volumes than the median).

Table 8.4 Percent of dealer value consisting of southern flounder, 2007 (NCDMF Trip Ticket Program).

Range	Number	Percent	Average	Median
<20%	141	62%	$427,681	$60,062
20 - 40%	34	15%	$145,140	$32,707
40 - 60%	14	6%	$70,120	$9,757
60 - 80%	14	6%	$83,907	$4,320
> 80%	25	11%	$17,827	$2,798
Total	228	100%		

8.1.3 ECONOMIC IMPACT OF COMMERCIAL FISHERY

The economic impact of the commercial southern flounder harvest to North Carolina's economy for 2008 is shown in Table 8.5. These impacts were calculated using IMPLAN, an economic modeling software. For example, the purchase of insurance for a fisherman's boat helps employ an insurance agency, which must purchase business supplies from another store and pay its employees. IMPLAN tracks these expenditures as money is spent and re-spent until it leaves the state's borders. Commercial fishermen in North Carolina operate almost exclusively as independent businessmen; because of this, the commercial fishing model native to IMPLAN is somewhat imprecise.[1] Using recent expenditure data gathered from commercial fishermen in the inshore fisheries of the Sounds (Crosson 2007a; Crosson 2007b), total expenditures for southern flounder-landing commercial trips for 2007 are as follows:

$$\text{Total commercial expenditures} = (t*\tilde{E}) + (n*(t/t\text{all})*\tilde{Y}) + (n*(t/t\text{all})*\tilde{I})$$

where t = number of flounder-landing trips, $\tilde{E}$=median per-trip expenditures, n = number of flounder-landing fishermen, $t$all = total trips taken by flounder-landing fishermen throughout the year, $\tilde{Y}$=median yearly fixed expenditures, and $\tilde{I}$=median proprietary income.[2]

Analysis using the 2006 IMPLAN model for the North Carolina commercial fishery yields the economic impact from expenditures in Table 8.5.

Table 8.5 Economic impact of the southern flounder-landing commercial trips in North Carolina, 2007 (NCDMF Trip Ticket Program, IMPLAN).

Total economic impact	$17,691,083
Economic inputs	$1,916,325
Proprietary income	$9,029,512
Additional economic activity generated	$6,745,246
Additional jobs generated	134

The other economic sectors most affected by commercial catch of the fishery are wholesale trade, oil and gas sales, domestic trade, home work and repair, government spending, boat building/repair, realty, medical services, food services, and international trade. This model does not include the post-landings economic effect of southern flounder, only the business inputs from the commercial fishermen. The economic effect of southern flounder landings on dealers, seafood markets, restaurants, and shipping interests requires data that is not currently available.

8.1.4 DEMOGRAPHIC CHARACTERISTICS OF COMMERCIAL FISHERMEN

The socioeconomic program at the DMF has been conducting a series of in-depth interview-style surveys with commercial fishermen along the coast since 2001. Data from these interviews is added to a growing database and used for fishery management plans, among other uses. A total of 250 of the fishermen in the database reported commercial landings of southern flounder. That group is used to provide a snapshot of North Carolina fishermen who catch southern flounder.

The demographic characteristics of the southern flounder-reporting fishermen surveyed by the Socioeconomic Program over the past five years are shown in Table 8.6. Nearly all were white males, with an average age of 50 and over 25 years of commercial fishing experience. Three quarters of them had a high school diploma and 20% had at least some college education.

[1] IMPLAN sector models are based on national averages. Because the large-scale commercial fleets of Alaska generate a large portion of the nation's fishing activity, the IMPLAN model needs to be adjusted to better reflect the regional fishing business model.
[2] Because of the presence of a few large-scale businesses in the data set, expenditure data was not normally distributed, so median (rather than mean) values were used for analysis.

Over half exceeded $30,000 in household income when surveyed, with 28% bringing in $50,000 or more. Only 11% had less than $15,000 in annual household income (Table 8.6).[3]

Fishing accounted for two-thirds of the household income from these fishermen. They are least likely to fish in January and February, which is the slowest time of the year for most fishermen.

Table 8.6 Demographic characteristics of southern flounder commercial fishermen (NCDMF Socioeconomic Program).

Variable	n = 250	Average or %
Years fishing		25
Age		50
Gender	Male	94.8%
	Female	5.2%
Race	White	97.2%
	Black	1.2%
	other	1.6%
Education level	Less than HS	29.8%
	HS grad	41.1%
	Some college	20.6%
	College graduate	8.5%
Marital status	Married	75.9%
	Divorced	12.4%
	Widowed	2.0%
	Never married	2.0%
	Separated	7.6%
Total household income	Less than $15,000	10.7%
	$15,001 - $30,000	35.5%
	$30,001 - $50,000	26.0%
	$50,001 - $75,000	14.5%
	More than $75,000	13.2%

8.1.5 HISTORICAL IMPORTANCE OF THE COMMERCIAL FISHERY

A historical overview of the southern flounder fishery can be found in Section 7.0, Status of the Fisheries. The socioeconomic interviewers asked fishermen how important commercial fishing has historically been in their communities. Almost all of them felt it had been vital, giving it a 9.5 on a 10-point scale. Perceptions of current community support were lower, at 6.7. The statement “fishing is important economically in my community” drew an 8.2.

8.1.6 OTHER TARGETED SPECIES OF THE COMMERCIAL FISHERY

Few commercial fishermen in North Carolina rely solely on southern flounder to make a living; these fishermen instead target other species as well such as blue crabs, striped mullet, spot, and shrimp (Table 8.7).

[3] The refusal rate on the household income question was 4%.

Table 8.7 Prevalent species targeted by southern flounder commercial fishermen (NCDMF Socioeconomic Program).

Species	% who land
Blue crabs	45%
Striped mullet	24%
Spot	23%
Shrimp	17%
Clams	17%
Oysters	16%
Perch	16%
Striped bass	14%
Spotted seatrout	12%
Shad	12%

8.1.7 PERCEIVED CONFLICTS

Fishermen were asked about conflicts in the previous year with recreational users and with other commercial fishermen. Conflicts with other users of a public resource are to be expected, and part of the job of the NCDMF is to balance the needs of different user groups. A third of commercial fishermen reported conflicts with other commercial fishermen. A slightly larger percentage (38%) reported having had conflicts with recreational fishermen.

8.1.8 PERCEPTION OF IMPORTANT ISSUES

The fishermen were also asked to rate the seriousness of a number of issues facing themselves and their businesses. Fuel prices were the most important issue, followed by development of the coast and losing working waterfronts (Table 8.8).

Table 8.8 Fishing related issues considered most important to commercial fishermen who landed southern flounder (NCDMF Socioeconomic Program).

Ranking	Issue
1	Fuel prices
2	Development of the coast
3	Losing working waterfronts
4	Low prices for seafood / imports
5	State regulations
6	Keeping up with regulations
7	Size limits
8	Federal regulations

8.2 RECREATIONAL SOUTHERN FLOUNDER FISHERY

8.2.1 ECONOMIC IMPACT OF THE RECREATIONAL FISHERY

The NCDMF collects data about recreational hook and line fishing in conjunction with the federal government's Marine Recreational Fisheries Statistics Survey (MRFSS). MRFSS occasionally includes a socioeconomic add-on to generate spending estimates. Combining the most recent socioeconomic data available (from 2006) with the average estimated expenditures per southern flounder-targeting and -landing recreational trips in 2008, the total expenditures are as follows:

Total recreational expenditures = (t*Ē)

where t = number of southern flounder-targeting and -landing trips and Ē=mean per-trip expenditures.

This analysis for the North Carolina hook and line fishery yields the economic impact from expenditures in Table 8.9.

As with the commercial analysis, an input-output model was generated using IMPLAN. The economic sectors most affected by efforts in the recreational fishery are food stores, wholesale trade, oil and gas sales, domestic trade, ice manufacture, hotels, charter fees, realty, home work and repair, business management, food services, and medical services.

Table 8.9 Economic impact of the southern flounder-landing recreational angling trips in North Carolina, 2007 (NCDMF Socioeconomic Program, IMPLAN).

Total economic impact	$25,390,614
Economic inputs	$15,733,180
Additional economic activity generated	$9,657,434
Additional jobs generated	324

Southern flounder are also occasionally caught by holders of the Recreational Commercial Gear License (RCGL). RCGL fishermen use commercial gear (primarily gill nets and trawls) to catch fish and shrimp, but cannot sell their catch. Combining the most recent socioeconomic data available (from 2007) with the average estimated expenditures per southern flounder-targeting and -landing recreational trips in 2008 produces Table 8.10.

Table 8.10 Economic impact of the southern flounder-landing RCGL trips in North Carolina, 2007 (preliminary) (NCDMF Socioeconomic Program, IMPLAN).

Total economic impact	$2,537,893
Economic inputs	$1,579,137
Additional economic activity generated	$958,756
Additional jobs generated	32

Major economic sectors affected include food and beverage stores, oil and gas stations, hotels, wholesale trade, and realty.

8.2.2 DEMOGRAPHIC CHARACTERISTICS OF RECREATIONAL FISHERMEN

Beginning in 2007, North Carolina required coastal recreational anglers to purchase a Coastal Recreational Fishing License (CRFL). One of the stated reasons for the creation of the CRFL was to enable more complete surveying of recreational anglers than are allowed by the MRFSS. Accordingly, the NCDMF began gathering socioeconomic information on hook-and-line recreational fishermen in 2009. Preliminary data is available, but substantive reports will not be ready until 2010.

In a study of 610 CRFL holders, 508 (83%) reported that they fish for southern flounder, and 149 of those (29%) at least occasionally use gigs. Like commercial fishermen, CRFL holders are primarily white males with an average age close to 50, but the recreational anglers have generally higher education and household incomes (Table 8.11).

Table 8.11 Demographic characteristics of southern flounder anglers (preliminary) NCDMF Socioeconomics Program.

Variable	n = 508	Average or %
Years fishing		28
Age		48
Gender	Male	91.5%
	Female	8.5%
Race	White	93.5%
	Black	2.2%
	other	4.4%
Education Level	HS grad or less	27.5%
	Some college	31.9%
	College graduate	27.6%
	Graduate school	12.2%
Marital Status	Married	80.7%
	Divorced	5.3%
	Widowed	1.0%
	Never married	11.0%
	Separated	1.2%
Total Household Income	Less than $15,000	1.8%
	$15,001 - $30,000	6.9%
	$30,001 - $50,000	15.7%
	$50,001 - $75,000	19.7%
	More than $75,000	16.3%
	Prefer not to answer	16.5%

The 2007 survey of RCGL holders revealed some demographic and attitudinal statistics comparable to those of the CRFL holders (Table 8.12).

Table 8.12 Demographic characteristics of southern flounder RCGL fishermen (NCDMF RCGL Program).

Variable	n = 292	Average or %
Years with RCGL		4.1
Age		84% over 40
Gender	Male	93.4%
	Female	6.6%
Race	White	98.5%
	Other	1.5%
Education level	Less than HS	8.8%
	HS grad	24.3%
	Some college	36.4%
	College graduate	30.5%
Marital status	Married	81.6%
	Divorced	7.0%
	Widowed	4.6%
	Never married	5.5%
	Separated	1.3%
Total household income	Less than $15,000	5.8%
	$15,001 - $30,000	12.5%
	$30,001 - $50,000	21.0%
	$50,001 - $75,000	23.6%
	More than $75,000	37.1%

8.2.3 OTHER TARGETED SPECIES OF THE RECREATIONAL FISHERY

None of the recreational anglers surveyed to date exclusively target southern flounder. Most of the other species they commonly target are also inshore fisheries, with the exception of king mackerel.

Table 8.13 Other species targeted by southern flounder anglers (preliminary) (NCDMF Socioeconomic Program).

Species	% who land
Spotted seatrout	75%
Spot	72%
Red drum	68%
Bluefish	67%
Atlantic croaker	64%
Black drum	54%
Sea mullet	52%
Weakfish	49%
Striped bass	47%
King mackerel	45%

8.2.4 PERCEPTION OF IMPORTANT ISSUES

CRFL holders were asked to rate a series of issues on the perceived importance to their fishing (Table 8.14). Water quality was the most important issue, followed by fuel prices. As with other recreational angling data, these results are preliminary.

Table 8.14 Fishing related issues considered most important to southern flounder anglers (preliminary) (NCDMF Socioeconomic Program).

Ranking	Issue
1	Water quality
2	Fuel prices
3	Keeping up with regulations
4	Finding enough time in my life to fish
5	Overfishing/too few fish
6	Access issues (lack of boat ramps, etc)
7	Weather
8	Bag/size limits
9	Losing fishing piers
10	Competition with commercial fishermen
11	Competition with other recreational fishermen/crowding

RCGL holders were surveyed on conflicts with other fishermen and asked their opinions about the amount of gear in the water. Over 70% stated that they did not have conflicts with commercial fishermen, and over 90% stated they did not have conflicts with hook-and-line recreational fishermen. Only 30% felt that there might be too much gear in the water where they fished.

8.3 DEFINITIONS AND ACRONYMS

CPI (Consumer Price Index) – The CPI measures the price paid by consumers for a fixed group of goods and services. Changes in the CPI over time constitute a common measure of inflation.

Deflated (Inflation-adjusted) price and value – Inflation is a general upward price movement of goods and services in an economy, usually as measured by the Consumer Price Index (CPI). Ex-vessel prices and values can be adjusted (deflated) according to the CPI to remove the effects of inflation so that the value of a dollar remains the same across years. Inflation adjusted values allow for easier understanding and analysis of changes in values.

9.0 ENVIRONMENTAL FACTORS

9.1 HABITAT

Habitat use patterns of southern flounder vary over time, space and by life stage. The species typically spawns in the fall and winter along the edge of the continental shelf. Water circulation passively transports planktonic flounder larvae through ocean inlets to interior coastal waters, and developing fry pass into the estuary in late winter (Peters et al. 1995). Post-larval flounder actively move to shallow, nearshore waters in the upper regions of low to moderate salinity estuaries (Walsh et al. 1999), the majority of which are designated by state resource managers as fish nursery areas. The relatively turbid water typical of this region provides a certain degree of protection for small flounder from visual-searching predators. As the flounder's body size increases, the likelihood of its survival in lower, less turbid regions of the estuary increase. Juvenile southern flounder prefer waters above mud bottom, along the edge of salt/brackish marsh, near areas with shell bottom substrate, and submerged aquatic vegetation (SAV) (Pattilo et al. 1997; Minello 1999; Walsh et al. 1999; Peterson et al 2003). However, juvenile and adult southern flounder are also abundant in deeper waters away from shore (NCDMF Pamlico Sound and Estuarine Trawl surveys). Each of these habitats provides ecological services that aid in maintaining and enhancing the southern flounder population. These habitats serve as nursery areas, refuge from piscivorous predators, foraging areas, and corridors for passage among different habitats. Some of the largest southern flounder are found around structures near inlets and other bottleneck areas (based on anecdotal fishing reports). Protection of each habitat type is critical to the sustainability of the southern flounder stock.

9.1.1 WATER COLUMN

Southern flounder depend on the water column throughout their life history for migration, spawning and larval transport. Water column habitat is defined as "the water covering a submerged surface and its physical, chemical and biological characteristics" (Street et al. 2005). In North Carolina, large concentrations of adult southern flounder migrate to offshore spawning grounds during the fall and winter. Larvae are spawned offshore and then migrate into the estuarine system by passive transport on nearshore and tidal currents. Burke et al. (1991) reported recruitment of larvae into North Carolina estuaries occur from November through April with peak recruitment occurring in February. These larvae settle into tidal mudflats near the head of the estuary, and in the spring, migrate upstream into the riverine habitats. During the spring and summer, southern flounder prefer the silt and mud substrate of these riverine systems and will sometime enter freshwater (Burke et al. 1991; Smith et al. 1999). Burke et al. (1991) concluded that settlement of southern flounder is influenced by salinity. Rulifson et al. (2009) also found that riverine freshwater systems may be an important secondary nursery habitat for southern flounder as well.

In addition to its role in spawning and larval transport, the water column provides food and oxygen critical for survival and growth of southern flounder populations. Inlets play an essential role in mixing sea water and fresh water, which is critical for maintaining salinity and current regimes, dispersing nutrients and pollutants, and providing migratory corridors for juvenile and adult fish and invertebrates. There are currently 20 inlets in North Carolina that connect estuarine waters to the sea. Unnatural or human-induced changes that reduce or increase flow into estuaries may result in environmental stress in organisms (SAFMC 1998).

9.1.2 WETLANDS

Wetlands are defined as "…areas that are inundated or saturated by an accumulation of surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions " (Street et al. 2005). Wetlands are considered one of the most biologically productive ecosystems in the world. It is estimated that over 95% of commercially harvested finfish and invertebrates in the United States are wetland dependent, a strong indication of their high habitat value (Feierabend and Zelazny 1987). Tidal marsh wetlands generally occur along the edge of estuaries and sounds in polyhaline and mesohaline waters. The combination of shallow water and thick vegetation provides excellent nursery and foraging habitat for southern flounder and many other fish species (Graff and Middleton 2003). Emergent vegetation structure such as coastal marsh has been recognized as habitat for juvenile and small adult fishes and flounder (Kneib and Stiven 1978; Hettler 1989). These shallow water wetlands provide refuge from large fish predators and provide a safe corridor for migration to other habitats within the system (Mitsch and Gosselink 1993; Rozas and Odum 1997). Riparian wetlands are also highly effective and well recognized for their ability to trap and filter pollutants from upland runoff, and store, spread, and slow stormwater runoff prior to entering surface waters (Mitsch and Gosselink 1993).

Regularly flooded marsh surfaces are used by resident and estuarine dependent transient juvenile fishes, providing expanded habitat for feeding and protection from predation during high tide (Hettler 1989). Hettler (1989) found that juvenile southern flounder utilize both channel edge marsh and rivulet edge marsh. Channel edge marsh is marsh that borders a third order tidal creek with adjoining water never draining more than one to two meters away from the marsh edge at low tide. Rivulet marshes are found at the upper end of first order streams and are usually completely drained at low tide but leave residual pools. Nanez-James et al. (2009) found that juvenile southern flounder will forage along the marsh edge of channel marshes utilizing the complex structure for predator avoidance while foraging for prey driven off the marsh surface.

Coastal wetlands were mapped by the North Carolina Division of Coastal Management (DCM) in 1994 and are shown in Figure 9.1. The highest percentages of estuarine wetlands occur in Core, Bogue and Pamlico sounds and in the southern estuaries, whereas the greatest proportion of riverine wetlands occur in the Cape Fear, Neuse, and Roanoke River basins. The largest acreage of salt/brackish marsh is in the Pamlico Sound regions (Street et al. 2005).

It is estimated that approximately 66% (4.7 million acres) of historical wetlands remain in North Carolina, including 88% (183,000 acres) of historical salt/brackish marsh (DWQ 2000a). Additionally, 29,560 acres (11.6%) of existing salt, brackish, and freshwater marsh appear to be physically altered (DCM unpublished data). Human population growth and the associated land use changes are the primary cause of wetland habitat loss today (Dahl 2000). Activities such as dredging, water control projects and hydrological alterations, shoreline stabilization, and sea level rise are the primary threats to wetland habitats.

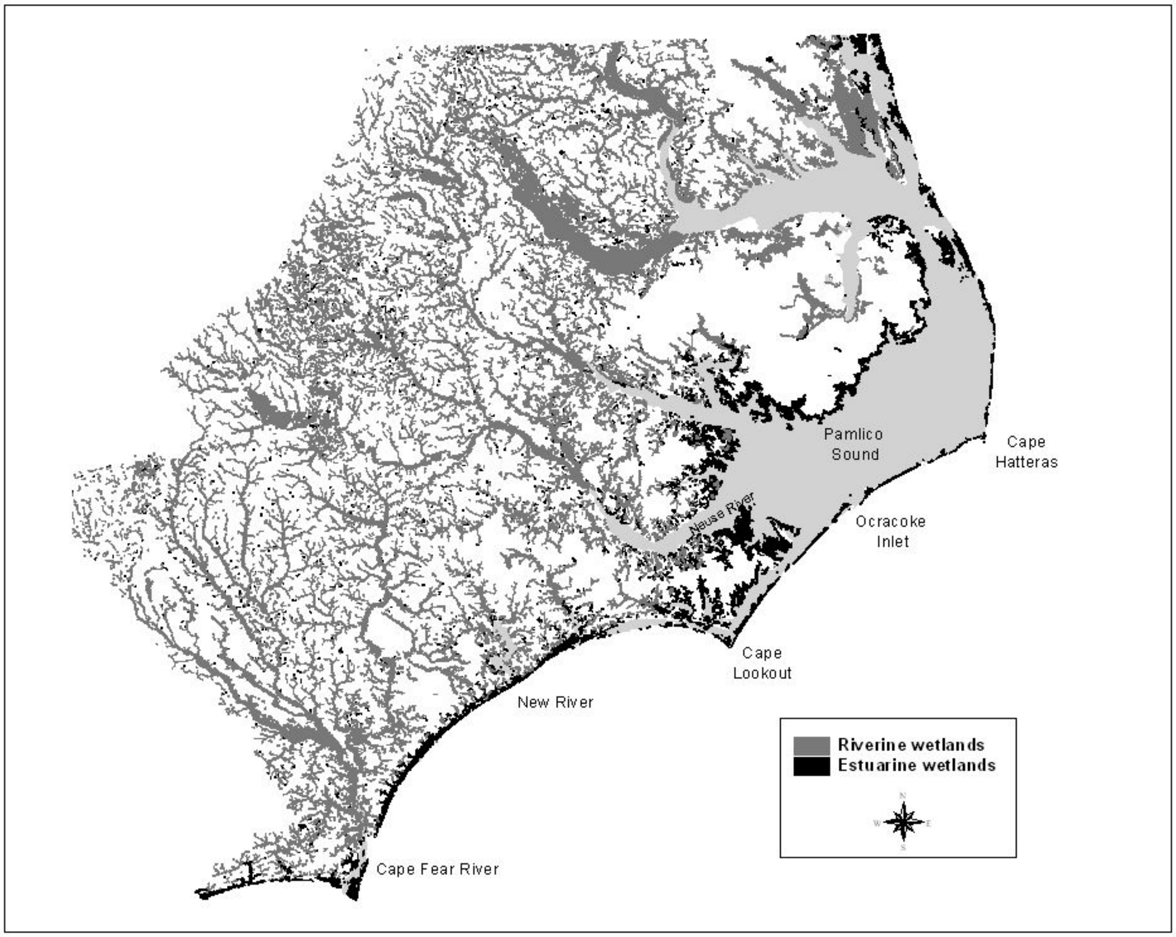


Figure 9.1 Location of esturarine and riverine wetlands in coastal North Carolina, based on 1994 DCM mapping data (Street et al. 2005).

9.1.3 SUBMERGED AQUATIC VEGETATION

Submerged aquatic vegetation (SAV) is another habitat utilized by southern flounder as a nursery area. SAV habitat is defined as "bottom recurrently vegetated by living structures of submerged, rooted vascular plants (roots, rhizomes, leaves, stems, or propagules), as well as temporarily unvegetated areas between vegetated patches" (Street et al. 2005). SAV occurs in both subtidal and intertidal zones and may be colonized by estuarine species, such as eelgrass (*Zostera marina*), shoal grass (*Halodule wrightii*), or widgeon grass (*Ruppia maritima*) or freshwater species, such as wild celery (*Vallisneria americana*) and sago pondweed (*Potamogeton pectinatus*). The spatial structure of SAV habitat can be quite variable, ranging from small isolated patches of plants less than a meter in diameter to continuous meadows covering several acres (Street et al. 2005). SAV abundance, biomass, and species composition in North Carolina waters varies seasonally with changes in temperature and light conditions (Dawes et al. 1995; SAFMC 1998). With the dynamic nature of SAV in mind, the NCMFC and the Coastal Resources Commission (CRC) have redefined the definition of SAV habitat to encompass the seasonal and spatial complexity of this habitat [NCMFC rule 15A NCAC 03I .0101 (4)(i)].

SAV maintains and enhances the overall functionality of estuaries and coastal rivers. The above and below ground structures of SAV modify wave energy regimes, stabilize sediments and adjacent shorelines, and cycles nutrients within the system (Thayer et al. 1984; SAMFC 1998). These processes generally increase water clarity, decrease the frequency of nuisance algal blooms, and promote conditions favorable for growth and expansion of SAV (Thayer et al. 1984). Also, because of their high rate of primary production, SAV provides an important source of organic matter. The large quantities of organic material produced by SAV support the base of a complex food web necessary for the maintenance of fish and invertebrate populations.

In addition to their importance to ecosystem function, SAV also provides crucial structural habitat for fishes and invertebrates. Over 150 species of fish and invertebrates, including southern flounder have been documented by NCDMF in seagrass beds in eastern Pamlico and Core sounds (NCDMF 1990). The three-dimensional structure of SAV provides a surface for small plants and animals to attach to and provides a safe refuge and foraging area for a large number of juvenile fish and invertebrates (SAFMC 1998). The structure of SAV grass blades provides an excellent nursery area and enhances a safe corridor between habitats, reducing predation (Micheli and Peterson 1999).

SAV provides structure for juvenile southern flounder. Nanez-James et al (2009) found that in Texas, the highest abundance of newly settled southern flounder was near the inlets in vegetated sandy areas such as SAV and marshes but with no significant differences between the two habitats. These findings suggest that seagrass beds and marsh edge function as important nursery areas by providing a complex structure for juvenile southern flounder for predator avoidance while supplying accessible prey.

North Carolina supports more acreage of SAV than any other state along the Atlantic coast with the exception of Florida (Street et al. 2005). The amount of SAV in North Carolina was estimated to be approximately 134,000 acres (Carraway and Priddy 1983; Ferguson and Wood 1994). The majority of SAV occurred in eastern Pamlico Sound and Core Sound in high salinity waters (Figure 9.2). SAV was also documented to occur in a narrow band along a portion of the western Pamlico Sound shoreline and the Pamlico and Neuse rivers and tributaries, although its distribution and abundance in this area was underestimated due to reduced water clarity. However, Davis and Brinson (1989) qualitatively described the location of SAV in this area. Areas south of Bogue Sound have not been mapped.

The estimations from mapping may not accurately reflect the current spatial coverage of SAV in North Carolina, especially in areas not suitably mapped such as portions of Albemarle and western Pamlico Sounds, and areas south of Bogue Sound. Because light is the primary limiting factor affecting its distribution, SAV is restricted to relatively shallow waters, usually less than two meters in depth. The amount of SAV fluctuates seasonally and inter-annually, depending on the species and salinity regime. In addition, changes in the distribution of SAV may have also occurred since the completion of the mapping. Nevertheless, the majority of SAVs in North Carolina occurs in the high salinity, shallow waters of eastern Pamlico and Core sounds and has appeared to be relatively stable and persistent over time (Ferguson and Wood 1994). In contrast, qualitative reports from the mid to late 1990s indicated large scale reductions of low salinity SAV habitat, primarily along the western shores of Albemarle and Pamlico sounds.

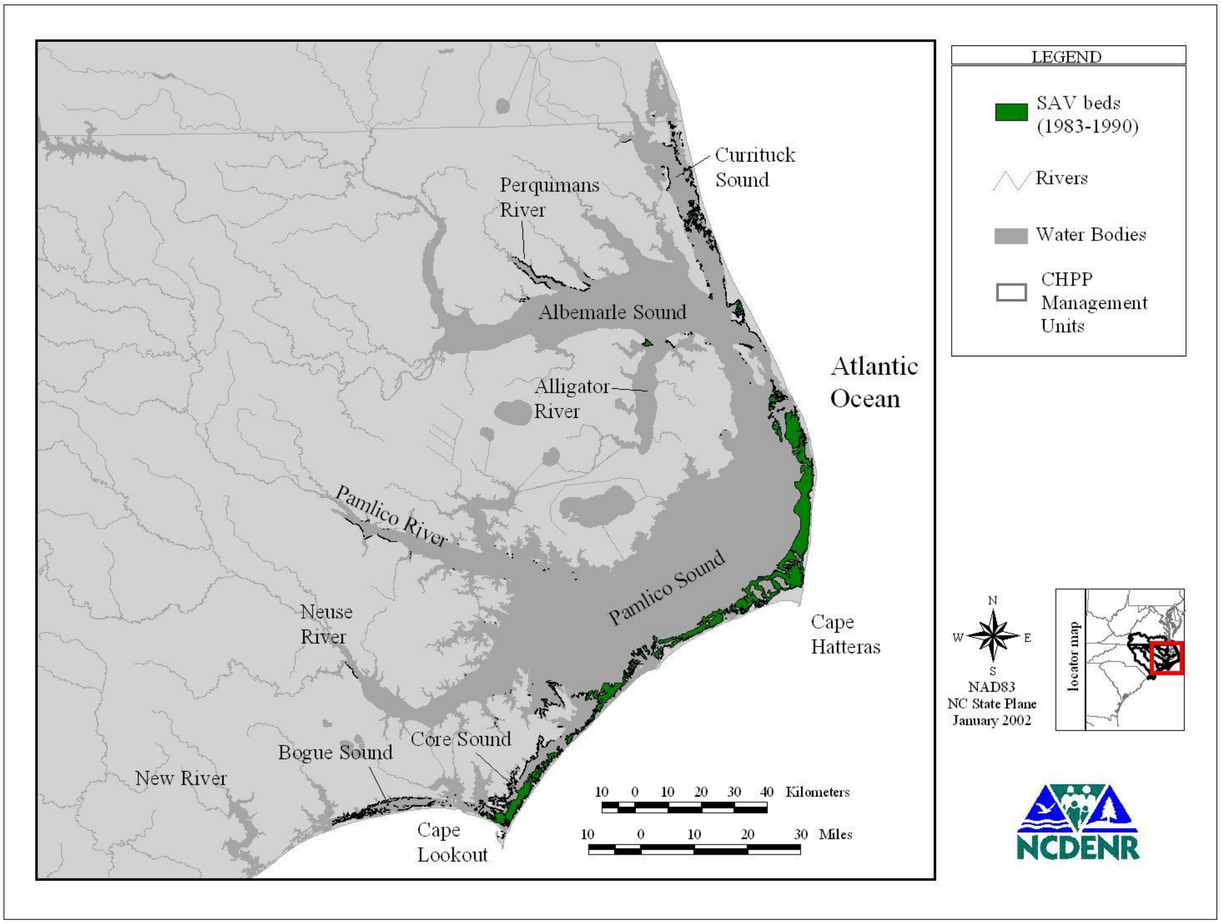


Figure 9.2 Distribution of known submerged aquatic vegetation habitat in North Carolina (Street et al. 2005).

9.1.4 SOFT BOTTOM

Southern flounder utilize shallow estuarine soft bottom as a nursery and foraging area. This habitat is defined as "unconsolidated, unvegetated sediment that occurs in freshwater, estuarine, and marine systems" (Street et al. 2005). The soft bottom habitat is separated into freshwater, estuarine, and marine habitats due to differing geomorphology, sediment type, water depth, hydrography, and/or salinity regimes (Street et al. 2005). Wetlands, SAV and shell bottom often occur adjacent to shallow soft bottom. In general, coarse sands are concentrated along high-energy and eroding shorelines, while fine muds are concentrated along low-energy shorelines and deepwater basins (Wells 1989; Riggs 1996).

Substrate appears to play a role in the distribution of southern flounder as it is related to salinity (Powell and Schwartz 1977; Burke et al. 1991). The highest densities of southern flounder are found in the upper estuary with narrow riverine habitat, low salinities, muddy substrate, detritus and high turbidities (Burke et al. 1991; Walsh et al 1999). These more turbid habitats may provide protection from predators. Burke et al. (1991) reported that larvae of both southern and summer flounder will recruit into estuaries at the same time and demonstrate considerable overlap in distribution within the estuary. However, segregation occurs quickly (Burke et al. 1991; Burke 1995). Pre-metamorphic larvae of southern flounder tend to concentrate on tidal flats in the upper reaches of estuaries where salinities range from 9 - 25 ppt and the substrate consists of 4 - 45 % sand while summer flounder larvae generally move into silt and mudflat areas in the lower and middle reaches of estuaries where salinity ranges are higher and the substratum more sandy (Burke et al. 1991). Capture data following segregation of the two species within the Newport River Estuary, NC showed that summer flounder were most common on sand flats than on mudflats in the lower estuary, while there was little difference in capture rates among southern flounder in sandy vs. muddy substrates in the upper reaches of the estuary.

Soft bottom is also a valuable foraging area for southern flounder. The sediment type and energy regime will affect the primary and secondary productivity of the bottom, and therefore the food items available to southern flounder. Prey distribution may then influence habitat selection by southern flounder. In substratum preference experiments in a laboratory setting, southern flounder exhibited a substratum preference when prey were present in experimental substrate but no preference when prey were excluded (Burke, 1995). As southern flounder grow, epibenthic or planktonic prey become more important and can influence the movement of southern flounder upstream. Likewise, the distribution of certain polychaetes may influence distribution of summer flounder into marsh habitat. It also appears that both southern and summer flounder colonize specific habitats where their prey is easily captured. Abiotic gradients such as salinity and temperature that affect flounder distribution are also often correlated with prey distribution (Burke 1995).

Soft bottom plays an important role in the functionality of estuarine systems, acting as both a source and sink for nutrients, chemicals, and microbes. Natural and human-induced nutrients and toxins are trapped and reprocessed in soft bottom areas through intense biogeochemical processes. The fate of these materials depends strongly on freshwater discharge, density stratification and salt wedge formation (Matson and Brinson 1985; Matson and Brinson 1990; Paerl et al. 1998). In North Carolina, an abundance of nutrients and organic matter are stored in soft bottoms. These materials are processed both within the sediments and from sediments into the overlying water column through microbial processes. Increased nutrient and organic inputs exacerbate microbial activity, often leading to declining dissolved oxygen concentration which can potentially affect the distribution of flounder.

9.1.5 SHELL BOTTOM

Shell bottom is defined in the CHPP as “estuarine intertidal or subtidal bottom composed of surface shell concentrations of living or dead oysters (*Crassostrea virginica*) hard clams (*Merceneria merceneria*) and other shellfish” (Street et al. 2005). Common terms used to describe shell bottom habitats in North Carolina are “oyster beds,” “oyster rocks,” “oyster reefs,” “oyster bars,” and “shell hash.” Shell hash is a mixture of sand or mud with gravel and/or unconsolidated broken shell (clam, oyster, scallop, and/or other shellfish). In North Carolina, shell bottom can be either intertidal or subtidal, and can consist of fringing or patch reefs (ASMFC 2007). Subtidal oyster mounds in Pamlico Sound may be several meters tall, while intertidal oyster reefs in the central and southern estuaries may be only a few oysters thick (Lenihan and Peterson 1998; NCDMF 2008c). Generally, oyster spat attach to existing oyster beds and other hard structures, as well as *Spartina alterniflora* roots creating a conglomeration of individuals (NCDMF 2008c). Intertidal oyster reefs in North Carolina may occur along the adjacent to salt marsh and SAV, or as isolated reef features, away from other structure (Grabowski et al. 2000).

Oyster distribution and abundance are limited by salinity, high temperature (Funderburk et al. 1991) and predators like oyster drills and boring sponges (Bahr and Lanier 1981). In North Carolina, intertidal oyster beds occur extensively throughout the central and southern coast where salinity ranges from 14 to 30 ppt. Subtidal oyster reefs also occur in the New, Newport and White Oak rivers. In the Albemarle-Pamlico system, oysters are concentrated in the lower portion of Pamlico Sound tributaries, along the western shore of Pamlico Sounds and to a lesser extent behind the Outer Banks (Street et al. 2005).

Southern flounder are one of several fish species that have been documented utilizing both natural and restored oyster reefs in Pamlico Sound (Lenihan et al. 2001; Street et al. 2005). Southern flounder have been collected on both oyster reefs and adjacent soft bottom areas. Peterson et al. (2003a) estimated the amount of fish production that shell bottom provides in addition to adjacent soft bottom habitats by using results from numerous studies. They compared the density of fish at different life stages on oyster reefs and adjacent soft bottom habitats. Published growth rates of species were then used to determine the amount of production gained from shell bottom. The species were separated into recruitment enhanced, growth enhanced and not enhanced. Recruitment enhanced species are those having early life stages showing almost exclusive association with shell bottom. Species that consumed shell bottom enhanced species were classified as growth enhanced and included southern flounder. Peterson et al. (2003a) concluded that every 10 m^2 of newly constructed oyster reef in the southeast US yields an additional 2.6 kg of fish production per year for the lifetime of the reef.

Shell bottom provides many important functions that enhance the health of the entire ecosystem for fishery and non-fishery species. Oysters filter sediment and pollutants from the water column, enhancing water quality and improving conditions for SAV growth. The hard multi-faceted shell structure aids in reducing wave energy, stabilizing sediment, and reducing shoreline erosion. Oysters, like SAV and benthic microalgae, facilitate storage and cycling of nutrients (ASMFC 2007).

The complex three-dimensional structure provides protective cover for juvenile and sub-adult finfish, while the small invertebrates living on and among oyster shells provide a food source (Meyer et al. 1996; ASMFC 2007). Fringing shell bottom or shell hash may serve as a nearshore corridor between habitats such as salt marsh and SAV, which southern flounder utilize (ASMFC 2007; Micheli and Peterson 1999). The bathymetric relief provided by the shell structure was thought to attract adults and enhance foraging during the spawning season.

9.2 NURSERY HABITAT PREFERENCE

Habitat preference by juvenile southern flounder differs somewhat regionally. Several studies indicate that salinity and benthic substrate is a major factor for early life stages of the southern flounder (Powell and Schwartz 1977; Burke et al. 1995; Walsh et al. 1999; Glass et al. 2008). Hettler (1989) found that southern flounder utilize marsh edge habitat in North Carolina while Nanez-James et al. (2009) found southern flounder in Texas utilized vegetated sandy bottom near tidal passes.

In North Carolina, soft-bottom habitats of coastal rivers are critical to juvenile southern flounder as well as freshwater habitat where flounder have been reported in the Tar, Roanoke, Neuse, and Caper Fear rivers (Rulifson et al. 2009). Data from the NCDMF Juvenile Trawl Survey (Program 120), the Pamlico Sound Trawl Survey (Program 195), and the Anadromous Fish Survey (Program 100) all illustrate that juvenile southern flounder utilize soft bottom habitat of primary nursery areas within North Carolina’s coastal estuarine and riverine systems and along the mainland side of Pamlico Sound. In addition southern flounder have also been collected along the higher salinity sandy areas along the Outer Banks (Figure 9.3). Although Program 100 does not specifically target southern flounder in its seine or trawl surveys, southern flounder are recorded when encountered and Figure 9.3 further illustrates the distribution of southern flounder in Albemarle Sound albeit probably not in representative numbers. The most common habitat characteristics among NCDMF sampling juvenile sampling sites are shallow water depth (<5 feet) and relatively wind-protected water bodies. Juveniles were most consistently abundant at the stations located within the Pungo, Pamlico and Neuse rivers as well as the bays and rivers between these two large rivers (Figure 9.3). In the Cape Fear and New rivers, juvenile southern flounder utilize the shallow upper reaches of tidal creeks (Figure 9.3).

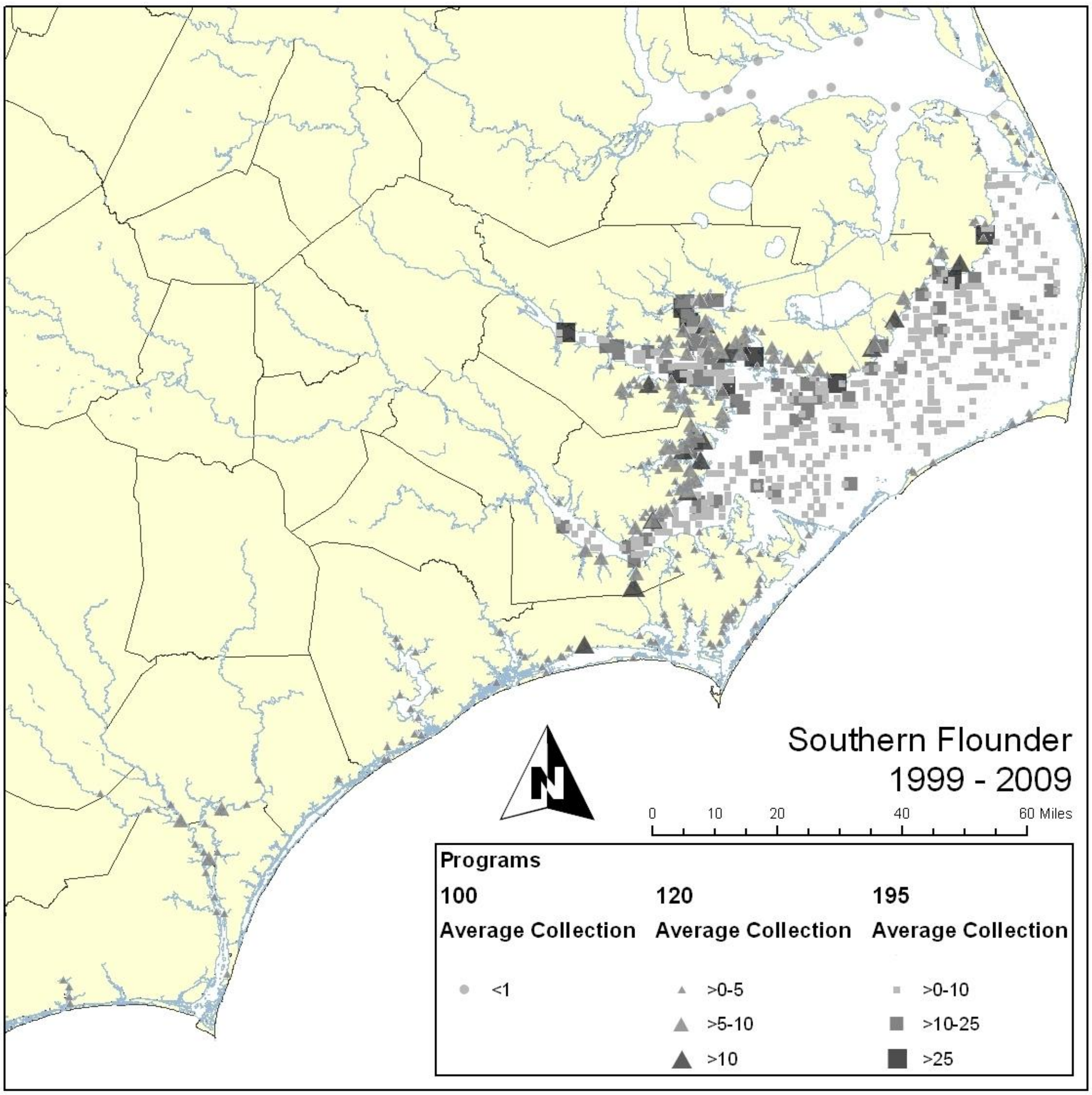


Figure 9.3 Distribution of southern flounder in North Carolina (NCDMF Biological Data Base).

Rulifson et al. (2009) conducted a study to determine the importance of coastal freshwater systems in North Carolina, for juvenile southern flounder, using the Tar-Pamlico River system as a model. The Tar and Pamlico rivers are the same river with the narrower portion above Highway 17 designated as the Tar River. The Pamlico River is designated below Highway 17. The salinity of the lower Tar River is considered fresh water (<0.5 ppt) while the upper Pamlico river is partially oligohaline (0.5 ppt - 5 ppt) and mesohaline (5 ppt - 18 ppt) downstream. Southern flounder were collected by electrofishing within the Tar River and by gillnets of various mesh sizes in the Pamlico River and Sound. The flounder were examined for mercury levels, fatty acid profiles and otolith microchemistry in order to determine the flounder's use and residency of freshwater habitat. It was found that 74% of the southern flounder in the freshwater environment reside there until time to migrate offshore to spawn. Age 0 and older sub-adult southern flounder were commonly found utilizing flat shallow muddy sand or sandy banks in the curves of the river. Mercury levels were elevated in southern flounder residing in freshwater, but were substantially below the human consumption advisory guideline. Reduced growth and low abundance are several indicators that the coastal rivers are not optimal habitat for southern flounder but should be considered as important secondary habitat due to fewer natural predators and very little fishing mortality, which increases the survival of these juvenile flounder.

9.3 HABITAT CONDITION

Because southern flounder utilize multiple habitats, protecting the integrity of the entire system is necessary in the management of southern flounder. These habitats are directly impacted by a number of activities, including, but not limited to estuarine shoreline stabilization, dredging for navigational purposes, fishery harvest (including trawling activities), and inlet stabilization. Protection and enhancement of spawning and nursery areas may be particularly important to enhance growth and survival of juvenile and adult southern flounder.

9.3.1 WETLANDS

It is estimated that approximately 66% (4.7 million acres) of historical wetlands remain in North Carolina including 88% (183,000 acres) of historical salt/brackish marsh (DWQ 2000a). Additionally, 29,560 acres (11.6 %) of existing salt, brackish, and freshwater marsh appear to be physically altered (DCM unpublished data). From the early 1800s to the early 1900s, ditching and draining for agriculture accounted for the majority of wetland losses (Heath 1975). From about 1950 to the 1990s, conversion to managed forest and agriculture accounted for 53% and 42%, of wetland loss, respectively with development associated activities responsible for the remaining 5% (Bales and Newcomb 1996). Since 1990, there have been greatly reduced losses from agriculture and forestry and increasing losses from development. However, between 1998 and 2000, due to a change in federal wetland regulations, approximately 12,000 acres of wetlands were ditched and drained, primarily in the southern portion of the coast. Changes in state regulations are now in place to prevent such activity (Street et al. 2005). Except for this period, there have been no new large-scale wetland drainage projects since the mid 1970s.

The primary threats to wetland habitat today are filling, dredging, and hydrological alterations associated with residential and commercial development. The Coastal Resource Commission (CRC) regulates development activities in Areas of Environmental Concern, which include coastal wetlands (15A NCAC 07H .0205). Generally, no development is allowed in coastal wetlands except water dependent activities, such as docks. The Environmental Management Commission (EMC) manages wetlands through the 401/404 Certification Program, under the federal Clean Water Act. This program focuses on avoiding and minimizing filling of wetlands and streams through review of all Environmental Assessments, Coastal Area Management Act (CAMA) Major, and US Army Corps of Engineers (USACE) permit applications.

Although the rate of wetland loss from dredging and filling activities has slowed, smaller losses continue to occur, which may still result in cumulative impacts. Human population growth and the associated land use changes are the primary cause of wetland habitat loss today (Dahl 2000). Since 1990, development activities such as dredging, water control projects and hydrological alterations are the primary threats to wetland habitats. Compensatory mitigation for permitted losses and voluntary restoration efforts has partially offset some of these losses. However, the type of wetland gained is often not equivalent to what was lost. In addition, not all impacts require mitigation.

In 2003 the Ecosystem Enhancement Program (EEP) was established through a cooperative agreement with the Department of Transportation (DOT), NCDENR, and the USACE. The program was developed to provide environmental mitigation to offset unavoidable impacts associated with transportation and other development, with the goal of restoring, enhancing, preserving, and protecting wetlands, streams, and riparian area functions (EEP 2006). EEP oversees mitigation programs for wetland impacts related to 1) transportation, 2) statewide stream and wetland 401 permits, 3) removal of riparian buffers, and 4) nutrient offset impacts. The program has been increasing the amount of wetland and stream mitigation completed annually.

Shoreline stabilization results in direct and gradual loss of wetlands but is not accounted for through the 401 permit process. Hard stabilization along estuarine shorelines can result in a cumulative loss of wetlands since a hardened structure 1) prevents landward migration of wetlands over time, 2) results in loss of marsh vegetation waterward of the structure, which cannot reestablish due to increased wave energy and scour against the vertical structure (Garbisch et al. 1973; Knutson 1977), and 3) reduces or eliminates the intertidal habitat due to shoreline deepening. Several studies have found that abundance of juvenile fish adjacent to bulkhead shorelines was much less than what occurred adjacent to unaltered naturally vegetated shorelines (80-300% less) (Mock 1966; Peterson et al. 2000; Waters and Thomas 2001). The difference was attributed to lower abundance of organic detritus and small benthic invertebrates, deeper water, and less intertidal vegetation. Ocean shoreline stabilization and prevention of barrier island processes, such as overwash and inlet migration, suppresses development of new tidal marsh behind barrier islands and is another deterrent to wetland expansion.

Because shoreline stabilization contributes to wetland loss which would impact nursery habitat, there is a need to more accurately assess where and how much of the estuarine shoreline is hardened. As part of CHPP implementation actions, the CRC is in the process of revising estuarine shoreline management rules using recommendations from the Estuarine Shoreline Biological and Physical Processes Work Group to minimize impacts to natural shoreline and nearshore fish habitat functions. These rule changes will encourage use of the most environmentally sensitive stabilization structure that is also effective for each specific location. Conservation and enhancement of wetlands is necessary for the overall health of aquatic ecosystems and the preservation of productive fishery species, such as southern flounder. Emphasis should be placed on initiatives such as wetland restoration, land acquisition and preservation, and agricultural cost-share best management practices (BMPs) to protect and enhance wetland habitat. The many fishery and water quality functions provided by wetlands make their preservation and restoration along North Carolina's coast a high priority for protection of all coastal fish habitats.

9.3.2 SUBMERGED AQUATIC VEGETATION (SAV)

The current spatial distribution and acreage of SAV is unknown since some areas that historically supported SAV were not mapped, western Pamlico Sound tributaries were not accurately quantified, and changes may have occurred since the original mapping. While there are reports of large-scale losses of SAV in North Carolina's low salinity tributaries on the mainland side of Pamlico Sound, (North Carolina Sea Grant 1997; J. Hawkins, NCDMF, personal communication, 2003), the high salinity grass beds behind the barrier islands appear relatively stable (Ferguson and Wood 1994). Efforts to comprehensively map high and low salinity SAV habitat began in 2007 through an interagency effort coordinated by Albemarle Pamlico National Estuary Program. This effort used aerial photography, ground truth surveys, and GIS mapping (North Carolina's Cooperative Interagency SAV Mapping and Monitoring Program). Photography and groundtruthing are completed. GIS mapping of portions of Albemarle Sound have been completed. This will provide baseline information on distribution of SAV in some areas, and may allow trend analysis of SAV in eastern Pamlico, Core and Bogue sounds. NOAA scientist Don Field compared the 2007 SAV map of Bogue Sound with the same area mapped in 1981 (Carroway and Priddy 1983). The results suggest changes in the relative proportion of sparse and dense SAV beds but little change in the total areas of the beds. Additional field monitoring of existing SAV beds is needed to identify environmental conditions necessary to support SAV, as well as models indicating where SAV could potentially occur in shallow water.

The greatest threat to SAV is large-scale nutrient enrichment and sediment loading, which increases turbidity, reduces light penetration, and subsequently impacts SAV growth, survival, and productivity (Goldsborough and Kemp 1988; Kenworthy and Haunert 1991; Funderburk et al. 1991; Stevenson et al. 1993). Catastrophic losses of seagrass beds have been correlated with these water quality problems in other states in the past (Twilley et al. 1985; Orth et al. 1986; Durako 1994). Nutrient enrichment and/or increased sediment loads impact SAV growth, survival, and productivity by increasing chronic turbidity in the water column from suspended sediment or phytoplankton associated with algal blooms. In North Carolina, most of the low salinity areas that have experienced large reductions in SAV coverage (Tar-Pamlico River and Neuse River basins), have nutrient loading issues, and are designated as Nutrient Sensitive Waters. Once SAV is lost, increased turbidity and sediment destabilization can result in accelerated shoreline erosion and make recolonization more difficult (Durako 1994; Fonseca 1996). Therefore, prevention of any additional SAV loss through water quality maintenance and improvement is a high priority for fishery management.

In North Carolina, there are water quality standards for light associated parameters including turbidity, total suspended solids (TSS), and chlorophyll *a*. Modifications to regulatory water quality standards may be needed to improve their effectiveness for SAV protection. A review of current chlorophyll *a*, TSS, and turbidity standards should be conducted to determine if they are appropriate for the protection of SAV in North Carolina waters or if a new standard for protecting water clarity for SAV is needed.

Dredging for navigational channels, marinas, or other infrastructure can physically damage or remove SAV, while shading from docks over grass beds can lead to gradual loss of SAV beneath the structures (Loflin 1995; Shafer 1999). As additional docks and marinas are constructed along the coast, the potential for boating-related impacts increase. Results from

Connell and Murphey (2004) indicate that current dock designs over SAV beds in North Carolina result in a reduction in SAV coverage and density. Regulations by CRC state that activities which will directly impact SAV, such as dredging or construction of docking facilities, should be avoided (15A NCAC 7H .0208(a)(5). Recent CRC rule changes in 2009 were made to reduce impacts to SAV and other fish habitats state that both piers and docking facilities located over SAV or shellfish beds in water depths less than two feet must be approved by NCDMF or NCWRC. These facilities should also be located to minimize the amount of SAV or shellfish beds under the structure.

Use of bottom disturbing gear can damage SAV beds, but NCMFC regulations restrict gears that cause the most damage over SAV habitat, including oyster dredges, crab dredges, and hydraulic clam dredges. Bay scallop dredges, which are smaller and have no teeth, cause less severe damage to SAV than oyster and crab dredges, and are allowed over SAV habitat. Hand gear, such as bull rakes and large oyster tongs, can uproot and damage SAV, but in much smaller areas than mechanical gears (Thayer et al. 1984). Current NCMFC rules prohibit use of rakes more than twelve inches wide or weighing more than six pounds in SAV. Clam kicking can also severely impact SAV habitat since substrate is displaced by propeller backwash (Guthrie and Lewis 1982; Peterson and Howarth 1987). Because of the severe disturbance to the bottom, clam kicking is restricted to sandy bottoms, that do not contain significant SAV or oyster resources in Core and Pamlico sounds, and Newport, North, New, and White Oak rivers. The fishery is managed intensively, with strong enforcement to prevent clam kicking in the restricted areas.

Shrimp and crab trawls can shear or cut the blades of SAV, or uproot plants without major disruption of the sediment (ASMFC 2000a). While shearing of grass blades does not kill a seagrass plant, shoot density is reduced, decreasing productivity and structural complexity. Where the trawl doors dig into the sediment, SAV plants can be uprooted and killed. The impact of the doors depends on gear configuration, vessel speed and other factors. High turbidity and sedimentation from use of bottom-disturbing fishing gear can reduce water clarity, affecting SAV growth, productivity, and in some cases, survival (ASMFC 2000a). The boundaries of No Trawl Areas in Core Sound were modified in the Shrimp Fishery Management Plan to avoid additional grass beds (NCDMF 2006a). Additional law enforcement may be needed to enforce buffers around closed areas supporting SAV, such as No Trawl Areas and Mechanical Clam Harvest Areas. If other areas are identified where bottom disturbing gears are impacting SAV, boundary changes should be evaluated.

9.3.3 SHELL BOTTOM

The current distribution of shell bottom habitat in North Carolina is much less than historical accounts in the late 19th century when subtidal oyster rocks were so prevalent, they were considered a navigation hazard (Newell 1988). The initial decline of shell bottom habitat coincided with the introduction of mechanical dredge harvesting techniques in 1889 (NCDMF 2008c). Oyster dredging removes oysters and reduces the vertical profile of oyster rocks, increasing the susceptibility of remaining shell bottom at that location to low dissolved oxygen (DO) and possible mortality (Lenihan and Peterson 1998). Most shell bottom losses have been to subtidal beds in Pamlico Sound, where over 90% of the oyster fishery was concentrated through the mid 20th century (Chestnut 1955; NCDMF 2008c). Currently, mechanical harvesting of oysters is restricted by the NCMFC to approximately 222,223 acres of shellfish bottom in Pamlico Sound and its bays north of Core Sound. Mechanical harvest is not allowed in Core Sound and south of Core Sound (NCDMF 2008c). Other causes of shell bottom losses include dredging for navigation channels or marinas. These activities can physically remove or damage existing shell bottom or result in turbidity that clogs oyster gills or covers sediment completely. Hydrologic modifications also impact oyster habitat by altering salinity regimes. While drainage for agriculture has changed little in recent years, drainage for urban/suburban development is increasing steadily.

In designated oyster management areas and other designated habitat areas, trawling and mechanical harvest of oysters is prohibited, including portions of Core and Pamlico sounds. Hand harvest methods for oysters and clams can also be destructive, but on a much smaller scale. Completion of mapping of North Carolina shellfish beds by NCDMF would enhance the ability to enforce existing regulations and make it possible to quantify changes to this habitat relative to changes in land use, water quality, and regulatory measures.

9.3.4 SOFT BOTTOM

Activities that lead to the deepening, loss, or chemical contamination of shallow and intertidal habitat are the greatest threat to this habitat. Dredging associated with construction of marina and dock facilities alters the shoreline configuration, circulation patterns, and changes in bottom sediment characteristics (Wendt et al. 1990). Light availability on the bottom of dredged marinas is lowered, reducing productivity from benthic algae (Iannuzzi et al. 1996). Operation of a marina can also affect productivity of the soft bottom community due to introduction of heavy metals, hydrocarbons, and bacteria (Chmura and Ross 1978; Marcus and Stokes 1985; Voudrias and Smith 1986). Heavy metals and hydrocarbons are toxic to many soft bottom dwelling invertebrates and benthic feeding fish (Weis and Weis 1989). Additionally, DO may become depleted or below biotic thresholds in dredged marina basins and channels. A North Carolina marina study found significantly lower DO concentrations (less than 5.0 mg/L) inside some marinas compared to outside marinas (DEHNR 1990). Estuarine shoreline stabilization can also degrade soft bottom habitat utilized by southern flounder by reducing or eliminating the intertidal zone, deepening shallow soft bottom habitat, or contaminating sediment from leaching of toxic preservatives from wood structures (Weis et al. 1998).

The extent of sediment contamination in North Carolina coastal waters is not well known. Sediment sampling is not routinely conducted by the DWQ since there are no sediment standards in the state. Studies examining sediment contamination at sites in North Carolina soft bottom have found various levels of contamination (Riggs et al. 1989; 1991; Hackney et al. 1998). The highest contamination levels tended to occur in low salinity areas with low flushing and high river discharge. In the Neuse River, surface sediments were found to contain elevated levels of several heavy metals, including zinc, copper, lead, and arsenic, primarily between New Bern and the mouth of the river. The contaminated sites were primarily attributed to permitted municipal and industrial treatment plant discharges. Marinas were also found to contribute substantial amounts of copper and variable amounts of zinc and lead. Nonpoint sources were more difficult to evaluate. In the Pamlico River, heavy metal contamination was less severe, although arsenic, cobalt, and titanium exceeded the levels found in the Neuse River (Hackney et al. 1998). These studies suggest that sediment contamination in some estuarine areas, especially those where both organic rich mud and waste water discharges are present, may be significant and could affect fish populations and the base of their food chain. To better determine if contaminated sediment is a significant threat to coastal fish habitat, the distribution and concentration of heavy metals and other toxic contaminants in freshwater and estuarine sediments needs to be adequately assessed and areas of greatest concern need to be identified.

Bottom disturbing gear can potentially impact soft bottom habitat, but because of the limited structure and dynamic nature of this habitat, it has historically been considered the most appropriate location for such gear. Of the bottom disturbing gears, trawling is more commonly used than dredges on soft bottom habitat in both estuarine and coastal ocean waters. Trawling can potentially impact soft bottom habitat by removing or damaging epifauna and burrow-forming infauna, reducing diversity and abundance of benthic community, smoothing sediment features, and increasing exposure to predators (Collie et al. 1997; Auster and Langton 1999). Sediment resuspension can increase turbidity, reducing light dependent benthic productivity, which in turn affects the benthic food web. While several studies have shown negative effects of trawling, other studies have found no negative impacts (Van Dolah et al. 1991; Currie and Parry 1996; Cahoon et al. 2002). No studies have specifically looked at the effect of trawling on the bottom habitat of Pamlico Sound or other large sounds in North Carolina.

Use of trawl nets, long haul seines, swipe nets, dredges, and mechanical harvest of shellfish is prohibited over productive shallow soft bottom habitat designated as a Primary and Secondary Nursery Area by the NCMFC (15A NCAC 03N .0104). There are approximately 147,000 acres of designated Primary Nursery Areas (PNA) and Secondary Nursery Areas (SNA) (15A NCAC 03N .0101 - .0105) in North Carolina (Figure 9.4). They are generally located in the upper portions of tidal creeks and rivers and usually include wetlands, soft bottom, and in some areas shell bottom. Dredging for navigational purposes is also not allowed in PNAs by CRC regulations.

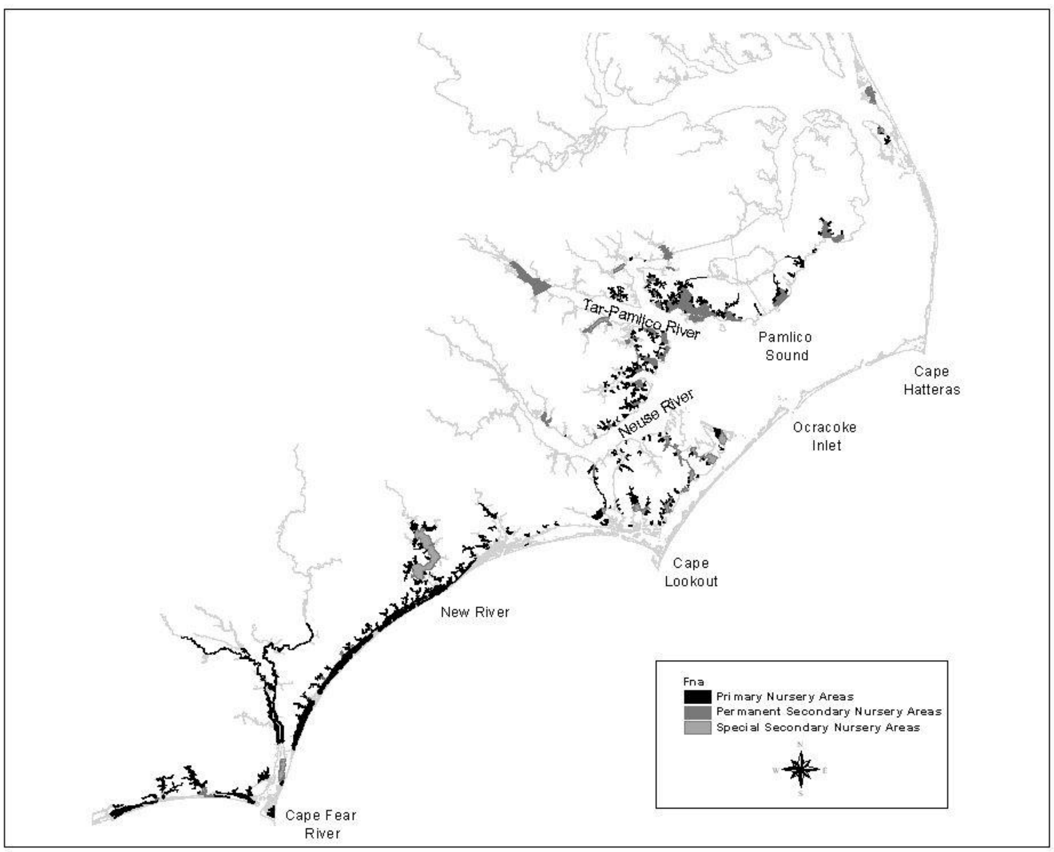


Figure 9.4 NCMFC designated fishery nursery areas.

9.4 WATER QUALITY

Good water quality is essential for maintaining the chemical properties of the water column needed to support the various life stages of southern flounder, as well as sustain other habitats that southern flounder utilize. Human activities that alter the preferred salinity or temperature conditions elevate toxins, nutrients, or turbidity, or lower dissolved oxygen levels can degrade water quality and impact growth and survival of southern flounder. These pollutants may be derived from both point and nonpoint sources. Increased sediment and nutrient loading in the water column can also enter coastal waters from point source discharges, nonpoint source stormwater runoff, or resuspension of bottom sediments. Specific sources that contribute to increased sediment loading include construction activities, unpaved roads, road construction, golf courses, uncontrolled urban runoff, mining, silviculture, row crop agriculture, and livestock operations (DWQ 2000b). Specific sources that contribute to increased nutrient loading include agricultural and urban runoff, wastewater treatment plants, forestry activities, and atmospheric deposition. Nutrients in point source discharges are from human waste, food residues, cleaning agents, and industrial processes. The primary contributors of nutrients from nonpoint sources are fertilizer and animal wastes (DWQ 2000b).

Point sources include direct discharges of treated domestic or industrial wastewater or untreated stormwater. Point source discharges are regulated by DWQ and the US Environmental Protection Agency (EPA). In estuarine waters, there are numerous wastewater discharges. EMC requires a *National Pollutant Discharge Elimination System* (*NPDES*) permit for point source discharges, which specifies limits of various pollutants in treated discharge waters, based on the water quality classification of the receiving stream. Areas classified as Nutrient Sensitive Waters have more stringent limits on nutrients. Leaks or ruptures of sewage pipes and failing lift stations can also lead to untreated sewage entering into coastal waters. In ocean waters, wastewater discharges are not allowed because this activity has been found to cause significant beach pollution in other states (Moore 1992). Dumping of sewage sludge and industrial wastes has also caused adverse impacts to the fishing industry (Cross et al. 1985). Ocean outfalls should continue to be prohibited in North Carolina to minimize water quality degradation to the water column.

Nonpoint stormwater runoff can originate from numerous activities, including urban development, roadways, marinas, concentrated animal operations, and land disturbance from agriculture and forestry. Stormwater runoff can carry nutrients, sediment, bacteria, and toxic chemicals into coastal waters. In some instances, stormwater is directly discharged into ocean or estuarine waters. Beach communities appear to be increasingly using “temporary” pumping of storm water to the beach as a solution to stormwater runoff. The runoff during heavy rain events floods the streets, in part due to improper siting of structures in flood zones, excessive impervious surface, and lack of upland stormwater retention areas. As coastal areas continue to develop and flooding problems increase, managing stormwater should be a high priority for protecting habitat and water quality.

Southern flounder in North Carolina occur in several coastal river basins, including the Roanoke, Chowan, Tar-Pamlico, Neuse, Pasquotank, White Oak, Cape Fear and Lumber river basins (Figure 9.5). Water quality standards and biotic integrity criteria are used as a “measuring stick” in use support assessments within these basins. Biotic integrity is determined from species composition and is evaluated in terms of biological diversity, sensitivity, and tolerance to man-made stresses and were developed and used on invertebrate and fish assemblages in freshwater streams. This evaluation in large rivers and estuaries has been more difficult. Biotic integrity and water quality are used to evaluate aquatic life with water quality standards varying according to the use supported (i.e., drinking water, shellfish harvest, primary recreation, aquatic life) as well as certain regulatory designations (NSW, ORW, HQW).

The primary cause of impairment in freshwater streams draining into coastal waters was low biological integrity, followed by fish consumption advisories for mercury and/or dioxin (Table 9.1). Other causes include low DO, fecal coliform, turbidity, nutrients, and copper with the relative magnitude of causes differing among river basins.

Figure 9.5 Location of North Carolina river basins (http://h2o.enr.state.nc.us/basinwide).

Table 9.1 Causes of DWQ use support impairment from 2006 assessment of freshwater streams and shorelines (miles).

River basin	Impaired biological integrity	Fish advisory (mercury or dioxin)	Low DO	Low pH	Fecal coliform	Turbidity	Nutrients	Copper	Other
Cape Fear	407	315	25	92	77	63	0	0	0
Chowan	31	40	44	42	0	0	22	0	0
Neuse	317	69	177	0	3	5	0	3	0
Pasquotank	4	0	31	20	0	0	0	0	0
Roanoke	42	240	10	0	0	14	0	11	0
Tar-Pamlico	89	29	14	0	14	0	0	0	0
White Oak	0	28	8	0	0	0	0	0	0
Total	890	721	309	154	94	82	22	14	0
Percentage	38.9	31.5	13.5	6.7	4.1	3.6	1	0.6	0

DWQ (2000a) reported heavy metals, chlorine and ammonia as a cause for impairments in freshwater streams. In downstream estuaries, the primary cause of impairment was listed as shellfish closures due to excess fecal coliform concentration followed by chlorophyll *a*. In the Neuse River estuary, the largest cause of impairment was chlorophyll a. In the White Oak River basin, the primary cause was shellfish closures due to fecal coliform concentrations. However, biological integrity of the estuarine and marine systems was not assessed.

Sources of impairment among freshwater streams are agriculture and row crop production, permitted wastewater discharge, and stormwater runoff from urban and built upon areas. In the Cape Fear River, permitted wastewater was the primary source of impairment. Agriculture was the primary source of impairment the Neuse and Tar-Pamlico rivers and atmospheric deposition was the primary source in the Roanoke River while urban runoff was the only source of impairment in the White Oak River.

9.4.1 WATER QUALITY STRESSORS

Compared to other fish species, southern flounder are fairly tolerant of temperature extremes and low dissolved oxygen. However, due to their behavioral tendency to lie upon the bottom, flounder are often exposed to anoxic and hypoxic conditions as well as to possible toxins within the sediment. According to data from DWQ, the greatest amount of impairment to coastal fresh water streams is due to excessive sediment loading and low DO. Fish kills are one of the more obvious indicators of habitat degradation and most of which have been attributed to low levels of dissolved oxygen. Southern flounder are among the many fishery species comprising fish kills.

Stressors attributed to water quality impairment in coastal waters are often associated with increased development. There has been a significant increase in population over the past 20 years in coastal river basins. Increased population has been directly correlated with increased impervious surfaces and hydrological alterations, which in turn results in increased stormwater runoff (Mallin et al. 2000). Increased population results in the need for additional septic tanks, increased wastewater treatment capacity, road infrastructure, and marinas, which can increase pollutant loading into coastal waters. Hydromodifications due to ditching and drainage of uplands and wetlands accelerates the quantity and rate at which pollutants enter estuarine waters, decreases the amount of filtering that occurs prior to pollutants entering the waters, and may alter the salinity regime in the upper estuary (DWQ 2000b). Loading and movement of sediment, nutrients, and toxins are often greater in channelized sections than natural streams, and can negatively impact the fish community and benthic habitats (White 1996; EPA 2001). Several studies have found that the size, number, and species diversity of fish in channelized streams are reduced and the fisheries associated with them are less productive than those associated with unchannelized reaches of streams (Tarplee et al. 1971; Hawkins 1980; Schoof 1980). Pate and Jones (1981) found that productivity of several species of juvenile fish was significantly less in PNAs that received moderate to high levels of drainage from ditched uplands. They attributed this to the unstable salinity conditions that occurred in areas adjacent to channelized systems following moderate to heavy rainfall (>1 inch/24 hr). Therefore, hydromodification of the system can be the driver of other subsequent water quality stressors, such as hypoxia, eutrophication, and toxic contamination.

9.4.1.1 HYPOXIA AND EUTROPHICATION

Adequate supply of DO is critical to survival of benthic invertebrates and fish. Most demersal fishes experience mortality in waters having 1-2 mg/L O_2, impaired larval growth where oxygen levels are less than 4.7 mg/L, and altered metabolism where oxygen levels are less than 4 mg/L (Miller et al. 1985; Gray et al 2002). Some estuarine species are capable of detecting and avoiding low oxygen waters and will generally move to shallower oxygenated waters, but there are species-specific differences in tolerance thresholds (Wannamaker and Rice 2000).

Tolerance thresholds for southern flounder are less than 5 mg/L, however post larval southern flounder will attempt to avoid DO less than 3.7 mg/L (Reagan and Wingo 1985). Low-oxygen conditions can occur naturally in a system from flushing of swamp waters, which characteristically have low DO, or from stratification of the water column due to wind, temperature, and salinity conditions. However, low oxygen conditions can also be fueled by increased stormwater runoff carrying nutrients and oxygen-consuming wastes, which result in excessive oxygen demand in the water column or sediment. Algal blooms deplete the water column of DO due to respiration and organic decomposition (DWQ 2000b). Dissolved oxygen depletion in the water column occurs most often in summer. Warm surface waters, calm winds, and reduced freshwater inflow reduce mixing of water. The stratified bottom layer of water is prevented from receiving oxygenated surface waters and rapidly becomes depleted of oxygen. Flounder “jubilees” resulting from low-oxygen conditions have been known to occur in the northern Gulf of Mexico and North Carolina’s estuarine waters, and occur in the late summer. These events happen suddenly, under very specific conditions of calm, shallow waters where flounder will aggregate along the water’s edge, in an attempt to escape the hypoxic water. This will result in flounder being easily gathered by fishermen. There is very little information available on these events (GSMFC 2000; C. Batsavage, NCDMF, personal communication). Shallow water estuaries with less frequent flushing often develop persistent stratification and bottom-water hypoxia that can last for weeks to months (Tenore 1972). Several studies have indicated that the frequency, duration, and spatial extent of low oxygen events have increased over the years due to increasing eutrophication of coastal waters from human and animal waste discharges, greater fertilizer use, loss of wetlands, and increased atmospheric nitrogen deposition (Cooper and Brush 1991; Dyer and Orth 1994; Paerl et al. 1995; Buzelli et al. 2002).

Fish kills are often attributed to low oxygen events. Over the past ten years in coastal river basins supporting southern flounder, the number of reported fish kills peaked in 2001 and has decreased and remained relatively low until 2008 (Table 9.2). Atlantic menhaden, spot, southern flounder, and Atlantic croaker were the most frequently reported estuarine species. Overall, fish kills were most frequent in the Neuse River basin, followed by the Tar-Pamlico, and Cape Fear river basins (Table 9.2). Fish kill activity was highest in the lower Neuse and Tar-Pamlico basins. In this mixing zone, low DO, high temperatures, and fluctuating salinity are stressful to fish life. In 2008, low DO was cited as a factor in 28 fish kill events, followed by unknown causes, toxic spills and algal blooms. Those kill events of unknown causes are those events where investigators cannot determine definitive causes, or suspected causes cannot be confirmed. Spills and algal blooms can also deplete oxygen from the water column. Overall, DO depletion, coupled with unfavorable environmental conditions, is the most common cause of fish kills in estuarine waters. It is unclear why there was a sharp increase in kill activity during 2008 (DWQ 2008).

Table 9.2 Reported fish kills in coastal river basins supporting southern flounder,1999-2008 (DWQ 2008).

River basin	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Roanoke	0	0	0	0	2	1	1	2	1	0	8
Chowan	1	0	1	2	2	1	1	0	1	2	12
Pasquotank	2	0	1	6	2	0	2	0	1	4	26
Tar/Pamlico	11	14	23	8	6	2	1	2	5	16	93
Neuse	16	23	37	9	21	8	9	10	10	21	172
White Oak	3	3	3	3	0	0	1	0	0	0	14
Cape Fear	14	12	5	8	3	1	2	5	1	10	84
Lumber	0	2	0	0	2	1	1	2	0	0	13
Yearly Total	47	54	70	36	38	14	18	21	19	53	422

9.4.1.2 TOXINS

Toxins in sediments or the water column can inhibit or alter reproduction or growth of aquatic organisms, or cause mortality in some situations (Weis and Weis 1989). Early life stages are most vulnerable to toxins (Funderburk et al. 1991). While the survival of some aquatic organisms is affected by toxins, other organisms survive and bioaccumulate the chemicals to toxic levels, passing them along in the food chain. Multiple studies have shown clear connections between concentrations of toxins in sediments and those in benthic feeding fish and invertebrates (Kirby et al. 2001; Marburger et al. 2002).

Toxic chemicals tend to accumulate in fine-grained sediments to several orders of greater magnitude than overlying waters, but can be resuspended in the water column by storm events or human activities such as dredging and trawling. Sediment toxicity can reduce the abundance of benthic prey available to southern flounder, reducing the quality of the habitat. Because macroinvertebrate diversity declines with increasing sediment contamination, food resources for benthic feeders like southern flounder may be limited in highly contaminated areas (Weis et al. 1998; Brown et al. 2000; Dauer et al. 2000).

Toxic chemicals come from localized point sources as well as diffuse nonpoint sources. Point sources include industrial and municipal waste discharges. Nonpoint sources of toxins include household and yard chemicals from urban runoff, petroleum and other chemicals from roads, parking lots, marinas, docks, and boating activity, runoff from agriculture and forestry, industrial emissions, and chemical spills (Wilbur and Pentony 1999).

Because low concentrations of heavy metals in the water column can be easily incorporated into fine-grained sediment, chemicals can accumulate in the sediment to toxic levels and be resuspended into the water column (Riggs et al. 1991). Studies have shown that fine-grained sediments are the primary reservoir for heavy metals, particularly organic rich muds (Riggs et al. 1991). Since organic rich muds occur extensively in North Carolina's estuaries and primary nursery areas, resuspension of contaminated organic rich muds is of particular concern.

9.4.1.3 WEATHER EVENTS

Hurricanes and other weather events can have a large influence on water quality in Pamlico Sound and other areas of North Carolina's coast. Hurricanes are considered an important natural perturbation that is necessary for the long-term maintenance of estuarine systems (Meeder and Meeder 1989). However, given the rising loss of wetlands and hydrological modifications, the effect of flooding and storm damage is intensified, and the resulting runoff is more severely contaminated. In 1996, Hurricanes Bertha and Fran resulted in severe flooding of coastal waters, anoxia, and multiple fish kills in both Neuse and Pamlico rivers and Pamlico Sound. Shortly after the passage of Hurricane Floyd in September 1999, some anoxic conditions were documented in Pamlico Sound (DWQ, NCDMF, unpublished data). Nevertheless, subsequent storms and strong winds prevented prolonged stratification of the water column and increased oxygen concentrations, minimizing fish kills in the Sound. Large inputs of nutrients and toxic chemicals were introduced into the system from flooded and failing hog lagoons and wastewater treatment plants, and from organic matter displaced from swamps and upland sources. The high number of fish kills in the Neuse and Tar-Pamlico river basins in 2001 may be a delayed ecological response to these nutrient inputs. In 2003, Hurricane Isabel breached a new inlet through Hatteras Island, which could have enhanced flushing in Pamlico Sound. However, DOT refilled the inlet to restore traditional transportation. Prevention of natural barrier island processes has been shown to have long-term effects on water quality in adjacent estuarine waters.

Global warming and sea level rise could have a significant impact on future estuarine conditions. As sea level continues rising, portions of barrier islands are expected to be inundated, increasing ocean influence and salinity in Pamlico Sound and its tributaries (Pearsall and Poulter 2005). On a global scale, 30% of global wetlands are expected to be lost due to the combination of sea level rise and development along the shoreline, which deters landward migration of wetlands (IPPC 2002). In the Albemarle-Pamlico system, where elevations are low and landscape slope is minimal, there is concern that the rate of vertical accretion of marsh peat (currently estimated at 2.4-3.6 mm/yr - Craft et al. 1993) will not be able to keep up with sea level rise and prevent submergence of wetlands (Moore et al. 2006; Pearsall and Poulter 2005). While the current rate of sea level rise in the Albemarle region is 4.3 mm/yr (Pearsall and Poulter 2005), the rate of sea level rise is expected to double or triple over the next 50-100 years (IPCC 2002). The effect of these changes to southern flounder is unknown, but will most likely influence suitability of nursery habitats and foraging areas. Wetland loss will result in less filtering of stormwater runoff and less available nursery areas. Efforts are needed to plan for and attempt to offset the impacts of sea level rise on North Carolina's estuarine system. The CRC recently hosted a forum on the current and projected rates of sea level rise in North Carolina and will generate a report on sea level rise to be used as a foundation for policy development and adaptation planning.

9.5 HABITAT AND WATER QUALITY PROTECTION

9.5.1 NCMFC AUTHORITY

Presently, the NCMFC has authority for managing, restoring, developing, cultivating, conserving, protecting, and regulating marine and estuarine resources. Marine and estuarine resources are defined as "All fish [including marine mammals, shellfish, and crustaceans], except inland game fish, found in the Atlantic Ocean and in coastal fishing waters; all fisheries based upon such fish; all uncultivated or undomesticated plant and animal life, other than wildlife resources, inhabiting or dependent upon coastal fishing waters; and the entire ecology supporting such fish, fisheries, and plant and animal life." (G.S. 113-129).

Although the NCMFC's primary responsibilities are management of fisheries (season, size and bag limits, licensing, etc.), the NCMFC has the authority to comment on state permit applications that may have an effect on marine and estuarine resources or water quality, regulate the placement of fishing gear, develop and improve mariculture, and regulate location and utilization of artificial reefs. Authority for the NCMFC is found at G.S. 143B-289.51 and 52.

9.5.2 AUTHORITY OF OTHER AGENCIES

The North Carolina Department of Environment and Natural Resources have several divisions responsible for providing technical and financial assistance, planning, permitting, certification, monitoring, and regulatory activities, which impact the coastal water quality or habitat. The Division of Coastal Management (DCM) is responsible for development permits along the estuarine shoreline in 20 coastal counties. Wetland development activity throughout North Carolina is permitted through the USACE and Division of Water Quality (DWQ; 401-certification program). The DWQ has established a water quality classification and standards program for "best usage" to promote protection of unique and special pristine waters with outstanding resource values. The High Quality Waters (HQW), Outstanding Resource Waters (ORW), Nutrient Sensitive Waters (NSW), and Water Supply (WS) classifications have outlined management strategies to control point and nonpoint source pollution. Various federal and state environmental and resource agencies, including NCDMF, evaluate projects proposed for permitting and provide comments and recommendations to the DCM, DWQ, and USACE on potential habitat and resource impacts. Waters that have been designated as PNAs by NCMFC or have a special EMC water quality classification, such as HWQ and ORW, are given additional consideration of impacts by DCM and DWQ prior to issuing a permit. Habitat protection relies on enforcement, the efforts of commenting agencies to evaluate impacts, and the incorporation of recommendations into permitting decisions. Habitats are also protected through the acquisition and management of natural areas as parks, refuges, reserves, or protected lands by public agencies and/or private groups.

9.5.3 COASTAL HABITAT PROTECTION PLAN (CHPP)

The Fisheries Reform Act (FRA) of 1997 mandated the DENR to prepare Coastal Habitat Protection Plan (CHPP -- G. S. 143B-279.8). The legislative goal for the CHPP is long-term enhancement of the coastal fisheries associated with coastal habitats. The CHPP provides a framework for management actions to protect and restore habitats critical to North Carolina's coastal fishery resources and involves mandatory participation by the three commissions that have regulatory jurisdiction over the coastal resources (Coastal Resource Commission), water (Environmental Management Commission), and marine fishery resources (Marine Fisheries Commission), as well as the Department. The CHPP was completed in December 2004 and implementation plans for each Division and the Department was approved in July 2005. Actions taken by all three commissions pertaining to the coastal area, including rule making, are to comply "to the maximum extent practicable" with the plans. The CHPP helps to ensure consistent actions among these three commissions as well as their supporting DENR agencies.

The CHPP describes and documents the use of habitats by species supporting coastal fisheries, status of these habitats, and the impacts of human activities and natural events on those habitats. Fish habitat is defined as freshwater, estuarine, and marine areas that support juvenile and adult populations of economically important fish, shellfish, and crustacean species (commercial and recreational), as well as forage species important in the food chain (Street et al. 2005). Habitats are categorized as wetlands, SAV, soft bottom, shell bottom, ocean hard bottom, and water column. The plan explains the environmental requirements, ecological value, status, and threats of the six fish habitats and includes management recommendations to protect and enhance the entire coastal ecosystem.

The CHPP recommends that some areas of fish habitat be designated as "Strategic Habitat Areas" (SHAs). SHAs are defined as specific locations of individual fish habitat or systems of habitat that have been identified to provide critical habitat functions or that are particularly at risk due to imminent threats, vulnerability, or rarity. While all fish habitats are necessary for sustaining viable fish populations, some areas may be especially important to fish viability and productivity. Protection of these areas would therefore be a high priority (Street et al. 2005). The process of identifying and designating SHAs began in 2005.

The CHPP focuses on the fish habitat and threats to the habitat. This FMP describes habitat conditions or needs for the various life stages of southern flounder. The FRA gives precedent to the CHPP and stipulates habitat and water quality considerations in the FMP be consistent with CHPP. Any recommendations will be considered and acted upon through the CHPP implementation process. The CHPP will be updated in 2010.

9.6 RECOMMENDED MANAGEMENT ACTIONS

Suitable and adequate habitat and water quality are critical elements in the ecology and productivity of estuarine systems. Degradation or improvement in one aspect of habitat may have a corresponding impact on water quality. Maintenance and improvement of suitable estuarine habitat and water quality is critical to successfully managing southern flounder stocks. The NCMFC, CRC, and EMC should adopt rules to protect critical habitats as outlined in the Coastal Habitat Protection Plans (CHPP). The North Carolina General Assembly and/or divisions of the DENR should develop a strategy to fully support CHPP implementation with additional staff and funding. The involvement of federal agencies and increased funding (state and federal) may be necessary to accomplish these actions. The NCMFC and NCDMF should continue to comment on activities that may impact aquatic habitats and work with permitting agencies to minimize impacts and promote restoration and research.

Strategic Habitat Areas and Primary Nursery Areas

1. Identify and designate Strategic Habitat Areas (SHAs) and Primary Nursery Areas (PNAs) that will help conserve southern flounder habitat.
2. Coordinate location of Strategic Habitat Areas and Primary Nursery Areas with local watershed planning to facilitate the linkage between watershed improvement efforts and management of sensitive aquatic habitats downstream.

Wetlands

3. Address unmitigated loss of riparian wetlands due to the indirect impacts of permitted structures using the supporting literature, existing permitting review requirements, land acquisition efforts, and land use planning initiatives, and/or additional regulations.
4. Restore altered wetland hydrology on lands managed for conservation (i.e. undeveloped local, state or federally owned lands such as parks, state game lands, wildlife refuges, and national seashores).
5. Employ land use data and sea level rise projections to determine priorities for wetland protection, enhancement, or restoration.

SAV

6. Coordinate SAV mapping efforts such that state-wide monitoring and trend analysis can be conducted most efficiently.
7. Expand nursery sampling to include high and low salinity SAV beds to adequately evaluate their use by southern flounder and other species, and trends in those species.
8. Examine the effect of spatial connectivity between SAV, wetlands, and shell bottom on southern flounder use, survival, growth and abundance.
9. Reduce point and non-point nutrient and sediment loading in estuarine waters, to levels that will sustain SAV, using relevant standards and regulatory/non-regulatory actions.
10. Evaluate and adjust as necessary dredging and trawling boundaries to protect existing SAV and allow some recovery where it historically occurred.
11. Seek additional resources to enhance enforcement of, and compliance with bottom

disturbing fishing gear restrictions that protect SAV and other fish habitats.

Soft Bottom

12. Acquire updated and coast-wide data on bathymetry, sediment type, and pollutant concentrations.

13. Complete a Beach and Inlet Management Plan that addresses larval passage issues with inlet stabilization.

14. Protect shallow soft bottom habitat through proper siting and construction of docks, marinas, and shoreline stabilization structures.

Shell Bottom

15. Continue mapping and monitoring the extent and quality of shell bottom in coastal North Carolina.

16. Continue development of oyster sanctuaries in Pamlico Sound with guidance from larval transport models, source population locations, overall fishery benefits, and location of suitable bed foundations.

17. Encourage restoration of oysters in conjunction with marsh-sill projects in suitable habitat areas, as an alternative to vertical stabilization.

Water Column

18. Increase coverage of waters assessed for aquatic life and increase coverage of continuous monitoring stations.

19. More incentives needed to generate conservation/restoration opportunities in areas with the most ecological benefit of restoration.

20. Reduce sewage spill pollution by upgrading plants and infrastructure and enforcing high fines for violations. Other needs include thorough inspections of sewage treatment facilities, collection infrastructure, land disposal sites, and on site wastewater treatment facilities to identify and prioritize sites needing upgrades.

21. Evaluate and implement alternatives for disposing of marina wastewater.

22. Secure funding for a Clean Marina Coordinator in order to maintain voluntary initiative.

23. Encourage use of Community Conservation Assistance Program (CCAP) to address existing stormwater systems.

24. Conduct post-implementation assessment of new coastal stormwater rules.

25. Monitor estuarine salinities for long term trends related to climate change.

26. Adjust habitat restoration goals to reflect the shifting distribution of species with long

term climate changes.

