NORTH CAROLINA SPOTTED SEATROUT

FISHERY MANAGEMENT PLAN

PREPARED BY THE

SPOTTED SEATROUT FISHERY MANAGEMENT PLAN ADVISORY COMMITTEE

AND THE

NORTH CAROLINA DIVISION OF MARINE FISHERIES
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
MOREHEAD CITY, NORTH CAROLINA

March, 2012
Revised February 2014

NC spotted seatrout stock assessment completed	January 2009
MFC approved FMP for public comment	March 2010
Finalized SSTAC and DMF recommendations	April 2010
MFC selected preferred management options	May 2010
Submitted to DENR for review	August 2010
Submitted to JLCSA	September 2010
MFC selected preferred management options	November 2010
MFC reapproved FMP for public comment	September 2011
Finalized SSTAC and DMF recommendations	October 2011
MFC selects preferred management options	November 2011
Submitted to JLCGO	January 2012
MFC adopts plan	February 2012

1. ACKNOWLEDGEMENTS

The North Carolina Spotted Seatrout Fishery Management Plan (FMP) was developed by the North Carolina Department of Environment and Natural Resources' Division of Marine Fisheries (DMF) under the direction of the North Carolina Marine Fisheries Commission (MFC) with the advice of the Spotted Seatrout Public Advisory Committee. Deserving special recognition are the members of the Spotted Seatrout Public Advisory Committee and the Plan Development Team who contributed their time and knowledge to this effort, as well as our colleages in Virginia who willingly provided Virginia's spotted seatrout data.

<u>Spotted Seatrout Public Advisory Committee</u>
Dr. Peter Finkelstein, co-chair
Joseph "Lee" Stone, co-chair
Rodney Cahoon
Jamey Copeland
Sammy Corbett
Tim Ellis
Mike Holleman
Brian Horsley
Ricky Kellum
I.D. Midgett, Jr.
Hubert Parrott
Marianne Rice
William "Jerry" Warren

<u>Spotted seatrout Plan Development Team</u>
Beth Burns, co-lead
Chip Collier, co-lead
Chris Batsavage
Christopher Bennett
Alan Bianchi
Dr. Brian Boutin
Dr. Scott Crosson
Christine Jensen
Doug Mumford
Chris Wilson
Bennett Wynne

<u>Virginia Marine Resources Commission Virginia</u>
Rob O'Reilly
Joe Cimino

<u>Virginia Institute of Marine Science</u>
Jon Lucy

2. TABLE OF CONTENTS

List of Tables

List of Figures

3. EXECUTIVE SUMMARY

Goals and Objectives

The goal of the North Carolina Spotted Seatrout Fishery Management Plan (FMP) is to determine the status of the stock and ensure long-term sustainability for the spotted seatrout (*Cynoscion nebulosus*) stock in North Carolina. To achieve these goals, it is recommended that the following objectives be met:

1. Develop an objective management program that provides conservation of the resource and sustainable harvest in the fishery.
2. Ensure the spawning stock is of sufficient capacity to prevent recruitment-overfishing.
3. Address socio-economic concerns of all user groups.
4. Restore, improve, and protect important habitats that affect growth, survival, and reproduction of the North Carolina spotted seatrout stock.
5. Evaluate, enhance, and initiate studies to increase understanding of spotted seatrout biology and population dynamics in North Carolina.
6. Promote public awareness regarding the status and management of the North Carolina spotted seatrout stock.

Stock Status

The 2009 North Carolina spotted seatrout stock assessment indicated that the spotted seatrout stock in North Carolina and Virginia has been overfished and that overfishing has been occurring throughout the entire 18-year time series [1991-2008 (Jensen 2009, Appendix 4)]. Much of the overfishing has been in recent years when recreational fishing effort and number of discards have increased. Recent SPR's are below the ASMFC recommended criteria of 20%.

Commercial and Recreational Fisheries

Spotted seatrout are harvested commercially and recreationally year round throughout North Carolina's estuarine and nearshore coastal waters with a peak occurring in the fall and winter. Historically, spotted seatrout made up only a small portion of North Carolina's total commercial landings, never exceeding 1% of the value of seafood landed overall in the state. The majority (65%) of North Carolina's commercial harvest from 1991 to 2008 was captured using estuarine gill nets.

In recent years, the fishing mortality associated with the recreational fishery is high in comparison to that of the commercial fishery. Spotted seatrout are discarded (released alive) for a variety of reasons including catch under the legal size limit, over the creel limit, or conservative catch and release practices. Recreational discards increased dramatically since 2003. Managers should be concerned with the increasing effort in the recreational fishery because the recreational fishery selects for smaller, younger fish than does the commercial fishery, reducing the opportunity for young spotted seatrout to spawn prior to being harvested (Jensen 2009, Appendix 4).

Habitat and Water Quality

Although primarily estuarine, spotted seatrout use habitats throughout estuaries, coastal bays, sounds, rivers and the coastal ocean. Spotted seatrout are found in most habitats identified by the North Carolina Coastal Habitat Protection Plan (CHPP) including: water column, wetlands, submerged aquatic vegetation (SAV), soft bottom, and shell bottom (Street et al. 2005). The CHPP has specific recommendations that will benefit habitats used by spotted seatrout.

Suitable water quality is a critical element in the ecology and productivity of estuarine systems. Degradation or improvement in one aspect of water quality may have corresponding impact on habitat. Maintenance and improvement of suitable estuarine water quality and habitat are critical factors in ensuring a sustainable spotted seatrout stock.

Management Issues and Proposed Actions

In the development of the Spotted Seatrout FMP, management options were developed for identified key issues through the FMP process. These issues and options were developed by the Division of Marine Fisheries (DMF) through the cooperation and advice solicited from public, Spotted Seatrout Advisory Committee, North Carolina Marine Fisheries Commission (MFC), Finfish and Regional Advisory committees, as well as the scientific community. Detailed issue papers for each of the key issues can be found in Section 10. The MFC selected preferred management strategies for each of the key issues at their May 13 -14, 2010 business meeting. A summary of the key issues along with the selected MFC management strategies are listed in a table on the following page. (*Any changes/additions to current rules or proclamations are underlined and italicized in the table).* Since the proposed management actions did not meet the reductions needed to end overfishing in two years as required by State Law 2010-13, management actions were revised in November 2011 by the MFC.

Adaptive Management Framework

The DMF proposes an adaptive management framework for sustainable harvest in the spotted seatrout fishery. Given the uncertainty in the actual level of harvest reductions that will be realized once these measures are put in place, and the continuing evolution of fishing restrictions from the Endangered Species Act, the DMF and the MFC may consider new information brought forward and revise the FMP sustainability measures accordingly.

Revision

There was an error on page 3 that listed the closure period after a cold stun to June 1. The date should have been June 15. The vote can be found in the MFC Advisor for the February 22-24, 2012 meeting. Audio from the meeting can be found under the Spotted Seatrout Fishery Management Plan file (http://portal.ncdenr.org/web/mf/2012-feb-22-24-mfc-meeting)

Current rules are listed in Section 4.7.3. Rules necessary to implement the MFC selected management options as outlined in this table are provided in Appendix 1.

ISSUE	MFC SELECTED MANAGEMENT STRATEGY	OBJECTIVES ADDRESSED	REGULATORY ACTION
Achieving Sustainable Harvest	• *½ reduction needed, 6 fish bag, 14-inch minimum size, and weekend closure for commercial gears year-round (no possession on weekends).* • *A maximum of 2 fish over 24 inches for recreational fishermen* • *The small mesh gill net attendance requirement is extended to include weekends, December through February* ***Management Strategy Modified in November 2011*** *Immediately: 14-inch minimum size limit, 4 recreational bag limit, 75 fish commercial trip limit, no gillnets in joint waters on weekends.* *2014: 14-inch minimum size limit, 3 fish recreational bag limit with a December 15- January 31 closure, 25 fish commercial trip limit (no closure)* *If Cold Stun Occurs: close spotted seatrout harvest through June 15 and retain 4 fish recreational bag limit and 75 fish commercial trip limit*	1,2	Repeal Rule 3M.0504 and utilize proclamation authority in 3M.0512
	• *Revisit the Spotted Seatrout FMP in 3 years to determine if sustainable harvest measures are working*	1,2	
Enforcement of Size, Creel Limit and Gear Regulations in Joint, Coastal or Inland Fishing Waters	• *Development of a mutual aid agreement between DMF Marine Patrol and WRC Wildlife Enforcement Officers for Inland fishing waters*	1,2,3	
Management Measures to Address User Group Competition	• Move forward with the mediation policy process to resolve conflict between spotted seatrout fishermen	1,2,3	

Impacts of Cold Stun Events on the Population	• Remain status quo with the assumption that the Director will intervene in the event of a catastrophic event and do what is necessary in terms of temporary closures by water body	1,2,3	Repeal Rule 3M.0504 and utilize proclamation authority in 3M.0512
	• *More extensive research on cold stun events by DMF, Universities, etc.*	1,2,3,5	
Use of Gigs to Harvest Spotted Seatrout December-March	• Status quo. DMF to continue to track contributions of gigs to overall landings.	1,2,3	

4. INTRODUCTION

4.1 Legal Authority for Management

Fisheries management encompasses all activities associated with maintenance, improvement, and utilization of fisheries resources, including research, development, regulation, enhancement, and enforcement. North Carolina's jurisdiction over spotted seatrout (*Cynoscion nebulosus*) is from the inland coastal fishing water boundary with joint or coastal fishing waters boundary out to three miles of the state's coastline.

The North Carolina General Assembly has provided a very powerful and flexible legal basis for coastal fisheries management. Many state laws provide the necessary authority for fishery management in North Carolina. General authority for stewardship of the marine and estuarine resources by the North Carolina Department of Environment and Natural Resources (DENR) is provided in G.S. 113-131. The Division of Marine Fisheries (DMF) is the agency of DENR that carries out this responsibility. Enforcement authority for DMF enforcement officers is provided by G.S. 113-136. General Statute 113-163 authorizes research and statistical programs. The North Carolina Marine Fisheries Commission (MFC) 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 MFC 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). The MFC also has authority to establish individual permits for various commercial fishing gears and activities under G.S. 113-169.1. General Statutes 113-221 and 143B-289.52 allow the MFC to delegate authority to implement its regulations for fisheries "which may be affected by variable conditions" to the Director of DMF by issuing public notices called "proclamations". The North Carolina General Assembly retained for itself the authority to establish commercial fishing licenses and fees and to limit entry into specific coastal fisheries.

The Fisheries Reform Act of 1997 (FRA) establishes a process for preparation of coastal fisheries management plans in North Carolina. 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 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 will produce a sustainable harvest, and

d. Specify a time period, not to exceed 10 years from the date of adoption of the plan, for ending overfishing, if it is occurring and achieving a sustainable harvest. This time period shall not apply to a plan for a fishery where the biology of the fish or environmental conditions make ending overfishing and achieving a sustainable harvest within 10 years impractical.

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”.

4.2 Goals and Objectives

The goal of the 2010 Spotted Seatrout Fishery Management Plan is to determine the status of the stock and ensure the long-term sustainability for spotted seatrout in North Carolina.

Objectives:

1. Develop an objective management program that provides conservation of spotted seatrout and sustainable harvest in the fishery.

2. Ensure that the spawning stock of spotted seatrout is of sufficient capacity to prevent recruitment-overfishing.

3. Address socio-economic concerns of all user groups.

4. Restore, improve, and protect critical habitats that affect growth, survival, and reproduction of the North Carolina stock of spotted seatrout.

5. Evaluate, enhance, and initiate studies to increase our understanding of spotted seatrout biology and population dynamics in North Carolina.

6. Promote public awareness regarding the status and management of North Carolina spotted seatrout.

4.3 Sustainable Harvest

The FRA mandates that fishery stocks be managed to allow for sustainable harvest and prevent overfishing. Sustainable harvest is defined as the amount of harvest, including release and discard mortality, that can be taken on a continuing basis without reducing the stock biomass of the fishery or causing the fishery to become overfished. The North Carolina spotted seatrout fishery will be considered overfished or experiencing overfishing if the spawning potential ratio (SPR) falls below a threshold of 20%. The SPR represents the ratio of the reproductive (spawning) potential of an average individual fish over its entire lifetime in a fished stock to that in an unfished stock.

Two types of reference points are typically defined in the determination of sustainable harvest: threshold and target. The threshold reference point is the level of spawning stock biomass below which the stock is overfished or fishing mortality rate above which the stock is undergoing overfishing. If a fishery crosses a threshold, then management actions must be taken to correct the situation. The spotted seatrout stock is considered to be overfished if the spawning stock biomass falls below a threshold associated with a 20% SPR and undergoing overfishing if fishing mortality rate rises above a threshold associated with the 20% SPR.

The target reference point is a level of fishing mortality rate or spawning stock biomass that management should maintain. At this level of fishing mortality rate or spawning stock biomass, the stock is deemed healthy and sustainable. A target reference point was not set for this management plan due to the lack of a stock-recruit relationship and the influence of environmental conditions on the spotted seatrout stock.

4.3.1 Management Strategy

Reduce F to maintain a 20% SPR which will increase the likelihood of sustainability through an expanded age structure and an increase in the spawning stock biomass. This strategy should provide a greater cushion for the population that would likely lead to faster recovery of the population after cold stun events. Consider revising reference points after the stock is reassessed in the next plan amendment based on the response of the population to the management measures selected in the initial FMP.

4.4 Definition of the Management Unit

The management unit for the North Carolina Spotted Seatrout FMP includes all spotted seatrout within the coastal and joint waters of North Carolina. The unit stock, or population unit, for North Carolina's assessment of spotted seatrout included all spotted seatrout caught in North Carolina and Virginia (see Appendix 4, Stock Status, for more details on management unit). Virginia's landings of spotted seatrout were included in the management unit due to the mixing of spotted seatrout from Virginia with fish from North Carolina. This decision was based on results from a Virginia spotted seatrout tagging study where 15% of the total recaptured fish were recaptured in North Carolina (J. Lucy, Virginia Institute of Marine Science, personal communication). Since mixing of fish from North Carolina and Virginia was observed, the North Carolina stock assessment model included harvest data from both North Carolina and Virginia.

4.5 General Problem Statement

The 2009 North Carolina spotted seatrout stock assessment indicated that the spotted seatrout stock in North Carolina/Virginia has been overfished and that overfishing has been occurring throughout the entire 18-year time series [1991-2008 (Jensen 2009, Appendix 4)]. Interim management measures were implemented in December 2009 to reduce overfishing. The purpose of this plan is to propose management measures that prevent overfishing and provide long-term sustainable harvest for the fishery. Areas to be addressed in the management of North Carolina's spotted seatrout fishery are: 1) management strategies; 2) insufficient data and research needs; 3) habitat and water quality; and 4) socioeconomic factors.

4.6 Interim Measures

The DMF is required, under the MFC guidelines, to recommend to the appropriate standing committee(s) any preservation management measures necessary and appropriate to maintain the well-being of the stock. These 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.

The stock assessment of North Carolina's spotted seatrout population determined the stock to be overfished and undergoing overfishing (Jensen 2009, Appendix 4). In accordance with the FRA (N.S.G.S. § 113-182.1 (c1)), interim management measures were implemented to ensure the viability of the stock while the FMP was being developed. The interim management measure adopted was based on life history information. Spotted seatrout mature at an early age, with most fish mature by 12 inches (89% of females), and essentially all of the females (98%) are mature by 14 inches. A 14 inch size limit would allow a larger percentage of fish to spawn at least once before being harvested. This would increase the size of the spawning stock biomass and therefore the number of recruits to the fishery in subsequent years. Proclamation FF-64-2009, effective December 4, 2009, suspended North Carolina Marine Fisheries Rule 15A NCAC 3M .0504 such that the 12 inch minimum size was suspended and it is unlawful to possess spotted seatrout less than 14 inches total length.

4.7 Existing Plans, Statutes and Rules

4.7.1 Existing Plans

This is the first fishery management plan developed for spotted seatrout in North Carolina. However spotted seatrout have been managed along the Atlantic Coast through an interjurisdictional fishery management plan (IJFMP) developed by the Atlantic States Marine Fisheries Commission (ASMFC). The ASMFC Spotted Seatrout IJFMP was developed in 1984, and updated in 1991 when Amendment 1 was passed. Amendment 1 developed a list of goals for coastwide management but allowed each state that had an interest in the spotted seatrout fishery (Florida through Maryland) to manage their stocks independently. The goals listed in the 2007 review of the ASMFC Spotted Seatrout IJFMP were:

1. Attain or maintain an optimum yield,

2. Maintain a spawning potential ratio of at least 20%,

3. Promote conservation of the stocks in order to reduce the inter-annual variation in availability an increase yield per recruit,

4. Promote the collection of economic, social, and biological data required to effectively monitor and assess management efforts relative to the overall goal,

5. Promote research that improves understanding of the biology and fisheries of spotted seatrout,

6. Promote harmonious use of the resource among various components of the fishery through coordination of management efforts among the various political entities having jurisdiction over the spotted seatrout resource, and

7. Promote determination and adoption of standards of environmental quality and provide habitat protection necessary for the maximum natural protection of spotted seatrout."

North Carolina followed the recommendation of the ASMFC Spotted Seatrout FMP Amendment 1 to have a minimum size limit of at least 12 inches and to collect data for spotted seatrout assessment and monitoring (1991). In addition to the recommendation of the ASMFC, North Carolina has a ten fish bag limit for recreational fishing. The commercial fisheries had a minimum size limit of 12 inches which increased to 14 inches in October 2009, and if fish are caught using hook-and-line, a ten fish bag limit.

4.7.2 Statutes

All authority for management of North Carolina's spotted seatrout fishery is vested in the State of North Carolina. There are few general statutes that govern specific aspects of finfish management in North Carolina or that focus specifically on spotted seatrout. General statutes that may apply to the spotted seatrout fisheries include:

- It is unlawful to fish in the ocean from vessels or with a net within 750 feet of a properly licensed and marked fishing pier. G.S. 113-185
- It is unlawful to engage in trash or scrap fishing (the taking of young of edible fish before they are of sufficient size to be of value as individual food fish) for commercial disposition as bait, for sale to any dehydrating or nonfood processing plant, or for sale or commercial disposition in any manner. The MFC's rules may authorize the disposition of the young of edible fish taken in connection with the legitimate commercial fishing operations, provided it is a limited quantity and does not encourage "scrap fishing". G.S. 113-185
- It is unlawful for any person without the authority of the owner of the equipment to take fish from nets, traps, pots, and other devices to catch fish, which have been lawfully placed in the open waters of the State. G.S. 113-268 (a)
- It is unlawful for any vessel in the navigable waters of the State to willfully, wantonly, and unnecessarily do injury to any seine, net or pot. G.S. 113-268 (b)
- It is unlawful for any person to willfully destroy or injure any buoys, markers, stakes, nets, pots, or other devices or property lawfully set out in the open waters of the State in connection with any fishing or fishery. G.S. 113-268 (c)

4.7.3 Marine Fisheries Commission Rules

The MFC may also approve rules that give the Fisheries Director the ability to issue proclamations establishing temporary provisions for finfish management due to the existence of variable conditions. These authorities are discussed in Section 4.1. Similarly, the statutory licensing and reporting requirements for fishing activities apply equally to all types of finfish harvest and there is no statute that would affect spotted seatrout directly.

The following rules were adopted by the MFC to manage spotted seatrout in North Carolina. The version of the rules shown below is taken from North Carolina Fisheries Rules for Coastal Waters effective January 1, 2005. These rules are codified in Title 15A Chapter 3 of the North Carolina Administrative Code (15A NCAC 03).

SUBCHAPTER 03J – NETS, POTS, DREDGES, AND OTHER FISHING DEVICES

SECTION .0100 – NET RULES, GENERAL

.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 .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 the use of gill nets or seines:
  (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 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 October 31 in the internal coastal and joint waters of the state designated in 15A NCAC 03R .0112(b).

(i) It is unlawful to use more than 3,000 yards of gill net with a mesh length 5 1/2 inches or greater per vessel in internal waters regardless of the number of individuals involved.

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. December 1, 2007; September 1, 2005; August 1, 2004; August 1, 2002.

SUBCHAPTER 3R - DESCRIPTIVE BOUNDARIES

.0100 - DESCRIPTIVE BOUNDARIES

.0112 ATTENDED GILL NET AREAS

(a) The attended gill net areas referenced in 15A NCAC 03J .0103 (g) are delineated in the following areas:

(1) Pamlico River, west of a line beginning at a point 35° 27.5768' N - 76° 54.3612' W on Ragged Point; running southwesterly to a point 35° 26.9176' N - 76° 55.5253' W on Mauls Point;

(2) Within 200 yards of any shoreline in Pamlico River and its tributaries east of the line beginning at a point 35° 27.5768' N - 76° 54.3612' W on Ragged Point; running southwesterly to a point 35° 26.9176' N - 76° 55.5253' W on Mauls Point; and west of a line beginning at a point 35° 22.3622' N - 76° 28.2032' W on Roos Point; running southerly to a point at 35° 18.5906' N - 76° 28.9530' W on Pamlico Point;

(3) Pungo River, east of the northern portion of the Pantego Creek breakwater and a

line beginning at a point 35° 31.7198' N - 76° 36.9195' W on the northern side of the breakwater near Tooleys Point; running southeasterly to a point 35° 30.5312' N - 76°35.1594' W on Durants Point;

(4) Within 200 yards of any shoreline in Pungo River and its tributaries west of the northern portion of the Pantego Creek breakwater and a line beginning at a point 35° 31.7198' N - 76° 36.9195' W on the northern side of the breakwater near Tooleys Point; running southeasterly to a point 35° 30.5312' N - 76° 35.1594' W on Durants Point; and west of a line beginning at a point 35° 22.3622' N - 76° 28.2032' W on Roos Point; running southerly to a point at 35° 18.5906' N - 76° 28.9530' W on Pamlico Point;

(5) Neuse River and its tributaries northwest of the Highway 17 highrise bridge;

(6) Trent River and its tributaries;

(7) Within 200 yards of any shoreline in Neuse River and its tributaries east of the Highway 17 highrise bridge and west of a line beginning at a point 34° 57.9116' N - 76° 48.2240' W on Wilkinson Point; running southerly to a point 34° 56.3658' N - 76° 48.7110' W on Cherry Point.

(b) The attended gill net areas referenced in 15A NCAC 03J .0103 (h) are delineated in the following coastal and joint waters of the state south of a line beginning on Roanoke Marshes Point at a point 35° 48.3693' N - 75° 43.7232' W; running southeasterly to a point 35° 44.1710' N - 75° 31.0520' W on Eagles Nest Bay to the South Carolina State line:

(1) All primary nursery areas described in 15A NCAC 03R .0103, all permanent secondary nursery areas described in 15A NCAC 03R .0104, and no trawl areas described in 15A NCAC 03R .0106 (2), (4),(5), and (6);

(2) In the area along the Outer Banks, beginning at a point 35° 44.1710' N - 75° 31.0520' W on Eagles Nest Bay; running northwesterly to a point 35° 45.1833' N - 75° 34.1000' W west of Pea Island; running southerly to a point 35° 40.0000' N - 75° 32.8666' W west of Beach Slough; running southeasterly and passing near Beacon "2" in Chicamicomico Channel to a point 35° 35.0000' N - 75° 29.8833' W west of the Rodanthe Pier; running southwesterly to a point 35° 32.6000' N - 75° 31.8500' W west of Salvo; running southerly to a point 35° 28.4500' N - 75° 31.3500' W on Gull Island; running southerly to a point 35° 22.3000' N - 75° 33.2000' W near Beacon "2" in Avon Channel ; running southwesterly to a point 35° 19.0333' N - 75° 36.3166' W near Beacon "2" in Cape Channel; running southwesterly to a point 35° 15.5000' N - 75° 43.4000' W near Beacon "36" in Rollinson Channel; running southwesterly to a point 35° 11.4833' N - 75° 51.0833' W on Legged Lump; running southeasterly to a point 35° 10.9666' N - 75° 49.7166' W south of Legged Lump; running southwesterly to a point 35° 09.3000' N - 75° 54.8166' W near the west end of Clarks Reef; running westerly to a point 35° 08.4333' N - 76° 02.5000' W near Nine Foot Shoal Channel; running southerly to a point 35° 06.4000' N - 76° 04.3333' W near North Rock; running southwesterly to a point 35°01.5833' N – 76° 11.4500' W near Beacon "HL"; running southerly to a point 35° 00.2666' N - 76° 12.2000' W; running southerly to a point 34° 59.4664' N - 76° 12.4859' W on Wainwright Island; running easterly to a point 34° 58.7853' N - 76° 09.8922' W on Core Banks; running northerly along the shoreline and across the inlets following the Colregs Demarcation line to the point of beginning.

(3) In Core and Back sounds, beginning at a point 34° 58.7853' N - 76° 09.8922' W on Core Banks; running northwesterly to a point 34° 59.4664' N - 76° 12.4859' W on Wainwright Island; running southerly to a point 34° 58.8000' N - 76° 12.5166' W; running southeasterly to a point 34° 58.1833' N - 76° 12.3000' W; running southwesterly to a point 34° 56.4833' N - 76° 13.2833' W; running westerly to a

point 34° 56.5500' N - 76°13.6166' W; running southwesterly to a point 34° 53.5500' N - 76° 16.4166' W; running northwesterly to a point 34° 53.9166' N - 76° 17.1166' W; running southerly to a point 34° 53.4166' N - 76° 17.3500' W; running southwesterly to a point 34° 51.0617' N – 76° 21.0449' W; running southwesterly to a point 34° 48.3137' N - 76° 24.3717' W; running southwesterly to a point 34° 46.3739' N – 76° 26.1526' W; running southwesterly to a point 34° 44.5795' N – 76° 27.5136' W; running southwesterly to a point 34° 43.4895' N – 76° 28.9411' W near Beacon "37A"; running southwesterly to a point 34° 40.4500' N – 76° 30.6833' W; running westerly to a point 34° 40.7061' N – 76° 31.5893' W near Beacon "35" in Back Sound; running westerly to a point 34° 41.3178' N -76° 33.8092' W near Buoy "3"; running southwesterly to a point 34° 39.6601' N – 76° 34.4078' W on Shackleford Banks; running easterly and northeasterly along the shoreline and across the inlets following the COLREGS Demarcation lines to the point of beginning;

(4) Within 200 yards of any shoreline, except from October 1 through October 31, south and east of Highway 12 in Carteret County and south of a line from a point 34° 59.7942' N - 76° 14.6514' W on Camp Point; running easterly to a point at 34° 58.7853' N - 76° 09.8922' W on Core Banks; to the South Carolina State Line.

History Note: Authority G.S. 113-134; 113-173; 113-182; 113-221; 143B-289.52; Eff. August 1, 2004.

SECTION .0400 – FISHING GEAR

.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' 15" N - 75° 32' 42" W) on Bodie Island to the northern terminus of the Bonner Bridge (35° 46' 30" N - 75° 32' 22" 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 at Cape Point (35° 12' 54" N - 75° 31' 43" W). The closed area begins one-half mile north of Cape Point at a point on the beach (35° 13' 26" N - 75° 31' 39" W) and extends in a clockwise direction, one-half mile from Cape Point, to a point on the beach (35° 13' 23" N - 75° 31' 59" W) northwest of Cape Point.

(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, those areas around the Surf City and Barnacle Bill's Fishing Piers bordered on the offshore side by a line 750 feet from the ends of the piers, on the southwest by a line beginning at a point on the beach one-quarter mile from the piers and on the northeast by a line beginning at a point on the beach 750 feet from the piers extending seaward to intersect the offshore boundaries.

(ii) From July 1 to December 31, those areas around the piers bordered on the offshore side by a line 750 feet from the ends of the piers, on the southwest by a line beginning at a point on the beach 750 feet from the piers and on the northeast by a line beginning at a point on the beach one-quarter mile from the piers 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, Center 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 New Inlet from October 15 through October 17.

(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; and
(D) Harbor Village Marina on Topsail Sound, Pender 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.

History Note: Authority G.S. 113-133; 113-134; 113-182; 113-221; 143B-289.52;
Eff. March 1, 1996.

SUBCHAPTER 03M – FINFISH

SECTION .0100 – FINFISH, GENERAL

.0102 UNMARKETABLE FOOD OR SCRAP FISH

(a) It is unlawful to land or dispose of finfish as trash or scrap fish if in violation of minimum size or possession limits established by rule or proclamation.

(b) It is unlawful to land or dispose of finfish as trash or scrap fish taken in connection with legitimate commercial fishing operations which are unmarketable as individual food fish by reason of size, except that a quantity not exceeding 5,000 pounds per vessel per day may be:

(1) Landed and sold to a licensed finfish dealer, a licensed fish dehydrating plant or licensed finfish processing plant, and

(2) Purchased or accepted by a licensed finfish dealer, a licensed finfish dealer, a licensed fish dehydrating plant or licensed finfish processor.

(c) Menhaden, herring, and gizzard shad are exempt from this Rule.

History Note: Authority G.S. 113-134; 113-185; 143B-289.52;
Eff. January 1, 1991.

.0504 Trout

(a) It is unlawful to possess spotted seatrout less than 12 inches total length.

(b) It is unlawful to possess more than 10 spotted seatrout per person per day taken by hook-and-line or for recreational purposes.

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. March 1, 1996; March 1, 1995; February 1, 1992;
Temporary Amendment Eff. September 9, 1996;
Temporary Amendment Eff. October 1, 1996;
Amended Eff. April 1, 1997;
Temporary Amendment Eff. July 1, 1999;
Amended Eff. October 1, 2008; August 1, 2000.

SUBCHAPTER 3Q - JURISDICTION OF AGENCIES: CLASSIFICATION OF WATERS
SECTION .0100 - GENERAL REGULATIONS: JOINT

.0103 COASTAL FISHING WATERS

Coastal fishing waters are the Atlantic Ocean; the various coastal sounds; and estuarine waters up to the dividing line between coastal fishing waters and inland fishing waters agreed upon by the Marine Fisheries Commission and the Wildlife Resources Commission. All waters which are tributary to coastal fishing waters and which are not otherwise designated by agreement between the Marine Fisheries Commission and the Wildlife Resources Commission are coastal fishing waters. The regulations and licensing of fishing in coastal fishing waters is under the jurisdiction of the Marine Fisheries Commission; except that inland game fish (exclusive of spotted seatrout, weakfish, and striped bass) are subject to regulations by the Wildlife Resources Commission in coastal fishing waters. Regulations and laws administered by the Marine Fisheries Commission regarding fishing in coastal waters are enforced by fisheries enforcement officers. Regulations regarding inland game fish in coastal fishing waters are enforced by wildlife enforcement officers unless otherwise agreed to by the Wildlife Resources Commission.

History Note: Authority G.S. 113-132; 113-134; 143B-289.52;

Eff. January 1, 1991.

4.7.4 Spotted Seatrout Regulation in Other States

All Atlantic states that have an interest in spotted seatrout have established at least a 12” size limit total length (Table 1). Most states have a recreational bag limit ranging from 1 to 15 fish. The commercial fisheries regulations use several different control measures ranging from total commercial closure (SC) to seasonal closures to gear limits.

Table 1. Rules regarding spotted seatrout management in other states along the Atlantic coast.

State	Recreational	Commercial	Other
New Jersey	13" TL; 8 fish	13" TL; 12" TL taken by otter trawl 9/1-12/31	Weakfish regulations apply to spotted seatrout
Delaware	12" TL	12" TL	Gill net restrictions
Maryland	14" TL; 10 fish	12" TL	Minimum mesh size restrictions for trawl and gill nets
Virginia	14" TL; 10 fish	14" TL; H&L 10 fish	Commercial quota/ Pound net haul seine allow 5% <14" by weight
North Carolina	12" TL; 10 fish	12" TL; H&L 10 fish	Minimum size increased to 14", interim measure 10/2009; BRD requirements for trawl
South Carolina	14" TL; 10 fish	No commercial harvest or sale	Gamefish status
Georgia	13" TL; 15 fish	13" TL; 15 fish	BRD requirements for trawl; gear mesh regulations
Florida	15-20" TL slot, 1 fish>20"; 5 fish Northern Region; 4 fish Southern Region; Seasonal Closures	15-24" TL; 6/1-8/31 season; 75 fish per day or vessel (lesser); H&L or cast net only	-

5. GENERAL LIFE HISTORY

5.1 Description and Distribution

Spotted seatrout, also known as speckled trout, is a member of the family Sciaenidae (drums), which includes weakfish (*C. regalis*), spot (*Leiostomus xanthurus*), kingfishes [*Menticirrhus* spp. (sea mullet)], Atlantic croaker (*Micropogonias undulatus*), black drum (*Pogonias cromis*), and red drum (*Sciaenops ocellatus*). This family of fishes is highly sought after in commercial and recreational fisheries. Spotted seatrout have two other species within its genus found in North Carolina's waters, weakfish and silver seatrout (*C. nothus*). Spotted seatrout can be distinguished from the other two species by the circular specks or spots on its body, dorsal fin, and caudal fin.

Spotted seatrout are medium-sized fish with a maximum size of 40 inches and 17 pounds (Froese and Pauly 2008). North Carolina's state record is a 12 pound 4 ounce fish caught in 1961. The average size of spotted seatrout landed in the North Carolina recreational fishery between 1991 and 2006 was between 14.2 and 16.4 inches (MRFSS 2008) and between 14 and 18 inches in the commercial fishery. The maximum observed length in North Carolina was a 32-inch spotted seatrout in the recreational fishery and 33 inches in the commercial fishery. The maximum otolith based age of spotted seatrout has been reported to be 10 years old in Virginia (Ihde 2000), 9 years old in North Carolina (Burns 1996), 7 years old in South Carolina (de Silva unpublished), 8 years old in Georgia (GA CRD 2003), 9 years old in Florida (Murphy et al. 2006), and 12 years old in Texas (Maceina et al. 1987). The oldest individual spotted seatrout are generally males (Moffett 1961; Maceina et al. 1987; Colura et al. 1994; Murphy and Taylor 1994; DeVries et al. 1997), although both male and female spotted seatrout have been sampled up to age 9 in North Carolina.

Spotted seatrout are found from Massachusetts to Mexico (Murphy et al. 2006). Spotted seatrout have distinct stocks along Florida's Atlantic Coast and in the Gulf of Mexico [GOM (Murphy et al. 2006)]. Stocks from Virginia's Chesapeake Bay were found to be significantly different than other Atlantic locations in Georgia and South Carolina (Wiley et al. 2003). However, there appears to be mixing between stocks based on the Virginia tagging studies. A tagging program for spotted seatrout has been initiated in North Carolina although it will take time to determine if separate stocks exist (NCFRG 2008; NCCRFL research ongoing). The Florida and GOM stocks are managed as distinct units and were established based on tagging and genetic studies.

5.2 Reproduction and Development

Spotted seatrout mature at an early age. Nearly all spotted seatrout are mature by age 1 [93% of females, 100% of males, and 96% of sexes combined (Jensen 2009, Appendix 4)]. Based on data collected by the DMF, the length at which 50% of spotted seatrout were mature was 7.9 inches for males and 9.6 inches for females.

The spawning season for spotted seatrout varies depending on location (Murphy et al. 1999). Virginia spotted seatrout spawn from May through August with peaks in the gonadosomatic index in May and July (Brown 1981). The spawning season in North Carolina is from April to October with a peak in May through June (Burns 1996). Spotted seatrout in Florida spawn from March to October with a peak in May (Murphy et al. 1999). The spawning period is generally within the first few hours after sunset (Luczkovich et al. 2008). A single spotted seatrout is capable of spawning repeatedly throughout the spawning season. During the peak of the season, older spotted seatrout (> 3 years old) spawn every two days while younger spotted seatrout (ages 0 and 1) spawn every 4 days (Murphy et al. 2006). Estimates of fecundity for spotted seatrout range from 3 to 20 million ova per year depending on age, length, water temperature (Murphy et al. 1999; Nieland et al., 2002; Roumillat and Brouwer, 2004); however, fecundity estimates specific to North Carolina are not available at this time. Spawning takes place on or near seagrass beds, sandy banks, natural sand, shell reefs, near the mouths of inlets, and off the beach (Daniel 1988; Brown-Peterson et al. 2002) and peaks around the full moon (Tucker and Faulkner 1987; McMichael and Peters 1989).

Temperature and salinity have an influence on the reproductive output of female spotted seatrout. Spawning is initiated when temperatures are between 25 and 28° C and salinity between 30 and 35 ppt (Johnson and Seaman 1986). Elevated water temperatures above 30° C have been shown to reduce spawning activity (Jannke 1971). However, more recent work determined salinity, especially low salinity, was the most probable factor for differences in spawning season, spawning frequency, and batch fecundity between GOM estuaries (Brown-Peterson et al. 2002).