27. Restore hydrology on lands used for silvaculture, agriculture, and urban development using Best Management Practices.

10.0 PRINCIPAL ISSUES AND MANAGEMENT OPTIONS

10.1 ACHIEVING SUSTAINABLE HARVEST[4]

Issue

Establish harvest reductions that end overfishing in two years and rebuild the spawning stock biomass by 2015.

Background

The 2009 North Carolina Southern Flounder Stock Assessment indicated the stock remains overfished and overfishing is still occurring (Takade-Heumacher and Batsavage 2009). In the terminal year (2007) of the stock assessment, the fishing mortality (F) was 0.7534, the female spawning stock biomass (SSB) was estimated at 4,358,990 pounds, and the spawning potential ratio (SPR) was 19% of a population in which no fishing occurs. Population improvements were apparent in the shift in the SPR associated with the time periods before and after the management changes in 2005 (Table 10.1). Both SPR and SSB increased, and F decreased. The 2005 Southern Flounder Fishery Management Plan (FMP) set the overfishing and overfished thresholds and targets at an SPR of 20% and 25%, respectively; the associated F rates with these SPRs were 0.57 (20% SPR) and 0.47 (25% SPR) (NCDMF 2005). The 2009 Stock Assessment proposed an overfishing and overfished threshold at an SPR of 30% and the target at an SPR of 35% in order to reduce the risk of recruitment overfishing. The threshold F at an SPR of 20% is 0.7223 and the target F at 25% SPR is 0.5937 (Table 10.2). The threshold female SSB at 20% SPR is 4,722,588 pounds and the target female SSB at 25% SPR is 5,903,817 pounds. The threshold F at a SPR of 30% is 0.4880 and the target F at 35% SPR is 0.4081. The threshold female SSB at 30% SPR is 7,084,845 pounds and the target female SSB at 35% SPR is 8,265,162 pounds. The North Carolina Division of Marine Fisheries (NCDMF) position on Amendment 1 of the Southern Flounder FMP sets the threshold at 25% SPR and target at 35% SPR. The associated F rates with these SPRs are 0.5937 (25% SPR) and 0.4081 (35% SPR), and the associated SSBs with these SPRs are 5,903,817 pounds (25% SPR) and 8,265,162 pounds (35% SPR).

Reductions in the overall harvest of southern flounder based on 2007 landings are necessary in order to achieve sustainable harvest. The overall harvest reductions under the current minimum size limit of 14 inches (20.5% in numbers of fish, 19.7% in pounds) are less than the overall harvest reductions needed under a 15-inch minimum size limit (30.6% in numbers of fish, 29.9% in pounds) due to the increased discards from the increased minimum size limit. All harvest reductions in this issue paper are based on numbers of fish. A size limit increase without any gear modifications increases discards, which results in a larger harvest reduction necessary to rebuild the stock.

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[4] Emailed to the Plan Development Team (PDT) on 6/15/2009
Presented to the Southern Flounder Advisory Committee (AC) on 7/1/2010
NCDMF recommendation 10/19/10

Table 10.1 Average SPR, average F, average SSB, and the actual SSB and terminal year SPR before and after the 2005 southern flounder FMP management changes, both estimates calculated using ASAP2.

Period	Average SPR	Average F	Average SSB (pounds)	Actual SSB (pounds)	Terminal year SPR
1999-2004*	12%	1.24	2,742,175	3,136,260	9%
2005-2007	20%	0.74	4,348,533	4,358,990	19%

*Terminal year is 2002

Table 10.2 Estimated F and SSB benchmarks (pounds) for female southern flounder from the 2009 Southern Flounder Stock Assessment.

	F	SSB (pounds)
$F_{20\%}$	0.7223	4,722,588
$F_{25\%}$	0.5937	5,903,817
$F_{30\%}$	0.4880	7,084,845
$F_{35\%}$	0.4081	8,265,162
$F_{40\%}$	0.3445	9,446,797

The North Carolina Marine Fisheries Commission (NCMFC) asked the NCDMF at its May 2009 business meeting to evaluate interim management measures designed to end overfishing in the southern flounder fishery and rebuild the SSB. The NCMFC later requested that the NCDMF present these interim management measures to the Southern Flounder Advisory Committee (AC) before presenting them to the NCMFC. However, the Chair of the NCMFC suspended the discussion of this issue by the AC in November 2009. The NCMFC then voted to table interim management measures for southern flounder due to the pending lawsuit by the Karen Beasley Sea Turtle Rehabilitation Center over sea turtle interactions with large mesh gill nets. Large mesh gill nets account for the greatest proportion of commercial southern flounder landings, so the pending litigation would have an impact on southern flounder landings. Interim management measures to achieve sustainable harvest could not be completely evaluated until the result of the pending litigation was certain. Proclamation M-8-2010 was implemented on May 15, 2010 to minimize interactions with sea turtles in the large mesh gill net fisheries while the NCDMF applies for a coast wide incidental take permit from the National Marine Fisheries Service (NMFS) under Section 10 of the Endangered Species Act.

This issue paper reevaluates the management options from the “Achieving Sustainable Harvest” issue paper from the 2005 North Carolina Southern Flounder FMP (NCDMF 2005). In addition, this issue paper will evaluate the potential harvest reductions to the southern flounder gill net fishery from Proclamation M-8-2010.

Current Authority

G.S. 113-134. RULES
G.S. 113-182. REGULATIONS OF FISHING AND FISHERIES
G.S. 143B-289.52. MARINE FISHERIES COMMISSION—POWERS AND DUTIES
NC Fisheries Rules for Coastal Waters 2009
15A NCAC 3M .0503 FLOUNDER

Discussion

The NCMFC adopted a guideline requiring that “management options that set quantifiable fishing restrictions must meet a minimum standard of 50 percent probability of achieving the management benchmark(s) (e.g. fishing mortality rate) necessary to achieve or maintain sustainable harvest”. The overall harvest reductions necessary to achieve sustainable harvest in the southern flounder fishery are based on this 50 percent probability of success. “Management options subject to this requirement shall be identified as express management options during FMP development and as express management measures upon FMP adoption or amendment” [NCMFC Guidelines III(B)(3)(a)(2)].

The NCMFC guidelines further state that “quantifiable management options that do not meet the minimum standard shall be eliminated from consideration as soon as their deficiency is discovered”. Some management options are likely to be effective in reducing mortality, but the resulting reduction may not be quantifiable using existing data sources. In such cases, the NCMFC guidelines state “for those instances where there is insufficient information to quantify the effect of an action on a management benchmark(s) or where the action has no effect on a management benchmark(s), management options shall be precautionary and risk averse”.

The available management options are designed to reduce overall harvest and can be used individually or in conjunction with one another to meet the required reductions projected to achieve sustainable harvest. Harvest reduction calculations are based on past landings and harvest. The ability of these calculations to predict future harvest reductions depend on environmental parameters, recruitment, and fishing effort to remain similar to past years. Any future changes to these factors can impact the actual harvest reductions that occur. The management options presented in this issue paper are a starting point for discussion on achieving sustainable harvest, and are detailed below. Public input can provide additional options.

Static Quota

A quota refers to the maximum amount of fish that can be legally landed within a specified time period. A static quota is one that undergoes few changes between time periods and is usually established based on historical levels of landings to prevent over-expansion of the fishery. The intent of a static quota for the southern flounder fishery would be to establish annual landings that allow the stock to be rebuilt by 2015. The commercial and recreational fisheries heavily rely on the harvest of age-1 and age-2 southern flounder, so incoming recruitment is very important for the sustainability of the stock (Takade-Heumacher and Batsavage 2009). Due to the variability in recruitment between years, a static quota may not be sufficient in preventing overfishing during years of poor recruitment. However, the stock projections that are based on a static quota assume an average recruitment, which accounts for the variations in annual recruitment. A static quota would need a payback provision in order to rebuild the stock by 2015. This means that any landings exceeding the annual quota would be deducted from the following year’s quota. Rollover of unused quota would not likely be implemented while the stock is being rebuilt.

Southern flounder are commercially landed year-round with approximately 67% of the annual harvest from September to November (Table 10.3). Southern flounder are landed in numerous commercial fisheries but are targeted by the estuarine gill net, pound net and gig fisheries. The seasons, time and magnitude of peak harvest of southern flounder are different in these fisheries (Figure 10.1). Therefore, a static quota may not allow all three of these targeted fisheries an equal opportunity to land southern flounder before the quota is reached.

A potential solution for an equitable static quota is to establish a September 1 to August 31 commercial fishing year. This would allow the fishing year to begin just before landings peak in the fall, and would decrease the likelihood of a closure when most of the directed fisheries occur. This would also eliminate the need for gear specific quotas for the pound net and gill net fisheries, as discussed in the "Achieving Sustainable Harvest" issue paper in the 2005 FMP (NCDMF 2005). The red drum commercial landings cap is currently managed on a September 1 to August 31 fishing year to coincide with the peak landings of southern flounder (NCDMF 2008b). The majority of red drum is landed as bycatch in the southern flounder gill net fishery, and the majority of southern flounder landings (~56%) from this fishery occur from September to November. Over 95% of the annual southern flounder landings from pound nets occur from September to November, which makes this fishery the most reliant on a September 1 start date. The peak landings of southern flounder from the gig fishery occur from June through August, which would be at the end of the fishing year. Therefore, the gig fishery would be impacted more negatively than the other directed fisheries if the quota was reached before August 31.

Table 10.3 Monthly commercial landings by gear, 2000-2007 (NCDMF Trip Ticket Program).

	Gig		Estuarine gill net		Other commercial gears		Pound net		Total	
Month	Landings (pounds)	Percent	Landings (pounds)	Percent	Landings (pounds)	Percent	Landings (pounds)	Percent	Landings (pounds)	Percent
January	890	1.09%	5,415	0.33%	836	0.87%	334	0.04%	7,475	0.28%
February	658	0.81%	7,877	0.48%	4,152	4.34%	98	0.01%	12,785	0.49%
March	1,030	1.26%	20,464	1.24%	13,966	14.59%	335	0.04%	35,795	1.36%
April	2,926	3.58%	61,983	3.76%	6,280	6.56%	876	0.11%	72,064	2.74%
May	8,990	11.01%	103,177	6.25%	5,791	6.05%	3,334	0.41%	121,292	4.61%
June	18,227	22.32%	140,375	8.51%	8,845	9.24%	2,844	0.35%	170,291	6.47%
July	17,507	21.44%	156,846	9.50%	10,285	10.74%	1,256	0.16%	185,894	7.06%
August	13,760	16.85%	194,898	11.81%	10,777	11.26%	2,300	0.29%	221,736	8.43%
September	6,397	7.83%	276,926	16.78%	11,440	11.95%	121,206	15.07%	415,969	15.81%
October	6,491	7.95%	397,567	24.09%	11,264	11.76%	423,916	52.72%	839,239	31.89%
November	3,994	4.89%	256,352	15.53%	8,117	8.48%	227,576	28.30%	496,040	18.85%
December	786	0.96%	28,342	1.72%	3,995	4.17%	20,064	2.50%	53,187	2.02%
Total	81,658	100.00%	1,650,224	100.00%	95,746	100.00%	804,139	100.00%	2,631,767	100.00%

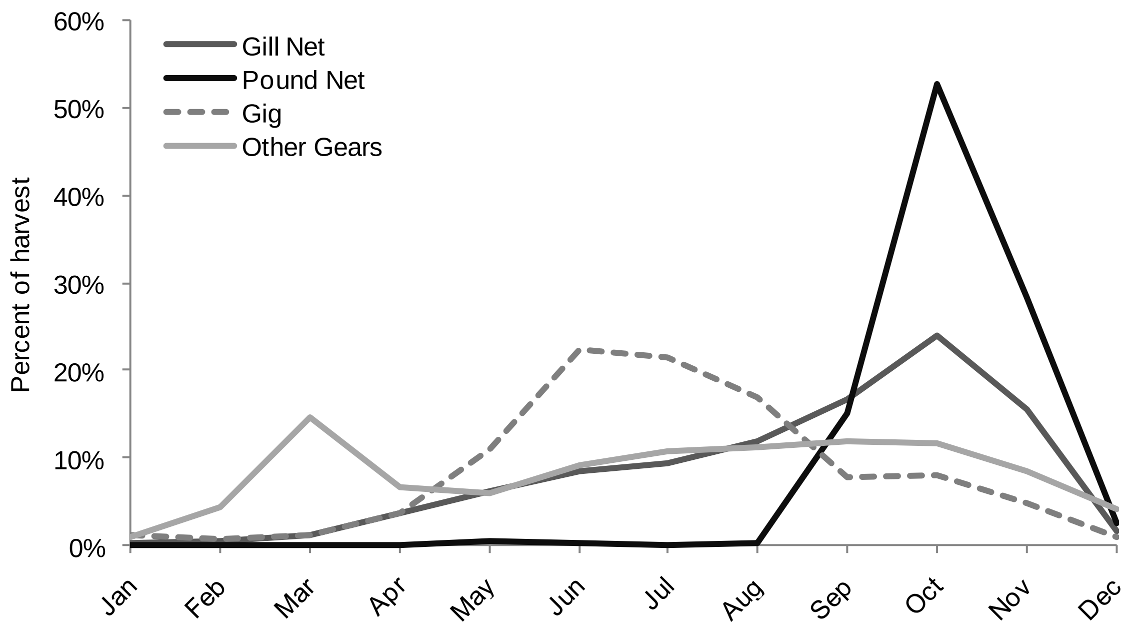

Figure 10.1 Monthly proportion of commercial southern flounder harvest by the gill net, pound net gig, and other commercial fisheries, 2000-2007 (NCDMF Trip Ticket Program).

Quota monitoring for the commercial southern flounder fishery could be complicated due to the high variability in daily landings, and the large number of dealers and participants in the fishery. The number of dealers and participants in the commercial southern flounder fishery far exceeds the number of dealers and participants in other quota monitored fisheries in the state. Daily reporting of landings during the peak harvest season would be difficult to monitor. If the peak landings occur during the beginning of the fishing year, then daily reporting may not be needed during that time. Regardless, the NCDMF will need to implement a monitoring system that can effectively track the commercial landings. And due to the number of dealers and participants in this fishery, it is unlikely the NCDMF could immediately implement a static quota monitoring system.

Managing the recreational fisheries with a static quota would be very difficult due to the lag time between the time of fishing and the time the harvest estimates become available through the Marine Recreational Fisheries Statistics Survey (MRFSS). Additionally, there are no annual harvest estimates for the recreational gig fishery. The 2009 Southern Flounder Stock Assessment assumed the annual recreational gig harvest equaled the annual hook and line harvest (Takade-Heumacher and Batsavage 2009). The Atlantic States Marine Fisheries Commission (ASMFC) manages the recreational summer flounder fishery through state specific regulations and allocations (ASMFC 2006). Annual harvest estimates that are projected from January-October harvest estimates are used to determine if a state has exceeded its recreational allocation. There is no system in place to monitor recreational landings on a real-time basis that would allow the fishery to be closed upon reaching the harvest limit. This management strategy results in many states changing their recreational size limits, creel limits and seasons on an annual basis to account for summer flounder harvest overages.

Dynamic Quota

A dynamic quota refers to a total allowable catch that fluctuates between years relative to the abundance of the resource and fishing pressure. In the case of southern flounder, the quota for a given year would be primarily driven by the strength of the year classes being subjected to fishing pressure. However, as with the static quota, all of the same drawbacks, including the issues with monitoring the landings on a daily basis and the high degree of variability in the daily landings, go along with implementing a dynamic quota. In addition, to adequately manage a dynamic quota, the NCDMF would need to determine if the fishery independent surveys used to estimate recruitment in the 2009 stock assessment can accurately predict year class strengths for quota management purposes. The terminal year estimates of recruitment from stock assessments tend to be the most uncertain, so it is not likely that the use of recruitment indices to determine a dynamic quota is a feasible possibility.

Limited Entry

A limited entry system would prevent expansion in the fishery beyond a specified level of participants. This type of system is established to prevent more fishermen from entering a fishery than the resource can support, or to reduce participants when the situation has already occurred. Eligibility for participation within the fishery is typically granted to those individuals who have demonstrated a historical utilization of and reliance on the resource. While a limited entry system could be established as a stand-alone system, it would be insufficient in preventing an increase in effort by those individuals allowed in the fishery. Therefore, overfishing may still occur. Limited entry systems work best when implemented in concert with quotas or gear restrictions. When a limited entry system and a quota are issued together, the quota ensures that the resource is not over-utilized, while the limited participation allows the fishermen remaining in the fishery a greater take in the available resource. In a limited entry system with no quota in place, restrictions on gear amounts and/or use per individual would aid in maintaining effort at a consistent level.

There are restrictions to establishing a limited entry system for fisheries in North Carolina. Section 3.4 of the Fisheries Reform Act (G.S. 113-182.1) concerning Fishery Management Plans (FMP) states that the North Carolina Marine Fisheries Commission can only recommend that the General Assembly limit participation in a fishery if it determines that sustainable harvest in the fishery cannot otherwise be achieved. Currently, there are other options available for achieving sustainable harvest. Therefore, limited entry is not a viable option for consideration at this time.

Increased Minimum Size Limit

Increasing the minimum size limit is a common management measure used to end overfishing, rebuild the spawning stock, and to allow a greater portion of fish an opportunity to spawn before they can be harvested. The short term effects of a minimum size limit increase would diminish the pool of younger and smaller fish immediately available for harvest, which in turn would produce a decrease in overall catch. The drop in landings, however, may not produce a corresponding drop in the fishing mortality rate initially, since for southern flounder, annual fishing mortality is measured from the age-2 to age-5 year classes (southern flounder are fully recruited to the fishery by the time they are age-2), and an increase in minimum size would predominately affect age-1 fish. In other words, decreasing the fishing mortality on age-1 fish may not have an immediate effect on reducing the annual fishing mortality that is based on age-

2 and older fish. Therefore, the benefit to the fishery of an increase in minimum size would not be realized until the increased survival of age-1 fish contribute to the pool of older age classes.

One of the major benefits of increasing the minimum size limit is that it would allow a larger number of the age-1 fish that would normally have been harvested the opportunity to spawn at least once prior to being harvested. This would increase the size of the spawning stock in subsequent years.

To determine the effect a 15-inch minimum size limit would have on allowing a greater number of age-1 female fish an opportunity to spawn, the length frequencies of age-1 fish from catches during the late part of the year (July-December) for 2006 and 2007 were examined. Age-1 female southern flounder caught during the early part of the year (January-December) were not considered because fish that were below the minimum size during the early part of the year could be legal sized fish by the late part of the year. Fish in the 14-inch size category comprised the greatest proportion of age-1 southern flounder females in the catches, so a 1-inch increase in the minimum size limit would allow a substantial number of age-1 female southern flounder an opportunity to spawn at least once (Table10.4).

The 2005 Southern Flounder FMP implemented a 14-inch minimum size limit for the commercial and recreational fisheries (NCDMF 2005). The expected percent reduction in catch from the size limit increase was 13.0% for the commercial fishery overall and 9.5% for the recreational fishery overall. The annual commercial landings decreased after the 14-inch minimum size limit was implemented, but it is uncertain as to how much of the reduction was from the size limit increase (Table 10.5). In contrast, the annual recreational harvest remained near the time series high after the 14-inch minimum size limit was implemented coast wide. However, the minimum size limit in the recreational fishery was 14 inches since October 1, 2002 for much of the coastal waters in the state; the recreational minimum size limit in western Pamlico Sound and its tributaries increased to 14 inches on April 1, 2005.

Table 10.4 Length frequency distribution of age-1 female southern flounder from catches during the late part of the year (July-December), 2006 and 2007 (NCDMF Biological Database).

Size class (Inches)	Age-1 females	Percent of catch	Cumulative percent	Percent mature
9	118	0.02%	0.02%	0.00%
10	62	0.01%	0.02%	0.06%
11	124	0.02%	0.04%	0.27%
12	407	0.05%	0.09%	2.81%
13	71,795	9.49%	9.58%	23.58%
14	301,648	39.86%	49.44%	59.96%
15	208,147	27.50%	76.94%	94.12%
16	107,188	14.16%	91.10%	98.73%
17	47,122	6.23%	97.33%	99.88%
18	18,930	2.50%	99.83%	99.98%
19	1,292	0.17%	100.00%	100.00%
20		0.00%	100.00%	100.00%
21		0.00%	100.00%	100.00%
22		0.00%	100.00%	100.00%
23	22	0.00%	100.00%	100.00%
Total	756,855			

Table 10.5 Annual proportions of commercial landings (pounds) and recreational harvest (pounds) of southern flounder, 1991-2007 (NCDMF Trip Ticket Program and MRFSS Survey).

Year	Commercial harvest (pounds)	Percent harvest	Recreational harvest (pounds)	Percent harvest	Total harvest (pounds)
1991	4,163,374	93.83%	273,674	6.17%	4,437,048
1992	3,145,020	95.49%	148,618	4.51%	3,293,638
1993	4,272,368	97.43%	112,812	2.57%	4,385,180
1994	4,878,639	94.87%	263,612	5.13%	5,142,251
1995	4,166,966	94.70%	233,238	5.30%	4,400,204
1996	3,807,009	94.29%	230,674	5.71%	4,037,683
1997	4,076,793	90.31%	437,234	9.69%	4,514,027
1998	3,952,729	95.73%	176,292	4.27%	4,129,021
1999	2,933,331	94.98%	155,010	5.02%	3,088,341
2000	3,205,792	85.53%	542,476	14.47%	3,748,268
2001	3,522,136	89.17%	427,822	10.83%	3,949,958
2002	3,436,753	87.90%	473,300	12.10%	3,910,053
2003	2,198,503	83.21%	443,614	16.79%	2,642,117
2004	2,454,577	74.27%	850,450	25.73%	3,305,027
2005	1,870,754	71.76%	736,202	28.24%	2,606,956
2006	2,287,823	75.74%	732,808	24.26%	3,020,631
2007	2,077,798	73.93%	732,618	26.07%	2,810,416
Annual average	3,320,610	89.01%	410,027	10.99%	3,730,636

To estimate the effect of an increase in the minimum size limit on future harvest, length frequency data from 2006 and 2007 were weighted to the commercial landings and the recreational harvest and analyzed. These were the only two full years in which the 14-inch minimum size limit was in place for both fisheries. The overall reduction in commercial landings in numbers of fish with a 15-inch minimum size limit is 31.2% (Table 10.6). Among the directed fisheries for southern flounder, the estuarine gill net fishery is most affected by a size limit increase. The harvest reduction in the recreational hook and line fishery in numbers of fish with a 15-inch minimum size limit is 16.3% (Table 10.7).

Table 10.6 Percent reductions (in numbers of fish) in harvest from an increase in the minimum size limit for each commercial fishery and the overall commercial fishery (NCDMF Biological Database).

	Cumulative percent reduction (in numbers of fish)				
Size limit (inches)	Gill net	Pound net	Gig	Other	All commercial fisheries
15	34.30%	24.14%	24.58%	13.42%	31.20%
16	62.14%	48.13%	57.52%	58.29%	58.76%
17	76.80%	66.92%	75.34%	76.04%	74.53%
18	85.36%	79.03%	84.73%	77.94%	83.78%
19	89.21%	86.01%	90.16%	84.35%	88.45%
20	91.15%	90.01%	93.87%	85.32%	90.90%

Table 10.7 Percent reductions (in numbers of fish) in harvest from an increase in the minimum size limit for the recreational fishery (MRFSS Survey).

Sizel limit (inches)	Cumulative percent reduction (in numbers of fish)
15	16.27%
16	34.83%
17	51.76%
18	66.23%
19	80.60%
20	87.13%

Some regions of the state will be more adversely affected than others from implementing an increase in the minimum size limit for the commercial and recreational fisheries (Table 10.8). Commercial gill net length frequency data from 2006 and 2007 from different areas of the coast were analyzed to examine the impacts of a minimum size limit increase on these areas. Gill net fishermen in Albemarle Sound and the Pamlico, Pungo, Bay and Neuse rivers will be impacted greatest by a 15-inch minimum size limit, while gill net fishermen in Pamlico Sound will be impacted the least. Southern flounder tend to be smaller in the western portions of the estuaries than those found in the eastern portions of the estuaries. Coast wide, an increased minimum size limit will likely have a greater impact on catches in the early half of the year when many of the mature southern flounder are still offshore. The reductions are larger during the early part of the year for every area except Albemarle Sound and the southern part of the coast (Table 10.8). Fewer samples were collected in the early part of the year, in general, and in particular for some areas, which may explain the lower percent reductions early in the year for some areas. The recreational length frequency data was too limited for this analysis, but it is very likely the relative impacts on this fishery in different areas of the coast would be similar.

Table 10.8 Percent reductions (in numbers of fish) in the commercial gill net fishery at different times of the year for different parts of the state from a 15-inch minimum size limit (NCDMF Biological Database).

	Percent reduction		
Area	Jan-Jun	Jul-Dec	Jan-Dec
Albemarle Sound*	29.1%	41.9%	41.7%
Pamlico Sound	22.5%	16.7%	17.4%
Rivers#	49.5%	36.4%	43.2%
Core & Back sounds	38.4%	24.4%	29.0%
New River	41.2%	20.3%	29.6%
Beaufort Inlet to SC line	25.3%	25.8%	25.8%

* Includes Currituck, Croatan and Roanoke sounds

Includes Pamlico, Pungo, Bay, and Neuse rivers

Recreational minimum size limits change on a nearly annual basis due to management measures designed to constrain recreational harvest of summer flounder to the state's recreational allocation, as mandated by the Atlantic States Marine Fisheries Commission (ASMFC) and the Mid Atlantic Fishery Management Council (MAFMC) Summer Flounder, Scup and Black Sea Bass FMP (Table 10.9). This has resulted in different recreational minimum size limits for flounder in different parts of the state. In general, the higher minimum size limits were implemented for areas where summer flounder are most commonly harvested by anglers, which minimizes the impacts summer flounder recreational management measures have on the recreational southern flounder fishery. Increasing the minimum size limit for southern flounder will not ensure uniform recreational size limits coast wide. Future harvest reductions for the recreational summer flounder fishery could result in an increased size limit for areas where summer flounder are most commonly harvested by anglers. In addition, any change to the minimum size limits in coastal and joint waters will result in regulations that are different than the inland North Carolina Wildlife Resources Commission (WRC) regulations. The WRC would need to change their existing flounder regulations to be compatible.

Any increase in the minimum size limit has the potential to increase the discards of undersized southern flounder in the commercial and recreational fisheries. For the commercial fisheries an increase in the minimum gill net mesh size used to target southern flounder and an increase in the minimum mesh size for escape panels in flounder pound nets would be needed to minimize discards of undersized southern flounder. The 2005 Southern Flounder FMP implemented a minimum large mesh gill net size of 5.5 inches stretched mesh and required escape panels of 5.5 inches stretched mesh in flounder pound nets coast wide in conjunction with the minimum size limit increase (NCDMF 2005). A higher overall harvest reduction is required with a 15-inch minimum size limit due to increased discards. Implementing the necessary gear changes would minimize discards and increase the chance of rebuilding the spawning stock. Gear restrictions to minimize undersized discards in the recreational fishery are more difficult because southern flounder are caught by anglers targeting them and are also caught incidentally by anglers targeting other species. This results in the use of a wide variety of terminal tackle and fishing techniques. Therefore, it is possible that increased discards in the recreational fishery might be greater than in the commercial fishery.

Table 10.9 Recreational flounder regulations in North Carolina, 1993-2010.

	Estuarine waters			Ocean waters		
Year	Size limit	Bag limit	Closed season	Size limit	Bag limit	Closed season
1993	13"	----	----	13"	----	----
1994	13"	----	----	14"	8 (1/1-10/31)/ 6 (11/1-12/31)	----
1995	13"	----	----	14"	8	----
1996	13"	----	----	14"	8	----
1997	13"	----	----	14" (1/1-3/31)/ 14.5" (4/1-12/31)	8 (1/1-3/31)/ 10 (4/1-12/31)	----
1998	13"	----	----	14.5" (1/1-6/6)/ 15" (6/7-12/31)	10 (1/1-6/6)/ 8 (6/7-12/31)	----
1999	13"	----	----	15"	8	----
2000	13"	----	----	15"	8	----
2001	13"	----	----	15.5"	8	5/1-5/14
2002	13" (1/1-9/30)/ 14"* (10/1-12/31)	----	----	15.5"	8	4/3-7/4
2003	13"/14"#	----	----	15"	8	----
2004	13"/14"#	----	----	14"	8	----
2005	14"	8 (4/1-12/31)	----	14"	8	----
2006	14"	8	----	14"	8	----
2007	14"	8	----	14.5"	8	----
2008	14"/15.5"^	8	----	14"/15.5"^	8	----
2009	14"/15"^	8	----	14"/15"^	8	----
2010	14"/15"^	8	----	14"/15"^	8	----

* 13" minimum size limit remained in western Pamlico Sound and its tributaries.

13" minimum size limit in western Pamlico Sound and its tributaries; 14" minimum size limit elsewhere.

^ 14" minimum size limit in western portions of Albemarle and Pamlico sounds and its tributaries, and ocean and estuarine waters south of Brown's Inlet to the SC border; 15.5" and 15" minimum size limits in eastern estuarine and ocean waters north of Brown's Inlet to the VA border.

Minimum size limit increases are effective at reducing harvest to a certain level as long as compliance with the regulations is consistent. The percent reductions in harvest associated with a minimum size limit increase assumes the proportion of undersized fish in the catches remains constant. However, recent data show that this is not the case. The proportion (in numbers) of undersized southern flounder in the estuarine gill net, pound net and recreational hook and line fisheries were compared for the years just prior to the minimum size limit increase (2000-2001 for the recreational fishery; 2003-2004 for the commercial fisheries) and for the first two full years (2006-2007) after the increase to the 14-inch minimum size limit. The percentage of undersized southern flounder in the estuarine gill net and pound net fisheries more than doubled (Table 10.10). However, the percentage of undersized southern flounder has actually decreased in the recreational fishery. The increase in the percentage of undersized southern flounder in the commercial fisheries could be the result of inadequate gear modifications in the 2005 Southern Flounder FMP, insufficient enforcement of the 14-inch minimum size limit, strong year classes entering the fishery or a combination of these factors. Regardless, if the percentage of undersized southern flounder continues to increase as the minimum size limit increases, then the expected harvest reductions will be diminished.

Table 10.10 Percentage of undersized southern flounder in the commercial and recreational catches under the 13-inch (2000-2001 and 2003-2004) and 14-inch (2006-2007) minimum size limits (NCDMF Biological Database).

	Percent undersized		
	Gill net	Pound net	Recreational
2000-2001			3.04%
2003-2004	2.91%	2.22%	
2006-2007	6.97%	5.82%	1.69%

Maximum Size Limit

Maximum size limits are typically used to protect large, mature fish from being harvested. This could also be implemented to help rebuild the SSB of southern flounder. A 24-inch maximum size limit for the commercial and recreational fisheries was used to determine the potential harvest reductions from this management measure. The harvest reduction in numbers of fish for the commercial fisheries is only 0.3%. The vast majority of the harvest is comprised of fish less than 20 inches (see Section 7.1—Status of the Commercial Fisheries). The harvest reduction in numbers of fish for the recreational fisheries is 2.3%. The recreational fisheries harvest fewer fish than the commercial fisheries, which contributes to the greater harvest reduction.

Implementing a maximum size limit would result in increased discards, and any dead discards would diminish the benefits to the population that this management measure provides. An alternative approach to this management option is to allow the possession of one fish 24 inches and greater. This would minimize the discards and the potential harvest reductions. The number of fish this size that are harvested annually in the commercial and recreational fisheries is so small that very few trips likely harvest more than one southern flounder that is 24 inches or greater. As a result there would be no measurable harvest reduction from this alternative management measure.

Season Closures

A season closure can be used to restrict harvest during certain times of the year and to reduce landings. Since effort can be increased during the open periods of the fishery to offset the benefits of the closed season, it is best to have closures that are a minimum of two weeks in duration, but preferably longer. The 2005 Southern Flounder FMP implemented a month-long season closure in December for the commercial fishery (NCDMF 2005).

To determine the effect a specific season closure would have on reducing harvest in the commercial fishery, monthly landings were averaged together from 2000 to 2007. These reference years for landings were chosen to coincide with the most recent landings in Section 7.1—Status of the Commercial Fisheries. These reference years also represent the most recent distribution of commercial landings among fisheries and areas. For the recreational fishery, bi-monthly harvest estimates were averaged together from 2003 to 2007. These reference years were chosen for their relatively consistent regulations (Table 10.9). A percent of the total annual harvest (in numbers of fish) was then attributed to each day of the year. An assumption in this approach is that daily harvest effort during years with season closures does not differ from years in which there is no limited season. For the commercial fishery, this analysis was also used to determine the potential harvest reductions from Proclamation M-8-2010, which prohibits the use of gill nets between 4 and 6.5-inch stretched mesh from Friday morning to Monday morning (3 days) all year, excluding Albemarle Sound, Currituck Sound and its tributaries. This essentially results in weekly closures for the southern flounder gill net fishery since large mesh gill nets account for nearly all of the southern flounder gill net landings. The 2011 calendar year was used to calculate the number of closed days per month.

The highest percent daily harvest in the commercial fishery occurs in October, and the highest percent daily harvest in the recreational fishery occurs in July and August. Therefore, it would take a longer season closure early in the year than during the time of peak landings and harvest to achieve the same percent reductions in landings and harvest (Figures 10.2 and 10.3). The estuarine gill net and pound net landings are greatest from September through November with approximately 56% of the average annual estuarine gill net landings and over 95% of the average annual pound net landings occurring during these months (Table 10.3). The commercial gig landings are highest from June through August with approximately 57% of the average annual landings occurring during these months.

Since the temporal distributions of landings and harvest for the commercial and recreational fisheries are different, it is possible that season closures for these fisheries could occur at different times of the year. Likewise, gear specific season closures for the commercial fishery could occur during different times of the year. Season closures during peak landings and harvest tend to be more effective than season closures when landings and harvest are minimal because season closures during peak landings and harvest leave less opportunity for recoupment by the fisheries. However, season closures during the peak harvest, particularly in the recreational fishery, are not easy to enforce because of difficulties communicating these closures to a large number of anglers and the enforcement problems associated with closures during the busy summer months. A recreational season closure during the summer would also have a greater impact on the recreational summer flounder fishery. Nonetheless, a recreational season closure could be effective at controlling recreational fishing effort and harvest that has increased despite management measures implemented in 2005. The time and magnitude of peak southern flounder landings are different for the estuarine gill net, pound net and gig fisheries, so an overall commercial season closure could impact one fishery more than the others. Alternatively, gear specific season closures for the commercial fishery could be implemented to provide equitable harvest reductions for the fisheries that target southern flounder.

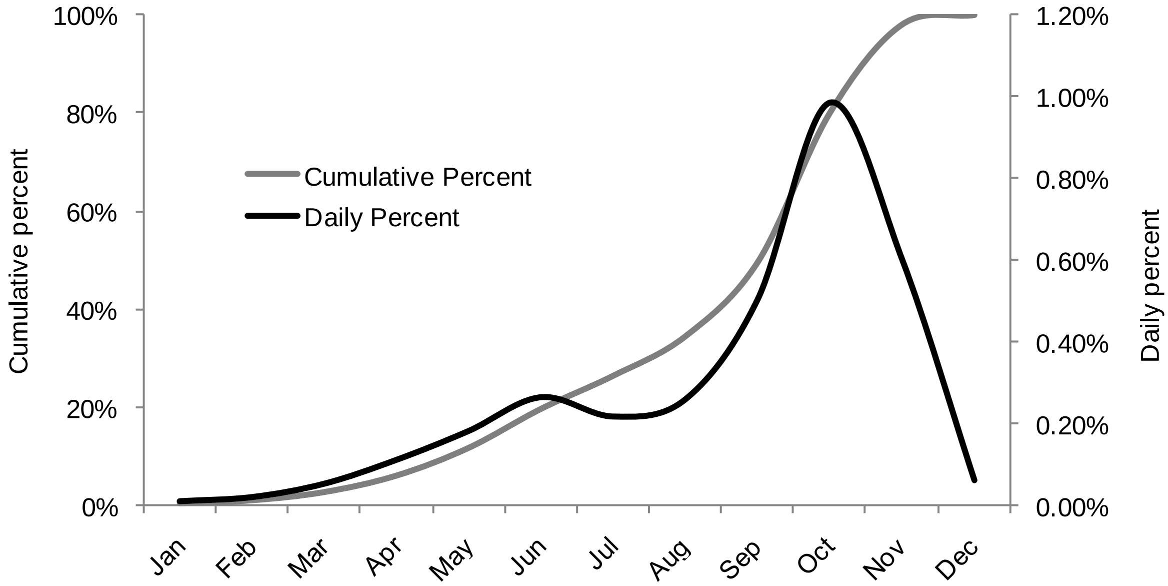

Figure 10.2 Daily and cumulative percent distributions of the overall annual commercial harvest, 2000-2007 (NCDMF Trip Ticket Program).

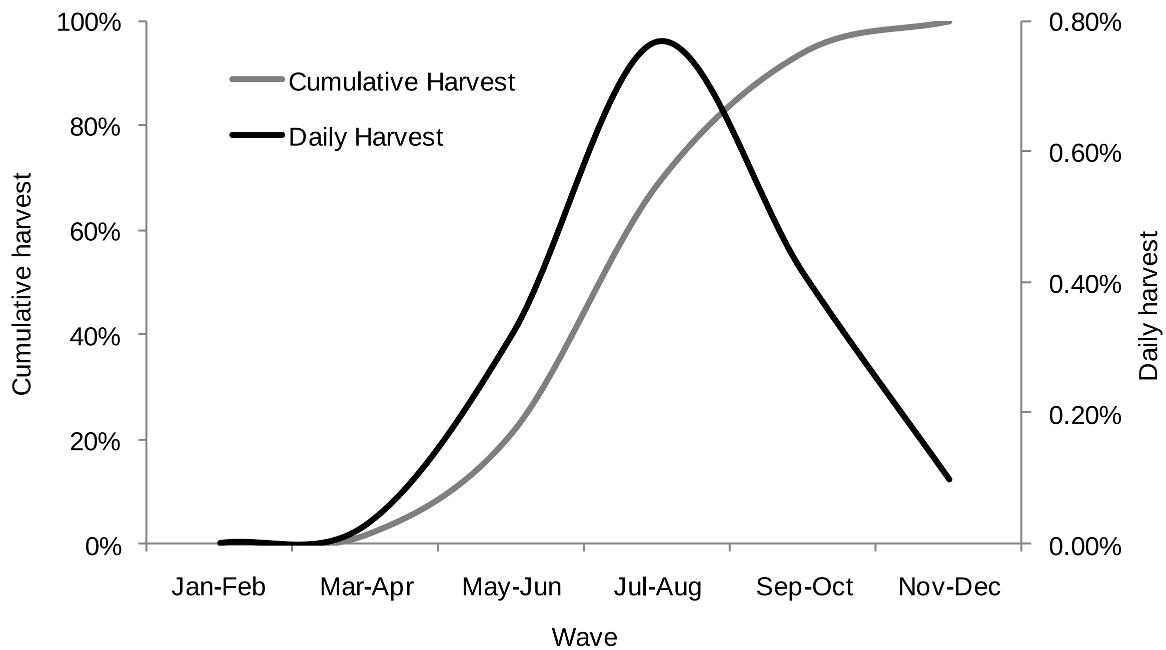

Figure 10.3 Daily and cumulative percent distributions of the overall annual recreational harvest, 2003-2007 (MRFSS Survey).

A possible result of overall season closures would be an increase in discards, particularly in fisheries that land, but do not target, southern flounder. Discards from the target fisheries could be minimized during closed seasons by removing the gear from the water. The peak landings of southern flounder from non-targeted (other) commercial fisheries occur from August through October as well as in March (Table 10.3). Southern flounder landings from these fisheries are a small (<5%) proportion of the annual commercial landings. Gear specific season closures for the commercial fishery could permit the harvest of southern flounder from non-targeted commercial fisheries, which would also reduce potential discards. However, gear specific reductions would need to be higher to offset the landings from the non-targeted commercial fisheries. In the recreational fishery, southern flounder that would normally be harvested would have to be released during the closed season, which would increase the number discards in this fishery. Consequently, the landings and harvest that will be converted to discards during a closed season should be considered.

Another possible result of a season closure could be an increase in effort during the open seasons. A closure early in the year could lead to increased fishing effort once the season opens. Similarly, a closure late in the year could lead to more effort as fishermen try to catch as many fish as possible before the fishery closes for the year. In either instance, the effectiveness of the closed season at reducing the fishing mortality would be reduced. Another possible result of a season closure is illegal harvest occurring during the closed season, which would diminish any expected harvest reductions. The enforcement of gear specific season closures would be more difficult than the enforcement of an overall season closure for the commercial fishery. These results would decrease the likelihood of achieving sustainable harvest by 2015.

Proclamation M-8-2010 results in an annual total of 144 closed days to large mesh gill nets outside of the December season closure for the southern flounder commercial fishery (Table 10.11). The daily harvest rates and monthly harvest reductions in the gill net fishery are lowest in the winter and highest in the fall, which coincides with the monthly harvest patterns for this fishery (Figure 10.1). From 2000 to 2007, Albemarle Sound, Currituck Sound and its tributaries accounted for 36.4% of the gill net landings in numbers of fish, which means this management measure impacts 63.6% of the annual gill net landings of southern flounder. This results in a harvest reduction of 27.0% in the gill net fishery (Table 10.11). From 2000 to 2007, gill nets accounted for 65.8% of the annual commercial southern flounder landings in numbers of fish, so the closed days for the gill net fishery results in an overall commercial harvest reduction of 17.8% in numbers of fish.

The 3-day closed seasons for the gill net fishery do allow an opportunity for fishermen to recoup their lost landings during the other four days of the week. Landings could also be recouped by gill netters shifting their effort to Albemarle and Currituck sounds where these closures do not apply, by gill netters entering the pound net or gig fisheries, or by gill netters using other gears or small mesh gill nets to land southern flounder. The 3-day closed seasons for only the gill net fishery would also prevent prolonged disruptions in the supply of southern flounder from the commercial fishery. The other management measures from Proclamation M-8-2010 such as no daytime sets of large mesh gill nets, lower maximum yardage limits, a 100-yard maximum length for individual gill net sets, and a maximum net height of 15 meshes could minimize recoupment of lost landings. In addition, excessive numbers of sea turtle interactions could close particular areas to large mesh gill nets, which could result in greater harvest reductions.

Table 10.11 Monthly and total commercial gill net landings reduction from weekly three day closures implemented by Proclamation M-8-2010 (based on 2011 calendar year) (NCDMF Trip Ticket Program).

Month	Number of days closed	Monthly landings	Per diem percent harvest	Monthly harvest reduction	Percent landings affected	Total reduction
January	15	0.39%	0.012%	0.19%	63.56%	0.12%
February	12	0.56%	0.020%	0.24%	63.56%	0.15%
March	12	1.46%	0.047%	0.56%	63.56%	0.36%
April	13	4.42%	0.147%	1.92%	63.56%	1.22%
May	14	7.36%	0.237%	3.32%	63.56%	2.11%
June	12	10.01%	0.334%	4.00%	63.56%	2.55%
July	14	9.07%	0.293%	4.10%	63.56%	2.60%
August	13	11.27%	0.364%	4.73%	63.56%	3.00%
September	12	16.01%	0.534%	6.41%	63.56%	4.07%
October	15	22.99%	0.742%	11.12%	63.56%	7.07%
November	12	14.82%	0.494%	5.93%	63.56%	3.77%
Total days	144				Total harvest reduction	27.02%

Trip/Creel Limits

Trip or vessel harvest limits are generally used within the confines of a quota to prevent harvesting the available amount of fish too quickly and to avoid exceeding the quota. Similar to a trip limit for the commercial fishery, a creel or bag limit for the recreational fishery is the number of fish allowed to be kept during a trip by an individual or boat. The 2005 Southern Flounder FMP implemented an 8 fish creel limit for the recreational southern flounder fishery (NCDMF 2005).

A trip or vessel harvest limit may not work well for the southern flounder commercial fisheries due to variability in the catches. Pound net and gill net landings can be quite large in the fall as the fish migrate to the inlets. The 2009 Southern Flounder Stock Assessment found that southern flounder discard mortality in the gill net fishery was 17.3% (Takade-Heumacher and Batsavage 2009). No discard mortality estimate was available for the pound net fishery, but anecdotal evidence suggests that it is low. Restrictive trip limits could result in increased discards in both the gill net and pound net fisheries on days when large catches occur.

Creel limits work well in the recreational fishery because the catches are less variable than the commercial fishery. The number of southern flounder caught per trip differs between anglers and recreational giggers (Takade-Heumacher and Batsavage 2009), so the average harvest reduction for the two recreational fisheries was calculated for each creel limit (Table 10.12). Recreational giggers tend to harvest more fish per trip than anglers but overall, it is rare for any recreational fishermen to harvest 8 southern flounder in a trip. The creel limit would need to be reduced to at least 3 fish per trip in order to achieve a substantial reduction. However, this could result in discards of legal sized southern flounder in excess of the creel limit. To minimize potential discards, a smaller creel limit reduction could be implemented with other management measures to meet the required harvest reductions.

Reducing the creel limit to a number that results in a substantial harvest reduction could result in some recreational giggers purchasing a standard commercial fishing license (SCFL) on the open market in order to harvest more southern flounder per trip. This has been a source of decline in the number of Recreational Commercial Gear License (RCGL) holders. Fishermen have replaced their RCGL with a SCFL to fish more gear (gill nets, in particular), harvest commercial quantities of fish and crustaceans, and not be subject to the net attendance requirements of the RCGL. Many of these fishermen choose not to sell their catch but instead retain it for personal consumption. If this were to occur in the recreational gig fishery, neither the North Carolina Trip Ticket Program nor the Marine Recreational Information Program [(MRIP) formerly Marine Recreational Fisheries Statistics Survey (MRFSS)] would collect the harvest information for these fish, which would increase the amount of the undocumented harvest of southern flounder.

Table 10.12 Percent reduction in harvest from reductions in the recreational creel limit (MRFSS Survey).

Creel limit	Percent reduction
1	-55.43%
2	-34.39%
3	-23.26%
4	-15.23%
5	-8.45%
6	-4.80%
7	-1.95%
8	0.00%

A creel limit reduction for southern flounder could have an effect on the recreational summer flounder fishery. The creel limit for ocean waters (where summer flounder are commonly landed) has been 8 fish since 1998 (Table 10.9). This creel limit would likely be reduced if the creel limit is reduced for southern flounder to alleviate any enforcement problems and because southern flounder are also harvested by anglers in the ocean. The WRC waters also have an 8 fish creel limit, so the WRC would also need to change their creel limit for consistent regulations.

Gear Limitations

The issue papers “Gear Requirements in the Flounder Pound Net Fishery” and “Gear Requirements in the Flounder Gill Net Fishery” evaluate the effectiveness of the gear requirements for these fisheries under the current minimum size limit of 14 inches. For the flounder pound net fishery, increasing the minimum escape panel mesh size from 5.5 inches to 5.75 inches would result in a harvest reduction of 11.2% in numbers of fish. From 2000 to 2007, pound nets accounted for 26.5% of the annual commercial southern flounder landings in numbers of fish, so an increase in escape panel mesh size to 5.75 inches stretched mesh would result in an overall commercial harvest reduction of 3.0% in numbers of fish. For the flounder gill net fishery, increasing the minimum mesh size from 5.5 inches to 5.75 inches would result in a harvest reduction of 3.1% in numbers of fish. From 2000 to 2007, gill nets accounted for 65.8% of the annual commercial southern flounder landings in numbers of fish, so an increase in minimum mesh size to 5.75 inches stretched mesh for large mesh gill nets would result in an overall commercial harvest reduction of 2.0% in numbers of fish. The lower maximum yardage limits for large mesh gill nets implemented by Proclamation M-8-2010 results in a potential harvest reduction of 9.3% for the southern flounder gill net fishery and an overall commercial harvest reduction of 6.1%.

The 3-day closed seasons for the gill net fishery combined with the maximum yardage limits for large mesh gill nets implemented by Proclamation M-8-2010 results in a total harvest reduction of 33.8% in numbers of fish for the southern flounder gill net fishery and an overall commercial harvest reduction of 22.2% in numbers of fish. Increasing the minimum mesh size for large mesh gill nets to 5.75-inch stretched mesh would result in an overall commercial harvest reduction of 23.6% in numbers of fish, and increasing the minimum mesh size for pound net escape panels to 5.75-inch stretched mesh would result in an overall commercial harvest reduction of 26.6% in numbers of fish.

Harvest reductions from increasing the minimum mesh sizes for flounder pound net escape panels and for flounder gill nets could help achieve sustainable harvest for the commercial fishery and reduce the number of undersized southern flounder caught by these gears. However, increasing the minimum mesh sizes for these gears could also result in the loss of other marketable species, and for flounder gill nets, the harvest reduction of southern flounder would be higher in the upper estuaries and in the spring.

Management Options

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

Commercial Fisheries

1) Status quo—implement management measures from Proclamation M-8-2010

    + No additional burden on fishermen, dealers, or Marine Patrol
    + Allows time to see the impact these measures will have on southern flounder landings
    + Closed days and maximum yardage limit reduction for the large mesh gill net fishery results in an overall commercial harvest reduction of 22.2%
    - Recoupment of landings through effort shifts to open days, other areas, or other fisheries could occur
    - Stock could suffer further decline if substantial recoupment of landings or non-compliance with these management measures occur

2) Implement a static quota

    + Controls harvest levels to projected harvest required to achieve sustainable harvest
    + No confusion over quota from year to year
    + Quota season that provides target fisheries an opportunity to land southern flounder could be established
    - Not sensitive to fluctuations in recruitment or availability of fish to the fishery
    - Additional reporting burden on commercial dealers
    - Requires a permitting system for dealers to implement
    - Requires additional resources for NCDMF to implement
    - May restrict harvest levels more or less than necessary
    - Potential to exceed the quota due to the magnitude of daily landings

- Quota overages must be deducted from the following year
- Potential for season to close early
- Unable to implement for recreational fishery

3) Implement a dynamic quota

+ Controls harvest levels
+ Sensitive to fluctuations in recruitment or availability of fish to the fishery
- Additional reporting burden on commercial dealers
- Requires a permitting system for dealers to implement
- Requires annual stock assessment update by NCDMF to implement
- Uncertainty in data prevents its use for quota management
- Confusion over the quota from year to year
- Potential to exceed the quota due to the potential magnitude of daily landings
- Unable to implement for recreational fishery

4) Increase the minimum size limit to 15 inches

+ Increase in the spawning stock biomass and the overall yield to the fishery in the long-term
+ Allows more immature fish the opportunity to spawn at least once before being landed
+ Reduces landings closer to a sustainable level
+/- Results in a 31.3% reduction in numbers of fish for the overall commercial fishery
- Decrease in the yield to the fishery in the short-term
- Greater impact to the gill net fishery than to the other commercial fisheries
- Some regions may be impacted more than others (i.e. Albemarle Sound and western Pamlico Sound and its tributaries)
- Impacts on catches greatest in early half of the year (January-June)
- Overfishing could still occur if fishing mortality increases on legal sized fish
- Effectiveness diminished if proportion of undersized fish in the catch increases

5) Implement an overall commercial season closure

+ Reduces landings closer to a sustainable level
+ Potentially allows more fish to survive the migration to the ocean to spawn
+ No reporting burden on fishermen or dealers
+ Decreased regulatory discards in the target commercial fisheries during the closed season
- Increased enforcement required
- Some fisheries may be impacted more than others
- Discards likely to increase in other commercial fisheries during closed season
- Effort could be increased during the open periods, thus reducing the effectiveness of the closure
- Effectiveness diminished if harvest occurs the during closed season

6) Implement gear specific commercial season closures

+ Reduces landings closer to a sustainable level
+ Landings reductions equally distributed among the target fisheries
+ Incidental catches of southern flounder in other commercial fisheries permitted

+ Decreased regulatory discards in the target commercial fisheries during the closed season
- More difficult to enforce than an overall commercial season closure
- Higher landings reductions are needed to offset incidental catches in other commercial fisheries
- Effort could be increased during the open periods, thus reducing the effectiveness of the closure

  Effectiveness diminished if harvest occurs during the closed season

7) Implement trip limits

   + Reduces effort and harvest in the fishery
   - Could lead to large increases in discard mortality
   - Could adversely impact some fisheries and fishermen more than others
   - Stock could suffer further decline

8) Increase the minimum mesh size for flounder pound net escape panels and flounder gill nets to 5.75-inch stretched mesh

   + Reduces the retention of undersized southern flounder
   + Reduction in discard mortality
   + Could reverse the trend of increased undersized southern in the landings
   + Harvest reductions from these gear changes (11.2% for pound nets, 3.1% for gill nets) would help achieve sustainable harvest for the commercial fishery
   - Gear changes required
   - Potential loss of other marketable species
   - Harvest reduction for flounder gill nets higher in the spring and in the upper estuaries

Recreational Fisheries

1) Status quo

   + No additional burden on fishermen, dealers, or Marine Patrol
   + No impact on the recreational summer flounder fishery
   - Sustainable harvest for the recreational fisheries not achieved
   - Trend of increased annual harvest could continue
   - Stock could suffer further decline

2) Increase the minimum size limit to 15 inches

   + Increase in the spawning stock biomass and the overall yield to the fishery in the long-term
   + Allows more immature fish the opportunity to spawn at least once before being caught
   + Reduces landings closer to a sustainable level
   + Results in a 16.3% reduction in numbers of fish for the overall recreational fishery
   - Decrease in the yield to the fishery in the short-term
   - Additional harvest reductions are needed to achieve sustainable harvest
   - Some regions may be impacted more than others (i.e. Albemarle Sound and western Pamlico Sound and its tributaries)
   - Impacts on catches greatest in early half of the year (January-June)

- Overfishing could still occur if fishing mortality increases on legal sized fish
- Effectiveness diminished if proportion of undersized fish in the catch increases

3) Implement a season closure

+ Reduces harvest closer to a sustainable level
+ Potentially allows more fish to survive the migration to the ocean to spawn
- Difficult to enforce if implemented during the summer months
- Greater chance for recoupment of harvest if implemented when harvest is relatively low
- Greater impact on recreational summer flounder fishery if implemented in the summer
- Discards likely to increase during closed season
- Effort could be increased during the open periods, thus reducing the effectiveness of the closure
- Effectiveness diminished if harvest occurs the during closed season

4) Reduce the 8 fish creel limit

+ Reduces effort and harvest in the fishery
+ Additional harvest reductions from a creel limit decrease would help achieve sustainable harvest for the recreational fishery
- Could result in discards of legal-sized fish if a very small creel limit is implemented
- Very small creel limit could result in recreational giggers purchasing a SCFL
- Could adversely impact some fisheries and fishermen more than others
- Does not work well as a stand alone measure

Management Recommendations

NCMFC Preferred Management Strategy*

- Commercial: Status quo (large mesh gill net management measures implemented by Proclamation M-8-2010), which results in an overall commercial harvest reduction of 22.2%.

- Recreational: Increase the minimum size limit to 15 inches and decrease the creel limit to 6 fish, which results in an overall recreational harvest reduction of 20.2%.

AC and NCDMF*

- Commercial: Status quo (large mesh gill net management measures implemented by Proclamation M-8-2010), which results in an overall commercial harvest reduction of 22.2%.

- Recreational: Increase the minimum size limit to 15 inches and decrease the creel limit to 6 fish, which results in an overall recreational harvest reduction of 20.2%.

*See Issue Paper 10.1.1 for most recent preferred commercial management strategies

Research Needs

- Investigate the feasibility of a quota as a management tool for the commercial southern flounder fishery
- Annual survey of the recreational gig fishery (underway)

10.1.1 ADDITIONAL MANAGEMENT OPTIONS FOR ACHIEVING SUSTAINABLE HARVEST OF SOUTHERN FLOUNDER[5]

Issue

Updated management options for achieving sustainable harvest for the commercial southern flounder fishery

Background

The North Carolina Marine Fisheries Commission (NCMFC) approved Draft Amendment 1 to the North Carolina Southern Flounder Fishery Management Plan (FMP) to send to the Secretary of the North Carolina Department of Environment and Natural Resources (NCDENR) and the Joint Legislative Commission on Seafood and Aquaculture (JLCSA) for review on November 4, 2010. As stated previously, reductions in the overall harvest of southern flounder based on 2007 landings are necessary in order to achieve sustainable harvest. The NCMFC preferred management strategy for achieving sustainable harvest in the commercial fishery was to allow the large mesh gill net management measures from the sea turtle lawsuit settlement agreement (settlement agreement) implemented by Proclamation M-8-2010 on May 15, 2010 to provide the required harvest reduction (as well as maintain the minimum mesh size of 5.5-inch stretched mesh for large mesh gill nets from April 15 to December 15 as provided in Issue 10.10). These measures were expected to be in place for the foreseeable future and result in an overall commercial harvest reduction of 22.2% based on 2007 commercial landings. The preferred management strategy for the recreational fishery was a statewide minimum size limit of 15 inches and a six-fish creel limit, which results in an overall recreational harvest reduction of 20.2%, based on 2007 recreational landings. Supplement A to the 2005 Southern Flounder FMP implemented the 15-inch minimum size limit and six-fish creel limit for the recreational fishery on February 21, 2011. However, large mesh gill net management measures have changed as the settlement agreement evolved through time and was implemented by several proclamations:

[5] Presented to Southern Flounder AC on 7/25/2012
NCDMF recommendation 7/27/2012
Presented to NCMFC 8/23/2012
Presented to Southern AC on 9/19
Presented to Finfish AC on 9/26/2012
Presented to the Northern AC on 9/27/2012
Presented to Southern Flounder AC (2nd time) on 10/17/2012

M-8-2010 May 15, 2010:	With the exception of western Albemarle and Currituck sounds, this proclamation limited the use of large mesh gill nets (4-6½-inch stretched mesh) to four nights per week, Monday through Thursday. It also limited the height of those gill nets to 15 meshes, required leaded bottom lines, and prohibited floats (except those used for identification) north of the Highway 58 Bridge. It also reduced the amount of gill net yardage allowed to 2,000 yards north of the Highway 58 Bridge and 1,000 yards south of it, and required 25-yard spaces between no more than 100-yard sections of gill net.
M-2-2011 January 20, 2011:	In order to have a shad harvest season, Albemarle Sound Management Area (ASMA), Pamlico Sound and its tributaries (including Pamlico, Pungo, Bay and Neuse rivers) and the Cape Fear River were exempted from the four-day fishing week, the mesh height, lead line and float requirements, and the 100-yard continuous length limit. These exemptions were in place until March 28, 2011.
M-27-2011 September 12, 2011:	Large mesh gill net restrictions were no longer required in Albemarle, Croatan and Roanoke sounds north and west of Highway 64/264 bridges as well as Pamlico, Bay and Neuse rivers.
M-30-2011 September 18, 2011:	An extra day (Monday) was allowed for setting large mesh gill nets south of Beaufort Inlet.
M-6-2012 February 2, 2012:	In order to have a shad harvest season, the ASMA, Pamlico Sound and its tributaries (including Pamlico, Pungo, Bay and Neuse rivers), upper New River and the Cape Fear River were exempted from the four-day fishing week, the mesh height, lead line and float requirements, and the 100-yard continuous length limit. These exemptions were in place until March 28, 2012.
M-23-2012 May 20, 2012:	Southern Core Sound (D1) was closed to large mesh gill nets and the 2,000-yard maximum length restriction was reduced to 1,000 yards from Beaufort to the Highway 58 Bridge.

Proclamations M-27-2011 and M-30-2011 exempted additional areas from the gill net management measures, and allowed an extra fishing day in the southern part of the coast. Proclamations M-2-2011 and M-6-2012 allowed for seasonal exemptions for the prosecution of the shad fishery. In May of 2012, Proclamation M-23-2012 closed southern Core Sound to the use of large mesh gill nets and the maximum allowable yardage of large mesh gill nets from Beaufort to the Highway 58 Bridge was decreased from 2,000 to 1,000 yards. These changes in gill net management make current management inconsistent with Draft Amendment 1 as approved by the NCMFC as *status quo* (large mesh gill net management measures implemented by Proclamation M-8-2010). It was considered *status quo* because at the time of approval, Proclamation M-8-2010 was in place.

Also occurring since the NCMFC approval of Amendment 1 was the declaration of Atlantic sturgeon as endangered, under the federal Endangered Species Act of 1973 (ESA) in April, 2012. Albemarle, Croatan and Roanoke sounds, along with the Pamlico, Bay and Neuse rivers were exempted from the sea turtle lawsuit settlement agreement restrictions by Proclamation M-27-2011, but those areas represent the locations where Atlantic sturgeon interactions are most likely to occur. River herring and American eel are also being considered for ESA listing by

National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service and if listed, may well require additional fishery management considerations.

The North Carolina Division of Marine Fisheries (NCDMF) has applied for incidental take permits for the North Carolina estuarine gill net fishery for both sea turtles and Atlantic sturgeon. It is uncertain whether NMFS will grant these permits to NCDMF and if granted, what additional restrictions these permits may have on the commercial southern flounder fishery. Any future management changes to estuarine gill nets enacted to reduce protected species interactions are likely to impact commercial harvest and effort to some extent. Previously these uncertainties were the reason draft Amendment 1 was not sent to the NCDENR secretary and the Joint Legislative Commission on Governmental Operations, which has replaced the JLCSA. With Draft Amendment 1 on hold since 2010, the NCDMF Southern Flounder Plan Development Team (PDT) met June 1, 2012 to discuss a process for completing draft Amendment 1 with the purpose to finalize management measures for achieving sustainable harvest of the southern flounder stock. The PDT decided that an update to the “Achieving Sustainable Harvest” issue paper (Issue 10.1) in Draft Amendment 1 was necessary to document the changes that have occurred since the NCMFC’s last action and to provide information to support the contention that effort has measurably decreased and may be adequate to meet the required reductions for sustainable harvest since the implementation of Proclamation M-8-2010 and those proclamations that followed. This paper only addresses the commercial sector of the fishery and does not address the recreational sector since management measures for the required reductions in that fishery were implemented via Proclamation FF-29-2011, effective February 21, 2011 as part of Supplement A to the Southern Flounder FMP. This paper provides additional information not available in the original issue paper and does not include discussion of management options already discussed in that paper. Please refer to the original issue paper for other management options.

Authority

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

N.C. Marine Fisheries Commission Rules 2011
15A NCAC 03M .0503 FLOUNDER

Discussion

The 2005 Southern Flounder FMP started the clock for a required rebuilding schedule of 10 years from the start date of adoption of that plan to achieve sustainable harvest. The 2009 N.C. Southern Flounder Stock Assessment indicated the stock remains overfished and overfishing is occurring (Takade-Heumacher and Batsavage 2009). Another stock assessment will need to be conducted to determine whether sustainable harvest is being achieved. The management strategy to achieve sustainable harvest in Draft Amendment 1 was to rely on Proclamation M-8-2010 to achieve the necessary harvest reductions. Continued management in the form of effort reduction to reduce sea turtle interactions in different areas (Figure 10.4) and Atlantic sturgeon interactions will very likely reduce effort and southern flounder landings in the gill net fishery.

Gill net effort decreased considerably after the implementation of Proclamation M-8-2010 based on gill net effort comparisons pre- versus post-settlement agreement (May 2010). It is important to note that M-8-2010 and all subsequent proclamations only applied to passive large mesh gill nets or set nets. Compared to the period from May-December 2009, 2010 effort for the same period decreased 51% (Table 10.13). This held true for the January-April 2011 period (post-M-8-2010) compared to January-April 2010 (pre-M-8-2010); during this time frame there was a 55% reduction in estuarine gill net effort (Table 10.14). Overall, for 2011 (first complete year with settlement agreement restrictions) there was a 48% reduction in effort compared to 2009 (the last full year before M-8-2010 went into effect) and a 55% reduction in effort compared to 2007 (Table 10.15).

Although changes in large mesh gill net management have occurred since December 2010, effort remains low in the estuarine passive gill net fishery (Table 10.16). Effort in 2011 decreased by 40% and 42% from 2009 and 2007 levels, respectively.

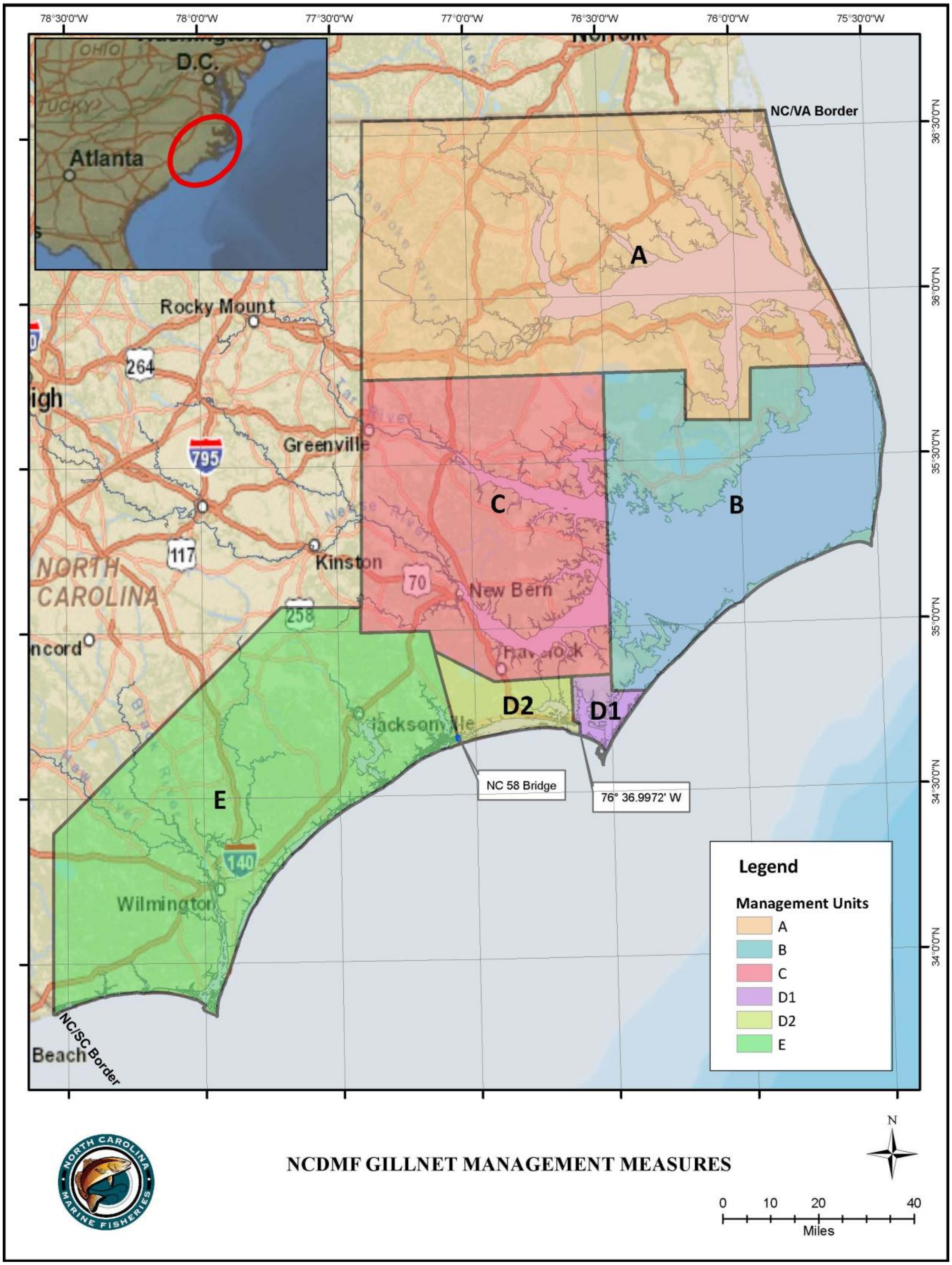

Figure 10.4. NCDMF sea turtle management areas

Table 10.13. Set gill net yardage comparison (thousands of yards) and percent change (total yards) from previous year and from 2007 by sea turtle management area May-December, 2007-2011.

Year	Area	Large Mesh Yards (4-6.5 ISM)	Yards/day	% Change from Previous Year	% Change from 2007
2007	Overall	27,637	115	-	-
	A	11,180			
	B	5,671			
	C	2,870			
	D1	5,623			
	D2	513			
	E	1,780			
2008	Overall	32,489	135	18	18
	A	13,561			
	B	6,446			
	C	2,249			
	D1	7,986			
	D2	530			
	E	1,718			
2009	Overall	31,343	130	-4	13
	A	13,446			
	B	5,955			
	C	2,912			
	D1	6,006			
	D2	737			
	E	2,286			
2010	*Overall*	*15,513*	*64*	*-51*	*-44*
	A	*5,662*			
	B	*5,392*			
	C	*1,253*			
	D1	*2,189*			
	D2	*304*			
	E	*714*			
2011	*Overall*	*12,463*	*52*	*-20*	*-55*
	A	*1,929*			
	B	*4,897*			
	C	*1,578*			
	D1	*2,762*			
	D2	*483*			
	E	*814*			

- *Italics indicate periods after Proclamation M-8-2010*

Table 10.14. Set gill net yardage comparison (thousands of yards) and percent change (total yards) from previous year and from 2007 by sea turtle management area January-April, 2007-2011.

Year	Area	Large Mesh Yards (4-6.5 ISM)	Yards/day	% Change from Previous Year	% Change from 2007
2007	Overall	7,808	63	-	-
	A	4,947			
	B	943			
	C	1,306			
	D1	310			
	D2	51			
	E	250			
2008	Overall	6,509	52	-17	-17
	A	3,335			
	B	1,351			
	C	1,050			
	D1	588			
	D2	30			
	E	155			
2009	Overall	4,776	39	-27	-39
	A	2,537			
	B	734			
	C	1,019			
	D1	248			
	D2	32			
	E	205			
2010	Overall	7,659	62	60	-2
	A	5,070			
	B	1,163			
	C	766			
	D1	448			
	D2	47			
	E	166			
2011	*Overall*	*3,477*	*28*	*-55*	*-55*
	A	*2,383*			
	B	*406*			
	C	*457*			
	D1	*110*			
	D2	*11*			
	E	*110*			

- *Italics indicate period after Proclamation M-8-2010*

Table 10.15. Set gill net yardage comparison (thousands of yards) and percent change (total yards) from previous year and from 2007 by sea turtle management area, January-December, 2007-2011.

Year	Area	Large Mesh Yards (4-6.5 ISM)	Yards/day	% Change from Previous Year	% Change from 2007
2007	Overall	35,445	97		
	A	16,127			
	B	6,614			
	C	4,177			
	D1	5,932			
	D2	565			
	E	2,031			
2008	Overall	38,998	107	10	10
	A	16,896			
	B	7,797			
	C	3,299			
	D1	8,574			
	D2	560			
	E	1,873			
2009	Overall	36,119	99	-7	2
	A	15,984			
	B	6,689			
	C	3,931			
	D1	6,255			
	D2	769			
	E	2,491			
2010	Overall	23,173	63	-36	-35
	A	10,731			
	B	6,555			
	C	2,019			
	D1	2,637			
	D2	351			
	E	880			
2011	*Overall*	*15,941*	*44*	*-31*	*-55*
	A	*4,312*			
	B	*5,303*			
	C	*2,035*			
	D1	*2,873*			
	D2	*494*			
	E	*924*			

- *Italics indicate first complete year after Proclamation M-8-2010*

Table 10.16. Set gill net trips comparison and percent change by sea turtle management area, January-December, 2007-2011.

Year	Area	Large Mesh Gill Net Trips (4-6.5 ISM)	Trips/day	% Change from Previous Year	% Change from 2007
2007	Overall	24,750	68		
	A	10,828			
	B	4,756			
	C	4,104			
	D1	2,739			
	D2	507			
	E	1,816			
2008	Overall	25,919	71	5	5
	A	11,474			
	B	5,359			
	C	3,102			
	D1	3,841			
	D2	502			
	E	1,641			
2009	Overall	24,166	66	-7	-2
	A	10,173			
	B	4,571			
	C	3,809			
	D1	2,785			
	D2	681			
	E	2,147			
2010	Overall	19,062	52	-21	-23
	A	9,017			
	B	4,980			
	C	2,078			
	D1	1,527			
	D2	345			
	E	1,115			
2011	*Overall*	*14,422*	*40*	*-24*	*-42*
	A	*4,725*			
	B	*4,053*			
	C	*2,230*			
	D1	*1,693*			
	D2	*520*			
	E	*1,201*			

- *Italics indicate first complete year after Proclamation M-8-2010*

Based on this, it is assumed that the implementation of Proclamation M-8-2010 and subsequent proclamations have resulted in a substantial reduction in effort and harvest in the set gill net fishery. Although changes in large mesh gill net management have occurred since December 2010, effort remains low overall in the estuarine gill net fishery (Table 10.17). Overall, gill net landings have decreased by 55% with the number of trips showing a decrease by 50% since 2007. Since 2009, the year before the settlement agreement was implemented, a 61% decrease in landings and a 52% decrease in effort (trips) have occurred. As the NCDMF becomes more proactive in the protection of endangered species through management of estuarine gill nets, effort is expected to remain low.

Table 10.17. Landings in pounds, number of vessels and number of trips by estuarine gill nets, 2007-2011.

	Estuarine Gill Nets		
Year	pounds	vessel	trips
2007	1,454,393	1,084	22,609
2008	1,770,204	1,034	23,493
2009	1,657,962	1,105	23,690
2010	958,271	929	15,134
2011	653,687	828	11,414

It should be noted that landings for two other major commercial gears, pound nets and gigs, were similar between 2007 and 2011 (Table 10.18). This provides support that the settlement agreement regulations were largely responsible for the reductions in landings from estuarine gill nets and not simply a reflection of a decline in the availability of southern flounder in 2011. One thing to consider when addressing sustainable harvest in the commercial southern flounder fishery is a potential increase in fishing effort in the pound net and gig fisheries that might cause recoupment of any potential reductions in the set gill net fishery. The NCDMF has observed a 13% increase in gig landings and 12% increase in the number of gigging trips since 2007. The number of vessels fishing with gigs rose by 23% (Table 10.18). Since 2009, gig landings have increased by 34% with effort in number of trips increasing by 43%. However, gigs continue to be a minor contributor to the overall southern flounder harvest, accounting for 8% and 9% of the annual harvest in 2010 and 2011, respectively. In 2007, gigs accounted for approximately 5% of the total harvest.

Pound net landings decreased slightly from 2007 by 4% with effort in number of trips decreasing only by 10% (Table 10.18). Since 2009, landings by pound nets have decreased by 22% with effort down by 23% (Table 10.18). Landings from gears other than gill nets, pound nets and gigs and the number of trips have decreased by 59% and 60%, respectively. Since 2009, other gears have shown a 73% decrease along with 62% decrease in the number of trips (Table 10.18).

Table 10.18. Landings, pounds and number of trips for gigs, pound nets and other gears 2007-2011.

Year	Gigs			Pound Nets			Other*		
	pounds	vessel	trips	pounds	vessel	trips	pounds	vessel	trips
2007	100,063	185	1,854	482,927	99	1,502	40,415	428	2,416
2008	82,846	160	1,459	685,546	93	1,508	63,793	445	2,510
2009	84,303	163	1,450	591,534	102	1,746	62,329	438	2,510
2010	128,081	248	2,283	571,151	95	1,610	32,054	349	1,384
2011	113,261	228	2,073	463,542	71	1,349	16,680	255	963

*All other fishing gears

Table 10.19. Commercial landings of southern flounder regardless of gear and percent change from 2007 harvest levels.

Year	Commercial Landings	
	Pounds	% Change from 2007
2007	2,082,996	-
2008	2,602,020	25
2009	2,395,384	15
2010	1,689,493	-19
2011	1,247,170	-40

Overall, landings decreased by 40% for 2011 compared to 2007. Compared to 2009 (the last year prior to Proclamation M-8-2010), 2011 landings decreased by 48% (Table 10.19). Other more qualitative factors may be playing a role in decreasing fishing effort as a result of the settlement agreement. The settlement agreement limits soak times for unattended large mesh gill nets from one hour before sunset to one hour after sunrise. This further decreases effort and likely results in a lower discard mortality. Fishermen must stay closer to home because of the night time set requirements and the need to remove nets no later than one hour after sunrise. These overnight sets also require twice the travel with one run setting the net and the other run fishing the net. This increases the time and cost needed for the fishermen to participate in this fishery. In areas with higher tidal amplitudes, low tides at sunset and sunrise can prevent gill netters from setting and retrieving their gear within the specified time frame. The 15-mesh height restriction for large mesh gill nets further limits those fishermen who fish in areas not conducive to this gear configuration.

This analysis of effort does not account for fish availability. It only looked at effort that has occurred under the current regulations and compared them to what happened in 2007. Any reduction in effort is assumed to be due to regulations. Southern flounder landings in the estuary are typically dominated by only a few age classes. Natural fluctuations in recruitment can have a direct impact on effort and landings in any given year. Based on the 2009 stock assessment, fishing mortality has decreased and spawning stock biomass has increased since the early 2000s (Takade-Heumacher and Batsavage 2009). For 2011, landings in all major commercial gears were similar to those that occurred in 2007 with the exception of estuarine gill nets. Of these gears, only estuarine gill nets had extensive regulations implemented and this gear experienced a drastic reduction in landings. Fishery independent gill net data from

Pamlico Sound had relative abundance indices from 2007 and 2011 that were nearly identical, indicating similar fish availability between the two years. It will take an updated stock assessment to determine if regulatory changes in the southern flounder fishery for both the commercial and recreational sectors have had the desired impact of reducing fishing mortality and rebuilding biomass to the desired levels. It should also be noted that since the most recent regulatory changes have only been in place for two years, there is a need for additional years of consistent regulations before the full impacts can be assessed with any certainty.

The management measures that have been put in place to protect sea turtles have decreased fishing effort in the southern flounder gill net fishery and effort will probably remain low compared to pre-settlement agreement times. Additional measures will likely follow as a result of the endangered listing of Atlantic sturgeon and could very well have a more direct impact on the regions that were exempted from many of the sea turtle regulations. Managers need flexibility in the management of southern flounder to react to changes in fishing effort and stock abundance to ensure that the southern flounder stock will continue to recover. Changes that have occurred since May 2010 have most likely benefited the southern flounder stock but the full measure of those changes will not be certain until a new stock assessment is performed. By default, the evolving management measures from the settlement agreement has been the strategy to deal with the dynamic situation of finding balance between interactions with protected species, the prosecution of the large mesh gill net fishery, and the sustainability of the southern flounder stock, until the stock can be assessed. Adaptive management, which is an approach that allows managers to take advantage of a variety of strategies and techniques that are adjusted, refined, and/or modified based on an improved understanding of system dynamics (NCDMF 2012), may be a tool to consider in the future management of southern flounder and further develop once a new assessment is performed.

Proposed Rules

None

Management Options

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

1a) Achieve sustainable harvest through protected species measures.

+ May meet harvest reductions necessary to rebuild stock and end overfishing
+ Requires no additional regulatory changes
- May not meet harvest reductions necessary due to potential for changing measures
- Requires all reductions for commercial sector to come from one gear type
- Possibility for increased effort, particularly from pound nets and gigs
- Adds uncertainty to stock assessment

1b) Achieve sustainable harvest through specific minimum measures for southern flounder.

+ More likely to meet harvest reductions necessary to rebuild stock and end overfishing
+ Requires no additional regulatory changes
+ Consistent regulations improve stock assessment
- Requires all reductions for commercial sector to come from one gear type
- Possibility for increased effort, particularly from pound nets and gigs

2) Implement other management measures outside of existing sea turtle restrictions to meet necessary reduction in harvest.

- \+ Regulations could be evenly distributed among gear users.
- \+ Higher likelihood of stock recovery
- \+ Less likelihood of regulations changing due to protected species management
- \- Will require additional reduction in landings beyond what is necessary
- \- Unnecessary economic impact on fishery
- \- No updated stock assessment available from which to develop or evaluate different management measures

Recommendations

MFC Preferred Management Strategy - Same as NCDMF recommendation

AC - Same as NCDMF recommendation

NCDMF - Accept management measures to reduce protected species interactions as the management strategy for achieving sustainable harvest in the commercial southern flounder fishery. Specifically these minimum measures for the flounder gill net fishery are:

1. Maintain the following gill net restrictions (excluding run-around, strike or drop net that is used to surround a school of fish and then is immediately retrieved):

A. For all internal coastal waters year round other than waters of Albemarle, Currituck, Croatan and Roanoke sounds north and west of Highway 64/264 bridges, Pamlico, Pungo, Bay and Neuse rivers, and only during shad season (Jan-Apr) for the upper New River and upper Cape Fear River, limit the use of large mesh gill nets (4-6½-inch stretched mesh) to four nights per week, Monday through Thursday, except allow an extra day (Sunday/Monday) for setting large mesh gill nets south of Beaufort Inlet.

B. For all internal coastal waters other than waters of Albemarle, Currituck, Croatan and Roanoke sounds north and west of Highway 64/264 bridges as well as Pamlico, Pungo, Bay and Neuse rivers limit the use of large mesh gill nets (4-6½-inch stretched mesh):

- to use or possess no more than 2,000 yards of large mesh gill net per fishing operation regardless of the number of vessels involved in coastal fishing waters north and east of a line at longitude 76° 36.9972' W, which runs northerly from a point on Shackleford Banks to Lennoxville Point, then to the head of Turner Creek, and northerly up the western side of North River.

- to use or possess no more than 1,000 yards of large mesh gill net per fishing operation regardless of the number of vessels involved in coastal fishing waters north and west of a line at longitude 76° 36.9972' W, which runs northerly from a point on Shackleford Banks to Lennoxville Point, then to the head of Turner Creek, and northerly up the western side of North River and bound in the south by the North Carolina-South Carolina border.

C. Unless otherwise specified the maximum large mesh gill net yardage allowed is 3,000 yards.

2. Conduct a stock assessment with data through 2013.

10.2 OCEAN HARVEST OF SOUTHERN FLOUNDER[6]

Issue

The impact of the ocean harvest of older, larger, and predominantly female southern flounder to the stock.

Background

Southern flounder are found in both the estuarine and ocean waters of North Carolina with harvest occurring in both the estuaries and ocean. Southern flounder spawn along the edge of the continental shelf from November to February. Some adult southern flounder return to the estuaries after spawning while others remain in the ocean (Watterson and Alexander 2004; Taylor et al. 2008). However, the proportion of the adult southern flounder remaining in the ocean and the annual variation of southern flounder remaining in the ocean is unknown (Takade-Heumacher and Batsavage 2009). In contrast, juvenile and sexually immature southern flounder spend their first two years in the estuaries before migrating offshore (Powell and Schwartz 1979; Daniels 2000). See Section 6.1 for more information on the general life history of southern flounder.

The 2009 stock assessment determined the southern flounder stock in North Carolina is overfished and overfishing is occurring (Takade-Heumacher and Batsavage 2009). In addition, the life history and fishery characteristics result in female fish comprising the vast majority of the landings and harvest. Fishermen have expressed concern over the harvest of southern flounder from the ocean and its impact on the stock status due to the disproportionate harvest of large female fish. This issue paper will review research on the portion of the southern flounder stock in the ocean as well as the commercial and recreational data on southern flounder from the ocean.

Most research conducted on adult southern flounder was focused on age, growth, and maturity and reported collective results from fish captured in the estuaries and the ocean or Gulf of Mexico (Stokes 1977; Nall 1979; Wenner et al. 1990; Safrit and Schwartz 1998; Monaghan and Armstrong 2000; Stunz et al. 2000; Fischer and Thompson 2004). However, two studies in North Carolina investigated the ocean residency of southern flounder (Watterson and Alexander 2004; Taylor et al. 2008).

The NCDMF conducted a study from 2001 to 2004 investigating the portion of the southern flounder population in the ocean (Watterson and Alexander 2004). The objectives of the study were to determine if a portion of the southern flounder population remained in the ocean after the spawning season, to characterize the population demographics (size, age, sex, maturity) of the southern flounder in the ocean, and to identify the spawning season and potential spawning habitat. The study area ranged from offshore Drum Inlet to offshore Carolina Beach at hard bottom locations (artificial reefs, ship wrecks, natural structure) and used scuba and spears to collect the fish.

A total of 495 individual dives were completed during the primary study and only 312 southern flounder were collected, compared to over 1,200 Gulf flounder collected during the study

[6] Emailed to the PDT on 3/18/10
Presented to the AC on 4/13/10
NCDMF recommendation 10/19/10

(Watterson and Alexander 2004). Southern flounder were collected throughout the year in the ocean with the majority of the fish collected in the summer and fall. The southern flounder ranged from 286 mm (11.3 inches) to 745 mm (29.3 inches). Eighty-three percent of the southern flounder collected were female and 17% were male. Less than 1% of the southern flounder were age-1 and approximately 70% were ages 2 and 3. Age-4 and age-5 fish accounted for 14% and 6% of the southern flounder collected, respectively (Watterson and Alexander 2004). Most of the female southern flounder were sexually mature; the occurrence of immature female southern flounder in the ocean was low and was typically found at the shallower locations closer to shore. No large spawning aggregations of southern flounder were observed. It was believed that the majority of southern flounder spawned close to the Gulf Stream, which was beyond the diving limitation of 130 feet for this study (Watterson and Alexander 2004).

Taylor et al. (2008) investigated migration patterns of southern flounder in North Carolina using otolith microchemistry to determine when the fish resided in the estuaries and in the ocean. Otolith microchemistry is the analysis of naturally occurring chemical markers from seawater, found in the otolith over time that traces the environmental history of a finfish and its movement to and from different salinities of estuarine and ocean waters. Results from their research suggested that not all adult southern flounder returned to the estuaries after migrating to the ocean to spawn. However, the degree of ocean residency was unclear because it was difficult to identify the differences in a fish residing in the estuaries close to inlets and fish residing in the near shore coastal ocean (Taylor et al. 2008).

Most of the recreational hook and line harvest of southern flounder occurs in estuarine waters with approximately 69% of southern flounder by number and 66% by weight harvested in the estuarine waters of the state from 1991 to 2007 (see Table 7.10 of Section 7.2—Status of the Recreational Fishery). The recreational harvest from the ocean from 1991 to 2003 varied without trend and ranged from 19,394 pounds in 2003 to 81,297 pounds in 1997. Annual ocean harvest from the recreational hook and line fishery since 2004 has exceeded 100,000 pounds with peak landings in 2004 (195,160 pounds) (see Table 7.10 of Section 7.2—Status of the Recreational Fishery).

The length frequency distributions of southern flounder harvested from the recreational hook and line fishery in the ocean and in the estuaries were compared to see if any differences in the size class distributions occur. The modal size class of southern flounder was smaller in the estuaries (14 inches) than in the ocean (15 to 16 inches), and southern flounder from 17 inches to 23 inches comprised a greater proportion of the ocean harvest (Figure 10.5). However, southern flounder 24 inches and greater comprised a larger proportion of the estuarine harvest with the largest southern flounder observed in the recreational hook and line fishery (31 inches) coming from the estuaries.

Commercial flounder landings reported through the North Carolina Trip Ticket Program are not tabulated by species. To determine the commercial landings of each species, it is assumed that all flounder harvested from internal waters are southern flounder, while all flounder taken from the ocean are summer flounder. According to dependent sampling efforts of the commercial fisheries by the NCDMF, it has been determined that southern flounder make up less than one percent of the catch from ocean waters, while summer flounder and Gulf flounder account for approximately two percent or less of the total flounder harvested from internal waters (NCDMF unpublished data).

Fishery dependent sampling of the ocean gill net fisheries, the winter trawl fishery, and the gig fishery has collected information on commercially-caught southern flounder from the ocean. The winter trawl and ocean gill net fisheries contributed some of the largest southern flounder sampled, although the numbers of southern flounder sampled from these fisheries were very small compared to estuarine gill net and flounder pound net fisheries (NCDMF 2007). These fish were incidental catches in the near shore flounder trawl fishery targeting summer flounder and the large mesh anchored gill net fishery targeting monkfish (*Lophius americanus*). The length frequency distribution of southern flounder from the ocean in the gig fishery is within the length frequency distribution of southern flounder from the estuaries (Figure 10.6). The NCDMF does not sample the commercial or recreational spear fisheries in the ocean.

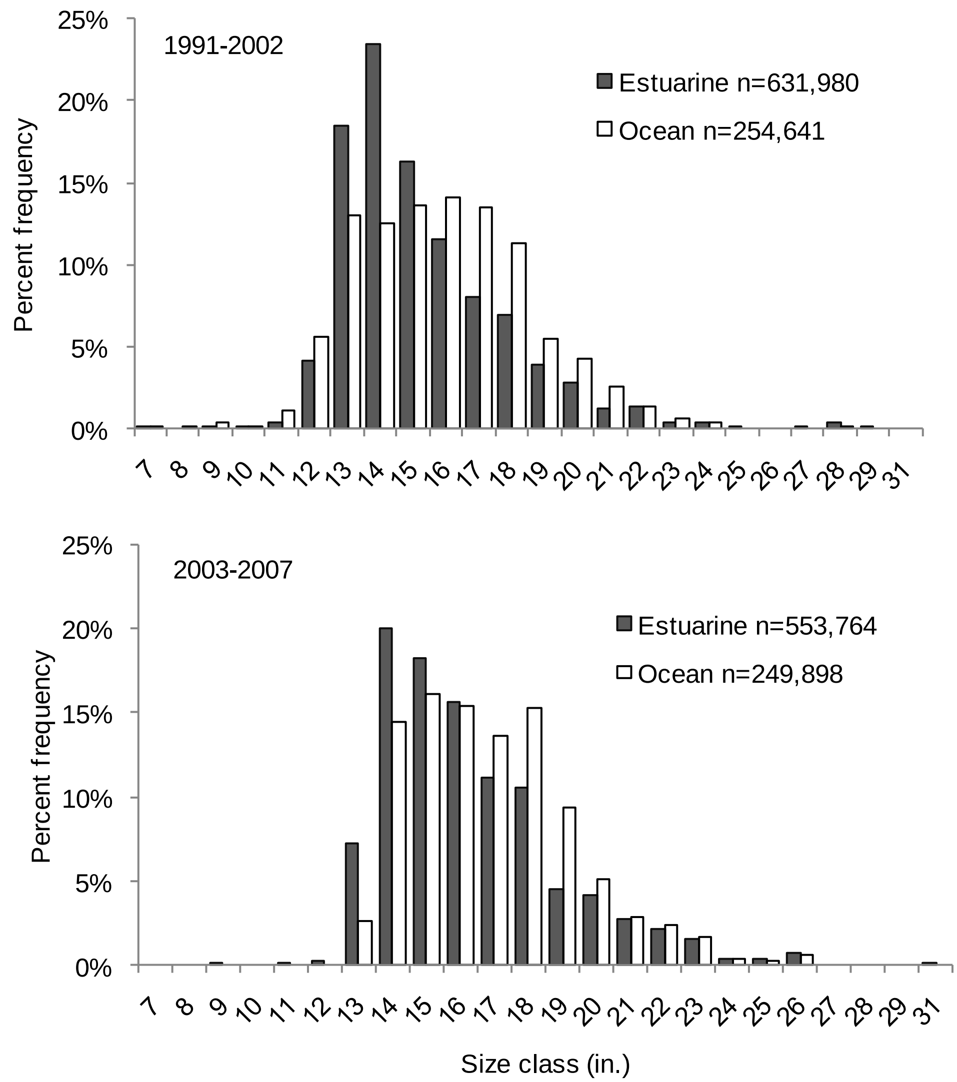

Figure 10.5 Expanded length frequency distributions of southern flounder in the ocean and estuarine recreational hook and line fisheries, 1991-2002 and 2003-2007 (MRFSS Survey).

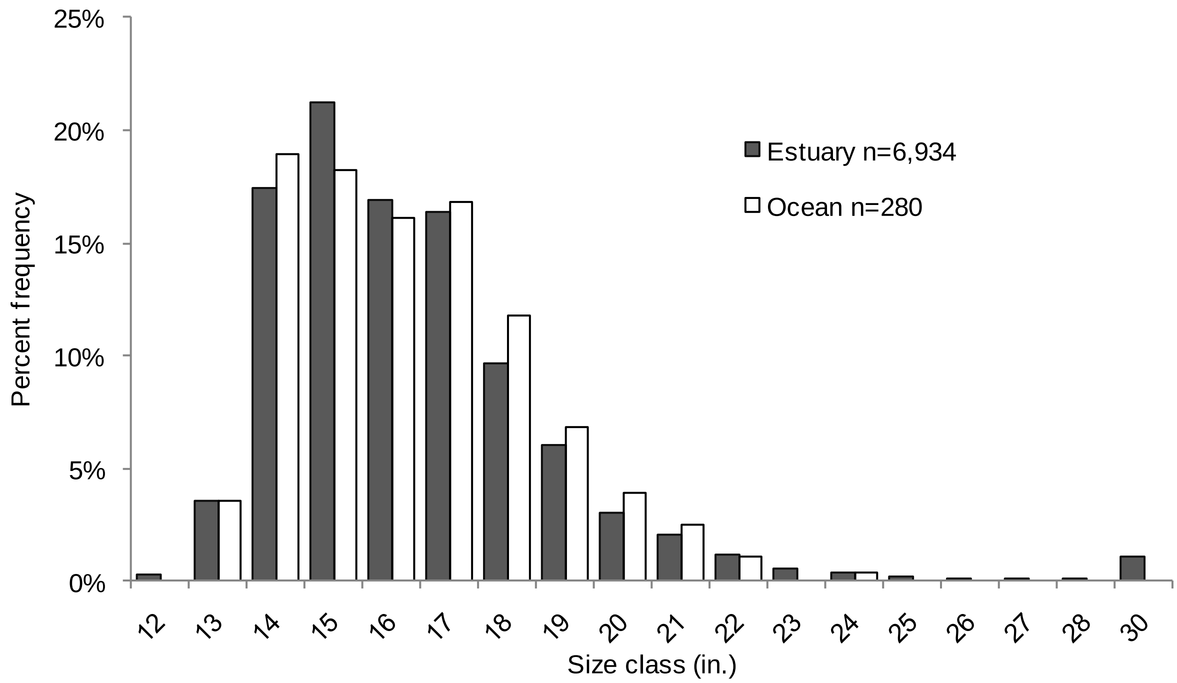

Figure 10.6 Expanded length frequency distributions of southern flounder sampled from commercial gig catches in the estuaries and the ocean (NCDMF Biological Database).

Current Authority

G.S. 113-134	RULES
G.S. 113-182	REGULATIONS OF FISHING AND FISHERIES
G.S. 143B-289.52	MARINE FISHERIES COMMISSION—POWERS AND DUTIES

NC Fisheries Rules for Coastal Waters 2009
15A NCAC 3M .0503 FLOUNDER

Discussion

The study conducted by the NCDMF found that southern flounder residing in the ocean tended to be larger, older, mature females compared to the southern flounder in the estuaries (Watterson and Alexander 2004). The study also found many more Gulf flounder residing in the ocean compared to southern flounder. Gulf flounder are not often found in low salinities so they are most often encountered in the ocean and the high salinity portions of the estuaries (Powell and Schwartz 1977; Stokes 1977; Walsh et al. 1999; NCDMF unpublished data). The Gulf flounder collected by the NCDMF for age and growth analysis tended to be larger from the ocean compared to the ones collected in the estuaries (Figure 10.7). The relatively low number of southern flounder collected in the ocean during this study could be the result of the majority of fish beyond the range of the study area, most of the southern flounder population residing in the estuaries, or the lack of large, old females in the population due to many years of overfishing (Watterson and Alexander 2004; Takade-Heumacher and Batsavage 2009). Despite southern flounder being found in the ocean throughout the year, it is also unclear if these fish enter the estuaries later in the season or if they remain in the ocean.

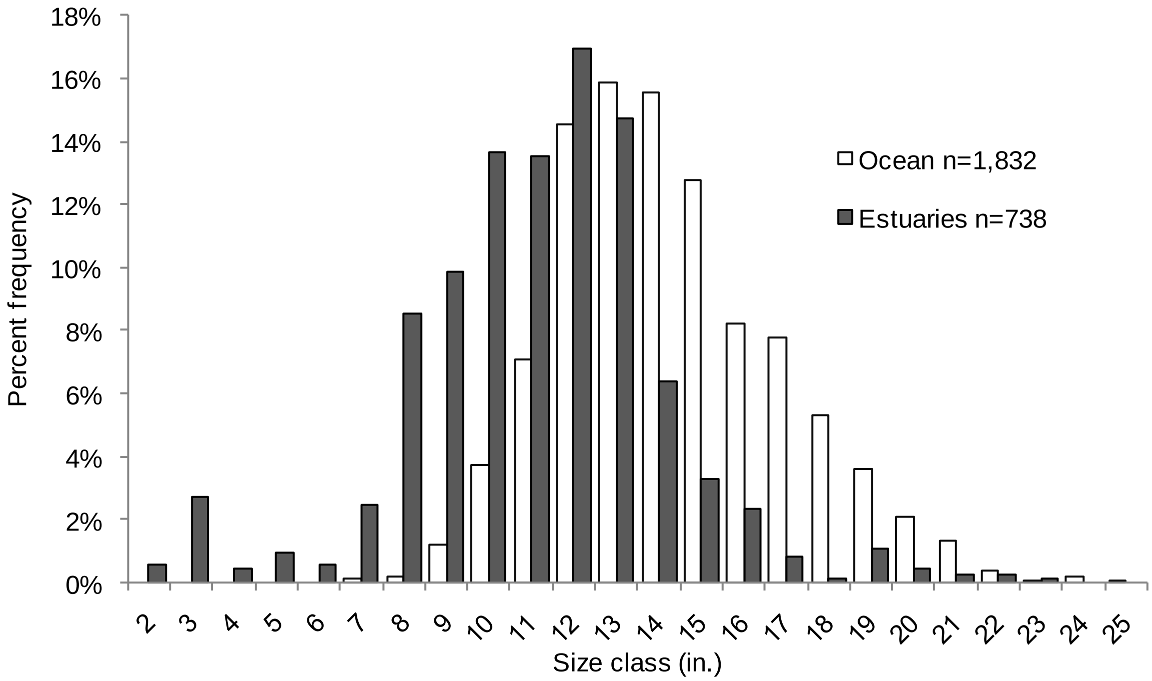

Figure 10.7 Length frequency distributions of Gulf flounder from NCDMF age and growth sampling in the estuaries and in the ocean (NCDMF Biological Database).

The proportion of the recreational hook and line harvest of southern flounder from the ocean is small compared to the proportion harvested from the estuaries. The modal size harvested in the ocean was greater than the modal size harvested in the estuaries, but the proportion of southern flounder 24 inches and greater was higher in the estuaries (Figure 10.5). The length frequency data show that larger, older, mature female southern flounder are harvested in both the ocean and the estuaries.

The abundance and length frequency distribution of Gulf flounder collected in the ocean by the NCDMF suggests that Gulf flounder are harvested by anglers in the ocean. Age and growth samples of Gulf flounder from the recreational fishery that were caught at the ocean artificial reefs confirm their presence in the ocean fishery (NCDMF, unpublished data). Despite their presence in the ocean recreational fishery, annual Marine Recreational Fisheries Statistics Survey (MRFSS) harvest estimates for Gulf flounder are highly variable and imprecise due to the relatively low occurrence of Gulf flounder (compared to southern and summer flounder) in the recreational fishery (Table 10.20). Accordingly, not all of the flounder harvested by anglers in the ocean are southern flounder.

Table 10.20 Recreational hook and line harvest estimates of Gulf flounder and the proportional standard error (PSE) of the estimates, 1991-2008 (MRFSS Survey).

Year	Harvest (Numbers)	PSE
1991	4,080	33.7
1992	1,164	44.9
1993	579	46.7
1994	-	-
1995	6,236	99.9
1996	-	-
1997	5,110	86.8
1998	-	-
1999	-	-
2000	5,178	46.5
2001	250	100.2
2002	2,303	73.9
2003	2,506	62.8
2004	10,313	32.2
2005	3,989	47.7
2006	235	100.2
2007	188	71.2
2008	15,923	33.6

The spawning season for southern flounder in North Carolina ranges from November to February (Monaghan and Armstrong 2000), but the exact locations for southern flounder spawning in the Atlantic Ocean remains unknown (Watterson and Alexander 2004; Wenner and Archambault 2005). The recreational hook and line harvest of southern flounder is very low during this time of year (Takade-Heumacher and Batsavage 2009). Therefore, it does not appear that the recreational fishery in the ocean is targeting spawning aggregations of southern flounder.

The NCDMF does not have a sampling program for either the commercial or recreational spear fisheries for flounder, and there is concern that these fisheries are targeting mature southern flounder. Annual commercial ocean landings of flounder from spear diving since 1994 have been less than 700 pounds per year with many years' landings less than 50 pounds per year. There are no harvest estimates for the recreational spear fishery, and the magnitude of this fishery is unknown. Commercial landings from this gear generally occur from May through October. These landings are recorded as summer flounder because the fish are landed in the ocean. Commercial fishing operations are limited to 100 pounds of flounder per trip if they do not possess a License to Land Flounder from the Atlantic Ocean (NCAC 03M .0503 (c)) or if the commercial ocean flounder season is closed (NCAC 03M .0503 (i)). It is likely that some of these fish are southern flounder, but the species proportions are unknown.

The current stock status of southern flounder in North Carolina is largely a result of the overharvest of ages 1 and 2 female fish. Many of these fish (particularly the age-1 fish) are spawning for the first time, and since many of these fish are harvested in the fall as they migrate out to the ocean, they do not get an opportunity to spawn (Takade-Heumacher and Batsavage 2009). The high fishing mortality on ages 1 and 2 fish may have contributed to the low number of larger, older southern flounder collected in the ocean (Watterson and Alexander 2004).

Reducing the fishing mortality on the overall population and allowing more fish an opportunity to spawn at least once before they are harvested should rebuild the spawning stock.

Management Options

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

1) Status quo (no additional commercial and recreational regulations specifically for ocean caught flounder)

   + No changes to existing regulations for flounder caught in the ocean
   + No impact to the harvest and landings of summer flounder and Gulf flounder from the ocean
   - No reductions to fishing effort on mature female southern flounder in the ocean

2) Implement management measures (i.e. minimum size limits, slot limits, creel/trip limits, closed seasons) specifically for the ocean commercial and recreational fisheries that reduce harvest of adult southern flounder in the ocean

   + Reduces fishing mortality on and provides protection to the mature female southern flounder population residing in the ocean
   - Increased regulations and enforcement
   - Increased disparity of regulations between the ocean and the estuaries
   - Does not provide protection to the adult southern flounder residing in the estuaries
   - Potentially impacts the harvest and landings of summer flounder and Gulf flounder

Management Recommendations

NCMFC Preferred Management Strategy

- Status quo and address the research recommendations.

AC and NCDMF

- Status quo and address the research recommendations.

Research Recommendations

- Further research on southern flounder that remain in the ocean after the spawning season
- Determine the exact locations of spawning aggregations of southern flounder in the ocean
- Continued otolith microchemistry research to gain a better understanding of ocean residency of southern flounder
- Tagging study of southern flounder in the ocean to gain a better understanding of migration patterns into the estuaries
- Update the southern flounder maturity schedule
- Fishery dependent sampling of the commercial spear fishery for flounder in the ocean
- Harvest estimates and fishery dependent sampling of the recreational spear fishery for flounder in the ocean

10.3 LARGE MESH GILL NET-RELATED CONFLICTS[7]

Issue

User conflicts that occur between large mesh commercial gill net fishermen and recreational anglers, and between large mesh gill net fishermen and other users.

Background

The NCDMF has addressed gill net-related conflict issues over the last 20 years. Gear related user conflicts involving large mesh gill nets of 5.5 inches stretched mesh and larger fishing for southern flounder have become more prevalent in recent years. The nature of the conflicts include anglers complaining about the lack of access to areas due to gill nets, bycatch of non-targeted finfish and protected species in large mesh gill nets, complaints by property owners who cannot access their boat docks due to large mesh gill nets, and complaints by commercial gill net fishermen about anglers and other users tampering with or damaging their gill nets.

User conflicts associated with large mesh gill nets have occurred in many areas along the coast. Table 10.21 lists the areas where these user conflicts were documented by NCDMF staff. Some of these locations were small in size (sound behind Hammocks Beach State Park and Queens Creek), while other locations are more extensive (sounds from Carolina Beach to Surf City and western Pamlico Sound). Most of the user conflict areas were in the central and southeastern coastal areas from Carteret County to Brunswick County. Several user conflict areas were documented in Hyde, Beaufort, Pamlico and Craven counties, while very few user conflicts were documented in the northeastern coastal area.

Many of the documented user conflicts associated with large mesh gill nets involved anglers targeting red drum, spotted sea trout, and southern flounder. The number of recreational fishing trips targeting these species has increased in recent years and consequently, the number of conflicts has also increased (Figure 10.8). The number of commercial gill net trips landing southern flounder has decreased from 1997 to 2005 but has slightly increased since 2006 (Figure 10.9). However, the amount of effort per gill net trip has increased and will be discussed further in the Discussion section.

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[7] Emailed to the PDT on 6/23/2009; Presented to Finfish AC on 8/3/2009; Presented to Inland AC 8/5/2009; Presented to the Northeast AC on 8/6/2009; Presented to the Southeast AC on 8/11/2009; Presented to the Central AC on 8/12/2009; Presented to the AC on 11/19/2009; NCDMF recommendation 10/19/10

Table 10.21 Documented areas of user conflicts associated with large mesh gill nets in the state.

Water body	County	Time(s) of year
Pamlico River tributaries	Beaufort/Pamlico/Hyde	Spring through fall
Newport River & tributaries	Carteret	Spring through fall
Bogue Sound Primary Nursery Areas (PNAs)	Carteret	Spring through fall
western Bogue Sound	Carteret	Spring through fall
North River	Carteret	Spring through fall
Back Sound	Carteret	Spring through fall
Core Sound (PNAs and no trawl areas)	Carteret	Spring through fall
Turnagain Bay	Carteret	Spring through fall
Long Bay	Carteret	Spring through fall
southwestern Pamlico Sound	Carteret	Spring through fall
western Bogue Sound	Carteret	Spring through fall
White Oak River	Carteret/Onslow	Spring through fall
Croatan Sound	Dare	Fall
Long Shoal River	Dare/Hyde	Fall
western Pamlico Sound	Hyde	Spring through fall
lower Cape Fear River & bays	New Hanover/Brunswick	Spring through fall
Sounds from Carolina Beach to Surf City	New Hanover/Pender	Spring through fall
New River	Onslow	Spring through fall
Queens Creek	Onslow	Spring through fall
Sound behind Hammocks Beach State Park	Onslow	Spring through fall
Neuse River tributaries	Pamlico/Craven/Carteret	Spring through fall

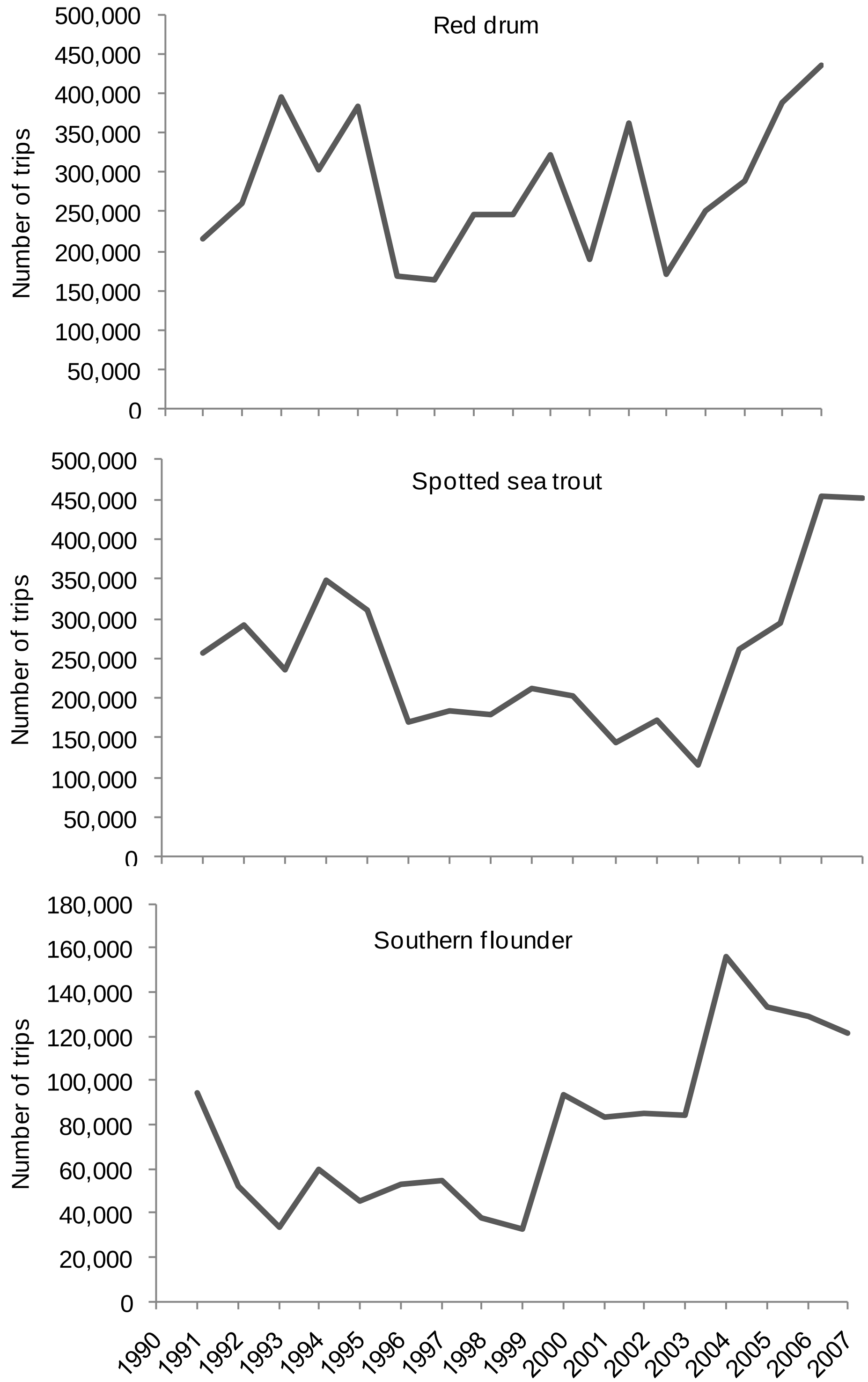


Figure 10.8 Number of recreational hook and line trips targeting or catching red drum, spotted sea trout, and southern flounder, 1991-2007. Note: The number of trips for each species is not additive because individual trips can target or catch multiple species (MRFSS Survey).

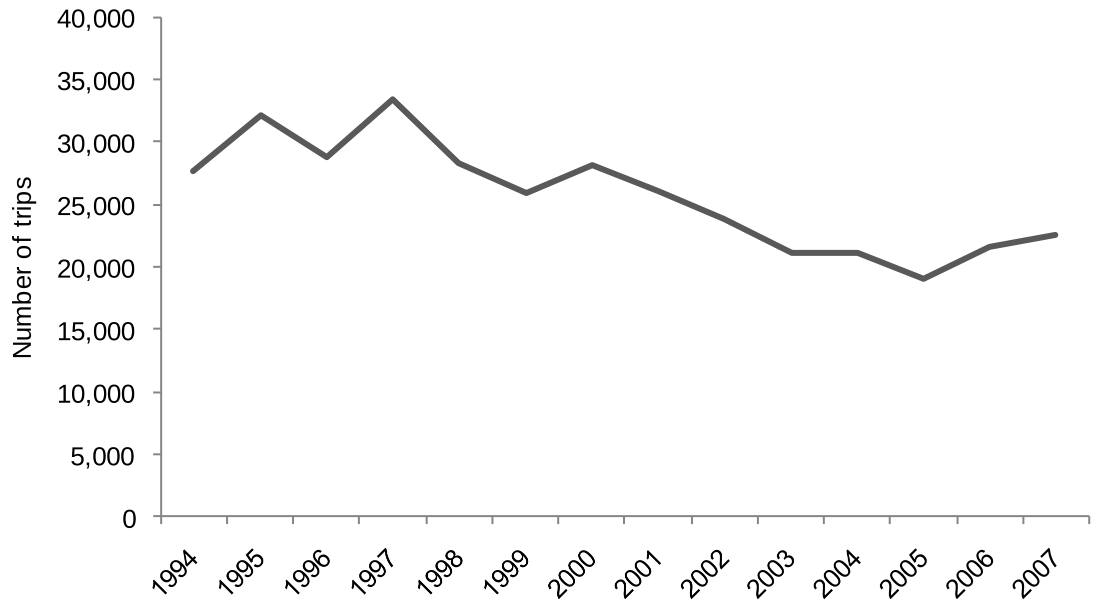


Figure 10.9 Number of estuarine gill net trips landing southern flounder, 1994-2007 (NCDMF Trip Ticket Program).

In October 2004 the NCMFC adopted a Conflict Management Policy, which states "that the overall goal of managing social conflicts is to foster cooperation, fairness, and equity among groups while maintaining user-diversity and access to public trust resources." The North Carolina Marine Fisheries Commission asked the NCDMF at its May 2009 business meeting to evaluate interim management measures designed to alleviate user conflicts associated with the large mesh gill net fishery. Interim management measures are actions taken to ensure the viability of the species or fishery while the plan is being developed or revised. The NCMFC voted to table recommendations on interim management measures in December 2009 due to the pending lawsuit by the Karen Beasley Sea Turtle Rehabilitation Center over sea turtle interactions with large mesh gill nets. This issue paper was developed through normal FMP review.

Current Authority

G.S. 113-134	RULES
G.S. 113-182	REGULATIONS OF FISHING AND FISHERIES
G.S. 143B-289.52	MARINE FISHERIES COMMISSION—POWERS AND DUTIES

NC Fisheries Rules for Coastal Waters 2009 (15A NCAC)

03J .0103	GILL NETS, SEINES, IDENTIFICATION, RESTRICTIONS
03M .0503	FLOUNDER
03J .0301 (j)	USER CONFLICTS
03J .0401	FISHING GEAR
03M .0512	COMPLIANCE WITH FISHERY MANAGEMENT PLANS

Discussion

There are several management options that could be implemented individually or in conjunction with one another. These management measures include ones that can be applied coast wide as well as those that can apply to specific areas. These management measures are detailed below.

Large Mesh Gill Net Yardage Limit Reduction

The North Carolina Marine Fisheries Commission implemented a 3,000 yard limit per fishing operation for large mesh gill nets as per management measures adopted in the 2005 Southern Flounder FMP (NCDMF 2005). The intent of this regulation was to reduce the effort of fishing operations setting more than 3,000 yards and to avoid further expansion of effort in the southern flounder gill net fishery. However, fishery dependent sampling of the estuarine gill net fishery indicate the average length of large mesh gill net fished has increased in some parts of the state, and these increases occurred after the FMP was implemented in 2005 (Figure 10.10). The most notable increase in effort was in Core and Back sounds where the average amount of large mesh gill net fished per operation increased from approximately 1,600 yards in 2000 to almost 2,500 yards in 2007. The average amount of large mesh gill net fished per operation also increased in Pamlico Sound and the Rivers (Pamlico, Pungo, Bay and Neuse rivers) since 2005. The Southern area of the state (Beaufort Inlet and all areas south) could not be examined due to small numbers of samples collected.

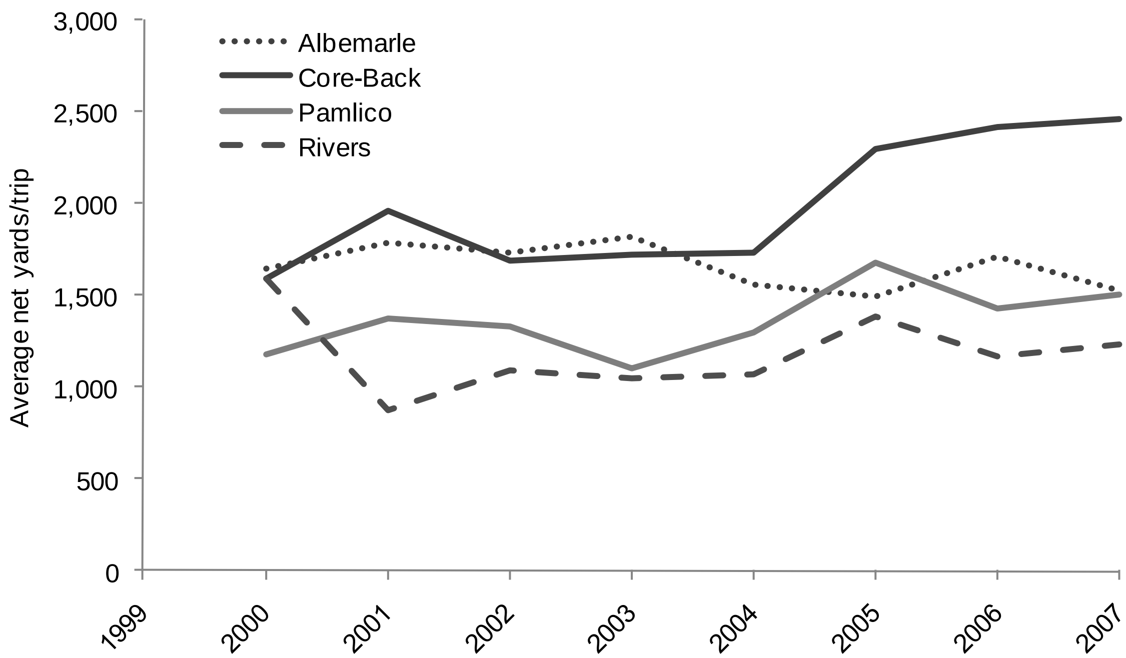


Figure 10.10 Average yardage of large mesh gill net fished per operation by water body, 2000-2007. The Rivers include the Pamlico, Pungo, Bay, and Neuse rivers (NCDMF Biological Database).

To further analyze the trends in the amount of large mesh gill net fished per operation, the proportion of large mesh gill net trips (in 500-yard increments) was examined. The majority of large mesh gill net trips in Core and Back sounds before 2005 fished between 1,501 and 2,000 yards per operation (Figure 10.11). Since 2005 the proportion of trips fishing greater than 2,500 yards in Core and Back sounds increased to nearly 60% of the estuarine gill net trips sampled. The proportion of trips fishing greater than 2,000 yards of large mesh gill net in Pamlico Sound has increased since 2005. The trend in the proportion of large mesh gill nets in Albemarle Sound and the Rivers was not as definitive. It should be noted that many of the trips sampled from Albemarle Sound actually occurred in Roanoke and Croatan sounds and therefore, may not be reflective of gill net yardage trends in this area overall.

As the amount of large mesh gill net fished has increased, the catch per unit effort (CPUE, pounds per trip) of flounder landed has decreased in many parts of the state (Figure 10.12). The minimum size limit increase from 13 inches to 14 inches in 2005 could be responsible for some of this decrease, but the CPUE increased in 2005 in Pamlico Sound and 2007 in Albemarle Sound. The 2009 Southern Flounder Stock Assessment determined the stock was overfished and overfishing was occurring (Takade-Heumacher and Batsavage 2009), and the CPUE data and gill net yardage increases indicate that there is more fishing effort than the southern flounder population can sustain.

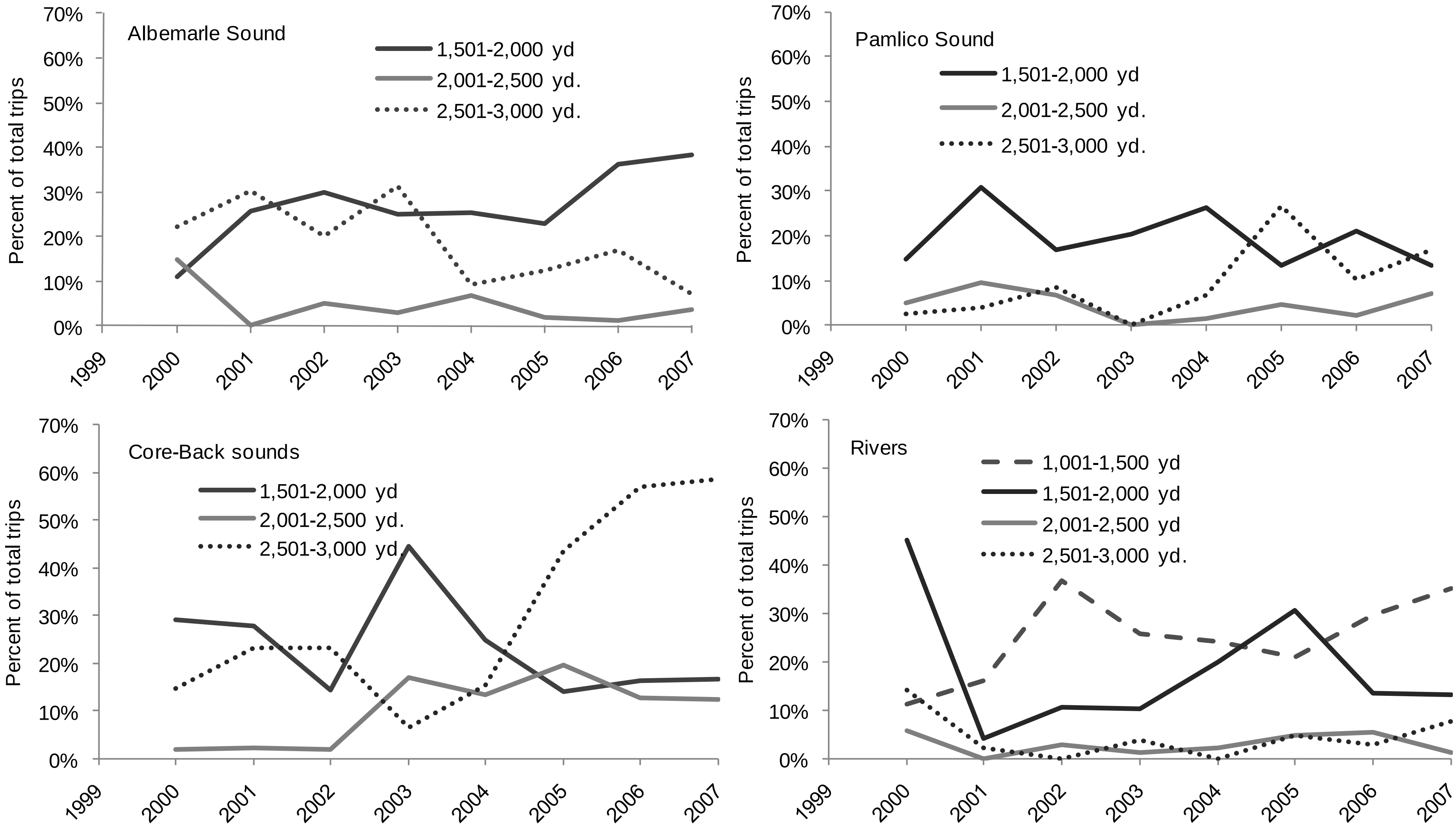


Figure 10.11 Proportion of large mesh gill net trips in 500 yard increments by water body, 2000-2007. The Rivers include the Pamlico, Pungo, Bay, and Neuse rivers (NCDMF Biological Database).

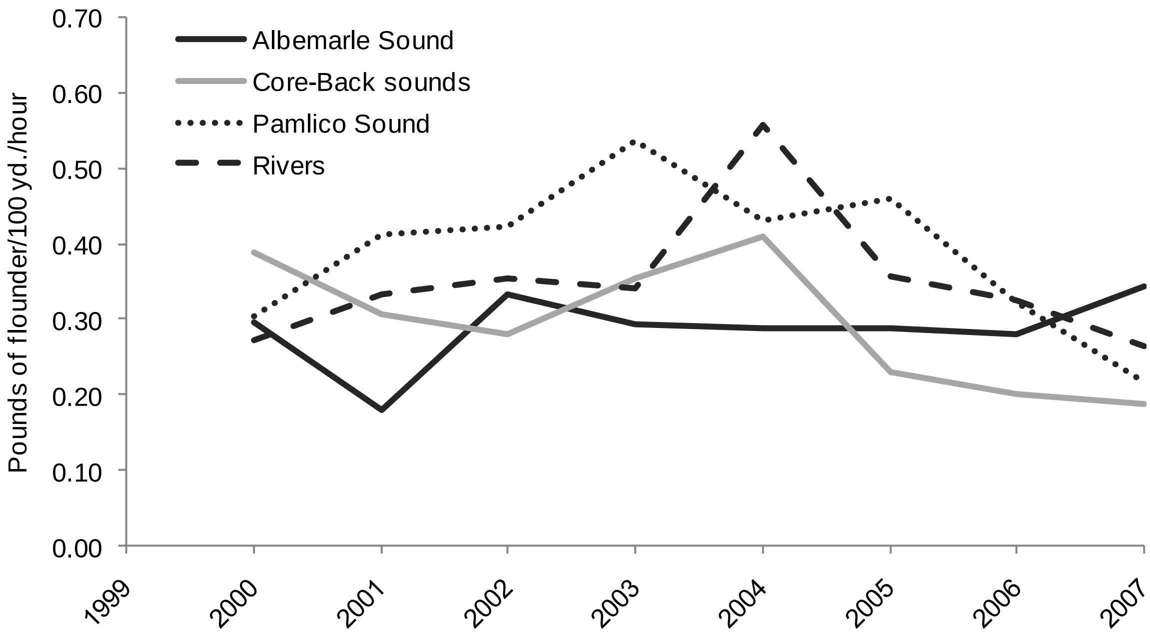


Figure 10.12 CPUE of flounder in large mesh gill nets by water body, 2000-2007. The Rivers include the Pamlico, Pungo, Bay, and Neuse rivers (NCDMF Biological Database).

Reducing the yardage limit for large mesh gill nets coast wide could provide more fishing access for anglers and fewer conflicts with other users, as well as address other issues. Additional large mesh gill net restrictions have occurred recently to protect species caught incidentally in large mesh gill nets; Amendment 1 of the Red Drum FMP included a rule change that unattended large mesh gill nets shall be set no closer than 10 feet from any shoreline from June through October to reduce dead discards of red drum (15A NCAC 03J .0103 (i) (2)) (NCDMF 2008b). Reducing the yardage limit for large mesh gill nets could further reduce the dead discards of red drum and striped bass from this fishery (NCDMF 2005). Protected species interactions, sea turtles in particular, are relatively common in the southern flounder gill net fishery (NCDMF 2005; Price 2009). A yardage limit reduction could reduce sea turtle interactions in this fishery, which could prevent further federal large mesh gill net closures in the state like the Pamlico Sound Gill Net Restricted Area (PSGNRA). A yardage limit reduction could reduce the harvest of southern flounder, which would help end overfishing and rebuild the spawning stock. However, it is uncertain what the magnitude of the reduction might be or if a reduction in landings would even occur. The reduction in the CPUE of southern flounder catches along with the increased large mesh gill net effort indicate that southern flounder landings could remain the same with less fishing effort.

A uniform large mesh gill net yardage limit for the state may not be appropriate. Many of the documented conflicts between users associated with large mesh gill nets occur along the southeastern coast of North Carolina (Table 10.21). The water bodies in this region are much smaller than what is found in the northeastern and central coasts. It is likely that a lower large mesh net yardage limit would be needed in the southeastern coast than in other parts of the state.

Limitations on How Large Mesh Gill Nets can be Set

Management measures that limit how much large mesh gill net can be set in a particular area could alleviate some of the user conflict issues. A specific complaint by anglers and other users is consecutive gill nets or single gill nets that are several hundred yards or more in length prevent them from accessing certain areas. If multiple gill net fishermen are fishing in a particular area, this could result in many areas that are not accessible to anglers and other users.

Potential management measures could be to limit the length of any individual large mesh gill net, limit the length of large mesh gill nets that can be set without any breaks or spacing, and to establish a minimum distance between large mesh gill net sets. This could provide anglers and other users access to more fishing locations and access to their boat docks while still allowing large mesh gill net fishermen to fish the same areas. Limiting the lengths of gill nets that can be set without breaks could also reduce discards of finfish such as red drum and reduce sea turtle interactions (NCDMF 2008b; Price 2009). Proclamation M-15-2008 implemented a maximum gill net length of 200 yards in the PSGNRA to minimize sea turtle interactions in the large mesh gill net fishery. These management measures could also reduce the amount of incidents of anglers and other users interacting with and damaging large mesh gill nets. Enforcing these management measures could be easier than a large mesh gill net yardage limit per operation because every gill net set by a given operation does not need to be observed by the Marine Patrol officer. The current maximum yardage limit of 3,000 yards for large mesh gill nets is difficult to enforce. These management measures could require gill net fishermen to purchase more anchors and buoys for their gill nets. If the amount of large mesh gill net that can be set without a break is too short or if the minimum distance between gill net sets is too long, it could impede the gill net fishermen’s ability to catch southern flounder.

Daytime Attendance of Large Mesh Gill Nets

Requiring the attendance of large mesh gill nets during daylight hours could alleviate some of the user conflicts associated with large mesh gill nets. Gill nets greater than 4 inches stretched mesh must be attended during daylight hours in portions of the Newport River (Proclamation M-13-2001). In general, this has resulted in large mesh gill net fishermen removing their gear from the water after fishing the nets in the morning and then resetting the nets the following evening. This has decreased user conflicts in these portions of the Newport River.

Catch rates of southern flounder in gill nets tend to be better in night time than daytime gill net sets, which could result in large mesh gill net fishermen and anglers being able to fish the same areas with minimal conflicts (Hassel 2009a). Removing large mesh gill nets from the water during the day could reduce regulatory discards of various finfish and sea turtle interactions. However, this management measure may not be practical everywhere in the state. Gill net fishermen that have a substantial transit time from their home port to the fishing grounds would have a difficult time removing their gear from the water in time. In addition, this could result in an added fuel cost for fishermen who would have to make an extra trip to reset their gear the following evening. This could be a potential management measure for specific areas where the gill netters’ transit times to the fishing grounds is relatively short. Regardless of whether the transit time to the fishing grounds is long or short, this management measure could result in increased safety concerns for the gill net fishermen due to fishing in low light conditions and inclement weather. A possible result of applying this management measure to a specific area is it forces the large mesh gill net fishermen to fish different areas, which could displace the user conflicts. This has happened in the Newport River where large mesh gill net fishermen relocated to portions of the river where large mesh gill nets can be left unattended. Recreational fishing effort in the Newport River expanded during the same time, which resulted in the current user conflicts.

Season Closures

Season closures are a potential interim management measure to end overfishing and rebuild the southern flounder spawning stock, but they could also alleviate user conflicts if they occur when the user conflicts happen. Every documented user conflict in Table 10.21 occurs in the spring, summer or fall so a season closure for either the commercial southern flounder gill net fishery or the entire southern flounder commercial fishery during these seasons could alleviate some of the user conflicts. In addition, a season closure during these times of year would also reduce the regulatory discards of red drum and striped bass and reduce sea turtle interactions (NCDMF 2008; Price 2009). However, a season closure during the entire time of the year when user conflicts occur would be much longer than what is required to end overfishing and would impact areas where no user conflicts occur. A season closure that ends overfishing and rebuilds the spawning stock during this time of year could be implemented in conjunction with other management measures to alleviate user conflicts associated with large mesh gill nets.

Large Mesh Gill Net Restrictions in Nursery Areas

Commercial gill net landings of southern flounder and recreational fishing for species such as red drum, southern flounder, and spotted sea trout occur through much of the estuarine waters both inside and outside of nursery areas. Nursery area designations were intended to protect juvenile species and were based on five indicator species (brown shrimp, blue crab, Atlantic croaker, spot, and southern flounder). There are rules prohibiting bottom disturbing gears (15A NCAC 03N .0104, and 15A NCAC 03N .0105) in these waters to protect juvenile fish and crustaceans.

Nursery areas are not equally distributed throughout the North Carolina coast. The northeastern coast has the least amount of designated nursery areas while the southeastern coast has the highest overall percentage of nursery areas (Figure 10.13). Large mesh gill net restrictions in these waters would have a disproportionate impact on gill net fishermen in the southeastern part of the state. Large mesh gill net restrictions in these waters could alleviate some user conflicts that occurred in nursery areas, but it could also displace gill net fishermen from these waters and cause user conflicts in other areas. Documented user conflicts have occurred outside of these waters, so this management measure alone would not resolve many of these conflicts.

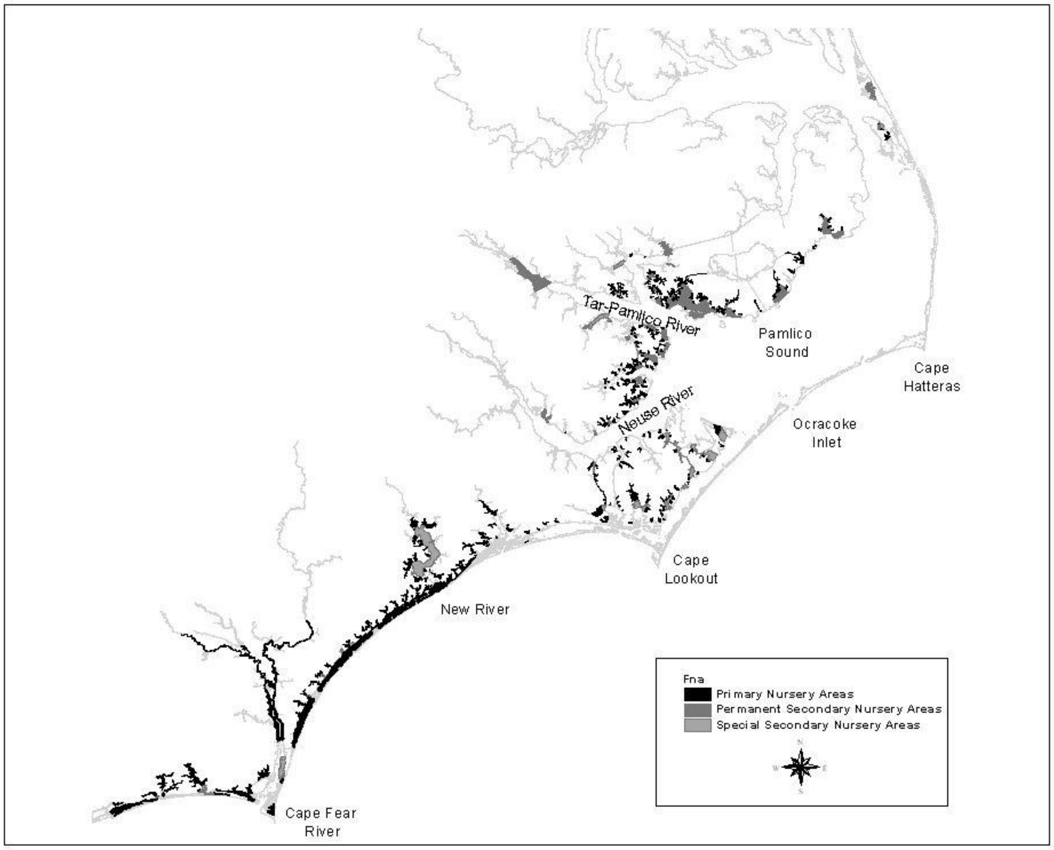


Figure 10.13 Designated nursery areas (primary, permanent secondary, and special secondary) along the North Carolina coast.

Mediation

Mediation is a process to achieve an acceptable long-term resolution to a conflict through an independent third party. Mediation works best when the parties involved in the dispute are willing to make concessions in order to accommodate both parties. The process works best when it is voluntary but can be used in other disputes. The NCDMF has used the mediation process in several cases over the years with favorable results. Mediation was recommended in the fall of 2008 to resolve the user conflicts between the large mesh gill net fishermen and anglers in the Newport River, but because only one party was willing to participate in the mediation process, the conflict between these two parties continued.

A potential option for when mediation fails to resolve user conflicts in specific areas is to prohibit fishing in a particular area by all user groups via the NCDMF Director's proclamation authority until the conflict is resolved. This could compel the parties to resolve their conflicts in order to regain access to a specific area, but parties not involved in the user conflict would also lose access to this area. The relatively extensive list of areas along the coast where user conflicts associated with large mesh gill nets occurs could result in multiple areas being closed to all fishing due to unresolved conflicts. This would also result in increased enforcement responsibilities for Marine Patrol and more displaced fishermen.

Area Specific Management Measures Versus Coast wide Management Measures

Interim management measures designed to alleviate user conflicts associated with large mesh gill nets can be implemented for either specific areas or coast wide, and each option has advantages and disadvantages. Area specific management measures can be crafted to directly address a particular user conflict, which could produce a better chance of resolving the conflict, would exclude areas without user conflicts from management measures, and the mediation process would be easier to implement for a specific area where there is a discrete number of people involved in the user conflict. Area specific management measures could result in different regulations for different water bodies, which could cause confusion for the fishermen, result in added enforcement responsibilities for Marine Patrol, and could displace fishermen and the user conflicts to different areas. Coast wide management measures can implement regulations that alleviate documented user conflicts and avoid future conflicts from occurring, can reduce regulatory discards of species such as red drum and striped bass, can reduce sea turtle interactions, and produce more consistent regulations along the coast. Coast wide management measures may not adequately address user conflicts for specific areas, regulations would apply to areas where no user conflicts exist, and the added enforcement responsibilities for Marine Patrol would be along the entire coast instead of specific areas. Although each option has similar numbers of advantages and disadvantages, coast wide interim management measures to resolve user conflicts can offer the added benefits of reducing regulatory discards of finfish such as red drum and striped bass as well as sea turtles.

Management Options

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

1) Status quo—no additional management measures

   + No additional burden on commercial fishermen, Marine Patrol, or managers
   - Delays resolving user conflicts associated with large mesh gill nets
   - Potential for more user conflicts to develop

2) Maximum yardage limit reduction for large mesh gill nets

   + Minimizes user conflicts by reducing the amount of large mesh gill net set by a commercial operation
   + Can be applied coast wide, which could prevent future user conflicts in other parts of the state
   + Reduce the amount of incidents of anglers and other users damaging large mesh gill nets
   + Potential to reduce dead discards of finfish such as red drum and striped bass
   + Potential to reduce sea turtle interactions, which could prevent further large mesh gill net closures like the PSGNRA
   - Uniform yardage reduction for large mesh gill nets may not be appropriate in all parts of the state

3) Limitations on how large mesh gill nets can be set

   + Minimizes user conflicts by limiting the length of large mesh gill net sets by a commercial operation

+ Minimizes user conflicts by implementing a minimum distance or break between large mesh gill net sets by a commercial operation
+ Can be applied coast wide, which could prevent future user conflicts in other parts of the state
+ Reduce the amount of incidents of anglers and other users damaging large mesh gill nets
+ Potential to reduce dead discards of finfish such as red drum and striped bass
+ Potential to reduce sea turtle interactions, which could prevent further large mesh gill net closures like the PSGNRA
+ Easier to enforce than a maximum yardage limit
- Increased enforcement responsibilities for Marine Patrol
- Could require gill net fishermen to purchase more anchors and buoys for their gill nets
- The gill net fishermen's ability to catch southern flounder could be impeded if the amount of large mesh gill net that can be set without a break is too short or if the minimum length between gill net sets is too long
- User conflicts could shift to other areas if applied to specific water bodies

4) Daytime attendance of large mesh gill nets

+ Minimizes user conflicts when gill net fishermen remove large mesh gill nets from the water during the day instead of attending the nets
+ Allows both anglers and gill net fishermen the opportunity to fish in the same areas
+ Reduce the amount of incidents of anglers damaging large mesh gill nets
+ Potential to reduce dead discards of finfish such as red drum and striped bass
+ Potential to reduce sea turtle interactions, which could prevent further large mesh gill net closures like the PSGNRA
+ Easier to enforce than a maximum yardage limit
- Increased enforcement responsibilities for Marine Patrol
- Not feasible for gill net fishermen that have a substantial transit time from their home port to the fishing grounds
- Increased fuel cost for gill net fishermen
- Increased safety concerns for large mesh gill net fishermen
- User conflicts could shift to other areas if applied to specific water bodies

5) Season closures

+ Minimizes user conflicts by closing the commercial southern flounder fishery during months when user conflicts occur
+ Can be applied coast wide, which could prevent future user conflicts in other parts of the state
+ Reduce the amount of incidents of anglers and other users damaging large mesh gill nets
+ Potential to reduce dead discards of finfish such as red drum and striped bass
+ Potential to reduce sea turtle interactions, which could prevent further large mesh gill net closures like the PSGNRA
+ Reduces landings of southern flounder closer to a sustainable level
- Increased enforcement responsibilities for Marine Patrol
- Season closures during the entire time of the year when user conflicts occur would be much longer than what is required to end overfishing
- Would impact areas where no user conflicts occur
- Not likely to work well as a stand alone management measure

6) Large Mesh Gill Net Restrictions in Nursery Areas

+ Potential to minimize user conflicts in nursery areas
- Increased enforcement responsibilities for Marine Patrol
- Disproportionate impact on gill net fishermen in the southeastern part of the state
- Only affects user conflicts in nursery areas
- Potential to displace user conflicts to other areas
- Does not address user conflicts outside of nursery areas

7) Mediation

+ Has worked in the past to resolve other user conflicts in the state
+ Potential to solve user conflicts for specific areas
+ Puts the responsibility on the user groups to solve the user conflict
- All parties involved in the user conflict must participate in order for success
- May not be effective in resolving user conflicts over multiple areas that involve many individuals
- Results could impact individuals who were not involved with the conflict
- Multiple user conflicts in the state could result in multiple mediation processes
- Potential to increase enforcement responsibilities for Marine Patrol

8) Area specific management measures

+ Crafted to directly address a particular user conflict
+ May produce a better chance of resolving the conflict
+ Excludes areas without user conflicts
- More confusion with different regulations in separate water bodies
- Increased enforcement responsibilities for Marine Patrol
- Displacement of user conflicts and fishermen to other areas

9) Coast wide management measures

+ Alleviate the user conflicts across many areas and avoid future conflicts in other areas
+ Reduce regulatory discards of red drum and striped bass and interactions with sea turtles
+ Apply more consistent regulations coast wide
- May not adequately address the user conflicts for specific areas
- Additional regulations for areas where conflicts do not exist
- Increased enforcement responsibilities for Marine Patrol

Management Recommendations

NCMFC Preferred Management Strategy

- Status quo—implement mediation and proclamation authority to address user conflicts associated with large mesh gill nets.

AC and NCDMF

- Status quo—implement mediation and proclamation authority to address user conflicts associated with large mesh gill nets.

Research Needs None

10.4 MINIMUM DISTANCE BETWEEN POUND NETS AND GILL NETS IN CURRITUCK SOUND[8]

Issue

Competition for space between pound nets and gill nets in Currituck Sound.

Background

Historically, pound nets and gill nets have accounted for the majority of southern flounder landings in the state. Pound nets were the predominant gear until 1995 when gill nets became the primary gear landing southern flounder (see Figure 7.7 in Section 7.1 Status of the Commercial Fishery). More information on the characteristics of the commercial fishery can also be found in Section 7.1 - Status of the Commercial Fishery. As gill net effort increased so has competition for space and resources between these two fisheries.

The 2005 Southern Flounder FMP addressed the issue of minimum distances between new and existing pound nets as well as between pound nets and gill nets (NCDMF 2005). The existing rule at the time of the FMP development was a coast wide minimum distance of 200 yards between a gill net and an active pound net set, which appeared to be a sufficient separation for Pamlico, Core and Back sounds. However, pound netters in Albemarle Sound believed the 200- yard minimum distance was not an adequate separation between pound nets and gill nets. The general concern was that a gill net or gill nets of sufficient length set 200 yards from a pound net could negatively affect the ability of the pound net to catch flounder, and conflicts stemmed from incidents where gill netters set their gear around the pound nets. There were also concerns about displaced effort from gill netters, attempting to avoid the provisions of fishing in the Pamlico Sound Gill Net Restricted Area (PSGNRA), would shift effort to the Albemarle Sound, but landings and effort in the gill net fishery were declining since 2001 (Figure 10.14). The result was a rule change where the minimum distance between gill nets and pound nets was 500 yards from August 15 through December 31 in Albemarle Sound and its tributaries west of a line from Powell Point to Caroon Point [15A NCAC 03J .0103 (d) (1)]; the 200 yard minimum distance remained for the rest of the state and for Albemarle Sound outside of this timeframe. The area in Albemarle Sound that has a 500-yard minimum distance between pound nets and gill nets does not include Currituck Sound. Pound netters in Currituck Sound have expressed the same concerns as the pound netters in Albemarle Sound that the 200-yard minimum distance between pound nets and gill nets is not an adequate separation between the two gears.

[8] Emailed to the PDT on 2/5/10
Presented to the AC on 3/9/10
NCDMF recommendation 10/19/10

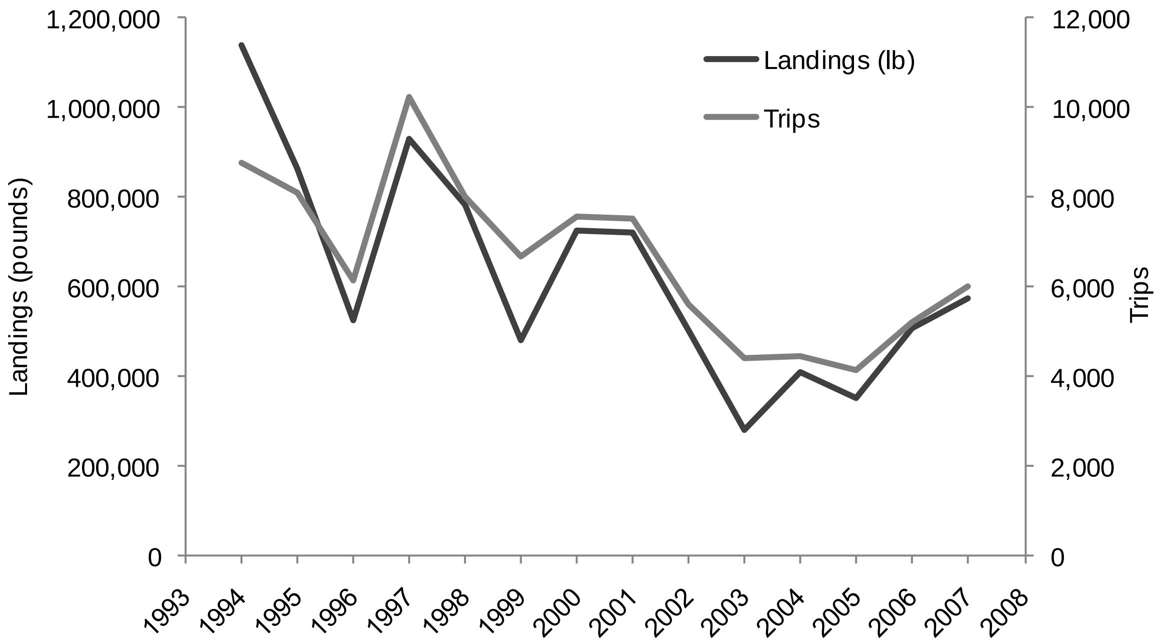


Figure 10.14 Southern flounder gill net landings and trips in Albemarle Sound and its tributaries, 1994-2007 (NCDMF Trip Ticket Program).

Landings of southern flounder in pound nets from Currituck Sound from 1994 to 2007 ranged from 6,611 pounds in 1999 to 44,867 pounds in 2002 and averaged 38,395 pounds per year (Figure 10.15). Landings since 2005 have averaged 22,606 pounds per year. The number of pound net trips landing southern flounder in Currituck Sound has followed the same general trend as landings (see Figure 7.8 in Section 7.1 Status of the Commercial Fishery). The number of trips ranged from 16 in 1994 to 86 in 1996. An average of 37 pound net trips per year landing southern flounder occurred from 2005 to 2007. The number of active flounder pound net permits in this part of the state (Currituck County) has decreased from 1995 to 2007 but has been relatively consistent since 2002 (see Table 7.3 in Section 7.1 Status of the Commercial Fishery). From 1994 to 2007, southern flounder gill net landings from Currituck Sound ranged from 58,555 pounds in 2003 to 214,049 pounds in 1997 and averaged 108,115 pounds per year (Figure 10.16). Landings since 2005 averaged 76,637 pounds per year. The number of gill net trips landing southern flounder in Currituck Sound has also followed the same general trend as landings (see Figure 7.12 in Section 7.1 Status of the Commercial Fishery). The number of trips ranged from 680 in 2003 to 2,000 in 1997. An average of 873 gill net trips per year landing southern flounder per year occurred from 2005 to 2007.

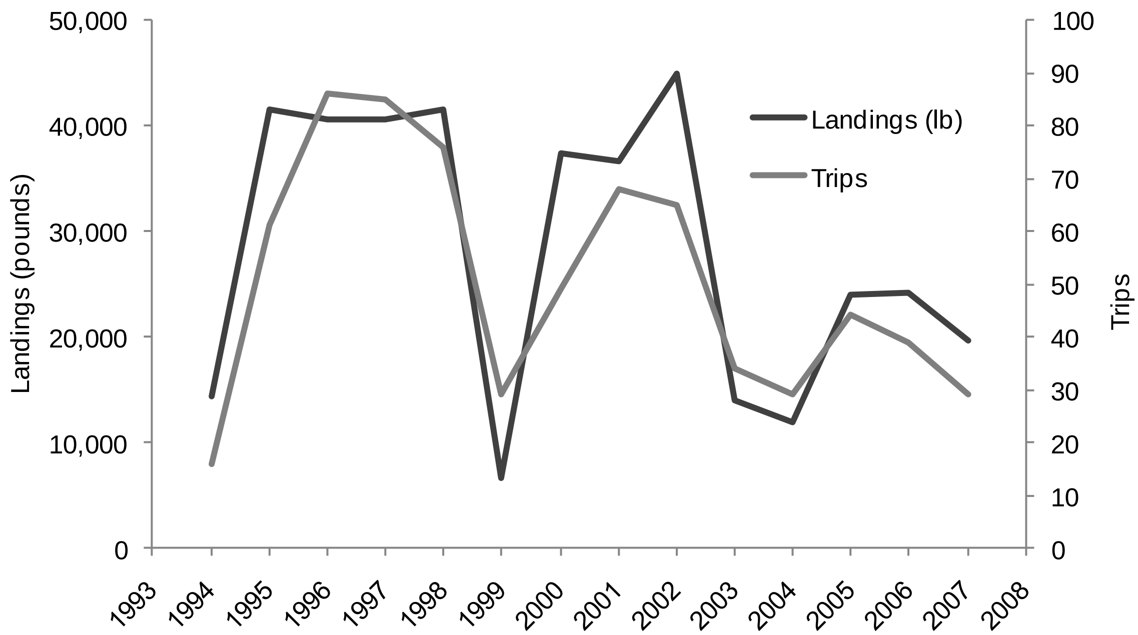


Figure 10.15 Southern flounder pound net landings and trips in Currituck Sound, 1994-2007 (NCDMF Trip Ticket Program).

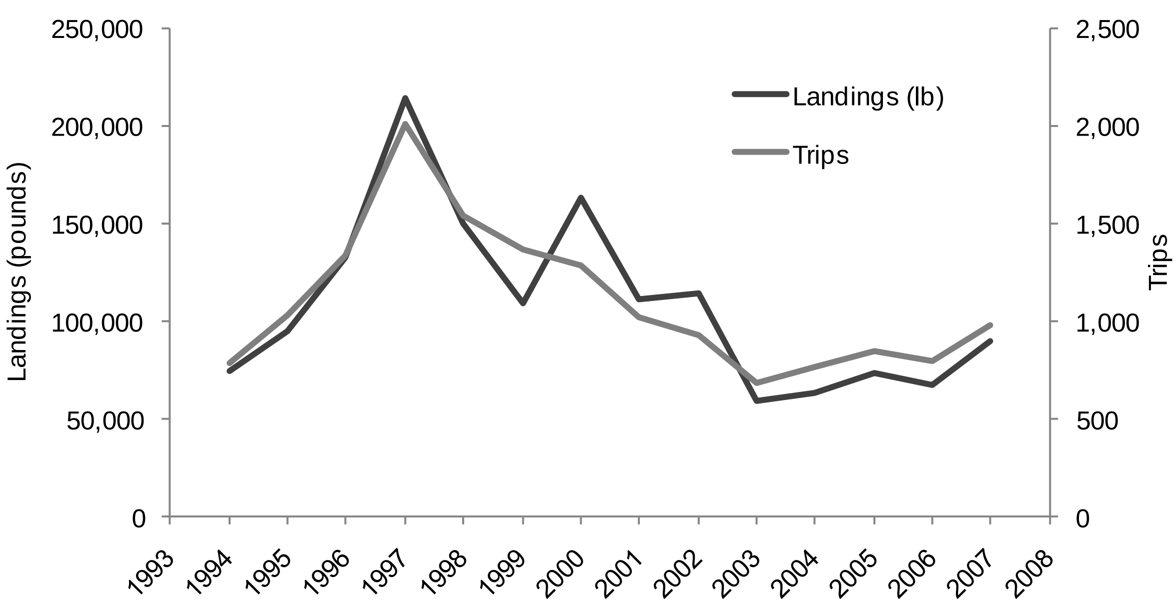


Figure 10.16 Southern flounder gill net landings and trips in Currituck Sound, 1994-2007 (NCDMF Trip Ticket Program).

Based on fishery dependent sampling of the Albemarle Sound area (including Currituck, Roanoke, and Croatan sounds), the majority of large mesh gill net trips targeting southern flounder ranged between 1,500 and 2,000 yards per trip since 2004 (Figure 10.17). However, the majority of the trips sampled occurred in Roanoke and Croatan sounds and therefore, may not reflect gill net yardage trends in this area overall. There was not enough fishery dependent gill net samples from Currituck Sound to analyze the trends in gill net yardage fished in this water body.

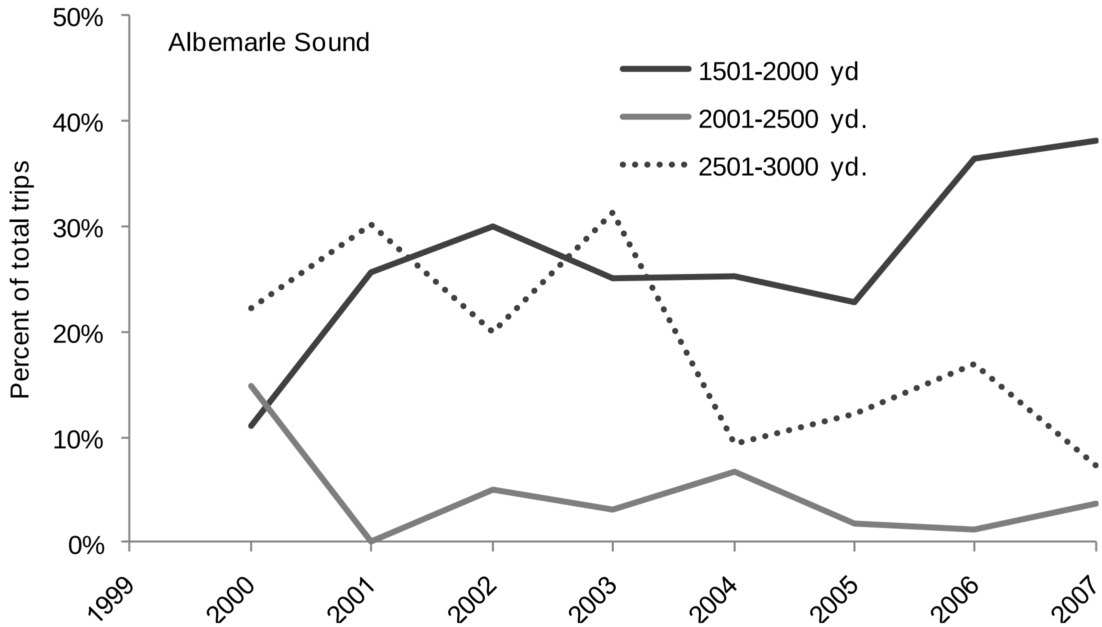


Figure 10.17 Proportion of large mesh gill net trips in 500 yard increments for Albemarle Sound and its tributaries (including Currituck, Roanoke and Croatan sounds), 2000-2007 (NCDMF Biological Database).

Current Authority

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

NC Fisheries Rules for Coastal Waters 2009 (15A NCAC)

3J .0103	GILL NETS, SEINES, IDENTIFICATIONS, RESTRICTIONS
3J .0501	DEFINITIONS AND STANDARDS FOR POUND NETS AND POUND NET SETS

Discussion

Both the landings of southern flounder and number of trips in the gill net fishery far exceed the landings and trips in the pound net fishery in Currituck Sound. The landings and effort in the pound net fishery has declined since 2003, while landings and effort in the gill net fishery has increased (Figures 10.16 and 10.17). However, it is not known if gill net yardage fished per trip in Currituck Sound has increased. Gill net trips landing southern flounder in Currituck Sound occur year round with most of the trips occurring in September and October. Almost all of the pound net trips landing southern flounder in Currituck Sound occur from September through November, which means peak effort in both fisheries overlaps. It is not known if behavior changes in the Currituck Sound gill net fishery, such as setting more gill net or setting gill nets closer to pound nets, have occurred.

When this issue was addressed in the 2005 Southern Flounder FMP, gill netters expressed the concern that by increasing the distance that gill nets could be fished from a pound net that they would be excluded from certain areas as new pound net permits were issued. However, one of the stipulations for a new pound net permit to be granted in a particular area is that it will not interfere with public navigation or existing, traditional uses of the area. This includes the historical use of gill nets or other fishing gears. Therefore, gill nets will not be excluded from areas in which they are currently fishing due to the introduction of new pound nets.

Management Options

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

1) Status quo (200-yard minimum distance between pound nets and gill nets in Currituck Sound)

   + No reduction in the available area for gill netters to set their nets
   + No new regulations
   - Conflict between the fisheries is not reduced
   - Inconsistent regulations with Albemarle Sound

2) Implement a minimum distance of 500 yards between pound nets and gill nets in Currituck Sound from August 15 through December 31

   + Reduce the conflict between the fisheries
   + Consistent regulations with Albemarle Sound
   - Reduces the available area for gill netters to set their nets
   - New regulations

Management Recommendations

NCMFC Preferred Management Strategy

- Status quo (200-yard minimum distance between pound nets and gill nets in Currituck Sound).

AC

- Implement a 500-yard minimum distance between gill nets and pound nets in Currituck Sound north of the Wright Memorial Bridge (US Highway 158) from August 15 through December 31.

NCDMF

- Status quo (200-yard minimum distance between pound nets and gill nets in Currituck Sound).

Research Recommendations

- Increased fish house sampling of the Currituck Sound flounder gill net and pound net fisheries
- Increased at-sea observer trips with gill netters and pound netters in Currituck Sound

10.5 EXPLORING THE ELIMINATION OF THE RECREATIONAL COMMERCIAL GEAR LICENSE (RCGL)[9]

Issue

Determine if the elimination or phase-out of the RCGL is appropriate.

Background

The North Carolina General Assembly enacted a moratorium on the sale of state commercial fishing licenses in 1994 and was based on concerns voiced by both recreational and commercial fishermen (NCSG 1996). This legislation was recommended by the Moratorium Steering Committee, which was established to oversee the study of North Carolina's entire fisheries management process and to recommend changes to improve the system. Five subcommittees were formed, including the license subcommittee. One of the recommendations from this committee was to create a Recreational Commercial Gear License (RCGL) to allow the continued tradition of using commercial gear to take seafood for personal consumption, but not for sale (NCSG 1996). Participation in this activity prior to the moratorium required the possession of a Commercial Fishing Vessel License. As a result of the findings of the Moratorium Steering Committee, a licensing restructure was mandated by the North Carolina Fisheries Reform Act of 1997 and implemented in July 1999 establishing the RCGL, solely for the recreational use of limited quantities of commercial gears. Fishing gears that may be used under this license include gill nets, pots, shrimp and skimmer trawls, shrimp pounds, trotlines, and seines. Fishermen who hold a RCGL must abide by the same size and creel limits as other recreational fishermen and are not allowed to sell their catch

The North Carolina Division of Marine Fisheries initiated a pilot survey project in 2001 to determine the most efficient and economical method for collecting data from RCGL holders (NCDMF 2009). All methods tested were based on mail survey techniques due to their lower cost when compared to phone or on-site surveys. A monthly mail survey was initiated in March 2002 to gather catch and effort data from RCGL holders. Questionnaires were mailed to randomly selected individuals from the RCGL population at a sampling rate of 30% of the total RCGL holders. Types of information collected through the survey included gears and quantity used, number of trips, estimates of the number and poundage of each species harvested, and estimated numbers of each species discarded. This survey was discontinued in 2009 due to budget constraints.

The Southern Flounder Advisory Committee (AC) expressed interest in exploring whether the RCGL should continue to be available to fishermen. A main reason for this interest was the sharp decrease in harvest and effort of southern flounder, a key target species for RCGL

[9] Emailed to the PDT on 2/15/10
Presented to the AC on 3/9/10
NCDMF recommendation 10/19/10

fishermen (see Section 7.2, Status of the Recreational Fishery). Other important reasons to pursue this issue were both documented and anecdotal conflicts with RCGL gear, and future management of gill nets in 2010 to eliminate sea turtle interactions.

Southern flounder harvest and effort from the RCGL has sharply declined from 2002 to 2007 (see Figure 7.24 and Figure 7.25 in Section 7.2, Status of the Recreational Fishery). Southern flounder are harvested by several different RGCL gears including large and small mesh gill nets, shrimp trawls, crab pots, and trotlines (see Table 7.13 in Section 7.2, Status of the Recreational Fishery). Large mesh gill nets account for the vast majority of the harvest. Over 90% of the large and small mesh gill net trips harvest 8 southern flounder or less per trip (see Table 7.14 in Section 7.2, Status of the Recreational Fishery). Southern flounder discards occur in many of these gears with large mesh gill nets and shrimp trawls accounting for the majority of the discards. Harvest and discards of southern flounder occur year round with peak harvest in October (see Figure 7.26 in Section 7.2, Status of the Recreational Fishery) and peak discards in July (see Figure 7.27 in Section 7.2, Status of the Recreational Fishery).

The total number of RCGL trips has declined since 2002 with the sharpest decline occurring from 2002 to 2003, which was a 30.4% reduction (Figure 10.18) (NCDMF 2009). The number of trips has decreased by only 2.5% (1,066 trips) from 2007 to 2008. The number of trips by gear type also showed a general declining trend since 2002 with large and small mesh gill nets showing the sharpest decline (Figure 10.19) (NCDMF 2009). The number of crab pot trips increased in 2007 before declining in 2008, and shrimp trawl trips increased in 2008. Small mesh gill nets comprised the greatest number of trips in 2002; crab pots comprised the greatest number of trips since 2003.

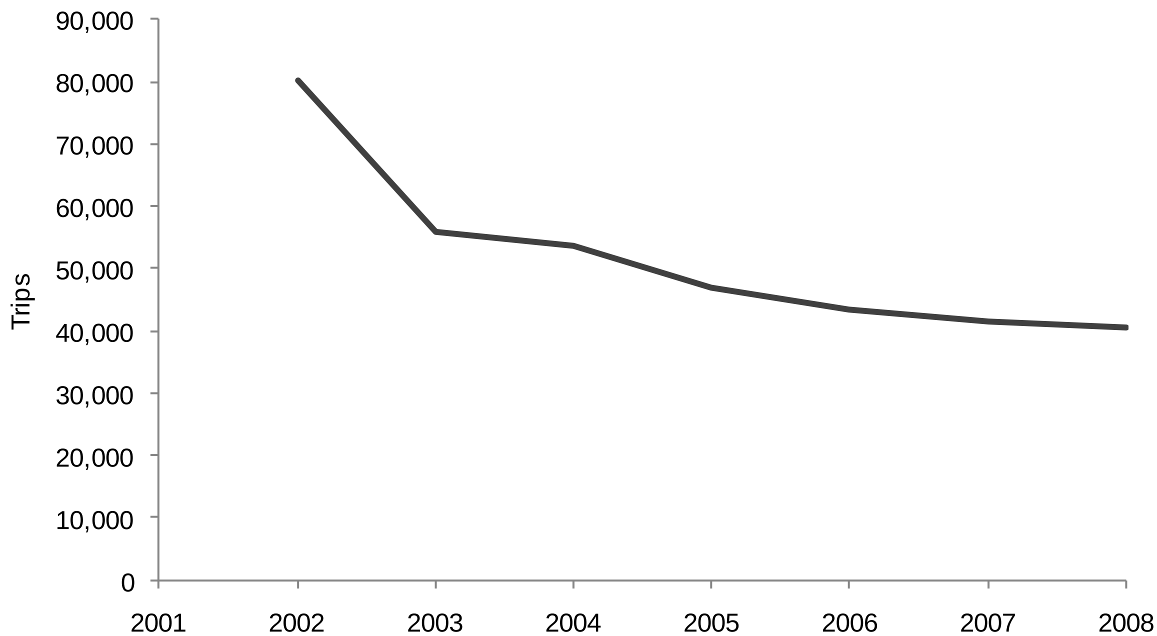


Figure 10.18 Total annual number of RCGL trips, 2002-2009 (NCDMF 2009).

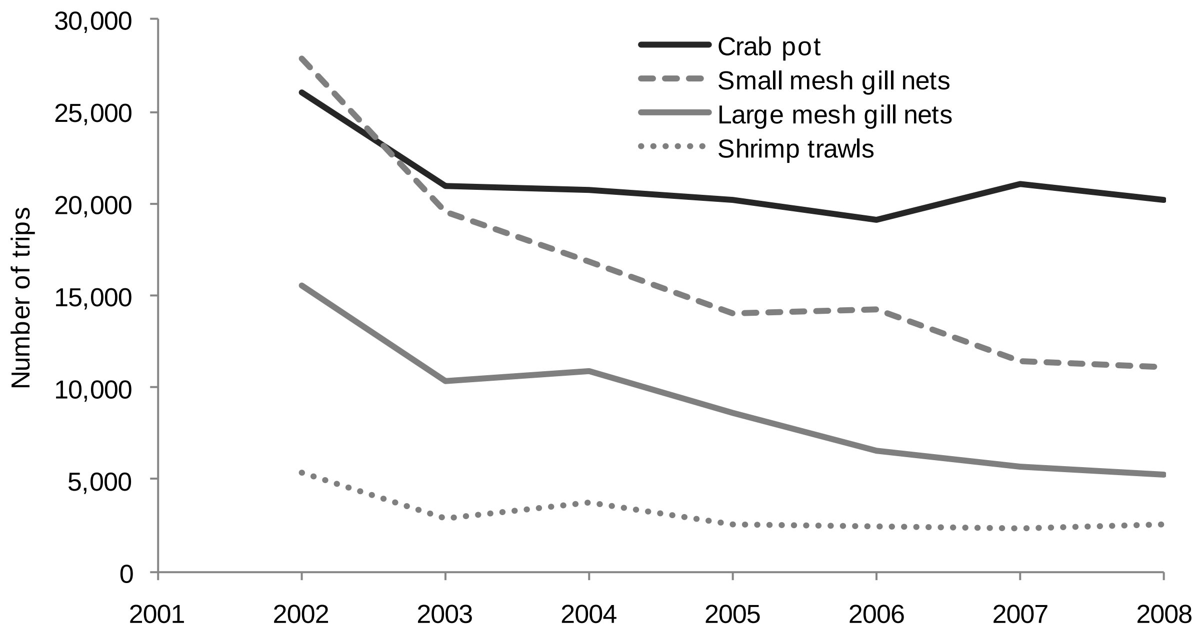


Figure 10.19 Total number of RCGL trips, by gear, 2002-2009 (NCDMF 2009).

The total number of RCGL licenses sold per year also decreased. In 2001, a total of 9,012 licenses were sold; the number of licenses decreased to 8,202 in 2004 and 7,347 in 2007 (NCDMF 2009). Despite this decrease in license sales, many fishermen have held a RCGL for multiple years. In 2007 over 40% of the RCGL holders have owned this license for 5 or more years. Throughout the survey period, the majority of RCGL holders were greater than age 40 (NCDMF 2009).

Current Authority

G.S. 113-134	RULES
G.S. 113-173	RECREATIONAL COMMERCIAL GEAR LICENSE
G.S. 113-182	REGULATION OF FISHING AND FISHERIES
G.S. 143B-289.52	MARINE FISHERIES COMMISSION--POWERS AND DUTIES

NC Fisheries Rules for Coastal Waters 2009 (15A NCAC)

03O .0302 AUTHORIZED GEAR

Discussion

Total effort and participation in the RCGL fishery has declined since 2002 with large and small mesh gill nets showing the greatest decline in effort. The marked decrease in large mesh gill net effort and corresponding decrease in southern flounder harvest was likely the result of the required full time attendance of large mesh RCGL gill nets from the NC Highway 58 Bridge at Emerald Isle south to the South Carolina state line, which was implemented by the 2005 Southern Flounder FMP (NCDMF 2005). Despite the overall decrease in effort and participation in the RCGL fishery, increased effort occurred for crab pots and shrimp trawls.

Southern flounder are caught by RCGL fishermen targeting southern flounder and by RCGL fishermen targeting other species. Southern flounder is among a number of species targeted by RCGL fishermen including spot, striped mullet, blue crabs and shrimp (brown, white, and pink) (Figure 10.20). Although landings for spot and shrimp decreased since 2002, landings of bluecrab and striped mullet have increased in the last few years. The RCGL harvest of southern flounder is minimal compared to the total annual harvest (commercial and recreational) of southern flounder (Takade-Heumacher and Batsavage 2009). Eliminating the RCGL would have a negligible impact on the recovery of the southern flounder stock but would impact RCGL fishermen targeting other species.

One source of decline in RCGL participation was from fishermen who replaced their RCGL with a standard commercial fishing license (SCFL) that was purchased on the open market. This allowed these fishermen to fish more gear (gill nets, in particular), harvest commercial quantities of fish and crustaceans, and not be subject to the net attendance requirements of the RCGL. Many of these fishermen choose not to sell their catch but instead retain it for personal consumption. As a result, neither the North Carolina Trip Ticket Program nor the RCGL harvest survey captures the landings information. The elimination of the RCGL could increase the amount of these undocumented landings as well as increase the amount of gear in the water.

There have been both documented and anecdotal reports of RCGL gear being set illegally or improperly. Marine Patrol has issued citations to RCGL fishermen who violate the laws for setting this gear. There is concern that RCGL gear set illegally or improperly will shed a negative light on the commercial fishing industry. However, the marking requirements for RCGL gear (hot pink buoys) make it easily distinguishable from commercial fishing gear.

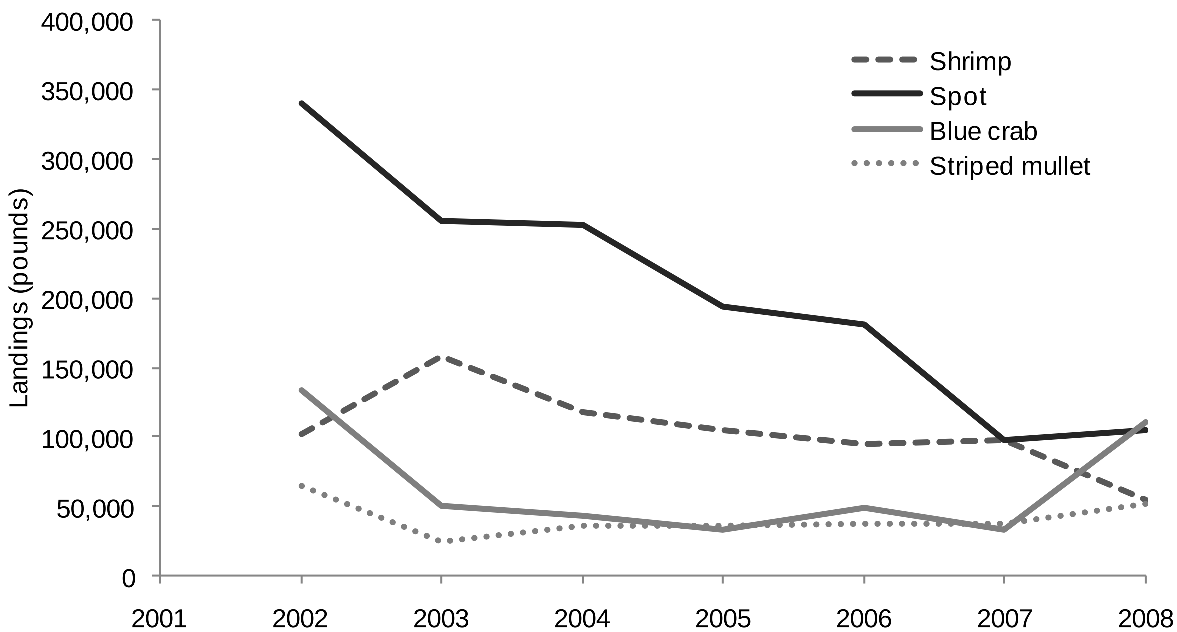


Figure 10.20 RCGL harvest of blue crab, shrimp, spot and striped mullet, 2002-2008 (NCDMF 2009).

The 1997 Fisheries Reform Act established the RCGL, and it is among the North Carolina General Statutes. Most changes to the stipulations of the RCGL or the elimination of this license would require action by the North Carolina General Assembly.

Although the number of RCGLs sold has decreased, this license is still a considerable source of revenue to the NCDMF. Division programs and sections such as the Trip Ticket Program, Marine Patrol, License Administration, and Information Technology receive revenues from this license as well as from the sale of commercial licenses. The elimination of the RCGL would have a substantial impact on the annual budgets for these programs and sections (S. Guthrie, NCDMF, personal communication).

Management Options

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

1) Status quo

+ Continued availability of a license that allows the use of limited amounts of commercial gear for personal consumption
+ Fishermen still limited to recreational harvest limits
+ No legislative changes to the general statutes
- Continued conflicts with RCGL gear
- Continued discards from RCGL gear
- No RCGL survey available to obtain harvest, discard, and effort information

2) Elimination of the RCGL

+ Eliminates conflicts with RCGL gear
+ Eliminates discards from RCGL gear
+ RCGL survey would not need to be reestablished
- Recreational fishery no longer available to fishermen
- Could result in fishermen purchasing a SCFL, which could result in more fishing gear being set and no documentation of species harvested (if retained for personal consumption and not sold)
- Requires a legislative change to the general statutes
- Affects RCGL holders that target crustaceans and finfish other than southern flounder
- Substantial loss of revenue for NCDMF programs and sections

3) Prohibit the use of gill nets by the RCGL

+ Eliminates conflicts with RCGL gill nets
+ Eliminates discards from RCGL gill nets
+ Other RCGL gears still allowed
- Recreational fishing gear no longer available to fishermen
- Could result in fishermen purchasing a SCFL, which could result in more fishing gear being set and no documentation of species harvested (if retained for personal consumption)
- Requires a legislative change to the general statutes
- Affects RCGL holders that target finfish other than southern flounder

4) Prohibit the use of shrimp trawls by the RCGL

- \+ Eliminates conflicts with RCGL shrimp trawls
- \+ Eliminates discards from RCGL shrimp trawls
- \+ Other RCGL gears still allowed
- \- Recreational fishing gear no longer available to fishermen
- \- Could result in fishermen purchasing a SCFL, which could result in larger shrimp trawls being used and no documentation of species harvested (if retained for personal consumption)
- \- Requires a legislative change to the general statutes
- \- Affects RCGL holders that target crustaceans

Management Recommendations

NCMFC Preferred Management Strategy

- Status quo and address research recommendations.

AC

- Status quo regarding the RCGL license until there are data indicating a negative influence on southern flounder and support the NCDMF research recommendations (reestablish a RCGL survey to obtain harvest, discard, and effort information, and establish at-sea observer program of the RCGL fishery) as well as a survey of SCFL holders who are inactive to collect data on what SCFL holders are doing with their licenses.*

NCDMF

- Status quo and address research recommendations.

*Note: NCDMF later reviewed information on fishermen who replaced their RCGL with a SCFL and found no increasing trend over time. 7/9/10

Research Recommendations

- Reestablish a RCGL survey to obtain harvest, discard, and effort information
- Establish at-sea observer program of the RCGL fishery

10.6 UPDATE ON SOUTHERN FLOUNDER BYCATCH IN THE COMMERCIAL CRAB POT FISHERY[10]

Issue

Update of information available on southern flounder bycatch in the crab pot fishery.