Spotted seatrout larvae use tidal flows to migrate into and within estuaries (Perret et al. 1980) where they settle in seagrass beds, shallow bays, and backwater creeks (McMichael and Peters 1989). Optimal temperature and salinity for juvenile spotted seatrout are 28° C and 28.1 ppt (Perret et al., 1980). Although fish survive at higher temperatures and salinities, there is evidence of reduced metabolism, which may be accompanied by reduced activity and growth (Wuenshel et al. 2004).

When the waters cool during the winter, juveniles migrate to deeper, warmer water in the estuaries and ocean. However, if winter temperatures are severe, particularly a large drop in temperature over a short period of time, then winter mortality may occur. Cold stun events have been documented in North Carolina (Merriner 1980), South Carolina (de Silva Draft), Florida (Johnson and Seaman 1986) and GOM (Perret et al. 1980). After winter, seatrout migrate to oyster bars and shallow bays.

Following the first winter, male spotted seatrout average 9.7 inches and females 12.8 inches (Table 2). Growth rate begins to decrease with age in North Carolina reaching an asymptote by age 4. The predicted average maximum size for seatrout in North Carolina is 26.4 inches for males and 30.5 inches for females.

5.3 Diet and Food Habits

Seatrout have ontogenetic changes in their diet. Seatrout less than 1.5 inches consume copepods as the primary prey. Fish between 1.5 and 5.5 inches consume mysids, amphipods, polycheates, and shrimp. These juvenile spotted seatrout have considerable dietary overlap with juvenile red drum and tend to inhabit similar areas (Holt and Holt 2000). Spotted seatrout larger than 5.5 inches become one of the top predators in estuaries where they feed on a variety of fishes and shrimp (Daniel 1988; McMichael and Peters 1989). Diet analysis of spotted seatrout in the lower Cape Fear River revealed that Atlantic menhaden and brown shrimp are the dominant prey items of spotted seatrout during the summer and fall, and other important prey species included pinfish, spot, and striped mullet, indicating that spotted seatrout are mainly piscivorous after reaching age 1 (Tayloe and Scharf 2006).

Table 2. Predicted average total length at age for North Carolina spotted seatrout.

*A seasonally adjusted von Bertalanffy growth equation with the Diaz et al. (2004) correction factor was used to predict the total length at age based on otolith age estimates. Samples (n=10,754) were collected from the recreational and commercial fisheries as well as fishery independent sampling programs from 1991 to 2006. (These are the estimated lengths at age based on a January 1st theoretical birth date).

	Males	Females	Combined
Age (years)	Length (in)	Length (in)	Length (in)
1	9.7	12.8	10.7
2	15.6	19.1	18.2
3	19.5	23.2	22.3
4	22.0	25.8	24.5
5	23.5	27.5	25.8
6	24.5	28.5	26.4
7	25.2	29.2	26.8
8	25.6	29.7	27.0
9	25.9	30.0	27.1

5.4 Migration Patterns

As with many estuarine and marine fish in North Carolina, spotted seatrout have distinct seasonal migrations. During the winter, seatrout migrate to deeper, warmer water. As the waters warm in the summer, seatrout return to oyster beds and shallow bays and flats (Daniel 1988). Although there is a distinct seasonal migration pattern, tagging studies have shown that spotted seatrout have considerable residency with individuals usually traveling less than 20 miles (Brown-Peterson et al. 2002; R Wiggers, South Carolina Department of Marine Resources, personal communication; J. Lucy, Virginia Institute of Marine Science, personal communication). A coastwide stock assessment of spotted seatrout has not been conducted given the largely residential nature of the species and the lack of data on migration where it does occur (ASMFC 2008). However, spotted seatrout in the northern portion of their range (Virginia /North Carolina) may be exceptions as evidenced by seasonal migration patterns (Brown 1981; Hildebrand and Schroeder 1928; Goode 1884; Mercer 1984), and more recently by tagging data (J. Lucy, Virginia Institute of Marine Science, personal communication). Spotted seatrout tagged in Virginia have been observed in North Carolina as far south as Wrightsville Beach and as far west in Pamlico Sound as Swan Quarter.

Due to its recreational importance, spotted seatrout were selected as a species for recreational tagging programs in Virginia and South Carolina. Although South Carolina continues to tag spotted seatrout, fishermen are discouraged from tagging these fish due to low tag return numbers. Virginia still tags spotted seatrout, but with a low reporting rate of only 3% (Lucy et al. 2007). Most spotted seatrout tagged by South Carolina Marine Game Fish Tagging Program and Virginia Game Fish Tagging Program remained within the same estuary (R Wiggers, South Carolina Department of Marine Resources, personal communication; J. Lucy, Virginia Institute of Marine Science, personal communication). Only two fish out of the 350 recaptured spotted seatrout migrated from South Carolina to North Carolina (R. Wiggers, South Carolina Department of Marine Resources, personal communication). Spotted seatrout tagged in Virginia had a higher portion of the recaptures in North Carolina [15% of the 227 recaptured (J. Lucy, Virginia Institute of Marine Science, personal communication)]. This led to the decision to incorporate Virginia in the unit stock for this spotted seatrout fishery management plan. The seatrout that were recaptured in North Carolina were generally caught during the fall and winter when the seatrout had a distinct southerly migration. Few fish have been tagged within North Carolina to determine seasonal migration patterns and possible stock structure, but the previously mentioned NCSU study (NCFRG 2010; NCCRFL research ongoing) should provide such information for inclusion in the FMP update.

6. STATUS OF STOCKS

The initial stock assessment for this FMP was completed in January 2009 and was based on data from 1991 to 2006. The results showed that the spotted seatrout stock was overfished and undergoing overfishing. Since the completion of that assessment, two additional years of data were reviewed and the results showed potential signs of improvement such as increased landings, expansion of the age composition of the catch, and increases in catch rates in the commercial gill net and recreational indices of abundance. The PDT decided to update the previous assessment to include data from 2007 and 2008. The results indicated only marginal improvement over the previous status. The stock moved from an average of 7% SPR in the previous assessment to 8% SPR in this update with a goal of 20%. The stock is still considered overfished and overfishing continues to occur at almost twice the rate of the threshold.

Data available for spotted seatrout assessment included commercial and recreational landings and information on age, length, weight, sex, and maturity from 1991 to 2008. Tagging data indicated that spotted seatrout migrate from Virginia to North Carolina; therefore, spotted seatrout from Virginia and North Carolina were considered a single population for this assessment. A statistical catch-at-age model was used to determine past and current fishing mortality rates and stock abundance levels. One fishery-independent index and two fishery-dependent indices of abundance were used to assist the model in finding a solution. Yield per recruit and biomass per recruit models were used to identify levels of fishing mortality and spawning stock biomass that can be used to determine if the stock is overfished or if overfishing is occurring or both.

The models found that the population of spotted seatrout has been overfished and that overfishing has been occurring for the entire time series. The spawning potential ratios (SPRs) for each of the benchmarks ranged from 18 to 40% (see Appendix 4, Stock Status). The Atlantic States Marine Fisheries Commission recommended a minimum SPR of 20% to minimize the possibility of recruitment failure; however, the levels of SPRs for recent years were below this minimum criterion.

It should be noted that cold stun events appeared to have a large influence on spotted seatrout population dynamics. The effects of these events appeared as increases in fishing mortality in the model; although it was not possible to quantify the increase in mortality associated with these events. Periodic increases in mortality associated with cold stuns should still be considered when implementing management measures as they are likely to continue to occur on a periodic basis and are largely unpredictable.

In recent years, the fishing mortality associated with the recreational fishery was high in comparison to that of the commercial fishery. In years not affected by cold stun events, the average fishing mortality in the recreational fishery has maintained a high average of 0.71 since 2002 compared to 0.51 in years prior. In contrast, the fishing mortality associated with the commercial fishery has decreased to a steady low of 0.23. Managers should be concerned with this trend because the recreational fishery uses hook and line which selects for smaller, younger fish than does the commercial fishery.

The population has largely been able to sustain itself against high levels of fishing pressure throughout the years because spotted seatrout grow quickly, most are fully mature at age 1, and they have a protracted spawning period (multiple spawns during a single season). These life-history traits should allow the population to recover relatively quickly, assuming there are few significant cold stun events during the recovery period. Management measures should be implemented to account for recent increases of recreational fishing and discard mortality and would maintain a sufficiently large spotted seatrout population to act as a buffer against the effects of future cold stun events.

According to the FRA, stock status should be evaluated on the stock's ability to produce sustainable harvest. Such an approach reflects stock biomass and is typically used to determine whether or not a stock is overfished. Stocks are also evaluated based on the rate of removals (i.e., the fishing mortality rate), which typically determines whether or not overfishing is occurring.

The North Carolina Division of Marine Fisheries (DMF) recommendation is to reduce F to maintain a 20% SPR, which will increase the likelihood of sustainability through an expanded age structure and an increase in the spawning stock biomass. This strategy should provide a greater cushion for the population that would likely lead to faster recovery of the population after cold stun events. When the stock is reassessed in the next plan, reference points may be amended based on the response of the population to the management measures selected in the initial FMP.

7. DESCRIPTION OF FISHERIES

7.1 Commercial Fishery

7.1.1 Collection of Commercial Statistics

Commercial landings data have been collected in North Carolina since the late 1800s. As time has progressed from the beginning of the series to the more recent time period, the collection of landings data has improved. 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 National Marine Fisheries Service (NMFS) standardized the collection methods of landings statistics for the U.S. South Atlantic fishery species in 1972. During this time period, landings were collected monthly from major seafood dealers, although reporting was not mandatory. A cooperative statistics program between NMFS and state agencies including the DMF and Virginia Marine Resources Commission (VMRC) Cooperative Statistics Programs began in 1978 to obtain more accurate harvest data. Data were gathered by surveying fish dealers for landings and value information. Although the survey provided managers with needed data, there were concerns over reliability of the data. These concerns arose since cooperation was voluntary and not all dealers agreed to participate, which resulted in unreported landings. Another shortcoming of the program was the lack of effort data. Therefore, DMF instituted a mandatory trip ticket program (NCTTP) in 1994 that provides reliable harvest information at the trip level. The program requires dealers to complete a trip ticket on each transaction (amount of landed fish) and to submit these tickets to DMF. Data collected since 1994 is considered the most reliable due to the mandatory reporting requirements of the dealers. Because of differences in data collection methods prior to 1994, caution should be exercised when comparing these data to the NCTTP data. Virginia commercial landings were obtained through the Virginia Marine Resources Commission

(VMRC) Trip Ticket Program from 1993 to 2006. The Virginia program differs from the NCTTP in that fishermen submit logbooks instead of dealer trip tickets.

7.1.2 Atlantic Coast Landings of Spotted Seatrout

Atlantic coast commercial landings of spotted seatrout (1960-2008) ranged from 165,000 pounds to 1.4 million pounds (Table 3). Total coastwide commercial landings of spotted seatrout were sustained at or above the 1 million pound level during most of the 1960's and 1970's. Since 1977, commercial landings have remained below 1 million pounds. Coastwide landings for 2001 to 2005 averaged 202,869 pounds, but increased in the last three years to 414,900 pounds. Prior to 1990, the majority of commercial landings were reported from the east coast of Florida. Since 1990, the majority of commercial landings have been reported from North Carolina. The sharp decline in Florida's commercial landings of spotted seatrout observed since 1995 coincided with the implementation of the entangling net restrictions enacted in July 1995 and the restrictive vessel limits, open season, and size limits enacted in January 1996 (Murphy et al., 2006). Since the harvest restrictions in the Florida spotted seatrout fishery, no other state has reported landings close to the landings observed in North Carolina. During the time period for the stock assessment, 1991 to 2008, an average of 75% of the landings were reported from North Carolina. In 2008, 83% of the landings were reported to be from North Carolina, while Virginia and the east coast of Florida were responsible for only 12% and 6% of commercial landings, respectively. Landings from states north of Maryland are minimal and/or inconsistently landed from year to year.

North Carolina Annual Landings
North Carolina commercial landings of spotted seatrout (Figure 1) have fluctuated since 1960, with highs in 1974 (670,200 pounds) then again in 1991 (660,662 pounds). Variability in annual catch has been common for this species and seemed to parallel the climatic conditions of the preceding spring and winter, i.e., low catches following severe winters. The large decline from 1976 to 1978 may have resulted from high mortalities caused by extremely cold winter temperatures in 1976 and 1977 (Merriner, 1980). Cold stun events have likely occurred in many years but confirmed reports occurred in December 1995 (affecting the 1996 fishing year), 2000, 2001, and 2003. Cold stun events appear to have a large influence on spotted seatrout population levels (Jensen 2009, Appendix 4) and thus contribute to fluctuations in landings. Increased landings in recent years (2006-2008) may be the result of mild winters coupled with good recruitment.

Virginia Annual Landings
Commercial landings of spotted seatrout in Virginia were only a fraction of what was caught in North Carolina, with 44,636 pounds the highest landings reported since 1991 (
Figure 1). Virginia landings averaged only 30,374 pounds in the past five years (2004 to 2008), but catches increased in 2007 & 2008. Virginia usually ranked third on the east coast below only North Carolina and Florida, until 2008 when it ranked second (Table 3). Landings from Virginia increased from 7 to 12% of the coastwide landings from 2004 to 2008. Virginia established an annual commercial quota of 51,104 pounds in 1995 although the quota has not been reached since it was enacted.

Table 3. Annual commercial landings (lbs) of spotted seatrout by state along the east coast, 1960-2008. FLEC=Florida East Coast. Other includes Connecticut, Rhode Island, New Jersey, and Delaware. Average based on years with reported landings.

Year	NY	MD	VA	NC	SC	GA	FLEC	Other	Total
1960			54,900	171,200	53,000	1,000	889,800		1,169,900
1961			73,800	209,100	56,100	1,700	749,500		1,090,200
1962			28,400	204,700	27,200	1,000	755,700		1,017,000
1963			25,700	232,400	47,800	5,100	801,300		1,112,300
1964			23,400	204,800	59,600	1,900	764,500		1,054,200
1965			40,400	175,100	35,000	8,900	682,100		941,500
1966			11,800	115,900	24,500	3,200	724,000		879,400
1967			3,700	122,500	1,600	6,900	599,200		733,900
1968			5,800	97,200	11,900	1,700	638,200		754,800
1969			19,400	189,100	8,300	2,700	679,600		899,100
1970			65,900	404,600	9,100	10,000	711,200		1,200,800
1971			44,400	337,600	24,200	15,600	494,900		916,700
1972			12,800	502,800	18,100	26,200	634,100		1,194,000
1973			9,500	611,100	5,800	26,800	665,800		1,319,000
1974			26,200	670,200	8,900	16,100	658,500		1,379,900
1975			72,500	632,500	17,100	30,900	535,100		1,288,100
1976			39,000	637,600	5,800	30,000	531,700		1,244,100
1977			3,800	323,500	600	16,000	493,900		837,800
1978			6,100	97,304	119	2,470	402,954		508,947
1979			3,500	105,034	2,977	4,987	475,809		592,307
1980			1,000	171,334	8,137	4,250	558,817		743,538
1981			4,000	113,304		629	736,026		853,959
1982			3,400	83,847	1,944	4,994	732,278		826,463
1983			4,400	165,360	4,479	5,795	481,535		661,569
1984			3,000	152,934	2,374	4,348	367,541		530,197
1985			8,302	109,048	1,770	7,149	369,756		496,025
1986			18,500	191,514	12,214	8,691	307,261		538,180
1987			13,300	315,380	11,941	10,739	317,044		668,404
1988			15,500	296,538	486	9,110	315,947		637,581
1989			18,500	451,909	33	10,565	361,973		842,980

Table 3. Continued

Year	NY	MD	VA	NC	SC	GA	FLEC	Other	Total
1990			21,435	250,634	1,095	5,942	236,453	20	515,579
1991		98	21,200	660,662		7,380	225,812	171	915,323
1992		364	10,395	526,271		11,310	247,189	165	795,694
1993		24	38,033	449,886		8,550	223,841	87	720,421
1994		30	44,636	412,458		5,112	247,666	142	710,044
1995		182	28,722	574,404		8,482	184,269	114	796,173
1996		14,961	4,476	226,668		7,501	48,254		301,860
1997		15,688	11,711	232,579		7,621	57,316		324,915
1998		19,794	21,774	307,777		2,845	41,556		393,746
1999		36,365	38,513	546,775		3,244	61,802		686,699
2000		20,270	19,918	375,159		1,997	45,393		462,737
2001		24,754	3,773	105,797			30,236		164,560
2002		11,771	9,308	175,609		969	44,641		242,298
2003	856	902	5,310	181,529			27,172		215,769
2004		342	17,290	131,019		815	29,616	2,050	181,132
2005*	19,747	2,410	21,448	129,645		<500	36,778	559	210,587
2006	20,701	245	28,529	312,714			36,689		398,878
2007	14,111	32	41,004	374,722			46,840		476,709
2008			43,601	304,622			20,889		369,112
Average	1,131	3,025	22,285	293,354	9,432	7,167	394,458	68	731,835

**Preliminary landings; total included the maximum of 500 lbs from Georgia (exact amount is confidential)*

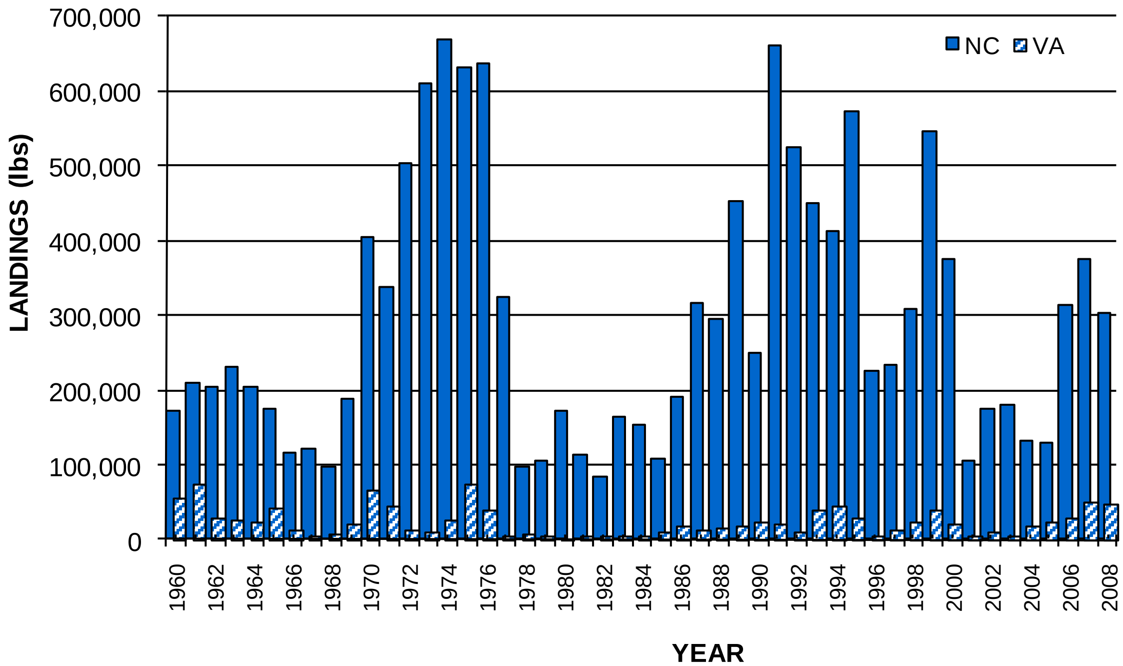


Figure 1. Commercial landings (lbs) of spotted seatrout in North Carolina and Virginia, 1960-2008.

7.1.3 Seasonal Harvest

7.1.3.1 North Carolina

Spotted seatrout were harvested throughout the year with a large peak in the fall/winter (October – February) and a small peak in the spring (April – May) (Figure 2). Although spotted seatrout have traditionally been harvested as bycatch in fisheries targeting other sciaenid species (red drum, black drum, weakfish, Atlantic croaker, spot), or striped mullet, bluefish, or southern flounder, a small directed fishery for spotted seatrout existed for spotted seatrout during the fall and winter in years when the stock was abundant.

7.1.3.2 Virginia

Virginia's commercial harvest of spotted seatrout was only a fraction of the North Carolina commercial harvest, with average monthly landings <1% of those landed in North Carolina. Virginia's monthly landings were highest during September, followed by October, and November (Figure 3).

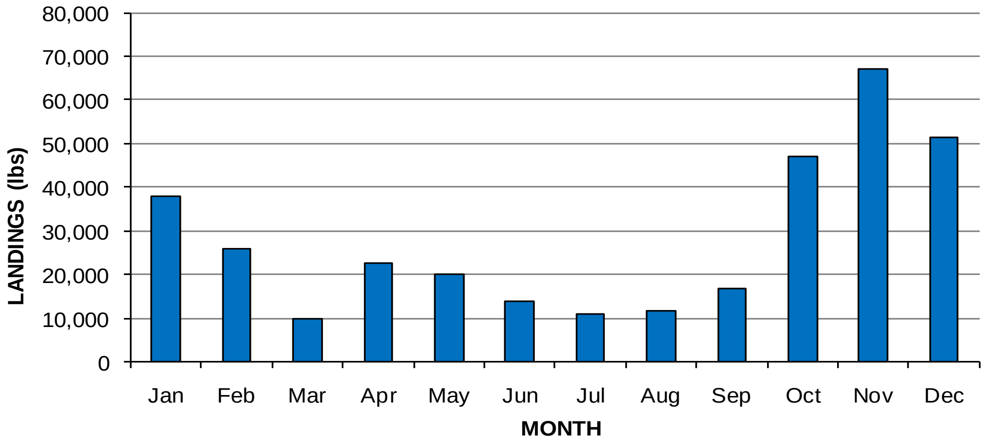


Figure 2. Average commercial landings (lbs) of spotted seatrout in North Carolina, by month, 1991-2008.

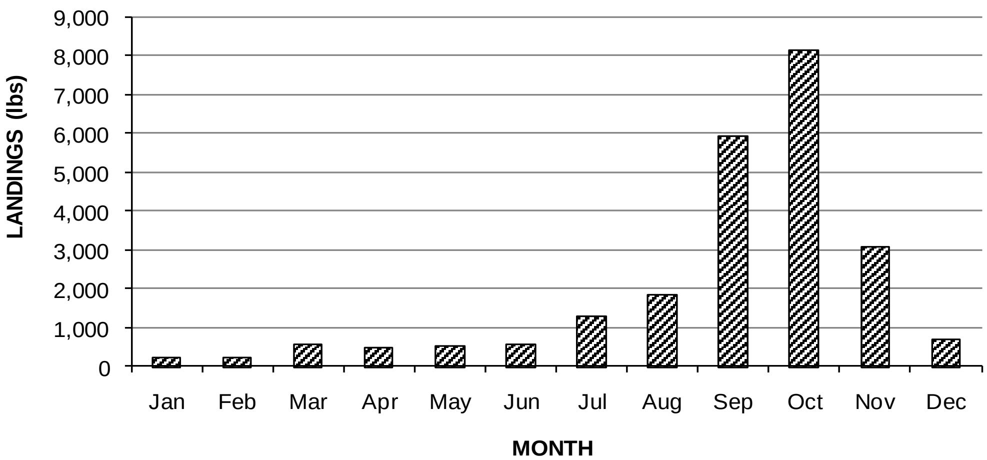


Figure 3. Average commercial landings (lbs) of spotted seatrout in Virginia, by month, 1991-2008.

7.1.4 Primary Harvest Areas

North Carolina

In North Carolina, spotted seatrout were primarily harvested commercially in nine waterbodies; Albemarle Sound, Bay River, Bogue Sound, Core Sound, Neuse River, New River, Atlantic Ocean, Pamlico River and Pamlico Sound. Pamlico Sound accounted for the majority of spotted seatrout landings; an average of 34% of the landings came from Pamlico Sound during 1972 to 2008. Pamlico Sound landings ranged from a low of 24,503 pounds in 2003 (cold stun year) to an annual high of 260,922 pounds in 1975 (Table 4). The Atlantic Ocean ranked second, accounting for an average of 17% of the spotted seatrout harvested. These trends have remained consistent over the years while the contributions by many other water bodies varied and were much smaller in comparison.

Virginia

The commercial harvest of spotted seatrout in Virginia was predominantly from the Chesapeake Bay which comprised an average of 73% of the landings (Table 5). Chesapeake Bay landings ranged from 3,025 pounds in 1996 to 35,529 pounds in 1999. In some years, a large proportion of landings were from the Poquoson River, a tributary of the Chesapeake Bay. Poquoson River landings comprised as much as 26% in 1991and 1993, and an average of 9% from 1991 to 2006. Interestingly, the Atlantic Ocean accounted for 37% of the landings in 2006. This was unique and perhaps representative of a shift in effort by commercial fishermen. The low landings observed in the Chesapeake Bay in 1996 may be attributable to a cold stun event, as it was in North Carolina for that year.

7.1.5 Primary North Carolina Counties of Landings

Historically, seven counties accounted for the majority of North Carolina spotted seatrout landings; Carteret, Dare, Pamlico, Beaufort, Hyde, Onslow and Craven. Of these seven, Carteret, Dare and Pamlico accounted for most of the commercial harvest of spotted seatrout. Over the years, Carteret, Dare and Pamlico counties have always ranked in the top three counties landing spotted seatrout while the other counties have fluctuated rankings over the years (Figure 4). Please note that county of landing is based on commercial dealer location.

Table 4. Commercial landings (lbs) of spotted seatrout in North Carolina by major water body, 1972-2008.

**"Other" includes: Inland waterway, North River/Back Sound, Roanoke Sound, Newport River, Croatan Sound, Pungo River, Cape Fear River*

Year	Atlantic Ocean	Albemarle Sound	Pamlico Sound	Pamlico River	Neuse River	Bay River	Core Sound	Bogue Sound	New River	Other	ALL
1972	79,465	7,365	142,060	32,100	121,525		97,457	10,185	1,935	10,700	502,792
1973	186,800	7,913	132,526	6,349	187,216		81,658	2,347	1,573	4,622	611,004
1974	85,136	21,317	143,496	63,563	182,209		91,019	34,258	7,592	41,017	669,607
1975	81,663	39,457	260,922	75,476	84,736		37,384	6,854	15,547	30,564	632,603
1976	26,092	63,604	239,144	68,867	137,518		57,076	8,295	21,010	15,720	637,326
1977	13,882	2,663	60,962	24,132	173,765		32,925	4,978	6,333	3,768	323,408
1978	18,356	4,035	48,667	5,921	7,823	200	6,599	293		5,410	97,304
1979	20,663	2,041	29,738	2,726	19,438	240	17,628			12,560	105,034
1980	37,951	2,693	38,644	466	12,609	3,462	56,794	412		18,303	171,334
1981	7,720	2,930	50,174	1,382	4,370	482	24,291	1,495		20,460	113,304
1982	11,571	5,567	45,404	821	6,150		2,992			11,342	83,847
1983	56,247	8,401	53,745	4,199	6,674	2,420	13,341	305		20,028	165,360
1984	23,633	441	73,215	643	5,554		26,676	2,523	945	19,304	152,934
1985	28,543	9	40,834	81	2,678		12,858	2,045	1,282	20,718	109,048
1986	63,561	2,940	56,413	2,618	5,766	2,160	16,838	7,068	2,835	31,315	191,514
1987	57,054	31,252	129,207	5,482	17,841	100	23,495	7,278	4,710	38,961	315,380
1988	44,485	11,410	117,635	20,040	24,118	16,691	19,900	11,449	3,430	27,380	296,538
1989	99,320	16,761	239,225	14,879	12,075	4,423	22,551	9,916	4,458	28,301	451,909
1990	59,975	1,119	85,519	3,663	3,211	921	32,000	11,546	9,038	43,642	250,634
1991	235,892	7,744	226,672	493	17,463	550	69,896	17,298	9,599	75,055	660,662
1992	107,818	18,248	246,449	2,249	15,990	4,752	56,699	10,537	8,608	54,921	526,271
1993	113,364	24,039	178,686	7,068	19,430	13,493	35,821	6,372	7,267	44,346	449,886
1994	65,419	14,214	180,677	18,655	37,556	8,024	59,761	6,115	2,726	19,210	412,358
1995	184,046	23,042	210,756	33,117	32,509	19,849	27,355	13,411	5,373	24,837	574,296
1996	35,725	1,434	62,237	19,794	39,533	24,905	18,158	5,841	7,591	11,362	226,580
1997	38,691	2,961	89,494	7,312	19,357	24,741	29,500	4,471	3,581	12,390	232,497
1998	18,836	5,920	126,998	13,046	37,621	23,614	53,103	7,279	4,792	16,462	307,671
1999	39,856	21,912	292,935	22,360	36,909	21,783	64,130	8,201	5,230	33,359	546,675
2000	56,901	9,382	120,527	26,388	44,799	39,122	19,144	7,372	6,571	46,370	376,574
2001	15,751	4,242	31,515	4,518	6,556	9,587	7,978	8,785	4,834	11,948	105,714
2002	12,155	12,407	41,813	18,092	27,660	14,456	20,650	4,230	5,097	18,996	175,555
2003	12,294	4,281	24,503	26,554	20,153	22,678	34,743	4,349	10,717	21,193	181,462
2004	20,649	1,888	33,459	7,843	14,071	2,746	28,070	1,282	9,032	11,923	130,961
2005	19,788	3,619	28,452	4,297	15,881	6,440	26,083	1,701	5,540	17,801	129,601
2006	34,172	9,158	66,130	11,048	44,804	19,665	72,505	4,809	11,783	38,547	312,620
2007	20,041	6,647	118,917	27,061	53,932	14,444	69,239	10,467	9,254	44,722	374,724
2008	18,151	12,924	76,471	48,686	36,616	10,003	32,775	6,743	10,036	52,140	304,545

Table 5. Commercial landings (lbs) of spotted seatrout in Virginia by major water body, 1991-2008.

Year	Atlantic Ocean	Seaside Eastern Shore	Chesa-peake Bay	James River	York River	Rappah annock River	Potomac River	Poquoson River	Chesa-peake Bay Tribs	ALL
1991	233		14,376	7	882		167	5,418	117	21,200
1992	171		7,811		97		130	2,128	3	10,340
1993	1,559	3	21,745	258	415	120	1,381	9,798	2,719	37,998
1994	3,646	1,536	34,795	2,466	199	118	89	1,169	580	44,598
1995	809	100	22,867	418	2,578	69	16	1,454	411	28,722
1996	681	4	3,025	235	190	101	39	98	113	4,486
1997	688	16	8,026	9	893	51	37	617	1,399	11,736
1998	181		17,749	46	198	885	48	2,265	402	21,774
1999	1,379	10	35,529	626	405	101	3,310	5,062	45	46,467
2000	532	8	12,814	37	50	30	6,206	3,224	2,049	24,950
2001	5	8	18,933	24		8	1,380	59	4	20,421
2002	687	16	21,234	44	2	14	1,924	120	45	24,086
2003	9		3,297	46	1,645	33	118	254	15	5,417
2004		128	9,616	28	306	17	419	299	18	10,831
2005	794	4	14,881	512	228	2	71	812	74	17,378
2006	17,870	417	26,060	1,047	954	20	19	1,797	40	48,224
2007	7,022	105	38,352	2,403	851	4	30	571	164	49,502
2008	5,870	66	34,088	1,273	951	234	31	3,996	471	46,980

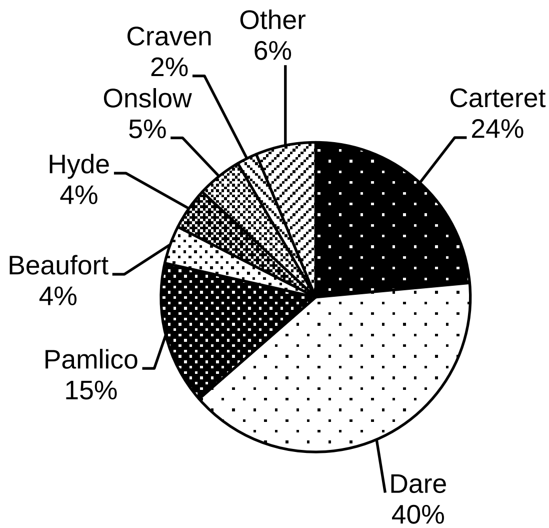


Figure 4. Percent landings of spotted seatrout by North Carolina County, 1991-2008.

7.1.6 Characteristics of North Carolina Spotted Seatrout Trips and Participation

The number of commercial trips landing spotted seatrout fluctuated but generally declined from 1995 to 2005, then increased in 2006 to 2008 (Figure 5). The number of commercial trips landing spotted seatrout was highest in 1995 at 16,856 trips. The number of trips decreased 44% from 1995 to 1996 (9,502 trips). The number of trips increased from 1996 to 1999 (15,319 trips), but decreased 57% from 1999 to 2001 (6,490 trips). The number of trips made was lowest from 2003 through 2005, when the average number of trips made was 5,839 trips. Trip lows in 1996, 2001, and 2003 through 2005 were consistent with documented cold stun event years.

The number of participants, vessels and dealers reporting landings of spotted seatrout generally declined from 1995 to 2005, then increased from 2006 to 2008 (Figure 6). The number of participants, vessels, and dealers was highest in 1995. The number of participants declined from 1,548 in 1995 to 710 in 2004. The number of participants increased slightly from 2004 to 2008 (921 participants), but this is only approximately 60% of the number of participants in 1995. The number of vessels landings spotted seatrout decreased 56% from 1,778 in 1995 to 787 in 2004, but have steadily increased to 1,026 vessels in 2008. The number of dealers buying and selling spotted seatrout was highest in 1995 (215), steadily declined to 162 dealers in 2005, then increased slightly from 2005 to 2008 (185 dealers).

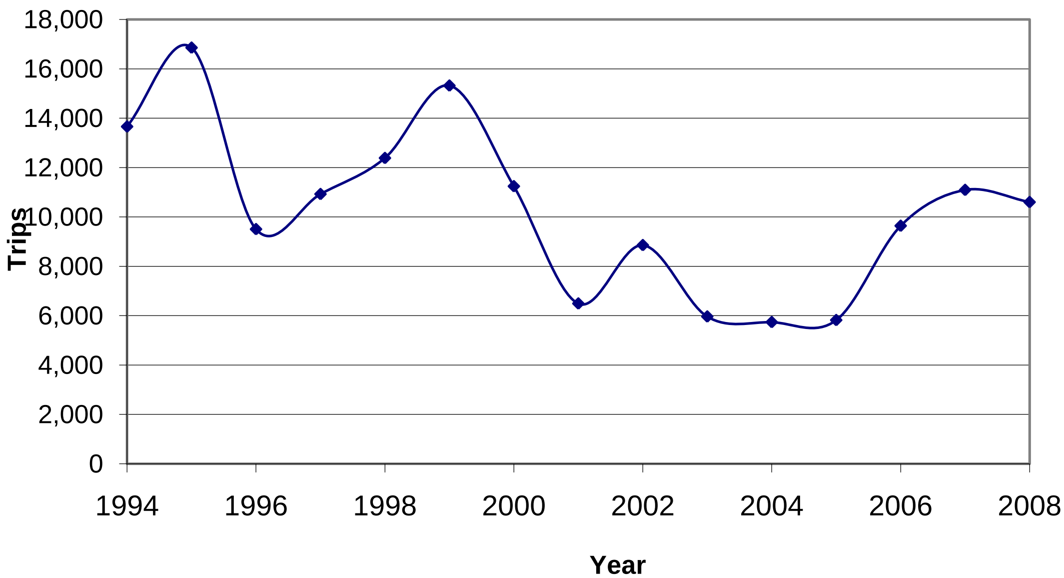


Figure 5. Number of trips landing spotted seatrout in North Carolina from 1994 to 2008.

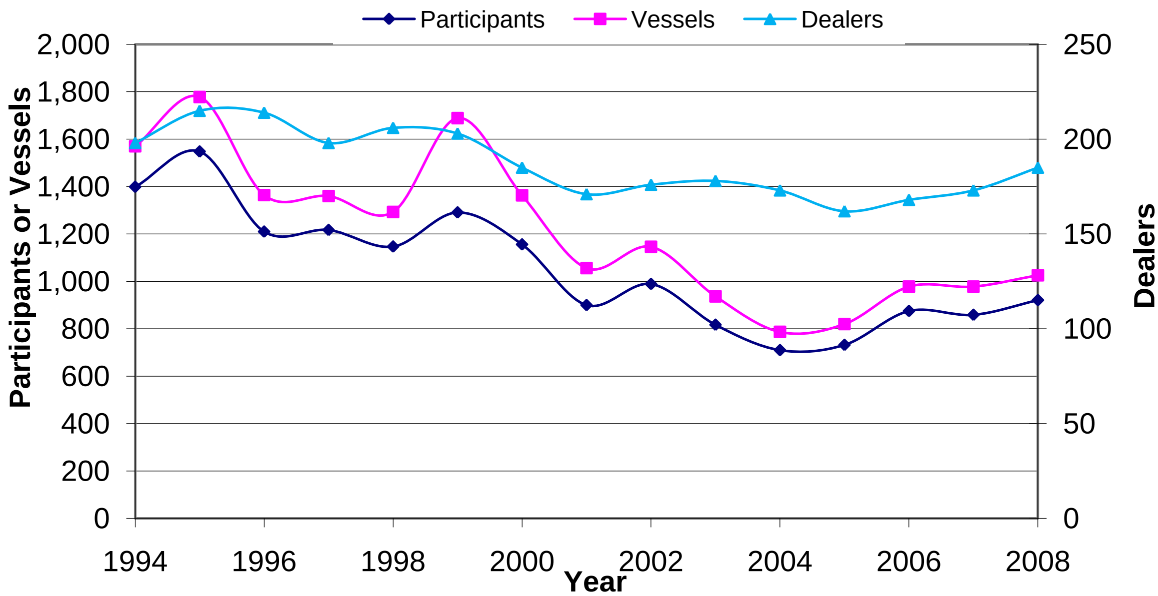


Figure 6. Number of participants, vessels, and dealers in the North Carolina spotted seatrout fishery from 1994 to 2008.

7.1.7 Primary Gears Fished

7.1.7.1 North Carolina Commercial Gear

Spotted seatrout have been commercially harvested in North Carolina using a variety of gears, but four gear types were most common: estuarine gill net, long haul seine, beach seine, and ocean gill net. Estuarine gill nets were the predominant gear (Figure 7). Historically, long haul seines (swipe nets) used in estuarine (inshore) waters were the dominant gear, but effort and landings by this gear have diminished in recent years (2000-2008). During the period of the trip ticket program (1994-2008), long haul seine (swipe net) landings dropped and estuarine gill nets became the dominant gear accounting for 67% of the landings. Haul seines fished in the Atlantic Ocean waters (i.e., beach seines) have been important in some years (up to 26% of the harvest in 1995). Contributions by ocean gill nets were minor but accounted for as much as 15% of the landings in 1993. Other gears that accounted for a minor portion of the landings included pound nets, gigs, trawls, rod and reel, and “by hand”.

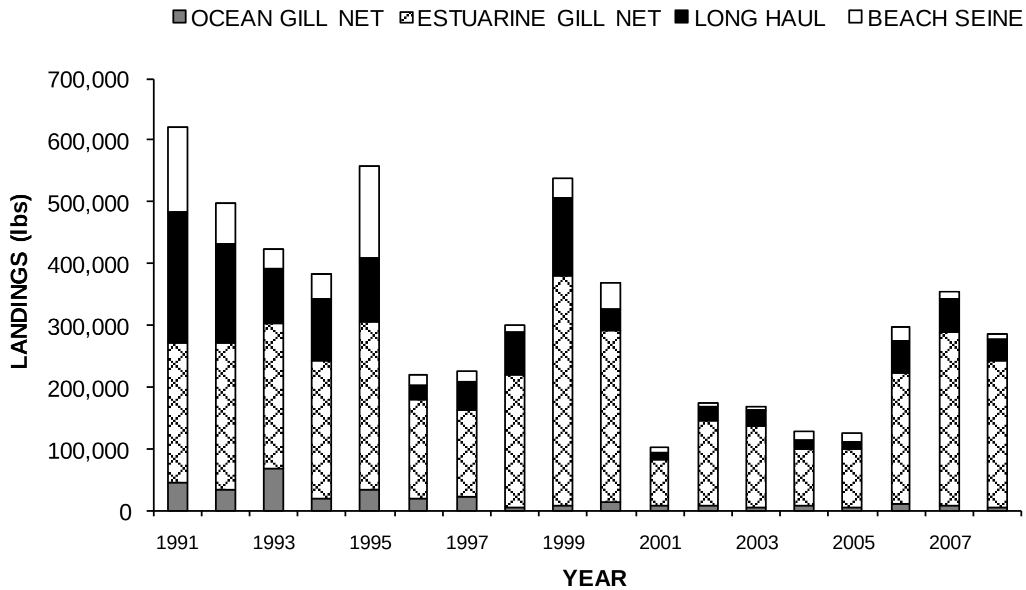


Figure 7. Commercial landings (lbs) of spotted seatrout in North Carolina by predominant gear type, 1991-2008.

Table 6. Annual landings (lbs) of spotted seatrout by commercial fishing gear in North Carolina, 1991-2008. "Other" includes pound nets, gigs, trawls, rod and reel, and hand harvest.

	Estuarine Gill Net		Ocean Gill Net		Beach Haul Seine		Long Haul/ Swipe Net		Other		Total
Year	lbs	%	lbs	%	lbs	%	lbs	%	lbs	%	lbs
1991	226,994	34	45,233	7	138,439	21	210,333	32	39,663	6	660,662
1992	237,692	45	32,118	6	65,177	12	163,009	31	28,275	5	526,271
1993	235,179	52	67,596	15	29,593	7	90,218	20	27,300	6	449,886
1994	222,097	54	19,557	5	41,233	10	99,757	24	29,814	7	412,458
1995	274,218	48	32,420	6	149,012	26	101,776	18	16,984	3	574,410
1996	162,596	72	17,942	8	16,947	7	22,574	10	6,609	3	226,668
1997	139,968	60	22,292	10	15,994	7	46,126	20	8,203	4	232,583
1998	212,925	69	5,712	2	12,304	4	68,286	22	8,550	3	307,777
1999	371,663	68	8,067	1	30,222	6	126,594	23	10,229	2	546,775
2000	277,865	74	12,526	3	43,107	11	33,911	9	9,248	2	376,657
2001	75,437	71	7,238	7	8,391	8	11,455	11	3,276	3	105,797
2002	136,683	78	6,891	4	4,896	3	23,768	14	3,405	2	175,643
2003	131,637	73	5,211	3	6,613	4	25,271	14	12,797	7	181,529
2004	91,743	70	8,226	6	12,061	9	14,740	11	4,249	3	131,019
2005	94,671	73	5,103	4	14,480	11	10,896	8	4,495	3	129,645
2006	213,558	68	9,937	3	23,704	8	49,528	16	15,987	5	312,714
2007	282,190	75	6,318	2	12,438	3	54,404	15	19,373	5	374,723
2008	236,211	78	5,271	2	10,927	4	34,144	11	17,991	6	304,544
Avg	201,296	65	17,648	5	35,308	9	65,933	17	14,803	4	334,987

7.1.7.1.1 Estuarine Gill Nets

The estuarine gill net fishery is a multi-species fishery which varies by region depending on the species targeted and the type of gill net used. Fishermen using estuarine gill nets to catch spotted seatrout employed three different gill netting techniques: set nets (float nets and sink nets), runaround gill nets, and drift nets. Landings by drift nets comprise such a small portion of the landings, that only set nets and runaround gill nets will be presented herein. The majority (65%) of North Carolina's commercial harvest from 1991 to 2008 was captured using estuarine gill nets (Table 6).

<u>Estuarine Set Gill Nets</u>
Set nets are anchored gill nets that are deployed and left to fish from a few hours to a few days depending on water temperature and season. Set nets can be further divided into float and sink categories, depending on how they fish within the water column. Float nets fish the entire height of the water column, while sink nets fish a fixed distance off the bottom and do not extend into the upper portion of the water column if the water is deeper than the height of the net. Tie-downs and nets without floats are used in some areas of the state to reduce the height of the net in the water column in order to avoid non-target species.

Estuarine set gill nets are the primary gear that harvest spotted seatrout in North Carolina. Set gill nets landed 37 to 62% with an average of 50% of North Carolina's commercial landings of spotted seatrout from 1994 to 2008.

The landings and number of trips catching spotted seatrout from estuarine set gill nets generally declined from 1999 to 2005 but then increased from 2005 to 2008 (Figure 8). However, even with the recent increase in trips and landings, the 2008 landings (153,957 lbs) were only half of the peak in 1999 (300,777 lbs).

Monthly landings of spotted seatrout by estuarine set gill nets occurred year round, but mostly occurred during the late fall and winter (October-February), with slight increases in the spring (April-May) (Figure 9).

Although spotted seatrout can be caught in a variety of mesh sizes, they are primarily harvested with small mesh set nets (< 5 inch mesh). Data collected from a fishery dependent sampling program was used to characterize this fishery (Table 7). Mesh sizes used varied by region, but overall ranged from 3 ¼ to 5 ¾ inch stretched mesh, with 4 inch mesh most common. Of the catches sampled that targeted spotted seatrout (n=126), the number of yards fished ranged from 67 to 3,000 yards with an average of 1,042 yards. Nets were set from 2 to 72 hours and fished in 2 to 9 feet of water.

Table 7. Small mesh (<5 inch) estuarine set gill net fishery parameters commonly associated with targeting spotted seatrout based on fishery dependent data (Program 461), 2001-2008 (DMF unpublished data).

		Gill Net Stretched Mesh Size (inches)				Net Length (yards)		
Region	N	Mode	Common Range	Min	Max	Mean	Min	Max
Albemarle Sound	4	–	3.26-5.76	3.26	5.76	700	600	800
Pamlico Sound	52	4.00	3.76-4.76	3.26	6.00	1,205	100	3,000
Pamlico/Neuse River	60	4.0 & 5.5	3.0-5.5	3.00	7.00	905	67	2,000
Core Sound-South	10	4.00	3.26-4.0	3.26	4.00	811	200	1,600
Combined	126	4.00	3.26-5.76	3.00	7.00	1,042	67	3,000

		Soak Time (hours)			Water Depth (feet)		
Region	N	Mean	Min	Max	Mean	Min	Max
Albemarle Sound	4	9	6	12	3	3	4
Pamlico Sound	52	26	4	72	4	2	8
Pamlico/Neuse River	60	15	12	48	4	2	9
Core Sound-South	10	18	2	48	4	3	5
Combined	126	20	2	72	4	2	9

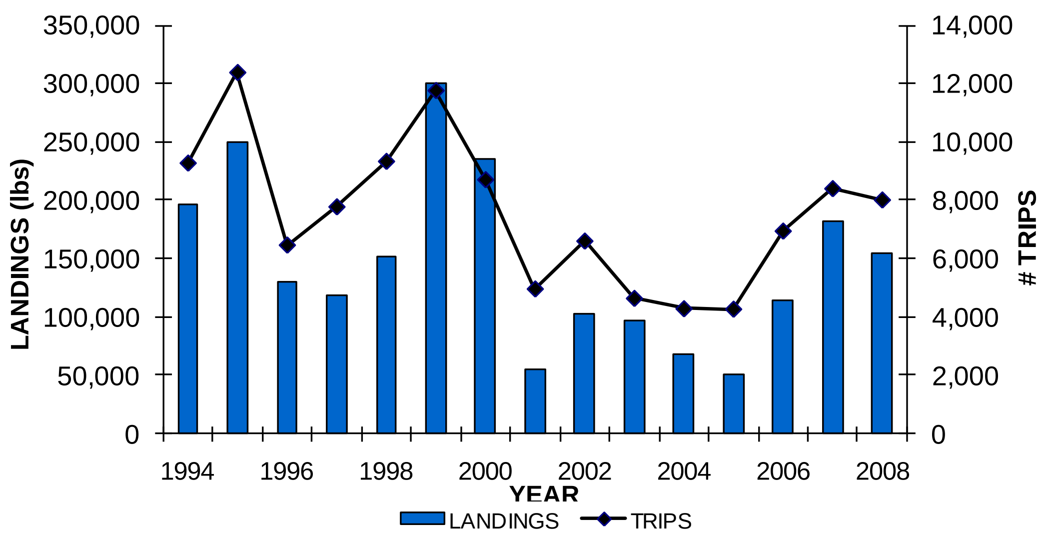


Figure 8. Landings (lbs) and total number of trips landing spotted seatrout from estuarine set gill nets, 1994-2008.

*Estuarine waters included all North Carolina waters other than the ocean.

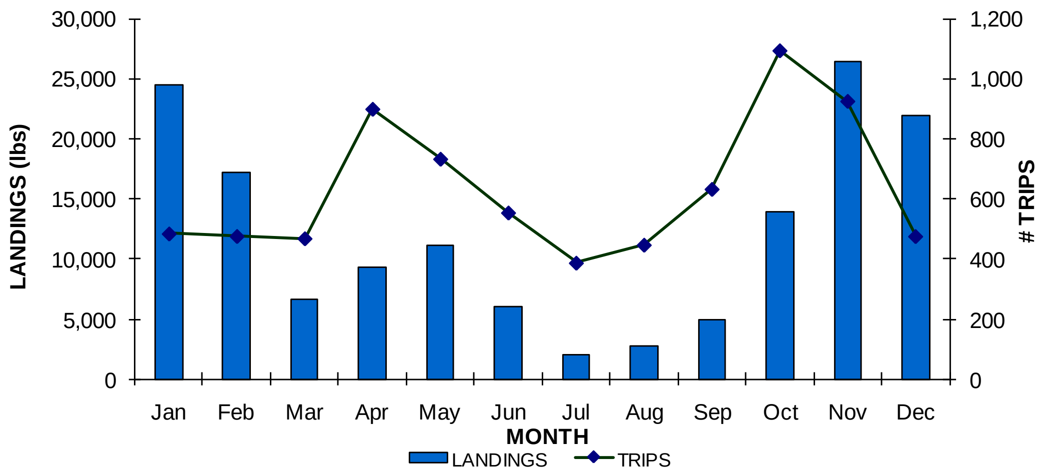


Figure 9. Landings (lbs) and number of trips landing spotted seatrout from estuarine set gill nets, by month, 1994-2008 average.

*Estuarine waters included all North Carolina waters other than the ocean.

Estuarine Runaround Gill nets

Runaround gill nets, also referred to as drop or strike nets, are fished in one or two ways. In one method, the net is attached to a point on the shore and deployed parallel with the terminal end finishing at another point along the shore to block a section of the shoreline. The boat is driven into the blocked section and the fish are frightened into the deeper water and caught in the net. The net is retrieved after several passes are made within the blocked area. In the other method, the net is set to encircle or wrap up a school of fish. Runaround nets are primarily used for striped mullet during the fall fishery.

The importance of runaround gill nets in North Carolina has steadily increased since 1972 and a continued surge in the mid 1990's may have been caused by the 1995 gill net closure in Florida state waters (DMF 2006b), as some of Florida's commercial fishermen moved their operations to North Carolina. More jet drive boats, spotting towers, night fishing, and runaround gill netting were reported by the mid 1990's (DMF 2006b). A shift from set nets to runaround fishing techniques may have been prompted by expanded fishery rules requiring gill net attendance for small mesh (< 5 inches stretch mesh), beginning in 1998.

Although spotted seatrout can be caught in a variety of mesh sizes, they are primarily harvested from small mesh runaround gill nets (< 5 inch mesh). Data collected from a fishery dependent sampling program was used to characterize this fishery (Table 8). Mesh sizes used varied by region, but overall ranged from 3 ½ inch to 4 inch stretched mesh, with 3 ¾ inch mesh most typically used. Of those catches sampled that targeted spotted seatrout (n=50), the number of yards fished ranged from 300 to 880 yards, and averaged 582 yards. Nets were set from less than 1 hour to 5 hours and set in 3 to 14 feet of water.

Table 8. Runaround gill net fishery parameters commonly associated with targeting spotted seatrout, 2001-2008 (DMF unpublished data).

		Gill Net Stretched Mesh Size (inches)				Net Length (yards)		
Region	N	Mode	Common Range	Min	Max	Mean	Min	Max
Albemarle Sound	1	–	3.76	3.76	3.76	800	800	800
Pamlico Sound	19	3.5 & 3.76	3.5-4.0	3.50	4.00	567	400	700
Pamlico/Neuse River	24	3.76	3.5-3.76	2.76	4.00	578	300	880
Core Sound-South	6	3.76	3.76	3.00	3.76	578	300	750
Combined	50	3.76	3.5-4.0	2.76	4.00	582	300	880

		Soak Time (hours)			Water Depth (feet)		
Region	N	Mean	Min	Max	Mean	Min	Max
Albemarle Sound	1	<1	<1	<1	-	-	-
Pamlico Sound	19	<1	<1	<1	5	4	6
Pamlico/Neuse River	24	2	6	<1	4	3	7
Core Sound-South	6	2	<1	5	5	3	14
Combined	50	2	5	<1	5	3	14

Runaround gill nets landed 3 to 33% and averaged 15% of North Carolina’s spotted seatrout commercial landings from 1994 to 2008.

Landings from estuarine runaround gill nets fluctuated from 1994 to 2005 but increased 137% from 2005 (42,943 lbs) to 2006 (101,571 lbs). Landings decreased in 2007 and 2008 but still remained above the average from 1994 to 2008. The number of trips increased steadily from 1994 (449 trips) to 1998 (893 trips) but was much lower than the number of trips made from 2006 to 2008 when the average number of trips per year was 1,062 (Figure 10). The decrease in trips from 1999 to 2004 was likely a reflection of the low numbers of spotted seatrout available during those years of consecutive cold stun events (2000, 2001, and 2003).

Monthly landings of spotted seatrout by estuarine runaround gill nets were highest in November and December (Figure 11). A large spike in the number of positive trips occurred during October without a corresponding spike in catch. This could be indicative of spotted seatrout bycatch in other fisheries that are active during October such as the striped mullet fishery.

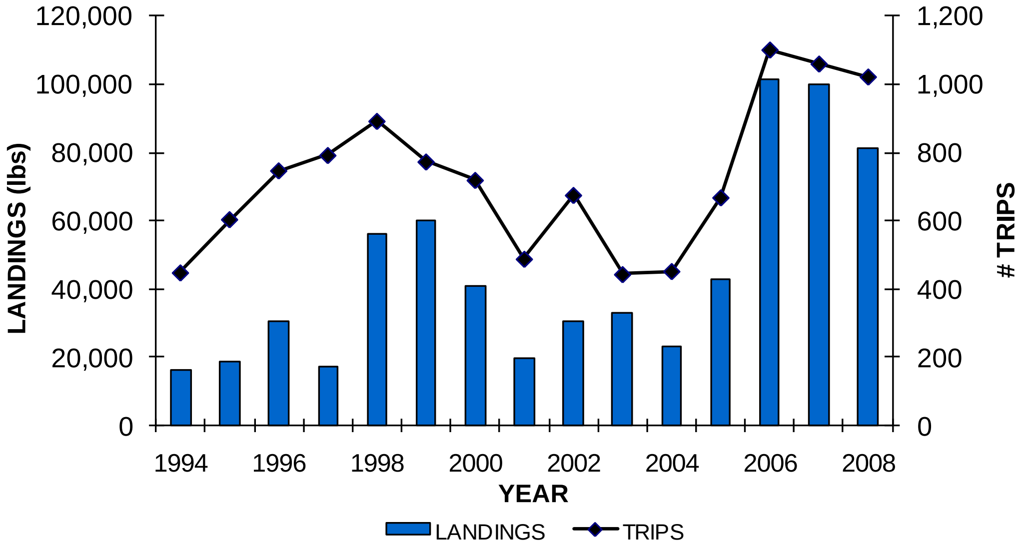


Figure 10. Landings (lbs) and total number of trips landing spotted seatrout from runaround gill nets in estuarine waters, 1994-2008.

* Estuarine waters included all North Carolina waters other than the ocean.

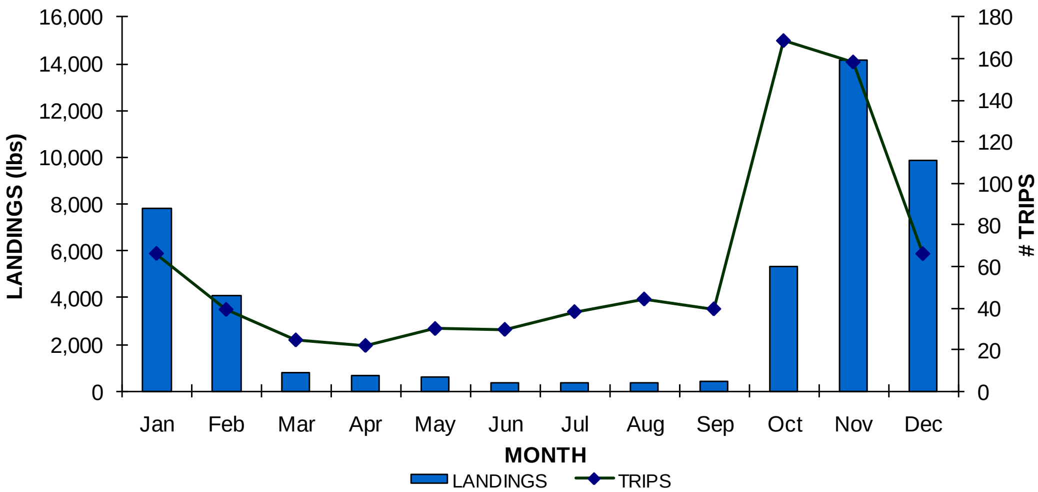


Figure 11. Landings (lbs) and number of trips landing spotted seatrout from runaround gill nets in estuarine waters, by month, 1994-2008 average.

*Estuarine waters included all North Carolina waters other than the ocean.

7.1.7.1.2 Long Haul Seines/Swipe nets

The North Carolina long haul seine fishery (including swipe nets) operates throughout much of the estuarine waters of North Carolina from Bogue Sound to northern Pamlico Sound and in some tributaries of Pamlico and Core sounds. The long haul seine (approximately 1,000 to 1,500 yards) is towed between two boats. After pulling a distance, the boats come together to circle the net. The net is enclosed (bunted) and the fish removed. The whole operation of setting, pulling, and bunting the net often takes a full day, with fishing usually starting before sunrise; rarely are two hauls made on one day. Guthrie et al. (1973) and Cunningham et al. (1992) described the long haul operation in detail. The swipe net fishery is similar to the long haul seine fishery except only one boat is used and a set stake takes the place of the second boat in the bunting of the net (DeVries and Ross 1983).

Landings of spotted seatrout by long haul seines were high in 1994, 1995, and 1999, but decreased 90% from a peak in 1999 (126,594 lbs) to a low in 2001 (11,455 lbs). Landings remained depressed from 2000 to 2005 but did show increases from 2006 to 2008 (Figure 12). Participation in the long haul fishery has been declining, with only thirteen traditional long haul and swipe net crews working from 2004 to 2006 (DMF 2007c), evident by the decrease in long haul seine trips from 1995 to 2005. The number of trips increased from 2005 to 2006, but the number of trips remained approximately 40% below the highest number of trips made in 1995 (685 trips).

The long haul season starts in the spring and continues through the fall (Figure 13).

More trips were made in July, with an average of 66 trips made. However, the best catches occurred in November and December when the average catch was 453 and 994 lbs/trip, respectively.

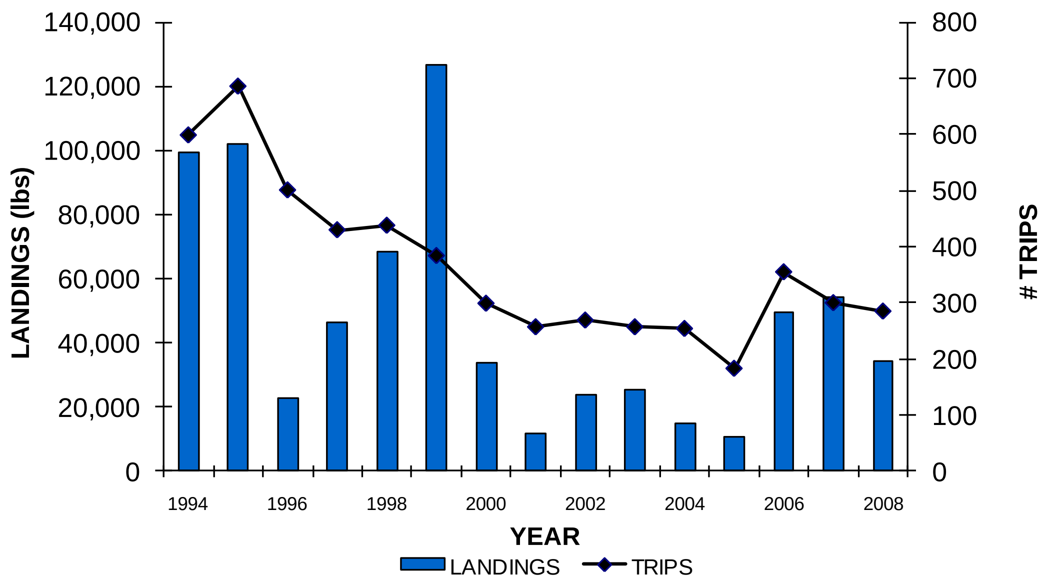


Figure 12. Landings (lbs) and total number of trips landing spotted seatrout from long hauls seines/swipe nets in estuarine waters, 1994-2008.

* Estuarine waters included all North Carolina waters other than the ocean.

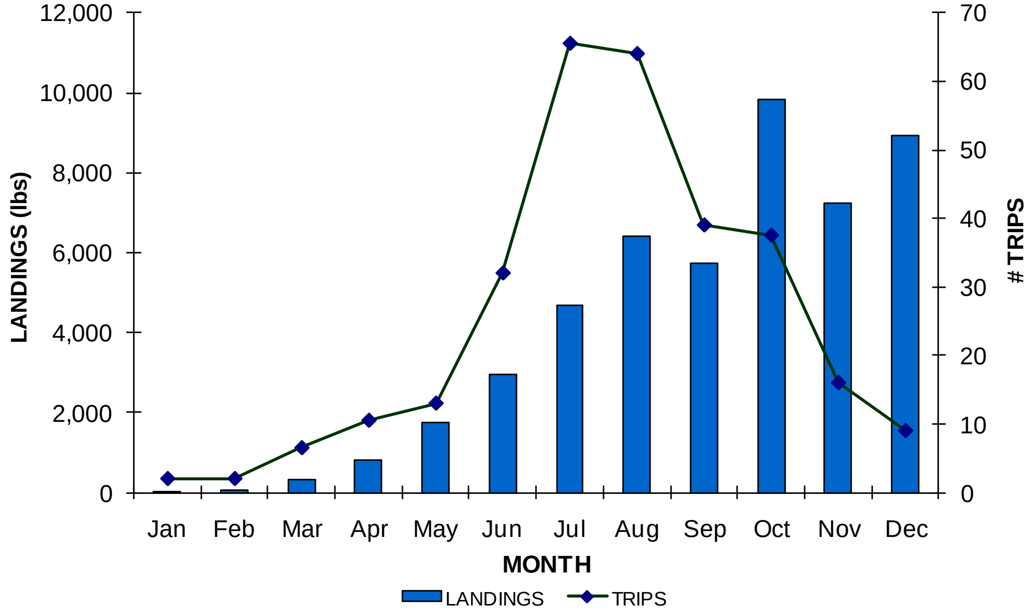


Figure 13. Landings (lbs) and number of trips landing spotted seatrout from long haul seines/swipe nets in estuarine waters, by month, 1994-2008 average.

*Estuarine waters included all North Carolina waters other than the ocean.

7.1.7.1.3 Beach Seines/Stop Nets

The beach seine fishery presently occurs along the northeastern coast of North Carolina, from the North Carolina/Virginia border to Cape Hatteras Inlet. The beach-based fishery involves setting and hauling a seine from the beach (Atlantic Ocean) to target nearshore migrating fish populations. Beach seines are set using dories launched from the beach, and retrieved back to the beach with 4-wheel drive trucks. This fishery is listed as a Category II fishery under the Marine Mammal Protection Act's (MMPA's) List of Fisheries (LOF).

A beach seine consists of a wash net, bunt and wing. The most common seine used is constructed of monofilament-nylon net (wash net, wings) and a multifilament –nylon bunt, but some beach seiners use nets constructed of monofilament-nylon throughout the seine.

Small mesh beach seines typically consist of 2 ⅞ to 3 ¼ inch stretched mesh and are fished in the spring (April-May) and fall (September-October). There is also a large mesh (7 to 9 inches stretched mesh) beach seine fishery that targets striped bass. Beginning in 2008, large mesh beach seines must be constructed of multifilament-nylon throughout. The striped bass beach seine fishery is limited to a seasonal quota, and opens by proclamation authority of the DMF Director, typically during the winter (December-February). The large mesh beach seine fishery rarely captures spotted seatrout and is not included herein.

The stop net fishery is a modification of the beach seine fishery, unique to Bogue Banks, that targets striped mullet. This fishery is restricted to October and November, and is listed as a Category II fishery under the MMPA's LOF.

A stationary “stop net” is added to the beach seine operation such that it is deployed perpendicular to the beach in an L-shaped configuration. Once the mullet are corralled, a beach seine is used to capture fish from within the stop net and hauled to shore using tractors (Francesconi 1994). There are four designated stop net locations between Beaufort and Bogue Inlets and are referred to as the Fort Macon, Atlantic, Salter Path and Emerald Isle sites.

A stop net is a 400 yard net with a continuous float and lead line connecting the inshore (suds and backstaff) and offshore (lead) sections (Steve et al. 2001). The first 100 yards of net is set perpendicular to the beach and is called the suds section. This net is constructed of 8 inch stretched mesh and sits approximately 10 feet deep. The second 100 yards is called the backstaff and is constructed of 8 inch stretched mesh and is 16 feet deep. The terminal end of the net is set parallel (75°-90° to the east compared to the south facing beach) to shore and is called the lead. The lead is 200 yards In length, has a stretched mesh size of 6 inch and is approximately 18-20 feet deep (Asher 2001). Each net is made of multifilament nylon.

After the stop net is set, a seine is used to capture fish that have entered the stop net corral. The seine is constructed of multifilament twisted polypropylene and monofilament nylon mesh, with 3 ¼ to 3 ¾ inch stretched mesh. When a school of mullet is observed, fishermen launch a wooden dory to set the beach seine (strike net) inside the stop net to corral the fish. The seine traces the net, returns to shore and is attached to an additional tractor. The tractors jointly haul in the catch.

A stop net is typically retrieved after five days, but soak times may vary between one to fifteen days (Asher 2001). The number of sets made range from zero to five per day, depending on the available catch, and average two to three sets per day (Francesconi 1994).

With the exception of peak landings in 1995 (149,012 lbs), landings of spotted seatrout by beach seines have been low and averaged 16,314 lbs from 1996 to 2008 (Figure 14). The number of trips generally declined from 1995 (613 trips) to a low in 2003 (76 trips), but was followed by an increase from 2003 to 2006. The severe drop in spotted seatrout landings by beach seines from 1995 to 1996, and the low landings and trips during 2001 to 2003, are likely indicative of the severe cold stun events that occurred in 1995, 2000, 2001 and 2003.

Beach seine landings of spotted seatrout typically occur during the spring (April-May) and fall (October-November) months (Figure 15). The average number of trips was highest in May (44 trips). If conditions are favorable, fishermen along the northern Outer Banks particularly target spotted seatrout during the full moon in May.

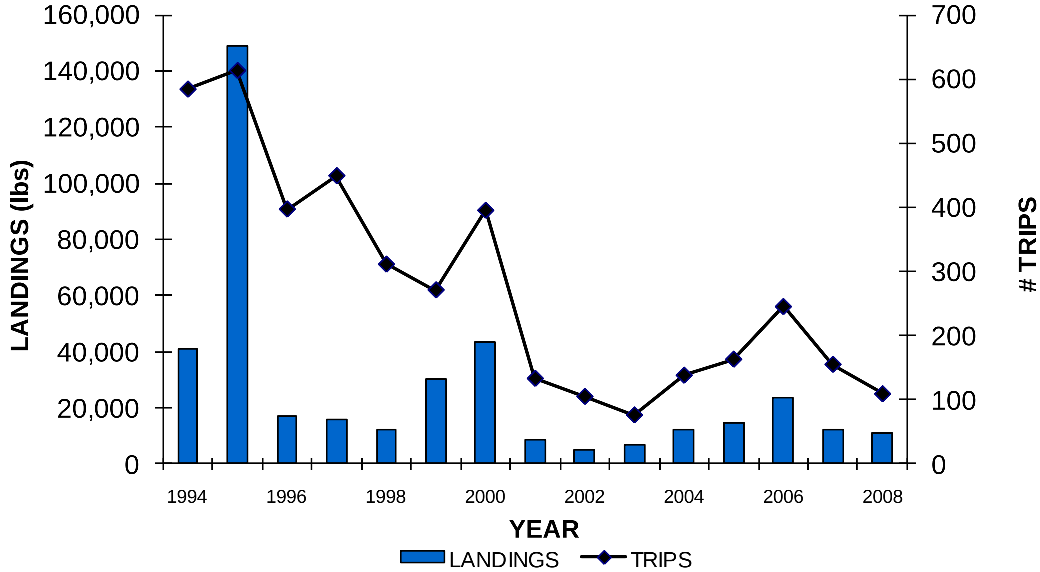


Figure 14. Landings (lbs) and total number of trips landing spotted seatrout from beach seines in ocean waters, 1994-2008.

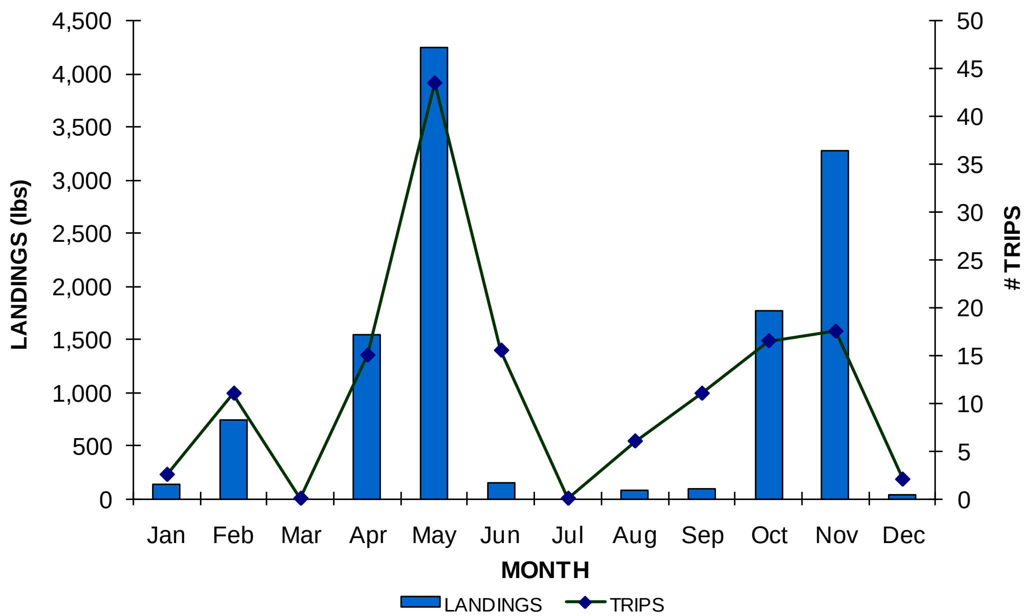


Figure 15. Landings (lbs) and number of trips landing spotted seatrout from beach seines in ocean waters, by month, 1994-2008 average.

7.1.7.1.4 Ocean Gill Nets

The nearshore and offshore coastal commercial gill net fishery of North Carolina is dominated by the set net fishery which comprises over 99% of the total trips and landings (Steve et al. 2001). Beach-based gill net fisheries which theoretically might fall under ocean gill nets are included in the beach seine summary (above).

Ocean Set Nets (sink nets)
According to DMF trip ticket statistics, over 99% of the nearshore gill net sets and 100% of the offshore gill net sets are comprised of sink nets. Therefore, floating gill nets are not discussed herein.

In North Carolina, the ocean sink net fishery began in Hatteras and dates back to the 1920's (Ross 1989). Since then, the fishery has changed from cotton twine gill nets into a monofilament gill net with mesh sizes ranging from small to large (2.5-14 inch stretched mesh). The nets are set using hydraulically powered net reels (Ross 1989). The sink gill net is a vertical wall of netting with a weighted leadline that allows the net to hang in the water column just above the ocean floor (NMFS 1996). The net is designed to capture mid-water or bottom-dwelling fish.