[10] Emailed to PDT on 9/16/2009
Presented to the AC on 2/9/2010
NCDMF recommendation 10/19/10

Background

The North Carolina Marine Fisheries Commission adopted a policy in November 1991 directing the NCDMF to establish the goal of reducing bycatch to the absolute minimum and incorporates that goal into actions. Actions could include, but are not limited to, gear modifications or regulatory changes that reduce the amount of undesirable catch. Bycatch is defined as "the portion of a catch taken incidentally to the targeted catch because of non-selectivity of the fishing gear to either species or size differences" Atlantic States Marine Fisheries Commission (ASMFC 1994). Bycatch can be divided into two components: incidental catch and discarded catch. Incidental catch refers to retained catch of non-targeted species. Discarded catch is that portion of the catch returned to the sea as a result of economic, legal, or personal considerations.

Two issues relating to southern flounder bycatch in crab pots are unmarketable southern flounder in actively fished crab pots and the marketable and unmarketable southern flounder in "ghost pots". Ghost pots are pots that either through abandonment or loss (float lines cut by boats, storm events, etc. and cannot be found by fishermen) continue to catch crabs and finfish (NCDMF 2004c). Abandonment of pots is when fishermen cut the buoys off old pots or simply leave the gear in the water (NCDMF 2004c). Recommendations in the 2005 Southern Flounder FMP concerning these issues include: endorse research to test the feasibility of biodegradable panels and the effectiveness of flatfish excluder devices in crab pots (NCDMF 2005). The 2004 North Carolina Blue Crab FMP identified these as high priority research items (NCDMF 2004c).

Multiple research projects have examined these two issues since the original issue paper was presented in the 2005 Southern Flounder FMP, including a study by the NCDMF which was finalized in 2008 (NCDMF 2004; NCDMF 2008). Since the original issue paper was presented in the 2005 Southern Flounder FMP, three NC Sea Grant Fishery Resource Grant (FRG) projects have quantified flounder and other finfish bycatch in crab pots in the Pamlico River (Hassell and Bonner 2008) and areas within Brunswick County, and Carteret County (Thorpe et al. 2004; Thorpe et al. 2005). Two FRGs investigating fish escape devices in working crab pots and escape panels in ghost pots were finalized in 2005 (Hassell 2005; Nobles et al. 2005). In addition to research on ghost pots, excluder devices, and biodegradable panels, the 2004 Blue Crab FMP also resulted in an extension the pot clean up period by nine days (January 15 through February 7) to allow more time to remove pots no longer in use by fishermen. The number of crab pots collected coast wide by NCMDF Marine Patrol during the clean up period has ranged from 906 pots in 2009 to 8,343 pots in 2004 (Table 10.22). The higher than usual number of pots collected in 2004 was likely a result of pot loss during Hurricane Isabel in September 2003. The number of pots found during the clean up period has declined in recent years, likely because: 1) effort has declined in some areas in the crab pot fishery; 2) increased effort by Marine Patrol to identify, tag, and secure removal of abandoned gear throughout the year; and 3) excessive widespread pot loss due to extreme weather events has been minimal since 2003. Numbers appear low in the crab pot clean up period because Marine Patrol officers only pick up pots with buoys still attached and pots without buoys that are visible in shallow water (H. Knudson, NCDMF Marine Patrol, personal communication).

It should be noted that the flounder size limit changed from 13-inches to 14-inches in April 2005 and likely increased the number of undersized fish estimated in the studies conducted after this regulatory change. Flounder were ranked high as a dominant finfish species in crab pots in all studies (Doxey 2000; Thorpe et al. 2004; Thorpe et al. 2005; Hassell and Bonner 2008). The number of flounder caught ranged from 0.13 to 4.00 fish per trip (Table 10.23). Undersized flounder ranged from 66% to 100% of the flounder caught in these studies and varied by season and location (Table 10.23). The overall percentage of dead flounder, instantaneous with the time that the pot was fished, was low and accounted for between 6% and 15% total flounder caught in each study, excluding the 0% indicated in Thorpe et al. (2005), which was due to low sample size (n = 2) (Table 10.23).

Table 10.22 Counts of the North Carolina coast wide collection of ghost crab pots during the crab pot clean up period (NCDMF Marine Patrol unpublished data).

Year	Northern district	Central district	Southern district	Total
2003	4,047	900	127	5,074
2004	7,708	527	108	8343*
2005	2,168	missing data	missing data	2,735
2006	1,117	391	24	1,532
2007	896	135	24	1,055
2008	757	190	110	1,057
2009	589	257	60	906

* The high number of ghost pots apparently was a result of pot loss from Hurricane Isabel in September 2003.

Table 10.23 Overview of NC Sea Grant Fishery Resource Grant studies investigating flounder bycatch in the crab pot fishery.

Fishery resource grant	Sampling period	Location	Total trips	Pots/trip	Total flounder caught	Percent flounder to total bycatch	CPUE (Number of flounder/ trip)	CPUE (Number of flounder/ pot)	Percent instantaneous dead	Percent undersized
Doxey 2000	March - October 1999	Neuse River	283	529/trip	359	34%	1.26	0.002	14%	79%
Thorpe et al. 2004	May - December 2003	Brunswick County	28	70-84/trip	112	49%	4.00		15%	66%
	May - December 2003	Carteret County	28	70-84/trip	57	21%	2.04		15%	78%
Thorpe et al. 2005	February - May 2005	Brunswick County	16	70-72/trip	9	90%	0.56		11%	100%
	February - May 2005	Carteret County	16	70-72/trip	2	7%	0.13		0%	100%
Hassell and Bonner 2008*	May - October 2007	Upper Pamlico River	70	300	144	58%	2.06	0.007	10%	
	May - September 2007	South Creek, Pamlico River	62	300	657	85%	10.60	0.039	6%	Significantly higher than in other location of study

Nobles et al. (2005) tested crab pots for finfish escapement outfitted with three different sized escape devices in August 2004 in the upper Pamlico River. The escape devices consisted of a 1/8-inch steel rod bent into a rectangle with the inside dimensions of: 1” x 10”; 1 ¼ ” x 10”; and 1 ½” x 10”. Escapement panels were placed in the upstairs of the crab pot 3” up from the floor on the front and back side of each pot. A total of 9 flounder were placed into the experimental pots, three in each device; all escaped after a soak time of 3 days. A second part of the experiment investigated the blue crab catch rates for the various sized devices to see if there were significant losses in blue crab catch. Although these devices reduced the overall number of marketable crabs, it also reduced culling time and provided larger crabs, which have a higher market value. The smaller escape device (1” x 10”) had the lowest crab loss yet still allowed flounder to escape from the pot. However, this experiment was completed in only one region of the state where larger crabs are available to pots; therefore further experimentation is needed in other areas to determine if crab loss is too high to validate their use. Another important aspect of this experiment is that these escape devices may reduce bycatch mortality from ghost pots by allowing the fish a means to escape the unfished pot.

Hassell (2005) tested escape panels in crab pots with the intent to provide escapement to both finfish and crabs if the pot were to become a ghost pot in the Pamlico River. The design had two panels (8 ½" x 4") located on the opposite sides of the upper panel of the crab pot, with standard crab pot wire on the inside of each opening and a weight to remain closed while in an upright position. These panels would become open when the pot rolled in any other position but upright. The intent being that pots end up on their side after catching in a prop or keel of a boat or after heavy wind events, thus opening the holes and allowing fish and crabs to escape the unfished pot. Degradable hog rings were added to one of the panels in case the pot was to remain upright; the degradable ring would eventually disintegrate and provide an opening for escapement. Legal sized flounder were placed in each of the pots, the pots were set in five different positions to estimate escapement with the devices and compared to control pots without the devices. These same experimental pots were also used in a commercial fishing operation for comparison. Finfish escapement was observed in the test pots in all positions except on the left side (Hassell 2005). Configuration of the pot prevented the door from opening when the pot was on its left side. When these pots were fished commercially for six months, there were significant differences in the amount of crabs caught between the control and test pots. Further work is needed to improve finfish escapement when the pot is in all positions and to determine if the decreased crab catch is due to crabs either not entering the pots or possibly exiting through the escape panels.

NCDMF conducted a study in four areas of the state to test finfish and crab catches in pots as if they were ghost pots (NCDMF 2008d). The sampling areas and times included: Alligator River (September 2002 – December 2006), Pamlico River (September 2002 – April 2005), Bogue Sound (September 2002 – December 2004), and Middle Sound (September 2003 – March 2005) and the pots were checked weekly. In Alligator River, 6% of the total finfish bycatch consisted of southern flounder (n = 10), showing a low initial mortality (10%). In the Pamlico River, southern flounder accounted for 18% (n = 16) of the total finfish bycatch and none were of marketable size. The condition of the southern flounder at first capture was 19% dead and condition on recapture was 64% dead with 36% escapement from the pot. In Bogue Sound southern flounder accounted for 37% (n = 36) of the total finfish bycatch in the pots, 31% were dead at first capture and 100% were dead upon recapture with no escapement. In Middle Sound southern flounder accounted for 24% (n = 83) of the total finfish bycatch in the crab pots. Twelve percent of the southern flounder were dead at first capture and 29% dead upon recapture and 71% escaped upon recapture.

Factors that affect ghost fishing include: number of pots lost, pot type, location, and target species behavior (Smolowitz 1978; NCDMF 2004). Significant reductions in ghost fishing mortality for crab pots could be achieved by minimizing pot loss and incorporating design features which prevent or reduce the effects of ghost fishing. A second part to the NCDMF (2008d) study looked at degradable material tests both from an experimental design and also under commercial conditions to allow for finfish and crab escapement after a predetermined length of time. Escapement or excluder devices specifically for flatfish were not tested during this study. There were many types of material used to time their breakpoints which varied considerably. Results of these studies will be evaluated for potential regulatory recommendation in the scheduled update of the Blue Crab FMP beginning in July 2009.

Determining which material works best in a water body and how other parameters impact degradation rates and performance of the crab pot are suggested for further investigation (i.e.: effects of microbial activities and light penetration).

Current Authority

G.S. 113-134	RULES
G.S. 113-173	RECREATIONAL COMMERCIAL GEAR LICENSE
G.S. 113-182	REGULATION OF FISHING AND FISHERIES
G.S. 143B-289.52	MARINE FISHERIES COMMISSION--POWERS AND DUTIES

NC Fisheries Rules for Coastal Waters 2009 (15A NCAC)

03I .0104(b)	LEAVING DEVICES UNATTENDED
03J .0301	POTS

Discussion

The majority of hard crab landings have originated from the Albemarle Sound and its tributaries (34%) and the Pamlico, Pungo, Neuse, and Bay rivers (26%) during 1994 to 2002 (NCDMF 2004c). Likewise, a substantial amount of crab pot fishing effort occurs in these areas. Since these areas are known to be preferred habitats for juvenile and sexually immature flounder, this increases the likelihood of undersized unmarketable southern flounder to be captured in the crab pot fishery (NCDMF 2005).

Studies are still needed to determine a more accurate estimate of southern flounder bycatch in crab pots coast wide. Recent studies have shown that although the initial mortality estimates for flounder are low, mortality increases significantly the longer flounder are left in the pots and should continue to be a concern with regards to ghost pots. The mortality caused by ghost pots is directly related to the durability of the pot and its retention capability. The majority of the flounder caught in crab pots are undersized so minimizing the mortality of these fish could result in both more southern flounder recruiting to the spawning stock and more southern flounder available for harvest. Therefore, minimizing pot loss and incorporating design features into the pots, such as a flatfish escapement device, to maximize flounder escapement should continue to be explored by the crabbing industry.

Management Options and Impacts

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

1) Options to reduce southern flounder bycatch in actively fished crab pots

   a) Status quo

      + No new regulations
      - Potential waste of finfish resource

   b) Require flatfish escapement devices in crab pots to reduce flounder bycatch

      + Reduce unmarketable flounder bycatch
      + Potentially increase recruitment of southern flounder into the spawning stock biomass
      + Increased escapement of undersized blue crabs
      - Reduce marketable flounder bycatch

- Loss of legal crabs
- Increased regulations and enforcement of those regulations

2) Options to minimize ghost pot fishing mortality

   a) Status quo

      + No new regulations
      - Continued problem with ghost pot fishing mortality

   b) Require degradable material and/or panels in crab pots

      + Reduce waste of the blue crab resource
      + Increase harvest of blue crabs
      + Reduce finfish bycatch in ghost pots
      + Potentially increase recruitment of southern flounder into the spawning stock biomass
      - Possible loss of legal catch due to premature failure of panels
      - Increased regulations and enforcement of those regulations
      - Increased cost to crab fisherman

Management Recommendations

NCMFC Preferred Management Strategy

- Status quo and expand research on flatfish escapement devices and degradable panels under commercial conditions to other parts of the state to evaluate existing and alternative designs, degradation rates, and estimate the retention rate of legal sized blue crabs and the cost to crab pot fishermen.

AC and NCDMF

- Status quo and expand research on flatfish escapement devices and degradable panels under commercial conditions to other parts of the state to evaluate existing and alternative designs, degradation rates, and estimate the retention rate of legal sized blue crabs and the cost to crab pot fishermen.

Research Recommendations

- Formulate a bycatch estimate of southern flounder from crab pots
- Further research on degradable materials to determine which material works best in a given water body and how other parameters, such as microbial activities and the effects of light penetration impact degradation rates and performance of the crab pot
- Further research on flatfish escapement devices that minimize undersized flounder bycatch and maximize the retention of marketable blue crabs

10.7 SOUTHERN FLOUNDER DISCARDS IN THE RECREATIONAL HOOK AND LINE FISHERY[11]

Issue

Release mortality of southern flounder in the recreational hook and line fishery and its potential impact on the stock.

Background

Southern flounder is an important fish for both the commercial and recreational fisheries in North Carolina. The commercial fisheries account for the majority of the total annual landings, but the proportion of the recreational harvest to the total landings has increased in recent years (Takade-Heumacher and Batsavage 2009). The average recreational harvest from 1991 to 1999 was 56,186 fish and 112,842 pounds. From 2000 to 2007, the average recreational harvest increased to 148,076 fish and 308,706 pounds (Table 10.24). The peak harvest of 196,906 fish and 425,221 pounds occurred in 2004. Since 2005, the harvest has averaged 162,619 fish and 366,938 pounds. The number of southern flounder released by recreational anglers has also increased in recent years. The average number of releases from 1991 to 1999 was 175,053 fish and ranged from 33,635 fish in 1991 to 336,756 fish in 1997. The average number of releases from 2000 to 2007 was 539,656 fish and ranged from 382,084 fish in 2003 to 879,373 fish in 2004. The number of southern flounder released in 2008 surpassed 1 million fish for the first time in North Carolina at 1,084,807 fish (unpublished data, NCDMF).

Table 10.24 North Carolina recreational hook and line harvest (number, weight, and proportional standard error (PSE) of the estimates) and number of releases of southern flounder, 1991-2007 (MRFSS Survey).

Year	Harvest (Number)	PSE	Weight (lb)	PSE	Released (Number)
1991	80,540	9.6	136,835	10.7	33,635
1992	38,892	14.6	74,308	16.5	83,025
1993	34,588	14.4	56,405	14.9	156,167
1994	72,124	11.9	131,804	12.6	257,032
1995	54,495	12.3	116,617	13.2	269,350
1996	67,416	13.8	115,336	16.4	178,354
1997	79,719	15.3	218,615	16.3	336,756
1998	42,727	16.1	88,147	17.1	197,069
1999	35,171	21.6	77,505	23.7	73,085
2000	150,315	15.0	271,234	14.6	454,862
2001	115,477	11.4	213,908	11.9	404,319
2002	115,154	13.8	236,648	15.5	515,374
2003	118,898	15.6	221,805	15.6	382,084
2004	196,906	11.1	425,221	11.6	879,373
2005	161,292	13.6	368,098	14.4	514,799
2006	172,136	12.5	366,400	12.8	566,653
2007	154,429	13.3	366,305	13.8	599,786

[11] Emailed to the PDT on 3/16/10
Presented to the AC on 4/13/10
NCDMF recommendation 10/19/10

Fish released by recreational anglers are not available for Marine Recreational Fisheries Statistics Survey (MRFSS) creel clerks to measure. Therefore, in the 2009 Southern Flounder Stock Assessment, it was assumed that all of the southern flounder released in the recreational hook and line fishery were below the minimum size limit. Although it is likely that some legal sized southern flounder were also released, this assumption was determined to be reasonable because the average catch per angler, per trip was well below the creel limit (see Table 7.9 in Section 7.2, Status of the Recreational Fishery). In addition, previous Northeast Fisheries Science Center's (NEFSC) summer flounder stock assessments assumed that all released summer flounder were undersized based on the New York Department of Environmental Conservation (NYDEC) party boat data that showed greater than 95% of released summer flounder were undersized (NEFSC 2002).

Hook and line release mortality has been extensively researched for many species of fish, but only a couple of studies exist for southern flounder (Gearhart 2002a; Brown 2007). There have only been a few hook and line release mortality studies for summer flounder with Lucy and Holton (1998) and Gearhart (2000) among the most recent studies. The southern flounder release mortality studies took place in North Carolina while the summer flounder release mortality studies took place in North Carolina and Virginia. These studies employed traditional angling practices to catch flounder, and the fish were held in either cages or tanks to evaluate short-term release mortality.

Gearhart (2002a) found the release mortality of southern flounder in low salinity waters (<19 ppt) was 19.4%, and the release mortality in high salinity waters ($\geq$19 ppt) was 9.5%. The weighted mortality estimate of 10.83% used in the 2009 Southern Flounder Stock Assessment was based on the mortality estimates from Gearhart (2002a). Brown (2007) reported an overall release mortality (low (<5 ppt) and high ($\geq$5 ppt) salinity combined) of 24.6% for southern flounder in the Neuse River. Lucy and Holton (1998) reported release mortality estimates of 6% (field experiments) and 11% (tank experiments) for summer flounder, while Gearhart (2000) reported a release mortality rate of 7.1% for summer flounder.

Hook location proved to be a significant factor for release mortality in most of these studies (Lucy and Holton 1998; Gearhart 2000; Gearhart 2002a). Deep hooked (hooks lodged in the esophagus, gills or deep mouth and tongue) summer flounder accounted for 95% of the summer flounder mortalities in tank experiments (Lucy and Holton 1998). Gearhart (2000; 2002a) found that a higher percentage of summer flounder and southern flounder hooked in the gut or esophagus died than those hooked in the jaw, mouth, or gill. Hook location was not a significant factor in the release mortality study by Brown (2007), but this may have been the result of the majority of southern flounder caught on artificial jigs instead of natural bait (unpublished data, NCDMF). Fishing with natural bait tends to have a higher incidence of deep hooking than fishing with artificial bait (Nelson 1998; Cooke and Suski 2005).

The impact of other factors on release mortality such as water temperature, salinity, hook removal, dissolved oxygen (DO), fish size, barbless hooks, and hook type varied among studies. Gearhart (2000) and Brown (2007) found that water temperature was a significant factor, but Lucy and Holton (1998) and Gearhart (2002a) did not. The water temperatures in the study by Lucy and Holton (1998) were a relatively narrow range (59^{o}F-75^{o}F), and much of the sampling by Gearhart (2002a) occurred in the summer with only minimal data available for the spring and fall, so seasonal effects on southern flounder release mortality could not be analyzed from this study. Dissolved oxygen was determined to be a significant factor in release mortality for southern flounder in the Neuse River, but hypoxic events during the study may have contributed to DO being a significant source of mortality (Brown 2007). Gearhart (2000) reported a higher percentage of deep hooked summer flounder caught on wide gap hooks than on circle hooks, but the difference was not statistically significant. Lucy and Holton (1998) also found no significant difference in summer flounder release mortality for the different hook types used in their study. Gearhart (2002a) reported higher release mortality for southern flounder caught in low salinity waters, but salinity was not found to be a significant factor in release mortality due to variable mortality rates for the individual field trials. While not statistically proven to reduce release mortality, leaving the hooks in deep hooked summer flounder showed the potential for lowering release mortality (Lucy and Holton 1998). In contrast Brown (2007) found that southern flounder were 10.4 times more likely to survive when the hook was removed compared to individuals that the hook was not removed.

Current Authority

G.S. 113-134. RULES
G.S. 113-182. REGULATIONS OF FISHING AND FISHERIES
G.S. 143B-289.52. MARINE FISHERIES COMMISSION—POWERS AND DUTIES

NC Fisheries Rules for Coastal Waters 2009
15A NCAC 3M .0503 FLOUNDER

Discussion

Management measures that regulate terminal tackle for recreational anglers are in place for other species. For the adult red drum fishery in Pamlico Sound, it is unlawful to use any hook larger than 4/0 from July 1 through September while using natural bait from 7:00 p.m. to 7:00 a.m. unless the terminal tackle consists of: 1. A circle hook defined as a hook with the point of the hook directed perpendicularly back toward the shank, and with the barb either compressed or removed; and 2. A fixed sinker not less than two ounces in weight, secured not more than six inches from the fixed weight to the circle hook (15A NCAC 03J .0306) (NCDMF 2008b). The North Carolina Wildlife Resources Commission (WRC) requires all anglers on the Roanoke River to use single barbless hooks from April 1 to June 30 to reduce the release mortality of striped bass on the spawning grounds (http://www.ncwildlife.org). In Florida, saltwater anglers are prohibited from using multiple hooks in conjunction with live or natural bait for a variety of species including flounder, spotted sea trout, red drum, and snook (http://www.MyFWC.com).

The release mortality studies on summer and southern flounder showed variable impacts of different factors on mortality, but deep hooked flounder exhibited a higher mortality rate in most cases (Lucy and Holton 1998; Gearhart 2000; Gearhart 2002a). The impact of circle hooks, barbless hooks and different hook sizes on deep hooking has been researched for other species (Aguilar 2003; Beckwith and Rand 2004; Cooke and Suski 2005; Vecchio and Wenner 2007). Although circle hooks result in lower incidences of deep hooking for other species (Cooke and Suski 2004), they may not be as effective for southern flounder. Anglers targeting flounder with natural bait typically wait before setting the hook to ensure that they hook the fish. This fishing practice can result in deep hooking a flounder with a circle hook. Circle hooks may also not be effective in certain flounder fishing applications such as drifting and trolling—especially in deep water. Gearhart (2000) noted that it was more difficult to hook summer flounder on circle hooks than on wide gap hooks while drifting and trolling. However, hooking efficiency with circle hooks could be better for anglers targeting flounder while fishing from a stationary platform (anchored boat, shore, dock, etc.). Cooke and Suski (2004) report that the benefits of circle hooks in terms of reduced mortality and hooking efficiency depends on the species of fish. More research is needed on different hook types and their impact on the deep hooking of southern flounder.

A season closure for the recreational hook and line southern flounder fishery during the summer months could reduce the discard mortality as well as the number of fish released. Although water temperature was a significant factor in only two of the four of the release mortality studies for southern and summer flounder, it is a significant factor for other species, striped bass in particular (Nelson 1998; Gearhart 2002b; Cooke and Suski 2005). The recreational season for striped bass in the estuaries and coastal rivers of North Carolina is closed during the warmer months of the year due to the high release mortality when the water temperature is warm (http://portal.ncdenr.org/web/mf/). Peak recreational harvest of southern flounder in North Carolina occurs in July and August, when the water temperatures are the highest. However, a closed season at this time of year would result in a substantial reduction in the recreational harvest of southern flounder (see Figure 7.22 in Section 7.2 Status of the Recreational Fishery). In addition, southern flounder are caught by anglers targeting other species so discard mortality would still occur with a season closure.

The number of southern flounder released by recreational anglers has increased in recent years with the largest number of releases occurring in 2008. The number of releases could further increase if strong year classes enter the fishery, the number of trips targeting southern flounder increases, or if the minimum size limit for the recreational fishery increases. A release mortality estimate of 10.83% results in a substantial number of dead discards each year for the recreational hook and line fishery.

Although existing research on the release mortality of summer and southern flounder does not definitively show a hook type or fishing practice that reduces mortality, anglers can still employ fishing practices that increases the chance of survival for the released fish. The North Carolina Coastal Recreational Angler's Guide that was published by the NCDMF provides tips on the proper methods of releasing fish (NCDMF 2008e). In addition, Cooke and Suski (2005) identify fishing practices to reduce release mortality for fish with no available data including: 1. Minimize angling duration; 2. Minimize air exposure; 3. Avoid fishing in extreme water temperatures; 4. Use barbless hooks and artificial lures; and 5. Refrain from fishing during spawning periods. Any fishing practices that increase the survival of released southern flounder can help in the rebuilding of the stock.

Management Options

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

1) Status quo

   + Continued promotion of proper methods of releasing fish
   + No additional enforcement responsibilities
   + No impact to anglers targeting other species
   + No disproportionate impact on fishing techniques (drifting, trolling, anchored, etc.) for flounder fishing
   - Release mortality reduced only if more anglers voluntarily adopt proper methods for releasing fish

2) Implement regulations on terminal tackle used to fish for southern flounder

+ Could reduce release mortality for southern flounder
+ Reduces variability in release mortality of terminal tackle
- Additional enforcement responsibilities
- More research needed on most appropriate hook sizes to minimize release mortality for southern flounder
- Impacts anglers targeting other species
- Disproportionate impact on fishing techniques (drifting, trolling, anchored, etc.) for flounder fishing

3) Implement a summertime season closure to the recreational southern flounder hook and line fishery

    + Could reduce release mortality for southern flounder
    + Could reduce the number of southern flounder released by anglers
    - Substantial harvest reduction to the recreational hook and line fishery
    - Discard mortality of southern flounder would still occur despite the closed season
    - Impacts anglers targeting other species
    - More research needed on which seasons would minimize release mortality for southern flounder
    - Additional enforcement responsibilities

Management Recommendations

NCMFC Preferred Management Strategy

- Status quo and expand research on factors impacting the release mortality of southern flounder and on deep hooking events of different hook types and sizes on southern flounder.

AC and NCDMF

- Status quo and expand research on factors impacting the release mortality of southern flounder and on deep hooking events of different hook types and sizes on southern flounder.

Research Recommendations

- Further research on factors that impact release mortality of southern flounder in the recreational hook and line fishery
- Research on deep hooking events of different hook types and sizes on southern flounder

10.8 INCIDENTAL CAPTURE OF PROTECTED SPECIES IN SOUTHERN FLOUNDER LARGE MESH GILL NET AND POUND NET FISHERIES[12]

Issue

Management actions for North Carolina's commercial large mesh estuarine flounder gill net fishery and flounder pound net fishery addressing incidental capture of protected species.

Background

Flounder gill nets are considered set nets of large mesh (5-inch and larger stretched mesh) that are deployed and left from only a few hours to several days depending on water temperature and depth. There are at least two types of flounder gill net operations, which can be broken down by vessel size: smaller boats (8-25 feet) that fish nearshore in shallow (<10 feet) water pulling the nets by hand or net reels, and larger vessels (> 25 feet) that fish in deepwater (≥ 10 feet) and use mechanical net reels to haul in the net. Flounder gill nets are known to interact with sea turtles. The Pamlico Sound Gill Net Restricted Area (PSGNRA) is the result of these interactions and has been in place since 2000. Area, season, mesh size, yardage, attendance of gear, and combinations of these restrictions are available for resource management and are currently used at various times of the year to prevent the waste of fish, to protect particular fish stocks, and minimize capture of protected species (NCDMF 2005).

Flounder pound nets are a stationary gear that directs fish into enclosures or pounds by means of a lead. Most flounder pound nets are fished seasonally in the fall and operate in Pamlico, Core, and Albemarle sounds. Permits are required to set pound nets and pound nets are required to have escape panels to cull undersized finfish. This gear is also known to have interactions with sea turtles. The National Marine Fisheries Service (NMFS) used to conduct an annual mark-recapture study of loggerhead, green, and Kemp's ridley sea turtles incidentally captured in pound nets set in Core and Pamlico sounds. From this study, NMFS researchers were able to document seasonal distribution, species composition, and abundance of sea turtles in the area (NCDMF 2006b).

Some of the public's negative perception of commercial fisheries in general stems from the incidental capture of non-target species and the capture of protected species such as sea turtles and marine mammals. Environmental, conservation, and sport fishing organizations have cited these catches to support the ban of any and all commercial gill net fishing operations (NCDMF 2005). The controversy has recently intensified due to NMFS observations of sea turtle interactions within gill nets in Core Sound and the issuance of a complaint for declaratory and injunctive relief by the Karen Beasley Sea Turtle Rehabilitation Center, represented by the Duke Environmental Law Clinic.

The Endangered Species Act (ESA)

The ESA was enacted in 1973, "to provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved, (and) to provide a program for the conservation of such endangered species and threatened species." The ESA is a

[12] Emailed to the PDT on 3/16/2010
Presented to AC 5/20/10
NCDMF recommendation 10/19/10

comprehensive act with eighteen sections that cover many aspects of endangered species protection and management (NCDMF 2006b).

The ESA defines a species as threatened when it is likely to become an endangered species within the foreseeable future. An endangered species is defined as any species which is in danger of extinction throughout all or a significant part of its range. A take is to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct (NCDMF 2006b).

Section 10 of the ESA provides for exceptions to the take prohibitions in the form of permits. These permits can be for either an intentional take or for an incidental take. Intentional take permits are intended for scientific purposes or to enhance the propagation or survival of the affected species. Incidental take permits are for activities that are otherwise lawful but are expected to incidentally take a listed species. Permit holders must develop and implement conservation plans that reduce and minimize the impacts of the take. Once a Section 10 permit application is reviewed and deemed appropriate, a permit is granted to authorize a specified level of takes. Along with the specified take that is authorized, the permit includes reporting requirements, and often includes other conditions that must be met (tagging, handling guidelines, data analyses, conservation plans, etc.). The Section 10 permit provision is very important to the regulated community, including the states, because it can allow a fishery to continue (under constraints) that would otherwise have to be shut down under the ESA mandates. Likewise, it allows the applicant the opportunity to try management measures to see if they would be successful in allowing the fishery to continue to operate (NCDMF 2006b).
Most of the species listed as endangered or threatened fall under federal jurisdiction either with the NMFS or the U.S. Fish and Wildlife Service (USFWS). The following is a list of endangered (E) or threatened (T) species that may occur in estuarine and ocean waters of North Carolina (NCDMF 2005):

Fish

- Smalltooth sawfish (*Pristis pectinata*) E
- Shortnose sturgeon (*Acipenser brevirostrum*) E

Reptiles

- Green sea turtle (*Chelonia mydas*) T
- Kemp's Ridley sea turtle (*Lepidochelys kempii*) E
- Hawksbill sea turtle (*Eretmochelys imbricate*) E
- Leatherback sea turtle (*Dermochelys coriacea*) E
- Loggerhead sea turtle (*Caretta caretta*) T (under review)

Mammals

- West Indian manatee (*Trichechus manatus)* E
- Finback Whale (*Balaenoptera physalus*) E
- Humpback whale (*Megaptera novaeangliae*) E
- Right whale (*Balaena glacialis*) E
- Sperm whale (*Physeter catodon*) E

Of this list, only the sea turtles and the shortnose sturgeon interact with flounder large mesh, estuarine gill nets and flounder pound nets.

On March 15, 2010 the NMFS and the USFWS announced their joint determination that the loggerhead sea turtle is globally compromised and issued a Federal Register notice (Federal

Register: 75(50), 12598-12656) the following day. The notice distinguishes nine separate loggerhead Distinct Population Segments (DPS) worldwide and list two as threatened and seven as endangered. The Northwest Atlantic loggerhead sea turtle population is proposed to be reclassified with endangered status (Conant et al. 2009).

In 2003, a workshop sponsored by NMFS and USFWS was held to review the status of Atlantic sturgeon (*Acipenser oxyrinchus*). The workshop attendees concluded that some populations seemed to be recovering while other populations continued to be depressed. As a result, NMFS initiated a second status review of Atlantic sturgeon in 2005 to reevaluate whether this species required protection under the ESA. That status review was completed in 2007. A determination of whether to propose to list Atlantic sturgeon under the ESA is expected in 2010.

The Marine Mammal Protection Act (MMPA)

The Marine Mammal Protection Act (MMPA) of 1972 was enacted in response to increasing concerns by scientists and the public that significant declines in some species of marine mammals were caused by human activities. It established a national policy to prevent marine mammal species and population stocks from declining to a point where they ceased to be significant functioning elements of the ecosystem.

The Department of Commerce through the NMFS is charged with protecting whales, dolphins, porpoises, seals, and sea lions. Walruses, manatees, otters, and polar bears are protected by the Department of the Interior through the USFWS.
The MMPA established a moratorium on the taking of marine mammals in U.S. waters. It defines “take” to mean “to hunt, harass, capture, or kill” any marine mammal or attempt to do so. Exceptions to the moratorium can be made through permitting actions for take incidental to commercial fishing and other nonfishing activities, for scientific research, and for public display at licensed institutions such as aquaria and science centers.

To date, there have been no observations of dolphin interactions by NCDMF gill net observers throughout North Carolina’s estuarine waters including the PSGNRA (B. Price, NCDMF, personal communication). According to the 2009 US Atlantic and Gulf of Mexico Marine Mammal Stock Assessment (Waring 2009) there are now nine new bottlenose dolphin Atlantic bay, sound and estuarine stocks. Two of these stocks are in North Carolina estuaries and are called the Northern North Carolina Estuarine System Stock and the Southern North Carolina Estuarine System Stock. As new information on the bottlenose dolphin stocks become available, medium mesh gill nets (≥ 5.0 inch stretch, < 7.0 inch stretch) may come under additional regulatory and nonregulatory management measures. There are no new management measures proposed for North Carolina waters at this time but changes can occur if there are reported or observed interactions in the flounder gill net fishery (R. Munden, NCDMF, personal communication).

Migratory Bird Treaty Act

The original 1918 statute implemented the 1916 Convention between the U.S. and Great Britain (for Canada) for the protection of migratory birds. Later amendments implemented treaties between the U.S. and Mexico, the U.S. and Japan, and the U.S. and the Soviet Union (now Russia). The statute makes it unlawful, unless permitted by regulations, to pursue, hunt, take, capture, kill or sell any migratory bird. The statute does not discriminate between live or dead birds and also grants full protection to any bird parts including feathers, eggs and nests. Over 800 species are currently on the list.

Migratory birds are managed federally by the USFWS. There are several species of diving ducks and seabirds that are unintentionally caught and drowned in gill nets. The USFWS completed a study to assess bird mortality in nearshore anchored gill nets in the ocean from New Jersey to Virginia and found that an estimated 2,387 birds were killed in the mid-Atlantic gill net fishery from February through April 1998 (Forsell 1999).

Current Authority

ENDANGERED SPECIES ACT OF 1973
MARINE MAMMALPROTECTION ACT OF 1972
MIGRATORY BIRD TREATY ACT OF 1918

NC Fisheries Rules for Coastal Waters 2009 (15A NCAC)

03I .0107 ENDANGERED OR THREATENED SPECIES

Discussion

The NCDMF has addressed protected sea turtle issues throughout the coastal waters since the 1970s. This has been accomplished by cooperative agreements with the North Carolina Wildlife Resources Commission (WRC), establishment of a sea turtle sanctuary, and proclamation authority given to the director of NCDMF. Most notably, the management of the PSGNRA and the formation of the NC Sea Turtle Advisory Committee (STAC) have been two very proactive means of addressing protection of sea turtles in North Carolina. Recommendations from the STAC have resulted in additional queries on recreational surveys, continued support of commercial bycatch reduction gear testing projects, and continuous outreach to the fishing industries.

The Pamlico Sound Gill Net Restricted Area (PSGNRA)

In 1999, increased sea turtle strandings were noted by the WRC – Sea Turtle Stranding and Salvage Network (NCSSTN) in the southeastern portion of Pamlico Sound. Investigation of the fisheries by NCDMF staff operating in the area at that time identified large (≥ 5-inch stretched mesh – flounder) and small (< 5-inch stretched mesh - spotted seatrout, *Cynoscion nebulosus*) mesh gill net fisheries as a potential source of fishery interaction with sea turtles. This event and subsequent commercial fishery observations began the PSGNRA, which is still in existence today. Initial monitoring of these fisheries in 1999 identified the large mesh gill net flounder fishery as a source of sea turtle interactions in Pamlico Sound during the months of September through December. With this information, the NMFS initially issued an emergency rule closing this area to large mesh gill net fishing operations to protect endangered and threatened sea turtles.

To maintain the gill net flounder fishery, NCDMF applied for and received an Incidental Take Permit (ITP #1259) under Section 10 of the ESA in 2000 (Gearhart 2001). The ITP authorized protected species interactions, allowing the fishery to operate under certain restrictions. The ITP contained a comprehensive conservation plan designed to reduce sea turtle interactions by establishing an authorized threshold of sea turtle takes, and intensive monitoring by fisheries observers, while allowing traditional gill net fisheries to be prosecuted. Observations in 2000 identified the deep water region of Pamlico Sound as the primary source for sea turtle interactions and subsequent mortality leading NMFS to establish a permanent rule for the 2001 fishing season that closed all potential fishing grounds utilized by the deep water large mesh gill net fisheries. In 2001, NCDMF applied for and received another ITP (# 1348) that implemented further restrictions by establishing prohibited fishing corridors and restricted areas throughout Pamlico Sound, known as the PSGNRA. NMFS then closed the rest of Pamlico Sound to gill nets with mesh sizes larger than 4.25 inch stretched mesh on September 27, 2001.

In 2003, NCDMF applied for and received a three-year ITP (#1398). This ITP contained a Habitat Conservation Plan (HCP) which implemented an intensive sea turtle observer and characterization program throughout the PSGNRA from September through December. These restricted areas remained unchanged and were monitored annually from September 1 through December 15 of each year. Observed levels of sea turtle interactions in the flounder gill net fishery remained below thresholds that were established by the ITP from 2002 through 2004 (Price 2005; Price 2004; Gearhart 2003).

In 2005, NCDMF applied for and received a six-year permit (ITP # 1528) with a few changes to the PSGNRA management area including the establishment of a state closure on top of the federal closure, redirection of observer coverage and the elimination of the permit requirements along the mainland side of Pamlico Sound (ITP # 1528; Price 2006). Management of the PSGNRA since 2005 has remained consistent and has provided continued protection of sea turtles while allowing a shallow water gill net fishery to operate along the Outer Banks and mainland side of Pamlico Sound (Figure 10.21). However, observed and estimated sea turtle interactions have increased considerably (Table 10.25). In 2007, the PSGNRA season closed two weeks early due to estimated interactions with live green sea turtles surpassing authorized thresholds (Price 2008). In 2008, observed and estimated interactions increased but remained below the authorized thresholds, allowing the season to continue (Price 2009). By 2009, a drastic increase in observed and estimated sea turtle interactions occurred and ultimately resulted in closing the season six weeks early, on October 22 due to estimated live green sea turtle captures surpassing authorized thresholds under ITP # 1528 (Table 10.25). Section 10 ITP # 1528 expires at the end of 2010. The NCDMF will continue to manage the fall flounder gill net fishery throughout Pamlico Sound from September through December of 2010, through this permit authorizing sea turtle interactions.

In addition to the gill net fishery observations in the PSGNRA since 2000, the NCDMF has also obtained commercial gill net fishery observations outside of the PSGNRA since 2004 in order to characterize effort, catch, and finfish bycatch and protected species interactions (Brown and Price 2005; Price 2007; Price 2009). The NCDMF has conducted both inshore and nearshore shrimp trawl observations (Brown 2009a; 2009b), and has obtained a limited number of pound net observations (Price 2007).

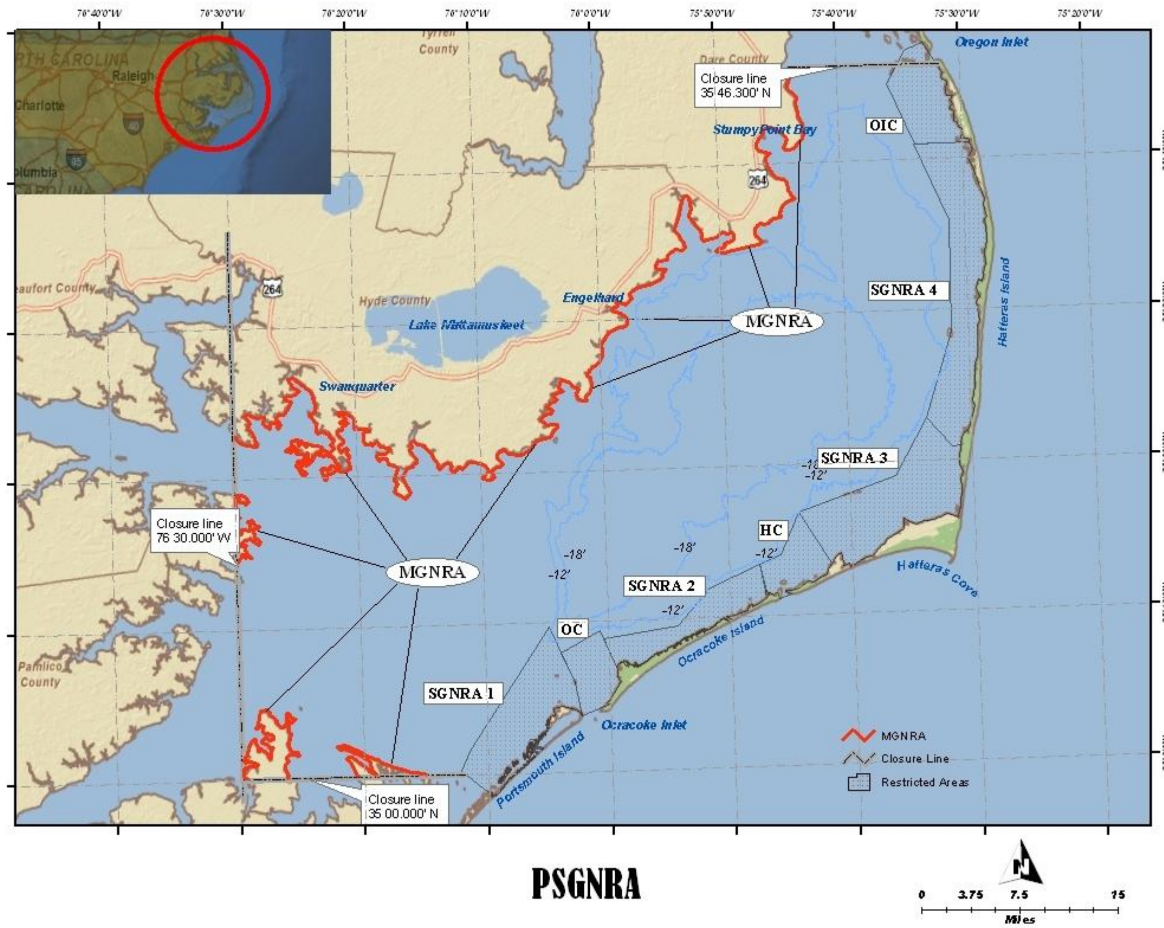


Figure 10.21 Map of the Pamlico Sound Gill Net Restricted Area (PSGNRA) from 2005 to December 2010.

Table 10.25 Observed and estimated sea turtle interactions by species and disposition inclusive with relative percent observer coverage by year throughout the PSGNRA , 2005-2009.

Year	Species	Disposition	Observed number	Total observed number	Estimated number	Total estimated number	Percent observer coverage
2005	Green	Alive	4		28		
	Kemp's	Alive	1		4		
	Loggerhead	Alive	1		8		
	Loggerhead	Dead	1	7	4	44	11.9
2006	Green	Alive	2		20		
	Green	Dead	3		17		
	Loggerhead	Alive		6	15	52	9.6
2007	Green	Alive	14		125		
	Green	Dead	5		30		
	Loggerhead	Alive	1	20	23	178	7.7
2008	Green	Alive	8		59		
	Green	Dead	7		36		
	Kemp's	Dead	1		4		
	Loggerhead	Alive	1	17	4	103	11.3
2009*	Green	Alive	21		228		
	Green	Dead	7		42		
	Kemp's	Alive	1		9		
	Kemp's	Dead	3		18		
	Loggerhead	Alive	1		11		
	Hawksbill	Dead	1	34	n/a	308	12.1
Total**			84	84	685	685	10.5

* 2009 estimates preliminary - report in press
** Percent observer coverage total is expressed as a mean percent from 2005 to 2009

The Sea Turtle Advisory Committee (STAC)

The Sea Turtle Advisory Committee (STAC) was formed in 2003 by the North Carolina Marine Fisheries Commission (NCMFC) in response to continuing problems with protected species interactions in fisheries throughout the North Carolina coast. Their objective was to develop solutions for the reduction of sea turtle interactions in commercial and recreational (hook and line) fishing gear, while maintaining economically viable fisheries throughout the estuarine waters of North Carolina. The STAC was comprised of stakeholders concerned with the bycatch of protected species in commercial and recreational fisheries. Stakeholders included recreational and commercial fishermen and the scientific community representing state and federal agencies, academia, and an environmental organization. The committee summarized its findings in a report which included a background summary about federal and state management, sea turtle natural history, sea turtle strandings, and characterization of North Carolina estuarine fisheries. The document concluded with identification of problems, development of solutions, and recommendations for the reduction of commercial and recreational fishery interactions with sea turtles, while maintaining North Carolina fisheries (NCDMF 2006b).

Over a three year effort, the STAC identified four inshore gears of primary concern with relation to sea turtle incidental catch throughout North Carolina. These gears were gill nets, pound nets, shrimp trawls, and recreational hook and line. Other gears were identified as gears of other concern, and many gears were identified as no concern (NCDMF 2006b).

Recommendations were provided to the NCMFC following completion of this report, and many of the recommended actions are currently in place. Throughout the STAC process, the recommendation to implement observer coverage for multiple fisheries of either primary or other concern was made in order to gather information where it is limited. The STAC also supported continued efforts for gear modification and testing with the objective of reducing sea turtle interactions (NCDMF 2006b).

STAC Recommendations (NCDMF 2006b):

Gill Nets (> 5 in stretch)

1. Establish mandatory observer coverage of all large mesh (≥ 5 in. stretch) gill nets throughout all estuarine waters. The level of coverage should have a minimum goal of 2% of the total effort by area. Coverage should increase (~10%) in areas when/where sea turtle interactions are occurring.
2. Provide education on sea turtle resuscitation to fishermen. Support outreach programs that encourage reporting sea turtles and compliance with regulations.
3. Implement state seasonal/area closures in identified problem areas.
4. Support continued efforts for gear modification and testing with the objective of reducing sea turtle interactions.

Pound Nets

1. Have state apply for a Section 10 permit for all pound nets that interact with sea turtles.
2. Encourage and educate the industry about the importance of regularly checking pound net leads and pounds during normal commercial fishing operations for the presence of sea turtles.
3. Require industry to catalogue gear time out of the water and report this to NCDMF.
4. Encourage industry to remove all webbing during closed seasons, and establish a recovery cost for pulling lost or abandoned gear.
5. Support sea turtle resuscitation education. Support educational outreach programs that emphasize importance of removing nets at end of season, checking nets regularly, mending holes or areas that may result in entanglement issues, and reporting sea turtles.
6. Evaluate existing observer coverage from NMFS. To obtain these data the NCMFC should request and routinely receive these data from NMFS.
7. Support gear modifications and testing that would reduce sea turtle interactions.

Recent Protected Species Issues and Impacts to the Southern Flounder Fishery

In June 2009, NMFS began an alternative platform (observations via another vessel) observer program in the Core Sound gill net fishery. NMFS observed increased sea turtle interactions in large mesh gill nets in the area in late June and notified NCDMF of their concern for unauthorized takes. NCDMF consulted with NMFS to discuss short and long-term plans to address unauthorized sea turtle takes in Core Sound and throughout the state. As a short term management measure to address the takes, NCDMF implemented gear restrictions on large mesh gill nets (yardage limits, mesh depth reduction, and net shot reductions) and observer requirements in Core Sound and adjacent water bodies (NCDMF Proclamation M-15-2009). As a long-term management measure, NCDMF continued working with NMFS to apply for a Section 10 ITP application for large mesh gill nets coast wide. NCDMF began compiling sea turtle interaction data from fishery independent gill net surveys, research projects and direct observations. NCDMF also delayed opening the PSGNRA until 5 September 2009 because of continued sea turtle interactions and anecdotal reports of increased sea turtle sightings throughout Pamlico Sound. Monitoring efforts in the PSGNRA continued through 22 October 2009, when authorized thresholds of live green sea turtles were surpassed, and NCDMF closed the PSGNRA for the remainder of the season.

On the same day that authorized sea turtle takes were exceeded in the 2009 PSGNRA, NCDMF received a 60-day Notice of Intent (NOI) to sue the NCDMF and NCMFC from the Duke Environmental Law Clinic. The Duke Environmental Law Clinic represented the Karen Beasley Sea Turtle Rescue and Rehabilitation Center Foundation and the NOI claimed that the NCDMF and NCMFC violated Section 9 of the ESA. Section 9 is the prohibition of takes of listed species. NCDMF again consulted with NMFS concerning this NOI and to further discuss the continued work towards a coast wide Section 10 ITP in order to address ESA requirements.

In November 2009, NCDMF received further correspondence from NMFS reiterating the need to 'satisfy the requirements of the ESA'. NCDMF continued compiling sea turtle interaction data and began developing an interim plan to address the issue throughout 2010, while the ITP application process continued. Correspondence continued with NMFS-Southeast Regional Office and NCDMF's interim plan to address sea turtle interactions in gill net fisheries throughout North Carolina was provided to NMFS in January 2010. This plan proposed a prohibition on the use of unattended gill nets of 3.5 inches stretched mesh and greater throughout the majority of the estuarine waters of North Carolina from May through December 2010 (Figure 10.22).

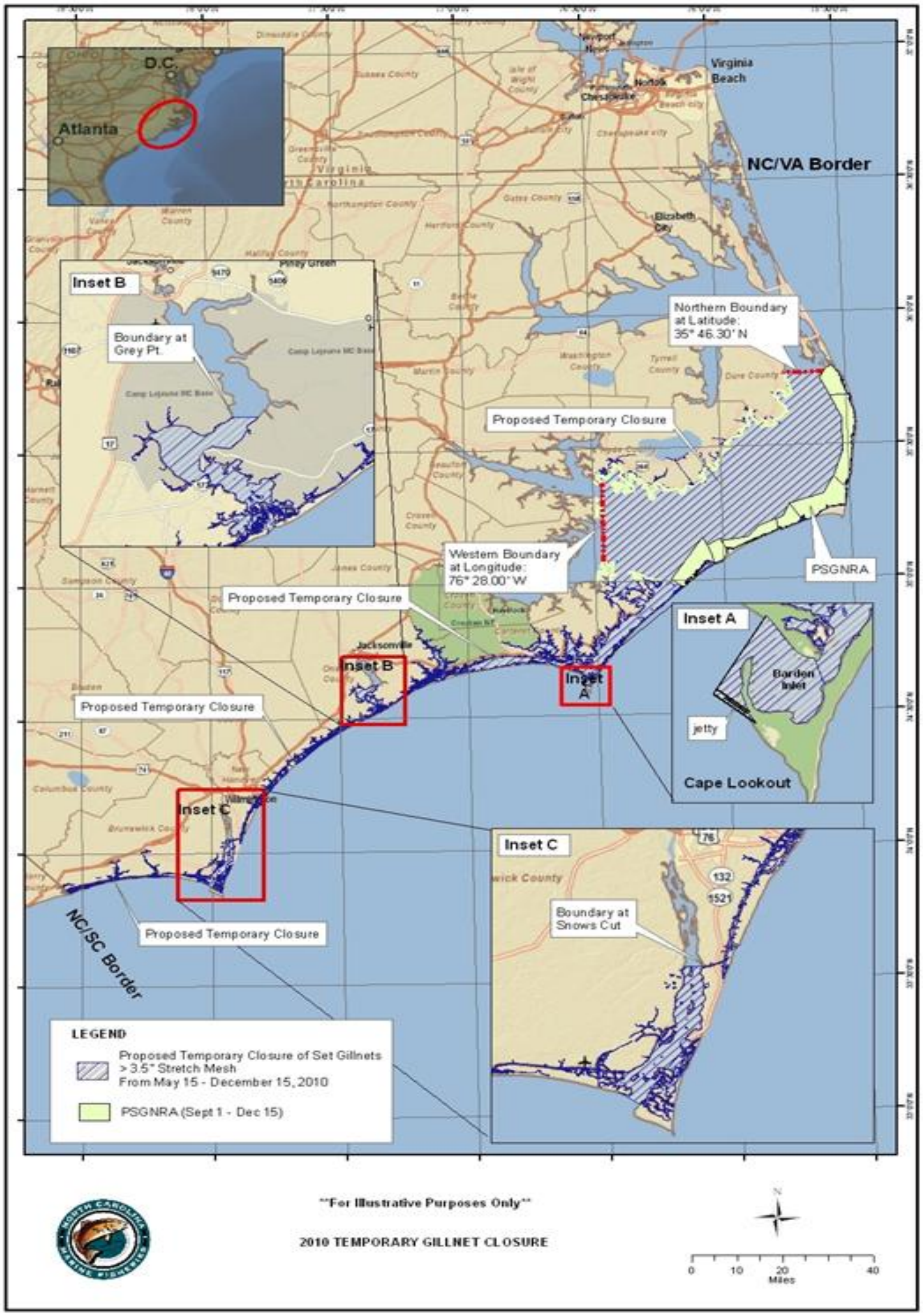


Figure 10.22 Temporary gill net closure proposed to the NCMFC in February 2010 but not approved.

In February 2010, NCDMF presented the interim proposal to the NCMFC and the public in an emergency NCMFC meeting on February 18, 2010. During the meeting, numerous commercial fishery representatives expressed great concerns with the closure indicating primarily the economic devastation that such a closure would create. Simultaneously, representatives from the Coastal Conservation Association (CCA) did not support the interim closure stating the plan was too limited. The NCMFC voted to direct NCDMF to implement other measures instead of the interim measures proposed by the NCDMF. These other measures included reductions in the number of days per week that gill nets would be allowed, reductions in net shot lengths, and reductions in total yardage allowed. On February 23, 2010, the Duke Environmental Law Clinic filed suit.

During the NCMFC meeting on March 23, NCDMF was directed by the NCMFC to implement a gill net proclamation to be effective May 15, 2010. This proclamation will restrict the number of days during the week that fishermen could operate (Monday – Friday), limit soak times to night time from 7:00 pm to 7:00 am, and establish a maximum yardage limit of 2,000 yards. These nets must be deployed as low profile with a net height of no more than 15 meshes, all cork and other buoys removed except as required for identification, and set in individual 100-yard shots with at least a 25-yard break between individual shots. These measures will be in effect coast wide throughout the estuarine waters of North Carolina and continue throughout the year. These recent events have affected the development of the Southern Flounder FMP Amendment and will result in impacts to fishing effort in the southern flounder large mesh gill net fishery. These most recent management measures as proposed by the NCMFC provide some direction for development of recommendations addressing the issue of overfished/overfishing status of southern flounder. However, until the legal issue of interactions of sea turtles with large mesh gill nets is resolved and a proclamation is issued, the future management of the large mesh flounder gill net fishery and its impacts to the southern flounder stock will remain uncertain.

Since the 1970s, the NCDMF has been proactive in developing ways to minimize impacts to threatened and endangered marine species. The NCDMF works closely with NMFS and other state and federal agencies to develop regulations that minimize impacts to protected species while trying to allow the prosecution of many economically important fisheries throughout the Atlantic as well as in North Carolina. In addition to the ITPs issued for the PSGNRA, the NCDMF has been issued ITPs for the shrimp trawl fishery off the North Carolina coast between Browns Inlet to Rich’s Inlet allowing limited tow times in lieu of the use of Turtle Excluder Devices (TEDs) because of high concentrations of algae which clog both shrimp trawl nets and TEDs. Since 2005, in response to high abundance of sea turtles in the lower Cape Fear River and interactions of these sea turtles with gill nets the NCDMF has required attendance of large mesh gill nets when sea turtles are documented. This has proven to be effective in reducing interactions with sea turtles and managing the fishery in the lower portions of the Cape Fear River. The NCDMF has been proactive at the state level by closely monitoring the PSGNRA through the establishment of an observer program and has laid the framework for other states to establish observer programs. The formation of the STAC with its representation of stakeholders has provided recommendations and guidance to the NCDMF in addressing protection of sea turtles in North Carolina.

The NCDMF has tested modified gill net designs for the purpose of reducing sea turtle interactions and still maintain acceptable levels of target species (Gearhart and Price 2003; Brown and Price 2005; Price and Van Salisbury 2007). These studies have identified low-profile gill net gear that can be used in the deep water portion of Pamlico Sound to mitigate the bycatch of sea turtles. In addition, the 2007 study indicated the potential transference of this technology in other gill net fisheries where similar conditions and sea turtle bycatch issues exist (Price and

Van Salisbury 2007; Gilman et al. 2010). Starting in July 2010, the NCDMF will begin research on the effectiveness of various designs of hard and soft fish pots in targeting flounder. Basic testing of pot characteristics (i.e. entrance size, shape, orientation, and color) will be conducted. The development of a fish pot fishery for flounder in the inshore waters of North Carolina could potentially have numerous advantages over other gears used to target flounder.

Pound nets and large mesh gill nets account for over 90% of the annual commercial southern flounder harvest in North Carolina with gill nets the dominant gear since 1995 (see Section 7.1 – Status of the Commercial Fisheries for more information). Any new restrictions on these fisheries to minimize sea turtle interactions can have a substantial impact on commercial southern flounder landings.

Management Options and Impacts

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

1) Status quo

    + Continued operation of fisheries for the short term
    - Continued litigation against NCDMF and NCMFC
    - Potential for fisheries to close due to protected species interactions
    - Loss of ability to manage state fisheries

2) Request funding for state observer program

    + Provides data on interactions, fisheries characterizations, and discard information
    + Allows for continued proactive management
    - Expensive
    - Could be difficult to achieve adequate observer coverage coast wide

3) Apply for ITP for large mesh gill net fisheries

    + Provides a legal means of having interactions
    + Provides data on protected species and fisheries characterization
    + Allows for continued proactive management
    - Expensive
    - Could be difficult to achieve adequate observer coverage coast wide

4) Continue gear development research to minimize species interactions

    + Allows fisheries to continue
    + Increased survival of protected species
    + Reduces interactions
    - Potential for fisheries to close due to protected species interactions while gear is being developed

Management Recommendations

NCMFC Preferred Management Strategy

- Request funding for state observer program.

- Apply for ITP for large mesh gill net fisheries.
- Continue gear development research to minimize species interactions.

AC

- Request funding for state observer program.
- Apply for ITP for large mesh gill net fisheries.
- Continue gear development research to minimize species interactions.
- Explore other funding mechanisms for the state observer program.

NCDMF

- Request funding for state observer program.
- Apply for ITP for large mesh gill net fisheries.
- Continue gear development research to minimize species interactions.

Research Recommendations

- Population dynamics research for all Atlantic protected species.
- Continued gear research in the design of gill nets and pound nets to minimize protected species interactions
- Development of alternative gears to catch southern flounder

10.9 GEAR REQUIREMENTS IN THE FLOUNDER POUND NET FISHERY[13]

Issue

Evaluation of the 5.5-inch stretched mesh escape panel under a 14-inch minimum size limit, and the increased amount of undersized southern flounder caught in the flounder pound net fishery.

Background

Escape panels in flounder pound nets are constructed of mesh that is larger than the pound net mesh and are designed to allow the majority of undersized flounder to escape the net. Escape panels are located on the back corners of the pounds (Figure 10.23). Research on escape panels by the NCDMF and fishermen began in October 1988 after the minimum size limit for flounder increased from 11 inches to 13 inches (NCDMF 2005; NCDMF 2007). The initial research showed that a pound net with 5.5-inch stretched mesh escape panels substantially reduced the number of undersized flounder (less than 13 inches). This initially resulted in the requirement of escape panels in flounder pound nets in Core Sound and southeastern Pamlico Sound (NCDMF 2005; NCDMF 2007). Further research in Pamlico Sound behind Hatteras and the Manns Harbor area (Croatan and eastern Albemarle sounds) showed similar results; this led to the requirement of 5.5-inch stretched mesh escape panels in flounder pound nets coast wide,

[13] Emailed to the PDT on 4/19/10
Presented to the AC on 5/20/10
NCDMF recommendations 10/19/10

except for Albemarle Sound west of Alligator River. Pound netters in Albemarle Sound west of Alligator River persuaded the North Carolina Marine Fisheries Commission (NCMFC) to exempt them from the rule as they insisted that these flounder were morphometrically different from flounder caught in other areas of the state (NCDMF 2005). The 2005 Southern Flounder FMP ended this exemption by implementing a coast wide use of 5.5-inch escape panels in flounder pound nets (NCDMF 2005).

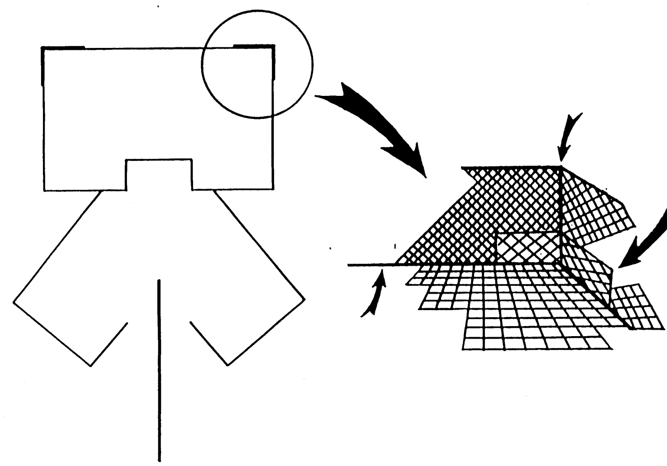


Figure 10.23 Location of escape panels in flounder pound nets.

Pound net escape panel research occurred sporadically from 1988 to 2001 and ranged from western Albemarle Sound to upper Core Sound. The majority of the samples collected and southern flounder measured were from the control nets, which were constructed of either 4-inch or 5-inch stretched mesh with no escape panels (Table 10.26). The 5.25-inch stretched mesh escape panel samples resulted from 5.5-inch escape panels shrinking after they were treated with anti-fouling solution (NCDMF 2005). Sampling with 5.75-inch and 6-inch escape panels was discontinued because of the considerable reduction of legal sized flounder at that time. The 5.5-inch escape panel nets allowed a substantial proportion of undersized southern flounder to escape compared to the control nets (Table 10.26). Approximately 23% of the southern flounder retained in the 5.5-inch escape panel nets were between 13 and 14 inches. Although samples from the 5.75-inch escape panels were limited, the proportion of undersized fish in the catch was considerably less than the 5.5-inch escape panels.

Table 10.26 Coast wide escape panel study (1988, 1994, 1995, 1998 and 2001) (NCDMF Biological Database).

Mesh size	Pound nets sampled	Number of southern flounder sampled	Percent retained less than 13"	Percent retained less than 14"
4" Control	27	2,897	39%	69%
5" Control	13	1,218	20%	55%
5.25 " Escape panel	8	710	32%	61%
5.50" Escape panel	7	414	9%	32%
5.75" Escape panel	4	288	3%	7%
6" Escape panel	3	94	15%	18%

The selectivity curves for southern flounder caught in the control nets and the nets with escape panels varied (Figure 10.24). The size at which 50% of the fish are retained by the pound net and 50% escape is called the L_{50}. The L_{50} generally increased as the mesh size of the pound net or the escape panel increased. The L_{50} for the 4-inch and 5-inch control nets were 13.2 inches and 13.5 inches, respectively while the L_{50} for the 5.5-inch escape panel nets was 14.8 inches. The L_{50} was highest for the 5.75-inch escape panel nets (16.1 inches). However, only 4 samples and 288 southern flounder lengths were collected with the 5.75-inch escape panel nets.

The percent length frequencies of southern flounder 14 inches and greater from the selectivity curves were compared for the 5.5-inch and 5.75-inch escape panels to examine whether any legal sized fish were lost when using the larger escape panels (Figure 10.25). By comparison, the 5.75-inch escape panels lost 11.2% more legal sized southern flounder less than 15.5 inches than did the 5.5-inch escape panels.

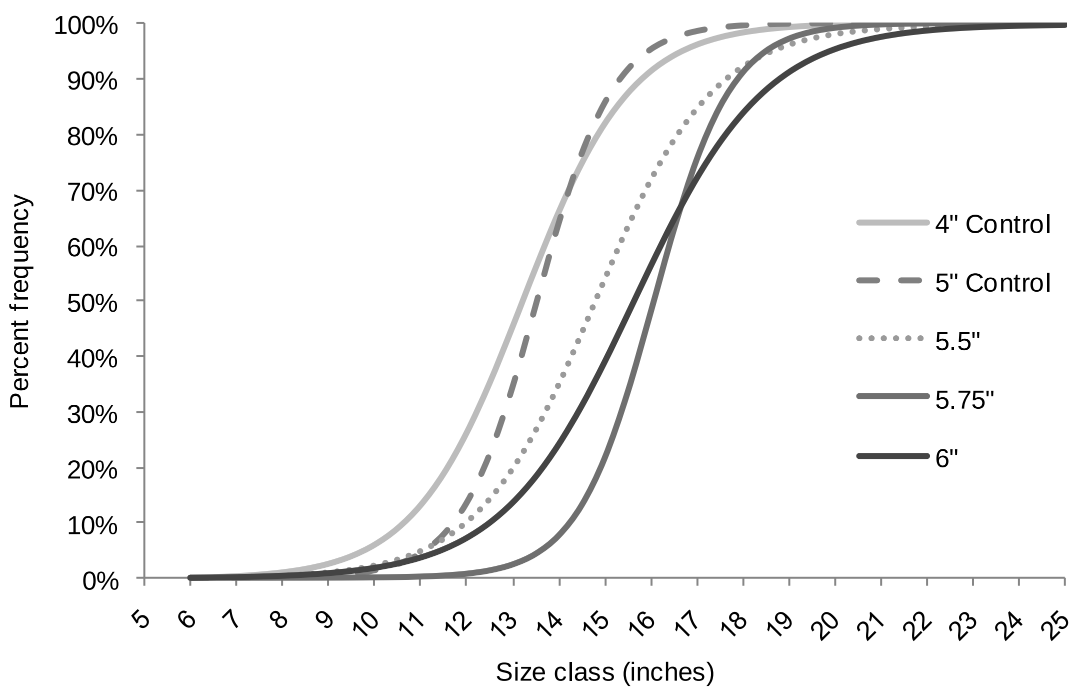


Figure 10.24 Selectivity curves of southern flounder retained in pound nets without escape panels and pound nets with different sized escape panels (NCDMF Biological Database).

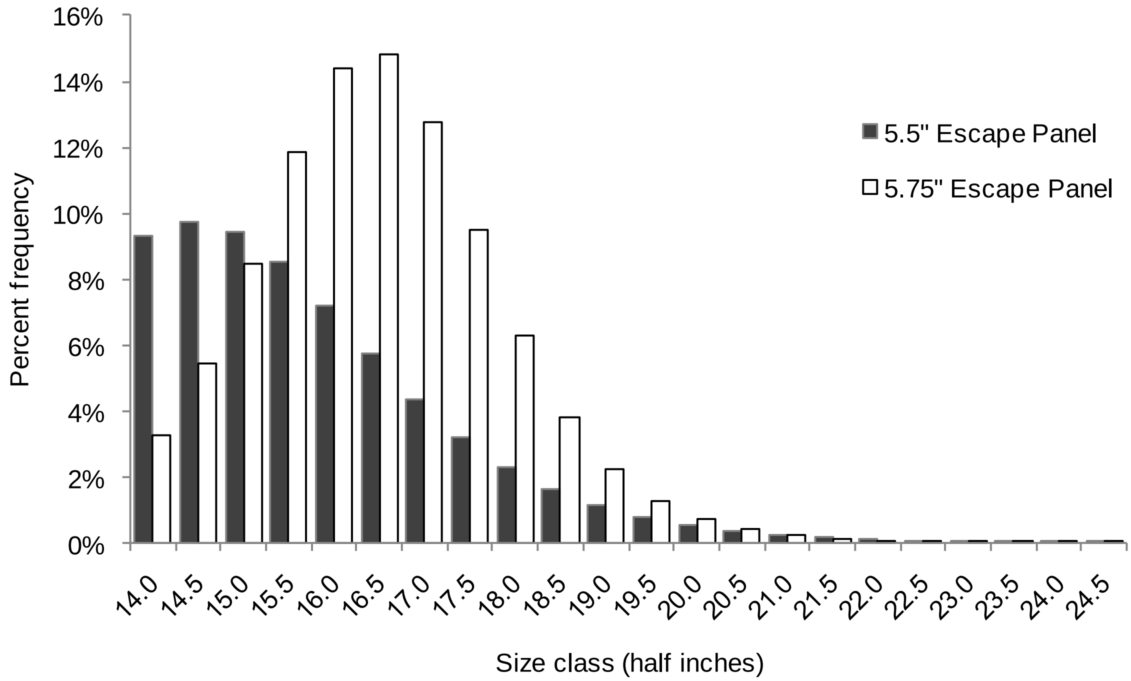


Figure 10.25 Percent frequencies of southern flounder 14 inches and greater retained from pound nets with 5.5-inch and 5.75-inch escape panels (NCDMF Database).

Despite the use of 5.5-inch escape panels coast wide since 2005, pound netters have noticed an increase in southern flounder less than 14 inches in their catches in the last few years. Pound nets in Croatan and eastern Albemarle sounds have captured a particularly large amount of undersized southern flounder. Fishermen in this part of the state have reported releasing over 10,000 undersized southern flounder from their pound nets in a single day with as many as 2,000 or more undersized southern flounder in a single pound net (NCDMF, unpublished data). NCDMF staff accompanied the pound netters on three trips in this region in October 2009 to sample the undersized flounder before they were released by the fishermen. A total of 1,049 undersized southern flounder was measured from the pound nets. Approximately 74% of the undersized southern flounder were between 13 inches and 14 inches and fish shorter than 13 inches accounted for less than 24% of the undersized fish measured (Figure 10.26). The small percentage of legal sized southern flounder in the samples was for fish at or very near the 14-inch minimum size limit. Staff also sampled the landed portion of one of these trips at the fish house. On this trip, undersized southern flounder accounted for 46.8% of the total number of southern flounder retained by the pound nets and 28.7% of the total weight (NCDMF, unpublished data).

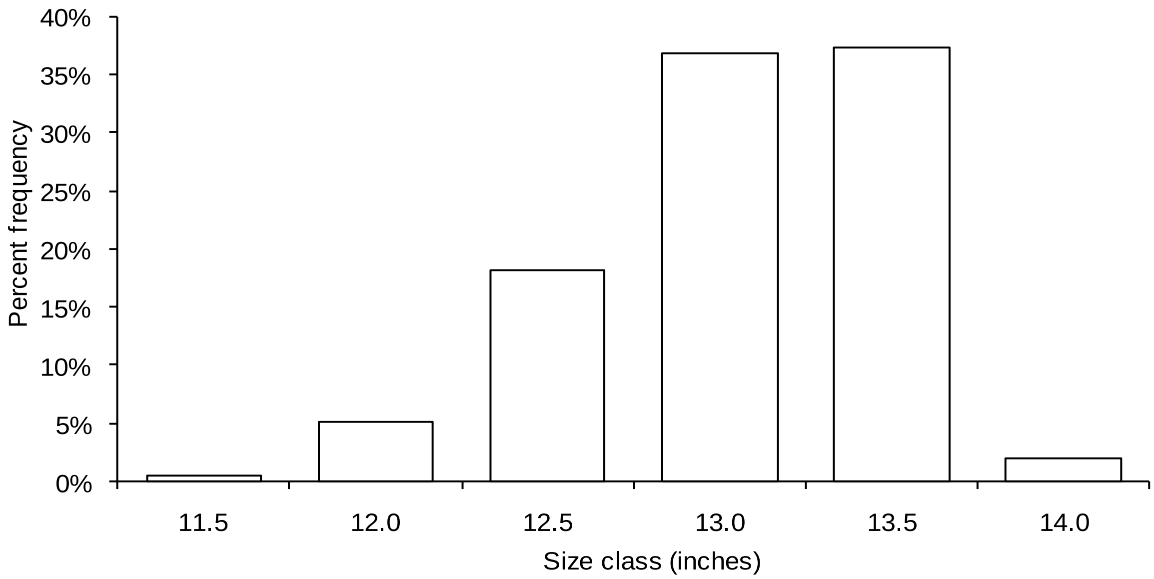


Figure 10.26 Length frequency distribution of undersized southern flounder sampled from flounder pound nets before being released by the fishermen in Croatan and eastern Albemarle sounds, October 2009 (NCDMF, unpublished data).

Current Authority

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

NC Fisheries Rules for Coastal Waters 2009 (15A NCAC)

03J .0107	POUND NET SETS
03J .0501	DEFINITIONS AND STANDARDS FOR POUND NETS AND POUND NET SETS

Discussion

The 5.5-inch escape panels were designed to reduce the number of southern flounder less than 13 inches that are retained by pound nets without losing too many legal sized southern flounder. However, with the current 14-inch minimum size, NCDMF studies indicate that 32% of the southern flounder retained in these nets are below the legal minimum size limit. The selectivity data for the 5.75-inch escape panel nets suggest that undersized flounder retained would be substantially reduced, but 11.2% of legal sized southern flounder (in numbers) would also be lost compared to the 5.5-inch escape panel. The legal southern flounder expected to be lost using a 5.75-inch escape panel are between 14 inches and less than 15.5 inches; the harvest reduction in weight is less than 11.2% because these fish are less than the average weight of southern flounder harvested in the pound net fishery. The escape panel research conducted by the NCDMF did not examine the retention of other marketable species, so it is unknown how a larger escape panel will affect these catches. Other marketable species typically comprise only 10-20% of the total weight of landings from flounder pound nets (NCDMF 2005; NCDMF 2007) and less than 6% of the total value of flounder pound net landings (NCDMF 2007). However, some pound netters have expressed concern over the potential loss of marketable species such as harvestfish ("star butters", *Peprilus alepidotus*), butterfish (*Peprilus triacanthus*), Florida pompano (*Trachinotus carolinus*), and blue crabs.

Recent observations by NCDMF staff and pound netters indicate that the retention of undersized southern flounder in flounder pound nets with a 5.5-inch escape panel can be quite high in some parts of the state, and the data collected from these trips show that many of the undersized flounder are between 13 inches and 14 inches. Different factors could be contributing to the recent occurrence of large numbers of undersized southern flounder observed in the pound nets including strong year class(es) entering the fishery or more southern flounder between 13 and 14 inches available to be caught in the pound nets now compared to when the escape panel research was conducted. When the minimum size limit was 13 inches, many of these fish could have been harvested before entering the pound nets.

The data collected on undersized southern flounder in pound nets in 2009 was very limited in sample size, time period, and area. Therefore, the size distribution of southern flounder caught in pound nets in Croatan and eastern Albemarle sounds may not be representative to the size distribution for those caught in other parts of the estuaries. Flounder pound netters in other parts of the coast have also reported releasing large numbers of flounder less than 13 inches. Most of the flounder pound nets are constructed of either 4-inch or 5-inch stretched mesh, but most of the pound nets sampled by NCDMF staff were constructed from 5-inch stretched mesh, which may have contributed to the small proportion of flounder less than 13 inches that were observed (NCDMF, unpublished data). In addition, the percentage of undersized southern flounder caught in pound nets may change throughout the season. At-sea observer coverage of the flounder pound net fishery coast wide and throughout the season could provide some insight on the seasonal and regional differences in the size distribution of southern flounder.

There was insufficient data to determine a dead discard mortality estimate for southern flounder from pound nets in the 2009 Southern Flounder Stock Assessment (Takade-Heumacher and Batsavage 2009). Anecdotal evidence suggests that the discard mortality is very low, but it is likely that some discard mortality exists. Many of the pound netters in the eastern portions of the estuaries have a market for live and bled flounder that are sold to the sushi and sashimi markets (NCDMF 2005; NCDMF 2007). If the pound netters process the live and bled flounder before culling the undersized flounder from their catches, it is possible that some of the undersized flounder are returned to the water dead. If 5.75-inch escape panels were implemented, less undersized flounder would be retained in the pound nets, which would reduce the time it takes to cull these fish from the catches. This could result in fewer undersized flounder being returned to the water dead, and it could allow the pound netters to process the live and bled flounder in a timelier manner.

The percentage of undersized southern flounder landed in the pound net fishery increased after the minimum size limit increased to 14 inches. In the two years prior to the size limit increase (2003 and 2004), undersized southern flounder comprised only 2.02% of the pound net catch of southern flounder. In the two full years after the size limit increase (2006 and 2007), undersized southern flounder comprised 5.82% of the catch. This increase in non-compliance by the fishermen could be the result of an inadequate escape panel size for a 14-inch minimum size limit, strong year class(es) entering the fishery in 2006 and 2007, insufficient enforcement of the 14-inch minimum size limit or a combination of these factors. Implementing 5.75-inch escape panels could help in reducing the percentage of undersized southern flounder landed in the pound net fishery.

Based on the escape panel research, southern flounder harvest from pound nets would decrease by 11.2% if 5.75-inch escape panels were implemented coast wide. Any harvest reduction from increasing the escape panel mesh size would go toward the overall harvest reduction of 20.5% from 2007 landings and harvest that is required to achieve sustainable harvest in the southern flounder fishery. However, the actual harvest reduction could be different than what was predicted by the escape panel research if, for example, the percentage of undersized southern flounder in the landings increases.

Pound nets are fished on a daily to weekly basis, depending on the weather, size of the catches, and market conditions (DeVries 1981, unpublished data NCDMF). Requiring pound netters to fish their nets after a certain number of days could reduce the number of undersized southern flounder retained by the pound nets and the amount of time the fish spend in the pound nets. However, pound netters rely on wind shifts to a northerly direction in the fall to trigger the migration of southern flounder from the estuaries to the offshore spawning grounds because the flounder are caught in the pound nets as they migrate to the ocean. Commercial fish house sampling as well as discussions with pound netters indicates that catches are lower when these northerly wind shifts do not occur. Requiring pound netters to fish their nets after a certain number of days could result in them fishing while conditions are not conducive to large catches or fishing when weather conditions are not safe. This requirement would also be difficult to enforce.

Management Options and Impacts

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

1) Status quo (5.5-inch escape panels coast wide)

   + No gear changes required
   + No new regulations
   + No increase in lost legal catch
   - Continued retention of a large number of undersized southern flounder
   - No reduction in landings to meet management goal
   - No reduction in the time it takes to cull undersized flounder from the catch
   - Trend of increased undersized southern flounder in the landings could continue

2) Implement 5.75-inch escape panels in flounder pound nets coast wide

   + Reduces the retention of undersized southern flounder
   + Reduces the time it takes to cull undersized flounder from the catch
   + Could reverse the trend of increased undersized southern flounder in the landings
   +/- Estimated 11.2% harvest reduction (in numbers) of southern flounder
   - Requires pound netters to replace the escape panels in their pound nets
   - Potential harvest reductions of other species landed in flounder pound nets

3) Require pound netters to fish their nets after a certain number of days

   + No gear changes required
   + Potential to reduce the number of undersized southern flounder retained by the pound nets and the amount of time they spend in the pound nets

+ Could reduce the time it takes to cull undersized flounder from the catch
- Increased expense to pound netters from having to fish their nets more often
- Potential for having to fish during unsafe conditions
- Trend of increased undersized southern flounder in the landings could continue
- Difficult to enforce

Management Recommendations

NCMFC Preferred Management Strategy

- Status quo (5.5-inch escape panels coast wide) and recommend further research on 5.75-inch escape panels.

AC

- Status quo (5.5-inch escape panels coast wide) and recommend further research on 5.75-inch escape panels.

NCDMF

- Status quo until further research is conducted to determine if rule changes are necessary.

Research Recommendations

- Further research on the size distribution of southern flounder retained in pound nets with 5.75-inch and 6-inch escape panels
- Research on the species composition and size distribution of fish and crustaceans that escape pound nets through 5.75-inch and 6-inch escape panels
- Coast wide at-sea observations of the flounder pound net fishery
- Discard mortality estimates of southern flounder from pound nets

10.10 GEAR REQUIREMENTS IN THE FLOUNDER GILL NET FISHERY[14]

Issue

Evaluation of the 5.5-inch stretched mesh minimum mesh size for large mesh flounder gill nets under a 14-inch minimum size limit, and the effort in the large mesh gill net fishery.

Background

The large mesh gill net fishery is the major commercial fishery targeting southern flounder with annual landings surpassing the flounder pound net fishery since 1995 (see Section 7.1, Status of the Commercial Fishery for more information). This issue was addressed in the 2005 Southern Flounder FMP to investigate gear requirements that minimize the undersized bycatch

[14] Emailed to the PDT on 6/2/2010
Presented to the AC on 7/1/2010
NCDMF recommendation 10/19/10
Revised by the PDT on 7/27/12
Presented to NCMFC on 8/23/12
Presented to the AC on 10/17/12

of southern flounder and to prevent further increases in gill net fishing effort (NCDMF 2005). The management measures implemented by the FMP for this issue were a minimum mesh size of 5.5 inches stretched mesh for large mesh gill nets from April 15 to December 15, a maximum yardage limit of 3,000 yards per operation for gill nets 5 inches stretched mesh and larger in estuarine waters, and the requirement that Recreational Commercial Gear License (RCGL) holders attend their large mesh gill nets at all times from the NC Highway 58 Bridge at Emerald Isle to the South Carolina state line (NCDMF 2005). The minimum mesh size of 5.5 inches stretched mesh for large mesh gill nets was implemented to minimize undersized bycatch of southern flounder resulting from the increase in the minimum size limit from 13 inches to 14 inches. Amendment 1 to the Red Drum FMP implemented full time attendance of gill nets 5 inches stretched mesh and greater that are set less than 10 feet from any point of the shoreline from June through October as a means of reducing red drum bycatch (NCDMF 2008b). Large mesh gill nets from 5 inches to less than 5.5 inches stretched mesh are prohibited in estuarine waters from April 15 to December 15 (15A NCAC 03J .0103 (b)) but are permitted at other times of the year for gill net fisheries targeting American shad, hickory shad, and spotted sea trout.

This issue paper will evaluate the effectiveness of the minimum mesh size under the current southern flounder minimum size limit of 14 inches for the commercial fishery and management measures that limit effort in the commercial gill net fishery. In addition, this issue paper will evaluate the potential impacts on effort and harvest in the southern flounder gill net fishery from Proclamation M-8-2010, which was implemented on May 15, 2010 to minimize interactions with sea turtles in the large mesh gill net fisheries while the NCDMF applies for a coast wide incidental take permit from the National Marine Fisheries Service (NMFS) under Section 10 of the Endangered Species Act. However, these management measures will still be in effect if an incidental take permit is granted. The specific management measures from Proclamation M-8-2010 that will be evaluated are the maximum yardage limit reductions, the maximum gill net length, the minimum distance between gill net sets, and the removal of large mesh gill nets from the water during the day. The impact of prohibiting large mesh gill nets from being set from Friday morning until Monday evening are evaluated in the issue paper “Achieving Sustainable Harvest”.

Current Authority

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

NC Fisheries Rules for Coastal Waters 2009 (15A NCAC)

03J .0103	GILL NETS, SEINES, IDENTIFICATION, RESTRICTIONS
03M .0503	FLOUNDER

Discussion

Data Sources

The data analysis for this issue paper relied on three different data sources: the NCDMF gill net observer program data, NCDMF fishery dependent fish house sampling of the estuarine gill net fishery, and the NCDMF trip ticket data. The gill net observer program data provided length frequency distributions of southern flounder caught in large mesh gill nets. The length frequencies from the different mesh sizes were compared to determine the differences in the proportion of undersized southern flounder caught and the potential harvest reductions from increasing the minimum mesh size of large mesh gill nets. The fishery dependent fish house sampling of the estuarine gill net fishery was analyzed to determine the proportion of large mesh gill net trips fishing 5.5-inch stretched mesh gill net by area and season, the average large mesh gill net yardage fished per operation by area and year, the proportion of large mesh gill net trips per operation in 500-yard increments by area and year, effort reduction from maximum yardage limit decreases, and the catch per unit effort (CPUE) of southern flounder in the large mesh gill net fishery by area and year. The trip ticket data provided the proportion of large mesh gill net trips landing southern flounder by season and area. This information was used for weighting the harvest reduction estimates from a minimum mesh size increase to 5.75-inch stretched mesh and from maximum yardage decreases by fishing effort.

Minimum Mesh Size

This issue in the 2005 FMP examined fishery independent (Albemarle Sound and Pamlico Sound Independent Gill Net surveys), fishery dependent (NCDMF gill net observer data), and a Fishery Resource Grant (FRG) gill net study conducted in Brunswick County (Beresoff et al. 2001) to determine the size distribution of southern flounder caught in different mesh sizes (NCDMF 2005). At that time, the NCDMF gill net observer program data was limited to the Pamlico Sound Gill Net Restricted Area (PSGNRA), which necessitated the use of fishery independent data and the FRG to cover other times and areas where large mesh gill nets were fished. However, the independent surveys do not use 5.75-inch stretched mesh gill nets, which is a commonly used mesh size by the commercial southern flounder gill net fishery. The NCDMF gill net observer program was expanded spatially and temporally in 2004, which provided observations outside of the location and time period for the PSGNRA. Therefore, the minimum mesh size analysis in this issue paper used length frequency data of southern flounder by mesh size from the NCDMF gill net observer program from 2001 to 2008 to determine the size distribution of southern flounder caught in 5.5-inch, 5.75-inch, and 6-inch stretched mesh gill nets. This data was examined coast wide and by area for the estuaries. The area designations are found in Table 10.27. Samples from Newport River and Bogue Sound were included in the Southern area for this analysis due to the relatively small number of samples collected from this region. The results of this analysis were also compared to two FRGs that examined gill net selectivity of southern flounder (Kimel et al. 2008; Hassell 2009b).

Table 10.27 Estuarine area designations and their associated water bodies.

Area	Water bodies
Albemarle	Albemarle Sound and its tributaries, including Currituck Sound
Croatan-Roanoke	Croatan and Roanoke sounds
Pamlico	Pamlico Sound and its bays
Rivers	Pamlico, Pungo, Neuse, and Bay rivers
Core-Back	Core and Back sounds, including North River
Southern	Beaufort Inlet to the South Carolina state line

A total of 18,227 southern flounder lengths was available for 5.5-inch stretched mesh gill nets, 8,444 lengths for 5.75-inch stretched mesh gill nets, and 31,941 lengths for 6-inch stretched mesh gill nets coast wide (Table 10.28). The Pamlico area had the most southern flounder length frequencies for all three mesh sizes. Length frequency data from 5.5-inch gill nets were greatest for the other areas. Although the program was expanded spatially and temporally in

2004, most of the sampling effort still came from the PSGNRA. Consequently, the length frequency data is quite limited for some area and mesh size combinations.

Table 10.28 Number of large mesh estuarine gill net trips observed that caught southern flounder and the number of southern flounder lengths by mesh size by area from the NCDMF gill net observer program, 2001-2008 (NCDMF Observer Program).

		Lengths by Mesh size		
Area	Observed trips	5.5-inch	5.75-inch	6-inch
Coast wide	1,867	18,227	8,444	31,941
Albemarle	97	2,200	334	131
Croatan-Roanoke	39	138	53	69
Pamlico	1,315	7,303	6,624	31,047
Rivers	281	5,640	254	133
Core-Back	77	1,447	1,179	560
Southern	58	1,499		

The size distribution of southern flounder from the different mesh sizes showed much overlap, but the 5.5-inch stretched mesh gill nets tended to catch smaller fish (Figure 10.27). Coast wide, the modal length of southern flounder by mesh size was 14 inches for 5.5-inch, 15.5 inches for 5.75-inch, and 15.5 inches for 6-inch stretched mesh. By area, the modal size of southern flounder ranged from 14 to 14.5 inches for 5.5-inch mesh, 14 to 15.5 inches for 5.75-inch mesh, and 15 to 16.5 inches for 6-inch stretched mesh. The disparity of modal fish sizes for the different areas is likely a result of sample size, differences in fish availability for these areas, and possibly a result of different twine sizes of gill nets used in different parts of the estuaries. Southern flounder 18 inches and greater were observed less frequently in the upper estuaries than in the lower estuaries (Figure 10.27). In general, smaller twine size gill nets are used in the upper portions of the estuaries such as Albemarle Sound and the Rivers (NCDMF, unpublished data). Smaller twine sizes tend to entangle fish rather than gill them (NCDMF 2005). Unfortunately, there were insufficient data available to analyze mesh size selectivity by twine size and by area fished.