Ocean sink nets vary in length and the number of meshes deep the net sits in the water column. Ocean sink nets can consist of several net panels which are 300-1,500 ft long, and once tied together ranged in length from 600 to 9,000 ft (Ross 1989). Various mesh sizes are used to capture different species at different life cycle stages. Net selections were dictated by season, water depth, location and target species. Spotted seatrout are not a target species but may be encountered as a bycatch in fisheries that target bluefish, weakfish, Atlantic croaker, kingfish (sea mullet), Spanish mackerel, and spiny and smooth dogfish. Since 1991, the contribution of ocean sink nets to the total harvest of spotted seatrout in North Carolina decreased from a high of 15% in 1993 (67,596 lbs) to an average of only 3% from 1998 to 2008 (Table 6).

Landings of spotted seatrout by ocean sink nets have decreased from an average of 21,867 pounds from 1994 to 1997 to 5,590 pounds from 1998 to 2008 (Figure 16). The number of trips taking spotted seatrout decreased from 854 trips in 1995 to 148 trips in 2008. These decreases were likely a reflection of the decreased population of weakfish since trips that targeted weakfish were most likely to take spotted seatrout (Kahn et al. 2006).

Landings of spotted seatrout by ocean sink nets was highest from October through February, but good catches occurred in April and May (Figure 17).

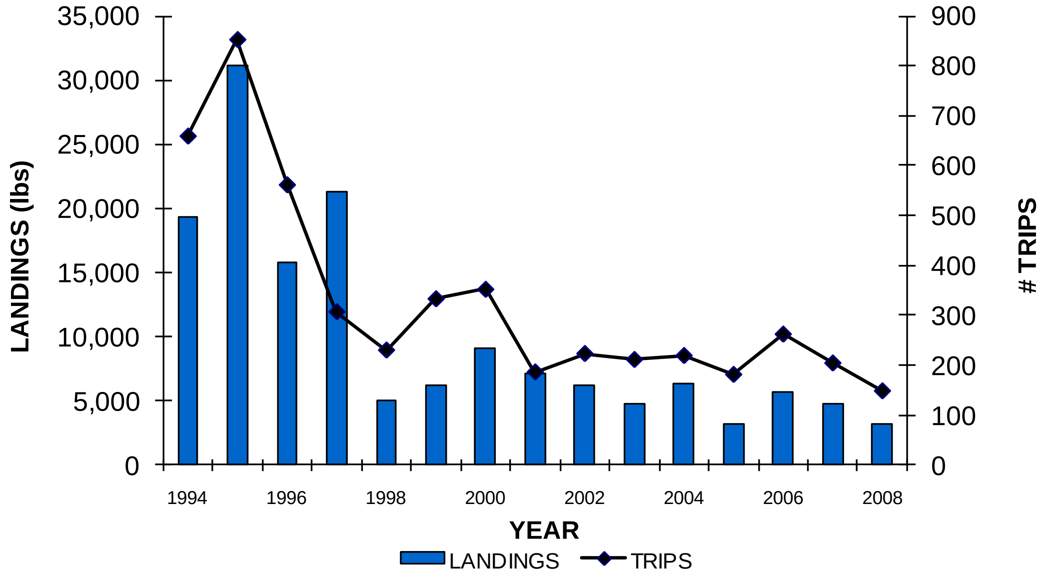


Figure 16. Landings (lbs) and total number of trips landing spotted seatrout from sink gill nets in

the Atlantic Ocean waters, 1994-2008.

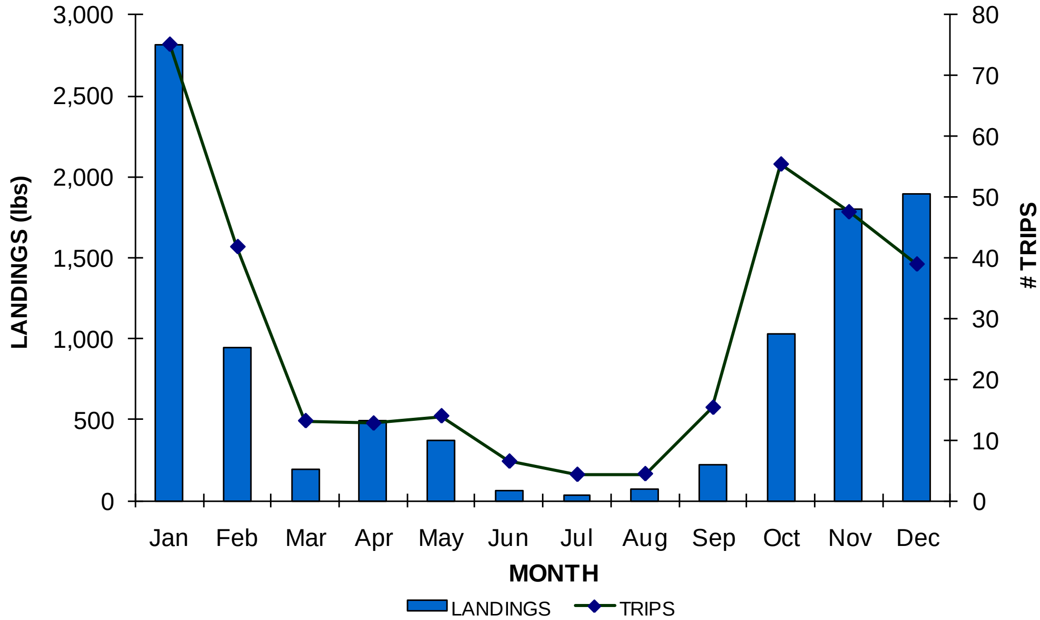


Figure 17. Landings (lbs) and number of trips landing spotted seatrout from sink gill nets in the Atlantic Ocean waters, by month, 1994-2008 average.

Ocean Runaround Gill Nets

Runaround gill nets, also referred to as strike nets, are used to encircle or "wrap up" a school of fish. In the ocean, runaround nets were primarily used to target striped mullet (*Mugil cephalus*) but take spotted seatrout incidentally (Figure 18) during the fall and winter months (Figure 19

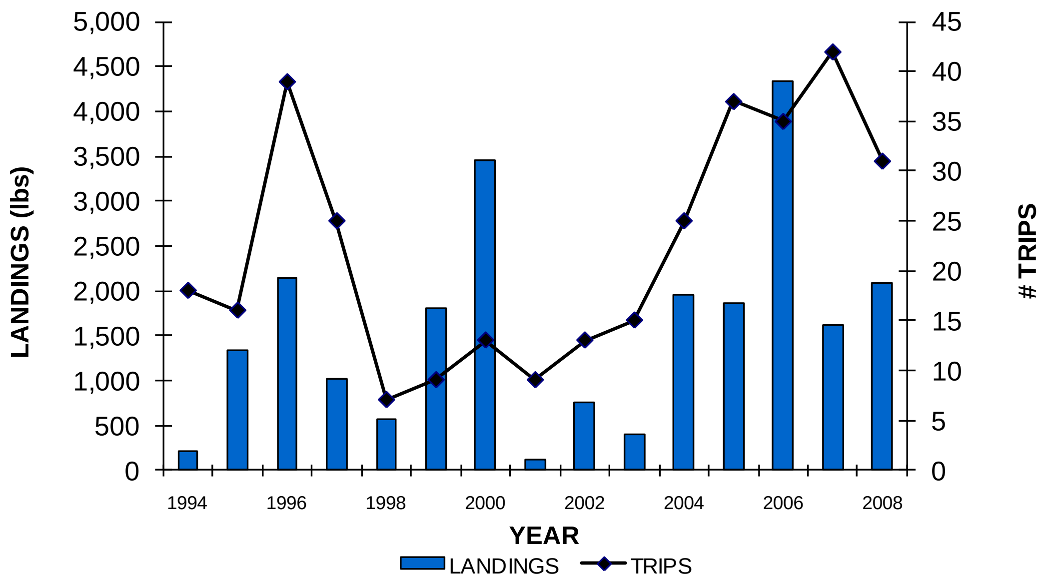


Figure 18. Landings (lbs) and total number of trips landing spotted seatrout from runaround gill nets in the Atlantic Ocean waters, 1994-2008.

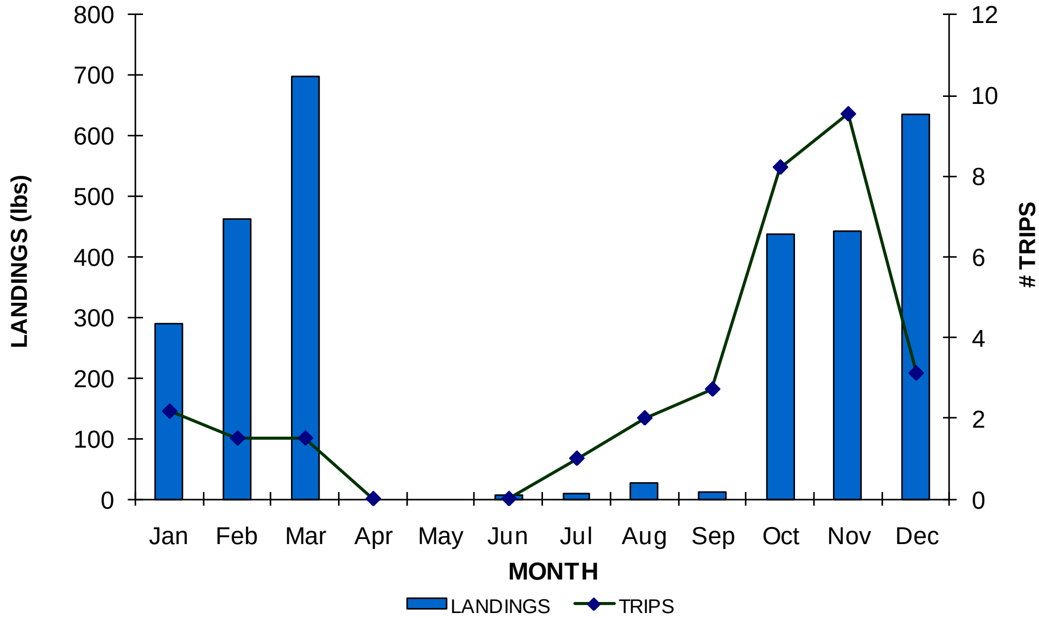


Figure 19. Landings (lbs) and number of trips landing spotted seatrout from runaround gill nets in the Atlantic Ocean waters, by month, 1994-2008 average.

7.1.7.2 Virginia Commercial Gear

Commercial landings of spotted seatrout in Virginia are predominantly by haul seines, accounting for an average of 75% of the landings from 1991 to 2006 (Figure 20; Table 9). Estuarine gill net and pound net landings were important in some years, contributing as much as 64% in 1992 and 32% in 2000. Other gear that accounted for a minor portion of landings included ocean gill nets, trawl, and handlines.

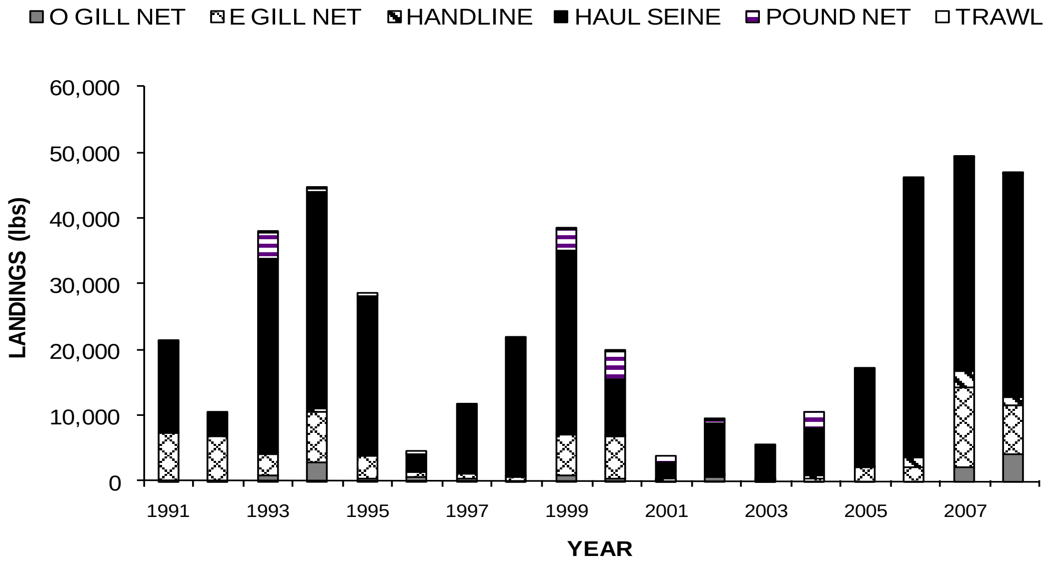


Figure 20. Commercial landings (lbs) of spotted seatrout in Virginia by predominant gear type, 1991-2008.

Table 9. Annual landings (lbs) of spotted seatrout by commercial fishing gear in Virginia, 1991-2008.

	Ocean Gill Net		Estuarine Gill Net		Handline		Haul Seine		Pound Net		Trawl		Total
Year	lbs	%	lbs	%	lbs	%	lbs	%	lbs	%	lbs	%	lbs
1991	209	1	7,224	34	0	0	13,557	64	199	1	11	0	21,200
1992	98	1	6,626	64	0	0	3,352	32	246	2	73	1	10,395
1993	887	2	3,319	9	230	1	29,304	77	4,040	11	206	1	37,986
1994	2,795	6	7,681	17	630	1	32,898	74	495	1	66	0	44,565
1995	249	1	3,537	12	212	1	24,087	84	113	0	553	2	28,751
1996	522	12	885	20	228	5	2,414	54	135	3	302	7	4,486
1997	273	2	822	7	289	2	10,245	87	86	1	0	0	11,715
1998	69	0	653	3	246	1	20,695	95	111	1	0	0	21,774
1999	895	2	6,098	16	268	1	27,841	72	3,307	9	35	0	38,444
2000	468	2	6,408	32	63	0	8,446	43	4,411	22	53	0	19,849
2001	13	0	151	4	197	5	2,420	64	992	26	0	0	3,773
2002	655	7	178	2	42	0	7,927	85	458	5	48	1	9,308
2003	9	0	187	4	23	0	5,038	95	74	1	0	0	5,331
2004	31	0	389	4	540	5	7,163	68	2,366	23	0	0	10,489
2005	84	0	1,927	11	126	1	14,967	86	0	0	203	1	17,307
2006	117	0	2,059	4	1,375	3	42,311	92	11	0	2	0	45,875
2007	2,189	4	12,064	24	2,425	5	32,455	66	1	0	247	1	49,381
2008	4,172	9	7,346	16	1,198	3	33,949	72	186	0	98	0	46,946
91-08	13,735	3	67,554	16	8,092	2	319,069	75	17,231	4	1,897	0	427,578

7.1.7.2.1 Haul Seines

At least two types of haul seines were used in Virginia: beach haul seines and open water haul seine. They are described separately here.

A beach haul seine is a small mesh net about 10 feet tall with a weighted lead line and a float line. To operate the rig, the net is loaded into a boat and one end is anchored to an object on the beach while the net is paid out of the boat which is generally propelled with a medium sized engine. The net is normally set out in a semicircle down the bank. Once the net is set out a rope which is tied to the end of the net is returned to the shore. This rope is used to haul the net back to the shore. Thus the fish are captured by encircling them with the net.

The second type is referred to as an open water haul seine. It is a combination of a pound net, a trawl net and a traditional haul seine. This type of net has been historically restricted to shallow water areas, typically less than 10 feet deep. The main net consists of a 3 inch mesh net made in 50 foot sections. The net starts out in a boat with one end anchored in shallow water. The boat then makes a large circular path ending at or near the anchor point. The boats used for this operation are generally 30 foot inboards. When the circle is closed, three or four fishermen get into the water and remove one of the panels and install a pocket on four poles. This pocket consists of a small mesh net that has three sides and a bottom much like the end of a pound net. Additionally a small mesh wing net is attached to one side of the pocket and inside the circular seine net. The diameter of the seine net is then reduced by removing panels until the diameter is approximately the size of the wing net. The wing net then is swept through the circular seine net and the fish are pressed into the pocket where they are bailed out in a manner similar to a pound net.

The majority of spotted seatrout landings in Virginia by haul seines come from open water haul seines operating in the Chesapeake Bay (Table 10). Landings occur year round, but primarily during the summer through fall, with peak landings in September and October (Table 11 and Table 12).

The use of this gear and its potential to damage SAV beds has been a controversial issue in Virginia. The Virginia General Assembly recently (2003) changed the definition of a haul seine. This rule change was necessary for the Virginia Marine Resources Commission to better prepare a haul seine fishery management plan that recognizes a more appropriate use of the gear which will minimize the impact of the net on the SAV beds.

7.1.7.2.2 Estuarine Gill Nets

Estuarine gill nets are the second most important gear used to harvest spotted seatrout in Virginia. From 2001 to 2006, estuarine gill nets accounted for <5% of the total commercial harvest, but increased to 24% and 16% in 2007 and 2008, respectively (Table 9). Landings in 2005 through 2008 increased from lows during 2001 to 2004. This suggests that Virginia may have experienced the same cold stun events as in North Carolina during 2000, 2001, and 2003 as well as the lack of a cold stun event since 2003.

Estuarine gill net landings from the Chesapeake Bay and its tributaries occurred year round. Landings peaked in the fall (September through October) and were also higher than average during then months of July and November (Table 13).

Table 10. Annual commercial landings (lbs) of spotted seatrout in Virginia, and percentage of landings by haul seines, and haul seine types, by waterbody, 1991-2008.

Year	Total Yearly Landings (lbs)	% Haul Seine Landings	% Beach Haul Seine Landings	% Chesapeake Haul Seine Landings
1991	21,200	64 %	0 %	64 %
1992	10,340	32 %	4 %	32 %
1993	37,998	77 %	4 %	76 %
1994	44,598	74 %	0 %	70 %
1995	28,722	84 %	0 %	83 %
1996	4,486	54 %	8 %	53 %
1997	11,736	87 %	1 %	84 %
1998	21,774	95 %	2 %	95 %
1999	46,467	72 %	0 %	59 %
2000	24,950	43 %	0 %	34 %
2001	20,421	64 %	0 %	12 %
2002	24,086	85 %	0 %	33 %
2003	5,417	95 %	0 %	93 %
2004	10,831	68 %	0 %	66 %
2005	17,378	86 %	3 %	83 %
2006	48,224	92 %	32 %	56 %
2007	49,381	66 %	8 %	58 %
2008	46,946	72 %	2 %	70 %
Total	474,955	75 %	5 %	49 %

Table 11. Monthly landings of spotted seatrout by haul seines, from the Chesapeake Bay only, 1991-2008.

	Month											
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1991			7		164	776	1,747	3,738	4,444	2,668		
1992					272	332	429	943	1,376			
1993		50		175		64	867	1,862	8,889	4,583	11,423	994
1994			12	15	5	107	900	1,854	21,552	4,361	1,601	804
1995	105			322	368	330	1,773	1,315	3,668	9,788	5,084	1,198
1996					89	111	243	494	843	410	206	
1997				217	211	173	176	749	6,650	1,635	49	16
1998				36	258	1,454	1,017	1,413	3,558	7,278	4,412	1,157
1999			2,240	2,335	308	309	692	1,736	3,565	4,758	10,558	881
2000	189		2,667	395	116	231	793	1,377	2,226	411	28	
2001				5	65	23		20	413	155	1,236	503
2002	19	72	13	4	44	115	76	25	901	938	5,669	51
2003			4		30	104	45	1,498	1,467	1,855	35	
2004			1		32	61	182	361	2,258	3,867	380	21
2005	38	8				46	176	892	7,787	5,491	20	
2006				112	423	881	1,360	504	4,985	15,656	1,507	1,447
2007	1,306			131	243	316	991	2,034	2,750	20,241	317	121
2008	285		45		208	373	651	809	5,781	24,147	673	115
Total	1,942	130	4,989	3,747	2,836	5,806	12,118	21,624	83,113	108,242	43,198	7,308

Table 12. Monthly landings of spotted seatrout in Virginia by haul seines, from the Atlantic Ocean beaches only, 1991-2008.

	Month										
Year	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1991								13			
1993			55	105				212	25		
1994			112				597	602	250	96	30
1995	40		25	38						30	3
1996								12	4	2	
1997		25	90	115				19	68	52	
1998								112			
1999								37	284	138	
2000							11			2	
2005									509		
2006				31				3,941	11,464		
2007	913				3			342	2,437	310	
2008					271	211	85	295			
Total	953	25	282	289	274	211	693	5,585	15,041	630	33

Table 13. Virginia gill net landings of spotted seatrout from the Chesapeake Bay and its tributaries, by month, 1991-2008.

	Month											
YEAR	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1991		663	1,529	1,238	265	67	231	91	209	2,550	372	
1992	63	1,607	72	595	51			11	1,216	29	2,982	
1993		70	478	193	273	62	72	44	357	979	732	43
1994				78	246	265	156	363	1,865	4,091	347	124
1995	2		207	510	267	288	253	84	481	210	639	585
1996			5	46	94	22	46	175	283	120	72	
1997		2	31	40	39	27	8	29	41	122	76	407
1998		28	87	46	96	10	9	65	30	40	26	214
1999	10	164	675	51	40	41	54	60	495	4,424	82	37
2000	6	26	40	22	113	20	17		5,628	262	264	
2001		6		66		2			4	62	11	
2002	21	8	33	5	29	21			12	36	8	5
2003				28	10	9	20	17	30	48	2	23
2004	6		15	3	46	11	25		112	147	23	1
2005	28	11	78	52	10			16	60	502	99	1,071
2006	16		20	34	17	40	23	81	121	824	828	55
2007	69	103	170	135	289	56	7,481	141	180	3,007	425	8
2008	32	74	117	136	265	148	241	1,677	3,850	517	207	82
Total	253	2,762	3,557	3,278	2,150	1,089	8,636	2,854	14,974	17,970	7,195	2,655

Table 14. Ocean gill net landings of spotted seatrout from coastal Virginia, by month.

	Month											
YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1991		70		63	64		1	4	7			
1992				78							20	
1993			549	232	20				10	73	3	
1994			139	29				3	463	2325		4
1995				100	9	27	9	39	24	5	7	
1996				72	113	1	13	2			4	160
1997		62	97	1	1	6			11	41	18	36
1998	8	60										1
1999	97	116	411	15	154		15	5			11	71
2000	40	151	212	11	2			2	2	4	15	29
2001			4						8		1	
2002	28	479	121							1	3	23
2003	3											6
2004						2	29					
2005				5	1		4	50	18			
2006	3			12	9	36	25	8		7	1	16
2007	148	116	28	11	151	31	20	1	10	1,349	145	179
2008	89	9		1		90	93	1	52	2,654	1,132	51
Total	416	1,063	1,561	630	524	193	209	115	605	6,459	1,360	576

7.1.7.2.3 Ocean Gill Nets

The ocean gill net fishery was a minor component of the Virginia commercial fishery. Less than 1% of the spotted seatrout harvest comes from this gear in most years. Landings occur throughout the year, with peaks in March and October (Table 14).

7.1.8 Size and Age Structure of the Commercial Harvest

7.1.8.1 Size and Age Structure of North Carolina's Commercial Harvest

Spotted seatrout caught commercially in North Carolina ranged from 8 inches to 30 inches TL, with a mode at 17 inches. The 12 inch size limit has been in place in North Carolina since 1991, but undersized fish are incidentally caught in the commercial fishery. The length frequency distributions of spotted seatrout sampled from various commercial fisheries are illustrated in Figure 21.

Age composition of the total commercial catch of spotted seatrout in North Carolina ranged from age 0 to age 9, and was primarily age 1 fish (Figure 22). Very few fish greater than age 3 were observed.

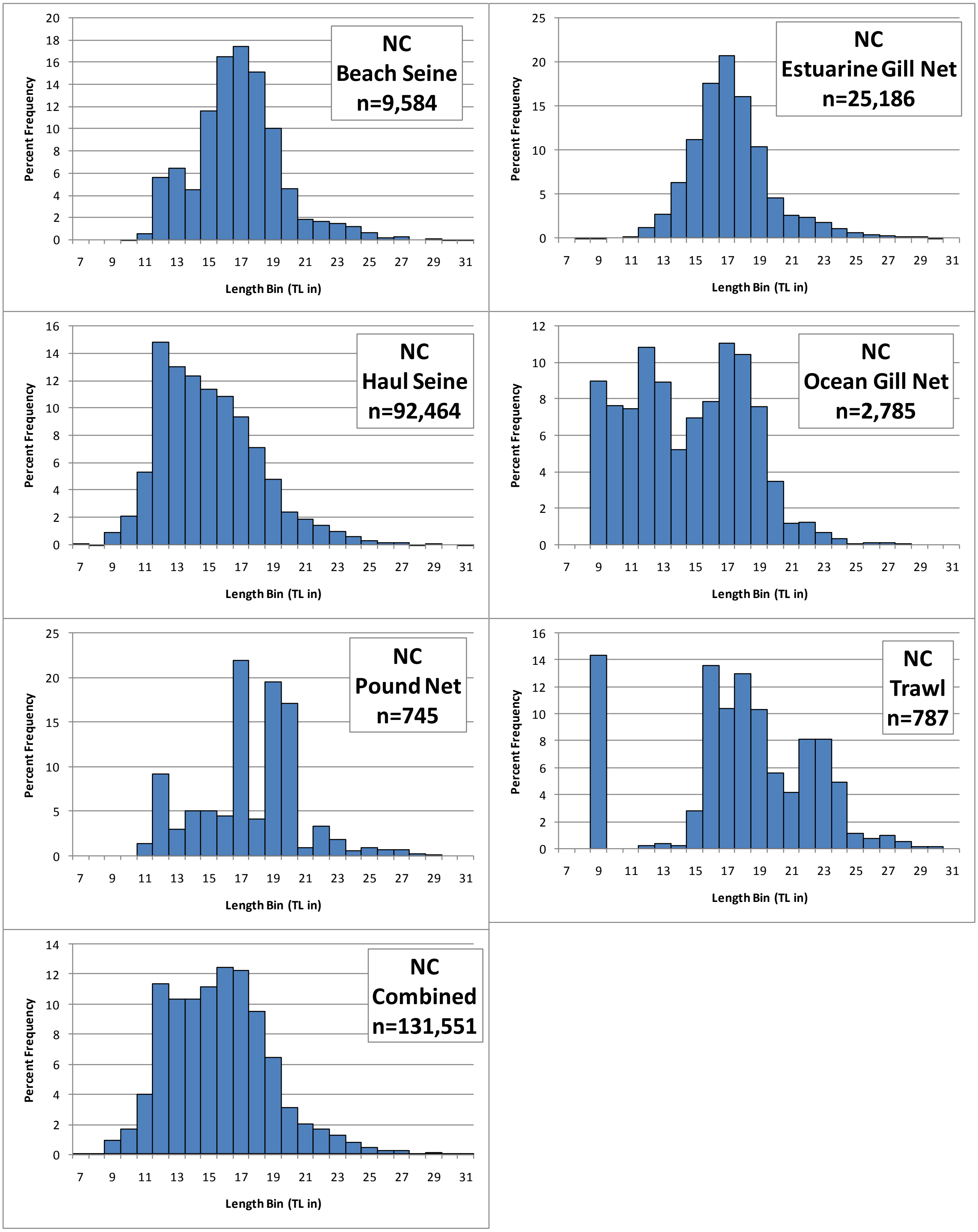


Figure 21. Length-frequency distributions of North Carolina commercial fisheries, 1994-2008.

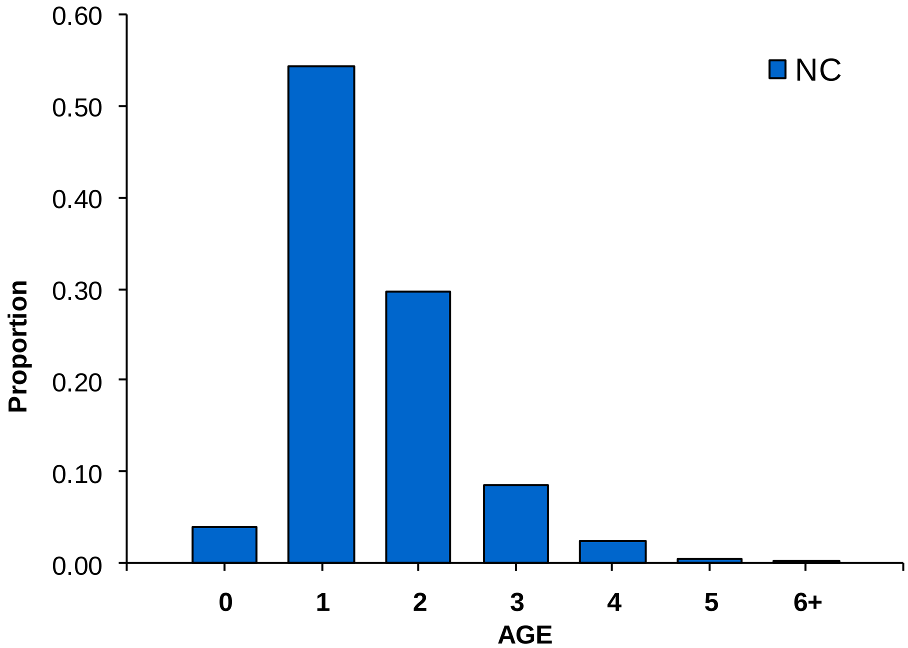


Figure 22. Age composition of spotted seatrout from the North Carolina commercial harvest, 1991-2008.

7.1.8.2 Size and Age Structure of Virginia's Commercial Harvest

Spotted seatrout caught commercially in Virginia ranged from 7 inches to 31 inches TL, with a mode at 17 inches. Virginia's 14 inch size limit has been in place since 1995, but undersized fish are incidentally caught in the commercial fishery. The length frequency distributions of spotted seatrout sampled from various commercial fisheries are illustrated in Figure 23.

The age composition of the total commercial catch of spotted seatrout in Virginia ranged from age 0 to age 9, and was primarily age 1 fish (Figure 24). Very few fish were greater than age 3.

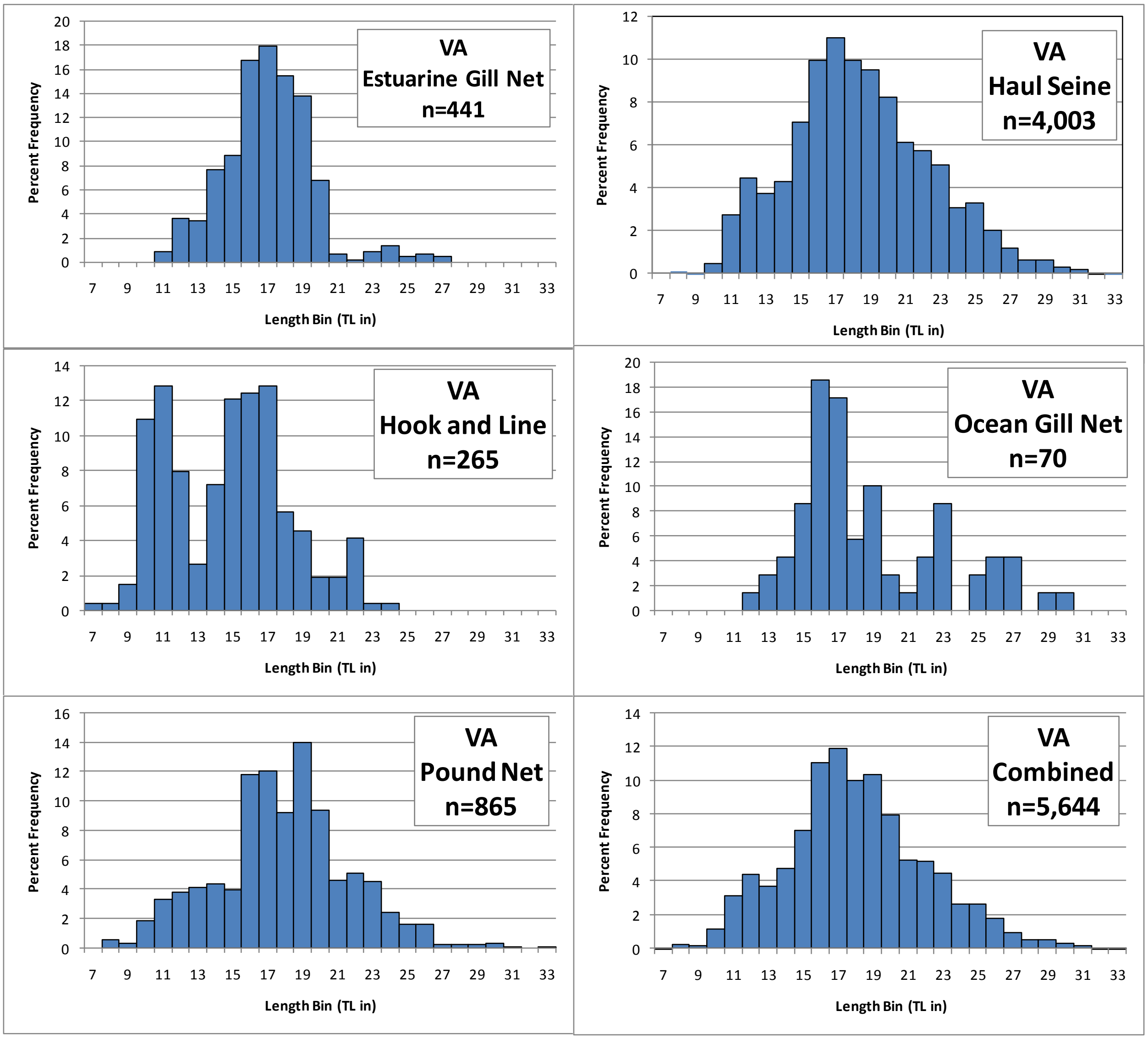


Figure 23. Length-frequency distributions of Virginia commercial fisheries, 1998-2008.

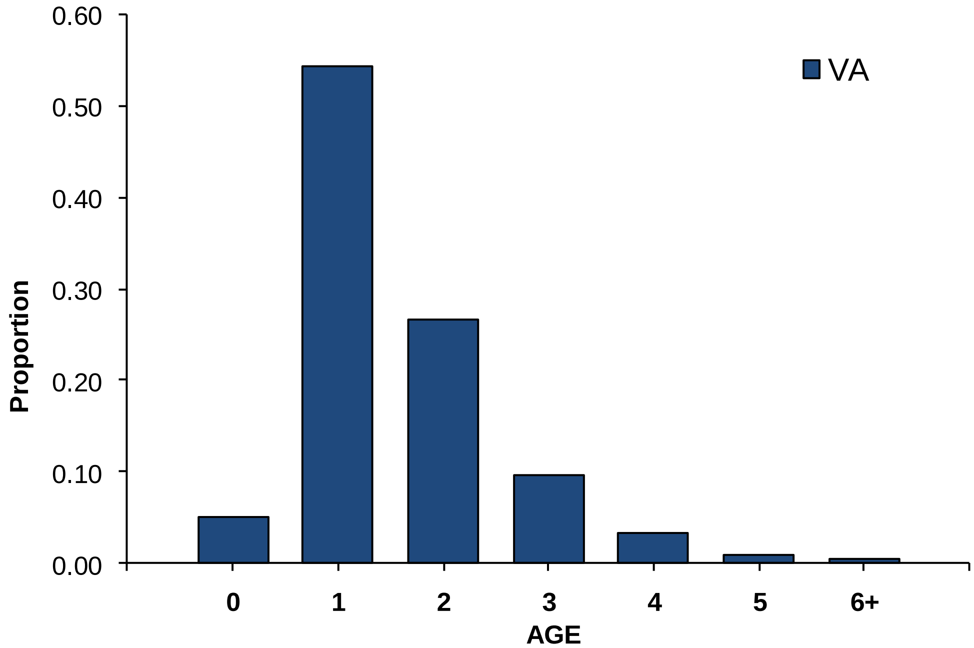


Figure 24. Age composition of spotted seatrout from the Virginia commercial harvest, 1998-2008.

7.2. Bycatch Associated with the Commercial Catch

7.2.1 Introduction

Bycatch is an important issue facing fishery managers throughout the world (Gray 2002). The Guidelines for the North Carolina Fishery Management Plans (FMP), as adopted by the MFC, set a standard for the FMP's to design management measures which minimize waste of fishery resources, including both target and non-target species. 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 (ASMFC 1994). Bycatch can be divided into two components: incidental catch and discarded catch. Incidental catch refers to retained or marketable catch of non-targeted species, while discarded catch is the portion of the catch returned to the sea as a result of regulatory, economic, or personal considerations.

Spotted seatrout are typically not a target species, but rather an incidental bycatch of multi-species fisheries such as the gill net, long haul seine, beach seine/stop net, or fish trawl fisheries. Rarely were undersized spotted seatrout observed in the sampling of commercial fisheries (DMF, unpublished data), as spotted seatrout are likely to pass through mesh sizes that dominate the commercial fishery. Undersized fish were also rarely seen by at sea observers aboard commercial gill net boats (B. Price, DMF, unpublished data) or in other gears that were not usually intended to harvest seatrout (i.e., shrimp or crab trawls) (S. McKenna, DMF, personal communication). Undersized spotted seatrout were also rarely seen in fishery-independent gill net sampling programs which used mesh sizes typical for the commercial fishery (DMF, unpublished data). It is likely that non-harvest losses occur to some extent from gill nets, haul seines/swipe nets, beach haul seines, stop nets, trawls, and crab pots, but the data available suggest the bycatch of spotted seatrout is minimal, and the spotted seatrout stock assessment assumed estimates of bycatch in the commercial fishery to be negligible.

The following discussion will describe the major commercial fisheries that land spotted seatrout, and the associated available bycatch data.

7.2.2 Description of Fisheries Landings and Available Data

7.2.2.1 Estuarine gill net fishery (refer to the Commercial Fishery section 7.1 for a complete description of this fishery)

The estuarine (inshore) gill net fishery is a multi-species fishery which varies by region depending on the species targeted and the type of gill net used. This fishery operates year round with peaks of activity in the spring, late summer and fall (Wilson 1997; DMF 2007b).

Information specific to North Carolina's estuarine gill net fishery can be drawn from four DMF sampling programs: the NC Trip Ticket Program (NCTTP), a Commercial Fish House Sampling Program (Fishery dependent estuarine gill net sampling), a Commercial Observer Program, and a Fishery Independent Gill Net Sampling Program.

Information gathered from these programs was used to characterize North Carolina's estuarine gill net fishery. North Carolina has a large number of commercially valuable species that are targeted by gill nets throughout the year with no single size gill net (i.e., mesh size) being ideal for all species. Gill net fishermen use specific mesh size nets depending on the species they intend to target. While multiple species are most often landed for a single trip, a target (key) species most often represents the majority of the catch.

NC Trip Ticket Program (NCTTP)
In order to characterize a specific estuarine gill net fishery, the species being targeted must first be identified. This information is not readily available and must first be inferred from the catch composition. Data collected from 2001 to 2008 was analyzed to determine the target species for each individual trip made. Because of the low bycatch associated with the drift and run-around gill nets, only anchored gill nets were included in this analysis. Using trip ticket data, the species of highest abundance in landings was considered the target species and was used to define the trip. After initial analysis, 95% of all gill net trips fell into one of sixteen key species. These sixteen species were then each identified as a separate fishery. For those remaining undefined trips, a hierarchy was used where the species of second and then third highest abundance was used to define the trip if it was represented by one of these sixteen species. Of the remaining trips (1%), the non-key species of highest abundance in the catch was used to define the trip. Overall, flounder was the primary species targeted by gill netters in estuarine waters of North Carolina (Table 15). Overall landings across all trips for each of the key species were summarized in Table 16.

Commercial Fish House Sampling Program (Fishery dependent estuarine gill net sampling)
Sampling of the estuarine gill net fishery was initiated by DMF in April 1991 to determine age, size, and composition of species taken in the gill net fishery. Trip information is gathered on water body fished, soak time (minutes), specific net type (i.e. float, sink), total length of nets (feet), mesh size (bar mesh, inches), net depth (float nets, recorded in feet), vertical fishing depth (sink nets, recorded in feet), twine size, average water depth (meters) and incidental species. Information from this program was used to estimate average yardage by mesh size of small mesh nets fished by area.

Commercial Observer Program

Starting in October of 2000, the Pamlico Sound flounder gill net fishery has been restricted, operating under an Incidental Take Permit (ITP) issued by NMFS to reduce interactions with endangered and threatened sea turtles. The restrictions on this fishery are effective from September 15 through December 31. Stipulations of the permit include permitted entry, restricted areas, limited yardage of gill net and mandatory scientific observer coverage. This ITP began the availability of observer data for the estuarine gill net fishery in North Carolina. From 2001 to 2003, coverage was limited to the fall Pamlico Sound flounder gill net fishery. From 2004 to 2006, coverage was expanded by DMF to include other regions and estuarine gill net fisheries. Participation in this expanded coverage by commercial gill netters was voluntary. Information gathered during observer trips includes data on effort and mesh sizes used, as well as data on the size and ultimate fate of captured species.

Fishery Independent Gill Net Sampling Program

DMF began an independent gill net survey (IGNS) in Pamlico Sound in 2001. The program was expanded to include the Pamlico, Pungo, and Neuse rivers in 2003. One objective of the study was to provide a relative index of abundance for key species, including spotted seatrout.

The IGNS utilizes a stratified random sampling design where locations are selected based on strata and depth. Sampling is divided into four regions: eastern Pamlico Sound (Dare County), western Pamlico Sound (Hyde County), Neuse River, and Pamlico/Pungo River. Each of these sampling regions is further divided into four evenly sized strata (Figure 25). A one square nautical mile grid system is laid over each stratum. Each stratum is sampled twice monthly. A sample consisted of two shots of gill net, and shots are made up of an array of panels, with each panel being 30 yards in length. Panels vary by ½ inch intervals in mesh size ranging from 3 to 6 ½ inches stretch mesh. For each sample, one shot was placed in deep ($\geq$6 ft) and one shot was placed in shallow (< 6 ft) water. Gill nets were set at dusk and fished the following morning with a target soak time of 12 hours. Nets set close to shore are either set perpendicular or parallel based on conditions and common fishing practice in the area.

Fishery Independent Gill Net Selectivity Study

DMF initiated a study to quantify catch rates and mortality of red drum, spotted seatrout, southern flounder, and striped bass during months in which small mesh gill net attendance is not required (October-December). A total of 288 small mesh gill net samples were collected in creeks off the Neuse and Bay rivers during the months of October-December 2005 and 2006. This study utilized three separate gangs of nets with each gang consisting of three nets (3 ½, 4, 4 ½" stretched mesh, each 30 yards long by 8 feet deep). Each individual 30 yard set composed a sample. Nets were set perpendicular and as close to shore as possible, left unattended and then fished each following day with a target soak time of 24 hours in a manner that closely mirrored commercial fishing practices.

Recreational Commercial Gear License (RCGL)

Commercial fishing gears such as gill nets, crab pots and shrimp trawls have been used for recreational purposes in the coastal waters of North Carolina for many years. To participate in these activities the user must possess a RCGL that entitles the individual to use limited amounts of commercial gear to catch fish for personal consumption but does not allow for the sale of the catch.

The DMF License and Statistics Section initiated a survey project in March 2002 to collect catch and effort data from RCGL holders. Questionnaires are mailed to 30% of all RCGL holders each month requesting that they indicate waterbodies commonly fished, types and amounts of gear used, number and weight of individual species kept, and number of individual species

Table 15. Number of anchored estuarine gill net trips with the species of highest abundance landed (target species) being used to define a trip, 2001-2008.

Species	2001	2002	2003	2004	2005	2006	2007	2008	Combined	(%)	cum%
Flounder	19,267	17,784	16,242	16,249	14,430	16,896	16,835	18,997	136,700	45	45
Striped mullet	5,404	5,109	4,194	3,566	3,578	3,384	3,847	3,363	32,445	11	56
Striped bass	5,218	5,054	4,930	4,404	4,375	3,363	2,565	637	30,546	10	66
Red drum	2,364	361	532	322	610	891	1,932	2,063	9,075	3	69
Spot	2,120	2,861	2,865	2,945	2,987	1,761	1,222	1,538	18,299	6	75
Bluefish	1,886	1,000	1,486	914	1,269	1,079	2,210	2,057	11,901	4	79
Menhaden	1,575	1,524	1,652	1,201	1,255	1,750	1,235	930	11,122	4	83
American Shad	1,321	1,749	1,865	1,557	1,450	1,326	1,721	952	11,941	4	87
Catfish	1,075	936	847	748	786	1,117	808	717	7,034	2	89
White Perch	899	1,155	1,842	980	890	876	689	1,559	8,890	3	92
Hickory Shad	800	219	199	622	554	305	193	668	3,560	1	93
Spanish mackerel	692	678	281	310	555	397	237	323	3,473	1	94
Spotted seatrout	500	968	732	567	568	1,310	1,963	1,794	8,402	3	97
Atlantic croaker	459	176	221	134	125	128	143	119	1,505	0	98
Weakfish	447	321	223	403	323	274	91	117	2,199	1	98
River Herring	352	510	386	319	414	291	9	8	2,289	1	99
Others (37 species)	473	340	280	239	177	328	405	650	2,892	1	100
Combined	44,852	40,745	38,777	35,480	34,346	35,476	36,105	36,492	302,273	100	100

Table 16. Annual landings (lbs) of major species in North Carolina's anchored estuarine gill net fishery, 2001-2008.

Species	2001	2002	2003	2004	2005	2006	2007	2008	Combined
Flounder	1,905,276	1,807,364	1,469,218	1,587,289	1,283,917	1,539,571	1,453,372	1,767,928	12,813,935
Menhaden	1,134,509	791,479	980,822	561,149	865,364	602,312	356,124	270,989	5,562,747
Striped Mullet	778,261	891,357	709,182	512,018	449,902	377,320	422,494	369,335	4,509,867
Spot	536,123	675,204	652,932	685,989	728,334	325,280	171,970	216,213	3,992,044
Croaker	136,232	125,741	88,027	81,586	65,197	56,852	25,233	62,559	641,426
Bluefish	445,555	256,451	488,170	267,349	368,342	231,817	430,410	295,130	2,783,222
Striped Bass	226,372	226,705	339,056	295,142	235,708	184,266	175,205	69,879	1,752,333
American Shad	119,925	238,923	356,303	241,001	179,411	161,248	285,072	105,665	1,687,548
White Perch	175,525	219,077	404,865	176,027	138,723	106,859	117,129	316,318	1,654,524
Catfish	155,373	157,399	170,153	125,599	118,345	134,700	152,025	191,804	1,205,398
Spanish Mackerel	183,834	199,166	74,470	88,935	178,607	97,682	55,953	75,520	954,167
Hickory Shad	161,234	44,195	63,388	173,402	169,442	48,983	33,732	62,873	757,248
Red Drum	129,509	66,335	78,806	44,962	103,648	145,831	211,504	208,075	988,669
Weakfish	106,464	95,321	69,863	89,238	101,176	74,261	25,238	37,747	599,309
Spotted Seatrout	55,038	101,934	96,929	67,850	50,756	114,348	181,866	153,951	822,671
River Herring	86,164	71,636	82,119	75,920	74,727	37,429	574	278	428,846
Sea Mullet	45,656	40,184	38,423	28,907	25,695	53,408	55,671	137,812	425,756

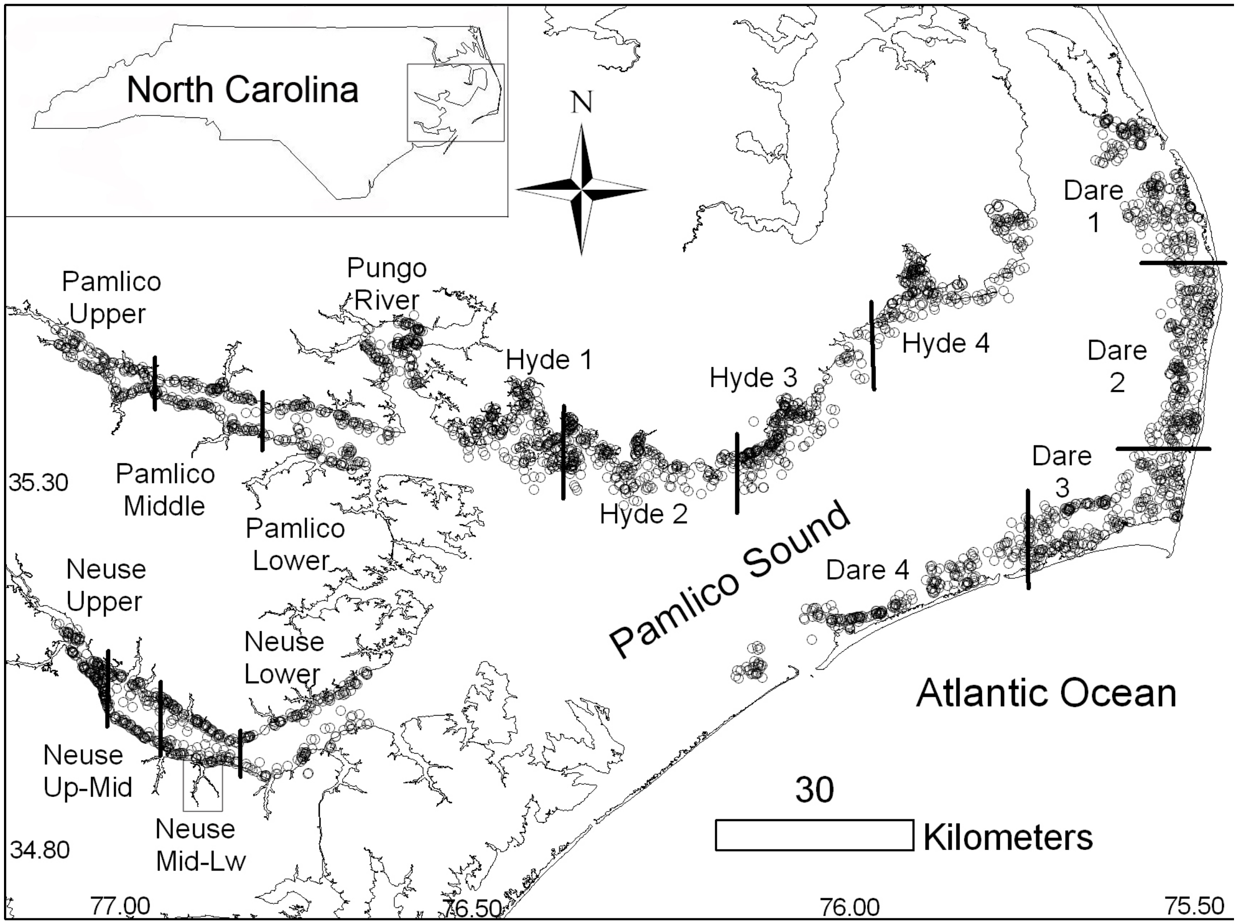


Figure 25. Independent gill net sampling program (Program 915) survey area, 2003-2008.

discarded at sea.

The RCGL survey design and extrapolation methods are described in North Carolina Recreational Use of Commercial Gear, Pilot Study (DMF 2004 b). The study was terminated in 2009 due to state budget cuts.

7.2.2.2 Long haul seine/swipe net fishery (refer to the Commercial Fishery section 7.1 for a complete description of this fishery)

The North Carolina long haul/swipe seine fishery is active throughout much of the estuarine waters of North Carolina from March to April until early November. Atlantic croaker, spot, weakfish, and occasionally bluefish and spotted seatrout dominated the marketable portion of the catches each year (DMF 2007b). The unmarketable quantity of edible finfish in the scrapfish component of long haul catches continues to be a management issue.

Data were obtained from the NCTTP, fishery dependent long haul seine/swipe net sampling program, and gear research.

Commercial Fish House Sampling Program (Fishery dependent long haul seine sampling)
Sampling of the long haul seine/swipe net fishery was initiated by DMF in 1978 to describe the areas, seasons and methods of the fishery as well as age, size, and composition of species taken in the long haul seine fishery. Trip information is gathered on water body fished, total length of nets (feet), mesh size of wings and back net (bar mesh, inches), and incidental species.

Information from this program was used to estimate annual discard estimates to identify and characterize bycatch of spotted seatrout in the traditional long haul/swipe net fishery.
Trip ticket analysis includes 1994-2008. Fish house sampling includes data from 1999 to 2008 to characterize the fishery under its current regulations (panel rule). Discard estimates include data from 1994 to 2008.

The primary objective was to quantity (by weight) spotted seatrout discards in the bait component landed by the long haul fishery and this was done through a simple ratio method. These estimates were determined by multiplying marketable landings from the NCTTP (by season and area -north and south of Bluff Shoals) times the sampled weight ratio of bait spotted seatrout in the fish house samples to marketable spotted seatrout from the fish house samples.

Formula for estimating statewide discards of spotted seatrout:

$$\text{Estimated Discards} = \frac{\text{lbs of seatrout in sampled bait}}{\text{lbs of marketed seatrout in samples}} \times \text{trip ticket landing of seatrout}$$

The estimated bait quantity is for landed bait and does not account for discards at sea. This ratio method of estimating bait assumes marketable fish by species are accurately collected by the NCTTP.

Bycatch reduction gear testing
In 1992 testing of various devices to reduce bycatch in the fishery began. One project was to evaluate an onboard culling device in the long haul seine fishery for its effectiveness in allowing undersized fish to escape alive. Another was to evaluate escapement panels in the long haul seine fisheries for their effectiveness in allowing undersized fish to escape.

7.2.2.3 Beach haul seine (refer to the commercial fishery section for a complete description of this fishery).

This beach-based fishery involves setting and hauling a seine from the beach (Atlantic Ocean) to target nearshore migrating fish populations. Beach seines are constructed of large (7-9 inch stretched mesh) or small mesh (2 ⅞ to 3 ¼ inch stretched mesh), but the large mesh beach seine fishery targets striped bass during the winter months and rarely captures spotted seatrout. The small mesh beach seine fishery operates predominantly during the spring (April-May) and fall (September-October), and can be used to target spotted seatrout.

Commercial Fish House Sampling Program (Fishery dependent beach haul seine/stop net sampling)
Beach seine sampling was initiated in the Northern District (Currituck and Dare County; 1982), and expanded to the Carteret County (beach haul seines and “stop nets”) in 1999, to delineate areas fished and describe the target species and seasonality of fishing effort, describe the species composition, size and age distribution, and relative abundance of species captured by this gear, seasonally. Trip information is gathered on water body fished, total length of nets (feet), mesh size of wings and bunt net (bar mesh, inches), and incidental species. Information from this program was used to estimate annual discard estimates to identify and characterize bycatch of spotted seatrout in the beach seine/stop net fishery.

7.2.2.4 Stop net fishery (refer to the Commercial Fishery section 7.1 for a complete description of this fishery)

The stop net fishery is a modification of the beach seine fishery, it is unique to Bogue Banks, and used to target striped mullet.

There have been long-standing conflicts between commercial stop net fishermen and recreational fishermen along Bogue Banks because of the conception that the stop nets interfere with the migration of fish along the Banks, decreasing recreational catch rates. A DMF study examined the effect of stop nets on catch rates of pier fishermen (Francesconi 1994). Although the study failed to find any effect, the conflict continued. To help alleviate this conflict, stop net fishermen agreed to “increase mesh size from four to eight inch stretch mesh to ensure that more fish swim through the nets” (Padgett 1995). The DMF continues to regulate this fishery by proclamation authority of the Director such that the inshore 100 yard section and the offshore 50 yard section are required to be constructed of 8-inch stretch mesh and the remainder of the net must be at least 6-inch (1993-present).

7.2.2.5 Trawl fishery

The North Carolina trawl fishery is a multispecies, multigear fishery that operates year round in internal and ocean waters. A shrimp trawl fishery typically operates from May through November, depending on availability of shrimp, with the majority of effort in internal waters; a finfish trawl fishery operates from October through May, exclusively in ocean waters; and a crab trawl fishery takes place primarily in March through June in inland waters. It is unlawful to use trawl nets for the taking of finfish in internal waters, unless incidental to crab or shrimp trawling.

7.2.2.5.1 Shrimp trawl fishery

North Carolina's shrimp fishery is unusual in the Southeast United States because three species are taken here and the majority of the effort is expended in internal waters. Bycatch of unwanted species in the shrimp fishery is a controversial topic and has been the subject of much debate. Specific details (areas fished, landings, regulations, etc.) of this fishery can be found in the 2006 NC Shrimp FMP (DMF 2006a).

The gear and effort used to catch shrimp depends on the target species and area fished. The vast majority of the shrimp harvest (93%) is taken by otter trawls. Conventional two-seam otter trawls are used for pink and brown shrimp, and a four-seam otter trawl is used for white shrimp. Skimmer trawls have gained popularity in recent years, and account for 2% of the average annual state landings (DMF 2006a). Skimmer trawls are modified wing nets sewn to an aluminum or steel pipe frame. The skimmer trawl tail bag can be hauled in more frequently hence increasing the efficiency of the harvest, and allowing the bycatch to be released more frequently, thus reducing bycatch mortality.

7.2.2.5.2 Fish trawl fishery

North Carolina's winter trawl fishery is a multispecies, multigear fishery that operates in the ocean waters from October through May. Fishing effort shifts to one of several target species depending on seasonal and geographical distribution, catchability, fishery regulations, and marketability.

A nearshore flynet fishery is comprised of North Carolina trawlers that fish for weakfish, Atlantic croaker, bluefish, butterfish, striped bass, and kingfishes. Flynet fishing generally takes place from Oregon Inlet to Cape Hatteras from October through April.

A nearshore flounder fishery targets summer flounder off North Carolina during November and December. The fishery may use traditional flounder trawls or a "combination net" that are higher profile nets used when seeking summer flounder as well as weakfish, butterfish, and squid.

A deepwater component of the fish trawl fishery occurs in deeper waters (depths greater than 20 fathoms) and can occur in November-December, and January through April. Different trawl gear is used depending on the species targeted: flounder trawls are used to target summer flounder, while flynets and combination nets are employed when Atlantic croaker or bluefish move into deeper waters.

<u>Commercial Fish House Sampling Program (Fishery dependent winter trawl sampling)</u>
Sampling of the offshore trawl fishery was initiated in the fall of 1979 to sample flounder, and expanded in 1981 to sample Sciaenids, describe the areas, seasons and methods of the fishery as well as age, size, and composition of species. Trip information includes head rope length, mesh size of body and cod-end (tailbag) of the trawl, water bodies fished, and number of days on the fishing grounds.

7.2.2.5.3 Crab trawl fishery

The crab trawl fishery has received a lot of attention due to the bycatch of finfish (mainly southern flounder) and sub legal crabs. There are few (less than 25) trawlers that exclusively harvest blue crabs in North Carolina's internal coastal waters. The number of vessels that reported crab trawls as at least one of the fishing gears used has ranged from 179 to 418 vessels since 1994, and averaged 290 vessels (NCTTP) per year. The majority (60%) of the effort in the crab trawl industry, based on number of trips, occurs between March and June.

Crab trawl headrope lengths for double-rigged vessels ranged from 30 to 45 ft, while twin-rigged vessels pulled four nets in the 30-ft range. Crab trawlers working in the western portion of Pamlico Sound and the rivers (Pamlico, Pungo, and Neuse) are required to use 4 inch tailbags, while crab trawlers working in the eastern side of the sound must use at least a 3 inch tailbag (15A NCAC 3L. 0202(a)). Tow times generally decrease as biomass and/or temperature increases. Specific details (areas fished, landings, regulations, etc.) of this fishery can be found in the 2004 North Carolina Blue Crab FMP (DMF 2004a).

7.2.2.6 Crab pot fishery

The crab pot was developed in the Chesapeake Bay in 1928 (Van Engel 1962). This is a cubed shaped wire device used to catch crabs, measuring approximately twenty four inches (24") on each side. Hard pots have one or more funnel shaped entrance port(s), a bait compartment, and an upper and lower chamber. Pots are generally baited with finfish (Atlantic menhaden, spot, etc) or shrimp heads. All hard crab pots are required to have two escape rings, and must be fished at least every five days. The peak months for crab pot landings are May through October, which account for 90% of the total landing (NCTTP 1994-2008).

Peeler pots are the same size as hard crab pots but are constructed from smaller mesh wire (<1 /12") and can only be baited with live adult male crabs. Over 91% of all landings from peeler pots occur from April through June (NCTTP 1996-2008). Specific details (areas fished, landings, regulations, etc.) of these fisheries can be found in the 2004 NC Blue Crab FMP (DMF 2004a).

The management issues relating to finfish bycatch in crab pots are: the composition, quantity, and fate of marketable and unmarketable discarded bycatch in actively fished pots and in "ghost pots". Limited information is available on finfish bycatch since dead fish are quickly consumed by blue crabs, leaving only bones and fins (Guillory 1993, DMF unpublished data 1993).

Ghost crab pots are defined as those pots that, either through abandonment or loss (float lines cut by boats, storm events, etc.) continue to catch crabs and finfish. Concern stemmed from the significant increase in the numbers of crab pots, the long life of vinyl coated pots, and the pot's ability to continue to trap crabs and finfish.

7.2.3 Bycatch Results

7.2.3.1 Estuarine gill net fishery results

After trips were defined through the trip ticket analyses, each fishery was then further characterized from available fish house sampling and observer data from 2001 to 2008. For each of the sixteen fisheries defined, information specific to mesh sizes used, yards of net fished, soak times and depths fished were included (Table 17 and Table 18). Species with similar parameters for mesh size are grouped together into large (> 5 inch) or small (< 5 inch) stretch mesh gill net fisheries. Available information is also separated by region. Regions include: Albemarle Sound, Core Sound to the South Carolina border, Pamlico and Neuse River, and Pamlico Sound.

The availability of various species in North Carolina's estuarine gill net fishery varies by season. Monthly landings by region for each of the sixteen key species are provided in Figure 26 and Figure 27.

Fishery independent gill net survey mortality results
Relatively few spotted seatrout were captured in the independent gill net survey. Spotted seatrout were the fourteenth most abundant species by weight, and their relative abundance was 0.5% of the number and 1% of the weight of the species captured (Table 19).

The length frequency distribution of spotted seatrout captured in the independent gill net survey (n=1,367) is presented in Figure 28. Twenty-five sublegal spotted seatrout (2%) were captured from 2003 to 2008. Most of the sublegal spotted seatrout were caught in small mesh nets, and mostly in the 3" and 3.5" mesh nets (n=21), with only four sublegal spotted seatrout (1%) captured from the 4" and 4.5" mesh nets.

The independent gill net survey also provides information on "at net" mortality of legal and sublegal sized spotted seatrout, by mesh size captured (Table 20). For 3"-4.5" meshes combined, "at net" mortality ranged from 17% (December) to 87% (September), and averaged 60%.

Fishery independent gill net selectivity study results
The length frequency distribution of spotted seatrout captured (n=126) in the gill net selectivity study is presented in Figure 29, with no sublegal spotted seatrout captured. Of the legal sized spotted seatrout captured in the study, the mortality, by mesh size, is presented in Table 21. Most fish were alive when captured (61%), with the lowest percent alive in the 3.5" mesh nets.

DMF commercial observer program
At sea samples to estimate dead spotted seatrout discards from gill nets:

North Carolina observer data was examined in anticipation of using the data to estimate discards of dead spotted seatrout from the estuarine gill net fishery. Available observer coverage was for the period of 2001 to 2008 (Table 22). However, much of the data was exclusively from the Pamlico Sound gill net fishery in the fall, which is primarily from large mesh gill net trips which do not catch many spotted seatrout. Due to these limited small mesh data, as well as the low number of spotted seatrout in the samples, annual coastwide estimates of discarded spotted seatrout could not be attempted.

Table 17. Large mesh (≥ 5 inch) estuarine gill net fishery parameters commonly associated with the targeting of various species, 2001-2008.

Flounder			Gill Net Stretch Mesh Size (inches)					Effort Data (yards fished)			Soak Time (hours)			Water Depth (ft)		
Region	Data Source	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Albemarle Sound	Fishery Dependent (pgm 461)	428	5.76	5.5-6.0	5.73	3.12	7.00	1,717	200	3,700	27	12	96	9	1	25
Pamlico Sound	Fishery Dependent (pgm 461)	804	6.00	5.26-6.5	5.85	2.88	7.00	1,527	75	5,600	23	4	72	3	1	18
Pamlico/Neuse River	Fishery Dependent (pgm 461)	667	5.50	5.26-5.5	5.47	1.86	7.00	1,214	50	6,000	18	4	72	4	1	18
Core Sound-South	Fishery Dependent (pgm 461)	690	5.50	5.5-6.0	5.62	2.88	7.00	2,073	200	6,000	19	8	72	4	1	12
ALL	Fishery Dependent (pgm 461)	2,589	5.50	5.26-6.5	5.68	1.86	7.00	1,653	50	6,000	21	4	96	4	1	25
Striped Bass			Gill Net Stretch Mesh Size (inches)					Effort Data (yards fished)			Soak Time (hours)			Water Depth (ft)		
Region	Data Source	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Albemarle Sound	Fishery Dependent (pgm 461)	38	5.50	5.5-8.0	5.94	2.50	10.00	1,006	100	3,000	20	1	24	8	3	15
Pamlico Sound	Fishery Dependent (pgm 461)	15	5.76	5.76-6.0	5.46	3.00	6.00	986	400	1,500	21	12	24	6	3	12
Pamlico/Neuse River	Fishery Dependent (pgm 461)	124	5.50	5.5-7.0	5.64	4.50	7.00	548	50	1,800	16	12	36	6	2	12
Core Sound-South	Fishery Dependent (pgm 461)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
ALL	Fishery Dependent (pgm 461)	177	5.50	5.5-8.0	5.69	2.50	10.00	667	50	3,000	17	1	36	6	2	15
Red drum			Gill Net Stretch Mesh Size (inches)					Effort Data (yards fished)			Soak Time (hours)			Water Depth (ft)		
Region	Data Source	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Albemarle Sound	Fishery Dependent (pgm 461)	14	6.00	5.5-6.0	5.68	4.50	6.00	833	100	2,000	17	12	24	3	2	7
Pamlico Sound	Fishery Dependent (pgm 461)	52	6.00	5.5-6.5	5.70	3.26	6.50	930	100	3,000	20	8	48	3	1	4
Pamlico/Neuse River	Fishery Dependent (pgm 461)	19	5.50	5.26-6.0	5.24	3.24	6.00	758	100	1,400	14	12	24	3	1	6
Core Sound-South	Fishery Dependent (pgm 461)	23	5.50	5.5-5.76	5.45	3.00	6.00	1,245	200	3,200	17	12	24	3	1	5
ALL	Fishery Dependent (pgm 461)	108	5.50	5.5-6.0	5.50	3.00	6.50	982	100	3,200	18	8	48	3	1	7
American Shad			Gill Net Stretch Mesh Size (inches)					Effort Data (yards fished)			Soak Time (hours)			Water Depth (ft)		
Region	Data Source	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Albemarle Sound	Fishery Dependent (pgm 461)	36	5.26	5.26-5.5	5.32	3.00	7.00	1,010	300	2,000	38	12	96	10	8	14
Pamlico Sound	Fishery Dependent (pgm 461)	15	5.50	5.50	4.97	3.12	6.00	1,200	198	2,000	27	12	48	5	2	10
Pamlico/Neuse River	Fishery Dependent (pgm 461)	253	5.50	5.26-5.5	5.49	3.76	12.00	747	100	2,500	23	10	72	8	1	20
Core Sound-South	Fishery Dependent (pgm 461)	10	5.50	5.50	5.47	5.26	5.50	250	200	400	23	12	24	8	4	10
ALL	Fishery Dependent (pgm 461)	314	5.50	5.26-5.5	5.45	3.00	12.00	772	100	2,500	25	10	96	8	1	20
Hickory Shad			Gill Net Stretch Mesh Size (inches)					Effort Data (yards fished)			Soak Time (hours)			Water Depth (ft)		
Region	Data Source	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Albemarle Sound	Fishery Dependent (pgm 461)	2	5.50	5.50	4.58	2.50	5.50	925	700	1,150	24	24	24	8	4	12
Pamlico Sound	Fishery Dependent (pgm 461)	39	4.00	3.0-4.0	3.86	2.88	6.00	1,444	400	3,800	22	12	48	4	1	10
Pamlico/Neuse River	Fishery Dependent (pgm 461)	25	5.50	3.76-5.5	4.76	2.88	5.50	833	231	1,900	25	12	48	10	3	15
Core Sound-South	Fishery Dependent (pgm 461)	13	3.76	3.26-4.0	3.62	1.50	4.00	939	400	1,900	20	12	24	4	2	6
ALL	Fishery Dependent (pgm 461)	79	5.50	3.76-5.5	4.16	1.50	6.00	1,105	231	3,800	23	12	48	6	1	15
Catfish		1	Gill Net Stretch Mesh Size (inches)					Effort Data (yards fished)			Soak Time (hours)			Water Depth (ft)		
Region	Data Source	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Albemarle Sound	Fishery Dependent (pgm 461)	1	3.24	3.24	4.37	3.24	5.50	1,700	1,700	1,700	17	17	17	11	11	11
Pamlico Sound	Fishery Dependent (pgm 461)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pamlico/Neuse River	Fishery Dependent (pgm 461)	54	5.50	5.26-5.5	5.53	5.00	7.00	703	150	1733	17	12	24	9	5	12
Core Sound-South	Fishery Dependent (pgm 461)	1	5.50	5.50	5.50	5.50	5.50	200	200	200	24	24	24	8	8	8
ALL	Fishery Dependent (pgm 461)	56	5.50	5.26-5.5	5.51	3.24	7.00	713	150	1733	17	12	24	9	5	12

Table 18. Small mesh (< 5 inch) estuarine gill net fishery parameters commonly associated with the targeting of various species,

2001-2008.

Spotted seatrout			Gill Net Stretch Mesh Size (inches)					Effort Data (yards fished)			Soak Time (hours)			Water Depth (ft)		
Region	Data Source	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Albemarle Sound	Fishery Dependent (pgm 461)	4	–	3.26-5.76	4.51	3.26	5.76	700	600	800	9	6	12	3	3	4
Pamlico Sound	Fishery Dependent (pgm 461)	52	4.00	3.76-4.76	4.23	3.26	6.00	1,205	100	3,000	26	4	72	4	2	8
Pamlico/Neuse River	Fishery Dependent (pgm 461)	60	4.0,5.5	3.0-5.5	4.19	3.00	7.00	905	67	2,000	15	12	48	4	2	9
Core Sound-South	Fishery Dependent (pgm 461)	10	4.00	3.26-4.0	3.70	3.26	4.00	811	200	1,600	18	2	48	4	3	5
ALL	Fishery Dependent (pgm 461)	126	4.00	3.26-5.76	4.17	3.00	7.00	1,042	67	3,000	20	2	72	4	2	9

Spot			Gill Net Stretch Mesh Size (inches)					Effort Data (yards fished)			Soak Time (hours)			Water Depth (ft)		
Region	Data Source	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Albemarle Sound	Fishery Dependent (pgm 461)	50	3.26	3.12-3.26	3.45	3.00	8.00	723	133	1,600	17	2	48	6	3	10
Pamlico Sound	Fishery Dependent (pgm 461)	62	3.00	2.88-3.5	3.44	2.88	6.00	1,080	200	3,000	22	1	48	6	2	13
Pamlico/Neuse River	Fishery Dependent (pgm 461)	16	3.00	3.0-5.5	3.76	3.00	5.50	497	167	800	10	2	24	6	3	7
Core Sound-South	Fishery Dependent (pgm 461)	61	3.00	3.0-3.26	3.22	2.62	5.76	518	100	2,500	13	1	24	6	3	20
ALL	Fishery Dependent (pgm 461)	189	3.00	3.0-3.5	3.39	2.62	8.00	733	100	3,000	17	1	48	6	2	20

Striped Mullet			Gill Net Stretch Mesh Size (inches)					Effort Data (yards fished)			Soak Time (hours)			Water Depth (ft)		
Region	Data Source	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Albemarle Sound	Fishery Dependent (pgm 461)	13	–	3.26-5.5	4.06	3.00	5.76	1,100	400	2,600	25	10	48	7	3	17
Pamlico Sound	Fishery Dependent (pgm 461)	14	4.00	3.76-4.0	4.48	3.26	6.50	888	250	1,500	16	1	24	5	1	20
Pamlico/Neuse River	Fishery Dependent (pgm 461)	78	3.76	3.0-5.5	3.73	2.88	5.50	720	200	1,800	12	1	24	4	3	10
Core Sound-South	Fishery Dependent (pgm 461)	53	3.76	3.5-4.0	3.80	2.88	7.00	496	150	2,200	9	1	36	5	3	12
ALL	Fishery Dependent (pgm 461)	158	3.76	3.0-5.5	3.87	2.88	7.00	668	150	2,600	12	1	48	5	1	20

Bluefish			Gill Net Stretch Mesh Size (inches)					Effort Data (yards fished)			Soak Time (hours)			Water Depth (ft)		
Region	Data Source	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Albemarle Sound	Fishery Dependent (pgm 461)	17	3.26	3.12-5.76	3.94	3.12	6.00	1,045	200	2,000	25	12	48	5	2	10
Pamlico Sound	Fishery Dependent (pgm 461)	237	3.26	2.88-6.0	3.80	2.62	6.50	1,054	100	3,900	22	2	48	6	1	17
Pamlico/Neuse River	Fishery Dependent (pgm 461)	6	5.50	3.26-5.5	5.28	3.26	5.50	1,340	1,200	1,700	12	12	12	3	3	4
Core Sound-South	Fishery Dependent (pgm 461)	25	3.00	2.88-5.5	3.51	2.88	6.00	948	150	2,000	17	12	24	5	3	8
ALL	Fishery Dependent (pgm 461)	285	5.50	3.0-5.5	3.81	2.62	6.50	1,049	100	3,900	21	2	48	6	1	17

Weakfish			Gill Net Stretch Mesh Size (inches)					Effort Data (yards fished)			Soak Time (hours)			Water Depth (ft)		
Region	Data Source	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Albemarle Sound	Fishery Dependent (pgm 461)	2	3.26	3.26	3.26	3.26	3.26	800	800	800	14	14	14	7	7	7
Pamlico Sound	Fishery Dependent (pgm 461)	33	3.00	2.88-3.26	3.31	2.88	6.26	1,414	250	4,000	22	1	48	8	3	14
Pamlico/Neuse River	Fishery Dependent (pgm 461)	1	3.00	3.00	3.00	3.00	3.00	200	200	200	12	12	12	7	7	7
Core Sound-South	Fishery Dependent (pgm 461)	2	–	3.0-4.0	3.21	3.00	4.00	650	500	800	18	12	24	4	4	5
ALL	Fishery Dependent (pgm 461)	38	3.00	2.88-3.26	3.29	2.88	6.26	1,318	200	4,000	21	1	48	7	7	14

Table 18. Continued.