Kimel et al. (2008) investigated mesh selectivity of southern flounder for 5.5-inch, 5.75-inch, 6-inch, and 6.25-inch stretched mesh gill nets in the southeastern part of the state between Mason and Topsail inlets. The modal size of southern flounder by mesh size was 14.2-14.6 inches for 5.5-inch, 15 inches for 5.75-inch, 15.4 inches in 6-inch, and 16.9 inches for 6.25-inch stretched mesh. Hassell (2009b) investigated gill net mesh selectivity of southern flounder for 5.5-inch, 5.75-inch, and 6-inch stretched mesh in the upper Pamlico River between Washington and Ragged Point. The modal size of southern flounder by mesh size was 15 inches for 5.5-inch, 15.4 inches for 5.75-inch, and 15.4 inches in 6-inch stretched mesh.

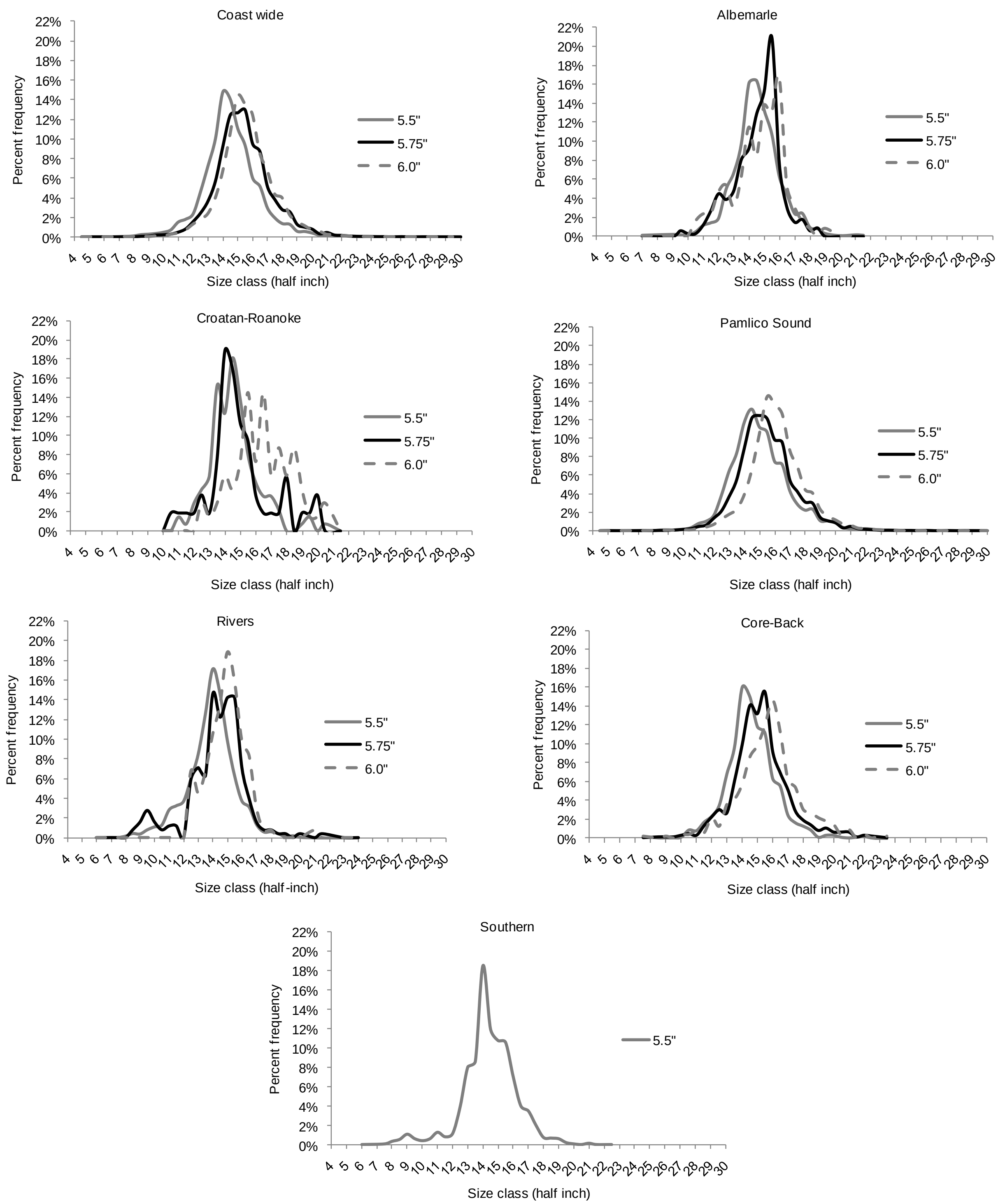


Figure 10.27 Length frequency distributions of southern flounder by mesh size and by area, 2001-2008 (NCDMF Observer Program).

The proportion of southern flounder less than 14 inches decreased as mesh size increased for most areas (Table 10.29). Coast wide, southern flounder less than 14 inches comprised 30% of the fish caught in 5.5-inch stretched mesh gill nets, 16% of the fish caught in 5.75-inch stretched mesh and 7% of the fish caught in 6-inch stretched mesh. By area, the proportion of southern flounder less than 14 inches in 5.5-inch stretched mesh ranged from 23% in Pamlico Sound to 42% in the Rivers. For 5.75-inch and 6-inch stretched mesh sizes, the Albemarle area and the Rivers had the highest proportion of southern flounder less than 14 inches. As was the case with the modal sizes by mesh size, the disparity in the proportion of undersized fish at the different areas is likely a result of differences in the size of the southern flounder available for capture in different areas, a reflection of low sample sizes, and possibly a result of different twine sizes of gill nets used in different parts of the estuaries.

In the southeastern part of the state between Mason and Topsail inlets, undersized southern flounder comprised 23% of the fish caught in 5.5-inch and 5.75-inch stretched mesh gill nets, 21% of the fish caught in the 6-inch stretched mesh, and 7% of the fish caught in 6.25-inch stretched mesh (Kimel et al. 2008). In the upper Pamlico River, undersized southern flounder comprised 17% of the fish caught in 5.5-inch stretched mesh, 6% of the fish caught in 5.75-inch stretched mesh and 1% of the fish caught in 6-inch stretched mesh (Hassell 2009b). The observer data and the FRGs show that the proportion of undersized southern flounder in gill nets can differ for different parts of the estuaries, but the proportion of southern flounder less than 14 inches generally decreases as the mesh size increases.

Table 10.29 Proportion of southern flounder less than 14 inches by mesh size and area, 2001-2008 (NCDMF Observer Program).

	Mesh size		
Area	5.5-inch	5.75-inch	6-inch
Coast wide	29.85%	15.53%	7.34%
Albemarle	26.32%	26.35%	19.08%
Croatan-Roanoke	30.43%	20.37%	7.25%
Pamlico	22.85%	14.28%	7.13%
Rivers	41.56%	29.13%	18.05%
Core-Back	26.40%	16.28%	13.39%
Southern	28.29%		

The proportion of southern flounder 14 inches and greater in the 5.5-inch stretched mesh was compared to the 5.75-inch and 6-inch stretched mesh sizes to examine whether any legal sized fish were lost using the larger gill nets (Figure 10.27). Potential harvest reductions were calculated by summing the differences in size class percent frequencies where a greater proportion of fish were caught in the 5.5-inch stretched mesh gill nets than in the 5.75-inch and 6-inch stretched mesh gill nets. This analysis showed that legal sized southern flounder less than 15 inches were lost from 5.75-inch stretched mesh gill nets and legal size southern flounder less than 15.5 inches were lost from 6-inch stretched mesh gill nets compared to what was retained in the 5.5-inch stretched mesh gill nets. The overall estimated reduction in number of fish between 5.5-inch and 5.75-inch gill nets was 7.1%. The overall estimated reduction in number of fish between 5.5-inch and 6-inch gill nets was 18.9%. The area specific estimated reductions in number of fish between 5.5-inch and 5.75-inch stretched mesh gill nets ranged from 3.7% in the Pamlico area to 10.4% in the Albemarle area (Table 10.30). The overall harvest reduction estimate of 7.1% was used for areas where the data was too limited to calculate an area specific reduction.

To determine the potential harvest reduction from increasing the minimum mesh size for large mesh gill nets to 5.75-inch stretched mesh, the proportion of large mesh gill net effort for mesh sizes less than 5.75-inch stretched mesh was examined for different areas and seasons using the fishery dependent fish house sampling of the estuarine gill net fishery. The season designations were winter (January-March), spring (April-May), summer (June-August), and fall (September-December). The proportion of large mesh gill net trips landing southern flounder by area from 2004 to 2007 from the trip ticket program was used to weight the harvest reduction estimates. Gear codes for large mesh (5-inch stretched mesh and greater) and small mesh (less than 5-inch stretched mesh) gill nets were added to the trip ticket program in 2004; examining these trips removed small mesh gill net trips that incidentally landed southern flounder. These reference years for landings were chosen to coincide with the most recent landings (2000-2007) in Section 7.1 - Status of the Commercial Fisheries.

The proportion of large mesh gill net effort for gill nets less than 5.75-inch stretched mesh was highest in the spring and decreased through the fall (Table 10.30). Fishermen tended to increase the mesh size used as larger fish became available in the late summer and fall. Large mesh gill net trips increased through the year with peak landings in the fall for most areas. When the area specific reductions (percentage of legal size southern flounder not retained by shifting from a 5.5-inch to a 5.75 inch gill net) are multiplied by the percentage of effort using gill nets less than 5.75-inch stretched mesh by area and season, the total weighted harvest reduction is 3.1% (Table 10.30). The Albemarle area would experience the largest proportion of this reduction because total large mesh gill net trips and large mesh gill net effort for gill nets less than 5.75-inch stretched mesh are highest in this area. The total weighted harvest reduction is relatively low because large mesh gill net effort from nets less than 5.75-inch mesh is lowest when overall large mesh gill net effort is the highest.

Table 10.30 Harvest reduction estimate in numbers of fish from increasing the minimum mesh size for large mesh gill nets to 5.75-inch stretched mesh from April 15 to December 15 (NCDMF Estuarine Gill Net Fish House Sampling Program)

Area	Season	Percent of total trips	Percent effort using < 5.75-Inch mesh	Mesh size reduction	Season and area reduction
Albemarle	Winter	2.72%	-	-	-
	Spring	2.92%	100.00%	10.39%	0.30%
	Summer	4.89%	16.85%	10.39%	0.09%
	Fall	12.97%	45.13%	10.39%	0.61%
Croatan-Roanoke	Winter	1.05%	-	-	-
	Spring	0.37%	57.06%	7.14%	0.01%
	Summer	1.62%	9.84%	7.14%	0.01%
	Fall	4.91%	15.49%	7.14%	0.05%
Pamlico	Winter	0.45%	-	-	-
	Spring	1.65%	94.52%	3.73%	0.06%
	Summer	8.62%	30.93%	3.73%	0.10%
	Fall	12.57%	10.20%	3.73%	0.05%
Rivers	Winter	2.11%	-	-	-
	Spring	4.89%	93.82%	4.98%	0.23%
	Summer	6.68%	90.06%	4.98%	0.30%
	Fall	7.39%	85.18%	4.98%	0.31%
Core-Back	Winter	0.02%	-	-	-
	Spring	2.06%	90.05%	7.13%	0.13%
	Summer	5.75%	86.84%	7.13%	0.36%
	Fall	4.65%	48.36%	7.13%	0.16%
Newport-Bogue	Winter	0.00%	-	-	-
	Spring	0.16%	60.00%	7.14%	0.01%
	Summer	0.76%	12.96%	7.14%	0.01%
	Fall	1.27%	69.11%	7.14%	0.06%
Southern	Winter	0.25%	-	-	-
	Spring	1.45%	26.13%	7.14%	0.03%
	Summer	3.96%	34.30%	7.14%	0.10%
	Fall	3.89%	57.09%	7.14%	0.16%
				Total harvest reduction	3.13%

This analysis assumes that the season and area specific effort estimates by mesh size from the estuarine gill net fish house sampling is reflective of the fishery in that season and area. The potential harvest reduction would be higher than estimated if the actual large mesh gill net effort for nets less than 5.75-inch mesh is higher than estimated. Conversely, the potential harvest reduction would be lower than estimated if the actual large mesh gill net effort for nets less than 5.75-inch mesh is lower than estimated.

Although increasing the minimum mesh size of large mesh gill nets to 5.75-inch stretched mesh shows a reduction in the number of legal sized southern flounder less than 15 inches, it is possible that this loss could be recouped by larger fish caught in 5.75-inch mesh and larger gill nets. There was no significant difference in the catch per unit effort in numbers of legal southern flounder caught in the three sampled mesh sizes in the upper Pamlico River (Hassell 2009b). Kimel et al. (2008) also found no significant difference in the catch per unit effort (CPUE) in pounds of flounder for the 5.5-inch, 5.75-inch, and 6-inch stretched mesh sizes. Gill net selectivity studies assume that the nets with different mesh sizes have similar fishing power (ASMFC 2000). If southern flounder of a certain size are not as available in a particular season or area, then one mesh size could have lower catch rates than the other mesh size. In the southern flounder fishery, fewer large fish are available in the spring than in the fall, so it is likely that the fishing power of the different mesh sizes is not equal throughout the year. Therefore, the estimated harvest reduction from increasing the minimum mesh size to 5.75-inch stretched mesh assumes appreciable recoupment of larger fish will not occur. If recoupment does occur, then the actual harvest reduction would be less.

Increasing the minimum mesh size of large mesh gill nets to 5.75-inch stretched mesh would reduce the proportion of undersized southern flounder that are caught, which could reduce the number of dead discards from the large mesh gill net fishery. The 2009 Southern Flounder Stock Assessment assumed an annual discard mortality rate of 17.3% from gill nets based on NCDMF gill net observer program data (Takade-Heumacher and Batsavage 2009). Seasonal discard mortality rates were unavailable for this fishery because the number of gill net observer samples by season and area was too variable. Smith and Scharf (2009) investigated post-release survival of undersized southern flounder from the large mesh gill net fishery in New River. The overall survival rate of undersized southern flounder retrieved from the net was 70% (30% mortality). At-net survival was lowest in the summer and highest in the spring and fall. Low dissolved oxygen events occurred regularly throughout the New River during the study, which may have contributed to a higher mortality estimate than what was observed in the NCDMF gill net observer data (Smith and Scharf 2009). However, the seasonal trends in mortality were similar to what was observed in the large mesh gill net samples from the Pamlico Sound Independent Gill Net Survey (spring/fall: 1%; summer: 14%) (Paramore 2009).

The impact of implementing a minimum mesh size increase for large mesh gill nets would be greatest in the spring when gill net effort from nets less than 5.75-inch stretched mesh is greatest and the availability of larger southern flounder is low. This is also during a time when southern flounder gill net mortality is relatively low (Paramore 2009; Smith and Scharf 2009). Instead of implementing the minimum mesh size increase from April 15 to December 15, it could be implemented from June 1 to December 15 to minimize the impact of this management measure on the spring fishery. Removing the spring months from this minimum mesh size increase would result in a total weighted harvest reduction of 2.4% (Table 10.30).

The percentage of undersized southern flounder landed in the gill net fishery increased after the minimum size limit increased to 14 inches. In the two years prior to the size limit increase (2003 and 2004), undersized southern flounder comprised less than 3% of the gill net catch of southern flounder. In the two full years after the size limit increase (2006 and 2007), undersized southern flounder comprised nearly 7% of the catch. This increase in non-compliance by the fishermen could be the result of an inadequate minimum large mesh gill net mesh size for a 14-

inch minimum size limit, strong year class(es) entering the fishery in 2006 and 2007, insufficient enforcement of the 14-inch minimum size limit, or a combination of these factors. Implementing a minimum mesh size of 5.75-inch for large mesh gill nets could help in reducing the percentage of undersized southern flounder landed in the gill net fishery.

Increasing the minimum mesh size for large mesh gill nets could also impact the landings of other marketable species by the southern flounder gill net fishery. Southern flounder account for over 80% of the landings from the southern flounder gill net fishery (NCDMF 2005). However, other species such as black drum, red drum, sheepshead, bluefish and white catfish are also commonly landed. An increased minimum mesh size could reduce the harvest of some species that are not caught as often in large mesh gill nets, but harvest could increase for species that are commonly caught in large mesh gill nets by selecting for larger fish. Gill net selectivity analyses for these species are needed to determine the actual impact on landings.

Maximum Yardage Limit

The intent of the maximum yardage limit of 3,000 yards per operation was to reduce the effort of fishing operations setting more than 3,000 yards and to avoid further expansion of effort in the southern flounder gill net fishery. However, fishery dependent sampling of the estuarine gill net fishery from 2000 to 2009 indicated that the average length of large mesh gill net fished has increased in some parts of the state, and these increases occurred after the FMP was implemented in 2005 (Figure 10.28). The most notable increase in effort was in Core and Back sounds where the average amount of large mesh gill net fished per operation increased from approximately 1,600 yards in 2000 to almost 2,500 yards in 2008. Proclamation M-15-2009, issued on August 6, 2009, decreased the maximum yardage limit for large mesh gill nets to 1,000 yards per operation in Core Sound, Back Sound, Newport River, and the estuarine waters behind Hammocks Beach State Park to minimize sea turtle interactions. This management measure decreased the average amount of large mesh gill net fished per operation to 2,100 yards in Core and Back sounds in 2009. It also contributed to the increased average amount of large mesh gill net fished in Pamlico Sound because this proclamation resulted in fishermen in Core Sound shifting their effort to Pamlico Sound. The average amount of large mesh gill net fished in the Rivers also increased by over 300 yards per trip in 2009. Very low sample sizes in the Albemarle area in 2002 and 2003 precluded investigating the trend in average yards of large mesh gill net fished for the entire time series for this area (Table 10.31). The average yardage fished for this area ranged between 1,650 and 2,150 yards per year. The Southern area of the coast (Bogue Inlet to the South Carolina state line) could not be examined due to small numbers of samples collected prior to 2008; the small number of samples from the Newport River and Bogue sounds for the entire time series also prevented analyzing the mean yardage fished for this area.

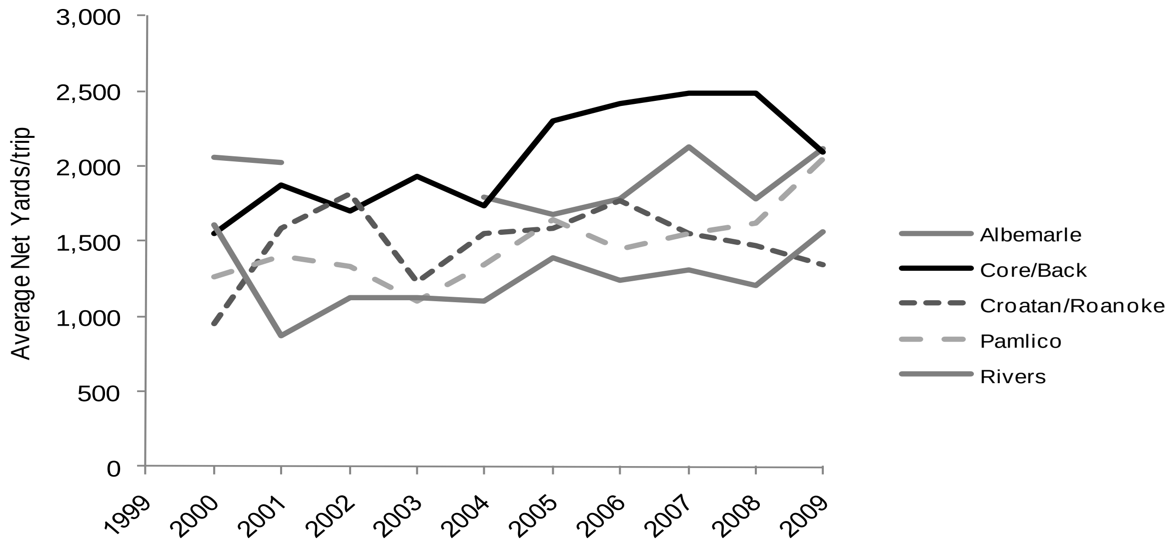


Figure 10.28 Average yardage of large mesh gill net fished per operation by water body, 2000-2009. Note: Insufficient data available for the Albemarle area in 2002 and 2003 due to very low sample sizes (NCDMF Estuarine Gill Net Fish House Sampling Program).

Table 10.31 Number of large mesh gill net samples by area available for maximum gill net yardage limit analysis, 2000-2009 (NCDMF Estuarine Gill Net Fish House Sampling Program).

	Area						
Year	Albemarle	Croatan-Roanoke	Pamlico	Rivers	Core-Back	Newport-Bogue	Southern
2000	35	18	78	70	49	3	2
2001	27	14	51	48	45	0	1
2002	3	15	60	100	55	0	8
2003	9	15	64	69	47	0	7
2004	23	48	72	47	52	3	3
2005	14	38	107	61	71	5	7
2006	18	56	174	70	79	8	2
2007	11	36	162	68	119	15	16
2008	16	41	178	49	168	7	51
2009	19	37	175	57	109	6	46

To further analyze the trends in the amount of large mesh gill net fished per operation, the proportion of large mesh gill net trips (in 500-yard increments) was examined. The majority of large mesh gill net trips in Core and Back sounds before 2005 fished between 1,501 and 2,000 yards per operation (Figure 10.29). The proportion of trips fishing greater than 2,500 yards in Core and Back sounds increased to 71% of the trips sampled in 2008 before decreasing to 54% in 2009. The proportion of trips fishing greater than 2,500 yards of large mesh gill net in Pamlico Sound has increased since 2005 with a substantial increase in 2009. The proportion of trips fishing between 1,501 and 2,000 yards in the Rivers increased in 2009, which likely contributed to the increase in average large mesh net fished here in 2009. Very few trips in Croatan and Roanoke sounds fished greater than 2,000 yards per trip; most trips fished less than 1,500 yards. The trend in the proportion of large mesh gill nets in Albemarle Sound was not as definitive.

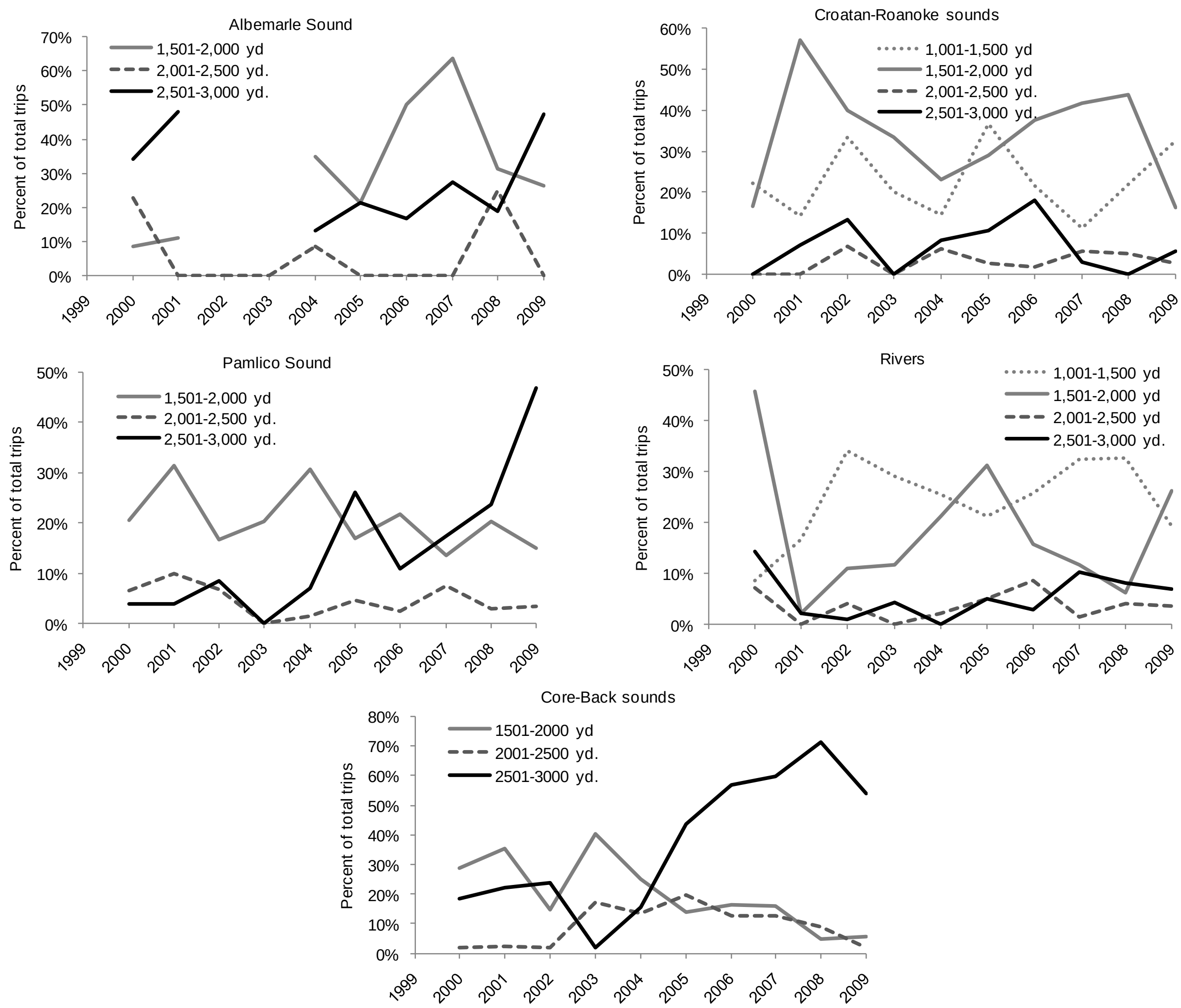
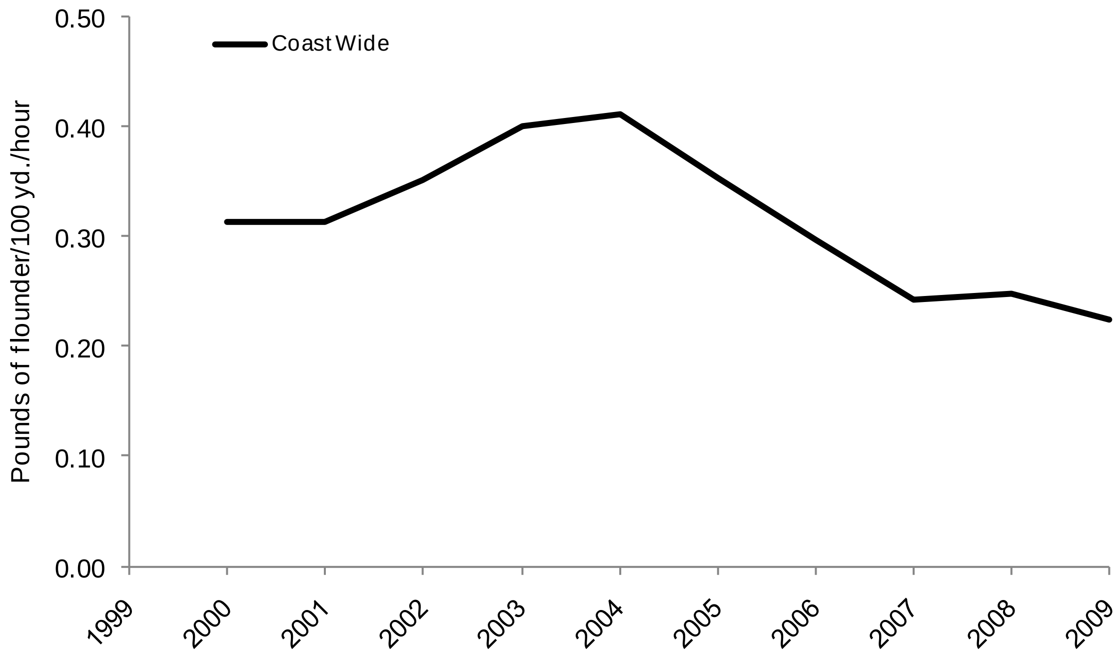


Figure 10.29 Proportion of large mesh gill net trips in 500 yard increments by water body, 2000-2009. Note: Insufficient data available for the Albemarle area in 2002 and 2003 due to very low sample sizes (NCDMF Estuarine Gill Net Fish House Sampling Program).

As the amount of large mesh gill net fished has increased, the CPUE (pounds per trip) of flounder landed has decreased overall and in many parts of the state (Figure 10.30). The minimum size limit increase from 13 inches to 14 inches in 2005 is responsible for some of this decrease, but the CPUE increased in 2007 for Albemarle Sound and in 2009 for Croatan and Roanoke sounds and has steadily decreased for several years after the size limit increase in places like Pamlico Sound and the Rivers. The CPUE tended to decrease in areas where the average yards of large mesh gill net fished per operation increased, which could be an indication that there is more fishing effort in these areas than the southern flounder population can sustain.



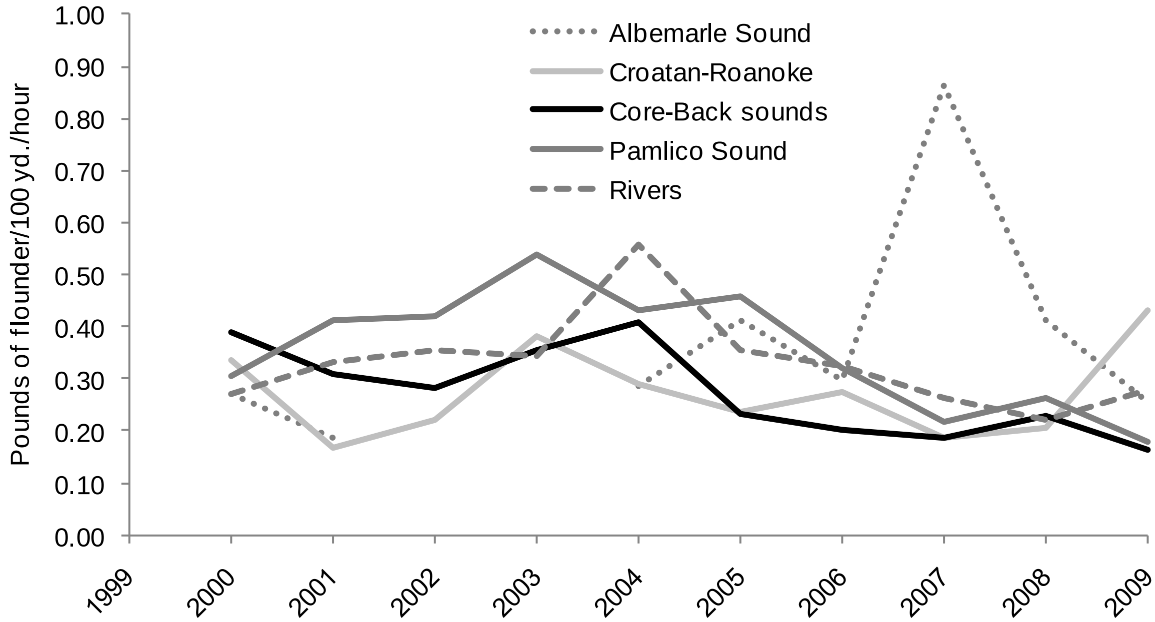


Figure 10.30 CPUE of flounder in large mesh gill nets coast wide and by water body, 2000-2009. Note: Insufficient data available for the Albemarle area in 2002 and 2003 due to very low sample sizes (NCDMF Estuarine Gill Net Fish House Sampling Program).

A yardage limit reduction could reduce the harvest of southern flounder, which would help end overfishing and rebuild the spawning stock. Management options for three different sets of yardage limits for different areas in the estuarine waters are given. To determine the potential harvest reduction estimate for each option, the reduction in effort was calculated based on the proportion of trips in 500-yard increments by area in 2009; this year was chosen because it represents the most current distribution of gill net fishing effort for southern flounder in the state.

The reduction in effort for trips in 500-yard increments was based on three different sets of yardage limits and the proportion of effort for trips in 500-yard increments by area. These effort reductions were then weighted by the proportion of large mesh gill net trips landing southern flounder by area from 2004 to 2007 from the trip ticket program.

Proclamation M-8-2010 reduced the maximum yardage limit for large mesh gill nets to 2,000 yards from Albemarle Sound east of Alligator River and Currituck Sound south of the US Highway 158 Bridge to western Bogue Sound at the NC Highway 58 Bridge at Emerald Isle; the yardage limit was reduced to 1,000 yards from south of the NC Highway 58 Bridge at Emerald Isle to the South Carolina state line (Figure 10.31). The large mesh gill net yardage limit for flounder gill nets remains at 3,000 yards in Albemarle Sound west of Alligator River and Currituck Sound north of the US Highway 158 Bridge. Under this management, the greatest effort reduction would occur in the Southern area due to the smaller yardage limit and in Pamlico, Core, and Back sounds since these areas had the highest proportion of large mesh gill net effort from trips fishing greater than 2,000 yards (Table 10.32, Figure 10.29). However, the effort reduction estimate for Core and Back sounds might be high because this data included samples collected before the maximum yardage limit was reduced to 1,000 yards by Proclamation M-15-2009 on August 6, 2009. The area specific harvest reduction is greatest for Pamlico Sound due to the proportion of large mesh gill net trips landing southern flounder from this area. The total weighted harvest reduction in numbers of fish is 9.3% (Table 10.32).

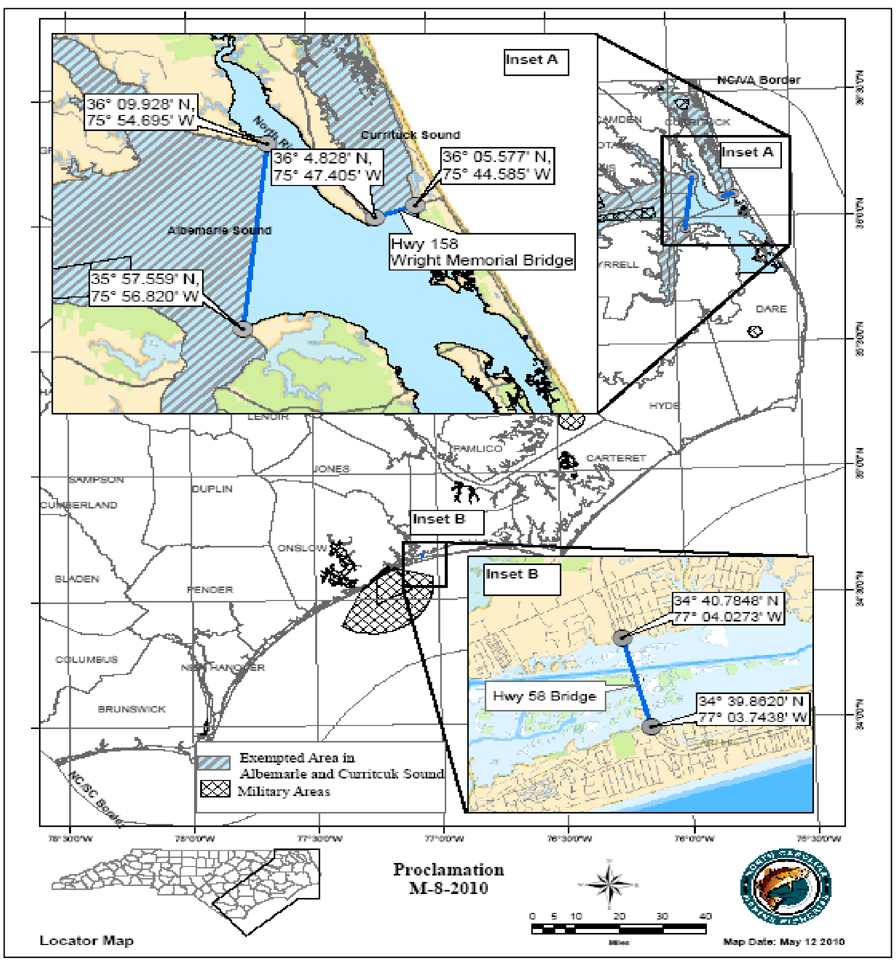


Figure 10.31 Map of the maximum yardage limits for large mesh gill nets implemented by Proclamation M-8-2010.

Table 10.32 Effort reduction and harvest reduction estimates from decreasing the coast wide maximum large mesh gill net yardage limit to 2,000 yards per operation from the Croatan/Roanoke area to Bogue Sound, and 1,000 yards per operation in the Southern area (NCDMF Estuarine Gill Net Fish House Sampling Program and NCDMF Trip Ticket Program).

Area	Effort reduction	Percent of total trips	Area reduction
Albemarle^	0.00%	23.49%	0.00%
Croatan-Roanoke*	2.34%	7.94%	0.19%
Pamlico*	15.59%	23.29%	3.63%
Rivers*	4.87%	21.06%	1.03%
Core-Back*	17.01%	12.48%	2.12%
Newport-Bogue*	0.00%	2.19%	0.00%
Southern#	24.03%	9.55%	2.29%
		Total harvest reduction	9.26%

^ 3,000 yd limit
* 2,000 yd limit
# 1,000 yd limit

Under Proclamation M-8-2010, no reduction in effort would occur in the Albemarle area, which accounts for the majority of southern flounder gill net landings in the state. This could result in effort shifting to this area in order to avoid the management measures implemented by this proclamation. Proclamation M-15-2009 decreased the maximum yardage limit for large mesh gill nets to 1,000 yards per operation in Core Sound, Back Sound, Newport River, and the estuarine waters behind Hammocks Beach State Park to minimize sea turtle interactions, so the 2,000-yard limit from Core Sound to Bogue Sound would actually be an increase in the maximum yardage limit in these waters. In addition, much of the large mesh gill net effort in the Rivers is from trips setting less than 1,500 yards. A 2,000-yard maximum yardage limit would result in minimal effort and harvest reductions for these areas, and it could result in increased effort if fishermen increased their fishing effort to 2,000 yards. An alternative option is to reduce the maximum large mesh yardage limit to 2,000 yards for the entire Albemarle area, 2,000 yards in Croatan, Roanoke, and Pamlico sounds, 1,000 yards per operation for the Rivers and the Southern area and maintain the 1,000 yard limit in Core, Back, and Bogue sounds and the Newport River. The greatest effort reductions under this option would occur in Core and Back sounds followed by the Rivers and Southern area (Table 10.33). However, the effort reduction estimate for Core and Back sounds might be high because this data included samples collected before the maximum yardage limit was reduced to 1,000 yards by Proclamation M-15-2009 on August 6, 2009. The area specific harvest reduction are greatest for the Rivers and Core and Back sounds due to the effort reduction and large proportion of large mesh gill net trips landing southern flounder from these areas. The total weighted harvest reduction in numbers of fish is 20.9% (Table 10.33).

Table 10.33 Effort reduction and harvest reduction estimates from decreasing the coast wide maximum large mesh gill net yardage limit to 2,000 yards per operation in the Albemarle, Croatan/Roanoke, and Pamlico areas and 1,000 yards per operation in the Rivers and from Core Sound to the South Carolina state line (NCDMF Estuarine Gill Net Fish House Sampling Program and NCDMF Trip Ticket Program).

Area	Effort reduction	Percent of total trips	Area reduction
Albemarle*	15.79%	23.49%	3.71%
Croatan-Roanoke*	2.34%	7.94%	0.19%
Pamlico*	15.59%	23.29%	3.63%
Rivers#	28.54%	21.06%	6.01%
Core-Back#	39.19%	12.48%	4.89%
Newport-Bogue#	8.33%	2.19%	0.18%
Southern#	24.03%	9.55%	2.29%
		Total harvest reduction	20.90%

* 2,000 yd limit

\# 1,000 yd limit

Another option would be the yardage limits proposed in the previous option (Table 10.26) except for a 2,000 yard maximum yardage limit for Core and Back sounds. It was quite evident that gill netters in Core and Back sounds shifted their fishing effort to Pamlico Sound after Proclamation M-15-2009 reduced the yardage limit to 1,000 yards (Figures 10.28 and 10.29). Fishermen in this portion of the estuaries typically fish in all three sounds, so a consistent yardage limit for this area would spread fishing effort over a wider area instead of concentrating it in just one area. The greatest effort reductions under this option would occur in the Rivers and Southern area (Table 10.34). The area specific harvest reductions are greatest for the Rivers due to the effort reduction and large proportion of large mesh gill net trips landing southern flounder. The total weighted harvest reduction in numbers of fish is 18.1% (Table 10.34).

Table 10.34 Effort reduction and harvest reduction estimates from decreasing the coast wide maximum large mesh gill net yardage limit to 2,000 yards per operation in the Albemarle, Croatan/Roanoke, Pamlico, and Core/Back areas and 1,000 yards per operation in the Rivers and from the Newport River to the South Carolina state line (NCDMF Estuarine Gill Net Fish House Sampling Program and NCDMF Trip Ticket Program).

Area	Effort reduction	Percent of total trips	Area reduction
Albemarle*	15.79%	23.49%	3.71%
Croatan-Roanoke*	2.34%	7.94%	0.19%
Pamlico*	15.59%	23.29%	3.63%
Rivers#	28.54%	21.06%	6.01%
Core-Back*	17.01%	12.48%	2.12%
Newport-Bogue#	8.33%	2.19%	0.18%
Southern#	24.03%	9.55%	2.29%
		Total harvest reduction	18.14%

* 2,000 yd limit
\# 1,000 yd limit

Harvest reduction estimates from reducing the maximum yardage limit assume that fishermen setting less than the new maximum yardage limit will not increase their fishing effort to the new limit, the gill net CPUEs remain constant, and the proportion of trips fishing more than the new yardage limits is reflective of the actual fishing effort in these areas; violations of any of these assumptions will impact the harvest reduction estimates. Large mesh gill net effort increased in some areas after the 3,000 yard maximum yardage limit was implemented in 2005 (Figures 10.28 and 10.29), and the CPUEs generally decreased in areas where large mesh gill net effort increased (Figure 10.30). Other management measures such as limitations on how and when large mesh gill nets can be set could help prevent effort increases. However, the decreasing CPUEs where large mesh gill net effort increased indicate that southern flounder landings could remain the same with less fishing effort. The uncertainty over whether these assumptions would be violated requires these harvest reduction estimates be viewed cautiously.

Limitations on How and When Large Mesh Gill Nets Can be Set

Management measures that limit the length of any individual large mesh gill net, limit the length of large mesh gill nets that can be set without any breaks or spacing, and to establish a minimum distance between large mesh gill net sets could be implemented to prevent increases in large mesh gill net effort. Proclamation M-18-2009 implemented a maximum gill net length of 200 yards and a minimum space of 25 yards between separate lengths of large mesh gill nets in the PSGNRA to minimize sea turtle interactions in the large mesh gill net fishery; Proclamation M-15-2009 implemented the same maximum gill net length of 200 yards and a minimum space of 25 yards between separate lengths of large mesh gill nets for Core Sound, Back Sound, Newport River, and portions of Bogue Sound to also minimize sea turtle interactions.

Proclamation M-8-2010 implemented a maximum large mesh gill net length of 100 yards and a minimum space of 25 yards between separate lengths of large mesh gill nets for all estuarine waters except for Currituck Sound and Albemarle Sound west of the Alligator River. Enforcing these management measures could be easier than a large mesh gill net yardage limit because every gill net set by a given operation does not need to be inspected by the Marine Patrol officer. The current maximum yardage limit of 3,000 yards for large mesh gill nets is difficult to enforce. These management measures could require gill net fishermen to purchase more anchors and buoys for their gill nets, which could also limit the amount of gill net an operation could set.

Removing large mesh gill nets from the water during the day, as required by Proclamation M-8-2010, could also prevent increases in large mesh gill net effort. This would result in less time available to fish gill nets, which would make setting additional gill nets impractical. This measure would also be easier to enforce than a maximum yardage limit because it does not require each net to be inspected by the Marine Patrol officer; any large mesh gill net set during the day would be in violation. This management measure could also have a greater impact on fishing effort in southeastern part of the state. The tidal amplitude is higher in this area, which precludes fishing in certain locations when low tide occurs at dusk and dawn.

Management Options

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

Minimum Mesh Size

1) Status quo (minimum mesh size of 5.5-inch stretched mesh for large mesh gill nets from April 15 to December 15)

   + No gear changes required
   + No new regulations
   + No increase in lost legal catch of southern flounder
   - Continued retention of a large proportion of undersized southern flounder
   - No reduction in landings to meet management goal
   - No reduction in discard mortality
   - Trend of increased undersized southern flounder in the landings could continue

2) Increase the minimum mesh size of large mesh gill nets to 5.75-inch stretched mesh from April 15 to December 15

   + Reduces the retention of undersized southern flounder
   + Could reverse the trend of increased undersized southern flounder in the landings
   + Reduction in discard mortality
   +/- Estimated 3.1% harvest reduction (in numbers) of southern flounder
   - Gear change required
   - Impact on harvest greatest in the spring when the availability of larger southern flounder is low
   - Harvest reduction greater in the Albemarle area and Rivers than in other areas
   - Could impact landings of other marketable species

3) Increase the minimum mesh size of large mesh gill nets to 5.75-inch stretched mesh from June 1 to December 15

   + Reduces the retention of undersized southern flounder, especially in the summer when mortality is highest
   + Could reverse the trend of increased undersized southern flounder in the landings
   + Reduction in discard mortality
   + Minimizes the impact to harvest in the spring with the availability of larger southern flounder is low
   +/- Estimated 2.4% harvest reduction (in numbers) of southern flounder
   - Gear change required
   - Harvest reduction greater in the Albemarle area and Rivers than in other areas
   - Could impact landings of other marketable species

Yardage Limit

1) Status quo (maximum yardage limits implemented by Proclamation M-8-2010)

   + Maximum yardage limit reduced for much of the estuarine waters
   + Reduction in gill net effort could help in achieving sustainable harvest
   - No effort reduction in the Albemarle area, where southern flounder gill net landings are highest
   - Potential for a shift in gill net effort to areas with fewer regulations
   - Maximum yardage limit of 2,000 yards is actually an increase for some areas
   - Potential for gill netters to increase their effort to the new yardage limits
   - Effort reduction higher for some areas more than other areas
   - Difficult to enforce

2) 2,000-yard maximum limit for large mesh gill nets in Albemarle, Croatan, Roanoke, and Pamlico sounds; 1,000-yard maximum limit for large mesh gill nets in the Rivers and from Core Sound to the South Carolina state line.

   + Maximum yardage limit reduced for all of the estuarine waters
   + Effort reduction where southern flounder gill net landings are highest
   + Reduction in gill net effort could help in achieving sustainable harvest
   + Yardage limits better suited to the large mesh gill net fishing effort for the different areas
   - Potential for a shift in gill net effort to areas with higher yardage limits
   - Potential for gill netters to increase their effort to the new yardage limits
   - Effort reduction higher for some areas more than other areas
   - Difficult to enforce

3) 2,000-yard maximum limit for large mesh gill nets in Albemarle, Croatan, Roanoke, Pamlico, Core, and Back sounds; 1,000-yard maximum limit for large mesh gill nets in the Rivers and from the Newport River to the South Carolina state line.

   + Maximum yardage limit reduced for all of the estuarine waters
   + Effort reduction where southern flounder gill net landings are highest
   + Reduction in gill net effort could help in achieving sustainable harvest
   + Yardage limits better suited to the large mesh gill net fishing effort for the different areas

+ Less likely that effort will shift from Core and Back sounds to southeast Pamlico Sound
- Potential for a shift in gill net effort to areas with higher yardage limits
- Potential for gill netters to increase their effort to the new yardage limits
- Effort reduction higher for some areas more than other areas
- Difficult to enforce

Maximum Net Length

1) Status quo (maximum large mesh gill net length of 100 yards, implemented by Proclamation M-8-2010)

   + Helps control large mesh gill net effort
   + Easier to enforce than a maximum yardage limit
   - Not implemented in the Albemarle area, where southern flounder gill net landings are highest
   - Potential for a shift in gill net effort to areas with fewer regulations
   - Could require gill net fishermen to purchase more anchors and buoys for their gill nets
   - Could impact gill netters more in some areas than in others

2) Coast wide maximum large mesh gill net length of 100 yards

   + Helps control large mesh gill net effort
   + Easier to enforce than a maximum yardage limit
   + Implemented where southern flounder gill net landings are highest
   + Less potential a shift in gill net effort to areas with fewer regulations
   - Could require gill net fishermen to purchase more anchors and buoys for their gill nets
   - Could impact gill netters more in some areas than in others

No Daytime Sets of Large Mesh Gill Nets

1) Status quo (restrictions on daytime sets of large mesh gill nets, implemented by Proclamation M-8-2010)

   + Helps control large mesh gill net effort
   + Easier to enforce than a maximum yardage limit
   - Not implemented in the Albemarle area, where southern flounder gill net landings are highest
   - Potential for a shift in gill net effort to areas with fewer regulations
   - Could impact gill netters more in some areas than in others

2) Coast wide restriction on daytime sets of large mesh gill nets

   + Helps control large mesh gill net effort
   + Easier to enforce than a maximum yardage limit
   + Implemented in the Albemarle area, where southern flounder gill net landings are highest
   + Less potential for a shift in gill net effort to areas with fewer regulations
   - Could impact gill netters more in some areas than in others

Management Recommendations

NCMFC Preferred Management Strategy
- Status quo (maintain minimum mesh size of 5.5-inch stretched mesh for large mesh gill nets from April 15 to December 15 and large mesh gill net management measures implemented by Proclamation M-8-2010). *(Proclamation M-8-2010 no longer valid)

AC - Status quo (maintain minimum mesh size of 5.5-inch stretched mesh for large mesh gill nets from April 15 to December 15 and large mesh gill net management measures implemented by Proclamation M-8-2010). *(Proclamation M-8-2010 no longer valid)

NCDMF*(revised) - Maintain the minimum mesh size of 5.5-inch stretched mesh for large mesh gill nets from April 15 to December 15.

*NOTE: After further analysis of the impact of restrictions enacted due to protected species on southern flounder commercial effort and to set specific gill net measures that are minimum requirements for this Amendment, the NCDMF endorsed the recommendation in Issue paper 10.1.1. Please see that document for further information on the history and recommendations that evolved from the sea turtle settlement agreement.

Research Recommendations

- Continue at-sea observations of the large mesh gill net fishery, especially outside of the PSGNRA, including acquiring biological data on harvest and discards
- Increase the number of large mesh gill catches sampled in areas such as Albemarle sound and the Newport River

11.0 RECOMMENDED MANAGEMENT STRATEGIES AND RESEARCH

11.1 MANAGEMENT STRATEGIES

The management strategies and research needs listed below are organized according to the General Problem Statement (Section 5.5) as recommended by the NCMFC. Each strategy is followed by a reference to the Principal Issue(s) and Management Options from Section 10.0 and indicated in parentheses that supports it, followed by which Objectives it addresses in Section 5.2. An overall discussion of the environmental factors is in Section 9.0 with recommended management strategies for habitat and water quality is found in Section 9.6.

11.1.1 ACHIEVING SUSTAINABLE HARVEST

The 2009 North Carolina Southern Flounder Stock Assessment indicated the stock remains overfished and overfishing is still occurring (Takade-Heumacher and Batsavage 2009). In the terminal year (2007) of the stock assessment, the fishing mortality (F) was 0.7534, the female spawning stock biomass (SSB) was estimated at 4,358,990 pounds, and the spawning potential ratio (SPR) was 19% of a population in which no fishing occurs. The NCDMF position on Amendment 1 of the Southern Flounder FMP sets the threshold at 25% SPR and target at 35% SPR. The associated F rates with these SPRs are 0.59 (25% SPR) and 0.41 (35% SPR), and the associated SSBs with these SPRs are 5,903,817 pounds (25% SPR) and 8,265,162 pounds

(35% SPR). Reductions in the overall harvest of southern flounder based on 2007 landings are necessary in order to achieve sustainable harvest.

[(Issues 10.1, 10.1.1 and 10.2), (Objectives 1, 2, 4, and 7)]

11.1.1.1 ACHIEVING SUSTAINABLE HARVEST

NCMFC Preferred Management Strategy*

- Commercial: Status quo (large mesh gill net management measures implemented by Proclamation M-8-2010), which results in an overall commercial harvest reduction of 22.2%.
- Recreational: Increase the minimum size limit to 15 inches and decrease the creel limit to 6 fish, which results in an overall recreational harvest reduction of 20.2%.

AC and NCDMF*

- Commercial: Status quo (large mesh gill net management measures implemented by Proclamation M-8-2010), which results in an overall commercial harvest reduction of 22.2%.
- Recreational: Increase the minimum size limit to 15 inches and decrease the creel limit to 6 fish, which results in an overall recreational harvest reduction of 20.2%.

*See 11.1.1.2 for most recent preferred commercial management strategies

11.1.1.2 ADDITIONAL MANAGEMENT OPTIONS FOR ACHIEVING SUSTAINABLE HARVEST OF SOUTHERN FLOUNDER

NCMFC Preferred Management Strategy – Same as NCDMF recommendation

AC - Same as NCDMF recommendation

NCDMF - Accept management measures to reduce protected species interactions as the management strategy for achieving sustainable harvest in the commercial southern flounder fishery. Specifically these minimum measures for the flounder gill net fishery are:

1. Maintain the following gill net restrictions (excluding run-around, strike or drop net that is used to surround a school of fish and then is immediately retrieved):

A. For all internal coastal waters year round other than waters of Albemarle, Currituck, Croatan and Roanoke sounds north and west of Highway 64/264 bridges, Pamlico, Pungo, Bay and Neuse rivers, and only during shad season (Jan-Apr) for the upper New River and upper Cape Fear River, limit the use of large mesh gill nets (4-6½-inch stretched mesh) to four nights per week, Monday through Thursday, except allow an extra day (Sunday/Monday) for setting large mesh gill nets south of Beaufort Inlet.

B. For all internal coastal waters other than waters of Albemarle, Currituck, Croatan and Roanoke sounds north and west of Highway 64/264 bridges as well as Pamlico, Pungo, Bay and Neuse rivers limit the use of large mesh gill nets (4-6½-inch stretched mesh):

- to use or possess no more than 2,000 yards of large mesh gill net per fishing operation regardless of the number of vessels involved in coastal fishing waters north and east of a line at longitude 76° 36.9972’ W, which runs northerly from a point on Shackleford Banks to Lennoxville Point, then to the head of Turner Creek, and northerly up the western side of North River.

- to use or possess no more than 1,000 yards of large mesh gill net per fishing operation regardless of the number of vessels involved in coastal fishing waters north and west of a line at longitude 76° 36.9972’ W, which runs northerly from a point on Shackleford Banks to Lennoxville Point, then to the head of Turner Creek, and northerly up the western side of North River and bound in the south by the North Carolina-South Carolina border.

C. Unless otherwise specified the maximum large mesh gill net yardage allowed is 3,000 yards.

2. Conduct a stock assessment with data through 2013.

11.1.1.3 OCEAN HARVEST OF SOUTHERN FLOUNDER

NCMFC Preferred Management Strategy

- Status quo and address the research recommendations.

AC and NCDMF

- Status quo and address the research recommendations.

11.1.2 CONFLICT BETWEEN FISHERIES

Conflicts between gear types and user groups have occurred in the southern flounder fishery over the past 20 years. These include conflicts between commercial large mesh gill nets and anglers and/or waterfront property owners, recreational large mesh gill nets and anglers and/or waterfront property owners, and between commercial large mesh gill nets and flounder pound nets.

[(Issues 10.3, 10.4 and 10.5), (Objectives 5 and 8)]

11.1.2.1 LARGE MESH GILL NET RELATED CONFLICTS

NCMFC Preferred Management Strategy

- Status quo—implement mediation and proclamation authority to address user conflicts associated with large mesh gill nets.

AC and NCDMF

- Status quo—implement mediation and proclamation authority to address user conflicts associated with large mesh gill nets.

11.1.2.2 MINIMUM DISTANCE BETWEEN POUND NETS AND GILL NETS IN CURRITUCK SOUND

NCMFC Preferred Management Strategy

- Status quo (200-yard minimum distance between pound nets and gill nets).

AC

- Implement a 500-yard minimum distance between gill nets and pound nets in Currituck Sound north of the Wright Memorial Bridge (US Highway 158) from August 15 through December 31.

NCDMF

- Status quo (200-yard minimum distance between pound nets and gill nets).

11.1.2.3 EXPLORING THE ELIMINATION OF THE RECREATIONAL COMMERCIAL GEAR LICENSE (RCGL)

NCMFC Preferred Management Strategy

- Status quo and address the research recommendations.

AC

- Status quo regarding the RCGL license until there are data indicating a negative influence on southern flounder and support the NCDMF research recommendations (reestablish a RCGL survey to obtain harvest, discard, and effort information, and establish at-sea observer program of the RCGL fishery) as well as a survey of SCFL holders who are inactive to collect data on what SCFL holders are doing with their licenses.

NCDMF

- Status quo and address the research recommendations.

Note: NCDMF later reviewed information on fishermen who replaced their RCGL with a SCFL and found no increasing trend over time. 7/9/10.

11.1.3 BYCATCH OF UNDERSIZED FLOUNDER AND PROTECTED SPECIES

Bycatch of undersized southern flounder occurs in commercial and recreational fisheries targeting southern flounder and in commercial and recreational fisheries targeting other species. The bycatch of southern flounder has increased in some fisheries after the 2005 Southern Flounder FMP implemented a 14-inch minimum size limit, and this bycatch could increase if a more regulatory measures are implemented. Protected species interactions in general, and sea turtle interactions in particular, are an issue with the southern flounder gill net and pound net fisheries. Implementing management measures that either minimize or eliminate these interactions are necessary for these fisheries to operate in compliance with the Endangered Species Act.

[(Issues 10.6, 10.7, 10.8, 10.9, and 10.10), (Objective 3)]

11.1.3.1 UPDATE ON SOUTHERN FLOUNDER BYCATCH IN THE COMMERCIAL CRAB POT FISHERY

NCMFC Preferred Management Strategy

- Status quo and expand research on flatfish escapement devices and degradable panels under commercial conditions to other parts of the state to evaluate existing and alternative designs, degradation rates, and estimate the retention rate of legal sized blue crabs and the cost to crab pot fishermen.

AC and NCDMF

- Status quo and expand research on flatfish escapement devices and degradable panels under commercial conditions to other parts of the state to evaluate existing and alternative designs, degradation rates, and estimate the retention rate of legal sized blue crabs and the cost to crab pot fishermen.

11.1.3.2 SOUTHERN FLOUNDER DISCARDS IN THE RECREATIONAL HOOK AND LINE FISHERY

NCMFC Preferred Management Strategy

- Status quo and expand research on factors impacting the release mortality of southern flounder and on deep hooking events of different hook types and sizes on southern flounder.

AC and NCDMF

- Status quo and expand research on factors impacting the release mortality of southern flounder and on deep hooking events of different hook types and sizes on southern flounder.

11.1.3.3 INCIDENTAL CAPTURE OF PROTECTED SPECIES IN SOUTHERN FLOUNDER LARGE MESH GILL NET AND POUND NET FISHERIES

NCMFC Preferred Management Strategy

- Request funding for state observer program.
- Apply for ITP for large mesh gill net fisheries.
- Continue gear development research to minimize species interactions.

AC

- Request funding for state observer program.
- Apply for ITP for large mesh gill net fisheries.

- Continue gear development research to minimize species interactions.
- Explore other funding mechanisms for the state observer program.

NCDMF

- Request funding for state observer program.
- Apply for ITP for large mesh gill net fisheries.
- Continue gear development research to minimize species interactions.

11.1.3.4 GEAR REQUIREMENTS IN THE FLOUNDER POUND NET FISHERY

NCMFC Preferred Management Strategy

- Status quo (5.5-inch escape panels coast wide) and recommend further research on 5.75-inch escape panels.

AC

- Status quo (5.5-inch escape panels coast wide) and recommend further research on 5.75-inch escape panels.

NCDMF

- Status quo until further research is conducted to determine if rule changes are necessary.

11.1.3.5 GEAR REQUIREMENTS IN THE FLOUNDER GILL NET FISHERY

NCMFC Preferred Management Strategy

- Status quo (maintain minimum mesh size of 5.5-inch stretched mesh for large mesh gill nets from April 15 to December 15 *(Proclamation M-8-2010 no longer valid)

AC and NCDMF

- Status quo (maintain minimum mesh size of 5.5-inch stretched mesh for large mesh gill nets from April 15 to December 15 *(Proclamation M-8-2010 no longer valid)

NCDMF*(revised)

- Maintain the minimum mesh size of 5.5-inch stretched mesh for large mesh gill nets from April 15 to December 15.

11.1.4 ENVIRONMENTAL FACTORS

Suitable and adequate habitat and water quality are critical elements in the ecology and productivity of estuarine systems. Degradation or improvement in one aspect of habitat may have a corresponding impact on water quality. Maintenance and improvement of suitable estuarine habitat and water quality is critical to successfully managing southern flounder stocks. The NCMFC, CRC, and EMC should adopt rules to protect critical habitats as outlined in the CHPP. The North Carolina General Assembly and/or divisions of the DENR should develop a strategy to fully support CHPP implementation with additional staff and funding. The involvement of federal agencies and increased funding (state and federal) may be necessary to accomplish these actions. The NCMFC and NCDMF should continue to comment on activities that may impact aquatic habitats and work with permitting agencies to minimize impacts and promote restoration and research.

A strategy should be developed and adopted by the NCMFC and DENR to accomplish the actions outlined below. These actions address Objectives 4, 6, and 7 of the FMP. Actions 1, 2, 3, 5, 6, 7, 8, 10, 11, 12, 15, 16, 17, 25, and 26 can be implemented by NCDMF/NCMFC. The other actions would need to be implemented through the cooperative efforts of the NC General Assembly and/or several divisions within the DENR. The involvement of federal agencies and increased funding (state and federal) may also be necessary to accomplish these actions. This information is also included in section 9.6.

AC and NCDMF Preferred Management Strategies

Strategic Habitat Areas and Primary Nursery Areas

1. Identify and designate Strategic Habitat Areas (SHAs) and Primary Nursery Areas (PNAs) that will help conserve southern flounder habitat.
2. Coordinate location of Strategic Habitat Areas and Primary Nursery Areas with local watershed planning to facilitate the linkage between watershed improvement efforts and management of sensitive aquatic habitats downstream.

Wetlands

3. Address unmitigated loss of riparian wetlands due to the indirect impacts of permitted structures using the supporting literature, existing permitting review requirements, land acquisition efforts, and land use planning initiatives, and/or additional regulations.
4. Restore altered wetland hydrology on lands managed for conservation (i.e. undeveloped local, state or federally owned lands such as parks, state game lands, wildlife refuges, and national seashores).
5. Employ land use data and sea level rise projections to determine priorities for wetland protection, enhancement, or restoration.

Submerged Aquatic Vegetation

6. Coordinate SAV mapping efforts such that state-wide monitoring and trend analysis can be conducted most efficiently.
7. Expand nursery sampling to include high and low salinity SAV beds to adequately evaluate their use by southern flounder and other species, and trends in those species.
8. Examine the effect of spatial connectivity between SAV, wetlands, and shell bottom on southern flounder use, survival, growth and abundance.
9. Reduce point and non-point nutrient and sediment loading in estuarine waters, to levels that will sustain SAV, using relevant standards and regulatory/non-regulatory actions.

10. Evaluate and adjust as necessary dredging and trawling boundaries to protect existing SAV and allow some recovery where it historically occurred.

11. Seek additional resources to enhance enforcement of, and compliance with bottom disturbing fishing gear restrictions that protect SAV and other fish habitats.

Soft Bottom

12. Acquire updated and coast-wide data on bathymetry, sediment type, and pollutant concentrations.

13. Complete a Beach and Inlet Management Plan that addresses larval passage issues with inlet stabilization.

14. Protect shallow soft bottom habitat through proper siting and construction of docks, marinas, and shoreline stabilization structures.

Shell Bottom

15. Continue mapping and monitoring the extent and quality of shell bottom in coastal North Carolina.

16. Continue development of oyster sanctuaries in Pamlico Sound with guidance from larval transport models, source population locations, overall fishery benefits, and location of suitable bed foundations

17. Encourage restoration of oysters in conjunction with marsh-sill projects in suitable habitat areas, as an alternative to vertical stabilization.

Water Column

18. Increase coverage of waters assessed for aquatic life and increase coverage of continuous monitoring stations.

19. More incentives needed to generate conservation/restoration opportunities in areas with the most ecological benefit of restoration.

20. Reduce sewage spill pollution by upgrading plants and infrastructure and enforcing high fines for violations. Other needs include thorough inspections of sewage treatment facilities, collection infrastructure, land disposal sites, and on site wastewater treatment facilities to identify and prioritize sites needing upgrades.

21. Evaluate and implement alternatives for disposing of marina wastewater.

22. Secure funding for a Clean Marina Coordinator in order to maintain voluntary initiative.

23. Encourage use of Community Conservation Assistance Program (CCAP) to address existing stormwater systems.

24. Conduct post-implementation assessment of new coastal stormwater rules

25. Monitor estuarine salinities for long term trends related to climate change.

26. Adjust habitat restoration goals to reflect the shifting distribution of species with long term climate changes.

27. Restore hydrology on lands used for silvaculture, agriculture, and urban development using Best Management Practices.

11.2 RESEARCH RECOMMENDATIONS

The following research recommendations were compiled from Section 9.0 and issue papers listed in the Principal Issues and Management Options Section 10.0. The list is presented in no particular order. Proper management of the southern flounder resource cannot occur until some of these research needs are met.

- Investigate the feasibility of a quota as a management tool for the commercial southern flounder fishery.
- Annual survey of the recreational gig fishery (underway).
- Further research on southern flounder that remain in the ocean after the spawning season.
- Determine the exact locations of spawning aggregations of southern flounder in the ocean.
- Continued otolith microchemistry research to gain a better understanding of ocean residency of southern flounder.
- Tagging study of southern flounder in the ocean to gain a better understanding of migration patterns into the estuaries.
- Update the southern flounder maturity schedule.
- Fishery dependent sampling of the commercial spear fishery for flounder in the ocean.
- Harvest estimates and fishery dependent sampling of the recreational spear fishery for flounder in the ocean.
- Increased fish house sampling of the Currituck Sound flounder gill net and pound net fisheries.
- Increased at-sea observer trips with gill netters and pound netters in Currituck Sound.
- Reestablish a RCGL survey to obtain harvest, discard, and effort information.
- Establish an at-sea observer program of the RCGL fishery.
- Formulate a bycatch estimate of southern flounder from crab pots.
- Further research on degradable materials to determine which material works best in a given water body and how other parameters, such as microbial activities and the effects of light penetration impact degradation rates and performance of the crab pot.
- Further research on flatfish escapement devices that minimize undersized flounder bycatch and maximize the retention of marketable blue crabs.
- Further research on factors that impact release mortality of southern flounder in the recreational hook and line fishery.
- Research on deep hooking events of different hook types and sizes on southern flounder
- Population dynamics research for all Atlantic protected species.
- Continued gear research in the design of gill nets and pound nets to minimize protected species interactions.
- Development of alternative gears to catch southern flounder.

- Further research on the size distribution of southern flounder retained in pound nets with 5.75-inch and 6-inch escape panels.
- Research on the species composition and size distribution of fish and crustaceans that escape pound nets through 5.75-inch and 6-inch escape panels.
- Coast wide at-sea observations of the flounder pound net fishery.
- Discard mortality estimates of southern flounder from pound nets.
- Continue at-sea observations of the large mesh gill net fishery, especially outside of the PSGNRA, including acquiring biological data on harvest and discards.
- Increase the number of large mesh gill catches sampled in areas such as Albemarle Sound and the Newport River.

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13.0 APPENDICES

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13.1 PUBLIC INFORMATION BROCHURE

Purpose

The Fisheries Reform Act of 1997 requires the division to prepare fishery management plans for adoption by the N.C. Marine Fisheries Commission for all commercially and recreationally significant species or fisheries that comprise state marine or estuarine resources. The goal of these plans is to ensure long-term viability of these fisheries. Each plan shall:

- Contain necessary information pertaining to the fishery or fisheries, including management goals and objectives, status of the relevant fish stocks, stock assessments of multi-year species, fishery habitat and water quality considerations consistent with the Coastal Habitat Protection Plan, social and economic impact of the fishery to the State, and user conflicts.
- Recommend management actions pertaining to the fishery or fisheries.
- Include conservation and management measures that will provide the greatest overall benefit to the State, particularly with respect to commercial and recreational opportunities, protection of marine ecosystems, and sustainable harvest.
- Specify a time period, not to exceed 10 years from the date of the adoption of the plan, for ending overfishing and achieving a sustainable harvest. The subdivision shall only apply to a plan for a fishery that is overfished. This subdivision shall not apply to a plan for a fishery where the biology of the fish or environmental conditions make ending overfishing or achieving a sustainable harvest within 10 years impracticable

North Carolina Southern Flounder Fishery Management Plan Advisory Committee

Commercial

Dennis Altman—Lowland

Glen Montgomery—Straits

Paul Rose—Moyock

Charles Van Salisbury—Engelhard

Recreational

Doug Bolton—Morehead City

George Gilbert—Morehead City

Jerry James—Beulaville

Ira "Duke" Spencer—Manteo

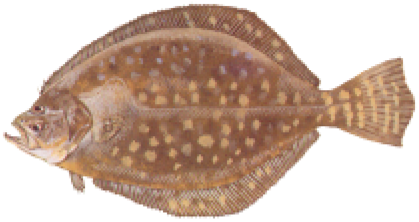
Scientist

Harry Daniels—Raleigh

Chris Taylor—Morehead City

N.C. Division of Marine Fisheries

Southern Flounder Fishery Management Plan Amendment I



The FMP Process

This document provides information concerning an upcoming fishery management plan amendment for southern flounder. The amendment will be developed by the N.C. Division of Marine Fisheries, with the aid of an advisory committee consisting of representatives of the commercial and recreational fishing sectors, as well as the scientific communities.

The initial draft management plan amendment will include a list of issues associated with the fishery and possible solutions to resolve those issues. As this draft progresses, the division will hold advisory committee meetings to obtain public input on the issues. The division and the advisory committee will then review and incorporate comments received, as necessary, and produce a final draft of the management plan. A series of public meetings will be held for the public to comment on the final draft prior to adoption by the N.C. Marine Fisheries Commission. Public hearings will be held prior to adoption of permanent rules to implement the final management plan recommendations.

N.C. Southern Flounder Fishery Management Plan

Goals and Objectives

The goal of Amendment 1 to the N.C. Southern Flounder Fishery Management Plan is to end overfishing and rebuild the spawning stock of southern flounder for long-term sustainable harvest and maintain the integrity of the stock.

To achieve this goal, the following objectives must be met:

- Ensure that the spawning stock biomass of southern flounder is adequate to produce recruitment levels necessary to increase spawning stock biomass and expand age distribution.
- Implement management measures that will achieve sustainable harvest.
- Promote harvesting practices that minimize bycatch.
- Continue to develop an information program to educate the public and elevate their awareness of the causes and nature of problems in the southern flounder stock, its habitat and fisheries, and explain the rationale for management efforts to sustain the stock.
- Address social and economic concerns of all user groups, including issues such as user conflicts.
- Promote the protection, restoration, and enhancement of habitats and environmental quality for the conservation of the southern flounder population.
- Initiate, enhance, and/or continue studies to improve the understanding of southern flounder population ecology and dynamics.
- Initiate, enhance, and/or continue studies to collect and analyze the socio-economic data needed to properly monitor and manage the southern flounder fishery.

Stock Status

Southern flounder (*Paralichthys lethostigma*) are estuarine dependent members of the left-eyed flounder family that include summer flounder and Gulf flounder. Southern flounder migrate offshore and south during late fall and winter, while returning inshore and moving north during late spring and summer. Southern flounder spawn in near shore continental shelf waters from November through March. Young fish enter inlets and settle on muddy bottoms in lower-salinity areas of estuaries.

North Carolina's southern flounder stock is listed as depleted, based on the 2009 stock assessment that determined that the stock is still overfished and overfishing is still occurring. An improvement in the spawning stock biomass and age class expansion occurred since the 2005 fishery management plan was implemented, but further harvest reductions are necessary to rebuild the stock. The commercial and recreational fisheries heavily rely on the harvest of age-1 and age-2 fish, which are the ages when female southern flounder begin to sexually mature. Based on the selectivity patterns of the fisheries, consecutive years of low recruitment can result in decreased spawning stock biomass and increased fishing mortality in subsequent years. Depleted stocks are those stocks where the spawning stock abundance is below a predetermined threshold or where low stock abundance precludes an active fishery.

Commercial and Recreational Fisheries

Southern flounder are landed commercially year round with much of the harvest occurring from September through November. Peak landings occurred in 1994 at more than 4.8 million pounds and have generally decreased since then (Figure 1). Gill nets and pound nets account for over 90 percent of the annual commercial landings with gill nets being the prominent gear since the mid 1990s. Much of the recreational harvest of southern flounder occurs in the summer and fall (July-October) by hook and line and gigs. Recreational harvest has increased in recent years with peak harvest in 2004 at more than 850,000 pounds (Figure 1).

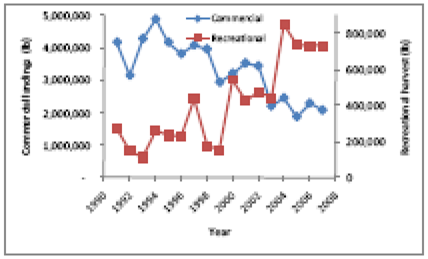


Figure 1. North Carolina commercial and recreational southern flounder landings, 1991-2007.

Management Issues

Management measures to achieve a sustainable harvest of southern flounder by ending overfishing and rebuilding the spawning stock by 2015 are the most important issues to be addressed in the management plan amendment. Management options include size limit increases, season closures, and creel limit decreases. Other management issues include gear requirements for the flounder gill net and pound net fisheries, user conflicts, protected species interactions, southern flounder bycatch in the crab pot fishery, minimum distance between pound nets and gill nets in Currituck Sound, recreational discards, ocean harvest of southern flounder, and differential size limits for the recreational fishery.

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13.2 TIMELINE FOR AMENDMENT 1 OF THE SOUTHERN FLOUNDER FISHERY MANAGEMENT PLAN

TASK	TIMELINE
Conduct data workshop	March 2008
Data complete for stock assessment	June 2008
Complete stock assessment	January 2009
Form PDT	March 2009
Appointment of FMP-AC by MFC Chair	March 2009
Development & consideration of interim management measures	May-December 2009
Develop goals & objectives, PDT	June 2009
Develop draft time line, PDT	August 2009
Identify initial issues, PDT	August 2009
Development of draft FMP with AC and PDT	August 2009-May 2010
Initial AC meeting	October 2009
Formulate issues concerning the resource with AC	December 2009-May 2010
Prepare draft PIB, PDT	December 2009/January 2010
Recommendations on interim management measures by MFC	December 2009
Approval of goals and objectives by MFC	December 2009
Present draft PIB to AC	February/March 2010
Dissemination of draft FMP to AC	June 2010
Review of draft by MFC for public meetings and MFC Committee review	August 2010
Public and Committee meetings on draft FMP*	August/September 2010

Address public comments in FMP with AC	September/October 2010
Present updated FMP to MFC and select preferred management options	November 2010
Address MFC comments in FMP	November 2010
Submit draft FMP to Fisheries Director	November 2010
PDT Meeting to Assess Finalizing FMP	June 1, 2012
Presentation and recommendation on Issue Paper 10.1.1 by AC	July 25, 2012
PDT meeting and DMF recommendation on Issue Paper 10.1.1	July 27, 2012
MRT meeting to develop final DMF position	July 30, 2012
Presentation of Issue Paper 10.1.1 with recommendations to MFC	August 2012
Public and Committee meetings on Issue Paper 10.1.1	September 2012
Address public comments on Issue Paper 10.1.1 with AC	October 2012
Selection of preferred management strategies by MFC	November 2012
Address MFC comments and submit revised draft Amendment 1 to DENR Secretary and JLCGO	December 2012
Review by DENR Secretary and JLCGO	December 2012
Incorporate Secretary, JLCGO comments	January 2013
Present final draft FMP to MFC for final approval	February 2013

*Public meetings for the PID and FMP will be held in each of the regional districts (northeast, central, southeast, and inland)

Timeline Acronyms

AC	-	Advisory committee for the fishery management plan
DMF	-	Division of Marine Fisheries
FMP	-	Fishery management plan
MFC	-	Marine Fisheries Commission
PDT	-	Plan Development Team (DMF staff)
PIB	-	Public Information Brochure
Secretary	-	Secretary of the Department of Environment and Natural Resources
JLCSA	-	Joint Legislative Commission on Seafood and Aquaculture
CAP	-	Compliance Advisory Panel
BRT	-	NCDMF Biological Review Team
MRT	-	NCDMF Management Review Team
Councils	-	Federal fishery management councils
ASMFC	-	Atlantic States Marine Fisheries Commission/Compact
RAT	-	DMF Rules Advisory Team

13.3 OVERVIEW OF MARINE FISHERIES COMMISSION FINFISH AND REGIONAL COMMITTEES RECOMMENDATIONS OF THE DRAFT AMENDMENT 1 TO THE SOUTHERN FLOUNDER FISHERY MANAGEMENT PLAN

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NCDMF, Southern Flounder, Regional & Finfish Advisory Committee Recommendations on Management Measures for Amendment 1 to the Southern Flounder FMP

ISSUE	NCDMF	SOUTHERN FLOUNDER	SOUTHEAST	INLAND	CENTRAL	FINFISH	NORTHEAST	HABITAT
Sustainable Harvest (Commercial)	Large mesh gill net management measures implemented by sea turtle lawsuit settlement agreement--22.2% harvest reduction	Large mesh gill net management measures implemented by sea turtle lawsuit settlement agreement--22.2% harvest reduction**	Large mesh gill net management measures implemented by sea turtle lawsuit settlement agreement--22.2% harvest reduction	Increase the minimum size limit to 15 inches and large mesh gill net management measures implemented by sea turtle lawsuit settlement agreement and have NCDMF develop triggers to monitor commercial harvest to ensure adequate harvest reduction occurs-- 48.0% harvest reduction*	Large mesh gill net management measures implemented by sea turtle lawsuit settlement agreement--22.2% harvest reduction	Large mesh gill net management measures implemented by sea turtle lawsuit settlement agreement--22.2% harvest reduction	Large mesh gill net management measures implemented by sea turtle lawsuit settlement agreement--22.2% harvest reduction**	
Sustainable Harvest (Recreational)	Increase the minimum size limit to 15 inches and decrease the creel limit to 6 fish--20.2% harvest reduction	Increase the minimum size limit to 15 inches and decrease the creel limit to 6 fish--20.2% harvest reduction**	Increase the minimum size limit to 15 inches and decrease the creel limit to 6 fish--20.2% harvest reduction	Increase the minimum size limit to 15 inches and decrease the creel limit to 6 fish--20.2% harvest reduction	Increase the minimum size limit to 15 inches and decrease the creel limit to 6 fish--20.2% harvest reduction	Increase the minimum size limit to 15 inches and decrease the creel limit to 6 fish--20.2% harvest reduction	Increase the minimum size limit to 15 inches and decrease the creel limit to 6 fish--20.2% harvest reduction**	
Gear Requirements in the Gill Net Fishery	Status quo minimum mesh size (5.5 inches stretched mesh) and large mesh gill net management measures implemented by sea turtle lawsuit settlement agreement	Status quo minimum mesh size (5.5 inches stretched mesh) and large mesh gill net management measures implemented by sea turtle lawsuit settlement agreement**	Status quo minimum mesh size (5.5 inches stretched mesh) and large mesh gill net management measures implemented by sea turtle lawsuit settlement agreement	Increase the minimum mesh size to 5.75 inches stretched mesh from 4/15 to 12/15 and large mesh gill net management measures implemented by sea turtle lawsuit settlement agreement**	Status quo minimum mesh size (5.5 inches stretched mesh) and large mesh gill net management measures implemented by sea turtle lawsuit settlement agreement	Status quo minimum mesh size (5.5 inches stretched mesh) and large mesh gill net management measures implemented by sea turtle lawsuit settlement agreement	Status quo minimum mesh size (5.5 inches stretched mesh) and large mesh gill net management measures implemented by sea turtle lawsuit settlement agreement**	
Gear Requirements in the Pound Net Fishery	Status quo minimum mesh size for escape panels (5.5-inch stretched mesh) until further research is conducted to determine if rule changes are necessary	Status quo minimum mesh size for escape panels (5.5-inch stretched mesh) and recommend further research on 5.75-inch stretched mesh escape panels**	Status quo minimum mesh size for escape panels (5.5-inch stretched mesh) until further research is conducted to determine if rule changes are necessary	Increase the minimum mesh size for escape panels to 5.75 inches stretched mesh coast wide**	Status quo minimum mesh size for escape panels (5.5-inch stretched mesh) and recommend further research on 5.75-inch stretched mesh escape panels	Status quo minimum mesh size for escape panels (5.5-inch stretched mesh) and recommend further research on 5.75-inch stretched mesh escape panels	Status quo minimum mesh size for escape panels (5.5-inch stretched mesh) and recommend further research on 5.75-inch stretched mesh escape panels to be conducted in 2011**	
Large Mesh Gill Net-Related Conflicts	Status quo (implement mediation and proclamation authority to address user conflicts with large mesh gill nets)	Status quo (implement mediation and proclamation authority to address user conflicts with large mesh gill nets)**	Status quo (implement mediation and proclamation authority to address user conflicts with large mesh gill nets)	Status quo as long as sea turtle lawsuit settlement agreement management measures are not relaxed in the future**	Status quo (implement mediation and proclamation authority to address user conflicts with large mesh gill nets)	Status quo (implement mediation and proclamation authority to address user conflicts with large mesh gill nets)	Status quo (implement mediation and proclamation authority to address user conflicts with large mesh gill nets)**	
Minimum Distance between Pound Nets & Gill Nets in Currituck Sound	Status quo (200-yard minimum distance between pound nets and gill nets)	Implement a 500-yard minimum distance between pound nets & gill nets in Currituck Sound north of the Wright Memorial Bridge (US 158) from Aug. 15 to Dec. 31**	No Recommendation	No Recommendation**	No Recommendation	No Recommendation--MFC decides based on public comments	Status quo (200-yard minimum distance between pound nets and gill nets)**	

ISSUE	NCDMF	SOUTHERN FLOUNDER	SOUTHEAST	INLAND	CENTRAL	FINFISH	NORTHEAST	HABITAT
Explore the Elimination of the RCGL	Status quo and address research recommendations	Status quo regarding the RGCL until there are data indicating a negative influence on southern flounder & support NCDMF research recommendations as well as a survey of SCFL holders who are inactive to collect data on what SCFL holders are doing with their licenses**	Status quo and address research recommendations and include gigs as a RCGL gear	Status quo and address research recommendations**	Status quo	Status quo regarding the RGCL until there are data indicating a negative influence on southern flounder & support NCDMF research recommendations as well as a survey of SCFL holders who are inactive to collect data on what SCFL holders are doing with their licenses	Status quo and address research recommendations**	
Protected Species Interactions in Southern Flounder Large Mesh Gill Net & Pound Net Fisheries	Request funding for state observer program, apply for Incidental Take Permit for large mesh gill net fishery, and continue gear development research to minimize protected species interactions	Request funding for state observer program, apply for Incidental Take Permit for large mesh gill net fishery, continue gear development research to minimize protected species interactions, and explore other funding mechanisms for the state observer program**	Request funding for state observer program, apply for Incidental Take Permit for large mesh gill net fishery, and continue gear development research to minimize protected species interactions	Request funding for state observer program, apply for Incidental Take Permit for large mesh gill net fishery, continue gear development research to minimize protected species interactions, and explore other funding mechanisms for the state observer program**	Apply for Incidental Take Permit for large mesh gill net fishery, population dynamics for all Atlantic Ocean sea turtles, continued research on the design of gill nets and pound nets to minimize protected species interactions, and development of alternative gears to catch southern flounder	Request funding for state observer program, apply for Incidental Take Permit for large mesh gill net fishery, and continue gear development research to minimize protected species interactions	Request funding for state observer program, apply for Incidental Take Permit for large mesh gill net fishery, and continue gear development research to minimize protected species interactions**	
Southern Flounder Bycatch in the Crab Pot Fishery	Status quo & expand research on flatfish escape devices & degradable panels under commercial conditions to other parts of the state	Status quo & expand research on flatfish escape devices & degradable panels under commercial conditions to other parts of the state**	Status quo & expand research on flatfish escape devices & degradable panels under commercial conditions to other parts of the state	Status quo & expand research on flatfish escape devices & degradable panels under commercial conditions to other parts of the state**	Status quo & expand research on flatfish escape devices & degradable panels under commercial conditions to other parts of the state	Status quo & expand research on flatfish escape devices & degradable panels under commercial conditions to other parts of the state	Status quo and request that the Blue Crab FMP address further research on flatfish escape panels and degradable material**	
Southern Flounder Discards in the Recreational Hook & Line Fishery	Status quo & expand research on factors impacting the release mortality of southern flounder & on deep hooking events of different hook types & sizes	Status quo & expand research on factors impacting the release mortality of southern flounder & on deep hooking events of different hook types & sizes**	Status quo & expand research on factors impacting the release mortality of southern flounder & on deep hooking events of different hook types & sizes	Status quo & expand research on factors impacting the release mortality of southern flounder & on deep hooking events of different hook types & sizes**	Status quo & expand research on factors impacting the release mortality of southern flounder & on deep hooking events of different hook types & sizes	Status quo & expand research on factors impacting the release mortality of southern flounder & on deep hooking events of different hook types & sizes	Status quo & expand research on factors impacting the release mortality of southern flounder & on deep hooking events of different hook types & sizes**	
Ocean Harvest of Southern Flounder	Status quo and address research recommendations	Status quo and address research recommendations**	Status quo and address research recommendations	Status quo and address research recommendations**	Status quo--no additional commercial & recreational regulations for ocean-caught flounder and address research recommendations	Status quo and address research recommendations	Status quo and address research recommendations**	
General AC Comments, Concerns & Other Recommendations			Request that any recreational regulation changes be made for inland waters by NCWRC at the same time as in joint/inland waters or ASAP	Request that a quota management system for the commercial southern flounder fishery be rapidly developed. All consensus recommendations are using the sea turtle lawsuit settlement agreement as the basis for these recommendations	Forward concerns regarding sea turtle lawsuit settlement agreement management measures occur where there are no observed sea turtle takes to the Sea Turtle AC			Environmental Factors Recommendations: Add Primary Nursery Areas to Strategic Habitat Areas heading; add a reference to CHPP to Recommendation #4 under Wetlands heading; add following recommendation under Water Column heading: Restore hydrology on lands used for silvaculture, agriculture, and urban development using Best Management Practices

*-Harvest reduction estimate includes mesh size increases for large mesh gill nets and pound net escape panels to 5.75 inches stretched mesh
**-Lack of quorum present for these recommendations, so committee agreed by consensus

ISSUE	DMF	Southern Flounder	Southern Region	Northern Region	Finfish	Public Comment
Additional Options for Achieving Sustainable Harvest of Southern Flounder	Accept management measures to reduce protected species interactions as the management strategy for achieving sustainable harvest in the commercial southern flounder fishery. Specifically these minimum measures for the flounder gill net fishery are: 1. Maintain the following gill net restrictions (excluding run-around, strike or drop net that is used to surround a school of fish and then is immediately retrieved): A. For all internal coastal waters year round other than waters of Albemarle, Croatan and Roanoke sounds north and west of Highway 64/264 bridges, Pamlico, Pungo, Bay and Neuse rivers, and only during shad season (Jan-Apr) for the upper New River and upper Cape Fear River, limit the use of large mesh gill nets (4-6½-inch stretched mesh) to four nights per week, Monday through Thursday, except allow an extra day (Sunday/Monday) for setting large mesh gill nets south of Beaufort Inlet. B. For all internal coastal waters other than waters of Albemarle, Croatan and Roanoke sounds north and west of Highway 64/264 bridges as well as Pamlico, Bay and Neuse rivers limit the use of large mesh gill nets (4-6½-inch stretched mesh): • to use or possess no more than 2,000 yards of large mesh gill net per fishing operation regardless of the number of vessels involved in coastal fishing waters north and east of a line at longitude 76° 36.9972' W, which runs northerly from a point on Shackleford Banks to Lennoxville Point, then to the head of Turner Creek, and northerly up the western side of North River. • to use or possess no more than 1,000 yards of large mesh gill net per fishing operation regardless of the number of vessels involved in coastal fishing waters north and west of a line at longitude 76° 36.9972' W, which runs northerly from a point on Shackleford Banks to Lennoxville Point, then to the head of Turner Creek, and northerly up the western side of North River and bound in the south by the North Carolina-South Carolina border. C. Unless otherwise specified the maximum large mesh gill net yardage allowed is 3,000 yards	July 25: Accept management measures to reduce protected species interactions (adaptive management) as the management strategy for achieving sustainable harvest in the commercial southern flounder fishery.	Sept 19: Same as DMF Request for DMF to make sea turtle settlement measures less restrictive for gill nets (no motion)	Sept 26th: Same as DMF Concern of DMF recommendation impacting PSGNRA rules for large mesh gill nets Motion to request NMFS complete a sea turtle stock assessment	Sept 27th: Same as DMF **	Public Comment from Northern AC meeting: Gill net fisherman reported that flounder caught this year are larger than in the past Phone Call: Request for two hours (instead of one) before sunset and after sunrise to set and retrieve gill nets due to safety concerns
Gear Requirements in the Gill Net Fishery	Keep recommendation for 5.5 in min mesh size on large mesh gill nets; remove recommendation to follow M-8-2010 because it no longer applies	No Comment	No Comment	No Comment	No Comment	No Comment

** Lack of a quorum present for these recommendations, so committee agreed by consensus

13.4 MARINE FISHERIES COMMISSION PROPOSED RULE CHANGES

No rule changes proposed by the NCMFC

13.5 STOCK STATUS OF NORTH CAROLINA SOUTHERN FLOUNDER (*PARALICHTHYS LETHOSTIGMA*)

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Stock Status of North Carolina Southern Flounder (*Paralichthys lethostigma*)

January 2009

Helen Takade-Heumacher
And
Chris Batsavage

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P.O. Box 769
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EXECUTIVE SUMMARY

Southern flounder (*Paralichthys lethostigma*) support substantial commercial and recreational fisheries in North Carolina. Increased fishing effort and concern for the southern flounder stock resulted in a stock assessment in 2004 and a Fishery Management Plan (FMP) in 2005. This stock assessment updates the status of the southern flounder stock, using fishery dependent and fishery independent data from 1991 to 2007. Southern flounder in North Carolina were considered a unit stock based on previous tagging studies. There is also evidence of adult southern flounder returning to the estuaries in the spring and summer subsequent to spawning offshore, and the presence of adult southern flounder remaining in the ocean off North Carolina after spawning.