Menhaden			Gill Net Stretch Mesh Size (inches)					Effort Data (yards fished)			Soak Time (hours)			Water Depth (ft)		
Region	Data Source	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Albemarle Sound	Fishery Dependent (pgm 461)	14	3.26	3.12-3.76	3.37	3.00	4.00	800	300	1,500	23	12	48	9	6	12
Pamlico Sound	Fishery Dependent (pgm 461)	19	–	3.0-3.26	3.59	2.88	6.00	1,159	200	2,000	23	9	48	7	3	15
Pamlico/Neuse River	Fishery Dependent (pgm 461)	19	2.88	2.88-3.0	3.01	2.50	4.00	567	200	1,000	12	12	15	9	4	15
Core Sound-South	Fishery Dependent (pgm 461)	3	3.00	3.0-3.12	3.04	3.00	3.12	900	200	1,500	13	2	24	4	3	6
ALL	Fishery Dependent (pgm 461)	55	3.00	2.88-3.26	3.31	2.50	6.00	858	200	2,000	18	2	48	9	3	15

Spanish mackerel			Gill Net Stretch Mesh Size (inches)					Effort Data (yards fished)			Soak Time (hours)			Water Depth (ft)		
Region	Data Source	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Albemarle Sound	Fishery Dependent (pgm 461)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pamlico Sound	Fishery Dependent (pgm 461)	59	3.50	3.5-3.62	3.52	3.00	4.00	1,340	500	2,700	8	2	8	13	6	17
Pamlico/Neuse River	Fishery Dependent (pgm 461)	2	3.50	3.5	3.50	3.50	3.50	1,500	1,500	1,500	2	2	2	16	16	16
Core Sound-South	Fishery Dependent (pgm 461)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
ALL	Fishery Dependent (pgm 461)	61	3.50	3.5-3.62	3.52	3.00	4.00	1,343	500	2,700	8	2	8	13	6	17

White Perch			Gill Net Stretch Mesh Size (inches)					Effort Data (yards fished)			Soak Time (hours)			Water Depth (ft)		
Region	Data Source	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Albemarle Sound	Fishery Dependent (pgm 461)	1	5.50	5.5	4.18	2.86	5.50	2,600	2,600	2,600	48	48	48	19	19	19
Pamlico Sound	Fishery Dependent (pgm 461)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pamlico/Neuse River	Fishery Dependent (pgm 461)	10	–	3.5, 5.5	4.13	3.00	5.50	503	120	900	18	12	48	4	3	6
Core Sound-South	Fishery Dependent (pgm 461)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
ALL	Fishery Dependent (pgm 461)	11	5.50	3.5,5.5	4.13	4.13	5.50	736	120	2,600	21	12	48	6	3	19

Sea Mullet			Gill Net Stretch Mesh Size (inches)					Effort Data (yards fished)			Soak Time (hours)			Water Depth (ft)		
Region	Data Source	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Albemarle Sound	Fishery Dependent (pgm 461)	3	3.00	3.0-3.26	3.09	3.00	3.26	1,607	800	1,200	20	12	24	9	7	10
Pamlico Sound	Fishery Dependent (pgm 461)	19	2.62	2.62-3.26	2.82	2.62	3.50	1,456	800	2,000	20	12	24	9	4	14
Pamlico/Neuse River	Fishery Dependent (pgm 461)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Core Sound-South	Fishery Dependent (pgm 461)	1	3.52	3.52	3.52	3.52	3.52	200	200	200	3	3	3	7	7	7
ALL	Fishery Dependent (pgm 461)	23	2.62	2.62-3.26	2.89	2.62	3.52	1,345	200	2,000	20	3	24	9	4	14

River Herring			Gill Net Stretch Mesh Size (inches)					Effort Data (yards fished)			Soak Time (hours)			Water Depth (ft)		
Region	Data Source	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Albemarle Sound	Fishery Dependent (pgm 461)	2	–	3.00	4.13	3.00	5.26	700	700	700	24	24	24	10	10	10
Pamlico Sound	Fishery Dependent (pgm 461)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pamlico/Neuse River	Fishery Dependent (pgm 461)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Core Sound-South	Fishery Dependent (pgm 461)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
ALL	Fishery Dependent (pgm 461)	2	–	3.00	4.13	3.00	5.26	700	700	700	24	24	24	10	10	10

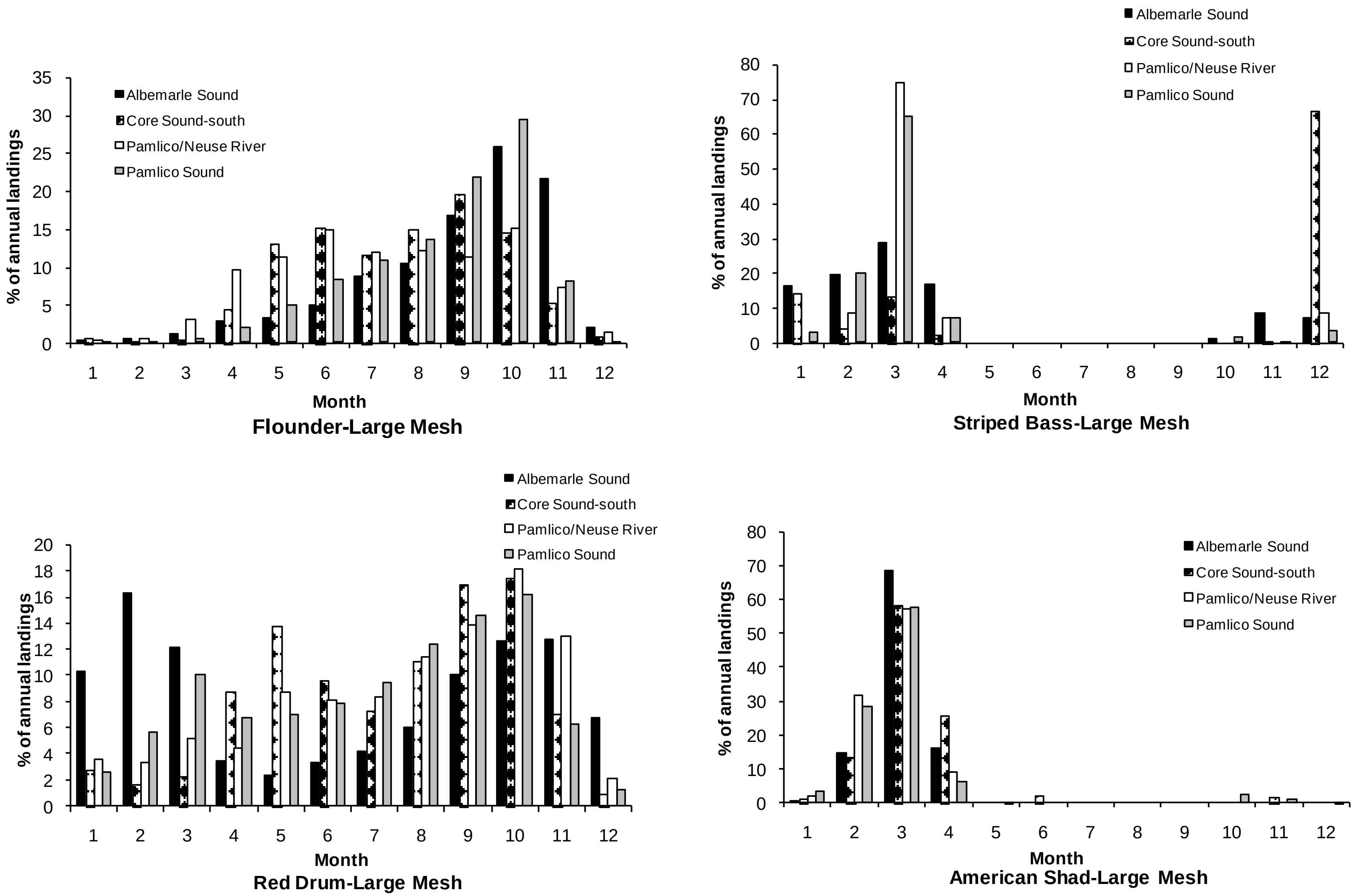


Figure 26. Monthly landings by region for common species targeted in the large mesh estuarine gill net fishery (2001-2008).

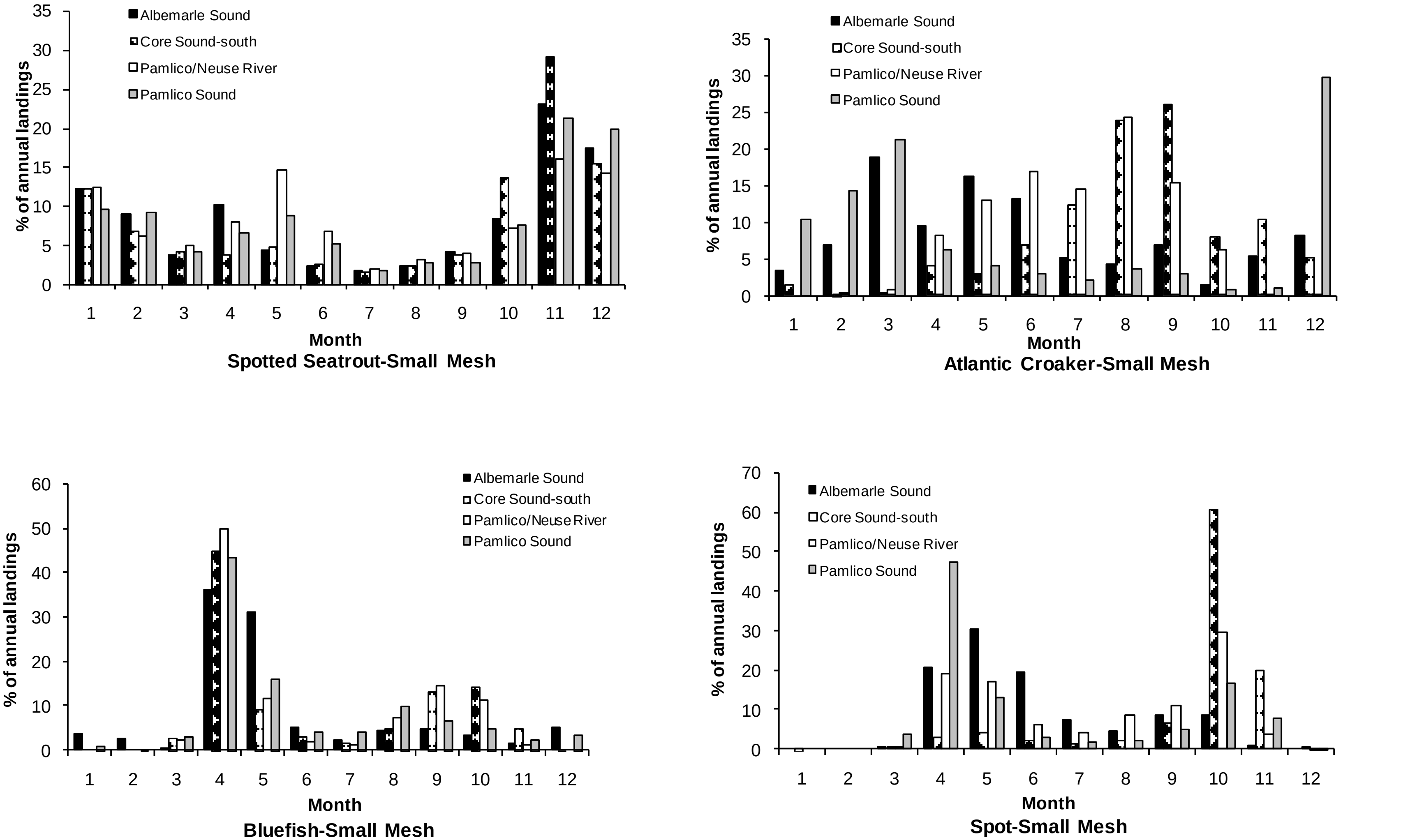


Figure 27. Monthly landings by region for common species targeted in the small mesh estuarine gill net fishery (2001-2008).

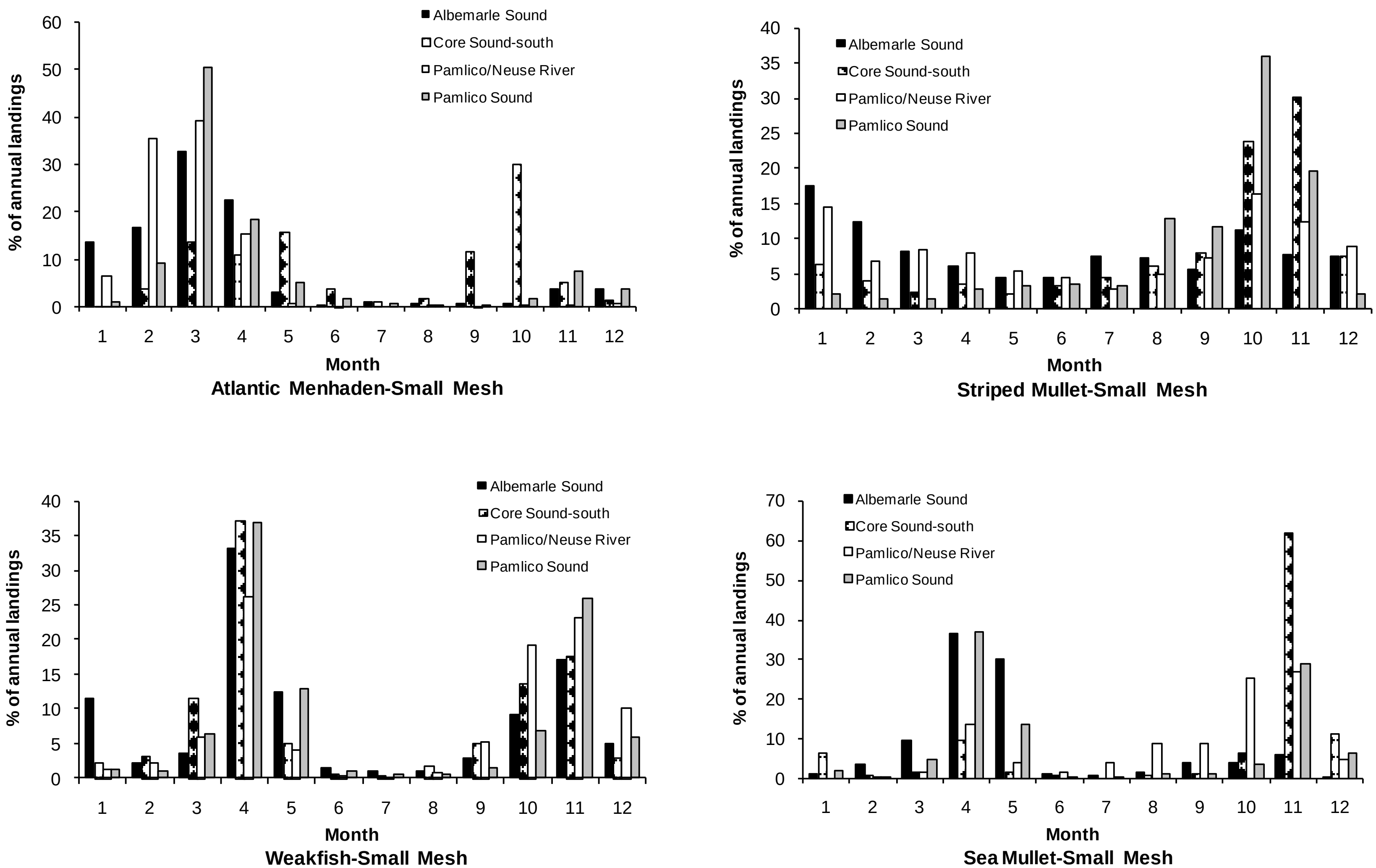
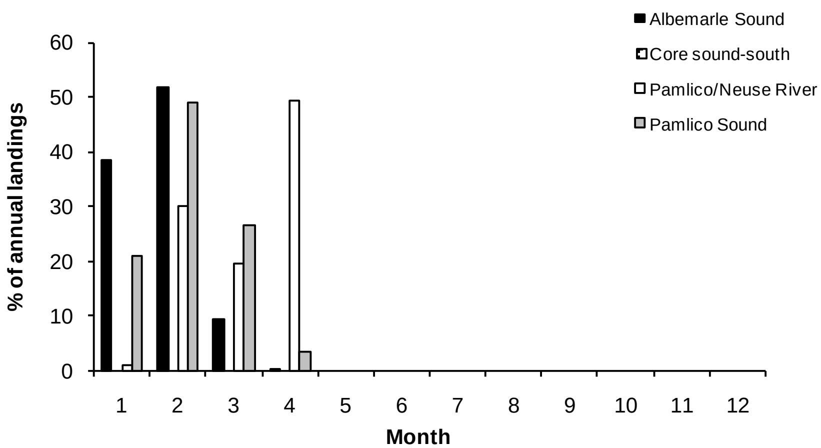
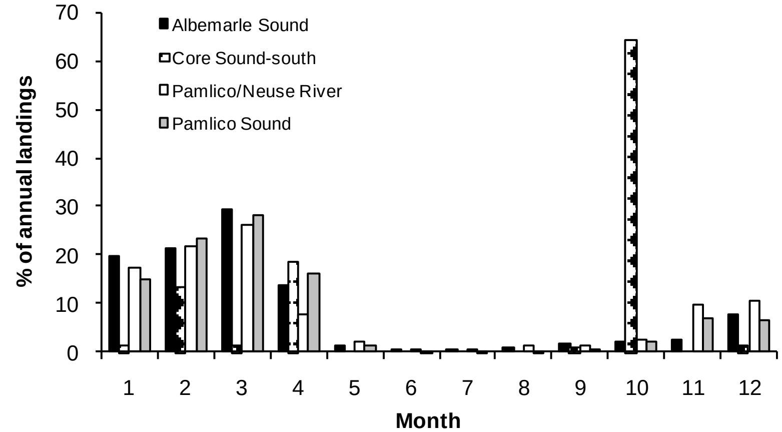


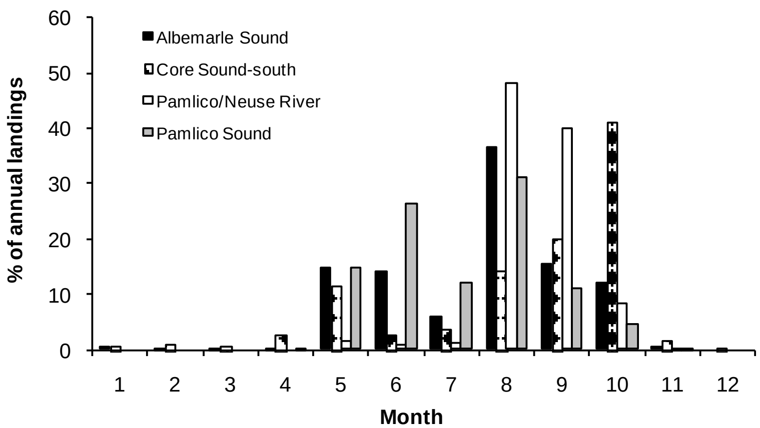
Figure 27. Continued.



River Herring-Small Mesh



White Perch-Small Mesh



Spanish Mackerel-Small Mesh

Figure 27. Continued.

Table 19. Species composition (top 99% by weight) from the Pamlico Sound Independent Gill Net Survey (Program 915) for 2003-2008 (sample number=3,651).

Species	Weight (lbs) Mean	Weight (lbs) Percent	Number Mean	Number Percent	Mean fish weight (lbs)
cownose ray	16.8	23	1.3	1.7	12.6
Atlantic menhaden	15.9	22	45.5	57.7	0.4
bluefish	5.3	8	5.0	6.4	1.1
red drum	5.1	7	2.0	2.6	2.4
gizzard shad	4.4	6	5.0	6.3	0.9
longnose gar	4.2	6	1.1	1.4	3.8
striped bass	2.9	4	0.9	1.1	3.2
striped mullet	2.4	3	2.0	2.5	1.2
southern flounder	2.2	3	1.9	2.5	1.1
hickory shad	1.5	2	1.2	1.6	1.3
spot	1.1	2	2.4	3.1	0.5
blue crab	1.1	2	3.6	4.5	0.3
black drum	0.9	1	0.6	0.7	1.6
spotted seatrout	**0.9**	**1**	**0.4**	**0.5**	**2.0**
common carp	0.7	1	0.1	0.2	6.4
horseshoe crab	0.7	1	0.2	0.2	4.3
Atlantic croaker	0.7	1	1.0	1.3	0.6
white catfish	0.7	1	0.4	0.5	1.5
spiny dogfish	0.4	1	0.1	0.1	5.6
weakfish	0.4	1	0.6	0.7	0.8
bowfin	0.4	1	0.1	0.1	4.1
white perch	0.4	1	0.7	0.9	0.6
smooth dogfish	0.4	1	0.2	0.2	2.4
American shad	0.2	0	0.1	0.1	3.0
houndfish	0.2	0	0.1	0.1	3.8
Moxostoma suckers	0.2	0	0.1	0.1	2.7
pinfish	0.2	0	0.5	0.6	0.3
Spanish mackerel	0.2	0	0.1	0.2	1.1
southern kingfish	0.2	0	0.2	0.3	0.6
sheepshead	0.0	0	0.0	0.1	2.2
gulf flounder	0.0	0	0.1	0.2	0.7
Atlantic sturgeon	0.0	0	0.0	0.0	4.0
largemouth bass	0.0	0	0.0	0.1	1.6
Atlantic spadefish	0.0	0	0.1	0.1	0.7
double-crested cormorant	0.0	0	0.0	0.0	5.3
striped bass x white	0.0	0	0.0	0.0	2.5

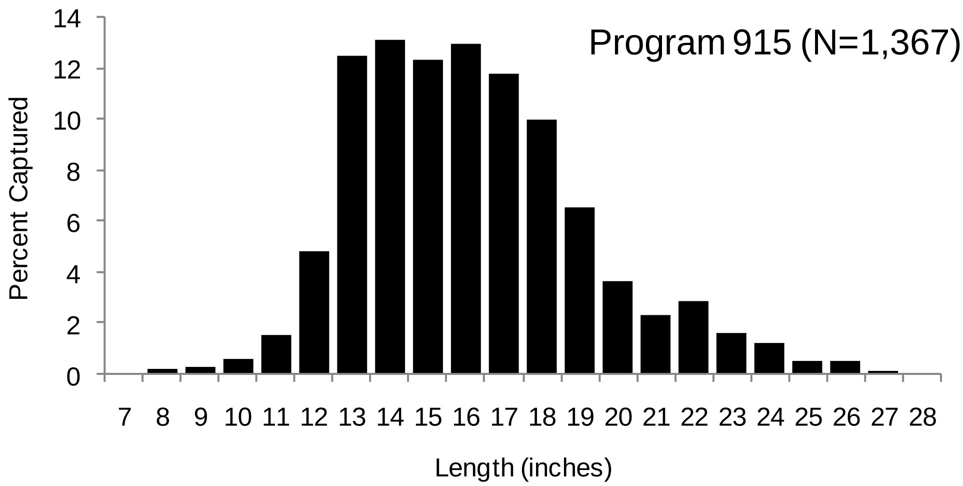


Figure 28. Length frequency of spotted seatrout captured from Program 915 (Independent gill net survey), 2003-2008.

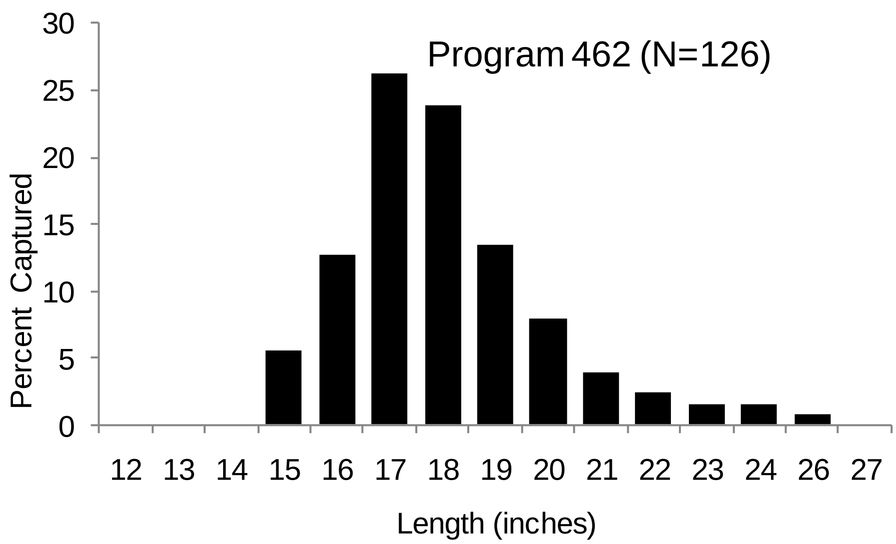


Figure 29. Length Frequency of spotted seatrout captured from gill net selectivity study (Program 462) on the Neuse River, NC-Fall 2005 and 2006.

Table 20. Percent "At-Net" Mortality of spotted seatrout caught by mesh size (3"-4.5" combined), by month, in the DMF Independent Gill net Sampling Program (P 915), 2003-2008.

Month	%Mortality	N
Feb	20	15
Mar	35	31
Apr	40	95
May	53	185
Jun	75	134
Jul	76	110
Aug	74	99
Sep	87	224
Oct	64	198
Nov	37	186
Dec	17	63
Total	60	1,340

Table 21. “At-net" mortality estimates, by mesh size, for spotted seatrout captured in the gill net selectivity study, Neuse River, NC, 2005 and 2006.

	3.5" Mesh		4" Mesh		4.5" Mesh		Total	
Status	N	Percent	N	Percent	N	Percent	N	Percent
Alive	25	51%	32	60%	20	83%	77	61%
Dead	24	49%	21	40%	4	17%	49	39%
Total	49		53		24		126	

DMF gill net release mortality
Estimate dead spotted seatrout discards resulting from the release mortality associated with gill nets:

From 1999 to 2000, DMF conducted studies to determine the short-term mortality associated with the release of spotted seatrout from estuarine gill nets. During this study, delayed mortality estimates were conducted for small (≤4 ½ inch) stretch mesh gill nets set in Roanoke Sound, Core Sound, and the Neuse River (Price and Gearhart 2002b). Spotted seatrout were held in pens (72 hours) to determine delayed mortality. Trials were held throughout the spring/summer (Mar-Aug) and fall/winter (Sep-Feb) in Outer Banks sites (Roanoke Sound and Core Sound) and River sites (Neuse River).

Overall delayed mortality for spotted seatrout averaged 30% throughout the spring/summer (Mar-Aug) and fall/winter (Sep-Feb) trials. Spotted seatrout displayed increased total mortality in 3.0 inch stretch mesh panels (Price and Gearhart 2002b). Delayed mortality of spotted seatrout decreased from the spring/summer trials to the fall/winter trials at the Outer Banks sites. The decreased delayed mortality for these fish in the fall/winter trials is likely a reflection of the cooler water temperature and corresponding increased dissolved oxygen content observed at the Outer Banks site from November through March. The gill net soak times were approximately the same (~12 hrs), being set at dusk and retrieved near daylight, thus no relationship between soak time and mortality was available.

Results of this study suggest that location (Outer Banks or River sites), dissolved oxygen, and mesh size significantly affect the survivability of spotted seatrout captured in gill nets (Price and Gearhart 2002b). Delayed mortality of spotted seatrout was significantly lower at the river sites (23%) when compared to the Outer Banks sites (42%; Table 23). Mortality was higher at Outer Banks (mean salinity = 19 ppt) sites for both trials, which suggests a decreased salinity tolerance for these fish. Overall delayed mortality averaged 30% in this study, but these are likely over-estimates due to the confounding factors of handling, transport, confinement, and tagging stress that may play a role in the observed mortality of these fishes. An extensive literature review revealed limited, existing information on delayed mortality estimates from gill net fisheries.

RCGL gill net release mortality
Data on the harvest and release of spotted seatrout captured in gill nets under the Recreational Commercial Gear License

The estimated catch of spotted seatrout taken in large and small mesh gill nets by RCGL holders are presented in Table 24. The majority of spotted seatrout, by far, are caught in small mesh gill nets. The number of trips has remained fairly constant since 2004, but the number and pounds of spotted seatrout harvested has increased steadily from 2004 to 2008. The number of estimated discards was highest in 2003 with as much as 49% of spotted seatrout caught in small mesh gill nets discarded. Annual estimates of spotted seatrout harvested by RCGL holders ranged from 7,000 to 21,904 pounds from 2002-2008.

The number of trips, landings, and discards of spotted seatrout taken by RCGL holders peaks during the month of October each year (Table 25). Exceptions occurred in 2002 when trips and the number of discards were highest in October but harvest was highest in May, and in 2003 when harvest was highest in January (most likely a reflection of harvest during a cold stun

Table 22. The total number of DMF observed commercial gill net trips by year and mesh size, 2001-2008.

Mesh	Year	#Observed Trips	#Sublegal (<12") Spotted Seatrout
large	2001	138	3
large	2002	163	3
large	2003	102	0
large	2004	458	6
large	2005	356	3
large	2006	350	4
large	2007	125	4
large	2008	256	6
large	**Total**	**1,948**	**29**
small	2001	64	0
small	2002	31	0
small	2003	32	0
small	2004	82	0
small	2005	118	2
small	2006	107	0
small	2007	5	0
small	2008	25	1
small	**Total**	**464**	**3**

Table 23. Delayed mortality of spotted seatrout captured during the small mesh gill net discard mortality study conducted at Outer Banks (high salinity) sites and River (low salinity) sites throughout Roanoke Sound, Core Sound, and Neuse River, NC, 1999-2000.

Spring/Summer					
Outer Banks			River		
Dead	Alive	% Mort	Dead	Alive	% Mort
5	7	42	6	20	23

Fall/Winter					
Outer Banks			River		
Dead	Alive	% Mort	Dead	Alive	% Mort
8	14	36	5	14	26

event) and the proportion of discards was highest in April.

Estimates of spotted seatrout catch by RCGL holders, by region are presented in Table 26. The number of trips, landings, and discards of spotted seatrout were largest in the Pamlico and Southern regions of the state, with the Central region important in some years. The amount of discards reported ranged from < 2% to as high as 61%.

Table 24. Recreational Commercial Gear License (RCGL) spotted seatrout catch by year and gear type, 2002-2008.

Year	Gear	Trips Number	Harvest Number	Harvest Pounds	Discard Number	% Discard Number
2002	Large Mesh Gill Nets	435	334	908	86	26
	Small Mesh Gill Nets	7,178	13,335	20,896	2,336	18
	All	7,613	13,669	21,804	2,422	18
2003	Large Mesh Gill Nets	363	386	813	95	25
	Small Mesh Gill Nets	2,750	5,945	10,679	2,886	49
	All	3,113	6,331	11,492	2,981	47
2004	Large Mesh Gill Nets	207	28	112	28	100
	Small Mesh Gill Nets	3,842	3,694	6,888	1,127	31
	All	4,049	3,722	7,000	1,155	31
2005	Large Mesh Gill Nets	233	211	631	0	0
	Small Mesh Gill Nets	3,919	5,888	8,831	1,171	20
	All	4,152	6,099	9,462	1,171	19
2006	Large Mesh Gill Nets	231	315	430	151	48
	Small Mesh Gill Nets	4,860	7,174	12,003	1,615	23
	All	5,091	7,489	12,433	1,766	24
2007	Large Mesh Gill Nets	530	331	863	48	15
	Small Mesh Gill Nets	4,481	8,060	12,899	1,726	21
	All	5,011	8,391	13,762	1,774	21
2008	Large Mesh Gill Nets	551	292	549	36	12
	Small Mesh Gill Nets	4,130	8,646	13,757	1,157	13
	All	4,681	8,938	14,306	1,193	13

Table 25. Recreational Commercial Gear License (RCGL) spotted seatrout catch by year and month, 2002-2008.

		Trips		Harvest		Harvest		Discard	
Year	**Month**	**Number**	**Percent**	**Number**	**Percent**	**Pounds**	**Percent**	**Number**	**Percent**
2002	1	26	0.3	128	0.9	224	1.0	0	0.0
	3	870	11.1	538	3.9	965	4.4	166	6.6
	5	696	8.8	3,495	25.5	5,350	24.5	216	8.7
	6	966	12.3	1,253	9.1	1,916	8.8	121	4.8
	7	563	7.2	2,529	18.4	4,373	20.0	136	5.4
	8	568	7.2	539	3.9	858	3.9	80	3.2
	9	781	9.9	1,163	8.5	1,790	8.2	492	19.7
	10	2,403	30.6	2,406	17.5	3,839	17.5	614	24.6
	11	840	10.7	1,317	9.6	1,722	7.9	566	22.6
	12	152	1.9	351	2.6	837	3.8	110	4.4
	All	7,864	100.0	13,718	100.0	21,876	100.0	2,501	100.0
2003	1	67	1.8	2,016	31.8	3,792	32.7	475	14.3
	2	199	5.5	141	2.2	243	2.1	8	0.2
	3	218	6.0	277	4.4	604	5.2	50	1.5
	4	375	10.3	741	11.7	1,400	12.1	1,782	53.6
	5	227	6.2	357	5.6	678	5.8	35	1.0
	6	190	5.2	223	3.5	436	3.8	74	2.2
	7	403	11.1	744	11.7	1,266	10.9	123	3.7
	8	376	10.3	270	4.3	419	3.6	309	9.3
	9	317	8.7	266	4.2	498	4.3	92	2.8
	10	837	23.0	896	14.1	1,596	13.8	50	1.5
	11	435	11.9	416	6.5	660	5.7	329	9.9
	All	3,642	100.0	6,347	100.0	11,592	100.0	3,327	100.0
2004	2	71	1.7	107	2.8	192	2.7	59	4.8
	3	48	1.1	135	3.6	280	4.0	106	8.5
	4	43	1.0	0	0.0	0	0.0	99	8.0
	5	74	1.7	78	2.1	106	1.5	9	0.7
	6	80	1.9	130	3.5	191	2.7	0	0.0
	7	472	11.0	236	6.3	526	7.4	290	23.3
	8	571	13.4	589	15.7	1,037	14.7	18	1.4
	9	352	8.2	402	10.7	763	10.8	83	6.7
	10	1,860	43.5	1,462	38.9	2,904	41.0	493	39.7
	11	605	14.1	418	11.1	649	9.2	53	4.3
	12	98	2.3	203	5.4	430	6.1	31	2.5
	All	4,274	100.0	3,760	100.0	7,079	100.0	1,243	100.0

Table 25. Continued.

Year	Month	Trips Number	Trips Percent	Harvest Number	Harvest Percent	Harvest Pounds	Harvest Percent	Discard Number	Discard Percent
2005	1	68	1.6	43	0.7	137	1.4	25	2.1
	2	157	3.6	195	3.1	351	3.6	19	1.6
	3	20	0.5	20	0.3	51	0.5	13	1.1
	4	26	0.6	19	0.3	29	0.3	19	1.6
	5	124	2.8	95	1.5	207	2.1	0	0.0
	6	103	2.4	215	3.4	267	2.7	32	2.6
	7	175	4.0	224	3.5	289	3.0	31	2.5
	8	529	12.1	554	8.7	716	7.3	57	4.7
	9	189	4.3	142	2.2	209	2.1	16	1.3
	10	1,834	42.1	3,021	47.7	4,385	45.0	552	45.9
	11	689	15.8	859	13.6	1,397	14.3	163	13.6
	12	442	10.1	949	15.0	1,713	17.6	275	22.9
	All	4,356	100.0	6,336	100.0	9,752	100.0	1,202	100.0
2006	1	76	1.3	115	1.5	202	1.6	0	0.0
	2	49	0.9	135	1.7	203	1.6	61	3.2
	3	14	0.3	14	0.2	27	0.2	0	0.0
	4	78	1.4	136	1.7	141	1.1	39	2.0
	5	297	5.2	610	7.8	961	7.4	115	5.9
	6	674	11.8	674	8.6	870	6.7	117	6.0
	7	295	5.2	287	3.7	555	4.3	103	5.3
	8	427	7.5	407	5.2	654	5.0	68	3.5
	9	838	14.7	1,291	16.6	2,022	15.6	355	18.2
	10	2,175	38.2	2,523	32.4	4,873	37.6	506	26.0
	11	529	9.3	701	9.0	1,118	8.6	82	4.2
	12	237	4.2	902	11.6	1,325	10.2	499	25.6
	All	5,688	100.0	7,795	100.0	12,950	100.0	1,946	100.0
2007	1	19	0.4	45	0.5	82	0.6	96	3.6
	2	27	0.5	290	3.3	485	3.3	20	0.8
	3	66	1.2	93	1.0	129	0.9	13	0.5
	4	266	4.9	433	4.9	684	4.6	133	5.1
	5	270	5.0	499	5.6	944	6.4	173	6.6
	6	422	7.8	892	10.0	1,437	9.7	198	7.5
	7	307	5.6	928	10.4	1,755	11.9	710	27.0
	8	818	15.0	698	7.8	1,011	6.9	352	13.4
	9	603	11.1	858	9.6	1,550	10.5	181	6.9
	10	1,477	27.1	2,006	22.5	3,530	23.9	471	17.9
	11	1,002	18.4	2,012	22.6	2,736	18.6	276	10.5
	12	167	3.1	155	1.7	406	2.8	6	0.2
	All	5,445	100.0	8,908	100.0	14,749	100.0	2,629	100.0

Table 25. Continued.

Year	Month	Trips Number	Trips Percent	Harvest Number	Harvest Percent	Harvest Pounds	Harvest Percent	Discard Number	Discard Percent
2008	1	68	1.3	266	2.9	387	2.7	68	5.2
	2	7	0.1	0	0.0	0	0.0	7	0.5
	3	115	2.2	88	1.0	128	0.9	14	1.0
	4	147	2.8	242	2.7	307	2.1	29	2.2
	5	465	9.0	780	8.6	1,298	9.0	114	8.7
	6	521	10.1	444	4.9	744	5.1	479	36.4
	7	311	6.0	331	3.7	478	3.3	55	4.2
	8	549	10.6	1,221	13.5	1,786	12.4	151	11.5
	9	757	14.7	1,121	12.4	2,079	14.4	255	19.4
	10	1,381	26.8	2,703	29.8	4,480	31.0	82	6.3
	11	722	14.0	1,694	18.7	2,408	16.7	62	4.7
	12	116	2.2	180	2.0	354	2.4	0	0.0
	All	5,157	100.0	9,070	100.0	14,448	100.0	1,317	100.0
All	1	324	0.9	2,613	4.7	4,825	5.2	663	4.7
	2	510	1.4	867	1.6	1,473	1.6	175	1.2
	3	1,352	3.7	1,165	2.1	2,185	2.4	362	2.6
	4	934	2.6	1,571	2.8	2,562	2.8	2,102	14.8
	5	2,152	5.9	5,914	10.6	9,543	10.3	664	4.7
	6	2,957	8.1	3,831	6.8	5,861	6.3	1,020	7.2
	7	2,525	6.9	5,279	9.4	9,243	10.0	1,447	10.2
	8	3,838	10.5	4,278	7.6	6,482	7.0	1,034	7.3
	9	3,838	10.5	5,244	9.4	8,912	9.6	1,474	10.4
	10	11,966	32.8	15,016	26.8	25,607	27.7	2,769	19.6
	11	4,821	13.2	7,416	13.3	10,690	11.6	1,531	10.8
	12	1,212	3.3	2,739	4.9	5,065	5.5	921	6.5
	All	36,428	100.0	55,934	100.0	92,447	100.0	14,164	100.0

Table 26. Recreational Commercial Gear License (RCGL) spotted seatrout catch by year and area, 2002-2008.

		Trips		Harvest				Discard	
Year	**Region**	**Number**	**Percent**	**Number**	**Percent**	**Pounds**	**Percent**	**Number**	**Percent**
2002	Central	1,307	16.60	1,117	8.10	1,887	8.60	267	10.70
	North	225	2.90	113	0.80	233	1.10	105	4.20
	Pamlico	3,179	40.40	7,404	54.00	11,309	51.70	1,358	54.30
	South	3,153	40.10	5,084	37.10	8,448	38.60	770	30.80
	All	7,864	100.00	13,718	100.00	21,876	100.00	2,501	100.00
2003	Central	696	19.10	1,124	17.70	2,104	18.20	2,034	61.20
	North	211	5.80	46	0.70	108	0.90	291	8.70
	Pamlico	911	25.00	2,896	45.60	5,542	47.80	764	23.00
	South	1,825	50.10	2,281	35.90	3,838	33.10	237	7.10
	All	3,642	100.00	6,347	100.00	11,592	100.00	3,327	100.00
2004	Central	1,085	25.40	670	17.80	1,536	21.70	545	43.90
	North	188	4.40	81	2.10	141	2.00	36	2.90
	Pamlico	833	19.50	996	26.50	2,014	28.50	231	18.60
	South	2,103	49.20	1,995	53.10	3,322	46.90	421	33.90
	Unknown	65	1.50	18	0.50	65	0.90	9	0.80
	All	4,274	100.00	3,760	100.00	7,079	100.00	1,243	100.00
2005	Central	794	18.30	1,135	17.90	1,848	19.00	218	18.20
	North	214	4.90	126	2.00	140	1.40	63	5.20
	Pamlico	970	22.30	1,531	24.20	2,666	27.40	287	23.90
	South	2,248	51.80	3,255	51.40	4,726	48.50	554	46.10
	Unknown	115	2.60	282	4.50	361	3.70	79	6.60
	All	4,342	100.00	6,329	100.00	9,741	100.00	1,202	100.00
2006	Central	689	12.10	1,545	19.80	3,083	23.80	576	29.60
	North	344	6.10	398	5.10	827	6.40	22	1.10
	Pamlico	2,063	36.30	2,856	36.60	4,453	34.40	887	45.60
	South	2,286	40.20	2,640	33.90	4,104	31.70	425	21.80
	Unknown	306	5.40	355	4.60	485	3.70	36	1.80
	All	5,688	100.00	7,795	100.00	12,950	100.00	1,946	100.00
2007	Central	1,192	21.90	1,113	12.50	2,094	14.20	278	10.60
	North	411	7.50	403	4.50	867	5.90	131	5.00
	Pamlico	1,745	32.00	3,585	40.20	6,063	41.10	1,365	51.90
	South	1,934	35.50	2,932	32.90	5,221	35.40	814	31.00
	Unknown	164	3.00	874	9.80	503	3.40	41	1.60
	All	5,445	100.00	8,908	100.00	14,749	100.00	2,629	100.00
2008	Central	944	18.30	2,365	26.10	3,520	24.40	534	40.60
	North	656	12.70	865	9.50	1,469	10.20	202	15.30
	Pamlico	1,676	32.50	2,640	29.10	3,985	27.60	305	23.20
	South	1,466	28.40	2,773	30.60	4,706	32.60	184	14.00
	Unknown	415	8.10	427	4.70	768	5.30	92	7.00
	All	5,157	100.00	9,070	100.00	14,448	100.00	1,317	100.00
All	Central	6,707	18.40	9,069	16.20	16,073	17.40	4,454	31.40
	North	2,250	6.20	2,033	3.60	3,784	4.10	850	6.00
	Pamlico	11,377	31.20	21,908	39.20	36,033	39.00	5,197	36.70
	South	15,015	41.20	20,960	37.50	34,365	37.20	3,406	24.00
	Unknown	1,065	2.90	1,957	3.50	2,182	2.40	257	1.80
	All	36,414	100.00	55,927	100.00	92,436	100.00	14,164	100.00

7.2.3.2 Long haul seine fishery results

Trip ticket analysis, fish house sampling and discard estimates only includes data from April through November (Table 27). These months represent the major operating season of the long haul fishery when fish house sampling occurs.

<u>Commercial Fish House Sampling Program (Fishery dependent long haul seine sampling)</u>

Incidental marketable bycatch
The long haul seine/swipe net fishery harvested 99% of targeted finfish between April and November based on trip ticket data (Table 27). Target species were Atlantic croaker, spot and weakfish and occasionally bluefish and spotted seatrout. Spotted seatrout were fairly incidental with trips averaging approximately 50-150 pounds (Table 27 and Table 28). Trip ticket landings by species, percent contribution, catch per trip and value from 1994 to 2008 are shown in Table 28. Spotted seatrout ranked 6th overall and represented 3% by weight with an average of 82.6 pounds per catch.

Fish house sampling from 1999 to 2008 illustrates similar results indicating that spotted seatrout represented 2.3% by weight of all catches (Table 29). Both trip ticket landings and fish house sampling coverage indicates that the long haul fishery for spotted seatrout is a minor fishery.

Bait
A portion of long haul catches is sold as bait. Annual mean bait percentages for all species by weight have ranged between 30 and 45% of the total catch (DMF 2007c). The dominant species in the bait each year was Atlantic croaker, spot, pinfish and Atlantic menhaden accounting for nearly 92% of the bait by weight and number (Table 30). Spotted seatrout constituted only a trace amount of the long haul bait fishery (<0.1%). DMF sampled the bait component of 447 long haul catches from 1999 to 2008 and the mean weight of spotted seatrout per catch was 0.2 pounds.

The quantity (weight) of undersized spotted seatrout discards in the bait component landed by the long haul fishery ranged from 0 to 1,127 pounds from 1994 to 2008 with an average of 198 pounds per year (Table 31). Discards of spotted seatrout in the long haul fishery compared to statewide commercial landings are negligible (Table 31). From 1994 to 2008, commercial harvest of spotted seatrout averaged 292,457 pounds and 14.7% of those fish landed were from the long haul fishery. From those spotted seatrout landed in the long haul fishery, 1.0% were sublegal or unmarketable (discards).

Effort
Participation in the long haul fishery has been declining. From 2004 to 2006, there were only thirteen traditional long haul and swipe net crews working (DMF 2007c). Nine crews worked northern Pamlico Sound, behind the Outer Banks from Hatteras Island to Oregon Inlet and Roanoke Sound. A second center of activity, worked by only one crew, is located in southern Pamlico Sound and Core Sound. The other three crews located in Core Sound work the areas of Atlantic, Davis and Sea Level (Gloeckner 2004, DMF 2007c).

Table 27. Average monthly landings (lbs) for spot, weakfish, A. croaker, bluefish, spotted seatrout and bait from the long haul/swipe net fishery, 1994-2008 combined.

	Spot		Weakfish		Croaker		Bluefish			Spotted Seatrout		Bait		Total
Month	Landings (lbs)	Percent	Landings (lbs)	Percent	Landings (lbs)	Percent	Landings (lbs)	Percent	Month	Landings (lbs)	Percent	Landings (lbs)	Percent	Percent
Jan	0	0%	4	0%	0	0%	0	0%	Jan	645	1%	108	0%	757
Feb	0	0%	0	0%	0	0%	0	0%	Feb	558	1%	35	0%	593
Mar	103	0%	265	0%	12	0%	20	0%	Mar	867	2%	87	0%	1,354
Apr	5,934	1%	17,950	9%	89	0%	3,174	6%	Apr	1,459	3%	710	2%	29,316
May	32,472	4%	20,012	10%	4,665	7%	5,677	10%	May	2,242	5%	2,208	8%	67,276
Jun	82,541	10%	18,485	9%	15,568	22%	8,415	15%	Jun	4,254	9%	5,370	19%	134,632
Jul	110,643	14%	21,447	10%	27,705	39%	11,458	20%	Jul	6,119	13%	7,299	26%	184,671
Aug	94,318	12%	39,466	19%	17,044	24%	15,245	26%	Aug	5,685	12%	6,922	24%	178,679
Sept	134,764	17%	47,945	23%	4,025	6%	8,151	14%	Sept	4,980	10%	4,405	15%	204,269
Oct	320,448	41%	41,321	20%	1,110	2%	5,067	9%	Oct	9,034	19%	1,396	5%	378,376
Nov	8,343	1%	2,474	1%	549	1%	434	1%	Nov	8,219	17%	0	0%	20,019
Dec	33	0%	270	0%	418	1%	37	0%	Dec	4,069	8%	11	0%	4,839
Total	789,598	100%	209,639	100%	71,184	100%	57,679	100%	Total	48,131	100%	28,550	100%	1,204,781

Table 28. Average annual landings (lbs), percent contribution (%), catch/trip (lbs/trip), and value for species landed in the NC long haul seine/swipe net fishery from 1994 to 2008.

Species	Landings (lbs)	Percent	Catch per trip (lbs/trip)	Value
Spot	789,598	52	1,356	$349,721
Weakfish	209,639	14	360	$110,956
Menhaden Bait	134,929	9	232	$13,299
Atlantic croaker	71,184	5	122	$20,662
Bluefish	57,679	4	99	$14,809
Spotted seatrout	**48,131**	**3**	**83**	**$59,864**
Hogfish	42,751	3	73	$10,108
Pinfish	32,550	2	52	$6,582
Bait	32,942	2	49	$2,761
Sea Mullet	20,973	1	36	$19,678
Carp	17,331	1	26	$1,001
Sheepshead	8,374	1	14	$3,222
Red drum	8,033	1	14	$7,697
Striped mullet	6,860	<1	12	$4,289
Black drum	6,278	<1	11	$1,733
Longnose gar	6,190	<1	11	$1,091
Catfish	5,938	<1	10	$1,548
Butterfish	5,729	<1	10	$2,615
Catfish	8,010	1	9	$2,068
Flounders	4,330	<1	7	$7,861
Starbutterfish	3,867	<1	7	$3,486
Other	540	<1	0	$430
Total	1,521,313		2,592	$645,051

Table 29. Species composition of long haul seine average *marketed* catches, Pamlico Sound area, April-October, 1999-2008 combined, N=505. (refer to DMF 2007c for list of other species).

Species	Weight (lbs) Mean	Weight (lbs) Percent	Number Mean	Number Percent	Mean fish weight (lbs)	Percent occur
Spot	2675.3	46	10,186	44	0.3	96
Atlantic croaker	880.4	15	4,765	21	0.2	83
Pinfish	651.0	11	4,452	19	0.1	90
Atlantic menhaden	460.4	8	1,403	6	0.3	40
Weakfish	362.7	6	702	3	0.5	86
Bluefish	236.9	4	270	1	0.9	90
Pigfish	150.6	3	612	3	0.2	80
Spotted seatrout	**131.2**	**2**	**79**	**0**	**1.7**	86
Southern kingfish	48.7	1	141	1	0.3	49
Black drum	38.3	1	20	<0.1	2.0	38
Sheepshead	23.8	<0.1	7	<0.1	3.5	51
Houndfish	20.6	<0.1	2	<0.1	10.6	16
Silver perch	19.7	<0.1	128	1	0.2	38
Jawed fishes	19.2	<0.1	-	<0.1	-	2
Harvestfish	19.1	<0.1	101	<0.1	0.2	20
Butterfish	5.7	<0.1	24	<0.1	0.2	15
Spanish mackerel	5.0	<0.1	6	<0.1	0.8	36
Atlantic thread herring	4.6	<0.1	60	<0.1	0.1	11
Striped burrfish	4.3	<0.1	10	<0.1	0.4	26
Kingfishes	3.5	<0.1	1	<0.1	2.4	11
Atlantic spadefish	3.3	<0.1	10	<0.1	0.3	18
Red drum	2.8	<0.1	1	<0.1	5.4	16
Southern flounder	2.8	<0.1	5	<0.1	0.6	23
Florida pompano	2.4	<0.1	2	<0.1	1.0	18
Striped mullet	2.2	<0.1	3	<0.1	0.8	8
Other*	0.2	<0.1	1	<0.1	2.3	3

Table 30. Species composition of long haul seine average *bait* catches, Pamlico Sound area, April-October, 1999-2008 combined, N=447. (refer to DMF 2007c for list of other species).

Species	Weight (lbs) Mean	Weight (lbs) Percent	Number Mean	Number Percent	Mean fish weight (lbs)
Atlantic croaker	762.9	28.5	5,012	27.9	0.2
Spot	712.7	26.6	5,510	30.7	0.2
Pinfish	569.3	21.2	4,677	26.1	0.2
Atlantic menhaden	419.8	15.7	1,588	8.9	0.2
Pigfish	77.6	2.9	468	2.6	0.2
Bluefish	55.3	2.1	153	0.9	0.4
Silver perch	22.3	0.8	145	0.8	0.2
Southern kingfish	12.6	0.5	68	0.4	0.2
Weakfish	10.6	0.4	57	0.3	0.2
Harvestfish	6	0.2	54	0.3	0.2
Atlantic thread herring	5.1	0.2	68	0.4	0
Striped burrfish	4.9	0.2	11	0.1	0.4
Butterfish	2.6	0.1	18	0.1	0.2
Striped searobin	2.2	0.1	17	0.1	0.2
Atlantic spadefish	1.3	0.1	10	0.1	0.2
Blue crab	1.1	<0.1	8	<0.1	0.2
Lookdown	1.1	<0.1	17	0.1	0
Hogfish	1.1	<0.1	4	<0.1	0.2
Spanish mackerel	0.9	<0.1	3	<0.1	0.2
Black drum	0.9	<0.1	3	<0.1	0.4
Southern stingray	0.9	<0.1	1	<0.1	0.7
Inshore lizardfish	0.7	<0.1	2	<0.1	0.4
Atlantic stingray	0.7	<0.1	1	<0.1	0.4
Northern searobin	0.7	<0.1	5	<0.1	0.2
Stingrays	0.7	<0.1	2	<0.1	0.2
Northern puffer	0.4	<0.1	1	<0.1	0.4
Southern flounder	0.4	<0.1	3	<0.1	0.2
Cownose ray	0.4	<0.1	-	<0.1	3.7
Spotted seatrout	**0.4**	**<0.1**	**2**	**<0.1**	**0.2**
Other*	<0.1	<0.1	-	<0.1	0.1

Table 31. North Carolina statewide commercial spotted seatrout landings (lbs), long haul fishery spotted seatrout landings, and estimated discard and number and percent contribution for market and discard, 1994-2008.

	Statewide	Long Haul Fishery					
Year	Commercial (lbs)	Market (lbs)	Discard (lbs)	Trips[1] (N)	Fish House (N)	Market[2] (%)	Discard[3] (%)
1994	412,358	98,821	46	941	53	24.00%	0.00%
1995	574,296	99,531	126	978	45	17.30%	0.10%
1996	226,580	20,233	84	998	75	8.90%	0.40%
1997	232,497	45,622	0	749	64	19.60%	0.00%
1998	307,671	65,099	49	639	60	21.20%	0.10%
1999	546,675	126,924	326	558	57	23.20%	0.30%
2000	376,574	29,113	0	435	53	7.70%	0.00%
2001	105,714	10,377	35	433	49	9.80%	0.30%
2002	175,555	24,108	1127	436	52	13.70%	4.70%
2003	181,462	24,513	0	474	41	13.50%	0.00%
2004	130,961	14,697	0	481	32	11.20%	0.00%
2005	129,601	12,020	1122	451	40	9.30%	9.30%
2006	312,620	49,473	4	538	40	15.80%	0.00%
2007	374,708	52,888	24	435	42	14.10%	0.00%
2008	299,588	33,425	31	391	36	11.20%	0.10%
Mean	**292,457**	**47,123**	**198**	**596**	**49**	**14.70%**	**1.00%**

1. Trips inflated by trip ticket procedure which may include swipe gill nets, but decreased trips in the long haul are evident.
2. Percent contribution of long haul fishery landings for seatrout to commercial landings statewide.
3. Percent spotted seatrout discards within spotted seatrout long haul fishery.

From 1994 to 2008, an average of 596 trips occurred in the long haul/swipe net fishery (Table 31) as reported in the trip ticket program (includes both traditional hauls as well as gill net swipe seines). There has been a general decline (58%) in trips from 1994 to 2008. Traditionally, the long haul fishery targeted spot, Atlantic croaker, weakfish, bluefish and occasionally spotted seatrout. Atlantic croaker, spot and weakfish landings by the long haul fishery have been noticeably lower than the landings of the 1970's and 1980's (DMF 2007c).

Conclusion
Although annual landings of spotted seatrout from the long haul fishery averaged 3%, these fish were part of the incidental bycatch. Most of the *Sciaenids* landed as bait are spot and croaker. Bait landings of spotted seatrout were negligible. Anytime a fishery lands a large percentage of bait relative to the total catch there is reason for fishery managers to be concerned. However, in regard to spotted seatrout in the long haul fishery, the amount of small unmarketable fish was so few that it would have little impact on the condition of this stock.

<u>Bycatch reduction gear testing</u>
The DMF tested a method for size selection of fish in long haul seine catches based on the use of 1 9/16 inch nylon ring escape panels mounted in the bunt of the seine. The panels were evaluated under commercial conditions in three areas of Pamlico Sound during the 1996 and 1997 fishing seasons. Total bycatch biomass reductions ranged from 25% to 37.4% for the three areas. The greatest reductions observed were for unmarketable spotted seatrout, which were reduced 60.1% by weight and 63.6% in number (Gearhart 2001). Results indicated that the panels should be required in the southern Pamlico and Core Sound areas only. Rule (15A NCAC 03J.0109(3) was implemented in late 1998 and has been in place since the 1999 fishing season.

7.2.3.3 Beach seine fishery results

Beach seines are used to target different species during different times of the year in varying regions of the state. Spotted seatrout are primarily caught in beach seines during January to May in the northernmost region of the state, harvestfish and spot are targeted during the summer months, and striped mullet are targeted by beach seines used in combination with stop nets in the Carteret County region during the fall months.

Unfortunately, landings by beach seines and stop nets cannot be differentiated due to a limited number of participants in the stop net fishery. Therefore, the stop net landings data are confidential. The landings presented below include both beach seines and stop net fisheries landings (Table 32). From 1994 to 2008, spotted seatrout harvested by beach seines and stop nets averaged only 4% of the total harvest and 26,836 pounds. The average catch was 97 pounds per trip. However, large catches (> 500 pounds) do occasionally happen during the spring months in the northern region and during the fall months in the southern region.

Although trip ticket data are confidential, biological sampling of the two fisheries can be used to describe both the beach seine and stop net catch. Spotted seatrout were the fifth most abundant species sampled, by weight, in the beach seine fishery (Table 33). They averaged 110 pounds per catch, represented 5% of the total weight of the catches, and averaged 2 pounds each. Bait samples from this fishery were primarily composed of small bluefish, menhaden, and spot. No spotted seatrout were observed in the bait samples from this fishery.

7.2.3.4 Stop net fishery results

As mentioned before, the stop net fishery mesh size configurations have resulted in an increase in mesh size for portions of the stop nets which may have resulted in the inadvertent bycatch of large-bodied marine species, including bottenose dophins (*Tursiops truncates).* NMFS investigated the incidental bycatch rates of dolphins, fish and other marine species in current and proposed stop net configurations (NMFS 2006, FR. Vol. 71, No.80). NMFS was concerned that decreasing the mesh size would cause bycatch of non-target species and undermine the compromise reached with pier owners in the early 1990's.

A study was conducted to examine the bycatch of all marine species in 4 inch and 8 inch stop nets during the 2005 and 2006 October-November fishing seasons to determine whether a modification to the mesh size of these nets would result in a change in bycatch rates (Thayer 2007). During this study, striped mullet account for 99% of the total fish hauled, with very little bycatch of other species. Spotted seatrout were caught exclusively in the 4 inch mesh size in the "suds section" of the net. It should be noted that during the study, approximately half of the suds portions of the nets were typically not in the water for approximately 1.5 hours before and after low tides. If the entire suds portion of all nets had been submerged, bycatch numbers would likely have been higher (Thayer 2007).

DMF's biological sampling of this fishery is limited (n=34), but of those catches sampled, spotted seatrout were the second most abundant by weight, the third most abundant by number, and averaged almost 2 pounds (Table 34). Bait sampled from the stop net fishery was 100% striped mullet.

As long as the stop net fishery continues to be prosecuted under current regulations, bycatch of spotted seatrout is not an issue in this fishery. However, should the NMFS decide to implement the Bottlenose Dolphin Take Reduction Plan (BDTRP) proposed rules (2004) such that only mesh sizes 4 inches or less be utilized within 300 feet of the beach/water interface, and if the DMF would allow such mesh sizes in the stop net fishery, bycatch of spotted seatrout could become an issue that would need to be addressed.

Table 32. Average annual landings (lbs), percent contributions (%), catch/trip (lbs/trip), and value for species landed in the NC beach seine/stop net fishery from 1994-2008.

Species	Landings (lbs)	Percent	Catch per trip (lbs/trip)	Value
Spot	182,897	26	677	$79,195
Striped Bass	121,945	17	625	$178,507
Mullets, Jumping	104,744	15	842	$64,318
Weakfish	61,104	9	203	$33,817
Bluefish	54,403	8	187	$13,748
Starbutter (Harvestfish)	29,688	4	283	$24,317
Dogfish, Uncl	29,048	4	1,614	$3,065
Spotted seatrout	**26,836**	**4**	**97**	**$32,588**
Sea Mullet (kingfish)	19,242	3	62	$17,556
Menhaden Bait	17,530	2	427	$1,910
Croaker	16,863	2	127	$5,255
Bait	9,476	1	249	$788
Dogfish, Spiny	5,287	1	598	$825
Mackerel, Spanish	5,259	1	47	$3,537
Red Drum	3,783	1	39	$4,025
Black Drum	3,334	0	41	$879
Hickory Shad (Jack)	2,698	0	128	$481
Butterfish	2,439	0	23	$1,047
Thresher Shark	1,880	0	248	$470
Little Tunny	1,711	0	76	$401
Skates	1,302	0	364	$182
Pompano	1,067	0	20	$1,285
Sandbar Shark	1,014	0	225	$232
Rock Sea Bass	938	0	938	$488
Northern Puffer	861	0	36	$304
Smooth Dogfish	777	0	204	$160
Unid Sharks	774	0	159	$184
Other	6,514	1	1,266	$3,531
Total	713,411		9,806	$473,094

Table 33. Species composition of beach seine average marketed catches, 1994-2008 combined, N=184.

Species	Weight (lbs) Mean	Weight (lbs) Percent	Number Mean	Number Percent	Mean fish weight (lbs)
Striped mullet	817.9	40	524	25	1.6
Spot	538.6	26	1,048	49	0.5
Weakfish	137.8	7	123	6	1.1
Bluefish	122.8	6	90	4	1.4
Spotted seatrout	**109.8**	**5**	**56**	**3**	**2.0**
Striped bass	94.6	5	24	1	4.0
Harvestfish	46.1	2	154	7	0.3
Clearnose skate	29.5	1	3	0	8.6
Southern kingfish	24.9	1	35	2	0.7
Hickory shad	23.4	1	16	1	1.5
Jawed fished	22.5	1	.	.	.
Southern stingray	18.1	1	.	.	.
Atlantic menhaden	15.4	1	10	1	1.5
Kingfishes	14.6	1	1	0	0.8
Gulf kingfish	9.5	1	12	1	0.8
Red drum	8.2	<0.1	1	<0.1	6.2
Spanish mackerel	5.7	<0.1	4	<0.1	1.6
Black drum	5.3	<0.1	2	<0.1	2.2
Atlantic croaker	5.1	<0.1	5	<0.1	1.0
Skates	4.0	<0.1	.	.	.
Mullets	3.7	<0.1	.	.	.
Banded drum	2.2	<0.1	5	<0.1	0.5
Atlantic spadefish	2.0	<0.1	8	<0.1	0.2
Butterfish	1.5	<0.1	4	<0.1	0.4
Cat sharks	1.5	<0.1	1	<0.1	2.7
Florida pompano	1.3	<0.1	3	<0.1	0.5
Sheepshead	1.1	<0.1	0	<0.1	4.0
Others	<0.2	<0.1	1	<0.1	1.0

Table 34. Species composition of stop net average marketable catches, 1994-2008 combined, n=34.

Species	Weight (lbs) Mean	Weight (lbs) Percent	Number Mean	Number Percent	Mean fish weight (lbs)
Striped mullet	3,021	83	4,123	90	0.7
Spotted seatrout	**233**	**6**	**140**	**3**	**1.9**
Bluefish	171	5	184	4	0.9
Spot	118	3	97	2	1.2
Mullets	49	1	.	.	.
Black drum	41	1	37	1	1.1
Red drum	8	0	2	<0.1	4.3
Gulf kingfish	3	0	7	0	0.4
Kingfishes	2	0	.	.	.
Florida Pompano	2	<0.1	5	0	0.3
Little tunny	1	<0.1	0	<0.1	14.3
Sheepshead	0	<0.1	1	<0.1	0.3
Weakfish	0	<0.1	0	<0.1	1.4
White mullet	0	<0.1	2	<0.1	0.1
Atlantic croaker	0	<0.1	0	<0.1	0.3
Summer flounder	<0.1	<0.1	0	<0.1	0.5
Gizzard shad	<0.1	<0.1	.	<0.1	.
Lookdown	<0.1	<0.1	.	<0.1	.
Harvestfish	<0.1	<0.1	.	<0.1	.

7.2.3.5 Trawl fishery results

7.2.3.5.1 Shrimp trawl fishery results

Data for spotted seatrout bycatch, incidental and discarded, in the North Carolina shrimp trawl fishery is available from the NCTTP, and various gear testing and characterization studies.

Marketable bycatch

An average of 375,638 pounds of marketable finfish is landed annually by shrimp trawls in North Carolina (NCTTP 1994-2008). Spotted seatrout accounts for less than 0.01% of the total shrimp trawl harvest with average yearly landings of 100 pounds (Table 35). Ninety-five percent of the reported landings come from four areas; Core Sound (50%), Pamlico Sound (34%), Atlantic Ocean (8%), and Bogue Sound (3%). In addition to the standard otter trawl, shrimp are harvested by skimmer trawls, a modified wing net sewn to an aluminum or steel pipe frame. Landings of spotted seatrout from this gear average 3 pounds per year.

Unmarketable bycatch

Characterization studies of bycatch in the shrimp trawl fishery in North Carolina were conducted in 2008 (Brown 2009), in 2004 and 2005 (Logothetis and McCuiston 2006), 1999 (Johnson 2003), and 1995 (Diamond-Tissue 1999). Brown (2009) examined the bycatch of shrimp trawlers in the near shore waters from Carteret to Brunswick counties. Catches were examined from 314 tows made over the course of 143 trips from July 2007 to June 2008. The total catch (bycatch and shrimp) of all sampled tows was 160,434 pounds of which 63 pounds were spotted seatrout (0.04% of the total catch). Logothetis and McCuiston (2006) quantified the catch of shrimp trawls working in the Intracoastal Waterway from the New River south to the South Carolina/North Carolina border (n=253 tows). The total weight of the bycatch was 8,067 pounds of which 12 pounds were spotted seatrout (0.15% of the bcatch). Johnson (2003) quantified the catch of shrimp trawlers working in Core Sound (n=46 tows) and the Neuse River (n=8 tows) during the summers of 1999 and 2000 and no spotted seatrout were observed in any of the catches. Diamond-Tissue's (1999) 1995 characterization study examined 52 tows conducted over 15 trips in the Pamlico Sound (n=16), Cape Fear River (n=24), Core Sound (n=4), and Atlantic Ocean waters off Carolina Beach (n=8). A total of 92 different species, including 66 species of finfish, 10 species of crabs, and 13 other invertebrates were identified (Diamond-Tissue 1999). Data was presented for the top ten species (number and weight) in each area and season, spotted seatrout was not listed in the top ten in any area. In addition to the three aforementioned characterization studies, Ingraham (2003) conducted a study of shrimp and finfish catch rates (day vs. night) in state waters from Topsail Inlet to Little River Inlet. A total of 66 tows were made, no spotted seatrout were captured.

7.2.3.5.2 Fish trawl fishery results

Spotted seatrout caught in the finfish trawl fisheries is negligible with <220 pounds of marketable spotted seatrout caught per season in most years. Exceptions occurred in 1999-2000 and 2006-2007 when 882 pounds and 1,102 pounds were landed (Batsavage 2007, Monaghan 2001).

7.2.3.5.3 Crab trawl fishery results

Marketable bycatch

Finfish landings from crab trawls averaged 62,004 pounds per year (NCTTP 1994-2008). The main finfish species landed was southern flounder accounting for 79% of the total. Spotted seatrout landings accounted for 0.6% of total finfish landings from this gear and averaged 366 pounds per year (Table 36). December (11%), January (32%), and February (41%) account for 84% of the spotted seatrout landings. Eighty-four percent of all spotted seatrout landings from crab trawls came from the Pamlico River.

Unmarketable bycatch

The unmarketable bycatch of spotted seatrout in the crab trawl fishery has been examined by McKenna and Camp (1992), McKenna and Clark (1993), and Lupton (1996). Total spotted seatrout captured in the studies was only 0.6 pounds, zero, and 2 fish, respectively.

Table 35. Annual landings (lbs) from shrimp trawls in North Carolina, 1994-2008.

Year	Total catch	Total finfish	Spotted seatrout
1994	7,806,149	450,372	685
1995	8,798,394	661,160	295
1996	6,153,084	965,241	3
1997	7,867,190	1,100,872	5
1998	5,049,918	222,366	13
1999	8,829,326	436,998	42
2000	10,001,754	346,769	160
2001	5,088,097	151,866	6
2002	9,286,511	243,527	32
2003	5,895,473	154,499	0
2004	4,720,874	205,213	99
2005	2,148,628	39,754	8
2006	5,013,152	112,812	58
2007	9,059,225	230,579	58
2008	9,105,472	312,547	38
Average	6,988,216	375,638	100

Table 36. Annual landings (lbs) from crab trawls in North Carolina, 1994-2008.

Year	Total catch	Total finfish	Spotted seatrout
1994	2,020,351	117,973	345
1995	1,144,968	66,785	1,511
1996	3,231,137	106,278	370
1997	3,421,417	106,831	140
1998	3,226,974	113,707	359
1999	1,925,483	92,888	636
2000	1,028,085	74,735	2,025
2001	1,091,793	64,736	43
2002	1,111,837	36,694	15
2003	1,388,528	57,611	3
2004	977,037	54,177	31
2005	429,387	24,598	0
2006	148,962	2,538	5
2007	32,172	2,671	11
2008	1,605,225	7,841	1
Average	1,518,891	62,004	366

7.2.3.6 Crab pot fishery results

<u>Marketable bycatch</u>

Annual landings of the marketable portion of the incidental finfish bycatch from hard crab pots averaged 55,292 pounds (NCTTP 1994-2008). Annual landings of spotted seatrout from hard crab pots averaged 1,236 pounds (Table 37). Eighty-three percent of the landed spotted seatrout were captured May through July. Spotted seatrout landed from hard crab pots have been reported from 24 waterbodies. Pamlico Sound accounts for 24% of the landings, followed by the Pamlico (23%), and Pungo rivers (14%), Albemarle Sound (9%), and Roanoke Sound (7%).

Reported average annual finfish landings from peeler pots are 1,266 pounds (NCTTP 1994-2008). Spotted seatrout account for 4% of the finfish landed with average annual landings of 45 pounds.

<u>Discarded unmarketable bycatch</u>

Four crab pot fishermen kept records of bycatch in their Neuse River hard and peeler pots from March through October 1999 (Doxey 2000). Hard crab pot data were collected from 283 trips during which 149,649 hard crab pots were fished. Peeler pot data were collected from 11 trips taken in May during which 1,950 peeler pots were fished. Seventeen finfish species were observed in hard crab pots and nine in peeler pots. Spotted seatrout made up 9% (n=61) of the catch in hard crab pots and 1% (n= 2) in peeler pots. The average size of spotted seatrout in the hard crab pots was 13”, range 5 to 18”, while the two fish captured in the peeler pots were 10” and 12”. Observed mortality of captured spotted seatrout was 59% in the hard crab pots and 0% in the peeler pots. The overall catch per pot for spotted seatrout was 0.001.