Data available for southern flounder included commercial and recreational landings, length frequencies from the commercial and recreational fisheries, age, growth and maturity data, and indices of abundance from fishery dependent (commercial gill net and recreational hook and line fishery) and fishery independent (Albemarle Sound Independent Gill Net, Pamlico Sound Independent Gill Net, Pamlico Sound Trawl, Estuarine Trawl, and Beaufort Inlet Ichthyoplankton Sampling Program) surveys. The model selected to estimate mortality and abundance for this assessment is a forward projecting statistical catch-at-age model called ASAP2. Yield per recruit and biomass per recruit models were used to identify levels of fishing mortality (F) and spawning stock biomass (SSB) for the determination whether or not the stock is overfished and whether or not overfishing is occurring.

The terminal year number-adjusted F was estimated at 0.7534, and the estimated terminal year SSB was 4,358,990 lb of female fish. Based on the range of possible reference fishing mortality rates from $F_{25\%}$ to $F_{40\%}$, an F threshold for this stock is between F=0.5937 and F=0.3445. The average fishing mortality rate over the 1991 – 2007 time period of F=1.1631 is above the upper bound of the reference mortality rates. Based on the reference SSB levels associated with the range of fishing mortality thresholds from $F_{25\%}$ to $F_{40\%}$, a threshold spawning stock biomass is between 5,903,817 lb and 9,446,797 lb, which exceeds the 2007 terminal year SSB estimate. With a $F_{35\%}$ fishing mortality target and $F_{30\%}$ fishing mortality threshold, the resulting benchmarks are 0.4081 and 0.4880 respectively. Using the average recruitment, the $F_{30\%}$ threshold SSB value was 7,084,845 lb of female fish. The 2007 terminal year F was expected to retain about 19% of the maximum SSB.

The stock status of southern flounder has improved since the earlier portion of the time series with decreases in F, increases in SSB and age class expansion in recent years. However, this assessment finds that the stock is still overfished and overfishing is occurring. The commercial and recreational fisheries heavily rely on the harvest of age-1 and age-2 fish, which are the ages when female southern flounder begin to sexually mature. Based on the selectivity patterns of the fisheries, consecutive years of low recruitment can result in decreased SSB and increased F in subsequent years.

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INTRODUCTION

Southern flounder (*Paralichthys lethostigma*) support commercial and recreational fisheries along the southeast Atlantic and Gulf coasts of the United States. Southern flounder are particularly important to the commercial and recreational fisheries in North Carolina. Annual commercial landings of southern flounder are among the highest and most valuable finfish landings in the State (NCDMF 2008a).

Increased fishing effort and concern for the southern flounder stock resulted in the North Carolina Marine Fisheries Commission (NCMFC) listing southern flounder a priority species for fishery management plan (FMP) development (NCDMF 2005). A provision of the 2005 Southern Flounder FMP was to review the stock status of southern flounder three years after implementation of the FMP (NCDMF 2005). This stock assessment updates the status of the southern flounder stock, as required by the 2005 Southern Flounder FMP, and includes the years from 1991 to 2007.

UNIT STOCK DEFINITION

Southern flounder tagging studies by Wenner et al. (1990), Monaghan (1992), and Scharf et al. (2008) show that most of the tagged southern flounder are recaptured close to the tagging site in the year they were released. Recaptures away from the tagging sites indicate that southern flounder move in a southward direction out of the estuaries during the fall with some of the recaptures occurring in neighboring states. The short time periods of these tagging studies preclude defining the southern flounder migration patterns with any certainty. Some adult southern flounder return to the estuaries after spawning in the ocean while others remain in the ocean offshore of North Carolina (Watterson and Alexander 2004, Taylor et al. 2008). For the purposes of this stock assessment, southern flounder in North Carolina are considered a unit stock. It is assumed that the southern flounder in North Carolina exhibit minimal mixing with southern flounder from the other southeastern states. In addition, while there is evidence of adult southern flounder returning to the estuaries in the spring and summer subsequent to spawning offshore, an unknown percentage of adult southern flounder remain in the ocean off North Carolina. The proportion of the stock that remains offshore is unknown.

COMMERCIAL FISHERY DESCRIPTION

The commercial fishery for southern flounder is conducted throughout the estuaries of North Carolina. Southern flounder are harvested year-round with peak landings from September to November (NCDMF 2005). Commercial landings of southern flounder averaged 3,796,743 lb from 1991 to 2002 with peak landings of 4,878,639 lb in 1994 (Figure 1). Average commercial landings from 2003 to 2007 decreased to 2,177,891 lb. Annual landings decreased to a low of 1,870,754 lb in 2005. Commercial landings accounted for an average of 89% of the total annual harvest of southern flounder in the State from 1991 to 2007 (Table 1). However, the proportion of commercial landings to total landings ranged from 83% to 97% from 1991 to 2003 but decreased to 72%-76% from 2004 to 2007.

Southern flounder are targeted in the estuarine gillnet, pound net and gig fisheries. Estuarine gill nets and pound nets harvested an average of approximately 92% of the annual commercial harvest (Table 2). Several different pound net fisheries occur in North Carolina including the bait (Atlantic menhaden (*Brevoortia tyrannus*)) and sciaenid (weakfish (*Cynoscion regalis*) and Atlantic croaker (*Micropogonias undulatus*)) and flounder pound net fisheries. Of these, the flounder pound net fishery accounts for the vast majority of the southern flounder landings from pound nets (Batsavage 2007). Southern flounder pound net landings are the total southern flounder harvested from the different pound net fisheries. Flounder pound nets are set in the late summer and fall to target paralichthid flounders as they migrate from the estuaries to the ocean. The pound net fishery harvested the majority of southern flounder until 1995 when the estuarine gill net fishery became the predominant fishery (Table 2) (NCDMF 2005). Southern flounder landings from the estuarine gill net fishery have increased from 53% of the commercial harvest in 2002 to 70% of the commercial harvest in 2007. Pound net landings showed the opposite trend during the same time period with landings decreasing from 40% of the commercial harvest in 2002 to 23% of the commercial harvest in 2007. NCDMF (2007a) provides a more detailed description the estuarine gill net and pound net fisheries. Southern flounder are also incidentally landed by a variety of other commercial gears.

RECREATIONAL FISHERY DESCRIPTION

Southern flounder are harvested recreationally in North Carolina by hook and line, gig, and the recreational use of commercial gears such as gill nets, trawls, pots, and seines. They are caught year-round throughout the estuaries, inlets, and near shore ocean waters of the State with the majority of harvest occurring in the summer and fall (Figure 2). Recreational harvest accounted for an average of 11% of the total annual harvest of southern flounder in the State from 1991 to 2007 (Table 1). However, the proportion of recreational landings to total landings was less than 10% from 1991 to 1999 but increased to 24%-28% from 2004 to 2007.

Recreational hook and line landings have increased in recent years. The average recreational harvest from 1991 to 1999 was 56,186 fish and 112,842 lb from 1991 to 1999. From 2000 to 2007, the average recreational harvest increased to 148,076 fish and 308,706 lb (Table 3). The peak harvest of 196,906 fish and 425,225 lb occurred in 2004. Since 2005, the harvest has averaged 162,619 fish and 366,938 lb.

The recreational gig fishery harvests a significant number of southern flounder, but there is no annual sampling program for this fishery, and therefore, no direct annual harvest estimates. However, limited data on this fishery were available to account for the southern flounder harvest. The NCDMF conducted a recreational gig survey from July 2000 to January 2003 to characterize the fishery and the catch, and to obtain an estimate of southern flounder harvest by gigs from the estuarine waters of North Carolina (Watterson 2003). The area surveyed ranged from northern Core Sound to the South Carolina State line. This region had the majority of the commercial gig landings, and it was assumed that this pattern was the same for the recreational fishery. This survey estimated the 2002 recreational harvest of southern flounder from the gig fishery at 188,059 fish and 371,370 lb, and the average weight of southern flounder harvested was 1.97 lb per fish (Watterson 2003). However, this estimate included samples from commercial giggers who, on average, harvested three times as many southern flounder per trip than recreational giggers. Consequently, the inclusion of commercial catches likely overestimated the recreational gig harvest. When commercial catches were removed from the analysis, recreational harvest estimates ranged from 96,409 fish and 189,926 lb to 110,664 fish and 218,008 lb. This compares to the 2002 hook and line fishery estimates of 115,154 fish weighing 236,650 lb, with an average fish weight of 2.06 lb (Table 3).

The 2002 recreational gig southern flounder harvest estimates and the 2002 MRFSS southern flounder hook and line harvest estimate were similar (Table 3). It is uncertain whether the coast wide recreational gig harvest in 2002 was greater than or less than the coast wide hook and line harvest that year because the gig survey did not cover the entire State. Based on the data from 2002, the annual recreational gig harvest was assumed to equal the annual recreational hook and line harvest for the entire time series covered in the stock assessment. The hook and line harvest estimate was multiplied by two to account for the recreational gig harvest (Table 1).

The number of southern flounder harvested per person per recreational gigging trip was examined to determine the percentage of gigging-trips exceeding the eight fish creel limit that was implemented in 2005 (no recreational creel limit existed for flounder harvested in internal waters when this survey was conducted in 2002). Most gigging trips harvested eight or less southern flounder per person (Table 4). Therefore, recreational gig harvest estimates were not adjusted for creel limit differences in the time series.

A Recreational use of Commercial Gear License (RCGL) allows fishermen to use limited amounts of commercial gear to harvest finfish and crustaceans for personal use. RCGL holders must abide by the same size and creel limits as recreational anglers and are not allowed to sell their catch. This license was implemented in July 1999; harvest and effort estimates from this sector have been available since 2002 (Table 5). Reliable RCGL harvest estimates prior to 2002 are unavailable because of considerable changes in the behavior of RCGL fishermen over the years (C. Wilson, NCDMF, personal communication). Because reliable RCGL harvest estimates are unavailable for the entire time series and because RCGL harvest of southern flounder was minimal compared to the total annual harvest, RCGL harvest was not included in the assessment.

REGULATORY AND MANAGEMENT HISTORY

Many of the regulations for commercial flounder fisheries prior to 2005 were imposed for the summer flounder fishery in the ocean and had very little impact on the southern flounder fishery in the estuaries. On September 1, 1988, the minimum size limit for the commercial harvest of flounder in estuarine and ocean waters increased from 11 in to 13 in. Escape panels of 5 ½ in stretched mesh were required for flounder pound nets on October 2, 1998. Flounder pound nets in Albemarle Sound west of the Alligator River were exempt from this regulation. The 2005 Southern Flounder FMP implemented several regulations to prevent overfishing of southern flounder in North Carolina as to produce long-term sustainable harvest of this species (NCDMF 2005). The commercial fishery regulations included the following:

- a 14 in minimum size limit in estuarine waters,
- a closure period from December 1 to December 31,
- a minimum mesh size of 5 ½ in stretched mesh for large mesh gill nets from April 15 through December 15,
- a 3,000 yard limit on large mesh gill nets, and
- the requirement of escape panels of 5 ½ in stretched mesh in pound nets in Albemarle Sound west of the Alligator River.

The 2005 Southern Flounder FMP also implemented a minimum tailbag mesh size of 4 in stretched mesh in crab trawls in western Pamlico Sound to minimize bycatch of undersized southern flounder. Additionally, the 2006 NCDMF Shrimp FMP closed upper portions of the Neuse, Pamlico and Pungo rivers to shrimp trawling to minimize southern flounder bycatch in this fishery and implemented a maximum combined 90 ft headrope length in the mouths of the Pamlico and Neuse rivers and all of the Bay River (NCDMF 2006a).

Similar to the commercial fishery, many of the regulations for the recreational fishery have been the result of summer flounder management. Unlike the commercial fishery, these regulations have had some impact on the southern flounder recreational fishery. The minimum size limit for the recreational harvest of flounder in estuarine and ocean waters increased from 11 in to 13 in on September 1, 1988 with no creel limit. This regulation for estuarine waters remained in effect through September 30, 2002. The minimum size limits, creel limits, and seasons changed on a nearly annual basis in the ocean because of Amendment 2 of the Mid Atlantic Fishery Management Council's Summer Flounder FMP (ASMFC 2006). Minimum size limits ranged from 14 in to 15 ½ in and creel limits ranged from six to 10 fish per person per day from 1994 to 2007 (Table 6). Closed seasons for the ocean were implemented in 2001 and 2002 to meet required recreational harvest reductions for summer flounder. The minimum size limit for flounder in internal waters increased to 14 in on October 1, 2002 with the exception of the western Pamlico Sound and its tributaries, where the minimum size limit remained 13 in. The 2005 Southern Flounder FMP implemented a 14 in minimum size limit for recreationally caught flounder and implemented an eight fish per person per day creel limit throughout the estuaries (NCDMF 2005). The FMP also required that participants in the recreational gig fishery be licensed, which occurred when the Coastal Recreational Fishing License (CRFL) was implemented on January 1, 2007. In addition, RCGL holders were required to attend their large mesh gill nets (5 ½ in stretched mesh and greater) at all times from the NC Highway 58 bridge at Emerald Isle south to the South Carolina state line to minimize bycatch (NCDMF 2005).

PREVIOUS ASSESSMENT RESULTS

The NCDMF completed a stock assessment for southern flounder in January 2004 for the 2005 Southern Flounder FMP (NCDMF 2005). A Virtual Population Analysis (VPA) age-structured model, a yield per recruit (YPR) model, and a spawning stock biomass per recruit (SSB/R) model were used to determine fishing mortality (F) and stock abundance levels as well as overfishing and target spawning potential ratio (SPR) levels from 1991 to 2002 (NCDMF 2005). Age abundance indices were developed from the NCDMF fishery dependent and fishery independent data sources for the model. The stock assessment determined the southern flounder stock was overfished and overfishing was occurring. The previous assessment found that the southern flounder stock is largely dependent on incoming recruitment with a high exploitation of age-1 and age-2 southern flounder. Fishing mortality rates averaged 1.91 (ages 2-5) in 2002 with an 80% probability that F was between 1.69 and 2.89. The estimated F in 2002 was expected to retain only about 5.4% of the maximum spawning stock biomass, well below the percentage of spawning stock necessary to sustain most stocks.

LIFE HISTORY INFORMATION

Southern flounder inhabit the riverine, estuarine, and coastal waters along the East Coast of North America from Virginia south to the Loxahatchee River on the Atlantic Coast of Florida. They are also found along the Gulf of Mexico coastline from the Caloosahatchee River estuary in Florida west to Texas and south into northern Mexico. However, this species is not found in waters surrounding the southern tip of Florida (Gilbert 1986). Juvenile southern flounder remain in the estuaries for the first two years of their lives before becoming sexually mature and joining the adult spawning stock. In the fall, the adult southern flounder move out through the inlets into the ocean waters to spawn. These migrations coincide with falling water temperatures (Shepard 1986, Pattillo et al. 1997). Following the spawning period offshore, many adult southern flounder return through the inlets to the estuaries and rivers. Some adult southern flounder remain in the ocean after spawning instead of returning to the estuaries (Watterson and Alexander 2004, Taylor et al. 2008). The proportion of the adult spawning stock remaining in the ocean and the annual variation in southern flounder remaining in the ocean is unknown.

Aging

The NCDMF began collecting southern flounder age and growth data on a comprehensive basis in April 1991 (Table 7). Whole otoliths were collected and length, weight, sex, maturity, gear type, and location were recorded for these samples. The samples came from a variety of gear types and from both fishery dependent (recreational and commercial) and fishery independent sampling programs. Age samples were collected monthly with sampling targets set for specified length bins. Otolith collection and processing techniques were similar to those described by Wenner et al. (1990). Ages were assigned from annuli counts and were adjusted for month of capture, timing of annulus formation, and a January 1 birthdate.

The number of southern flounder age samples collected per year has varied over the 17 year time series. The sample sizes were even more variable when the age samples are separated by sex and by 6 month time periods (January-June; July-December) (Table 7). The relatively fast growth of southern flounder necessitated the temporal separations, while the differential growth rates between sexes and the longevity of males and females necessitated the separation by sex. The maximum age for females was age-9 and the maximum age for males was age-6. The number of females far outnumbered the number of males collected (approximately 82% female). The size range of males was much smaller than females (male maximum size: 495 mm; female maximum size: 835 mm). There were more age samples collected during July-December than in January-June. Although southern flounder can be caught year round in North Carolina waters, the majority of the fishing effort occurs during the latter part of the year. Southern flounder spawn in the winter, so the larger mature fish are offshore during the early part of the year and therefore, are not as available to the various fisheries and sampling programs that encounter them.

Growth

The NCDMF age and growth data and young of year (YOY) southern flounder data from NCDMF fishery independent sampling were used for growth curve calculations in a nonlinear regression model using the Solver data analysis tool in Microsoft Excel 2007. Fractional ages, calculated on a quarterly basis, were used to model seasonal growth for both male and female southern flounder using the von Bertalanffy growth equation:

$$l_t = L_\infty \, [1-e^{-K(t-t0)}],$$

where l_t is length at fractional age, L_∞ is maximum theoretical length, K is the growth coefficient and t_0 is the theoretical age at which a fish's length would equal zero. The inclusion of YOY southern flounder data and an adequate number of fishery independent age and growth samples below the minimum size limits allowed the use of a growth model without adjustments for the effects of minimum size limits (Diaz et al. 2004).

Female southern flounder grow faster and live longer than male southern flounder (Figure 3). Consequently, females have a smaller growth coefficient (0.284) than males (0.803) (Table 8). Maximum theoretical length for southern flounder was estimated at 699 mm for females and 381 mm for males. The female von Bertalanffy growth parameters are comparable to the female von Bertalanffy growth parameters from other life history studies and the 2004 NCDMF stock assessment (Wenner et al. 1990, Stunz et al. 2000, NCDMF 2005). However, the growth parameters from the previous NCDMF stock assessment had higher maximum theoretical lengths (849 mm for females; 406 mm for males) and lower growth coefficients (0.191 for females; 0.562 for males) (NCDMF 2005). The inclusion of YOY data in the growth model and five more years of age and growth data likely contributed to the different results. Specifically, the inclusion of YOY data resulted in the t_0 closer to 0 and forced the curve to asymptote at the maximum age.

Sex Ratio at Length

Sex ratios were examined to determine the proportion of males and females within 1-inch size bins by using a logistic model that predicts the proportion of females per size bin:

$$\text{Proportion female} = 0.5 \text{ for } L < 12 \text{ in, and}$$
$$\text{Proportion female}=1/(1+e^{(-R(L-I))}) \text{ for L} > 12 \text{ in,}$$

where, R is the rate of change, L is total length (in), and I is the length at which 50% of the fish are expected to be female. The assumed ratio of males and females was 1:1 at the size bins 12 in and smaller due to the majority of samples in these size bins where sex was undetermined (Figure 4). The rate of change (R) was 0.9399. The predicted length for a 1:1 sex ratio was 12.1 in and no males were greater than 19 in. The predicted sex ratios per size bin were used to generate female specific catch at age matrices for the different fisheries.

The faster growth rate of females and sex ratios greater than the minimum size limits heavily skewed towards females resulted in females comprising the majority of southern flounder harvested by the commercial and recreational fisheries. Consequently, female only age length keys and length frequencies were used as input data for the stock assessment.

Maturity

The stock assessment used the length specific southern flounder maturity schedule developed by Monaghan and Armstrong (2000). A logistic model that predicted the proportion of mature females per 10 mm size bins was developed:

$$\%mature=1/(1+e^{(-R(L-I))}),$$

where, R is the rate of change, L is total length (mm), and I is the length at which 50% of the fish are expected to be mature. The rate of change (R) was 0.07984. The predicted length for 50% maturity (I) was 345 mm (13.6 in), and all female southern flounder were mature by 480 mm (19.0 in). To develop the age specific maturity schedule for female southern flounder on January 1, the predicted mean lengths at age for female southern flounder on January 1 from the von Bertalanffy growth model were applied to the corresponding lengths in the maturity schedule to determine the percent mature at age. The maturity schedule at age was 0% at age-0, 0.27% at age-1, 94.10% at age-2 and 100% at ages 3 and older. The maturity schedule used in the 2004 Southern Flounder Stock Assessment was 0% at age-0, 59% at age-1, 79% at age-2, and 100% at ages 3 and older. The 2004 Southern Flounder Stock Assessment used a February 1 birth date, which resulted in a higher percentage of mature fish age-1 and lower percentage of mature age-2 fish than the current stock assessment. When Wenner et al. (1990) applied their maturity schedule to their von Bertalanffy growth model, they found that female southern flounder in South Carolina began maturing prior to turning age-3 and reached 100% maturity before becoming age-4.

Length-Weight Relationship

Southern flounder length and weight data from the NCDMF age and growth database were analyzed for a length-weight relationship. The length-weight relationship for southern flounder was determined by using the power function:

$$W= aL^{b},$$

where W is weight (kg), L is total length (mm), a is the unit conversion coefficient, and b is the volumetric expansion coefficient. The unit conversion coefficient (a) was 3×10^{-9} and the volumetric expansion coefficient (b) was 3.241. The analysis was conducted for all sexes combined because there is very little difference in the weight of males and females for any given length class (Wenner et al 1990, Wenner and Archambault 2005). Therefore, samples with no sex recorded were also included in the analysis. The weight-length relationship is found in Figure 5. This length-weight relationship was used to calculate the mean weight at age in the model.

Natural Mortality

The natural mortality rate (M) was calculated using the Lorenzen method (1996), which estimates M by age:

$$M = 3.0 * W^{-0.288}$$

where M is the natural mortality and W is weight in grams. However, the M estimates generated by the Lorenzen method must be scaled to the M found by using the Hoenig (1983) equation:

$$ln(M) = 1.44 - 0.982*ln(t_{max})$$

The Hoenig equation estimated an M of 0.400 using a maximum age of 11, which is the maximum observed age plus two. This resulted in a natural mortality vector as follows:

Age	Natural Mortality Vector (-y)
0	1.161
1	0.569
2	0.403
3	0.332
4	0.294
5	0.270
6+	0.255

It should be noted that any M estimate could be used to scale the Lorenzen estimates. The southern flounder data workgroup preferred the Hoenig method over other available methods.

ASSESSMENT DATA SOURCES

Fishery dependent and fishery independent southern flounder data were available for the stock assessment. Fishery dependent data sources included commercial and recreational landings, and commercial and recreational length frequency data. Fishery independent data sources included length frequency and effort data from the Albemarle Sound Independent Gill Net Survey, the Pamlico Sound Independent Gill Net Survey, the Pamlico Sound Trawl Survey, the Estuarine Trawl Survey, and the Beaufort Inlet Ichthyoplankton Sampling Program. All data sources were from the NCDMF except for the Beaufort Inlet Ichthyoplankton Sampling Program, which was conducted by the National Oceanic and Atmospheric Administration (NOAA).

FISHERY DEPENDENT DATA

Commercial Landings and Length Frequencies

The NCDMF Trip Ticket Program (NCTTP) began on January 1, 1994 along with mandatory reporting of trip level commercial landings data for all North Carolina seafood dealers. Commercial landings data were gathered through the National Marine Fisheries Service (NMFS)/North Carolina Cooperative Statistics program prior to the implementation of the NCTTP from 1978 to 1993. Reporting was voluntary during this period, with North Carolina and NMFS port agents sampling the State’s major dealers. For further information on the sampling methodology for the NCTTP, see Lupton and Phalen (1996).

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. Fishery 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 (unpublished data, NCDMF).

Commercial length frequency data were obtained by the NCDMF fishery dependent sampling of commercial catches targeting a variety of fish, shellfish, and crustaceans year round throughout the state. The commercial finfisheries sampled include estuarine gill net, ocean gill net, winter trawl, flounder pound net, sciaenid pound net, long haul seine/swipe net, beach seine, and commercial gig. Although southern flounder are caught by and sampled from all of these fisheries, they are most commonly sampled from the fisheries that target southern flounder (estuarine gill net, flounder pound net, and commercial gig). Samples were collected at the trip level as fish were offloaded and graded at the dock. Southern flounder length measurements were collected by gear, market grade, and area fished from fish houses along the North Carolina coast. Individual fish were measured for total length (1 mm TL) and a total weight (0.1 kg) of all fish measured in aggregate was obtained. The total weight of the catch by species and market grade was obtained for each trip, either by using the trip ticket weights or some other reliable estimate. Length frequencies obtained from a sample were then expanded to the total catch of a trip using the total weights from the trip ticket. All expanded catches were combined to describe a given commercial gear for six-month periods (January-June, July-December).

Comprehensive sampling of the flounder pound net fishery began in 1989. Flounder pound net sampling occurs primarily from September to December and catches were sampled throughout the range of the fishery from Albemarle Sound to Back Sound. The annual number of southern flounder measured from the flounder pound net fishery ranged from 2,639 fish in 2003 to 8,198 fish in 1992 (Table 9). This fishery catches a wide size range of southern flounder. Modal size classes vary by year and are partly a result of dominant year classes. The number of samples collected and size ranges of fish sampled per year has fluctuated due to varying sampling intensity and fishing effort.

The estuarine gill net sampling program began in 1991 and occurs year-round throughout the state with variable degrees of sampling intensity in different areas and times of the year. Southern flounder samples come from both small (less than 5 in stretched mesh) and large mesh (5 in stretched mesh and greater) catches, but the majority of the samples come from large mesh catches (target fishery). The number of southern flounder samples is higher during the latter part of the year (July-December) when the fishery is more active (Table 10). The annual number of southern flounder measured from the estuarine gill net fishery ranged from 2,673 fish in 1992 to 12,611 fish in 2007. The modal size classes were 340 and 360 mm in this fishery for most of the time series. The larger modal length class in July-December 2005-2007 was likely a result of the minimum size limit increase to 14 in in 2005.

The majority of the southern flounder estuarine gill net samples from 1991 to 1994 were from western Pamlico Sound and the Pamlico River catches. The size ranges of fish sampled were not as broad during these years because the catches from these areas were mostly comprised of younger, smaller southern flounder. Sampling intensity in other areas of the State increased during the late 1990s. Sampling in Core Sound began in 1996, and catches were sampled more frequently after 1998. Samples from the southern counties (Onslow, Pender, New Hanover, and Brunswick) began in 1998.

The sampling of commercial gig catches began in September 2004. The catches sampled ranged from southern Pamlico Sound to Lockwood Folly River with the majority from Core and Back sounds. The number of gig fishery samples collected per year was lower than in the estuarine gill net and pound net fisheries, however, the effort and landings of southern flounder in this fishery were much lower (Table 11) (NCDMF 2008a). The size range of southern flounder sampled in the gig fishery was similar to the flounder pound net fishery. To compensate for the lack of commercial gig fishery length frequency data from 1991 to January-June 2004, July-December flounder pound net length frequencies were used as a proxy. Length frequency distributions from the fall flounder pound net fishery were similar to the spring and fall length frequency distributions from the commercial gig fishery (Figure 6). This allowed for creation of a commercial gig catch at age matrix that covered the time series of the assessment.

Commercial CPUE Index

A commercial gill net fishery index was developed from landings in the NCDMF's NCTTP database to track the changes in older age classes of southern flounder. The NCDMF Trip Ticket Program has collected trip level data since 1994; therefore, a commercial fishery index was developed using a trip as a measure of effort since the program's implementation. The anchored gill net fishery that targets southern flounder was selected as the most appropriate fishery to use for a commercial fishery index because the gill net fishery accounts for the majority of southern flounder landings, operates in all months of the year, and occurs throughout the State. As with any fishery dependent index, however, trip level effort was not standardized, and it was assumed that behavior in this fishery did not significantly change through the time series.

A Stephens and MacCall (2004) trip selection criterion was used to determine which trips target southern flounder. The Stephens and MacCall (2004) criterion uses a logistic regression analysis to compare the different types of species landed on a trip and determines which species are the best predictors of the target species by assuming the best predictor species use the same habitat as the target species. By using this method, null trips are selected. Trips were also retained if they were comprised of 50% or more, by weight, of southern flounder.

Once the trips were selected, a delta-lognormal analysis was run in PC SAS to generate the index (SAS 2006). This approach helps to minimize variability in the data by using year, month and waterbody as factors in the analysis. The delta-lognormal analysis combines the analysis from a binomial and lognormal analysis together to generate the index (Lo et al. 1992, Maunder and Punt 2004). The standardization of the index was accomplished by dividing by the mean. Southern flounder CPUE fluctuated during the time series but showed a slight declining trend from 2002 to 2007 (Figure 7).

Recreational Landings and Length Frequencies

The Marine Recreational Fishery Statistics Survey (MRFSS) estimates the recreational harvest from the hook and line fishery. The survey has two parts: a coastal county household telephone survey and an angler intercept survey at access sites. The survey data were combined to estimate numbers of fish harvested, released, harvest biomass, total trips, and numbers of people fishing recreationally. Beginning in 1987, North Carolina supplemented the MRFSS sampling targets for the State, increasing the sample size by nearly six fold. The supplemental sampling has greatly improved catch estimate precision. Catch is classified as Type A, Type B1, or Type B2. Type A catch is fish that are available for length, weight and enumeration data. Type B1 catch is harvested fish that are not in whole form, discarded dead, or not available for length and weight data. Type B2 catch is fish that were released alive. The sum of Types A and B1 equals total harvest, and the sum of Types A, B1, and B2 equals total catch. Proportional standard error (PSE) was used to examine the precision of MRFSS estimates. Catch estimates are generated for two month periods (Wave), methods of fishing (Mode), and fishing locations (Area). For further information on MRFSS and the recreational sampling methodology, see NCDMF (2008a). Weighted length frequency data from the Type A catch was used to generate the recreational catch at age matrix.

Recreational CPUE Index

A recreational CPUE index was created from the MRFSS data using the estimated total number of southern flounder caught (harvested and released) divided by the total number of directed, caught, and targeted trips. A directed trip was defined as a trip where southern flounder were caught or listed as a target species by the angler during the intercept interview. Targeted trips were defined as southern flounder as one of the top two species sought by the anglers during the intercept interview. The index fluctuated without trend through most of the time series from 1991 to 2007 (Figure 8).

Discard Estimates

The NCDMF gill net observer data were used to estimate discards and discard mortality from the estuarine gill net fishery. Only observer data from 2004 to 2006 were used because observer trips occurred throughout the year and covered much of the estuarine waters in the State. This time period also covers the different minimum size limits (13 in in 2004, 14 in in 2005 and 2006) for the commercial southern flounder fishery. The observer data estimated an annual discard mortality rate of 17.3% for regulatory discarded southern flounder. This estimate is similar to the mortality estimates for southern flounder in the NCDMF Pamlico Sound Independent Gill Net Survey (NCDMF 2007b). Sampling among seasons and areas was too variable to calculate seasonal discard mortality rates. The assumed mortality rate for the unmarketable southern flounder in the observer data was 100%. Examples of unmarketable southern flounder include legal sized fish partially eaten by crabs or birds and spoiled fish. The total observed dead regulatory discards and the unmarketable southern flounder was 4.5% of the total number of observed kept southern flounder. This resulted in a dead discard rate of 4.5%. The total annual dead discards were estimated by multiplying the dead discard rate by the annual total numbers of southern flounder harvested in the estuarine gill net fishery. The underlying assumptions with this methodology are that the observer data is representative of the commercial estuarine gill net fishery, all marketable, legal sized southern flounder were kept, and the discard mortality rates remained constant. There was insufficient data for estimating discards in other fisheries such as the pound net, gig, crab pot, and shrimp trawl fisheries.

The MRFSS estimates the number of southern flounder released alive by anglers, but the estimates are not species specific because the MRFSS clerks did not observe the released flounder. In order to develop release estimates for southern flounder species in the State, the proportion of southern flounder harvested in a particular Wave, Mode, and Area was applied to the number of released flounder from the same Wave, Mode, and Area. This method assumes that the species proportion of released flounder is the same as the kept flounder. A hook and line release mortality study by Gearhart (2002) found the release mortality of southern flounder in low salinity waters was 19.4%, and the release mortality in high salinity waters was 9.5%. A weighted mortality estimate was calculated by applying the high and low salinity mortality estimates to the annual numbers of southern flounder observed by the MRFSS in high and low salinity areas. This resulted in a weighted discard mortality estimate of 10.83% that was applied to the number of released southern flounder to calculate the number of dead discards from the recreational fishery (Table 12). The majority of southern flounder sampled in the MRFSS were from high salinity areas in the State, which resulted in a weighted discard mortality estimate that is more similar to the high salinity mortality estimate than the low salinity mortality estimate. Much of the sampling by Gearhart (2002) occurred in the summer with only minimal data available for the spring, and fall, so seasonal effects on release mortality could not be analyzed from this study. However, peak recreational harvest of southern flounder occurs in the summer (Figure 2).

Length frequencies of southern flounder below the recreational minimum size limit from the Albemarle Sound Gill Net Survey were assigned to the recreational releases in order to include these fish in the catch at age analysis. The 6-month length frequencies (January-June and July-December) were pooled across years to account for small sample sizes for particular 6-month periods. This survey was chosen because catches of southern flounder were representative of the size range of undersized fish that recruit to hook and line gear. The assumption behind this decision was that anglers released only undersized southern flounder. Although it is likely that some legal sized southern flounder were also released, this assumption was determined to be reasonable because the average catch per angler, per trip was well below the creel limit (Table 13). Previous Northeast Fisheries Science Center's (NEFSC) summer flounder stock assessments assumed that all released summer flounder were undersized based on the New York Department of Environmental Conservation (NYDEC) party boat data that showed greater than 95% of released summer flounder were undersized (NEFSC 2002).

Catch at Age Matrices

Catch at age matrices were developed for the commercial and recreational sectors and their respective discards by gear. Catch at age matrices were calculated using commercial and recreational landings and harvest, age-length keys and respective length frequency distributions. Annual age length keys and length frequencies were in 1 in size bins for semiannual periods (January-June and July-December). These semiannual periods account for the relatively fast growth of southern flounder. Holes in the semiannual age length keys were filled by using the pooled age length keys from 1991 to 2007 from the same semiannual period. Holes were filled when less than three fish were available for a given size bin in a semiannual key. Commercial landings were converted to numbers of fish for each fishery using semiannual mean weights by market grade for each fishery. Length frequencies for each market grade from fishery dependent sampling were generated for each commercial fishery. Market grade specific pooled length frequencies were used to fill holes in market grades with no length frequency data in a particular fishery and season. The proportion of females at size was applied to the length frequency distributions to create a female catch at length component. These catch at length matrices were converted to numbers at age using the semiannual female age length keys.

The majority of female southern flounder harvested in the target commercial fisheries were ages 1 and 2, which accounts for approximately 86% of the average annual estuarine gill net and pound net catches and 83% of the average annual commercial gig catches (Tables 14-16). The commercial gig fishery harvested a greater proportion of age-3 southern flounder than the estuarine gill net and pound net fisheries (Table 16). The catch composition at age for the other commercial fisheries was similar to the estuarine gill net, pound net and commercial gig fisheries (Table 17). The proportion of age-0 and age-1 female southern flounder decreased in 2005 when the minimum size limit increased to 14 in. The increased proportion of age-3 southern flounder in 2006 and age-4 southern flounder in 2007 was a result of a relatively strong 2003 year class. The estimated numbers of female southern flounder discarded in the estuarine gill net fishery ranged from 15,691 fish in 1992 to 36,191 fish in 1994 (Table 18). The majority of the female discards were age-1 and approximately 96% of average annual estuarine gill net discards were ages 0-2.

The majority of female southern flounder harvested in the recreational gig and hook and line fisheries were ages 1 and 2 but comprised a smaller proportion of the average annual catch (77%) than the commercial fisheries (Table 19). The higher minimum size limits in the ocean and estuarine recreational fisheries may have contributed to this trend (Table 6). Over 97% of the female discards in the recreational fisheries were ages 0-2 (Table 20).

FISHERY INDEPENDENT DATA

Albemarle Sound Independent Gill Net Survey

A catch per unit effort (CPUE) at age for female southern flounder was calculated from the Albemarle Sound Independent Gill Net Survey. This independent gill net survey is a random stratified multi mesh monofilament gill net survey, designed to monitor the Albemarle/Roanoke striped bass population since October 1990 (Godwin 2007) (Figure 9). Survey indices from 1991 to 2007 were available for the stock assessment. The fishing year is divided into three segments: 1) a Fall/Winter survey period, which begins approximately November 1 and continues through February 28; 2) a Spring survey period that begins March 1 and continues through approximately June 30, and 3) a summer survey period that starts July 1 and continues through October 30. The sampling methods remain the same during each sampling season. However, areas fished, sampling frequency, and sampling effort were altered seasonally to sample the various segments of the striped bass population. Samples from only November and December were used because these months cover all of the areas fished in the survey, and colder water temperatures that are common in January and February do not affect the catchability of southern flounder to the gear in these months.

Two sets of twelve mesh sizes (2½, 3, 3½, 4, 4½, 5, 5½, 6, 6½, 7, 8, and 10 in stretched mesh) of gill nets were set by each of the two survey crews. Gill nets were constructed in 40 yard sections for each mesh size for a total of 960 yards of gill net per sample. The crews sampled each of the six zones providing 24 fishing days per month and 96 fishing days for November and December combined. A fishing day was defined as each crew fishing the full complement of nets specified for one day (24 hours).

The predicted sex ratios per size bin used to generate sex specific catch at age matrices for the different fisheries was applied to the total numbers of southern flounder caught in November and December of the survey. The semiannual female only age length keys were then applied to the female survey lengths to develop the female CPUE at age. The overall annual CPUE of southern flounder from this survey declined after 1993 and varied without trend until 2007, which was among the highest CPUEs in the time series (Figure 10). The CPUE at age matrix showed that on average, southern flounder are fully selected to the gear at age-1 (Table 21). Age-0 fish were not fully selected to the gear because the smallest mesh size in the survey is 2 ½ in stretched mesh. Therefore, age-1 and age-2 indices are used in the model.

Pamlico Sound Independent Gill Net Survey

A CPUE at age for female southern flounder was calculated from the Pamlico Sound Independent Gill Net Survey. The program began in 2001 with four objectives: 1) to calculate annual abundance indices for key species in Pamlico Sound (including southern flounder), 2) to provide supplemental samples for age, growth, and reproduction studies, 3) to evaluate catch rates and species distribution in relation to bycatch, and 4) to characterize habitat use (Figure 11) (NCDMF 2007b). Survey indices from 2001 to 2007 were available for the stock assessment. The survey was conducted using a stratified-random survey design with depth (greater or less than 6 ft) and region as strata. Regions were overlaid with a one-minute by one-minute grid system, with sampling sites selected randomly using PROC PLAN in SAS (SAS 2006). Each grid selected was sampled with a net array of 30-yard segments of 3, 3 ½, 4, 4 ½, 5, 5 ½, 6, and 6 ½ in stretched mesh for 240 total yards of gill net fished in both the deep and shallow strata. For each month, random samples were obtained from 16 shallow and 16 deep water sites. Gear was deployed within an hour of sunset and soaked for approximately 12 hours before retrieval. The sampling season occurred annually from February 15 to December 15.

The predicted sex ratios per size bin used to generate sex specific catch at age matrices for the different fisheries was applied to the total numbers of southern flounder caught in the survey. The semiannual female only age length keys were then applied to the female survey lengths to develop the female CPUE at age. The overall annual CPUE of southern flounder from this survey showed a decreasing trend (Figure 12). The CPUE at age matrix shows that southern flounder were fully selected to the gear at ages 1 and 2 (Table 22). Age-0 fish were not fully selected to the gear (smallest mesh size 3 in stretched mesh). Therefore, age-1 and age-2 indices were used in the model.

Pamlico Sound Trawl Survey

This survey was initially designed to provide a long-term fishery-independent database for the waters of the Pamlico Sound, eastern Albemarle Sound, and the lower Neuse and Pamlico rivers (Figure 13). However in 1990, the Albemarle Sound sampling in March and December was eliminated, and sampling occurred only in the Pamlico Sound and associated rivers and bays during the same two weeks in June and September (NCDMF 2007c). Since 1991, there were only two years in which the survey did not occur over the same time series: 1999, and 2003. In 1999, samples were collected during the month of July and the end of September and October because vessel repairs and hurricanes prevented following the normal schedule. In September 2003, Hurricane Isabel caused a delay and sampling was completed in October. It was advised to use the 1999 index with caution since there were significant delays for both months.

The survey gear is double rigged demersal mongoose trawls towed at 2.5 knots for 20 minutes (NCDMF 2007c). The headrope length of the trawl is 30 ft, the mesh size of the body of the trawl is 1 7/8 in stretched mesh and the tail bag mesh size is 1 ½ in stretched mesh. The volume covered in a 20-minute tow is estimated at 29,138 m^3 (1,050,000 ft^3) for both nets combined. All species were sorted and a total number and weight was recorded for each species. For target species, 30-60 individuals were measured and collectively weighed. Environmental data taken during each tow included temperature, salinity, wind speed, and wind direction. The two catches from each tow were combined to form a single sample in an effort to reduce variability.

Survey indices from 1991 to 2007 were available for the stock assessment. The Pungo River stratum was included in the juvenile index calculations, which only include the years 1991-2007 when this stratum was included in the sampling. The juvenile index was the annual geometric mean (weighted by strata) of the number of individuals per tow for YOY southern flounder. Quarterly length frequency distributions were examined to determine the size range for YOY of each species. YOY size cutoff ranges for southern flounder were less than 160 mm TL in June and less than 230 mm TL in September. The annual geometric mean was derived only from the month of September because it was suspected that the YOY southern flounder were not recruiting to the gear until September and the June samples may include age 1 southern flounder (J. Chris Taylor, NOAA, personal communication). Peak abundance of southern flounder in the Pamlico Sound Survey occurred in 1992 and 1996 before declining to the time series low in 1998 (Figure 14). Juvenile abundance since 1999 has fluctuated between 0.35 in 2007 to 1.18 in 2005.

Estuarine Trawl Survey

In 1971, the NCDMF initiated a coast wide estuarine trawl survey. The initial objectives of the survey were to identify the primary nursery areas and produce annual recruitment indices for economically important species such as spot (*Leiostomus xanthurus*) Atlantic croaker, weakfish, southern flounder, summer flounder, blue crab (*Callinectes sapidus*), and brown shrimp (*Farfantepenaeus aztecus*) (NCDMF 2008b). Other objectives included monitoring species distribution by season and by area, and to provide data for the evaluation of environmental impact projects. Various gears and methodologies were used in the survey since 1971. In 1978 and 1989, major gear changes and standardization in sampling occurred. In 1978, tow times were set at one minute during daylight hours. In 1989, an analysis was conducted to determine a more efficient sampling time frame to produce juvenile abundance indices with acceptable precision levels for the target species. A set of 105 core stations was identified and sampled each year in May and June only.

The survey gear is a two seam otter trawl towed for one minute, with tows calibrated to span 75 yards (NCDMF 2008b). The headrope length is 10.5 ft, the mesh size of the body of the trawl is ¼ in bar mesh and the tail bag mesh size is 1/8 in bar mesh. Tows were made with the tide and boat speed was adjusted to account for wind. Core stations were sampled in the mid-two weeks of May and June. All species were sorted, and a total number was recorded for each species. For target species, 30-60 individuals were measured. Environmental data taken during each tow included temperature, salinity, wind speed, and wind direction.

Survey indices from 1991 to 2007 were available for the stock assessment. The juvenile index is the annual geometric mean of the number of individuals per tow for YOY. The annual geometric mean was calculated by combining both months (May and June). A subset of the 105 core stations was used for the calculations of indices. YOY size cutoff ranges for southern flounder were less than 70 mm TL in May and less than 100 mm TL in June. Peak abundance of southern flounder in the Estuarine Trawl Survey occurred in 1996 and 2003 with the time series low occurring in 1998 (Figure 15). Juvenile abundance steadily declined from 2004 to 2006 before increasing in 2007.

Beaufort Inlet Ichthyoplankton Sampling Program

The Beaufort Inlet Ichthyoplankton Sampling Program at the NOAA Center for Coastal Fisheries and Habitat Research is the longest consecutive ichthyoplankton sampling program along the US east coast, representing a 21-year time series of larval fish ingress through one of five major inlets into North Carolina estuaries (Taylor et al. 2007). Research efforts using these data have addressed timing of immigration, age and size characteristics of larvae, inferences on spawning sources, and biophysical linkages to larval transport. Many of the most abundant species that are sampled are members of a guild that spawn near the continental shelf in the fall and winter. The larvae are transported shoreward and ingress through inlets in the Southeast US into estuarine nursery habitats.

The ichthyoplankton sampling program occurs at a single location 1 km upstream from Beaufort Inlet on the bridge crossing onto Pivers Island, North Carolina, adjacent to Gallants Channel and feeding into the Newport River Estuary. An estimated 10% of the water flowing through Beaufort Inlet passes through this channel and provides tidal exchange for the surrounding estuarine complex. Larvae are collected using a 2-m^2 rectangular plankton net with

1 mm mesh and fitted with a flow meter. The net was deployed at the surface during night time flood tides. Maximum channel depth (at high tide) is approximately 3 m. Four replicate sets were made weekly from November to April from 1986 to 2004. From 1986 to 1998, near-constant sample durations of 5 minutes were used, resulting in some variability (though precisely known) of volume filtered. After 1998, a digital flow meter was used and filter volume was standardized to approximately 100 m^3. Samples were preserved in alcohol, sorted, and identified in the laboratory. Samples from the entire time span were standardized to numbers of individuals per 100 m^3.

Survey indices from 1991 to 2004 were available for the stock assessment. A processing backlog of the last three years of samples prevented recent data from being available. Annual mean larval concentrations for southern flounder were calculated from weekly (November to April) concentrations and reported as geometric mean. Units were scaled as larvae per 100 m^3. The annual geometric means show cyclical trends through much of the time series with an increasing trend of indices to the time series high after 2001 (Figure 16).

METHODS

ASAP2 MODEL

The model selected to estimate mortality and abundance for this assessment is a forward projecting statistical catch at age model called ASAP2, (NOAA Fisheries Toolbox 2008a). The forward calculation method used for ASAP2 does not require the catch at age to be calculated without error. This means that the model will not attempt to fit the catch at age values perfectly. This version of ASAP also allows the flexibility to use different selectivity curves for various gears and when regulatory changes cause shifts within the fishery. The parameters are estimated in phases, which allow parameters to be estimated in smaller batches rather than all at once. Catchability in the first year, the annual fully selected F (F_{mult}) in the first year, and unexploited stock size are estimated in phase one. Phase two estimates the abundance in numbers (N) in the first year, and phase three estimates F_{mult} deviations. Phase four estimates recruitment deviations and phase five estimates the stock recruitment steepness. Equations related to the ASAP2 model can be found in the technical documentation bundled with the model, as well as the AD Model Builder code (NOAA Fisheries Toolbox 2008c). Tuning followed the method suggested in the User Manual, with the tuning coefficients of variation (CV) listed in Table 23 and lambdas remaining at 0 except for sensitivity analysis (NOAA Fisheries Toolbox 2008c).

The model was configured using three catch at age matrices: 1) the commercial gill net fishery only, 2) all other commercial fisheries combined (gigs, pound nets, and all other gears), and 3) recreational fisheries combined. There were two additional discard at age matrices separate from the catch at age: one for the commercial gill net fishery and one for the recreational hook and line fishery. It was not possible to calculate discards for the recreational gig fishery and any other commercial fisheries.

The index selection process occurred in steps. The southern flounder data workgroup met to determine which surveys were appropriate for southern flounder indices and how best to calculate those indices. The fishery independent indices were calculated at the individual age level and only those ages considered to be fully selected to the survey gear or with sufficient annual sample size were included. After initial model runs were conducted, the model was re-run excluding indices with poor fits.

There were two dome-shaped selectivity periods for the commercial gill net fishery: 1991-2004 and 2005-2007 (Table 24). For all other commercial fisheries, there were two asymptotic selectivity periods: 1991-2004 and 2005-2007. For the recreational fisheries, there were three asymptotic selectivity periods: 1991-1998, 1999-2004, and 2005-2007. The default shape for selectivity curves in the model is asymptotic, though other shapes can be used. In the case of the dome-shaped selectivity for the gill net fishery, the majority of larger southern flounder do not entangle in the mesh sizes commonly used in this fishery. All selectivity changes were primarily the result of minimum size limit changes in the commercial and recreational fisheries (Table 6) (NCDMF 2005).

YIELD-PER-RECRUIT

Yield-per-recruit (YPR) and biomass-per-recruit (BPR) models, as configured in the NOAA Fisheries Toolbox, were used to determine F and SSB thresholds (NOAA Fisheries Toolbox 2008e). The ASAP2 model does calculate F benchmarks internally, but advises that those benchmarks are not reliable if there have been changes in selectivity over time or between fisheries. As there are different selectivities occurring over time, benchmarks must be calculated separately from the ASAP2 model. The selectivity used in the YPR was an average of the selectivities in the terminal year, which was calculated by dividing the sum of the directed F by the maximum F of the vector. Several different benchmarks were calculated to determine the most appropriate for management. The benchmarks were $F_{0.1}$, $F_{25\%}$, $F_{30\%}$, $F_{35\%}$, and $F_{40\%}$ and their related spawning stock biomasses (SSB). The related SSB values were calculated by taking the calculated SSB per recruit value and multiplying it by the ASAP2 estimated average recruitment for the last seven years. The stock lacks a spawner-recruit relationship, which precludes calculating MSY and similar benchmarks.

ASSESSMENT ASSUMPTIONS

The ASAP2 model and other forward projection models have several assumptions. As mentioned previously, this forward-projecting model does not assume that the catch at age matrices are determined without error. Forward projecting models tune to the catch at age matrix and the incorporated indices. Indices are assumed to reflect the actual population abundance. Influences on abundance measurements (e.g. regulation changes in a dependent index) beyond natural and usual fishing removals must be considered in the analysis. Since the model is projecting forward, the beginning of the time series is the most uncertain. This model also requires assumptions about the level of fit with most of the input data, leading to large numbers of estimated output parameters. These parameters include catchability in the first year, F_{mult} in the first year, unexploited stock size, numbers of fish (N) in the first year, F_{mult} deviations, recruitment deviations, and the stock recruitment steepness. Another assumption is the catch at age matrices are a more precise measure of the actual catch at age than the discard at age matrices. The commercial catch data is assumed more precise than the recreational catch data. In general, the indices were assumed to be less precise than the catch at age because the catch at age is an estimate of absolute catch while the indices are proportional to but not absolute estimates of population abundance. Average F ages 2 to 5 were chosen for determination of stock status values as those ages encompass fish that are likely to be fully selected to most gear types. While age-1 is a large component of the catch, it is not fully selected.

RESULTS

FISHING MORTALITY

The overall trend of fishing mortality (F) is a recent decline from the earlier part of the time series. Fishing mortality peaked twice, once in 1994 at 1.5693 and again in 2002 at 1.6511 (Figure 17 and Table 25). After 2004, there is a sharp drop in F to the lowest F in the time series in 2005 at 0.6813. Since 2005, F has increased to 0.7534 in 2007. The directed F for the different fisheries show that F was highest from 1994-2003 for the commercial gill net fishery and decreased slightly after that (Table 26). This can be seen by examining the peak F for each year. There has been a clear decrease in F for the other commercial fisheries, primarily influenced by declines in the pound net fishery (Tables 27). The F was highest at the beginning of the time series (1991-1995) to the current lows. The F has increased in the recreational fisheries, which was initially very low and then increased starting in 2000 (Table 28). At the beginning of the time series, the largest component of F was from the commercial fisheries other than gill net, while in recent years the largest F component was from the commercial gill net fishery (Figure 18). The smallest component early in the time series was the recreational fishery, while in the most recent years it was the commercial fisheries other than gill nets.

SPAWNING STOCK BIOMASS (SSB)

Spawning stock biomass has increased in recent years from an earlier plateau. In 1991, the estimated SSB was 4,080,760 lb, with the highest SSB occurring 2005 at 4,381,680 lb (Figure 19 and Table 29). The lowest SSB occurred in 2000 at 2,202,480 lb. From 2003 to 2005, there was a notable increase in SSB from 2,218,950 lb to 4,381,680 lb. Since 2005 there has been a slight increase in SSB to the terminal year value of 4,358,990 lb.

RECRUITMENT

Recruitment at age-0 was below the estimated time series average (11,263,348 fish) for six of the last seven years (Figure 20 and Table 30). In contrast, only two of the first seven years were below the time series average for age-0 fish. Recruitment estimated for the terminal year (2007) was 8,214,610 fish. Peak recruitment of 17,777,400 fish occurred in 2003, and the minimum recruitment (5,969,280 fish) during the time series occurred in 1998 (Figure 20 and Table 30).

ABUNDANCE

Total abundance showed a decreasing trend throughout the time series (Figure 21 and Table 30). Total abundance peaked in 2003 at 21,795,173 fish. Only one year prior to 1997 had a total abundance less than 17 million fish, while eight years had a total abundance less than 17 million fish since 1998. The age-1 abundance showed a slight declining trend and age-2 fish varied in abundance with a slight decline through much of the time series (Figures 22 and 23). The highest abundance for ages 3 through 6+ fish have occurred most recently from 2005 through 2007 (Figures 24-27). Over half of the stock was estimated to be age-0, with the only notable shift in age structure a small increase in older fish (ages 3 through 6+) in the last two years of the assessment. With the majority of the stock comprised of age-0 fish, the total abundance trends most closely resemble the age-0 trends. Strong year classes, like 2003, typically resulted in lower F estimates in the following two years (2004 and 2005). The years of high F, 1994 and 2002, do not have a clear total abundance pattern that would explain the changes in F. In the two years prior to 2002, there was below average recruitment, but that did not occur in the two years prior to 1994. The high F estimates were more likely a function of high removals, as was the case in 1994, which had the highest removals in the assessment (Table 1).

STOCK-RECRUIT RELATIONSHIP

ASAP2 attempted to estimate a stock-recruitment relationship based on the data available. The current stock-recruit relationship did not fit to a Beverton-Holt stock-recruitment relationship (Figure 28). Instead, the observed values scattered around a straight predicted relationship line. This current relationship had a steepness of near one (0.9995) and was not appropriate for use in determining MSY values. The current stock-recruit relationship may have been the result of the relatively short time frame of the stock assessment and the limited contrast in the data.

STOCK STATUS DETERMINATION

FRA criteria

According to the North Carolina Fisheries Reform Act, population status is determined by the stock's ability to achieve sustainable harvest. Such an approach reflects stock biomass, and is typically used to determine whether a stock is overfished. A stock is also evaluated based on the rate of removals, e.g. the F rate, which determines whether overfishing is occurring. Actual reference levels for this stock are determined through the FMP development process, and therefore only generalized statements are provided here. The proposed benchmarks are a $F_{30\%}$ threshold and a $F_{35\%}$ target.

YPR and Biological Reference Points

With the lack of any significant stock-recruitment relationship, it was not possible to generate traditional maximum sustained yield (MSY) benchmarks. The benchmarks require a stock-recruitment relationship. It is possible to use spawning potential ratio (SPR) as a proxy, which estimates a proportion of the spawning population remaining relative to the spawning population of an unfished stock. These rates historically range from 30 to 40 percent for most stocks, as some historical examinations of SPR showed increasing risk of recruitment overfishing at levels smaller than 30% (Walters and Martell 2004).

Based on the range of possible reference fishing mortality rates from $F_{25\%}$ to $F_{40\%}$, an F threshold for this stock is between F=0.5937 and F=0.3445 (Figure 29 and Table 31). Estimated fishing mortality in all years between 1991 and 2007 exceeds the upper bound of $F_{25\%}$ =0.5937, and thus overfishing likely occurred during the entire time period (Figure 30). The average fishing mortality rate over the 1991 – 2007 time period of F=1.1631 is above the upper bound of the reference mortality rates (Figure 30). Based on the reference SSB levels associated with the range of fishing mortality thresholds from $F_{25\%}$ to $F_{40\%}$, a threshold spawning stock biomass is between 5,903,817 lb and 9,446,797 lb (Figure 29 and Table 31). Possible reference spawning stock biomass levels exceed the estimated spawning stock biomass in every year from 1991 to 2007. Therefore, it is likely that the stock has been overfished for the entire period (Figure 31). Since the last assessment, while there has been a decrease in F and an increase in SSB, the stock is likely still overfished and overfishing is likely still occurring.

The YPR estimated fishing mortality benchmarks for both threshold and target values. With a $F_{35\%}$ fishing mortality target and $F_{30\%}$ fishing mortality threshold, the resulting benchmarks are 0.4081 and 0.4880 respectively (Table 31). Using the average recruitment, the threshold SSB value was 7,084,845 lb ($F_{30\%}$) of female fish. These values were at or above the SPR levels that increased risk for recruitment overfishing. The SPR is currently 19%.

MEASURES OF PRECISION AND RETROSPECTIVE ANALYSIS

Varieties of procedures are available to evaluate model fit, including observed versus predicted plots for indices, bootstrap estimates of precision and bias, and retrospective patterns. The fit of the observed indices to the model predicted indices was examined. The Albemarle Sound IGNS for ages 1 and 2 fits to the data fairly well except for the earliest years of the time series (Figures 32 and 33). The Pamlico Sound IGNS fit for age-1 appeared to be offset by one year, while the age-2 fit was very good (Figures 34 and 35). The Pamlico Sound Survey and Estuarine Trawl survey fits for age-0 were also fairly good throughout the time series (Figures 36 and 37). The Bridgenet survey index was mixed, with some years of good fits (1995-1998), however the final years of index data did not fit well and the increasing trend was not matched (Figure 38). Neither of the dependent indices, MRFSS or commercial gill net, exhibited a particularly good fit (Figures 39 and 40).

The Monte Carlo Markov Chain (MCMC) method examined the normality of the estimates generated by the model, using 500 iterations and a thinning rate of 200. The F MCMC curves all appeared to be more normal in shape, though the inflection point of the cumulative distribution does not pass through the median for any of the years (Figure 41). The SSB estimates were slightly skewed towards higher values in the curves and they do not have cumulative distribution inflection points that pass directly through the median (Figures 42). The overall shapes of the curves are generally normal, with the F curve more normally distributed than the SSB curve. Ideal model fit would result in completely normal estimate distributions, which did not occur in this case, but this configuration resulted in the closest normal behavior of the runs. The uncertainty in the terminal estimates of F and SSB and the benchmarks could not be investigated because the current model configuration does not have the capability to input benchmark values calculated externally from the model. In the future, this would be a useful diagnostic.

In the retrospective analysis, the current model configuration was applied to previous years, truncating the data series. The analysis looks at the consistency of the same parameter estimates as “new” data (in the form of successive years) are introduced (NRC 1998). The 2002 and 2003 estimates were not shown because the retrospective analysis did not solve properly for those years. Those years may require significantly different configurations to solve in comparison to the current terminal year in terms of the index and parameter weightings. When estimates are biased, there is a systematic increase or decrease in estimated values as data were truncated. Estimated F from 2004 to 2007 had relatively little retrospective bias, though the 2005 estimates were slightly higher and 2004 estimates were slightly lower than the other years of the analysis (Figure 43). Spawning stock biomass showed an extremely small amount of retrospective bias between years with a slight overestimation of SSB in 2004 (Figure 44). Age-0 abundance was overestimated in 2004 and 2005, but lacked any clear trends (Figure 45). Retrospective biases for female total abundance showed no real trends in terminal year estimation (Figure 46). The mix of overestimations and underestimations makes it unclear if the issue is completely systematic. The retrospective patterns of ages 3 through 6+ were examined for possible recent year overestimations. The analyses did not indicate that the recent high increases were systematic overestimations for ages 3 through 5, but age-6+ had some overestimations for entire time series (2003 and 2006) (Figures 47-50). However, the highest abundance estimates were in the last two years and may not be sufficient to determine if there is retrospective bias.

Two other models were examined to determine if the F scale was correct. This test ran both a virtual population analysis (VPA) similar to the primary model from the last assessment and a simple biomass model (NOAA Fisheries Toolbox 2008d, NOAA Fisheries Toolbox 2008b). The VPA was configured using the same data as the ASAP2 model. The biomass model used the total catch and an aggregate Albemarle Sound IGNS survey CPUE as the estimate of abundance. All three models had similar levels of F and similar patterns for the time series (Figure 51). From 1999 to 2007, all three models estimated similar patterns that increase to a peak F in 2002, and then decline to the terminal year.

DISCUSSION

The North Carolina southern flounder stock is currently overfished and is undergoing overfishing. While the stock has continued to undergo overfishing throughout the time series, there have been improvements in the stock's condition. In 2005, F hit a time series low (Figure 30), and the SSB reached a time series high (Figure 31). The age structure has also shifted in recent years with a greater portion of older fish (ages 4 through 6+) in the total population (Figures 24-26). The strong 2003 year class (age-4 in 2007) (Figure 20) and decreased F rates appear to be responsible for the increase in age-4 and greater fish in the population. Therefore, improvements have occurred in the stock since the terminal year (2002) of the previous assessment (NCDMF 2005).

When compared to the previous southern flounder assessment, the overall fishing mortality estimates are lower and the overall SSB estimates are higher, but there were some notable differences between the two assessments (NCDMF 2005). First, the initial model used in 2004 stock assessment was a VPA and this stock assessment used the ASAP2 model. This changed the calculation method from a backward to a forward calculating model. The primary impact on the assessment by changing the model is that it decreased the amount of retrospective bias. There were also changes to the data, which included additional indices because of the longer time series, the inclusion of sampling data from other agencies (NOAA Bridgenet Survey), and different assumptions to some of the datasets compared to the assumptions in the 2004 stock assessment. The assumption about the recreational gig harvest is one example. Another example is how the catch at age matrices differed between the two assessments. The 2004 stock assessment used a February 1 birth date and excluded age and growth samples of southern flounder from the ocean while this assessment used a January 1 birth date and included age and growth samples of southern flounder from the ocean. The main reason for including these samples was the southern flounder in the ocean are part of the unit stock. In addition, a portion of the recreational harvest of southern flounder is from the ocean, there is evidence of mature southern flounder returning from the ocean to the estuaries in the spring, and a proportion of the spawning stock remains in the ocean after spawning. However, this proportion and the annual variation of southern flounder remaining in the ocean are unknown. The age and growth samples from the ocean include a substantial number of fish age-3 and older. Excluding these samples from the catch at age matrices likely contributed to the higher F values in the 2004 stock assessment.

Although the stock has appeared to improve in recent years, there are still some concerns regarding the nature of the fisheries and the uncertainty in the data used in the assessment. The commercial and recreational fisheries heavily rely on the harvest of age-1 and age-2 southern flounder, so incoming recruitment is very important for the sustainability of the stock. In addition, many of these age-1 and age-2 fish are first time spawners, so the ones harvested in the fall as they migrate to the ocean do not get an opportunity to spawn. Consecutive years of low recruitment can result in increased F and decreased SSB in subsequent years, as evident in this stock assessment (Figure 17; Figures 19 and 20). The benchmarks for determining whether the stock is overfished and whether overfishing is occurring are partly dependent on the maturity schedule developed by Monaghan and Armstrong (2000) and the von Bertalanffy growth curve. If the proportion of mature female southern flounder at age is lower than estimated, then it is likely the F benchmarks are lower and the SSB benchmarks are higher than calculated in this stock assessment. The consequence would be the stock is further away from the rebuilding targets and thresholds than currently estimated.

The lack of a trend in total abundance in spite of clear trends in fishing mortality and SSB is unusual. One possible reason for no trend in total abundance is that the calculation of age-0 and age-1 fish may be overestimations of the actual population. This assessment could not account for all sources of removals. Of particular concern is the current inability to estimate shrimp trawl bycatch, which would consist primarily of age-0 fish. This could lead to the systematic overestimation of young fish. Overestimation of young fish could be further compounded if there have been changes in the amounts of fish caught as bycatch over time. If there is an increasing trend of the removal of young fish from the population, then it is currently not reflected in the estimates of those ages. For future assessments, including all sources of removals is essential to determine the most accurate estimate of total abundance.

Current estimates of recreational gigging catch and effort are based on a single year study on the recreational gig fishery. The study demonstrated that the potential exists for the gig fishery to have a significant contribution to the overall removals from the stock. The current formulation reflects the conditions of only one year of the study and does not allow for annual variation separate from the preexisting MRFSS estimates. This variation could be important, so annual southern flounder harvest estimates from the recreational gig fishery should be a priority.

RESEARCH RECOMMENDATIONS

The annual harvest and effort of the recreational gig fishery are unknown. Estimates necessary for the assessment to account for removals were generated using a previous study. An annual coast wide survey of the recreational gig fishery should be developed to collect harvest and effort data. Discard estimates should also be developed for the recreational gig fishery for future assessments separate from the hook and line recreational fishery.

The current discard estimates should continue to be refined for future assessments. Continuing and expanding the estuarine gill net observer program to sample more areas and seasons in the State on an annual basis would help refine the discard estimates in the gill net fishery and improve estimates of the total removals from the population. Discard information also needs to be collected for other commercial fisheries, such as the shrimp trawl, crab pot and pound net fisheries, which could not be included as a source of removals in this stock assessment but are clearly a source of removals in young fish.

The current maturity schedule of southern flounder should be updated to identify any potential shifts in maturity since the previous study and to ensure appropriate F and SSB benchmarks.

The aging data available for large southern flounder (508 mm (20 in) and greater) are currently limited. This could skew the number of fish for those large sizes in the catch at age matrices. The annual collection of otoliths from large southern flounder should be improved, especially in the first half of the year (January-June).

The current unit stock for southern flounder is the coastal waters of North Carolina. Tagging data related to the movements of southern flounder are limited. Further studies to determine the movement patterns of southern flounder to better determine if the unit stock is limited to North Carolina or covers a larger geographic area should be pursued.

A portion of southern flounder remains offshore after spawning occurs. Further research on southern flounder that remain offshore after spawning is necessary.

MRFSS creel clerks cannot directly observe the recreational releases of flounder. A study to determine the species composition of flounder released recreationally is required.

Currently available data should continue to be maintained and updated for future assessments. Collection of southern flounder data from fishery independent programs should continue. An expanded time series of adult CPUE estimates may improve stock recruitment relationships in future assessments.

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Table 1. Annual proportions of commercial and recreational harvest (pounds) of southern flounder, 1991-2007.

Year	Commercial harvest	Percent harvest	Recreational harvest	Percent harvest	Total harvest
1991	4,163,374	93.83%	273,674	6.17%	4,437,048
1992	3,145,020	95.49%	148,618	4.51%	3,293,638
1993	4,272,368	97.43%	112,812	2.57%	4,385,180
1994	4,878,639	94.87%	263,612	5.13%	5,142,251
1995	4,166,966	94.70%	233,238	5.30%	4,400,204
1996	3,807,009	94.29%	230,674	5.71%	4,037,683
1997	4,076,793	90.31%	437,234	9.69%	4,514,027
1998	3,952,729	95.73%	176,292	4.27%	4,129,021
1999	2,933,331	94.98%	155,010	5.02%	3,088,341
2000	3,205,792	85.53%	542,476	14.47%	3,748,268
2001	3,522,136	89.17%	427,822	10.83%	3,949,958
2002	3,436,753	87.90%	473,300	12.10%	3,910,053
2003	2,198,503	83.21%	443,614	16.79%	2,642,117
2004	2,454,577	74.27%	850,450	25.73%	3,305,027
2005	1,870,754	71.76%	736,202	28.24%	2,606,956
2006	2,287,823	75.74%	732,808	24.26%	3,020,631
2007	2,077,798	73.93%	732,618	26.07%	2,810,416
Average	3,320,610	89.01%	410,027	10.99%	3,730,636

Table 2. Annual commercial landings (pounds) of southern flounder by gear, 1991-2007.

Year	Gig	Estuarine gill net	Pound net	Other	Total
1991	174,392	1,478,357	1,980,510	530,115	4,163,374
1992	40,587	1,141,439	1,759,437	203,557	3,145,020
1993	59,326	1,695,248	2,339,844	177,950	4,272,368
1994	68,135	2,253,821	2,273,062	283,620	4,878,639
1995	76,062	2,150,113	1,723,086	217,705	4,166,966
1996	58,987	1,877,162	1,653,818	217,043	3,807,009
1997	88,555	2,380,989	1,413,442	193,808	4,076,793
1998	65,633	2,406,760	1,283,390	196,947	3,952,729
1999	57,390	1,906,905	788,084	180,951	2,933,331
2000	81,541	2,097,658	880,705	145,889	3,205,792
2001	79,505	1,909,228	1,377,479	155,924	3,522,136
2002	79,254	1,820,954	1,394,953	141,592	3,436,753
2003	71,567	1,476,636	550,959	99,342	2,198,503
2004	88,190	1,607,299	662,510	96,579	2,454,577
2005	68,217	1,292,532	465,011	44,995	1,870,754
2006	84,926	1,543,091	618,573	41,234	2,287,823
2007	100,063	1,454,393	482,927	40,415	2,077,798

Table 3. Annual number, weight (pounds), and proportional standard errors (PSE) of southern flounder harvested and number released from the recreational hook and line fishery, 1991-2007. Estimates come from the Marine Recreational Fisheries Statistics Survey (MRFSS).

Year	Number	PSE	Weight (lb)	PSE	Released
1991	80,540	9.6	136,837	10.7	33,635
1992	38,892	14.6	74,309	16.5	83,025
1993	34,588	14.4	56,406	14.9	156,167
1994	72,124	11.9	131,806	12.7	257,032
1995	54,495	12.3	116,619	13.2	269,350
1996	67,416	13.8	115,337	16.4	178,354
1997	79,719	15.3	218,617	16.3	336,756
1998	42,727	16.1	88,146	17.1	197,069
1999	35,171	21.6	77,505	23.7	73,085
2000	150,315	15.0	271,238	14.6	454,862
2001	115,477	11.5	213,911	11.9	404,319
2002	115,154	13.8	236,650	15.5	515,374
2003	118,898	15.6	221,807	15.6	382,084
2004	196,906	11.1	425,225	11.6	879,373
2005	161,292	13.6	368,101	14.4	514,799
2006	172,136	12.5	366,404	12.8	566,653
2007	154,429	13.3	366,309	13.8	599,786

Table 4. Number of southern flounder landed per person, per trip by recreational giggers, 2002. Current creel limit is highlighted. Note: number of trips landing less than one southern flounder was from trips where the number of giggers outnumbered the number of southern flounder harvested (e.g. a trip with three giggers that harvested two southern flounder).

Fish per angler	Number of samples	Percent	Cumulative percent
0	465	12.0	12.0
1	2,372	61.0	73.0
2	617	15.9	88.9
3	208	5.4	94.2
4	107	2.8	97.0
5	53	1.4	98.3
6	19	0.5	98.8
7	12	0.3	99.1
8	15	0.4	99.5
9	5	0.1	99.6
10	2	0.1	99.7
11	3	0.1	99.8
12	4	0.1	99.9
13	2	0.1	99.9
15	1	0.0	99.9
16	1	0.0	100.0
30	1	0.0	100.0
All	3,887	100.0	100.0

Table 5. Annual effort and harvest (number and pounds) by gear in the RCGL fishery, 2002-2007.

Year	Gear	Trips Number	Percent	Harvest Number	Percent	Harvest Pounds	Percent	Discard Number	Percent
2002	Crab Pot	8,729	31.1	2,996	5.6	4,602	4.6	4,295	8.2
	Large Mesh Gill Nets	14,394	51.4	44,456	83.8	83,136	83.9	16,915	32.4
	Small Mesh Gill Nets	2,895	10.3	4,788	9.0	9,825	9.9	3,769	7.2
	Shrimp Trawl	2,011	7.2	793	1.5	1,543	1.6	27,182	52.1
	All	28,029	100.0	53,032	100.0	99,107	100	52,161	100.0
2003	Crab Pot	4,328	22.0	1,135	2.6	2,252	2.6	1,661	7.5
	Large Mesh Gill Nets	9,129	46.3	29,769	67.9	55,856	65.4	9,830	44.4
	Small Mesh Gill Nets	5,240	26.6	12,702	29.0	26,644	31.2	6,568	29.7
	Trotline (unspecified)	17	0.1	17	0.0	51	0.1	0	0.0
	Shrimp Trawl	1,000	5.1	202	0.5	568	0.7	4,075	18.4
	All	19,714	100.0	43,826	100.0	85,371	100	22,134	100.0
2004	Crab Pot	5,080	24.6	1,192	2.7	2,453	2.9	2,148	8.4
	Large Mesh Gill Nets	9,590	46.4	33,680	75.1	62,833	73.9	11,821	46.5
	Small Mesh Gill Nets	5,002	24.2	9,070	20.2	17,823	21	7,629	30.0
	Shrimp Trawl	996	4.8	892	2.0	1,862	2.2	3,837	15.1
	All	20,668	100.0	44,835	100.0	84,970	100	25,435	100.0
2005	Crab Pot	3,624	23.2	849	2.8	1,832	3.2	1,422	7.9
	Large Mesh Gill Nets	7,576	48.5	22,201	72.4	42,361	73.5	7,781	43.2
	Small Mesh Gill Nets	4,036	25.8	7,113	23.2	12,257	21.3	5,255	29.2
	Shrimp Trawl	396	2.5	516	1.7	1,182	2.1	3,565	19.8
	All	15,632	100.0	30,679	100.0	57,634	100	18,023	100.0
2006	Crab Pot	3,775	27.1	868	4.2	1,754	3.9	1,870	10.4
	Large Mesh Gill Nets	5,631	40.4	15,045	72.4	30,871	68.4	5,543	30.7
	Small Mesh Gill Nets	3,909	28.1	4,751	22.9	12,215	27.1	4,105	22.8
	Shrimp Trawl	605	4.3	115	0.6	279	0.6	6,518	36.1
	All	13,921	100.0	20,779	100.0	45,120	100	18,036	100.0
2007	Crab Pot	3,255	27.6	586	3.2	1,353	3.3	1,933	13.2
	Large Mesh Gill Nets	4,439	37.6	12,024	66.5	26,047	63.9	5,383	36.9
	Small Mesh Gill Nets	3,746	31.7	5,300	29.3	12,948	31.8	4,122	28.2
	Shrimp Trawl	372	3.2	181	1.0	405	1	3,155	21.6
	All	11,812	100.0	18,092	100.0	40,753	100	14,591	100.0
Total	Crab Pot	28,792	26.2	7,627	3.6	14,246	3.5	13,328	8.9
	Large Mesh Gill Nets	50,758	46.2	157,175	74.4	301,103	72.9	57,272	38.1
	Small Mesh Gill Nets	24,828	22.6	43,724	20.7	91,713	22.2	31,449	20.9
	Trotline (unspecified)	17	0.0	17	0.0	51	0	0	0.0
	Shrimp Trawl	5,380	4.9	2,698	1.3	5,840	1.4	48,332	32.2
	All	109,776	100.0	211,242	100.0	412,955	100.0	150,381	100.0

Table 6. Recreational flounder regulations in North Carolina, 1993-2007.

	Estuarine Waters			Ocean Waters		
Year	Size Limit	Bag Limit	Closed Season	Size Limit (TL)	Bag Limit	Closed Season
1993	13"	----	----	13"	----	----
1994	13"	----	----	14"	8 (1/1-10/31)/ 6 (11/1-12/31)	----
1995	13"	----	----	14"	8	----
1996	13"	----	----	14"	8	----
1997	13"	----	----	14" (1/1-3/31)/ 14.5" (4/1-12/31)	8 (1/1-3/31)/ 10 (4/1-12/31)	----
1998	13"	----	----	14.5" (1/1-6/6)/ 15" (6/7-12/31)	10 (1/1-6/6)/ 8 (6/7-12/31)	----
1999	13"	----	----	15"	8	----
2000	13"	----	----	15"	8	----
2001	13"	----	----	15.5"	8	5/1-5/14
2002	13" (1/1-9/30)/ 14" (10/1-12/31)	----	----	15.5"	8	4/3-7/4
2003	14"	----	----	15"	8	----
2004	14"	----	----	14"	8	----
2005	14"	8 (4/1-12/31)	----	14"	8	----
2006	14"	8	----	14"	8	----
2007	14"	8	----	14.5"	8	----

Table 7. Number at age and size ranges (mm) of male and female southern flounder aging samples, 1991-2007.

	January-June						July-December					
	Male			Female			Male			Female		
Year	No. of fish	Age range	Size range	No. of fish	Age range	Size range	No. of fish	Age range	Size range	No. of fish	Age range	Size range
1991	1	1	220	13	1-3	240-520	97	0-3	180-440	327	0-5	200-720
1992	45	1-3	140-320	95	0-3	160-520	142	1-2	260-400	156	0-4	160-580
1993	52	1-3	140-320	87	1-4	140-380	21	1-3	260-380	97	1-4	320-600
1994	0			2	3	500-520	0			80	1-4	340-600
1995	19	0-3	160-340	20	1-3	180-480	82	1-3	240-480	151	1-4	280-640
1996	25	0-3	140-360	94	1-5	160-700	68	0-2	100-380	276	0-5	120-720
1997	26	1-3	120-380	186	1-5	140-640	38	1-2	200-360	239	0-5	200-780
1998	22	1-3	200-380	180	1-5	200-640	151	0-4	144-400	400	0-6	140-760
1999	18	1-4	220-400	162	1-5	220-620	52	0-3	120-400	255	0-5	120-780
2000	9	1-3	200-340	203	1-6	180-680	30	0-2	220-480	405	1-7	160-780
2001	32	1-5	200-440	204	1-7	200-760	101	0-5	180-460	305	0-7	180-740
2002	9	0-3	200-380	161	0-6	180-740	43	1-3	220-400	221	0-7	200-780
2003	11	1-3	220-360	88	1-8	200-660	24	0-6	220-400	161	0-9	200-800
2004	14	1-4	220-360	189	1-5	180-700	129	0-3	160-460	547	0-6	160-820
2005	19	1-3	240-460	207	1-7	200-780	180	0-3	220-400	443	0-6	200-760
2006	56	1-3	220-360	312	1-6	200-760	61	0-3	180-380	434	0-5	160-720
2007	28	1-5	200-400	179	1-8	180-740	88	0-4	200-420	412	0-5	200-680

Table 8. von Bertalanffy growth parameters for male and female southern flounder.

Parameter	Male	Female
L_∞	381 mm	699 mm
K	0.803	0.284
t_0	-0.011	-0.761

Table 9. Number, length range (mm) and modal lengths (mm) of southern flounder measured from the flounder pound net fishery, 1991-2007.

Year	Number of samples	Number measured	Length range	Modal length(s)
1991	56	5,100	260-620	420
1992	85	8,198	140-680	340
1993	62	6,086	260-640	340
1994	38	3,491	100-600	340, 420
1995	65	7,336	220-640	340, 420
1996	57	5,952	280-720	400
1997	53	4,912	300-740	340, 440
1998	40	4,261	280-700	340, 400
1999	58	6,698	280-760	420
2000	66	5,768	300-700	360
2001	71	7,711	280-720	340
2002	67	6,837	120-740	420
2003	40	2,639	280-680	400
2004	55	5,636	280-700	380
2005	47	4,702	180-700	380
2006	60	6,337	260-660	380
2007	81	5,272	320-700	380

Table 10. Number, length range (mm) and modal lengths (mm) of southern flounder measured from the estuarine gill net fishery, 1991-2007.

	January-June				July-December			
Year	Number of samples	Number measured	Length range	Modal length	Number of samples	Number measured	Length range	Modal length
1991	28	1,453	260-480	340	45	2,029	300-540	340
1992	31	967	300-520	340	77	1,706	160-660	340
1993	51	763	160-480	360	91	2,007	240-500	360
1994	26	1,072	300-460	360	70	2,203	220-540	360
1995	103	3,165	180-500	340	104	3,568	220-640	340
1996	71	1,878	140-480	340	126	5,994	220-640	360
1997	78	1,948	240-520	360	119	4,026	220-720	340
1998	78	1,823	200-620	340	139	5,756	220-640	360
1999	65	1,612	280-520	360	170	4,932	200-740	360
2000	110	4,352	300-680	340	210	7,327	300-740	340
2001	111	3,913	220-620	340	153	5,065	300-640	360
2002	109	3,202	180-700	340	203	7,433	300-680	360
2003	124	3,335	280-660	340	239	7,622	280-640	360
2004	104	2,737	300-680	360	245	8,884	220-760	360
2005	114	2,606	320-600	360	268	8,149	260-700	380
2006	175	3,839	320-700	360	360	8,697	300-780	380
2007	156	3,115	240-700	360	368	9,496	260-700	360

Table 11. Number, length range (mm) and modal lengths (mm) of southern flounder measured from the commercial gig fishery, 2004-2007.

	January-June				July-December			
Year	Number of samples	Number measured	Length range	Modal length	Number of samples	Number measured	Length range	Modal length
2004					9	480	320-620	400
2005	15	432	320-780	360	28	1,054	340-700	380
2006	15	754	340-680	440	26	931	340-660	420
2007	14	451	340-720	440	47	1,645	320-700	380

Table 12. Annual weighted release mortality estimates for southern flounder, 1987-2007. Weighted estimates are based on the observed harvest of southern flounder from high and low salinity locations.

High salinity mortality	9.50%
Low salinity mortality	19.40%

Year	High salinity counties Total catch	Low salinity counties Total catch	Combined catch	Weighted mortality
1987	311	21	332	10.12%
1988	474	45	519	10.36%
1989	208	38	246	11.02%
1990	243	545	788	16.35%
1991	851	117	968	10.70%
1992	472	45	517	10.37%
1993	739	27	766	9.85%
1994	1,240	255	1,495	11.19%
1995	1,394	183	1,577	10.65%
1996	1,101	313	1,413	11.69%
1997	2,041	129	2,170	10.09%
1998	903	134	1,037	10.78%
1999	406	51	457	10.61%
2000	1,683	340	2,023	11.16%
2001	1,690	522	2,212	11.84%
2002	1,897	126	2,023	10.12%
2003	1,199	909	2,107	13.77%
2004	2,750	106	2,856	9.87%
2005	1,904	57	1,961	9.79%
2006	2,859	59	2,918	9.70%
2007	1,839	51	1,890	9.77%
Total	26,202	4,073	30,275	10.83%

Table 13. Number of southern flounder harvested per angler, per trip 1987-2007.

Fish per angler	Number of samples	Percent	Cumulative percent
0	465	12.0	12.0
1	2,372	61.0	73.0
2	617	15.9	88.9
3	208	5.4	94.2
4	107	2.8	97.0
5	53	1.4	98.3
6	19	0.5	98.8
7	12	0.3	99.1
8	15	0.4	99.5
9	5	0.1	99.6
10	2	0.1	99.7
11	3	0.1	99.8
12	4	0.1	99.9
13	2	0.1	99.9
15	1	0.0	99.9
16	1	0.0	100.0
30	1	0.0	100.0
All	3,887	100.0	100.0

Table 14. Numbers and percentages of female southern flounder at age from the commercial estuarine gill net fishery, 1991-2007.

	Age										Total
	0	1	2	3	4	5	6	7	8	9	
1991	1,843	348,275	528,882	37,911	4,626	675	56	-	-	-	922,268
1992	2,249	165,040	279,576	80,221	7,902	525	47	0	-	-	535,562
1993	1,247	498,466	221,237	165,870	26,214	181	3	1	-	-	913,219
1994	32,535	512,974	515,701	158,690	73,244	929	26	2	2	-	1,294,103
1995	3,257	648,081	417,686	73,061	4,288	563	15	13	2	-	1,146,966
1996	250	461,036	506,982	40,650	6,015	374	12	43	2	-	1,015,364
1997	22,210	600,321	442,045	139,831	22,478	1,019	93	48	-	-	1,228,045
1998	981	536,072	644,510	40,379	2,255	439	53	8	1	-	1,224,698
1999	88,826	366,554	347,526	168,342	8,560	1,109	-	7	-	-	980,924
2000	78,085	745,382	199,215	94,282	14,982	2,809	76	35	6	-	1,134,872
2001	6,725	462,506	495,988	51,275	16,527	3,389	23	0	-	-	1,036,433
2002	14,069	428,904	372,111	122,363	10,278	1,690	19	16	5	-	949,455
2003	44,046	422,240	314,480	17,771	2,593	492	282	16	17	-	801,937
2004	33,600	436,787	298,651	36,234	4,017	646	91	37	26	-	810,089
2005	6,467	182,890	444,626	35,659	6,526	579	138	31	-	-	676,915
2006	926	228,817	267,396	247,429	15,186	5,403	24	10	9	8	765,207
2007	6,393	251,089	374,736	53,959	52,721	4,008	212	17	-	-	743,134
Total	343,712	7,295,435	6,671,347	1,563,924	278,412	24,830	1,170	284	71	8	16,179,192

Table 14. Continued.

	Age										Total
	0	1	2	3	4	5	6	7	8	9	
1991	0.20%	37.76%	57.35%	4.11%	0.50%	0.07%	0.01%	0.00%	0.00%	0.00%	100.00%
1992	0.42%	30.82%	52.20%	14.98%	1.48%	0.10%	0.01%	0.00%	0.00%	0.00%	100.00%
1993	0.14%	54.58%	24.23%	18.16%	2.87%	0.02%	0.00%	0.00%	0.00%	0.00%	100.00%
1994	2.51%	39.64%	39.85%	12.26%	5.66%	0.07%	0.00%	0.00%	0.00%	0.00%	100.00%
1995	0.28%	56.50%	36.42%	6.37%	0.37%	0.05%	0.00%	0.00%	0.00%	0.00%	100.00%
1996	0.02%	45.41%	49.93%	4.00%	0.59%	0.04%	0.00%	0.00%	0.00%	0.00%	100.00%
1997	1.81%	48.88%	36.00%	11.39%	1.83%	0.08%	0.01%	0.00%	0.00%	0.00%	100.00%
1998	0.08%	43.77%	52.63%	3.30%	0.18%	0.04%	0.00%	0.00%	0.00%	0.00%	100.00%
1999	9.06%	37.37%	35.43%	17.16%	0.87%	0.11%	0.00%	0.00%	0.00%	0.00%	100.00%
2000	6.88%	65.68%	17.55%	8.31%	1.32%	0.25%	0.01%	0.00%	0.00%	0.00%	100.00%
2001	0.65%	44.62%	47.86%	4.95%	1.59%	0.33%	0.00%	0.00%	0.00%	0.00%	100.00%
2002	1.48%	45.17%	39.19%	12.89%	1.08%	0.18%	0.00%	0.00%	0.00%	0.00%	100.00%
2003	5.49%	52.65%	39.22%	2.22%	0.32%	0.06%	0.04%	0.00%	0.00%	0.00%	100.00%
2004	4.15%	53.92%	36.87%	4.47%	0.50%	0.08%	0.01%	0.00%	0.00%	0.00%	100.00%
2005	0.96%	27.02%	65.68%	5.27%	0.96%	0.09%	0.02%	0.00%	0.00%	0.00%	100.00%
2006	0.12%	29.90%	34.94%	32.33%	1.98%	0.71%	0.00%	0.00%	0.00%	0.00%	100.00%
2007	0.86%	33.79%	50.43%	7.26%	7.09%	0.54%	0.03%	0.00%	0.00%	0.00%	100.00%
Average	2.12%	45.09%	41.23%	9.67%	1.72%	0.15%	0.01%	0.00%	0.00%	0.00%	100.00%

Table 15. Numbers and percentages of female southern flounder at age from the pound net fishery, 1991-2007.

	Age										Total
	0	1	2	3	4	5	6	7	8	9	
1991	805	476,814	559,318	11,767	1,979	454	97	-	-	-	1,051,234
1992	105	204,063	581,080	101,484	9,663	1,679	215	31	-	-	898,320
1993	13,108	748,865	369,308	235,740	3,281	644	70	0	-	-	1,371,016
1994	34,326	444,253	457,936	143,242	65,525	550	37	0	0	-	1,145,869
1995	3,322	344,551	364,899	45,306	2,223	203	6	4	1	-	760,516
1996	55	245,574	444,648	64,500	10,481	253	32	50	0	-	765,592
1997	11,303	276,348	247,358	57,424	11,628	2,166	38	31	0	-	606,297
1998	1,092	247,656	314,400	15,710	2,354	459	26	35	0	-	581,730
1999	28,377	110,960	141,960	52,146	4,639	1,031	0	12	-	-	339,126
2000	19,031	234,866	88,647	50,440	10,461	475	5	23	0	-	403,950
2001	4,173	271,319	350,673	16,215	20,419	5,967	12	15	-	-	668,792
2002	6,797	253,980	244,259	81,708	8,118	2,315	9	11	1	-	597,197
2003	10,465	116,940	125,679	5,707	1,178	299	185	3	0	-	260,455
2004	12,288	178,612	98,693	10,746	1,644	67	2	1	-	-	302,052
2005	1,849	59,425	131,352	17,150	3,228	226	120	6	-	-	213,356
2006	524	84,788	89,461	74,566	7,733	2,786	0	2	0	-	259,860
2007	1,644	74,300	98,895	19,148	23,571	887	10	3	-	-	218,459
Total	149,261	4,373,313	4,708,565	1,002,999	188,125	20,460	864	230	3	-	10,443,820

Table 15. Continued.

	Age										Total
	0	1	2	3	4	5	6	7	8	9	
1991	0.08%	45.36%	53.21%	1.12%	0.19%	0.04%	0.01%	0.00%	0.00%	0.00%	100.00%
1992	0.01%	22.72%	64.69%	11.30%	1.08%	0.19%	0.02%	0.00%	0.00%	0.00%	100.00%
1993	0.96%	54.62%	26.94%	17.19%	0.24%	0.05%	0.01%	0.00%	0.00%	0.00%	100.00%
1994	3.00%	38.77%	39.96%	12.50%	5.72%	0.05%	0.00%	0.00%	0.00%	0.00%	100.00%
1995	0.44%	45.30%	47.98%	5.96%	0.29%	0.03%	0.00%	0.00%	0.00%	0.00%	100.00%
1996	0.01%	32.08%	58.08%	8.42%	1.37%	0.03%	0.00%	0.01%	0.00%	0.00%	100.00%
1997	1.86%	45.58%	40.80%	9.47%	1.92%	0.36%	0.01%	0.01%	0.00%	0.00%	100.00%
1998	0.19%	42.57%	54.05%	2.70%	0.40%	0.08%	0.00%	0.01%	0.00%	0.00%	100.00%
1999	8.37%	32.72%	41.86%	15.38%	1.37%	0.30%	0.00%	0.00%	0.00%	0.00%	100.00%
2000	4.71%	58.14%	21.95%	12.49%	2.59%	0.12%	0.00%	0.01%	0.00%	0.00%	100.00%
2001	0.62%	40.57%	52.43%	2.42%	3.05%	0.89%	0.00%	0.00%	0.00%	0.00%	100.00%
2002	1.14%	42.53%	40.90%	13.68%	1.36%	0.39%	0.00%	0.00%	0.00%	0.00%	100.00%
2003	4.02%	44.90%	48.25%	2.19%	0.45%	0.11%	0.07%	0.00%	0.00%	0.00%	100.00%
2004	4.07%	59.13%	32.67%	3.56%	0.54%	0.02%	0.00%	0.00%	0.00%	0.00%	100.00%
2005	0.87%	27.85%	61.56%	8.04%	1.51%	0.11%	0.06%	0.00%	0.00%	0.00%	100.00%
2006	0.20%	32.63%	34.43%	28.69%	2.98%	1.07%	0.00%	0.00%	0.00%	0.00%	100.00%
2007	0.75%	34.01%	45.27%	8.77%	10.79%	0.41%	0.00%	0.00%	0.00%	0.00%	100.00%
Average	1.43%	41.87%	45.08%	9.60%	1.80%	0.20%	0.01%	0.00%	0.00%	0.00%	100.00%

Table 16. Numbers and percentages of female southern flounder at age from the commercial gig fishery, 1991-2007.

	Age										Total
	0	1	2	3	4	5	6	7	8	9	
1991	111	35,934	54,378	3,966	850	175	11	0	0	-	95,426
1992	0	5,133	11,038	3,357	557	121	12	3	4	-	20,226
1993	118	10,912	9,488	7,485	1,461	81	7	1	1	-	29,553
1994	1,333	15,767	15,724	5,495	1,802	54	1	0	0	-	40,176
1995	208	20,592	15,923	4,544	460	72	2	0	0	-	41,801
1996	2	14,604	16,322	1,939	501	65	1	0	0	-	33,435
1997	1,173	23,321	15,684	6,520	1,333	142	5	1	1	-	48,180
1998	88	16,156	19,276	1,895	98	31	1	0	0	-	37,545
1999	4,211	11,829	10,494	5,716	418	13	0	0	0	-	32,682
2000	2,438	26,783	9,515	6,200	1,237	215	4	0	0	-	46,392
2001	228	15,631	23,806	5,417	895	127	3	0	0	-	46,108
2002	633	16,607	16,859	7,519	869	175	7	1	1	-	42,671
2003	1,762	18,069	17,268	1,480	129	11	1	1	1	-	38,724
2004	886	21,044	21,499	2,896	281	17	0	0	0	-	46,624
2005	270	8,411	24,168	2,843	631	176	39	8	-	-	36,547
2006	48	11,290	15,529	15,208	1,290	344	17	0	6	-	43,732
2007	222	11,418	26,641	5,571	5,500	854	61	5	18	-	50,290
Total	13,732	283,502	323,611	88,054	18,310	2,675	171	22	33	-	730,110

Table 16. Continued.

	Age										Total
	0	1	2	3	4	5	6	7	8	9	
1991	0.12%	37.66%	56.98%	4.16%	0.89%	0.18%	0.01%	0.00%	0.00%	0.00%	100.00%
1992	0.00%	25.38%	54.58%	16.60%	2.75%	0.60%	0.06%	0.02%	0.02%	0.00%	100.00%
1993	0.40%	36.92%	32.10%	25.33%	4.94%	0.27%	0.02%	0.00%	0.00%	0.00%	100.00%
1994	3.32%	39.24%	39.14%	13.68%	4.48%	0.13%	0.00%	0.00%	0.00%	0.00%	100.00%
1995	0.50%	49.26%	38.09%	10.87%	1.10%	0.17%	0.01%	0.00%	0.00%	0.00%	100.00%
1996	0.01%	43.68%	48.82%	5.80%	1.50%	0.20%	0.00%	0.00%	0.00%	0.00%	100.00%
1997	2.44%	48.40%	32.55%	13.53%	2.77%	0.29%	0.01%	0.00%	0.00%	0.00%	100.00%
1998	0.23%	43.03%	51.34%	5.05%	0.26%	0.08%	0.00%	0.00%	0.00%	0.00%	100.00%
1999	12.89%	36.20%	32.11%	17.49%	1.28%	0.04%	0.00%	0.00%	0.00%	0.00%	100.00%
2000	5.25%	57.73%	20.51%	13.37%	2.67%	0.46%	0.01%	0.00%	0.00%	0.00%	100.00%
2001	0.50%	33.90%	51.63%	11.75%	1.94%	0.28%	0.01%	0.00%	0.00%	0.00%	100.00%
2002	1.48%	38.92%	39.51%	17.62%	2.04%	0.41%	0.02%	0.00%	0.00%	0.00%	100.00%
2003	4.55%	46.66%	44.59%	3.82%	0.33%	0.03%	0.00%	0.00%	0.00%	0.00%	100.00%
2004	1.90%	45.14%	46.11%	6.21%	0.60%	0.04%	0.00%	0.00%	0.00%	0.00%	100.00%
2005	0.74%	23.01%	66.13%	7.78%	1.73%	0.48%	0.11%	0.02%	0.00%	0.00%	100.00%
2006	0.11%	25.82%	35.51%	34.78%	2.95%	0.79%	0.04%	0.00%	0.01%	0.00%	100.00%
2007	0.44%	22.71%	52.98%	11.08%	10.94%	1.70%	0.12%	0.01%	0.03%	0.00%	100.00%
Average	1.88%	38.83%	44.32%	12.06%	2.51%	0.37%	0.02%	0.00%	0.00%	0.00%	100.00%

Table 17. Numbers and percentages of female southern flounder at age from the other commercial fisheries, 1991-2007.

	Age										Total
	0	1	2	3	4	5	6	7	8	9	
1991	2,178	79,626	286,884	9,799	1,542	353	18	-	-	-	380,401
1992	-	64,087	65,492	10,489	3,104	697	64	7	-	-	143,940
1993	9,770	45,905	29,181	27,555	17,015	135	10	1	-	-	129,572
1994	647	30,060	81,024	31,900	16,685	90	1	0	0	-	160,407
1995	1,411	69,679	53,428	14,929	594	76	3	7	0	-	140,127
1996	530	56,809	56,982	8,445	2,008	33	1	1	0	-	124,809
1997	955	33,571	26,801	13,566	2,993	251	5	1	0	-	78,143
1998	118	39,161	65,820	10,859	200	13	1	1	0	-	116,172
1999	16,018	29,649	37,477	20,244	3,293	23	1	0	-	-	106,706
2000	5,419	52,352	29,149	4,700	1,141	1,650	18	72	0	-	94,504
2001	924	43,794	46,918	5,466	812	89	1	0	-	-	98,004
2002	2,295	42,677	30,110	10,133	1,135	343	2	1	1	-	86,698
2003	63	6,266	24,994	9,178	919	39	2	0	-	-	41,461
2004	3,127	17,821	31,461	3,160	273	644	124	17	-	30	56,658
2005	403	5,370	19,338	1,444	206	73	7	6	-	4	26,850
2006	145	7,237	7,817	6,736	299	57	2	3	-	-	22,297
2007	133	5,784	10,596	1,920	2,582	79	5	0	-	-	21,099
Total	44,135	629,849	903,472	190,524	54,801	4,646	267	118	2	35	1,827,848

Table 17. Continued.

	Age										Total
	0	1	2	3	4	5	6	7	8	9	
1991	0.57%	20.93%	75.42%	2.58%	0.41%	0.09%	0.00%	0.00%	0.00%	0.00%	100.00%
1992	0.00%	44.52%	45.50%	7.29%	2.16%	0.48%	0.04%	0.00%	0.00%	0.00%	100.00%
1993	7.54%	35.43%	22.52%	21.27%	13.13%	0.10%	0.01%	0.00%	0.00%	0.00%	100.00%
1994	0.40%	18.74%	50.51%	19.89%	10.40%	0.06%	0.00%	0.00%	0.00%	0.00%	100.00%
1995	1.01%	49.73%	38.13%	10.65%	0.42%	0.05%	0.00%	0.01%	0.00%	0.00%	100.00%
1996	0.42%	45.52%	45.66%	6.77%	1.61%	0.03%	0.00%	0.00%	0.00%	0.00%	100.00%
1997	1.22%	42.96%	34.30%	17.36%	3.83%	0.32%	0.01%	0.00%	0.00%	0.00%	100.00%
1998	0.10%	33.71%	56.66%	9.35%	0.17%	0.01%	0.00%	0.00%	0.00%	0.00%	100.00%
1999	15.01%	27.79%	35.12%	18.97%	3.09%	0.02%	0.00%	0.00%	0.00%	0.00%	100.00%
2000	5.73%	55.40%	30.84%	4.97%	1.21%	1.75%	0.02%	0.08%	0.00%	0.00%	100.00%
2001	0.94%	44.69%	47.87%	5.58%	0.83%	0.09%	0.00%	0.00%	0.00%	0.00%	100.00%
2002	2.65%	49.23%	34.73%	11.69%	1.31%	0.40%	0.00%	0.00%	0.00%	0.00%	100.00%
2003	0.15%	15.11%	60.28%	22.14%	2.22%	0.09%	0.01%	0.00%	0.00%	0.00%	100.00%
2004	5.52%	31.45%	55.53%	5.58%	0.48%	1.14%	0.22%	0.03%	0.00%	0.05%	100.00%
2005	1.50%	20.00%	72.02%	5.38%	0.77%	0.27%	0.03%	0.02%	0.00%	0.02%	100.00%
2006	0.65%	32.46%	35.06%	30.21%	1.34%	0.26%	0.01%	0.01%	0.00%	0.00%	100.00%
2007	0.63%	27.41%	50.22%	9.10%	12.24%	0.38%	0.02%	0.00%	0.00%	0.00%	100.00%
Average	2.41%	34.46%	49.43%	10.42%	3.00%	0.25%	0.01%	0.01%	0.00%	0.00%	100.00%

Table 18. Numbers and percentages of female southern flounder dead discards at age from the commercial estuarine gill net fishery, 1991-2007.

	Age										Total
	0	1	2	3	4	5	6	7	8	9	
1991	1,445	18,584	4,809	782	94	12	1	1	-	-	25,727
1992	1,238	12,792	1,467	155	31	7	1	1	-	-	15,691
1993	5,419	13,735	4,098	2,308	120	8	1	1	-	-	25,689
1994	7,804	21,262	5,653	1,135	321	14	1	2	-	-	36,191
1995	6,580	19,816	5,242	814	80	10	1	1	-	-	32,544
1996	5,883	17,622	4,403	843	65	7	1	1	-	-	28,825
1997	415	26,373	5,506	1,636	526	19	1	1	-	-	34,477
1998	6,925	21,343	5,562	358	35	11	1	1	-	-	34,235
1999	10,896	9,968	5,636	860	63	7	1	1	-	-	27,433
2000	11,425	18,170	2,490	665	118	12	1	-	-	-	32,881
2001	5,623	16,587	6,365	743	234	24	1	1	-	-	29,578
2002	9,081	12,916	3,482	896	235	27	1	1	-	-	26,640
2003	5,045	12,646	5,034	202	32	8	3	1	-	-	22,973
2004	3,916	13,787	4,356	461	31	15	1	-	-	-	22,567
2005	1,492	7,428	12,017	400	101	1	-	-	-	-	21,440
2006	2,642	14,881	3,604	2,646	28	18	-	-	-	-	23,820
2007	1,873	16,163	5,009	466	105	6	-	-	-	-	23,622
Total	87,702	274,075	84,734	15,371	2,217	205	17	13	-	-	464,334

Table 18. Continued.

	Age										Total
	0	1	2	3	4	5	6	7	8	9	
1991	5.62%	72.23%	18.69%	3.04%	0.36%	0.04%	0.01%	0.00%	0.00%	0.00%	100.00%
1992	7.89%	81.52%	9.35%	0.99%	0.20%	0.05%	0.01%	0.00%	0.00%	0.00%	100.00%
1993	21.09%	53.47%	15.95%	8.98%	0.47%	0.03%	0.00%	0.00%	0.00%	0.00%	100.00%
1994	21.56%	58.75%	15.62%	3.14%	0.89%	0.04%	0.00%	0.00%	0.00%	0.00%	100.00%
1995	20.22%	60.89%	16.11%	2.50%	0.24%	0.03%	0.00%	0.00%	0.00%	0.00%	100.00%
1996	20.41%	61.14%	15.28%	2.93%	0.22%	0.02%	0.00%	0.00%	0.00%	0.00%	100.00%
1997	1.20%	76.49%	15.97%	4.74%	1.52%	0.06%	0.00%	0.00%	0.00%	0.00%	100.00%
1998	20.23%	62.34%	16.25%	1.04%	0.10%	0.03%	0.00%	0.00%	0.00%	0.00%	100.00%
1999	39.72%	36.34%	20.55%	3.14%	0.23%	0.02%	0.00%	0.00%	0.00%	0.00%	100.00%
2000	34.75%	55.26%	7.57%	2.02%	0.36%	0.04%	0.00%	0.00%	0.00%	0.00%	100.00%
2001	19.01%	56.08%	21.52%	2.51%	0.79%	0.08%	0.00%	0.00%	0.00%	0.00%	100.00%
2002	34.09%	48.48%	13.07%	3.36%	0.88%	0.10%	0.00%	0.00%	0.00%	0.00%	100.00%
2003	21.96%	55.05%	21.91%	0.88%	0.14%	0.04%	0.01%	0.00%	0.00%	0.00%	100.00%
2004	17.35%	61.09%	19.30%	2.04%	0.14%	0.07%	0.00%	0.00%	0.00%	0.00%	100.00%
2005	6.96%	34.65%	56.05%	1.87%	0.47%	0.01%	0.00%	0.00%	0.00%	0.00%	100.00%
2006	11.09%	62.47%	15.13%	11.11%	0.12%	0.08%	0.00%	0.00%	0.00%	0.00%	100.00%
2007	7.93%	68.43%	21.20%	1.97%	0.44%	0.02%	0.00%	0.00%	0.00%	0.00%	100.00%
Average	18.89%	59.03%	18.25%	3.31%	0.48%	0.04%	0.00%	0.00%	0.00%	0.00%	100.00%

Table 19. Numbers and percentages of female southern flounder at age from the recreational hook and line and gig fisheries, 1991-2007.

	Age										
	0	1	2	3	4	5	6	7	8	9	Total
1991	163	48,814	72,021	7,556	1,739	554	97	88	-	-	131,032
1992		24,475	22,813	13,624	1,795	547	146	146	-	-	63,546
1993	547	24,072	15,385	14,769	1,841	355	78	67	-	-	57,114
1994	3,551	44,530	49,993	17,090	8,399	1,419	168	88	-	-	125,239
1995	610	36,184	46,090	11,307	2,129	442	45	-	-	-	96,807
1996		41,696	59,510	12,813	2,885	35	-	-	-	-	116,938
1997		56,486	63,467	20,400	5,622	1,212	23	23	23	-	147,257
1998	122	24,679	42,382	6,317	1,088	378	-	-	-	-	74,966
1999	1,455	12,717	25,694	21,694	2,961	175	-	-	-	-	64,698
2000	11,601	130,934	68,621	36,189	9,700	3,540	-	138	-	-	260,723
2001	1,202	59,772	113,136	19,256	10,675	3,790	87	44	-	-	207,963
2002	1,437	70,757	87,241	44,199	5,149	3,057	141	-	-	-	211,980
2003	12,189	77,179	88,897	25,910	4,060	443	294	575	575	-	210,121
2004	7,262	142,544	163,347	40,575	10,343	3,398	259	91	-	-	367,819
2005	1,666	51,547	185,819	47,808	13,016	3,132	1,437	140	-	-	304,566
2006	506	72,900	112,338	120,494	14,710	5,274	26	144	-	206	326,599
2007	778	57,858	131,904	46,223	56,165	2,842	31	-	-	-	295,801
Total	43,090	977,144	1,348,658	506,225	152,277	30,595	2,832	1,543	599	206	3,063,168

Table 19. Continued.

	Age										
	0	1	2	3	4	5	6	7	8	9	Total
1991	0.12%	37.25%	54.96%	5.77%	1.33%	0.42%	0.07%	0.07%	0.00%	0.00%	100.00%
1992	0.00%	38.52%	35.90%	21.44%	2.83%	0.86%	0.23%	0.23%	0.00%	0.00%	100.00%
1993	0.96%	42.15%	26.94%	25.86%	3.22%	0.62%	0.14%	0.12%	0.00%	0.00%	100.00%
1994	2.84%	35.56%	39.92%	13.65%	6.71%	1.13%	0.13%	0.07%	0.00%	0.00%	100.00%
1995	0.63%	37.38%	47.61%	11.68%	2.20%	0.46%	0.05%	0.00%	0.00%	0.00%	100.00%
1996	0.00%	35.66%	50.89%	10.96%	2.47%	0.03%	0.00%	0.00%	0.00%	0.00%	100.00%
1997	0.00%	38.36%	43.10%	13.85%	3.82%	0.82%	0.02%	0.02%	0.02%	0.00%	100.00%
1998	0.16%	32.92%	56.53%	8.43%	1.45%	0.50%	0.00%	0.00%	0.00%	0.00%	100.00%
1999	2.25%	19.66%	39.71%	33.53%	4.58%	0.27%	0.00%	0.00%	0.00%	0.00%	100.00%
2000	4.45%	50.22%	26.32%	13.88%	3.72%	1.36%	0.00%	0.05%	0.00%	0.00%	100.00%
2001	0.58%	28.74%	54.40%	9.26%	5.13%	1.82%	0.04%	0.02%	0.00%	0.00%	100.00%
2002	0.68%	33.38%	41.16%	20.85%	2.43%	1.44%	0.07%	0.00%	0.00%	0.00%	100.00%
2003	5.80%	36.73%	42.31%	12.33%	1.93%	0.21%	0.14%	0.27%	0.27%	0.00%	100.00%
2004	1.97%	38.75%	44.41%	11.03%	2.81%	0.92%	0.07%	0.02%	0.00%	0.00%	100.00%
2005	0.55%	16.92%	61.01%	15.70%	4.27%	1.03%	0.47%	0.05%	0.00%	0.00%	100.00%
2006	0.16%	22.32%	34.40%	36.89%	4.50%	1.61%	0.01%	0.04%	0.00%	0.06%	100.00%
2007	0.26%	19.56%	44.59%	15.63%	18.99%	0.96%	0.01%	0.00%	0.00%	0.00%	100.00%
Average	1.26%	33.18%	43.77%	16.51%	4.26%	0.85%	0.09%	0.06%	0.02%	0.00%	100.00%

Table 20. Numbers and percentages of female southern flounder dead discards at age from the recreational hook and line fishery, 1991-2007.

	Age										
	0	1	2	3	4	5	6	7	8	9	Total
1991	160	1,141	464	92	4	-	-	-	-	-	1,862
1992	1,244	3,263	89	4	-	-	-	-	-	-	4,599
1993	2,138	4,996	1,220	487	2	-	-	-	-	-	8,842
1994	4,887	8,315	1,322	156	13	-	-	-	-	-	14,693
1995	5,181	7,616	1,762	450	29	-	-	-	-	-	15,038
1996	3,097	5,792	1,245	110	2	-	-	-	-	-	10,246
1997	2,138	14,980	1,770	395	185	-	-	-	-	-	19,468
1998	2,941	7,371	1,377	38	-	-	-	-	-	-	11,727
1999	1,106	2,190	904	236	4	-	-	-	-	-	4,439
2000	13,671	11,862	744	139	-	-	-	-	-	-	26,415
2001	5,848	13,824	4,307	353	52	-	-	-	-	-	24,385
2002	10,700	14,420	4,249	965	160	-	-	-	-	-	30,494
2003	6,440	11,723	3,965	433	37	-	-	-	-	-	22,598
2004	13,157	33,097	4,062	322	5	-	-	-	-	-	50,644
2005	4,208	13,591	12,988	504	79	-	-	-	-	-	31,370
2006	12,377	18,126	2,668	1,648	-	-	-	-	-	-	34,819
2007	6,341	28,599	3,634	285	-	-	-	-	-	-	38,860
Total	95,634	200,906	46,768	6,619	571	-	-	-	-	-	350,499

Table 20. Continued.

	Age										
	0	1	2	3	4	5	6	7	8	9	Total
1991	8.60%	61.28%	24.94%	4.95%	0.23%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
1992	27.05%	70.94%	1.92%	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
1993	24.18%	56.50%	13.79%	5.50%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
1994	33.26%	56.59%	9.00%	1.06%	0.09%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
1995	34.45%	50.65%	11.72%	2.99%	0.19%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
1996	30.22%	56.53%	12.15%	1.08%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
1997	10.98%	76.95%	9.09%	2.03%	0.95%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
1998	25.08%	62.86%	11.74%	0.33%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
1999	24.91%	49.33%	20.36%	5.31%	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
2000	51.75%	44.90%	2.81%	0.53%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
2001	23.98%	56.69%	17.66%	1.45%	0.21%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
2002	35.09%	47.29%	13.93%	3.17%	0.52%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
2003	28.50%	51.88%	17.55%	1.92%	0.16%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
2004	25.98%	65.35%	8.02%	0.64%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
2005	13.41%	43.32%	41.40%	1.61%	0.25%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
2006	35.55%	52.06%	7.66%	4.73%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
2007	16.32%	73.60%	9.35%	0.73%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
Average	26.43%	57.45%	13.71%	2.24%	0.16%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%

Table 21. Survey CPUE at age for female southern flounder from the Albemarle Sound Independent Gill Net Survey, 1991-2007.

	Age						
Year	0	1	2	3	4	5	Total CPUE
1991	0.386	2.940	0.810	0.000	0.000	0.000	4.136
1992	0.444	2.077	1.710	0.058	0.002	0.000	4.292
1993	0.404	2.535	0.698	0.357	0.000	0.000	3.993
1994	0.271	0.677	0.302	0.097	0.041	0.000	1.388
1995	0.643	0.907	0.304	0.021	0.000	0.000	1.875
1996	0.107	0.284	0.212	0.010	0.000	0.000	0.612
1997	0.067	1.389	0.251	0.019	0.027	0.000	1.753
1998	0.189	0.880	0.440	0.005	0.000	0.000	1.515
1999	0.166	0.160	0.111	0.025	0.001	0.001	0.464
2000	0.578	0.606	0.044	0.014	0.002	0.000	1.244
2001	0.306	1.331	0.709	0.012	0.009	0.000	2.367
2002	0.424	0.811	0.342	0.088	0.010	0.002	1.677
2003	0.237	0.381	0.183	0.008	0.006	0.003	0.818
2004	0.347	1.459	0.178	0.014	0.001	0.000	1.998
2005	0.141	0.550	0.646	0.027	0.003	0.000	1.368
2006	0.278	0.757	0.396	0.249	0.012	0.006	1.698
2007	0.512	2.592	0.642	0.068	0.051	0.003	3.866
Average	0.324	1.196	0.469	0.063	0.010	0.001	2.063

Table 22. Survey CPUE at age for female southern flounder from the Pamlico Sound Independent Gill Net Survey, 2001-2007.

	Age									
Year	0	1	2	3	4	5	6	7	8	Total
2001	0.0930	0.4758	0.6239	0.1284	0.0400	0.0094	0.0000	0.0000	0.0000	1.3706
2002	0.1530	0.7001	0.5671	0.2287	0.0172	0.0064	0.0000	0.0000	0.0000	1.6724
2003	0.1188	0.7171	0.6106	0.0628	0.0110	0.0006	0.0003	0.0000	0.0000	1.5213
2004	0.1003	0.6477	0.5038	0.0693	0.0079	0.0000	0.0000	0.0000	0.0000	1.3291
2005	0.0536	0.4723	0.9867	0.1055	0.0214	0.0029	0.0000	0.0000	0.0000	1.6424
2006	0.0606	0.3051	0.3196	0.3460	0.0296	0.0046	0.0000	0.0000	0.0000	1.0654
2007	0.0440	0.3305	0.3656	0.0565	0.0492	0.0098	0.0000	0.0000	0.0000	0.8556
Average	0.0890	0.5212	0.5682	0.1425	0.0252	0.0048	0.0000	0.0000	0.0000	1.3510

Table 23. Tuning coefficient of variation (CV) estimates used in the final configuration of ASAP2.

Data	Tuning CV
Fmult in First Year	3.00
N in First Year	0.30
Fmult Deviations	0.25
Recruitment Deviations	0.30
Steepness	0.30
Selectivity	1.80
Commercial Gill Net Catch	0.10
Recreational Catch	0.20
Commercial Other Catch	0.10
Commercial Gill Net Discards	1.50
Recreational Discards	1.50
MRFSS Index	0.60
Age-1 Albemarle Sound IGNS Index	0.80
Age-2 Albemarle Sound IGNS Index	0.75
Age-1 Pamlico Sound IGNS Index	0.55
Age-2 Pamlico Sound IGNS Index	0.20
Pamlico Sound Survey Index	0.55
Estuarine Trawl Survey Index	0.50
Bridgenet Index	0.55
Commercial Gill Net Index	0.20

Table 24. ASAP2 estimates of selectivity by fishery and period for southern flounder females.

	Age						
Fishery/Period	0	1	2	3	4	5	6+
Commercial Gillnet							
1991-2004	0.0050	0.3416	0.9835	1.0000	0.9697	0.6108	0.0751
2005-2007	0.0031	0.3522	1.0000	0.7612	0.5559	0.3973	0.2794
Recreational							
1991-1998	0.0050	0.2169	0.9386	0.9988	1.0000	1.0000	1.0000
1999-2004	0.0092	0.1821	0.8427	0.9923	0.9997	1.0000	1.0000
2005-2007	0.0117	0.1513	0.7293	0.9760	0.9984	0.9999	1.0000
Commercial Other							
1991-2004	0.0043	0.2769	0.9712	0.9997	1.0000	1.0000	1.0000
2005-2007	0.0029	0.3402	0.9893	0.9999	1.0000	1.0000	1.0000

Table 25. ASAP2 estimates of fishing mortality-at-age for all ages and average fishing mortality for ages 2-5, female southern flounder, 1991-2007.

				Age				
Year	0	1	2	3	4	5	6+	Fishing Mortality
1991	0.0058	0.3731	1.2335	1.2666	1.2549	1.1117	0.8980	1.2361
1992	0.0044	0.2803	0.9256	0.9505	0.9415	0.8310	0.6661	0.9300
1993	0.0062	0.4001	1.3075	1.3415	1.3270	1.1515	0.8896	1.3175
1994	0.0075	0.4873	1.5674	1.6068	1.5854	1.3275	0.9426	1.5693
1995	0.0062	0.4038	1.2934	1.3260	1.3071	1.0795	0.7399	1.2967
1996	0.0056	0.3621	1.1655	1.1955	1.1790	0.9806	0.6843	1.1690
1997	0.0065	0.4205	1.3299	1.3626	1.3401	1.0707	0.6686	1.3354
1998	0.0062	0.4053	1.2744	1.3051	1.2826	1.0134	0.6116	1.2771
1999	0.0061	0.3701	1.1642	1.2010	1.1803	0.9249	0.5437	1.1687
2000	0.0064	0.3644	1.1686	1.2143	1.1957	0.9594	0.6067	1.1802
2001	0.0068	0.3747	1.2201	1.2706	1.2536	1.0357	0.7104	1.2235
2002	0.0091	0.5038	1.6375	1.7051	1.6820	1.3845	0.9404	1.6511
2003	0.0072	0.3657	1.1998	1.2609	1.2435	1.0124	0.6674	1.2090
2004	0.0063	0.2934	0.9849	1.0454	1.0328	0.8559	0.5918	0.9947
2005	0.0045	0.2140	0.6858	0.6639	0.5966	0.5406	0.4987	0.6813
2006	0.0048	0.2572	0.8072	0.7601	0.6720	0.6001	0.5463	0.7795
2007	0.0047	0.2479	0.7799	0.7366	0.6521	0.5830	0.5313	0.7534

Table 26. ASAP2 estimates of fishing mortality-at-age for all ages and average unweighted F (ages 2-5) for the commercial gill net fishery, 1991-2007.

				Age				
Year	0	1	2	3	4	5	6+	Fishing Mortality
1991	0.0014	0.1340	0.3908	0.3942	0.3830	0.2420	0.0296	0.3525
1992	0.0007	0.1021	0.3021	0.3074	0.2981	0.1876	0.0230	0.2738
1993	0.0019	0.1653	0.4779	0.4864	0.4722	0.2962	0.0359	0.4332
1994	0.0032	0.2403	0.7031	0.7164	0.6954	0.4349	0.0517	0.6375
1995	0.0006	0.2127	0.6197	0.6302	0.6080	0.3830	0.0455	0.5602
1996	0.0000	0.1846	0.5417	0.5491	0.5346	0.3347	0.0409	0.4900
1997	0.0037	0.2492	0.7323	0.7446	0.7177	0.4562	0.0557	0.6627
1998	0.0000	0.2498	0.7339	0.7463	0.7222	0.4526	0.0553	0.6638
1999	0.0033	0.2385	0.6928	0.7094	0.6872	0.4333	0.0480	0.6307
2000	0.0029	0.2211	0.6423	0.6557	0.6358	0.4013	0.0492	0.5838
2001	0.0016	0.2031	0.5930	0.6018	0.5853	0.3701	0.0438	0.5376
2002	0.0026	0.2784	0.8112	0.8257	0.7942	0.5033	0.0603	0.7336
2003	0.0029	0.2152	0.6270	0.6401	0.6201	0.3894	0.0479	0.5692
2004	0.0023	0.1649	0.4801	0.4887	0.4758	0.2979	0.0369	0.4356
2005	0.0009	0.1216	0.3487	0.2686	0.1956	0.1411	0.0993	0.2385
2006	0.0000	0.1533	0.4518	0.3442	0.2532	0.1808	0.1274	0.3075
2007	0.0011	0.1470	0.4336	0.3314	0.2433	0.1739	0.1224	0.2956

Table 27. ASAP2 estimates of fishing mortality-at-age for all ages and average unweighted F (ages 2-5) for all other commercial fisheries, 1991-2007.

				Age				
Year	0	1	2	3	4	5	6+	Fishing Mortality
1991	0.0035	0.2241	0.7861	0.8092	0.8094	0.8094	0.8094	0.8035
1992	0.0026	0.1646	0.5772	0.5941	0.5943	0.5943	0.5943	0.5900
1993	0.0035	0.2219	0.7781	0.8010	0.8012	0.8012	0.8012	0.7954
1994	0.0035	0.2265	0.7946	0.8179	0.8182	0.8182	0.8182	0.8122
1995	0.0027	0.1711	0.6003	0.6179	0.6181	0.6181	0.6181	0.6136
1996	0.0024	0.1558	0.5466	0.5626	0.5628	0.5628	0.5628	0.5587
1997	0.0023	0.1445	0.5067	0.5215	0.5217	0.5217	0.5217	0.5179
1998	0.0021	0.1321	0.4633	0.4769	0.4771	0.4771	0.4771	0.4736
1999	0.0017	0.1103	0.3869	0.3982	0.3983	0.3983	0.3983	0.3954
2000	0.0017	0.1110	0.3894	0.4009	0.4010	0.4010	0.4010	0.3981
2001	0.0028	0.1772	0.6215	0.6397	0.6399	0.6399	0.6399	0.6353
2002	0.0024	0.1343	0.4951	0.5134	0.5136	0.5136	0.5136	0.5089
2003	0.0015	0.0963	0.3378	0.3477	0.3479	0.3479	0.3479	0.3453
2004	0.0011	0.0700	0.2456	0.2528	0.2529	0.2529	0.2529	0.2511
2005	0.0004	0.0511	0.1487	0.1503	0.1503	0.1503	0.1503	0.1499
2006	0.0005	0.0599	0.1742	0.1761	0.1761	0.1761	0.1761	0.1756
2007	0.0005	0.0571	0.1661	0.1679	0.1679	0.1679	0.1679	0.1675

Table 28. ASAP2 estimates of fishing mortality-at-age for all ages and average unweighted F (ages 2-5) for the recreational fishery, 1991-2007.

				Age				
Year	0	1	2	3	4	5	6+	Fishing Mortality
1991	0.0000	0.0124	0.0546	0.0578	0.0585	0.0586	0.0586	0.0574
1992	0.0002	0.0092	0.0455	0.0486	0.0487	0.0487	0.0487	0.0479
1993	0.0000	0.0089	0.0447	0.0499	0.0516	0.0517	0.0517	0.0495
1994	0.0000	0.0124	0.0645	0.0698	0.0704	0.0705	0.0705	0.0688
1995	0.0000	0.0127	0.0670	0.0712	0.0733	0.0742	0.0742	0.0714
1996	0.0004	0.0149	0.0735	0.0792	0.0799	0.0800	0.0800	0.0782
1997	0.0005	0.0144	0.0826	0.0887	0.0875	0.0905	0.0905	0.0873
1998	0.0000	0.0119	0.0711	0.0777	0.0782	0.0782	0.0782	0.0763
1999	0.0002	0.0139	0.0748	0.0903	0.0919	0.0920	0.0920	0.0873
2000	0.0000	0.0259	0.1303	0.1545	0.1563	0.1563	0.1563	0.1494
2001	0.0000	0.0248	0.1438	0.1728	0.1764	0.1774	0.1774	0.1676
2002	0.0000	0.0353	0.1922	0.2315	0.2310	0.2383	0.2383	0.2233
2003	0.0010	0.0426	0.2197	0.2648	0.2690	0.2712	0.2712	0.2562
2004	0.0000	0.0433	0.2483	0.2972	0.3018	0.3019	0.3019	0.2873
2005	0.0000	0.0283	0.1695	0.2404	0.2469	0.2490	0.2491	0.2265
2006	0.0000	0.0277	0.1729	0.2338	0.2425	0.2429	0.2429	0.2230
2007	0.0000	0.0193	0.1711	0.2339	0.2407	0.2410	0.2411	0.2217

Table 29. ASAP2 estimates of spawning stock biomass for female southern flounder in pounds and +/- one standard deviation, 1991-2007.

Year	-1 Std Dev	SSB	+1 Std Dev
1991	3,845,100	4,080,760	4,316,420
1992	4,038,050	4,268,640	4,499,230
1993	3,438,990	3,680,830	3,922,670
1994	3,551,440	3,779,450	4,007,460
1995	2,857,360	3,010,600	3,163,840
1996	3,397,890	3,568,220	3,738,550
1997	3,136,080	3,290,670	3,445,260
1998	3,021,720	3,213,780	3,405,840
1999	2,874,530	3,055,970	3,237,410
2000	2,070,910	2,202,480	2,334,050
2001	3,324,490	3,487,050	3,649,610
2002	2,995,300	3,136,260	3,277,220
2003	2,099,600	2,218,950	2,338,300
2004	2,224,030	2,352,340	2,480,650
2005	4,168,400	4,381,680	4,594,960
2006	4,043,490	4,304,930	4,566,370
2007	3,978,570	4,358,990	4,739,410

Table 30. ASAP2 estimates of female abundance, by age and total, in numbers of fish, 1991-2007.

	Age							
Year	0	1	2	3	4	5	6+	Total
1991	8,555,140	5,014,000	2,246,320	213,129	45,900	10,920	3,985	16,089,394
1992	15,620,000	2,663,780	1,954,470	437,289	43,089	9,753	4,001	20,732,382
1993	13,192,300	4,870,510	1,139,390	517,644	121,275	12,526	4,836	19,858,481
1994	15,237,200	4,106,100	1,848,050	205,980	97,107	23,976	4,563	21,522,976
1995	10,969,200	4,736,330	1,427,870	257,616	29,635	14,826	6,230	17,441,707
1996	13,135,900	3,414,010	1,790,420	261,780	49,081	5,977	6,149	18,663,317
1997	11,680,300	4,090,870	1,345,540	373,038	56,826	11,251	4,115	17,561,939
1998	5,969,280	3,634,440	1,520,820	237,864	68,519	11,088	4,578	11,446,589
1999	15,424,200	1,857,880	1,371,880	284,193	46,277	14,162	4,997	19,003,589
2000	10,730,400	4,801,010	726,377	286,226	61,352	10,595	6,535	16,622,495
2001	9,810,710	3,338,870	1,887,840	150,875	60,976	13,832	5,859	15,268,962
2002	8,854,600	3,051,740	1,299,420	372,443	30,383	12,973	5,979	13,627,538
2003	17,777,400	2,747,940	1,043,890	168,872	48,569	4,212	4,289	21,795,173
2004	7,562,680	5,527,450	1,079,110	210,174	34,338	10,438	2,874	14,427,064
2005	10,663,500	2,353,510	2,333,310	269,335	53,011	9,111	4,618	15,686,394
2006	8,079,500	3,324,690	1,075,610	785,448	99,486	21,757	6,224	13,392,715
2007	8,214,610	2,518,250	1,455,220	320,676	263,516	37,864	11,907	12,822,043

Table 31. Estimated F and SSB thresholds and targets for female southern flounder.

	Fishing Mortality	SSB
$F_{0.1}$	0.3573	9,188,593
$F_{25\%}$	0.5937	5,903,817
$F_{30\%}$	0.4880	7,084,845
$F_{35\%}$	0.4081	8,265,162
$F_{40\%}$	0.3445	9,446,797

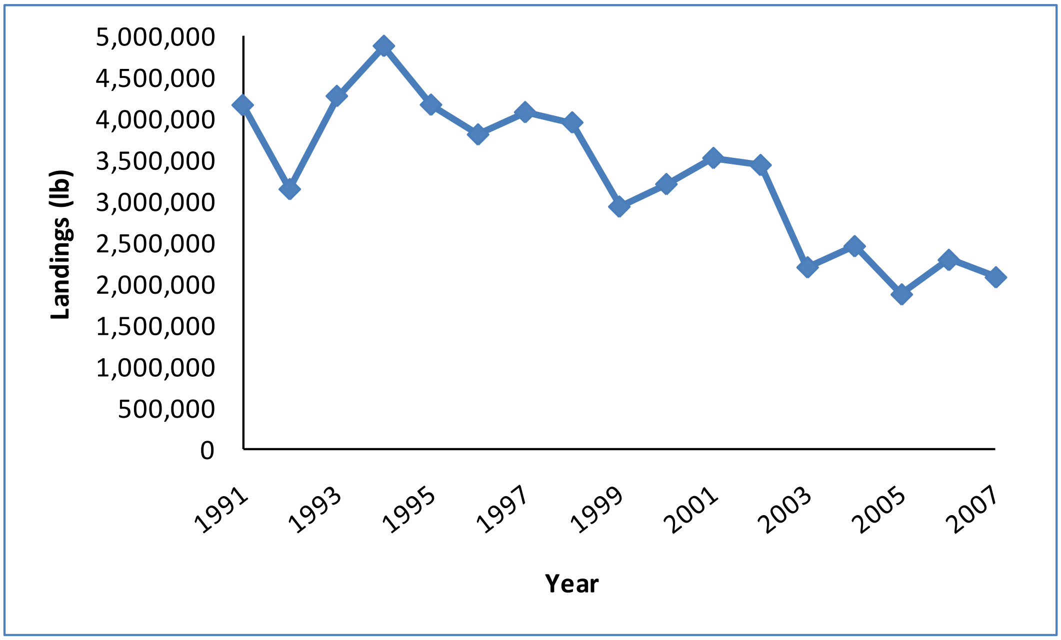


Figure 1. Annual commercial coast wide landings (pounds) of southern flounder, 1991-2007.

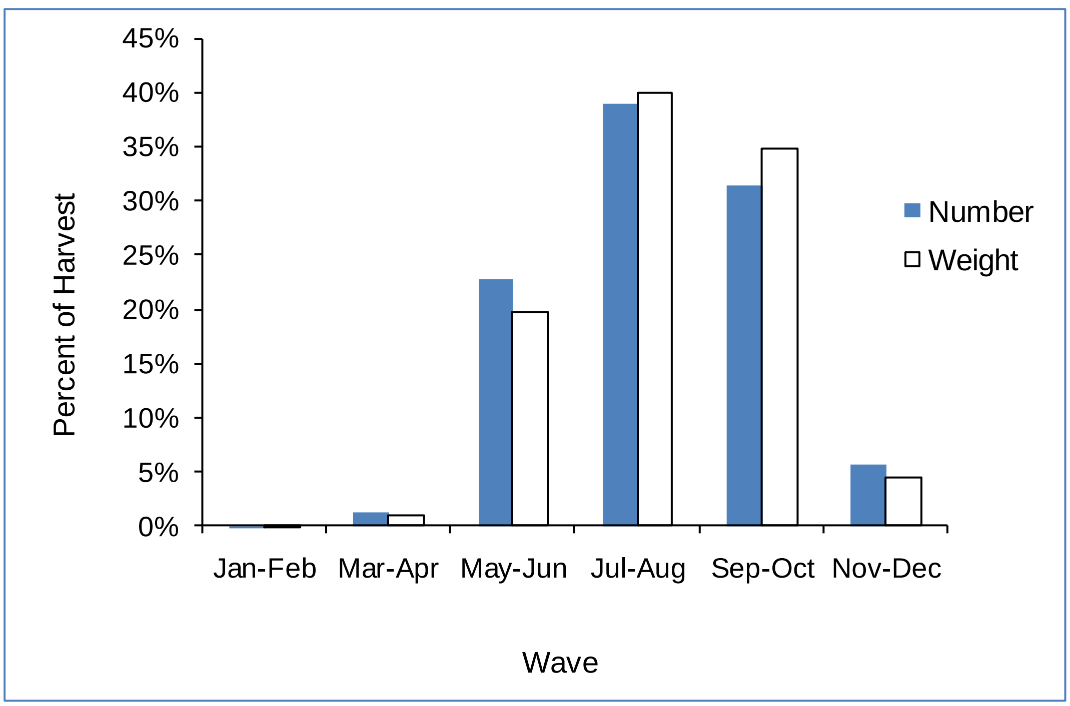
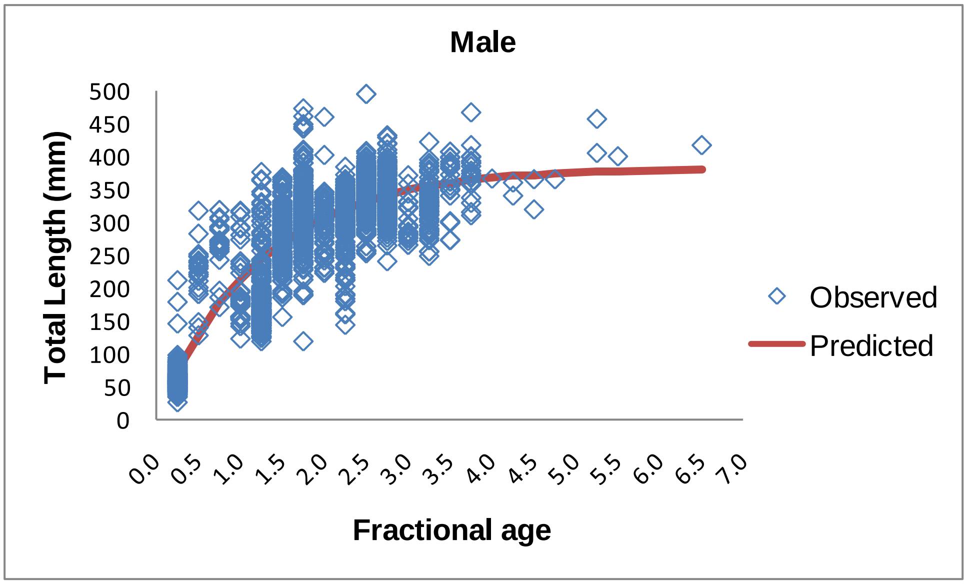


Figure 2. Proportions of harvest by wave in numbers and weight (pounds) of southern flounder in the recreational hook and line fishery, 1991-2007.



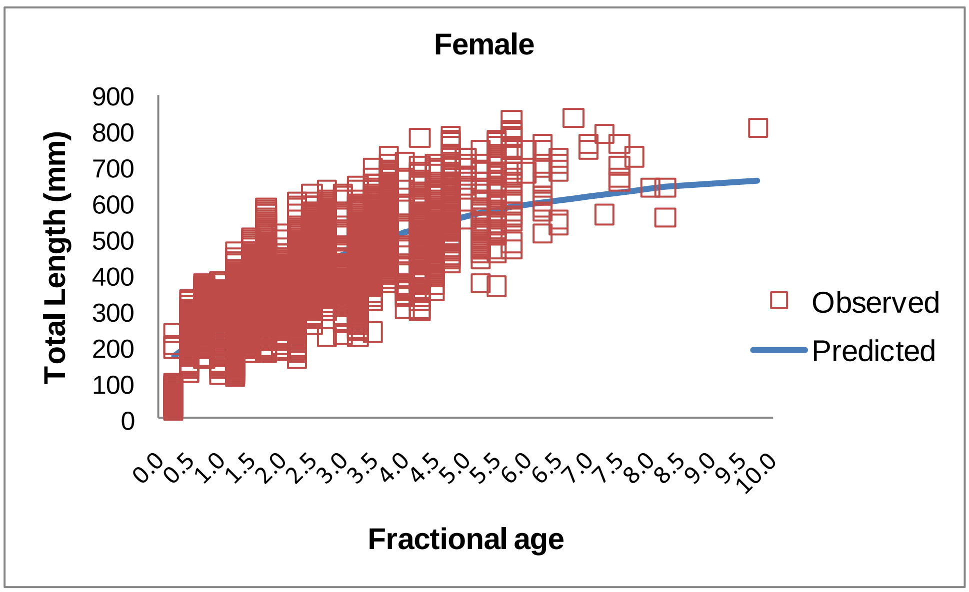


Figure 3. Observed and predicted growth rates of male and female southern flounder.

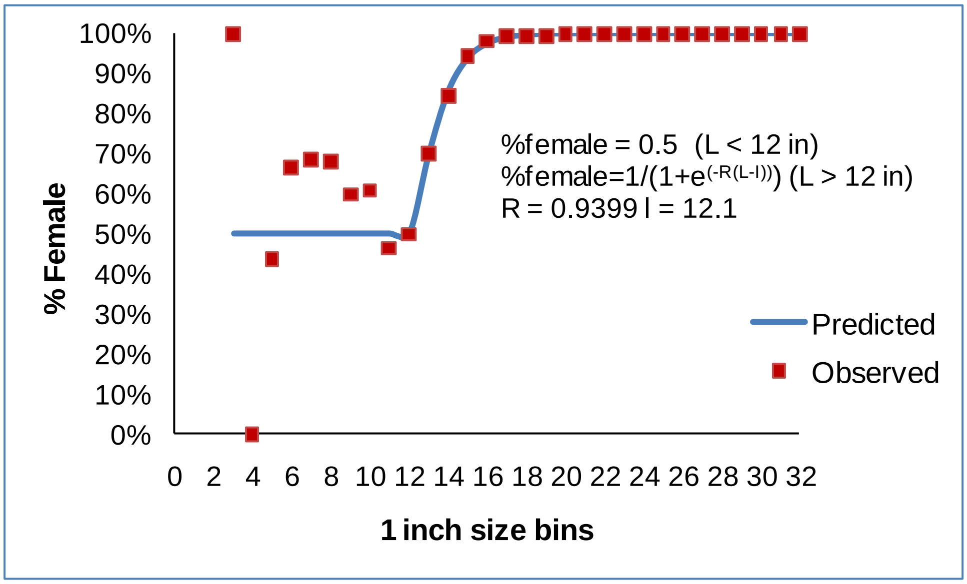


Figure 4. Observed values and predicted curve of the proportion of female southern flounder per size bin.

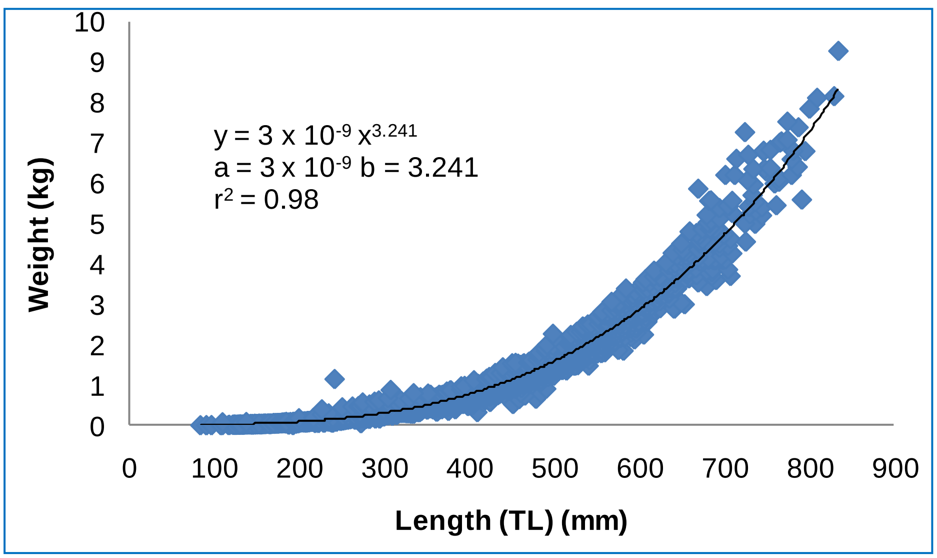


Figure 5. Length-weight relationship for southern flounder.

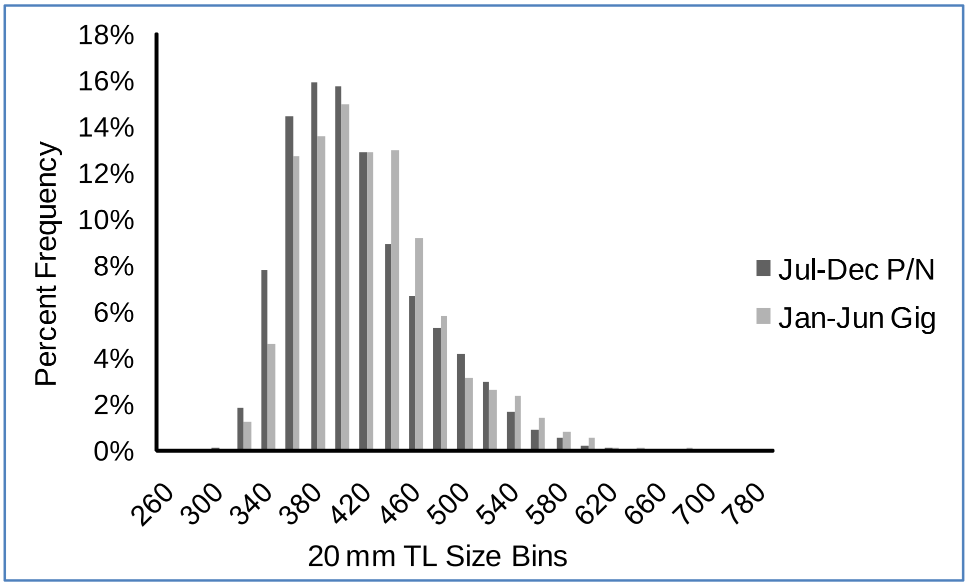


Figure 6. Comparison of length frequency distributions (mm) of southern flounder from commercial gigs during the months of January through June and from pound nets during the months of July through December.

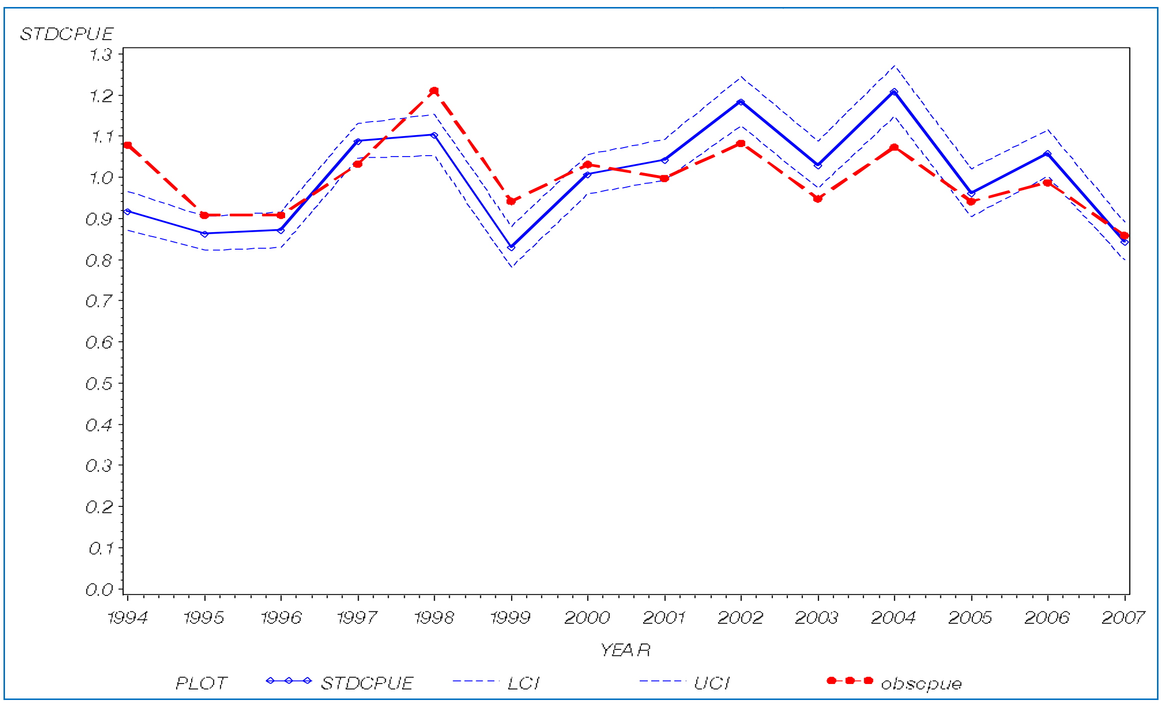


Figure 7. Observed and Delta-Lognormal standardized commercial gill net CPUE for southern flounder. Dashed red line is observed CPUE, solid blue line is standardized CPUE, dashed blue lines are 95% confidence intervals.

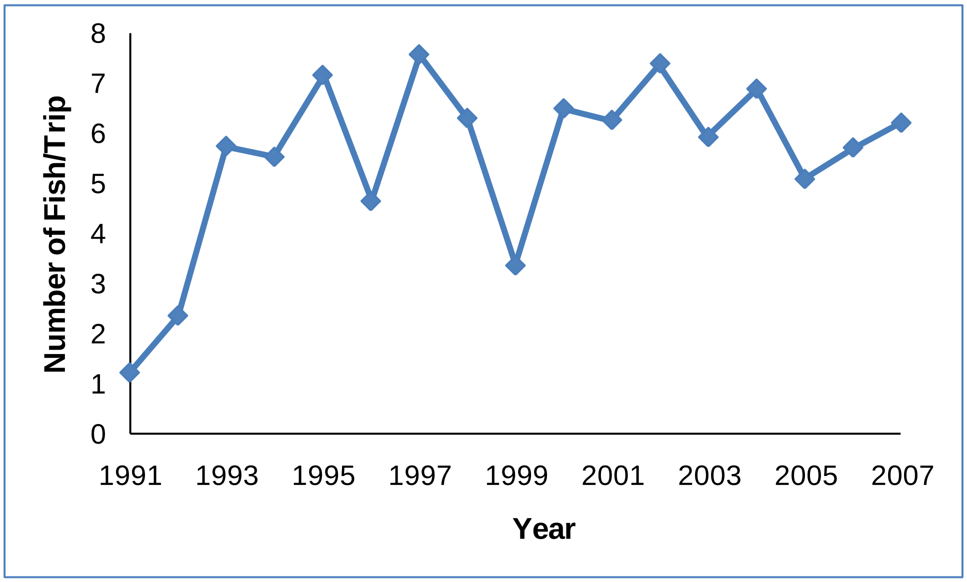


Figure 8. Recreational CPUE of southern flounder from the hook and line fishery, 1991-2007.

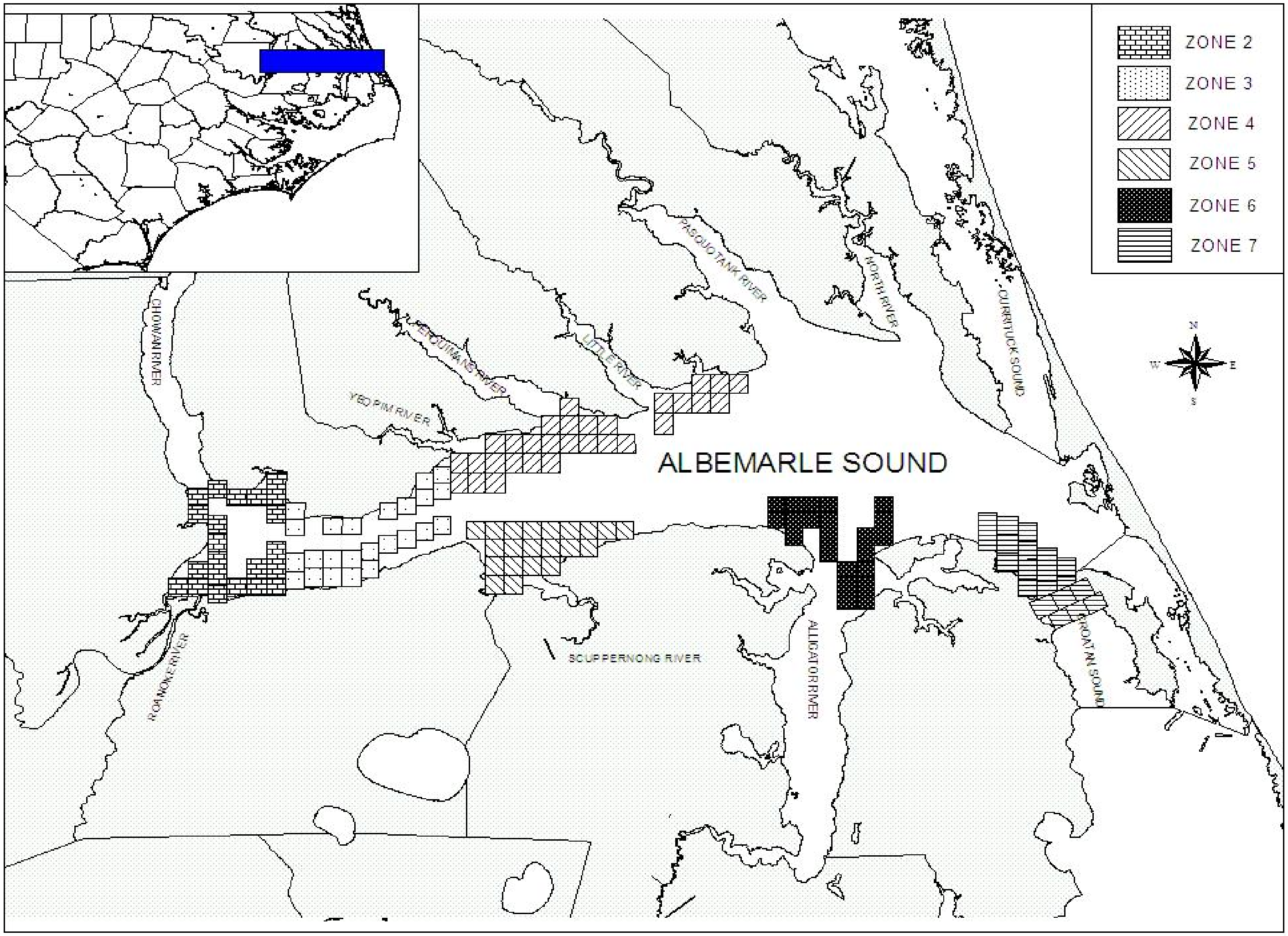


Figure 9. Sample zones for the Fall/Winter NCDMF Independent Gill Net Survey, Albemarle and Croatan Sounds, NC (Godwin 2007).

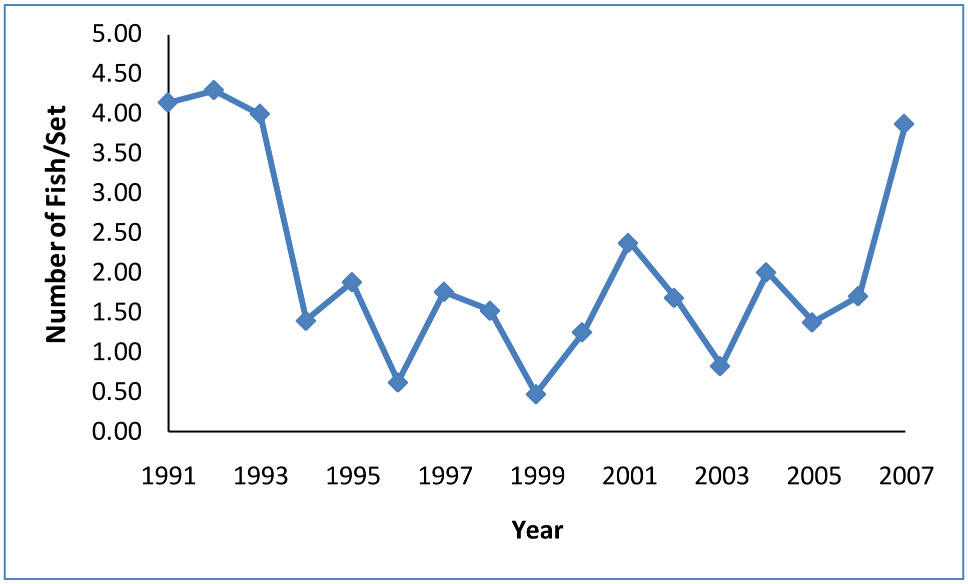


Figure 10. Annual CPUE of southern flounder from November and December Albemarle Sound Independent Gill Net Survey samples, 1991-2007.

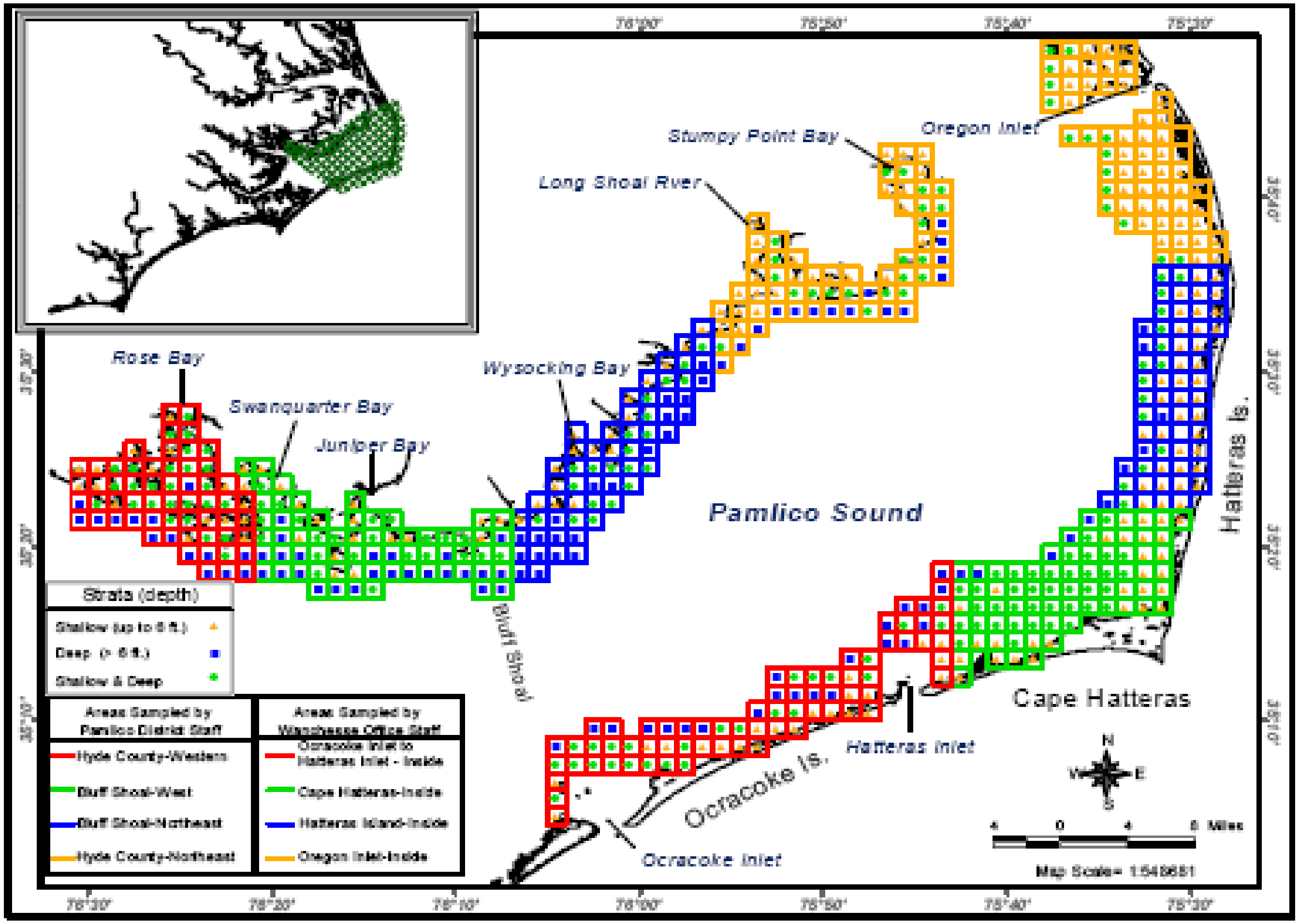


Figure 11. The sample regions and grid system for the Pamlico Sound Independent Gill Net Survey in Dare and Hyde counties of North Carolina (NCDMF 2007b).

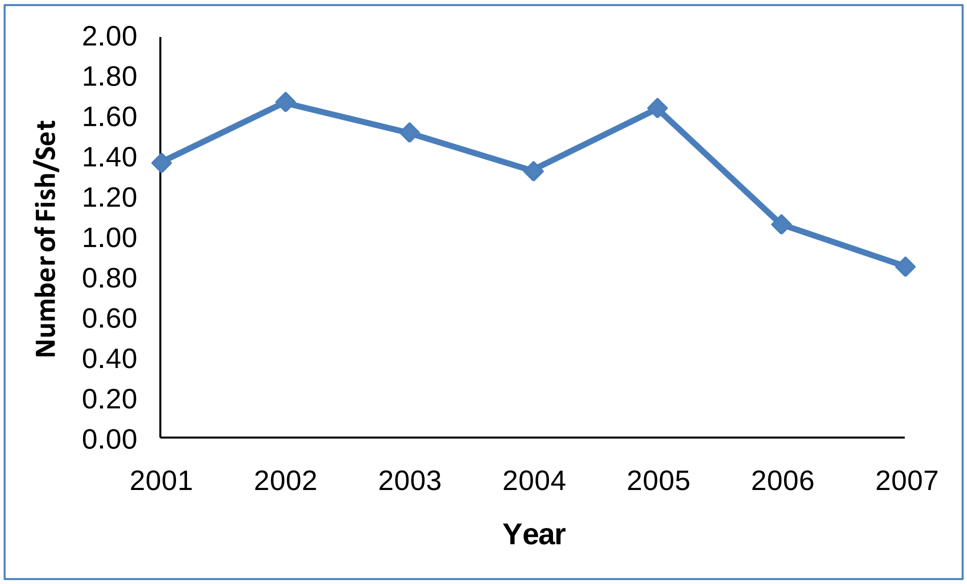


Figure 12. Annual CPUE of southern flounder from the Pamlico Sound Independent Gill Net Survey, 2001-2007.

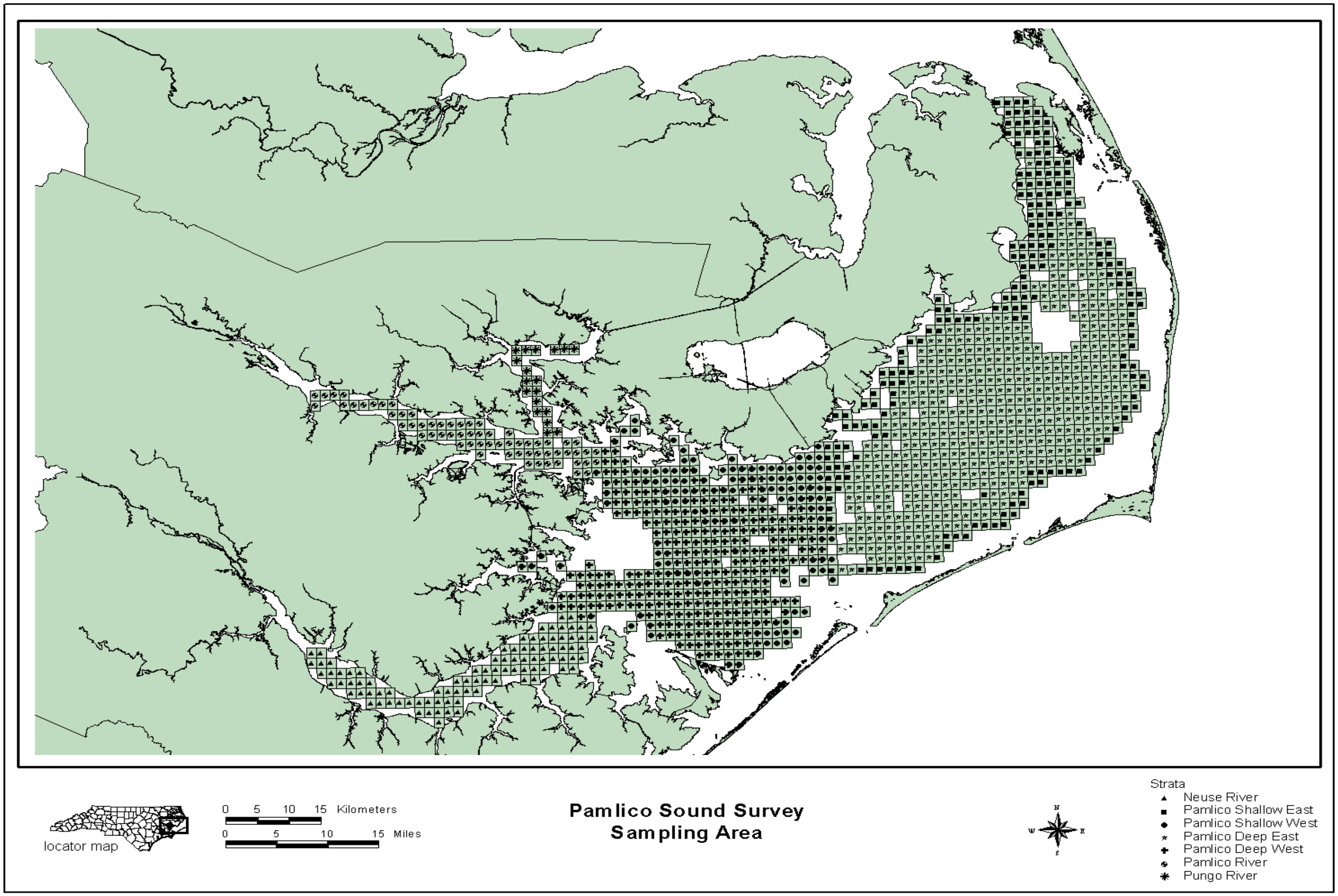


Figure 13. Location and grids of the Pamlico Sound Survey area of eastern North Carolina (NCDMF 2007c).

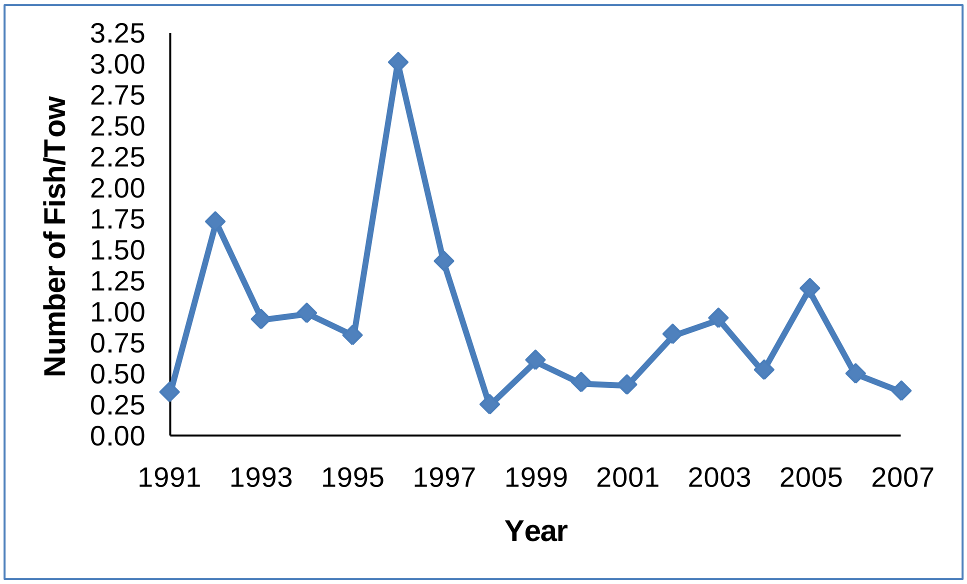


Figure 14. Annual CPUE of southern flounder from the Pamlico Sound Survey, 1991-2007.

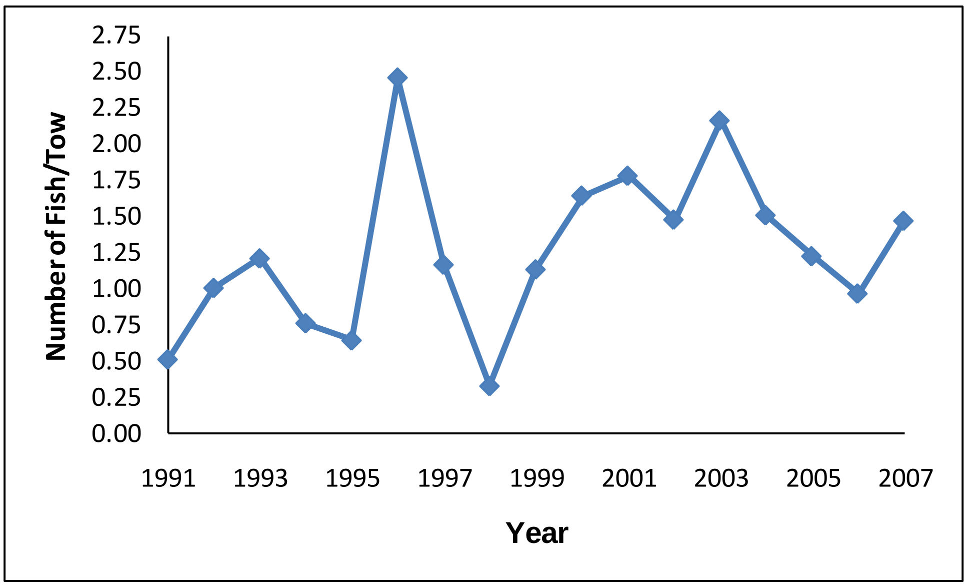


Figure 15. Annual CPUE of southern flounder from the Estuarine Trawl Survey, 1991-2007.

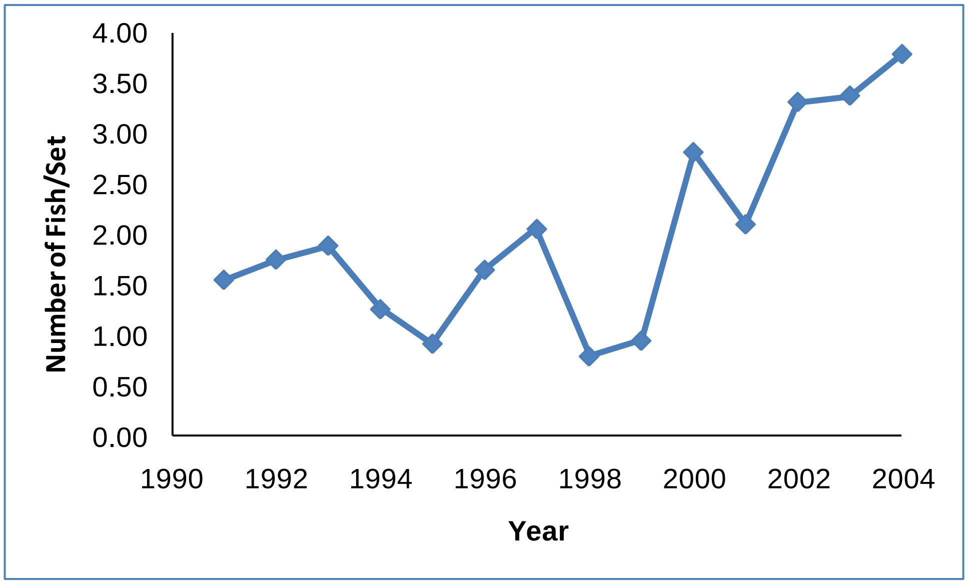


Figure 16. Annual CPUE of southern flounder from the NOAA Beaufort Inlet Ichthyoplankton Sampling Program, 1991-2004*.*

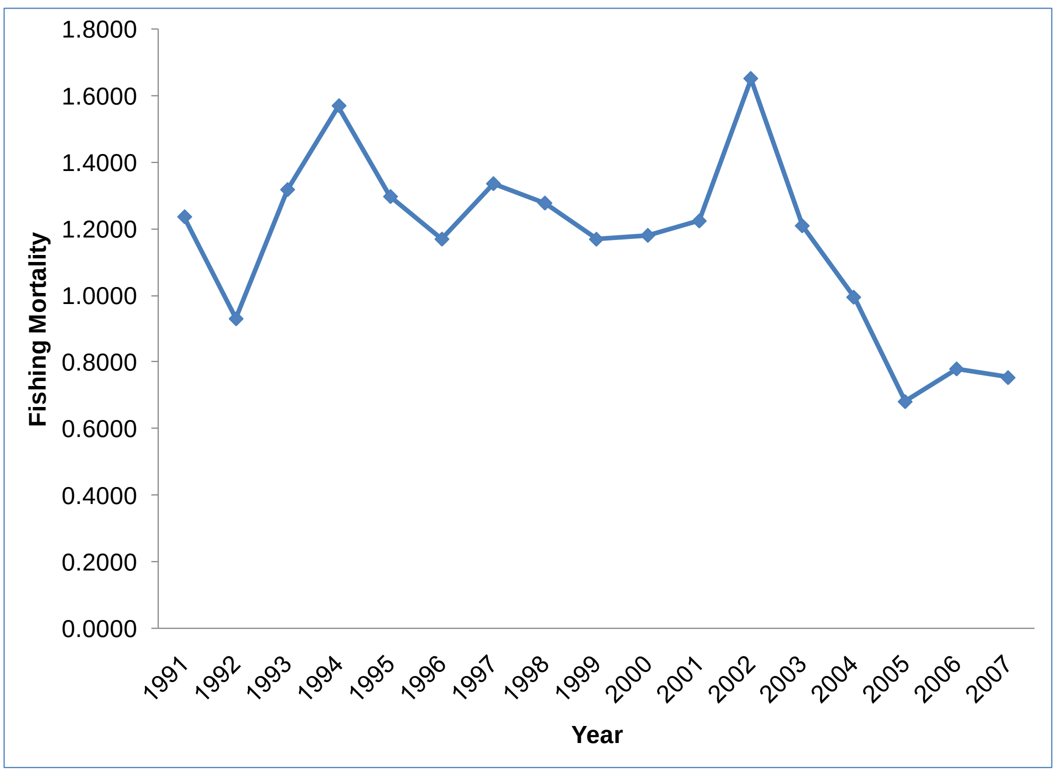


Figure 17. ASAP2 estimates of average fishing mortality of ages 2-5 for female southern flounder, 1991-2007*.*

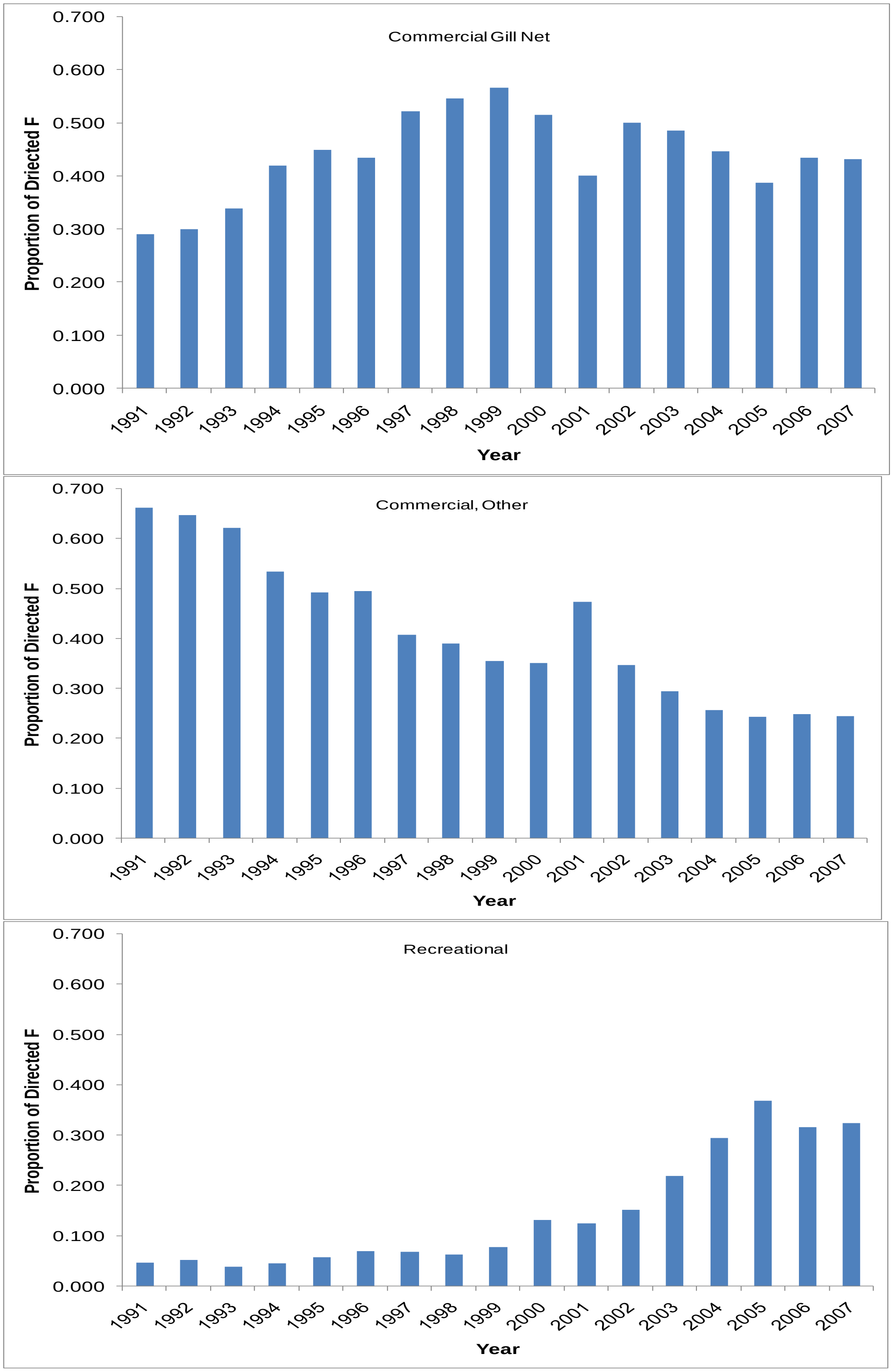


Figure 18. Proportion of directed F by fishery, 1991-2007.

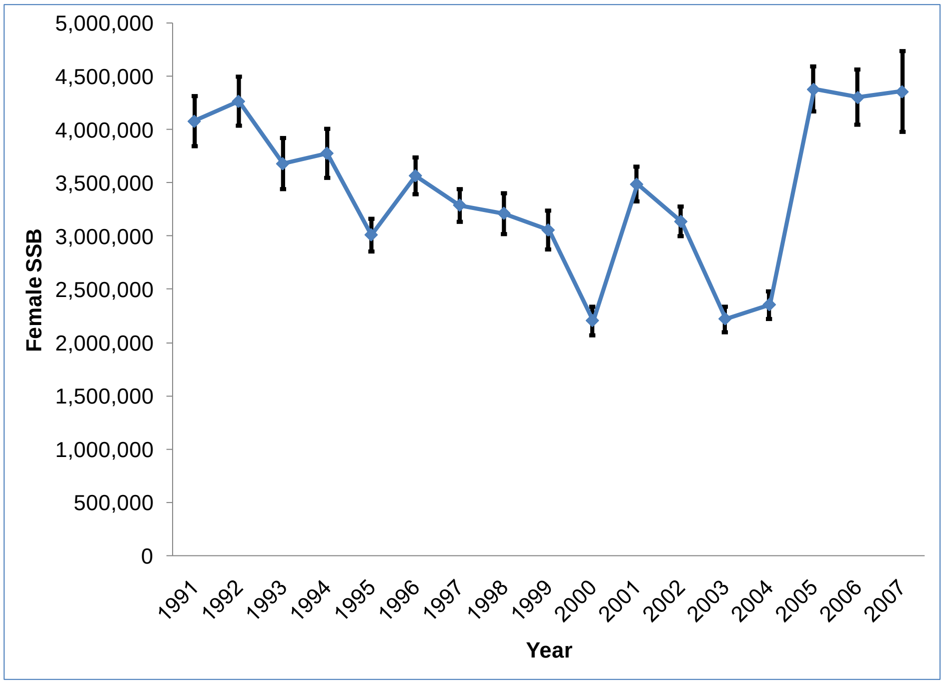


Figure 19. ASAP2 estimated female southern flounder SSB in pounds with +/- 1 standard deviation, 1991-2007.

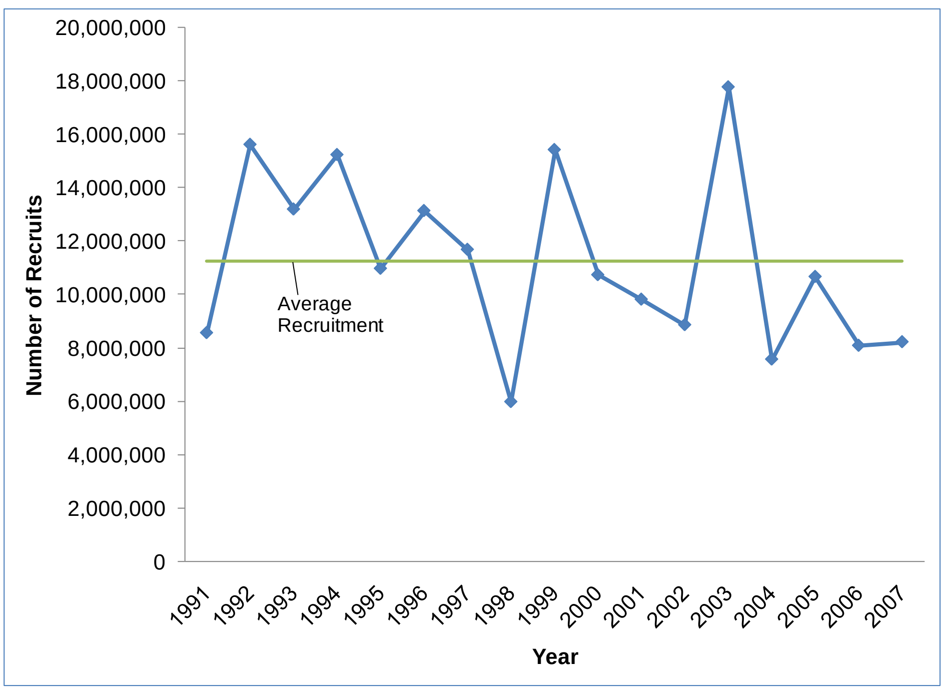


Figure 20. ASAP2 estimated female recruitment of age-0 southern flounder in numbers of fish, 1991-2007.

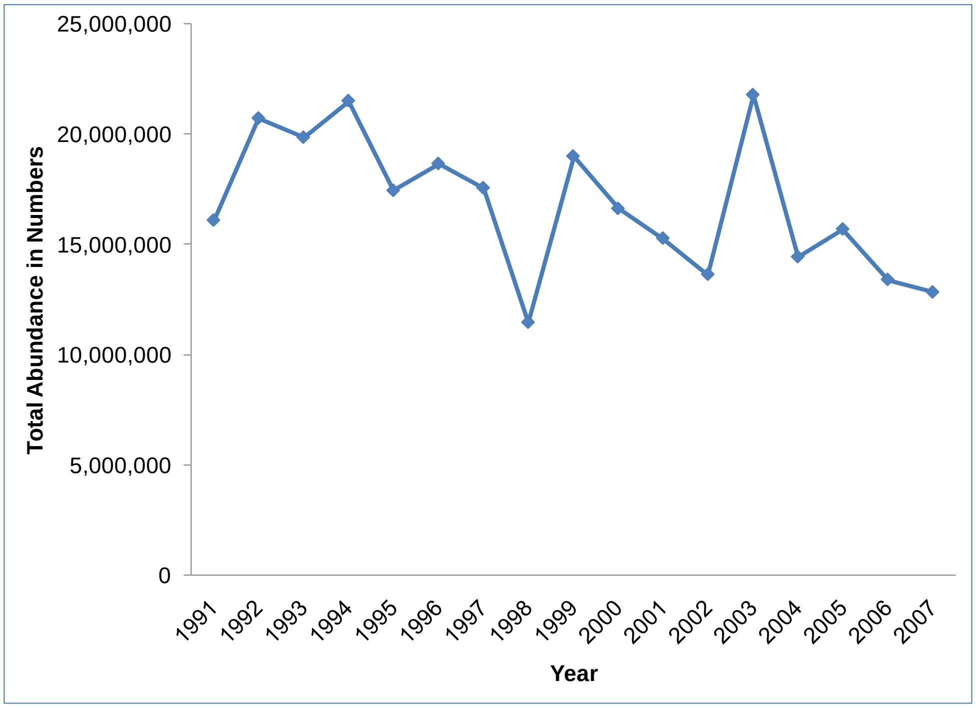


Figure 21. ASAP2 estimated total abundance of female southern flounder in numbers of fish, 1991-2007.

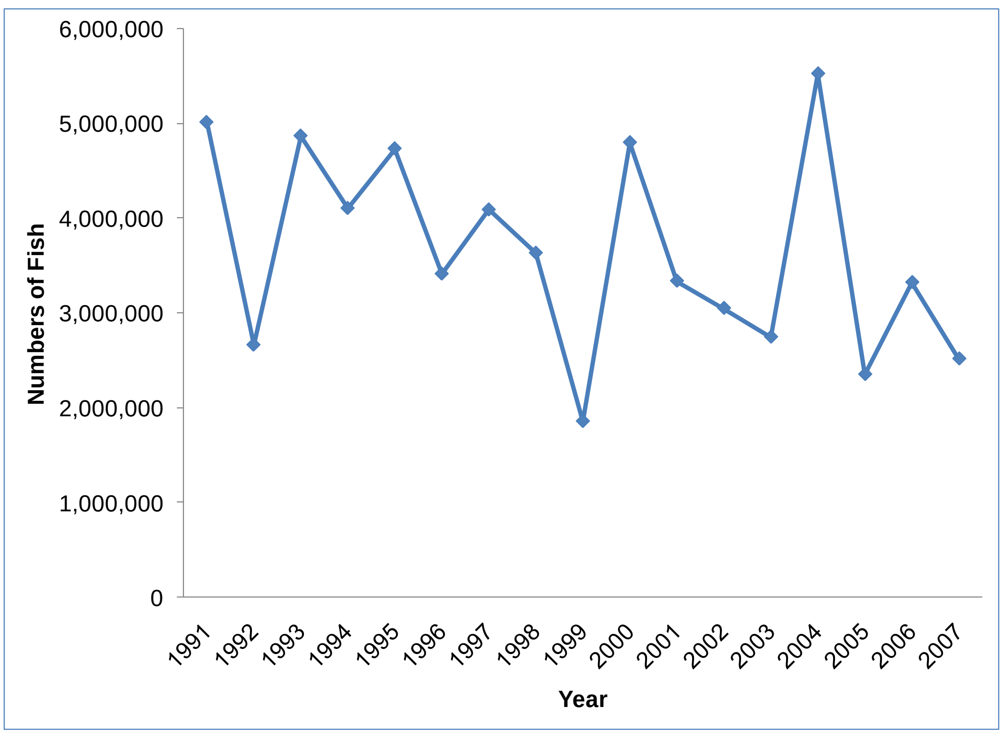


Figure 22. ASAP2 estimated age-1 abundance of female southern flounder in numbers of fish, 1991-2007.

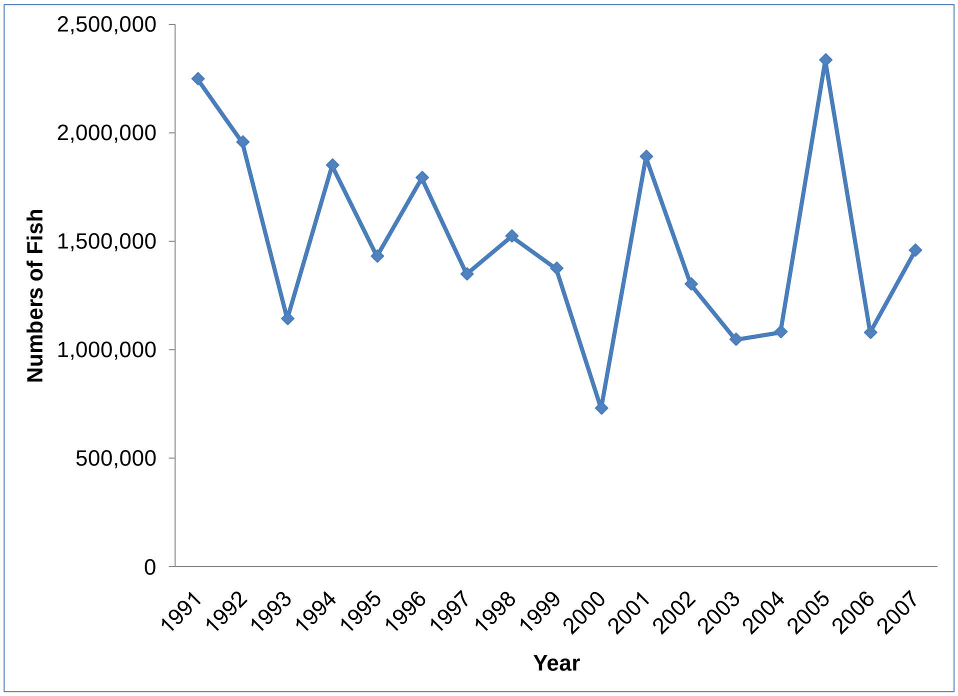


Figure 23. ASAP2 estimated age-2 abundance of female southern flounder in numbers of fish, 1991-2007.

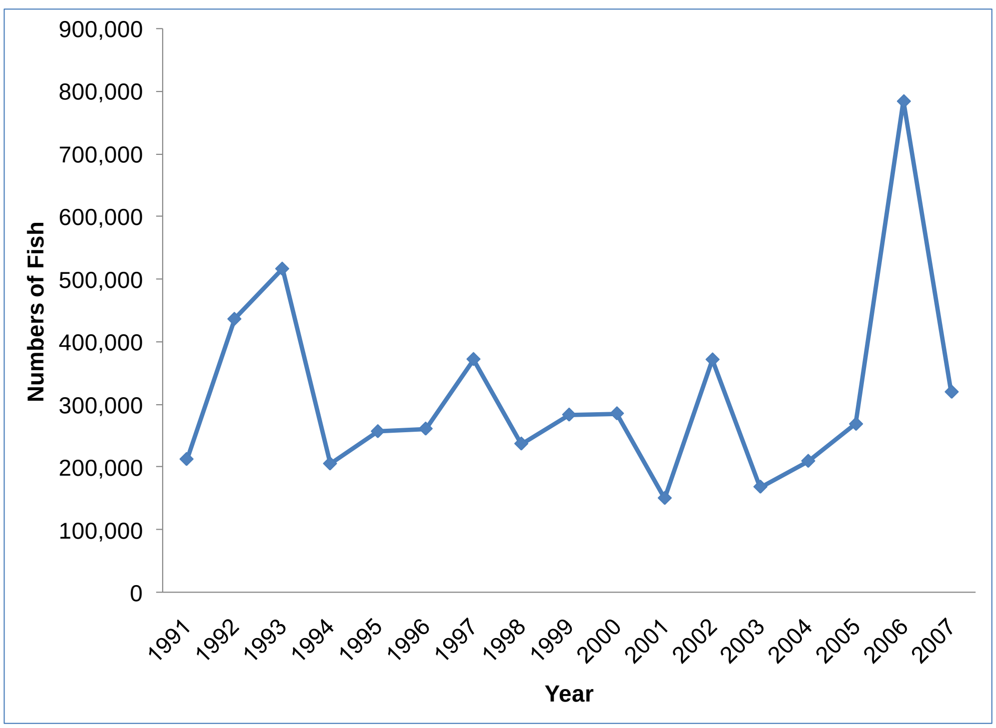


Figure 24. ASAP2 estimated age-3 abundance of female southern flounder in numbers of fish, 1991-2007.

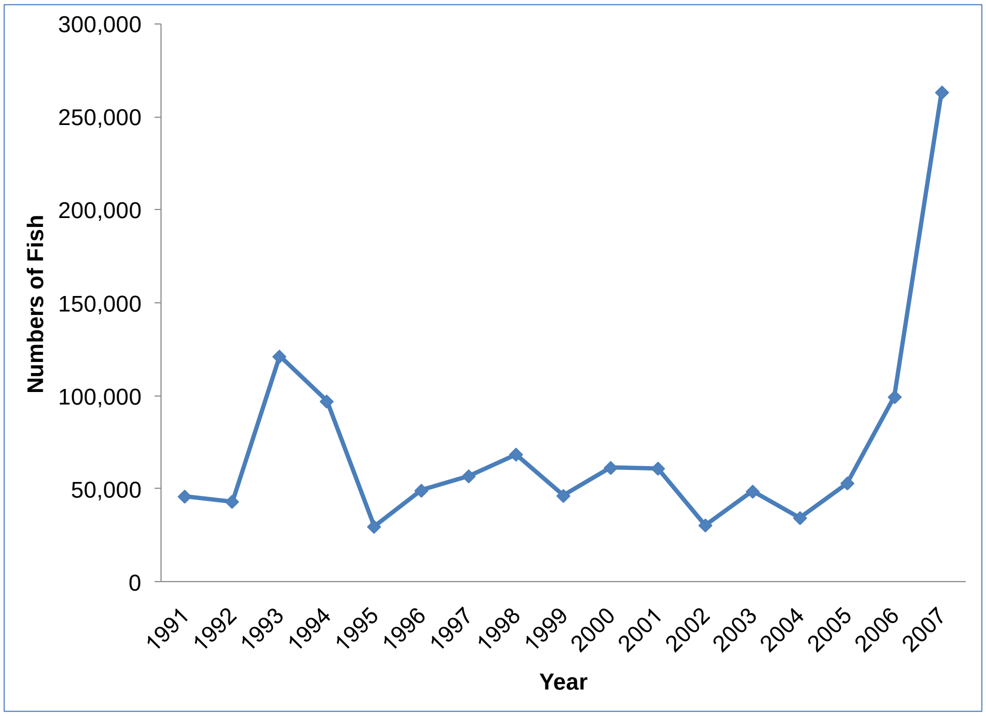


Figure 25. ASAP2 estimated age-4 abundance of female southern flounder in numbers of fish, 1991-2007.

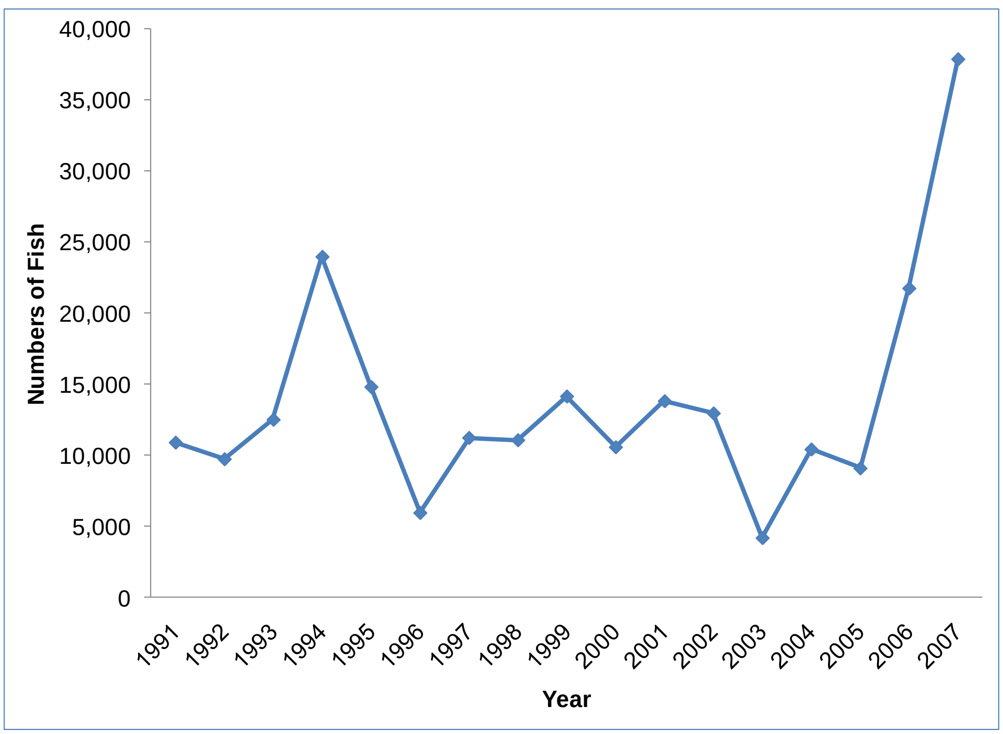


Figure 26. ASAP2 estimated age-5 abundance of female southern flounder in numbers of fish, 1991-2007.

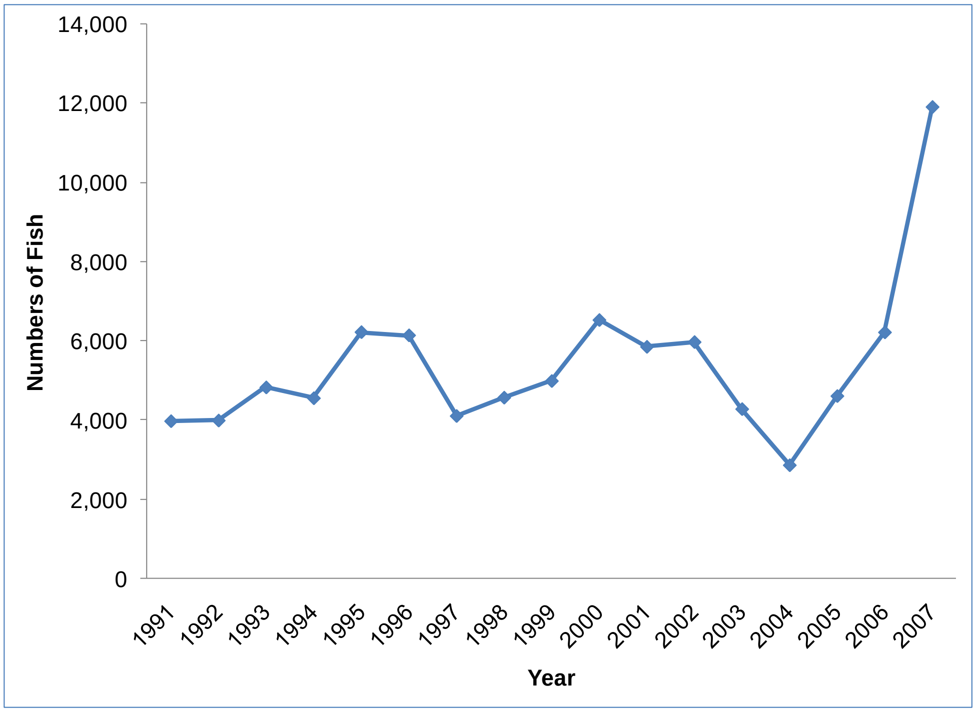


Figure 27. ASAP2 estimated age-6+ abundance of female southern flounder in numbers of fish, 1991-2007.

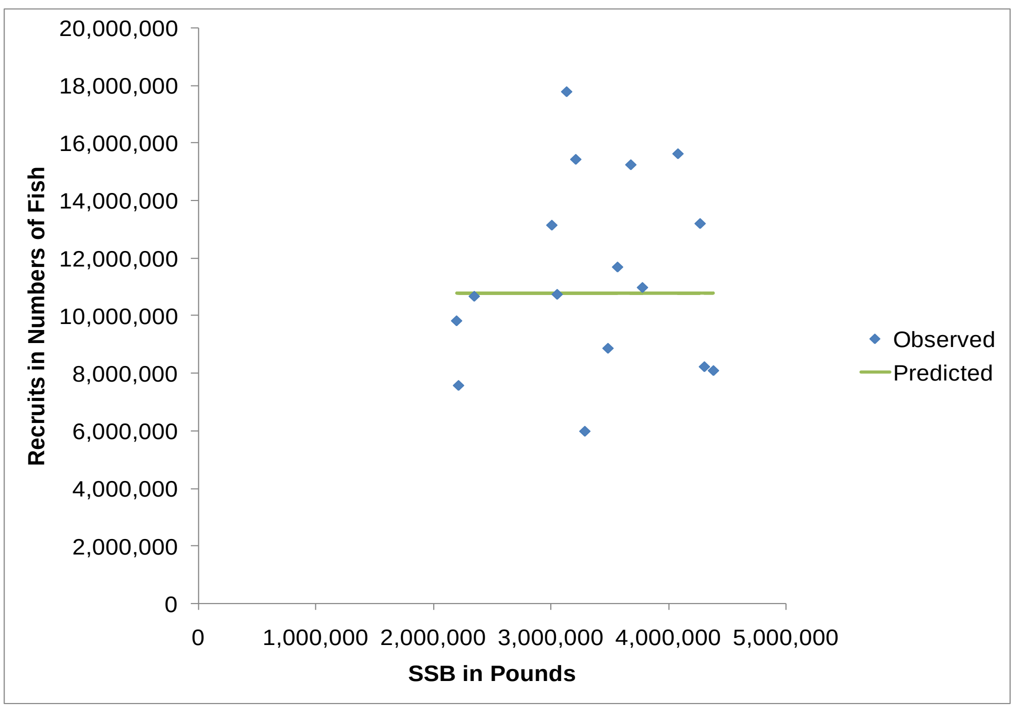


Figure 28. Stock-recruit relationship estimated from ASAP2 for female recruits in numbers of fish from female SSB in pounds.

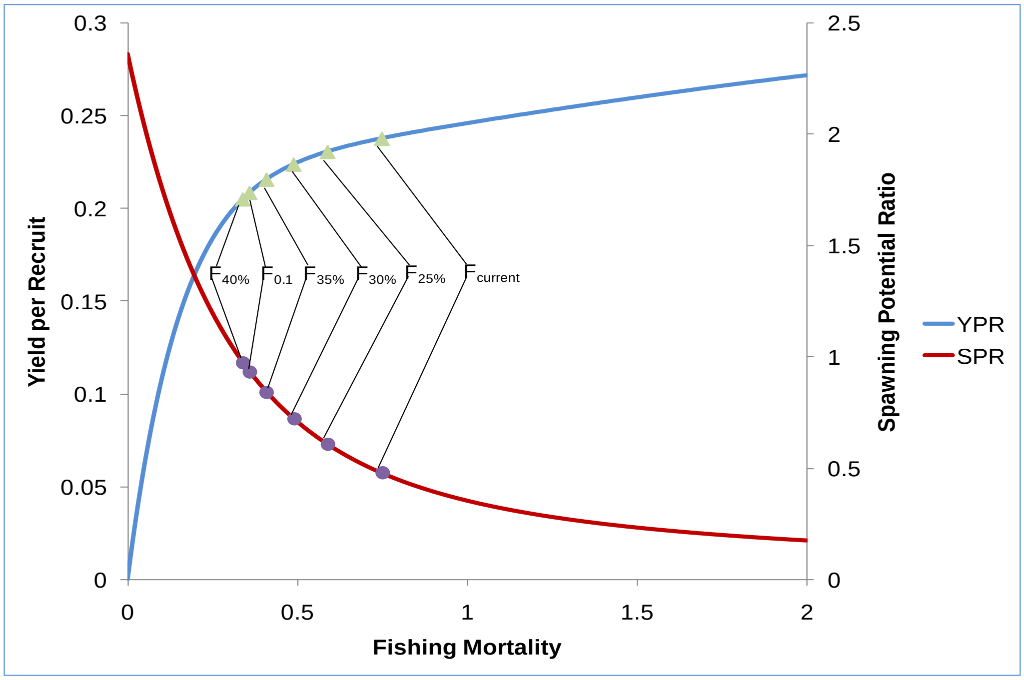


Figure 29. The yield per recruit and spawning stock biomass per recruit estimates from the model estimating F and SSB thresholds, including $F_{current}$, the terminal year.

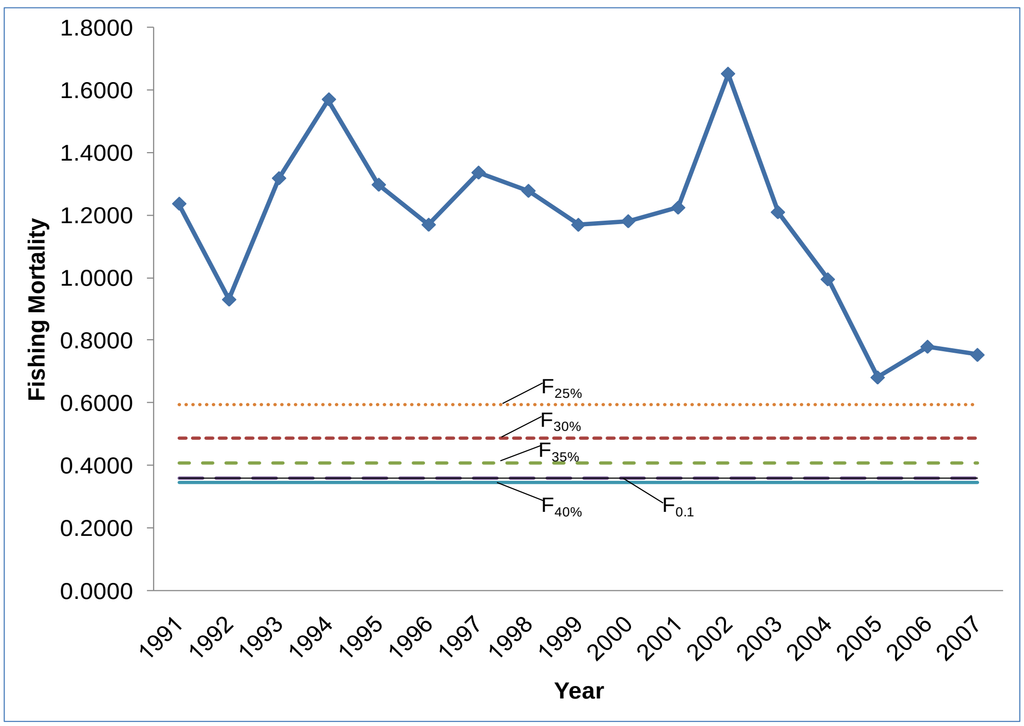


Figure 30. ASAP2 estimates of average fishing mortality of ages 2-5 for female southern flounder with estimated thresholds, 1991-2007.

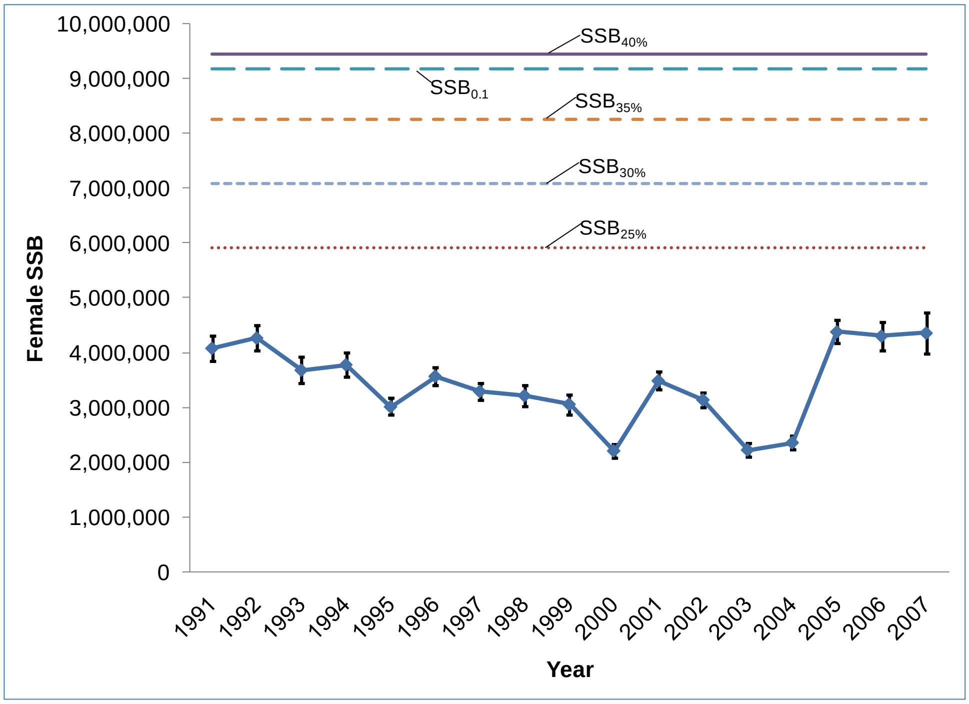


Figure 31. ASAP2 estimated female southern flounder SSB in pounds with +/- 1 standard deviation with estimated thresholds, 1991-2007.

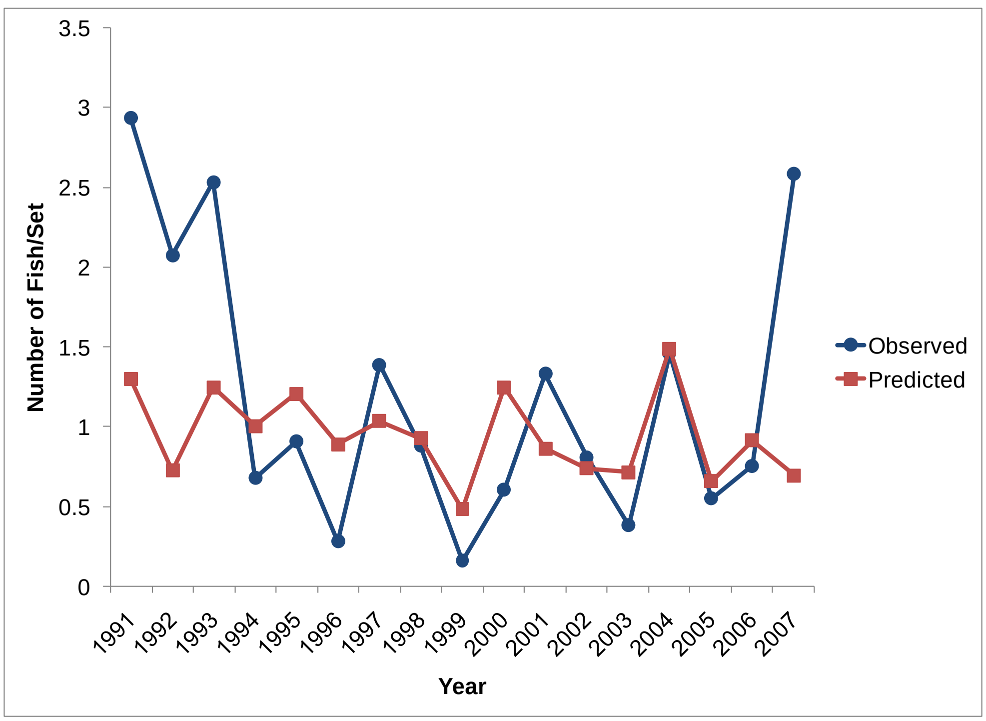


Figure 32. The observed versus predicted age-1 index for the Albemarle Sound IGNS, 1991-2007.

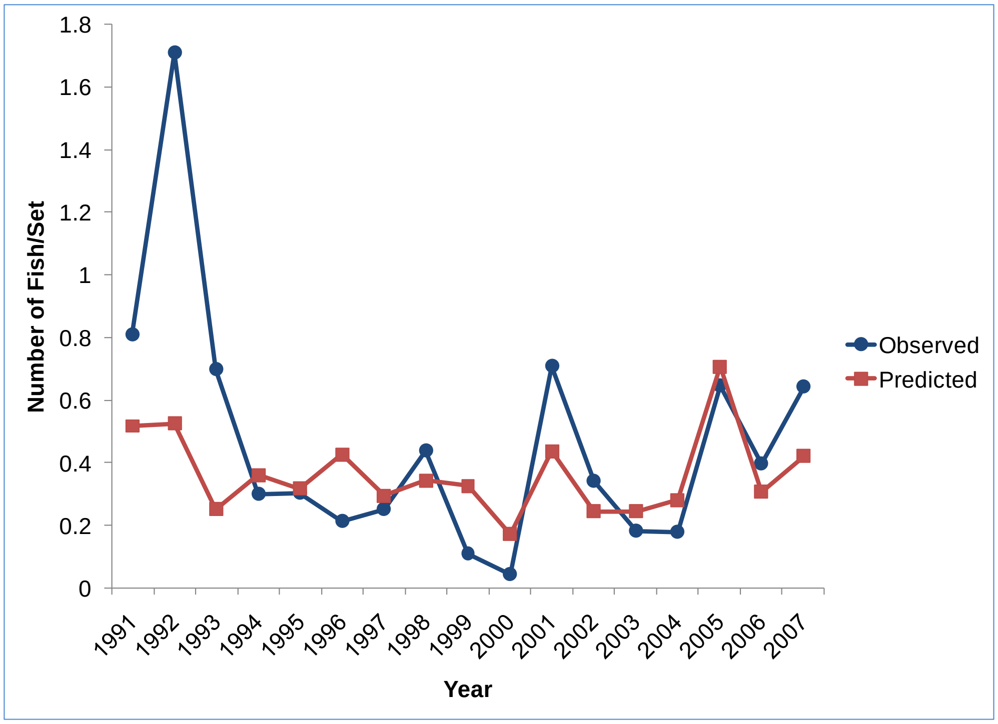


Figure 33. The observed versus predicted age-2 index for the Albemarle Sound IGNS, 1991-2007.

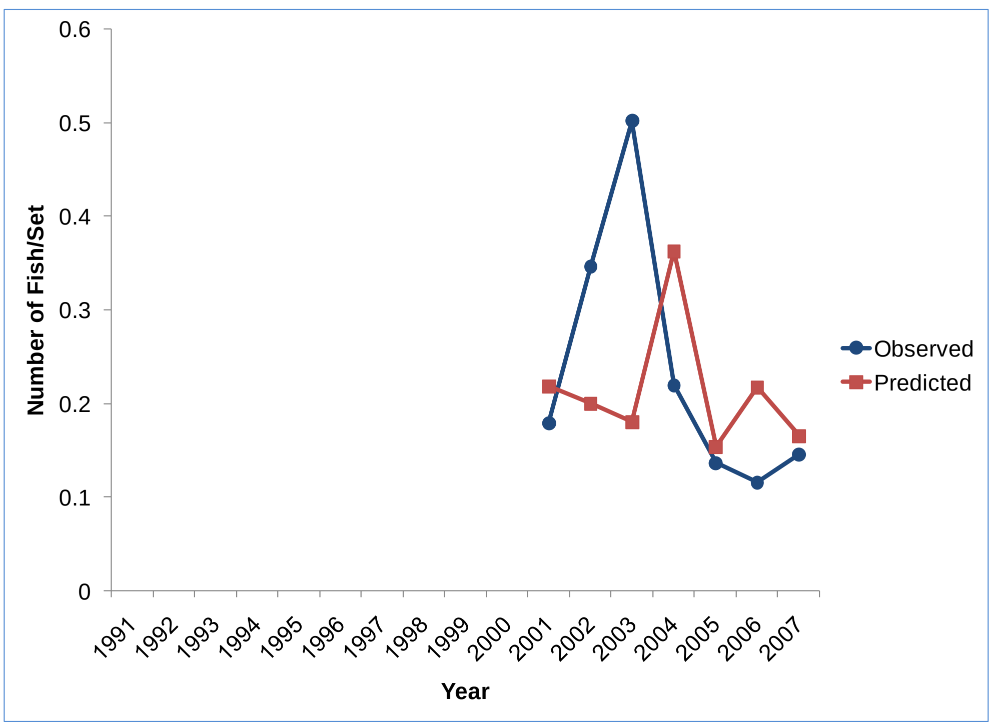


Figure 34. The observed versus predicted age-1 index for the Pamlico Sound IGNS, 2001-2007.

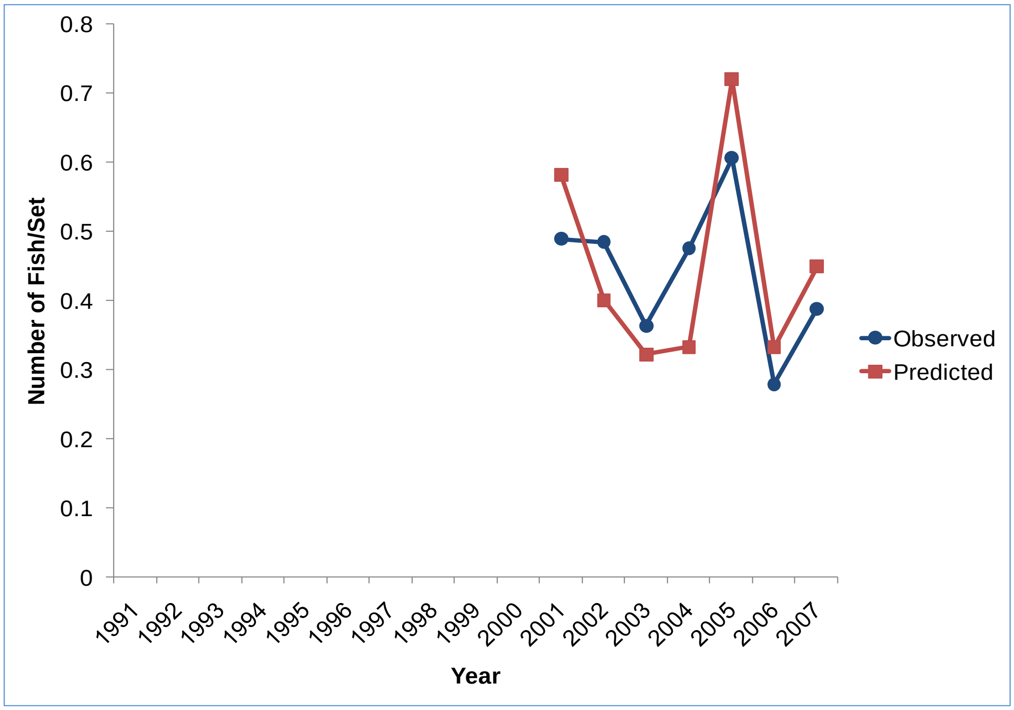


Figure 35. The observed versus predicted age-2 index for the Pamlico Sound IGNS, 2001-2007.

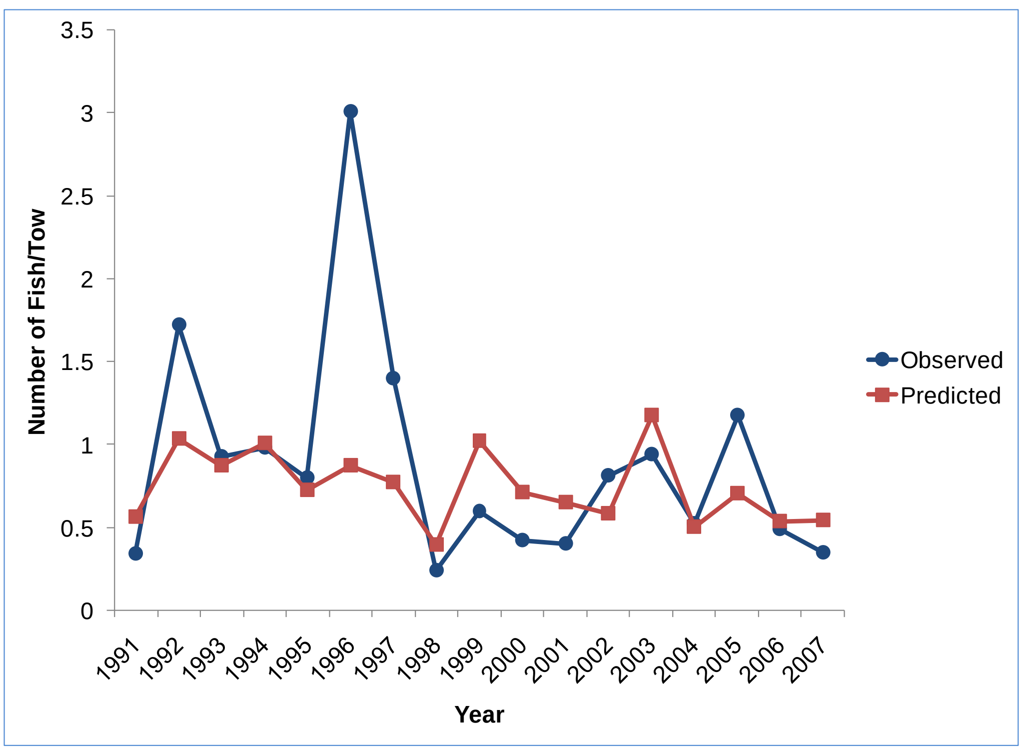


Figure 36. The observed versus predicted age-0 index for the Pamlico Sound Survey, 1991-2007.

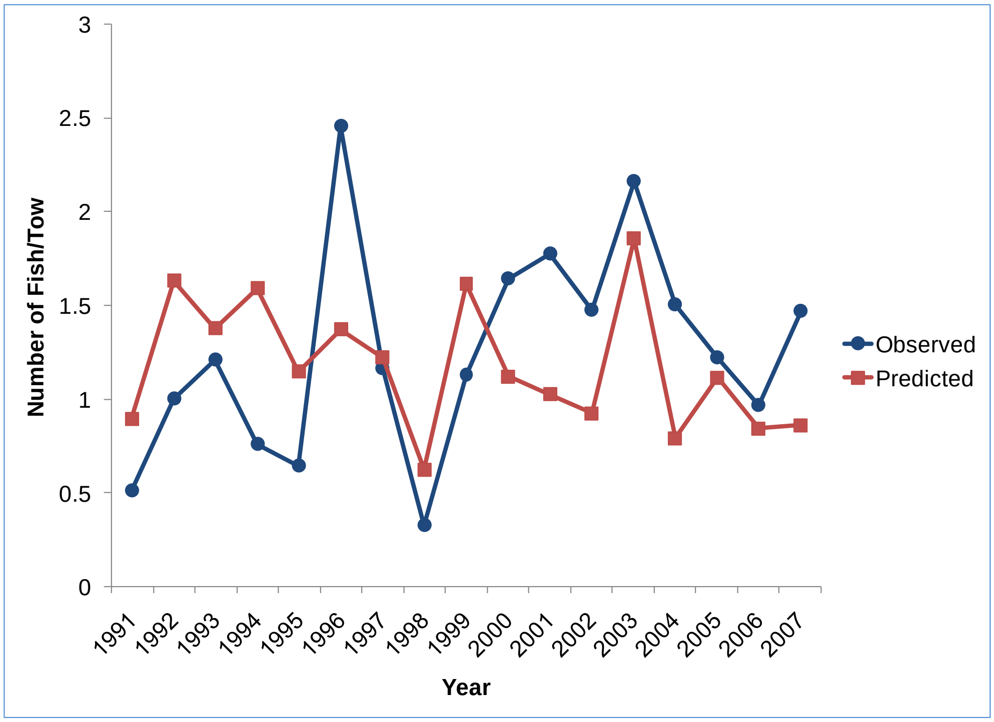


Figure 37. The observed versus predicted age-0 index for the Estuarine Trawl Survey, 1991-2007.

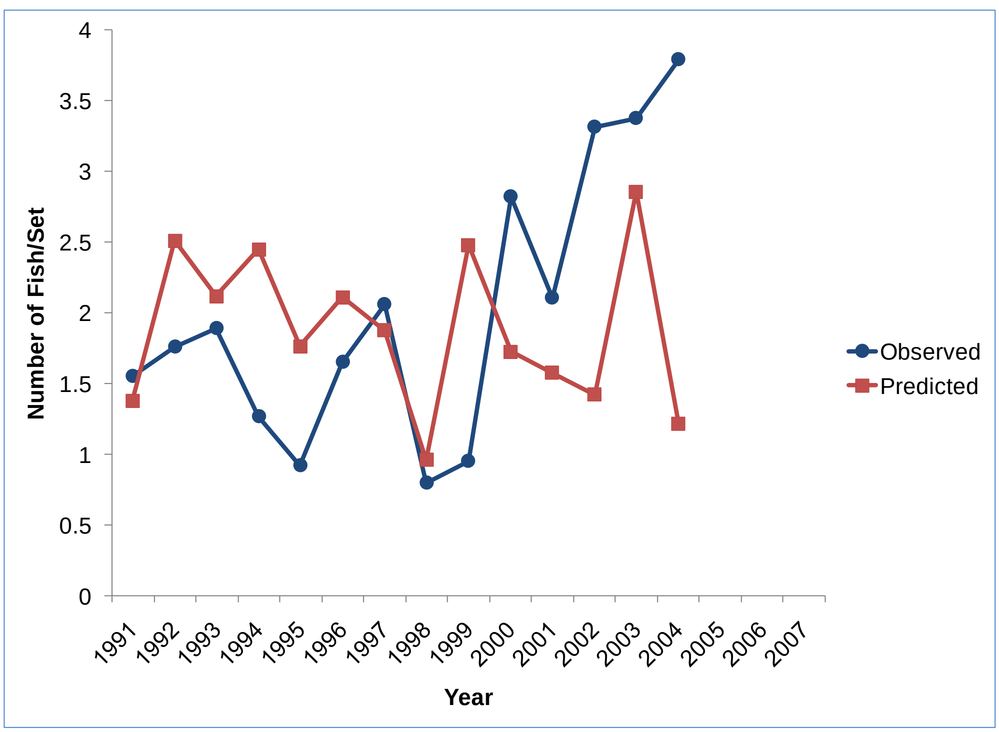


Figure 38. The observed versus predicted age-0 for the Bridgenet index, 1991-2004.

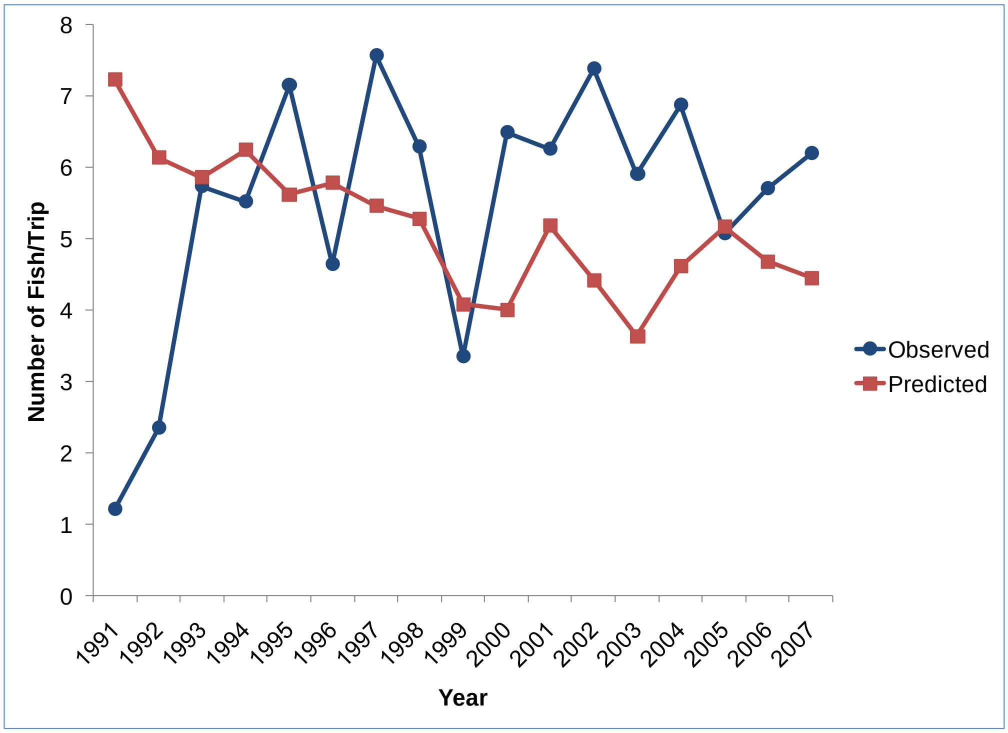


Figure 39. The observed versus predicted for the MRFSS age-aggregated index, 1991-2007.

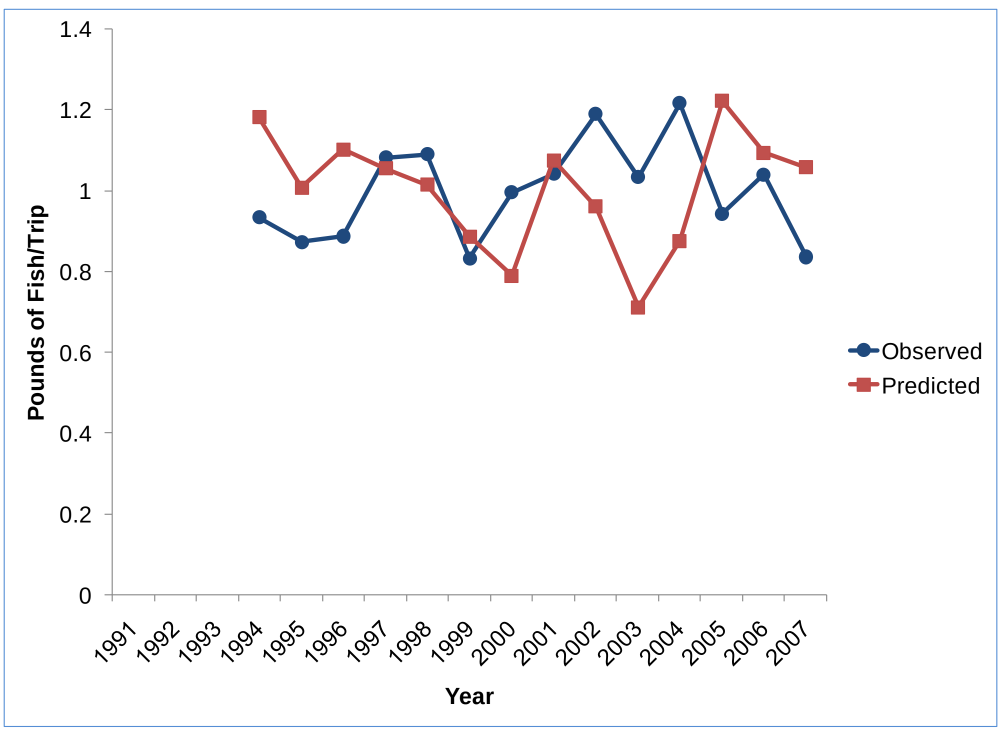


Figure 40. The observed versus predicted for the commercial gill net age-aggregated index, 1994-2007.

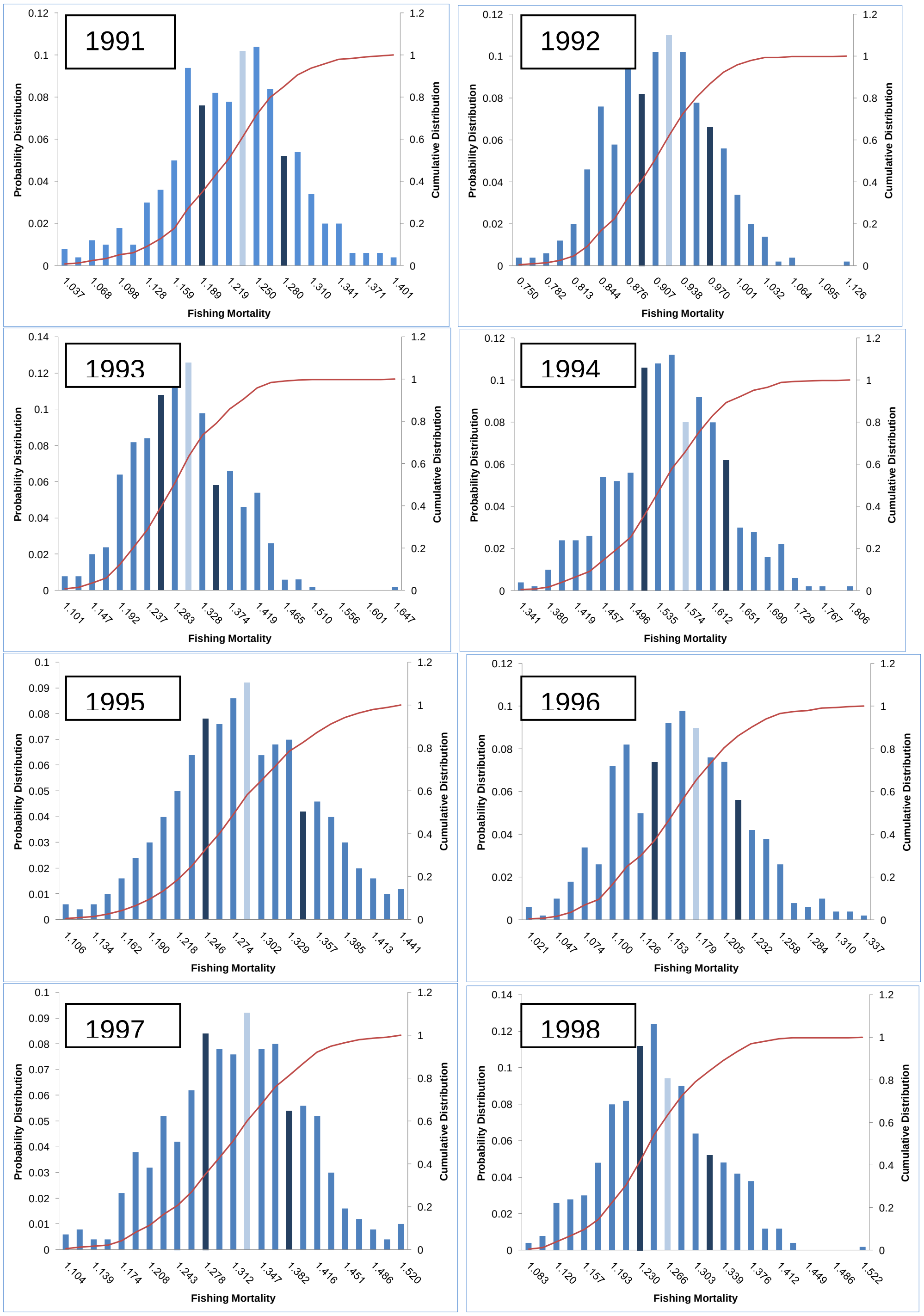


Figure 41. MCMC estimates of fishing mortality over 500 iterations for all years. The bar graph is the probability distribution while the smoothed line is the cumulative distribution. Dark green bars denote 80% confidence intervals and light gray bar denotes the median. Page one covers 1991-1998.

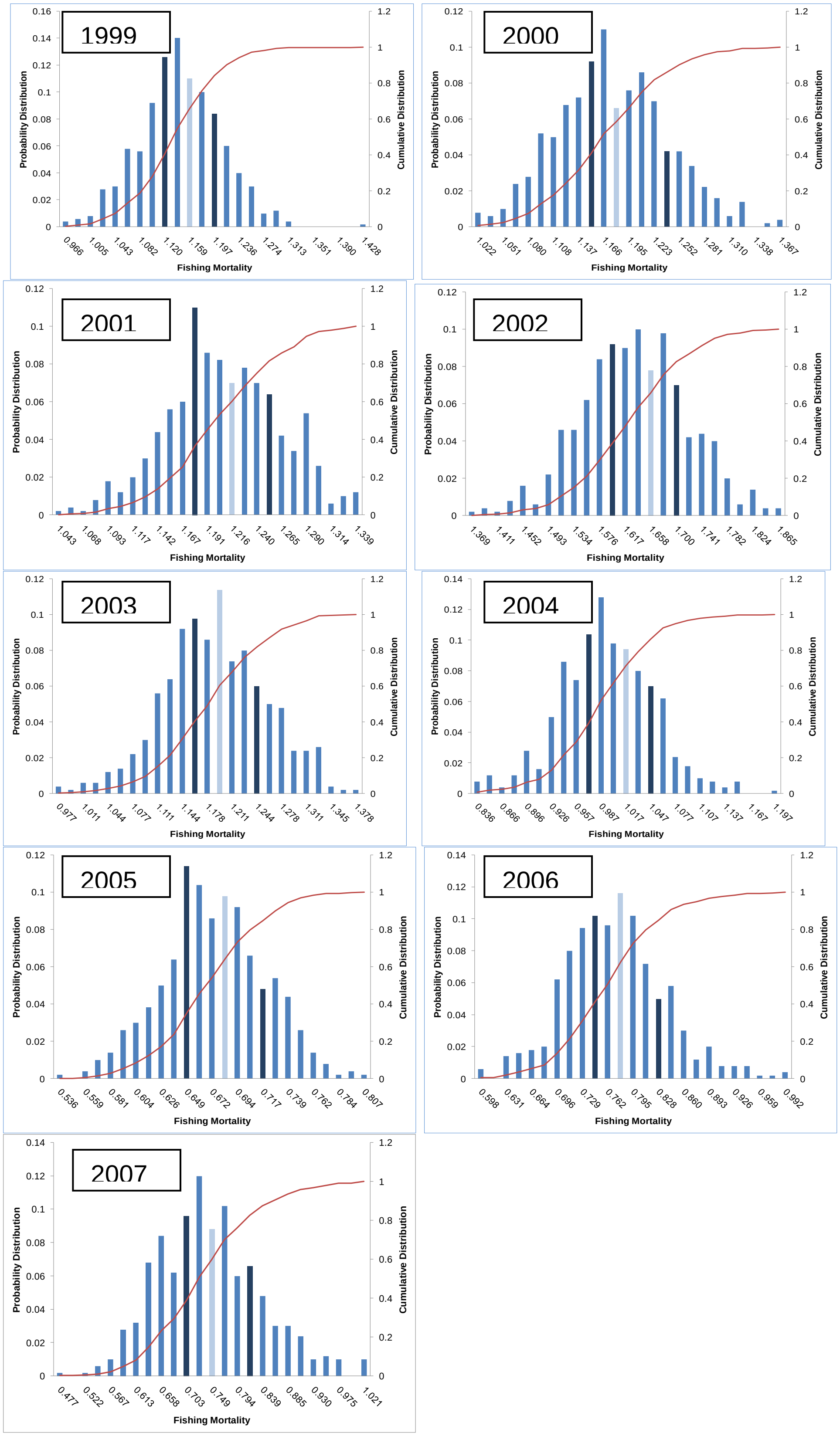


Figure 41. Continued for years 1999-2007.

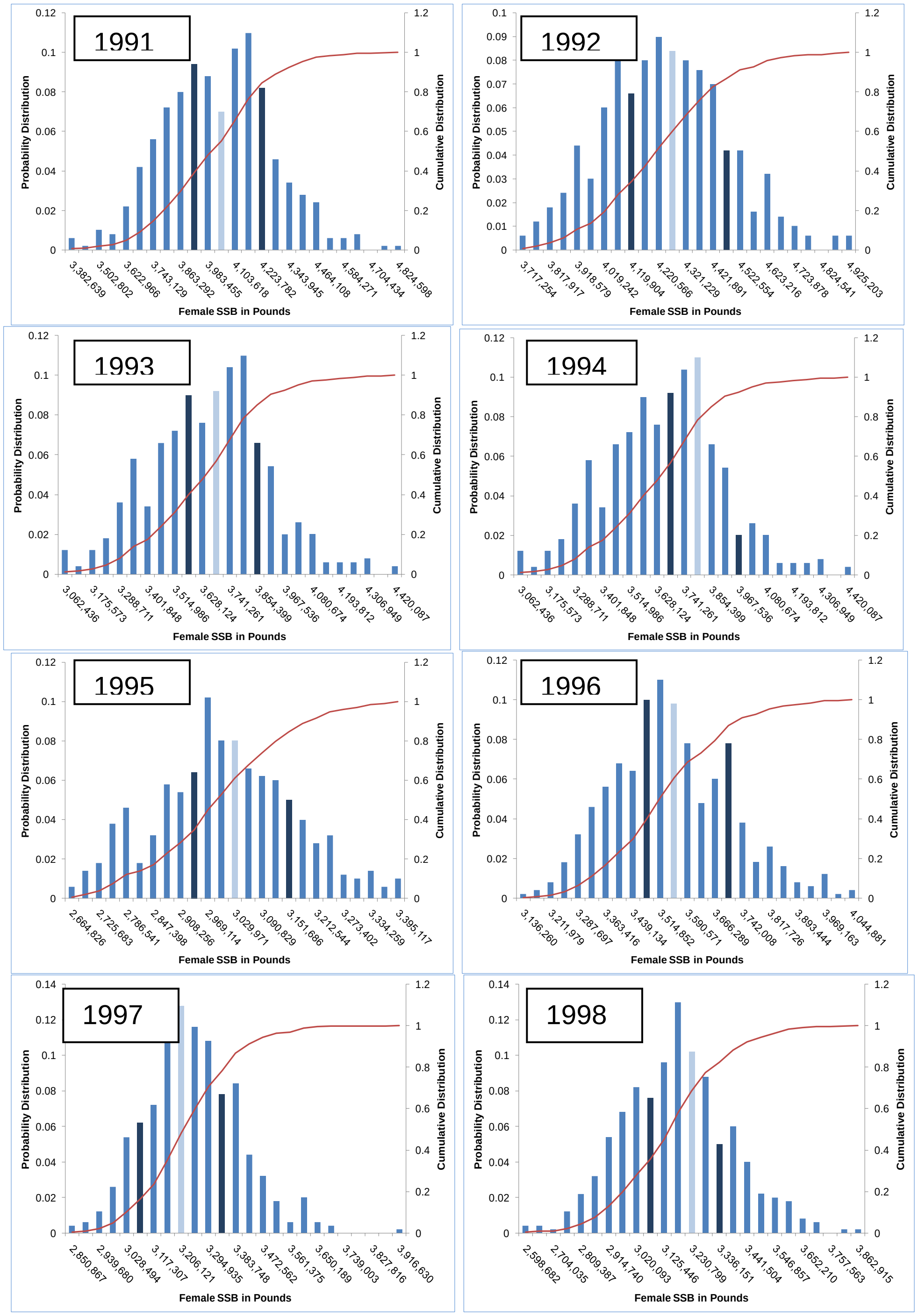


Figure 42. MCMC estimates of SSB over 500 iterations for all years. The bar graph is the probability distribution while the smoothed line is the cumulative distribution. Dark gray bars denote 80% confidence intervals and light gray bar denotes the median. Page one covers 1991-1998.

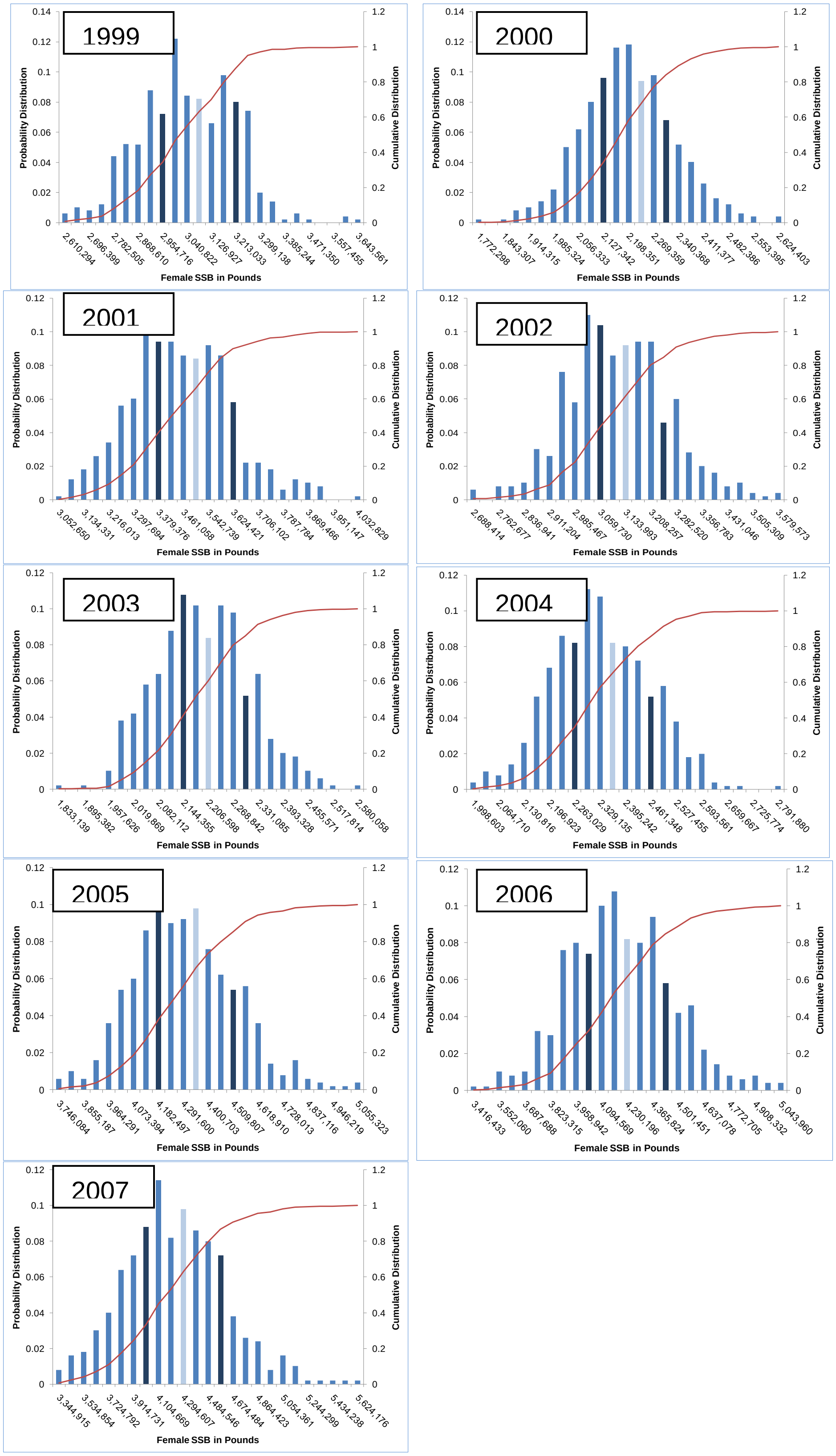


Figure 42. Continued for years 1999-2007.

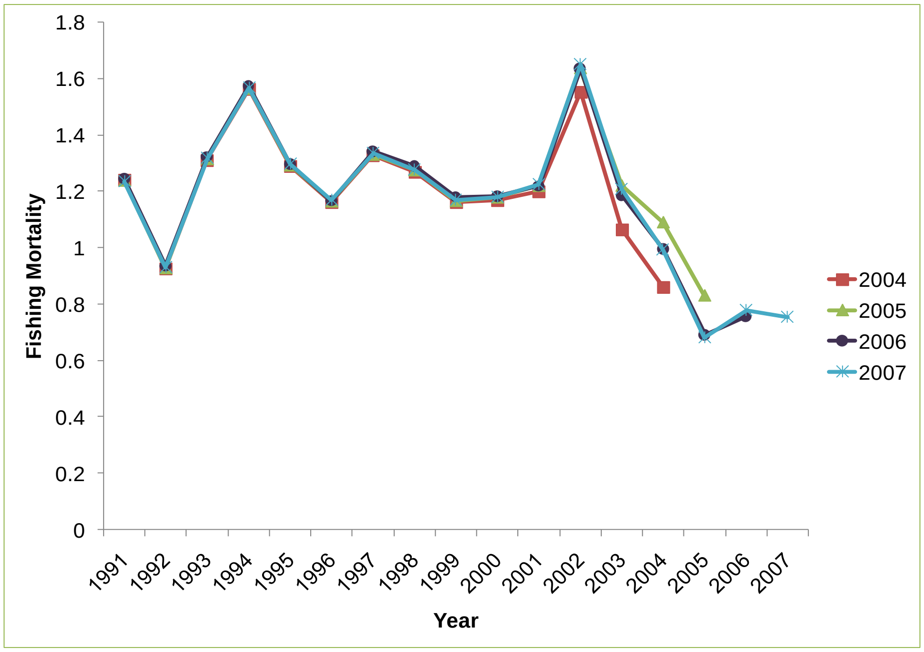


Figure 43. Retrospective trend in female southern flounder fishing mortality from the ASAP2 model, for terminal years, 2004-2007.

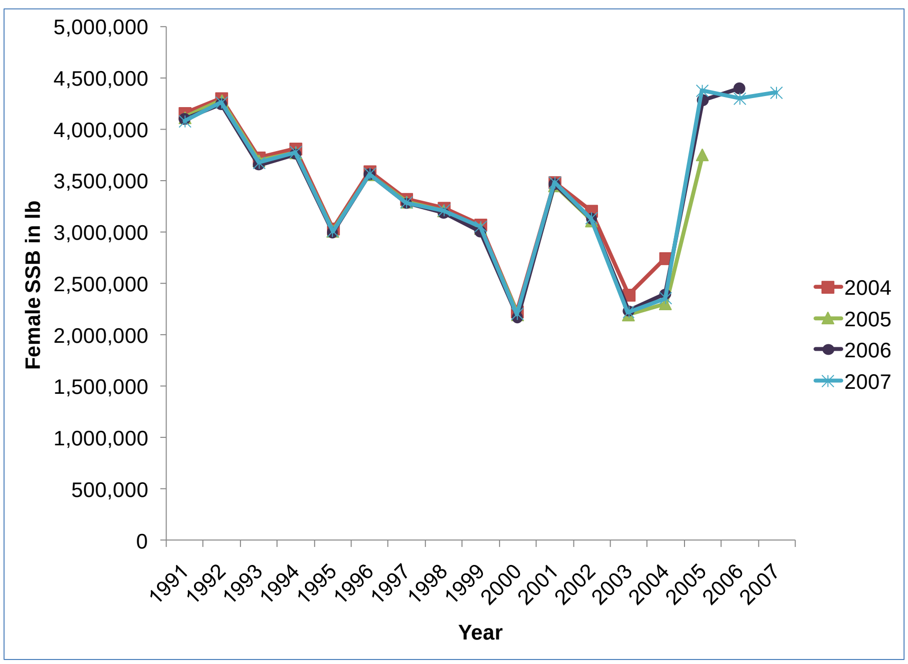


Figure 44. Retrospective trend in female southern flounder SSB in pounds from the ASAP2 model, for terminal years, 2004-2007.

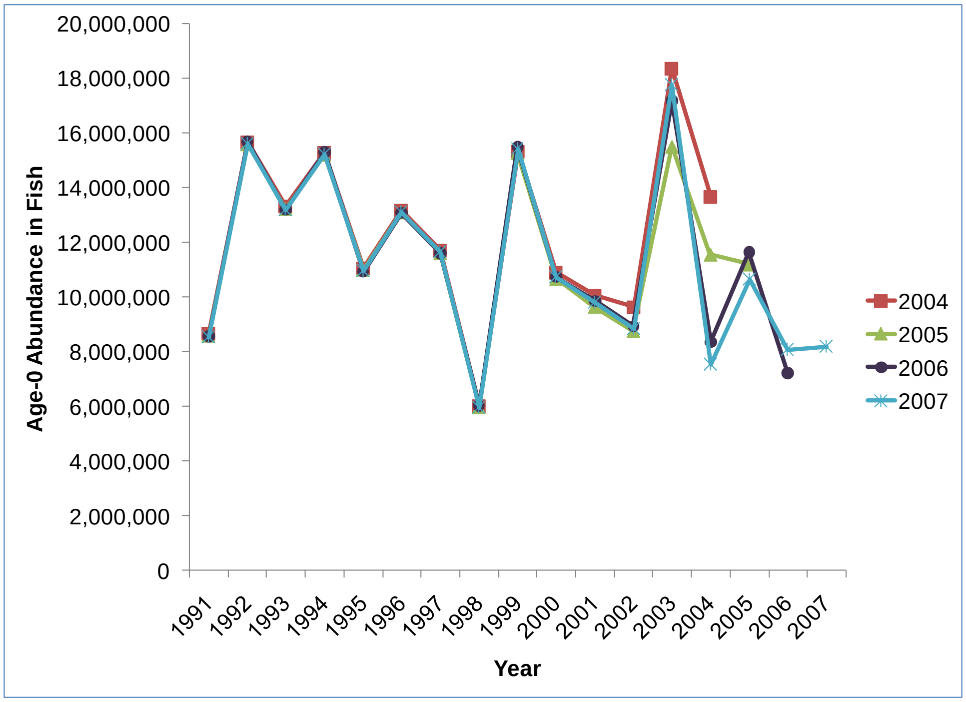


Figure 45. Retrospective trend in female southern flounder age-0 recruitment in numbers of fish from the ASAP2 model for the terminal years, 2004-2007.

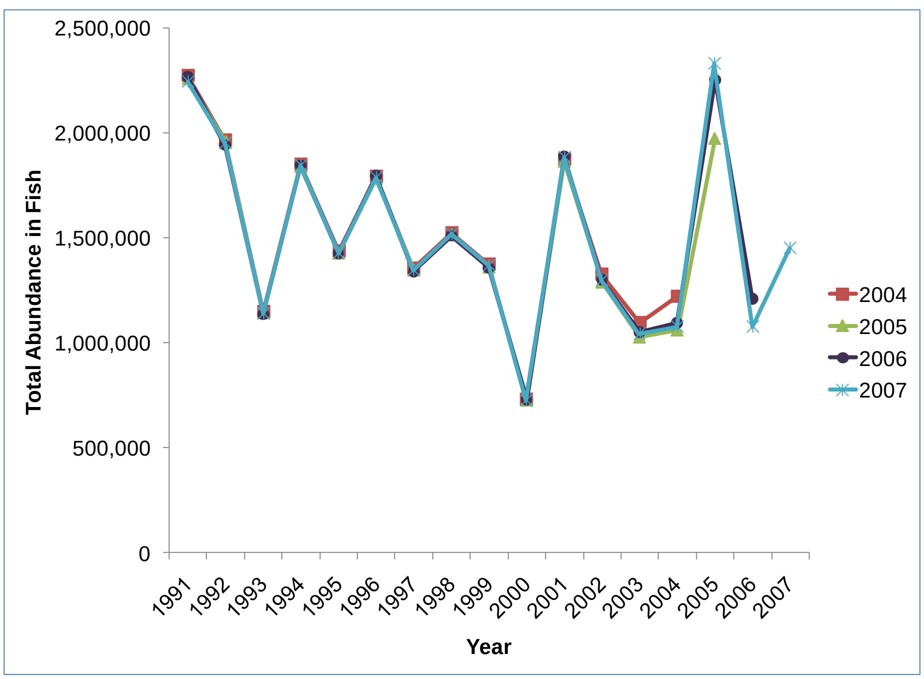


Figure 46. Retrospective trend in female southern flounder total abundance in numbers of fish from the ASAP2 model for the terminal years, 2004-2007.

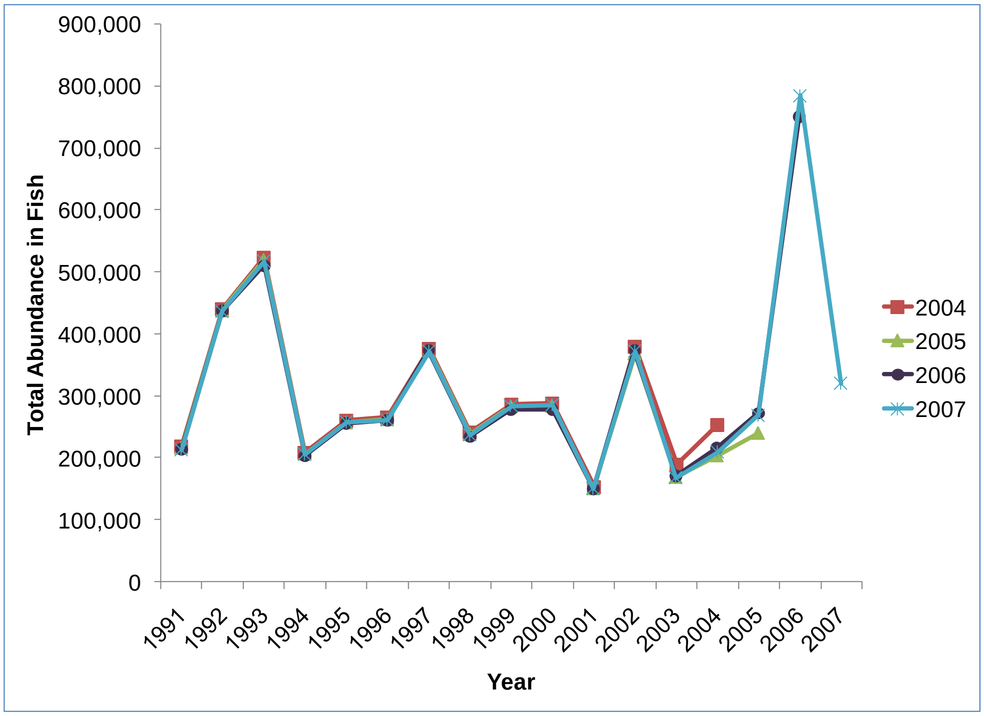


Figure 47. Retrospective trend in female southern flounder age-3 in numbers of fish from the ASAP2 model for the terminal years, 2004-2007.

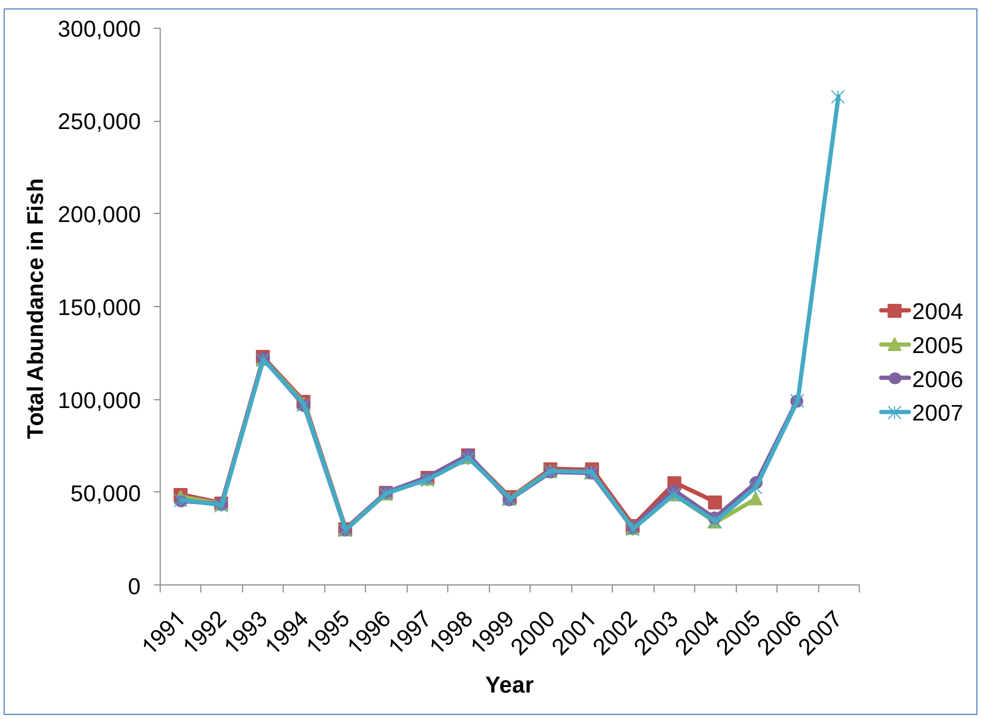


Figure 48. Retrospective trend in female southern flounder age-4 in numbers of fish from the ASAP2 model for the terminal years, 2004-2007.

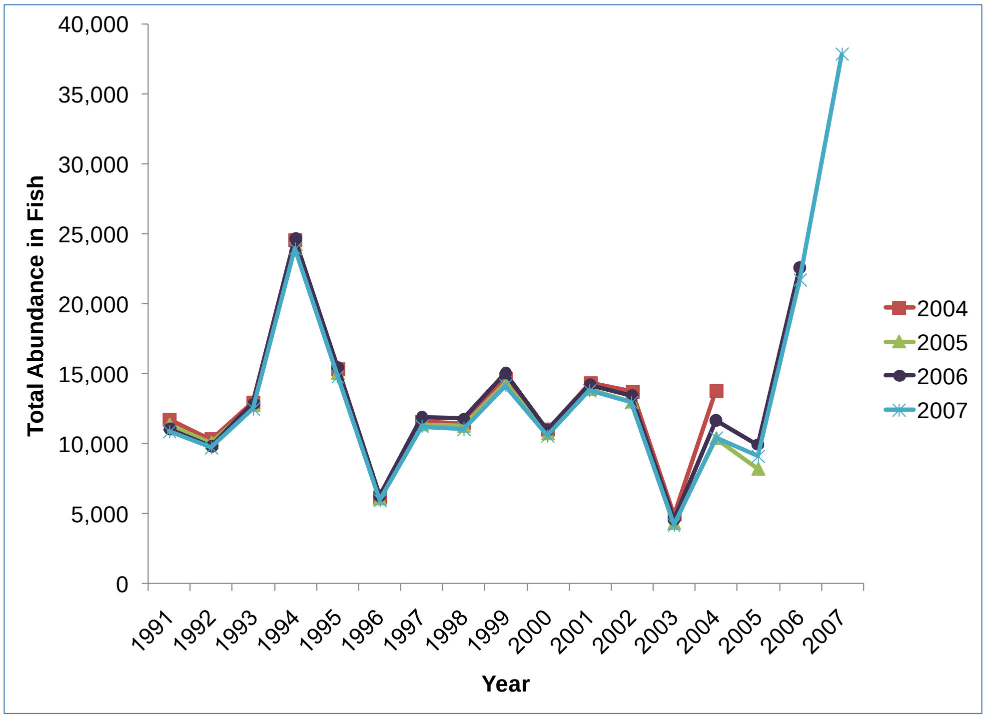


Figure 49. Retrospective trend in female southern flounder age-5 in numbers of fish from the ASAP2 model for the terminal years, 2004-2007.

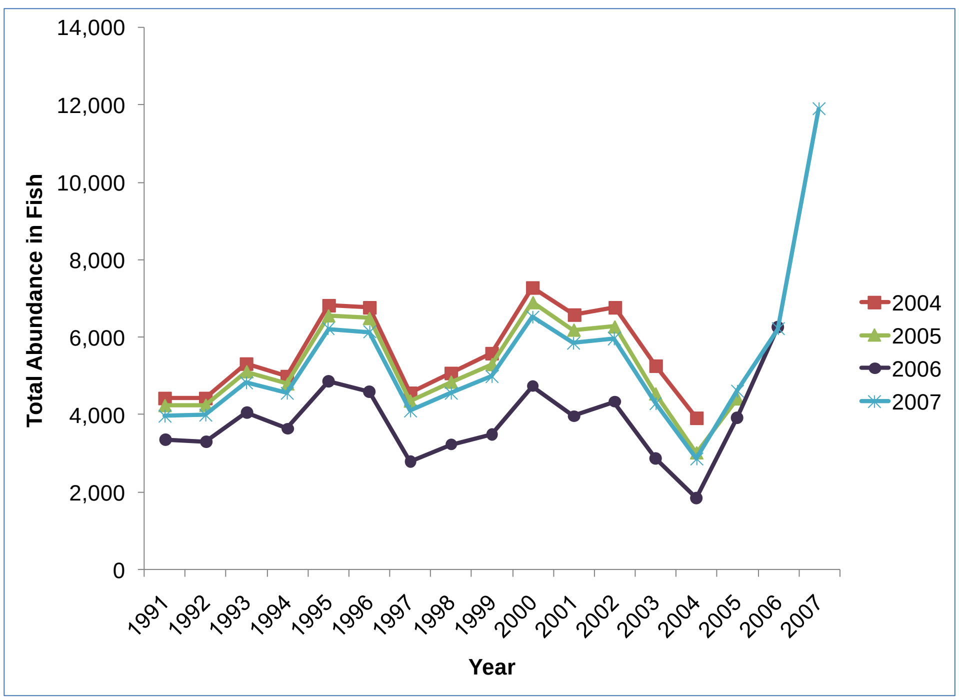


Figure 50. Retrospective trend in female southern flounder age-6+ in numbers of fish from the ASAP2 model for the terminal years, 2004-2007.

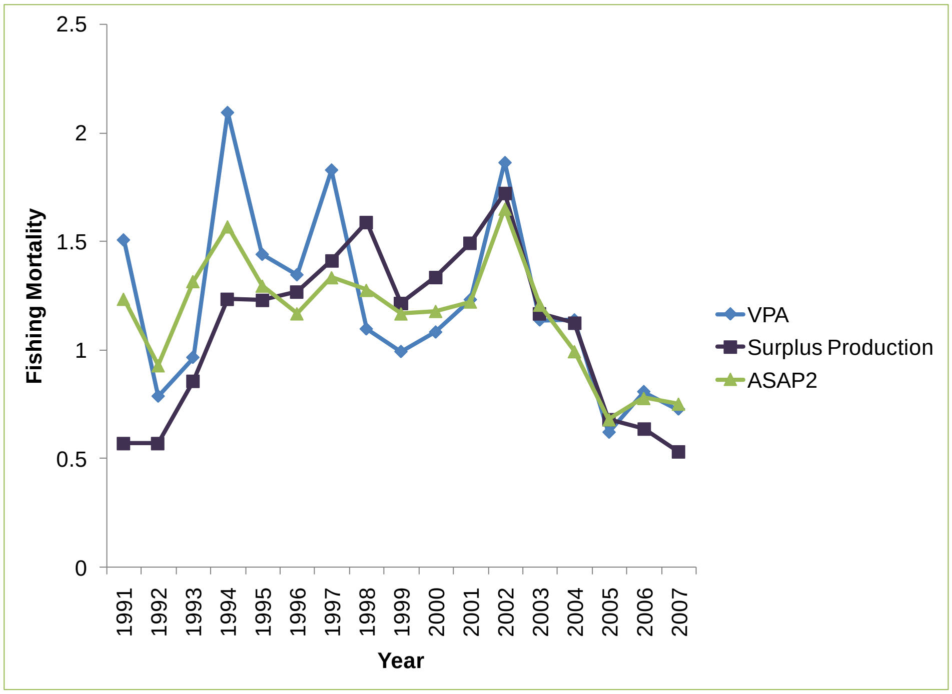


Figure 51. Comparison of estimated F of VPA and simple biomass models with the primary ASAP2 run.