Thorpe et al. (2004) documented the bycatch in hard crab pots (May – December 2003) from Core Sound [CS (28 trips)] and Brunswick County [BC (28 trips)]. No spotted seatrout were captured.

Hassell and Bonner (2008) examined the bycatch of hard crab pots in the Pamlico River. Samples were collected from 132 trips, May to October, during which 37,730 pots were examined for bycatch. Of the 1,037 finfish captured, 23 were spotted seatrout, which represented 2% of the total finfish bycatch. Thirty-nine percent of the captured spotted seatrout were dead when the pots were fished. The overall catch per pot for spotted seatrout was 0.001.

The DMF (2008) conducted a ghost pot study in Alligator River, Pamlico River, Bogue Sound, and Middle Sound areas of the state from September 2002 to December 2006. The study was designed to identify effective biodegradable materials that would allow the escapement of species caught in ghost pots as well as determine species caught in ghost pots by area, number of individuals caught, and estimate a mortality rate for each species. No spotted seatrout were caught in the four year study.

Table 37. Annual landings (lbs) from hard crab pots in North Carolina, 1994–2008.

Year	Total catch	Total finfish	Spotted seatrout
1994	50,742,796	136,896	1,838
1995	44,755,856	74,113	1,433
1996	63,269,269	52,711	351
1997	103,879,373	145,895	1,600
1998	57,418,640	35,290	708
1999	54,504,177	58,559	4,894
2000	38,507,465	37,715	773
2001	29,520,784	55,558	382
2002	35,495,763	56,956	2,251
2003	40,398,537	40,970	53
2004	32,001,720	22,865	142
2005	23,709,328	16,565	56
2006	24,492,258	28,003	1,187
2007	20,760,964	39,371	979
2008	30,826,451	27,909	1,888
Average	43,352,225	55,292	1,236

7.3 Recreational Fishery

Spotted seatrout are highly targeted recreational fishes along the southeast Atlantic Coast and Gulf of Mexico. Its current abundance and willingness to take natural and artificial baits along with its fine eating qualities make the species tremendously popular with anglers. Anglers target spotted seatrout in nearly all inshore waters, from the surf to far up coastal rivers. The popularity of spotted seatrout as a primary target species has fluctuated across the time series. Since 2005, spotted seatrout has not only ranked first as the primary species targeted in the South Atlantic but in North Carolina as well.

7.3.1 Recreational Fishing Practices

Spotted seatrout are taken by a variety of methods throughout the coastal zone. Depending on the time of year, anglers fish for spotted seatrout from the surf, piers and jetties, bays and rivers, and inland creeks. The fall season produces the largest portion of the catch and offers the most widespread fishing opportunities. Anglers generally catch spotted seatrout using an array of artificial and natural baits. Preferred artificial baits include soft and hard bodied lures of various colors and shapes fished on the bottom, mid-water, and top water. Bottom fishing using natural baits (including live shrimp, mullet, and mud minnows) is also very popular and can be very productive as well.

While lures and fishing techniques are constantly evolving, the past ten years has seen significant changes and improvements in lures and other tackle available to anglers that target and catch spotted seatrout. There is anecdotal evidence that these improvements have had a positive impact on catch rate and overall fishing success. In the early 2000's, bait manufacturers introduced "scented" soft-bodied lures that have become very popular and successful with anglers targeting spotted seatrout. Hard-bodied artificial baits such as MirrOlure® have also undergone design and color pattern changes increasing their effectiveness. Many anglers also attest to better catch rates due to the widespread use of braided fishing lines. Braided lines along with new graphite rod building technology provide increased sensitivity improving strike detections resulting in more fish caught.

Over the past several years a fishing technique has become popular during winter months when large numbers of fish migrate into upper estuarine and inland areas. This technique involves slow trolling from boats using a variety of lures suspended from floats. Once schools of fish are located within the area, anglers slow down their vessels and begin to cast using more conventional methods. In addition to hook and line catches, some spotted seatrout are taken by recreational commercial gear (gill nets) where permitted (ASMFC, 1984).

7.3.2 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 inside waters along the entire North Carolina coast. In 2002, DMF began collecting data from recreational fishermen who are allowed to harvest recreational limits of finfish while using commercial gear if they possess a Recreational Commercial Gear License (RCGL). In 2004 DMF 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 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 unpredictable distribution of spotted seatrout due to changes in salinity in upper estuarine and inland regions will make results from this survey a useful addition in future assessment of the overall harvest of this species.

7.3.3 Marine Recreational Fisheries Statistics Survey

MRFSS provides the primary data that are used to estimate the impact of marine recreational fishing on marine resources (DMF 2007d). MRFSS was initiated in 1979 by the National Marine Fisheries Service to gather information from 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. 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). 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 (DMF 2007d).

In 2008 DMF along with 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. DMF's efforts in securing this pilot project were to fulfill the obligation to use the CRFL data to better estimate impacts from recreational anglers on economically important species.

7.3.4 MRFSS Harvest Estimates

Along the Atlantic Coast, three states are responsible for harvesting 79% of the recreational spotted seatrout harvest since 1991. Georgia, North Carolina, and the east coast of Florida are respectively responsible for harvesting 28%, 27%, and 24% of all Atlantic Coast recreationally caught spotted seatrout (Table 38).

Landings of spotted seatrout from these three states are so similar in magnitude that each have had six of the highest yearly landings by weight during the 18-year time period. Since 2006, the harvest of spotted seatrout in North Carolina has been significantly larger than estimates from Florida (east coast) or Georgia.

Table 38. East Coast recreational harvest in pounds of spotted seatrout, 1991-2008.

Year	Delaware	Maryland	Virginia	North Carolina	South Carolina	Georgia	Florida East Coast
1991	979	34,753	121,604	472,397	628,011	1,449,853	534,371
1992	0	7,802	56,685	508,760	227,210	430,946	543,491
1993	243	12,800	201,562	307,151	268,055	586,426	392,827
1994	0	26,764	175,184	679,996	183,343	412,392	357,441
1995	584	31,464	148,544	478,674	247,987	667,379	642,670
1996	317	0	77,269	197,261	171,727	196,487	249,898
1997	0	32,963	261,911	311,891	163,771	242,506	380,276
1998	919	37,189	61,888	444,441	151,718	262,896	329,793
1999	3,459	0	290,694	690,606	146,277	916,860	428,061
2000	924	2,972	195,544	385,190	267,297	565,903	545,202
2001			26,733	213,438	58,885	369,083	502,254
2002	0		28,882	274,100	111,954	302,559	353,693
2003		3,494	218,061	145,936	140,276	502,278	316,279
2004		0	134,602	385,624	229,541	377,370	390,880
2005		10,761	76,325	628,739	326,501	263,209	603,891
2006		9,993	132,629	941,161	369,165	531,441	533,121
2007		0	305,599	988,527	211,225	531,637	594,506
2008			194,097	911,097	292,813	713,453	296,633
Total	7,425	210,955	2,707,813	8,964,989	4,195,756	9,322,678	7,995,287
Average	675	14,064	150,434	498,055	233,098	517,927	444,183

North Carolina harvest of spotted seatrout fluctuated widely from 1991 until its lowest level (145,936 lbs) in 2003. Landings exhibited a steep increase from 2004 (385,624 lbs) through 2006 (941,161 lbs) and have since maintained record levels (Table 38, Figure 30). The recreational spotted seatrout harvest in Virginia is substantially lower than that of North Carolina. As shown in Table 40 and Figure 31, Virginia estimates of harvest (pounds) were lowest in 2001 (26,733 lbs) and reached their highest level in 2007 (305,599 lbs). Precision of harvest estimates in terms of the proportional standard error (PSE) were below 20 in all years for North Carolina while Virginia had only four years (1994, 1995, 2007, and 2008) of the 18-year time series with a PSE less than 20.

Table 39. North Carolina recreational harvest (number and lbs) of spotted seatrout,1991-2008.

Year	Harvest (number)	PSE	Weight (lbs)	PSE
1991	316,895	10.3	472,397	11.2
1992	333,990	11.3	508,760	11.8
1993	206,523	8.7	307,151	8.5
1994	457,636	7.5	679,996	8.0
1995	325,927	9.5	478,674	10.8
1996	151,380	16.6	197,261	15.5
1997	256,719	11.1	311,891	11.4
1998	294,501	12.2	444,441	13.0
1999	410,321	12.4	690,606	13.2
2000	250,450	14.9	385,190	17.1
2001	182,124	14.1	213,438	14.1
2002	197,484	15.6	274,100	17.2
2003	106,415	18.6	145,936	19.2
2004	316,894	12.9	385,624	13.2
2005	512,262	11.2	628,739	11.6
2006	577,537	9.8	941,161	10.9
2007	525,156	10.5	988,527	12.1
2008	576,703	9.6	911,097	10.4

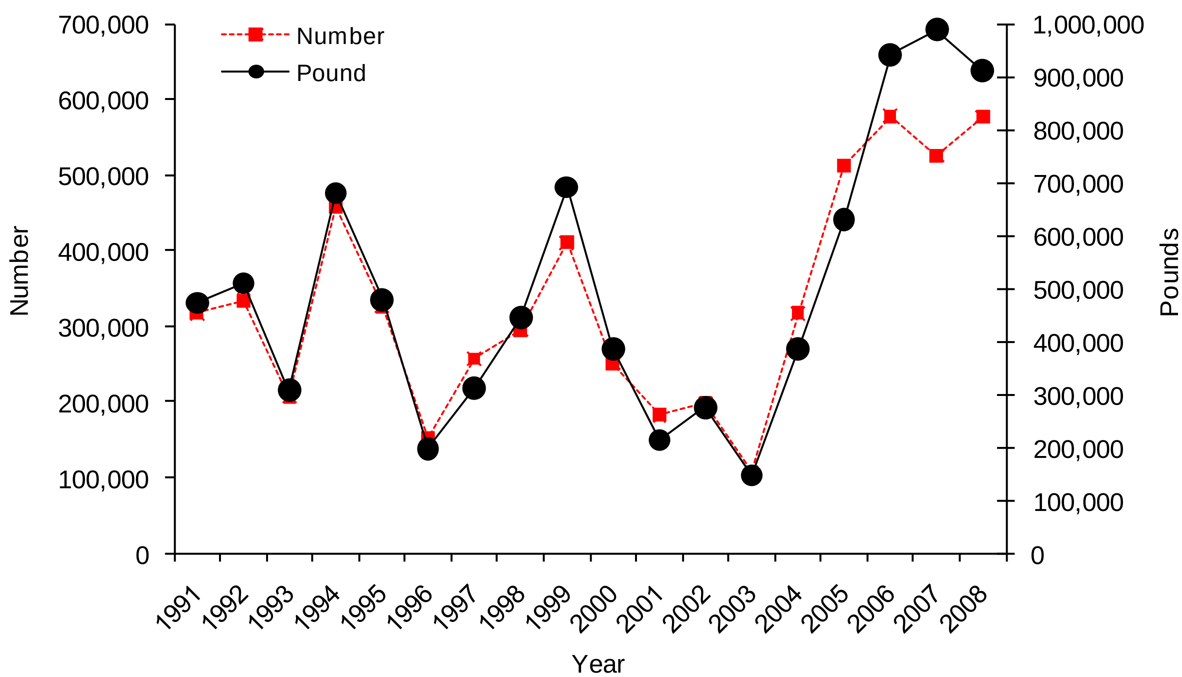


Figure 30. North Carolina recreational harvest (number and pounds) of spotted seatrout, 1991- 2008.

Table 40. Virginia recreational harvest (number and pounds) of spotted seatrout, 1991-2008.

Year	Harvest (number)	PSE	Weight (lbs)	PSE
1991	69,032	21.6	121,604	21.7
1992	30,091	24.6	56,685	26.1
1993	103,131	21.8	201,562	22.4
1994	115,025	12.7	175,184	13.5
1995	90,838	17.8	148,544	17.6
1996	46,098	25.1	77,269	24.1
1997	92,725	21.7	261,911	23.9
1998	34,623	24.9	61,888	26.0
1999	138,492	24.8	290,694	24.6
2000	90,135	23.7	195,544	23.5
2001	13,447	36.9	26,733	22.1
2002	16,303	27.5	28,882	34.2
2003	102,484	22.0	218,061	21.5
2004	74,747	26.3	134,602	28.9
2005	31,416	53.7	76,325	54.4
2006	56,475	39.2	132,629	40.5
2007	145,736	18.9	305,599	17.9
2008	78,768	18.9	194,097	18.6

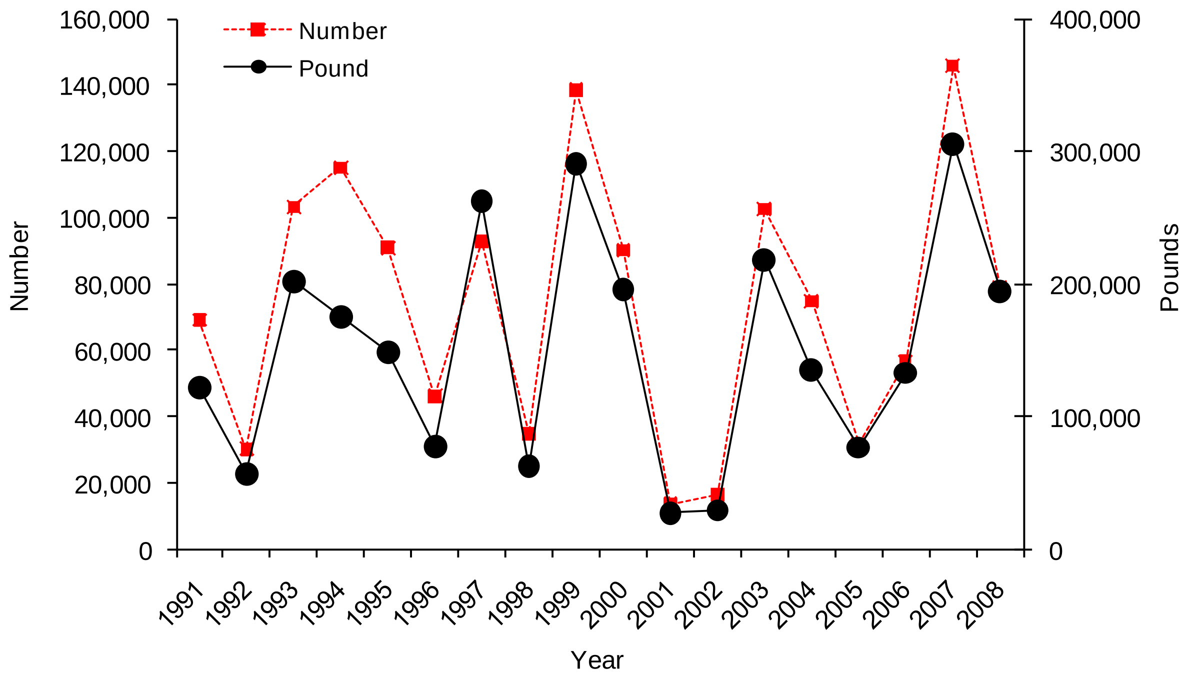


Figure 31. Virginia recreational harvest (number and pounds) of spotted seatrout, 1991-2008.

Precision of harvest estimates associated with the MRFSS is largely influenced by the number of observations (samples of a given species). NOAA Fisheries funds the MRFSS nationally at a level to provide estimates of catch with levels of precision required to satisfy regional (i.e., North Atlantic, Mid-Atlantic, South Atlantic, and Gulf) fisheries management needs. These limitations prompted the DMF in 1987 to increase the number of samples obtained through MRFSS to meet state level fisheries management objectives. Unfortunately fisheries managers in most states rely on NOAA to fund its recreational data collection and have not increased sample needed for conducting state level assessments. Therefore, due to high variability and low precision of estimates, spotted seatrout harvest data from Virginia should be used with caution.

7.3.5 MRFSS Discard Estimates

Spotted seatrout are discarded (released alive) for a variety of reasons including catch under the legal size limit, over the creel limit, or conservative catch and release practices. MRFSS provides estimates of discards and identifies the disposition of fish released. Approximately 88% of discards are released because of the minimum size limit (Table 41).

The annual estimates of spotted seatrout discards were less variable in North Carolina during 1991 through 2003, ranging from 150,896 fish in 1992 to 479,583 in 2002. Since 2003, the numbers of discarded spotted seatrout sharply increased to a record level of 1,657,378 fish in 2008 (Figure 32).

Table 41. Disposition of spotted seatrout discarded (released alive) by recreational anglers, 1991-2008.

Year	Released (Legal)	Released (Not Legal)	Year	Released (Legal)	Released (Not Legal)
1991	13.25	86.75	2000	-	100.00
1992	10.26	89.74	2001	16.24	83.76
1993	10.37	89.63	2002	10.19	89.81
1994	15.12	84.88	2003	10.11	89.89
1995	4.45	95.55	2004	15.15	84.85
1996	1.67	98.33	2005	9.94	90.06
1997	7.69	92.31	2006	17.07	82.93
1998	7.69	92.31	2007	12.20	87.80
1999	10.34	89.66	2008	12.06	87.94

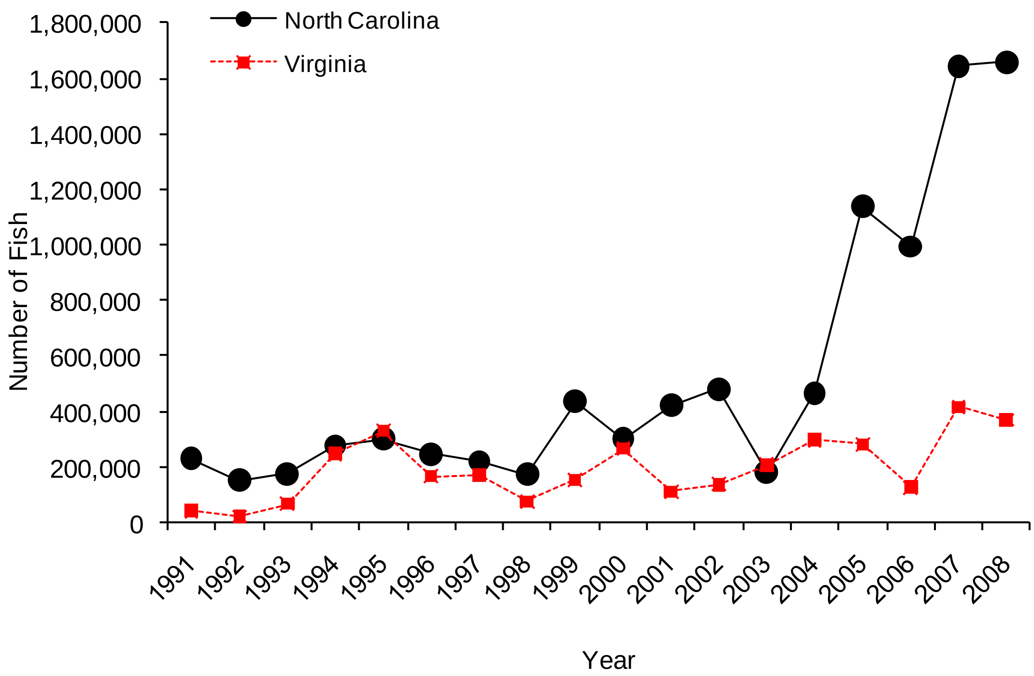


Figure 32. Number of discarded (released alive) spotted seatrout in North Carolina and Virginia, 1991-2008.

7.3.6 MRFSS Catch Per Angler Trip

The average catch (harvest and release) of spotted seatrout per successful angler trip has fluctuated throughout the time series ranging from a low 2.3 fish per angler in 2000 up to a high of 5.3 fish per angler in 2005. Three of the four highest CPUE levels occurred since 2005 (Figure 33). Approximately 90% of anglers harvest fewer than six spotted seatrout per trip while 5% of anglers reach their creel limit (Table 42). The occurrence of such a high percent of anglers reaching their maximum creel limit suggests that anglers may measure the successfulness of their trip based on reaching the creel limit.

7.3.7 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. During 1991-2008 spotted seatrout landings were relatively low during waves 1 (January-February) and 2 (March-April). Harvest began to increase in wave 3 (May-June) but peaked in wave 6 (November-December) representing approximately 45% of the total spotted seatrout harvest (Table 43).

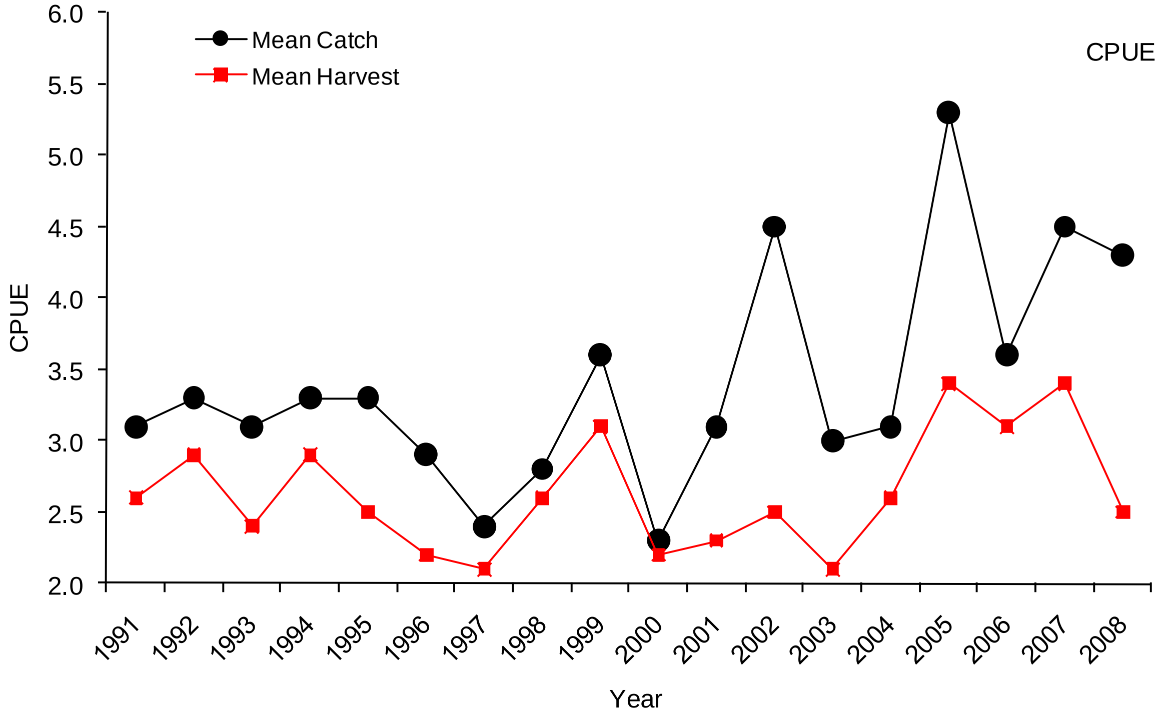


Figure 33. Catch and harvest per successful angler trip for spotted seatrout, 1991-2008.

Table 42. Frequency distribution of the numbers of spotted seatrout caught per angler trip.

	Number of Spotted Seatrout Per Angler Trip										
Year	0	1	2	3	4	5	6	7	8	9	10+
1991	9.0	44.8	14.6	9.6	6.5	6.0	1.4	1.4	1.4	1.1	4.1
1992	6.4	43.9	21.2	5.5	7.0	3.5	1.2	2.6	2.3	0.3	6.2
1993	8.4	41.5	18.8	7.8	5.7	9.6	2.4	2.1	0.9	2.1	0.9
1994	5.6	38.3	21.6	8.8	6.5	4.2	1.1	2.6	1.6	2.1	7.6
1995	2.6	50.1	12.9	12.7	9.2	2.4	2.8	1.2	0.7	0.7	4.6
1996	9.0	49.4	24.7	9.0	1.2	1.8	0.9	.	0.6	0.3	3.0
1997	14.8	40.2	19.1	10.5	4.8	2.3	2.0	1.1	0.7	1.8	2.9
1998	7.1	43.5	16.4	7.7	6.3	4.7	4.0	2.4	0.5	1.8	5.5
1999	4.6	39.0	16.9	10.4	8.0	3.4	3.1	2.1	1.8	1.8	8.9
2000	8.8	52.7	15.8	9.6	1.5	4.2	1.5	1.5	.	0.4	3.9
2001	9.2	37.5	22.1	14.2	6.7	3.3	2.1	1.3	0.8	0.4	2.5
2002	3.3	42.0	14.4	23.8	5.5	3.3	1.7	0.6	0.6	0.6	4.4
2003	6.8	49.6	18.8	10.3	0.9	5.1	5.1	0.9	0.9	0.9	0.9
2004	1.0	45.7	22.3	9.3	3.4	7.6	0.3	5.5	1.0	.	3.8
2005	3.9	30.0	19.2	13.5	8.6	4.9	2.9	2.7	3.9	2.2	8.1
2006	3.0	33.7	19.4	13.1	5.9	7.7	6.3	1.2	3.5	0.3	5.8
2007	0.8	31.2	23.4	12.2	7.2	4.2	3.2	4.4	3.6	1.5	8.4
2008	4.0	44.6	18.7	11.0	6.6	2.6	3.9	0.7	2.4	2.2	3.3

Table 43. Harvest of spotted seatrout by wave, 1991-2008.

	Wave of Estimate (two-month period)												
	Jan/Feb		Mar/Apr		May/Jun		Jul/Aug		Sep/Oct		Nov/Dec		
Year	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Total
1991	1,260	0.4	5,844	1.8	73,501	23.2	20,232	6.4	69,744	22.0	146,314	46.2	316,895
1992		0.0	8,191	2.5	56,702	17.0	16,074	4.8	173,884	52.1	79,139	23.7	333,990
1993		0.0		0.0	50,496	24.5	35,410	17.1	48,938	23.7	71,678	34.7	206,522
1994		0.0	3,712	0.8	62,970	13.8	38,728	8.5	171,548	37.5	180,679	39.5	457,637
1995		0.0	868	0.3	27,252	8.4	47,099	14.5	53,133	16.3	197,574	60.6	325,926
1996		0.0	1,813	1.2	21,520	14.2	13,301	8.8	45,766	30.2	68,980	45.6	151,380
1997		0.0	3,482	1.4	34,998	13.6	70,453	27.4	59,822	23.3	87,964	34.3	256,719
1998		0.0	0	0.0	84,563	28.7	62,107	21.1	85,386	29.0	62,445	21.2	294,501
1999		0.0	1,359	0.3	71,425	17.4	67,301	16.4	148,425	36.2	121,812	29.7	410,322
2000		0.0		0.0	42,890	17.1	54,743	21.9	75,770	30.3	77,047	30.8	250,450
2001		0.0	1,606	0.9	25,481	14.0	12,185	6.7	61,435	33.7	81,417	44.7	182,124
2002		0.0	251	0.1	21,081	10.7	25,048	12.7	62,687	31.7	88,417	44.8	197,484
2003		0.0	3,708	3.5	25,834	24.3	16,107	15.1	5,572	5.2	55,195	51.9	106,416
2004		0.0	1,266	0.4	9,235	2.9	23,324	7.4	94,232	29.7	188,837	59.6	316,894
2005	840	0.2	954	0.2	35,202	6.9	13,351	2.6	120,425	23.5	341,491	66.7	512,263
2006	34,994	6.1	34,574	6.0	107,700	18.6	49,287	8.5	109,919	19.0	241,064	41.7	577,538
2007	5,528	1.1	7,290	1.4	34,208	6.5	112,634	21.4	50,329	9.6	315,167	60.0	525,156
2008	16,457	2.9	13,886	2.4	63,588	11.0	66,851	11.6	121,664	21.1	294,258	51.0	576,704
Total		1.0*		1.5		14.1		12.4		26.0		45.0	

* Continuous Wave 1 sampling began in 2005.

7.3.8 MRFSS Catch by Area

MRFFS provides estimates based on internal or oceanic waters. Approximately 61% of spotted seatrout by weight and 64% by number were harvested in the internal waters of the state during 1991 through 2008 (Table 44). Standard MRFSS estimates of catch and effort are not provided at the county and specific waterbody levels. However, MRFSS intercept data can be summarized at many levels including county of landing and waterbody of catch. The use of unexpanded intercept data has been useful in the past for predicting the impact of potential management measures (for example, refer to Section 10.2.4 Management Measures to Address User Group Competition).

7.3.9 MRFSS Length Frequency Distribution of Catch

Since 1991, MRFSS samplers have measured and weighed over 10,000 spotted seatrout. The number measured has been highly variable ranging from 130 in 2003 to 1,076 in 1994. The variability in the number measured is influenced by fish availability and distribution and level of sampling. The average sized fish during the times series has ranged from just over 14.7 to 16.5 inches in total length and 1.1 pounds to 1.7 pounds (Table 45).

Table 44. Contribution of spotted seatrout harvest by weight and number from ocean and internal waters, 1991-2008.

	Harvest (number)				Harvest (lbs)			
Year	Internal	Percent	Ocean	Percent	Internal	Percent	Ocean	Percent
1991	195,120	61.6	121,775	38.4	267,361	56.6	205,037	43.4
1992	278,044	83.2	55,947	16.8	423,848	83.3	84,912	16.7
1993	117,423	56.9	89,100	43.1	177,728	57.9	129,423	42.1
1994	247,535	54.1	210,101	45.9	352,357	51.8	327,641	48.2
1995	137,969	42.3	187,958	57.7	173,041	36.2	305,633	63.8
1996	103,514	68.4	47,866	31.6	123,658	62.7	73,603	37.3
1997	185,087	72.1	71,632	27.9	215,449	69.1	96,440	30.9
1998	237,132	80.5	57,369	19.5	343,280	77.2	101,160	22.8
1999	284,436	69.3	125,885	30.7	444,679	64.4	245,928	35.6
2000	174,515	69.7	75,935	30.3	230,561	59.9	154,628	40.1
2001	140,096	76.9	42,028	23.1	167,790	78.6	45,648	21.4
2002	154,790	78.4	42,694	21.6	232,261	84.7	41,839	15.3
2003	39,688	37.3	66,727	62.7	59,806	41.0	86,129	59.0
2004	147,607	46.6	169,287	53.4	201,553	52.3	184,071	47.7
2005	337,942	66.0	174,320	34.0	399,685	63.6	229,051	36.4
2006	367,906	63.7	209,630	36.3	548,213	58.2	392,948	41.8
2007	274,230	52.2	250,926	47.8	450,783	45.6	537,742	54.4
2008	422,781	73.3	153,922	26.7	657,290	72.1	253,807	27.9

Table 45. Lengths and weights of spotted seatrout observed by MRFSS samplers, 1991-2008.

	Number of	Length (Inches, TL)			Weight (lbs)		
Year	Samples	Minimum	Maximum	Average	Minimum	Maximum	Average
1991	744	4.76	25.52	15.35	0.22	6.17	1.43
1992	543	4.96	24.78	15.70	0.22	4.85	1.48
1993	485	9.30	25.68	16.11	0.22	5.51	1.54
1994	1,076	10.61	24.62	16.10	0.33	5.51	1.45
1995	852	8.44	25.81	16.13	0.33	5.29	1.51
1996	307	8.89	24.95	15.36	0.33	5.51	1.41
1997	622	8.85	23.72	14.89	0.11	4.41	1.13
1998	550	11.10	23.47	16.17	0.44	4.08	1.49
1999	699	11.68	27.49	16.54	0.33	5.51	1.63
2000	330	11.43	25.85	15.86	0.44	5.73	1.45
2001	326	11.56	24.25	14.89	0.22	4.96	1.21
2002	283	11.92	25.44	15.25	0.33	5.51	1.27
2003	130	9.96	25.68	15.21	0.33	5.73	1.40
2004	313	8.93	23.06	15.50	0.22	3.88	1.28
2005	669	8.69	25.81	14.70	0.33	5.29	1.25
2006	740	10.16	26.63	16.31	0.22	5.73	1.51
2007	523	10.90	28.47	16.31	0.44	7.28	1.66
2008	833	11.64	27.24	16.05	0.33	6.61	1.55
All	10,025	4.76	28.47	15.79	0.11	7.28	1.44

Length frequencies observed for spotted seatrout exhibited both modal distributions with peaks in either the 12 to 13 inch bins or 16 to 17 inch size bins and bi-modal distributions with peaks in both the 12 to 13 inch size bins and 16 to 17 inch size bins throughout the time series examined (Figure 34 through Figure 36). The length distributions between internal and ocean caught fish suggest that on average, slightly larger fish were caught in ocean waters. For the entire time series roughly 90% of fish from internal waters were 18 inches or less, whereas 90% of fish from ocean waters where 19 inches or less (Figure 37 through Figure 39).

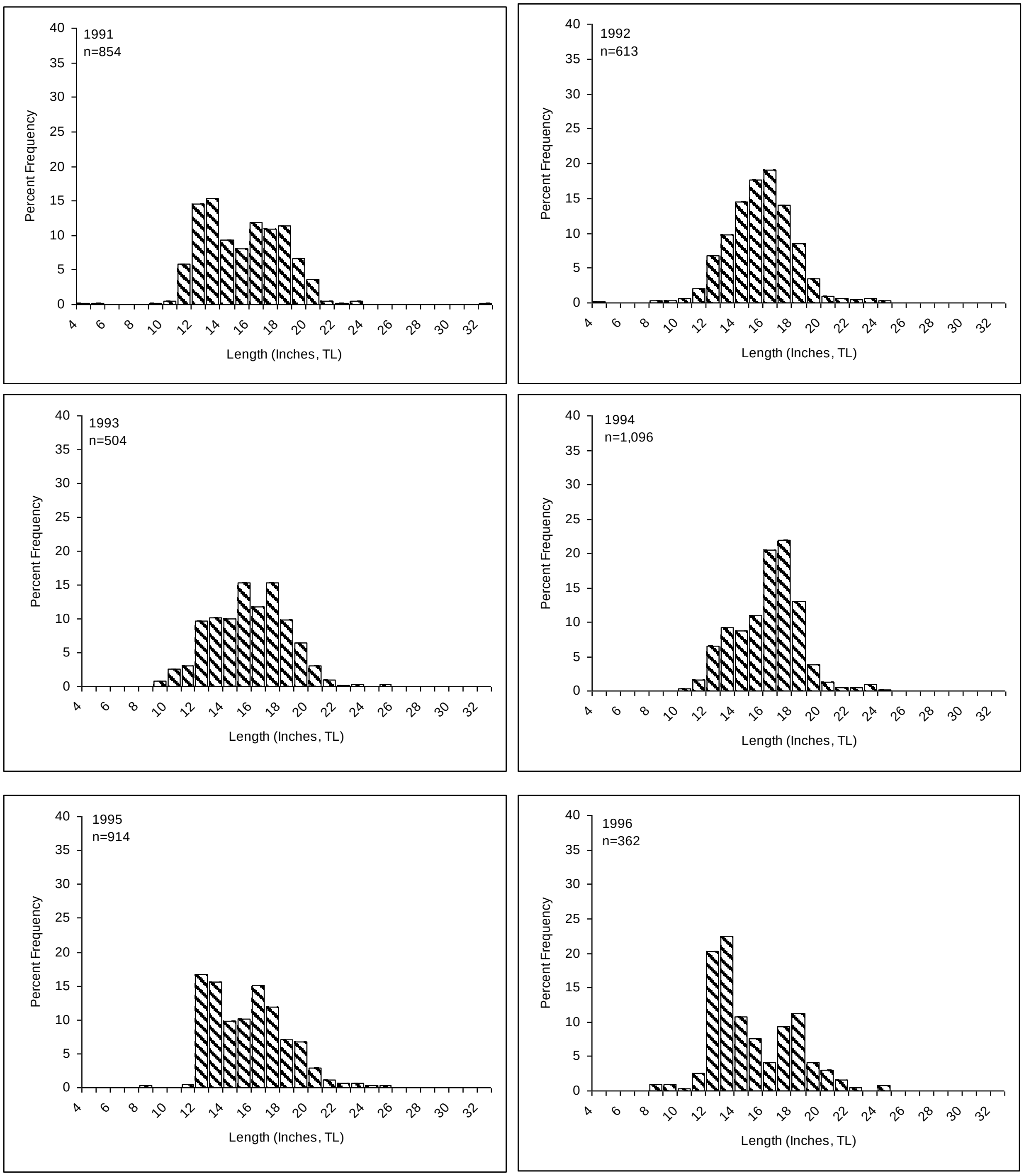


Figure 34. Length frequencies of spotted seatrout, 1991-1996.

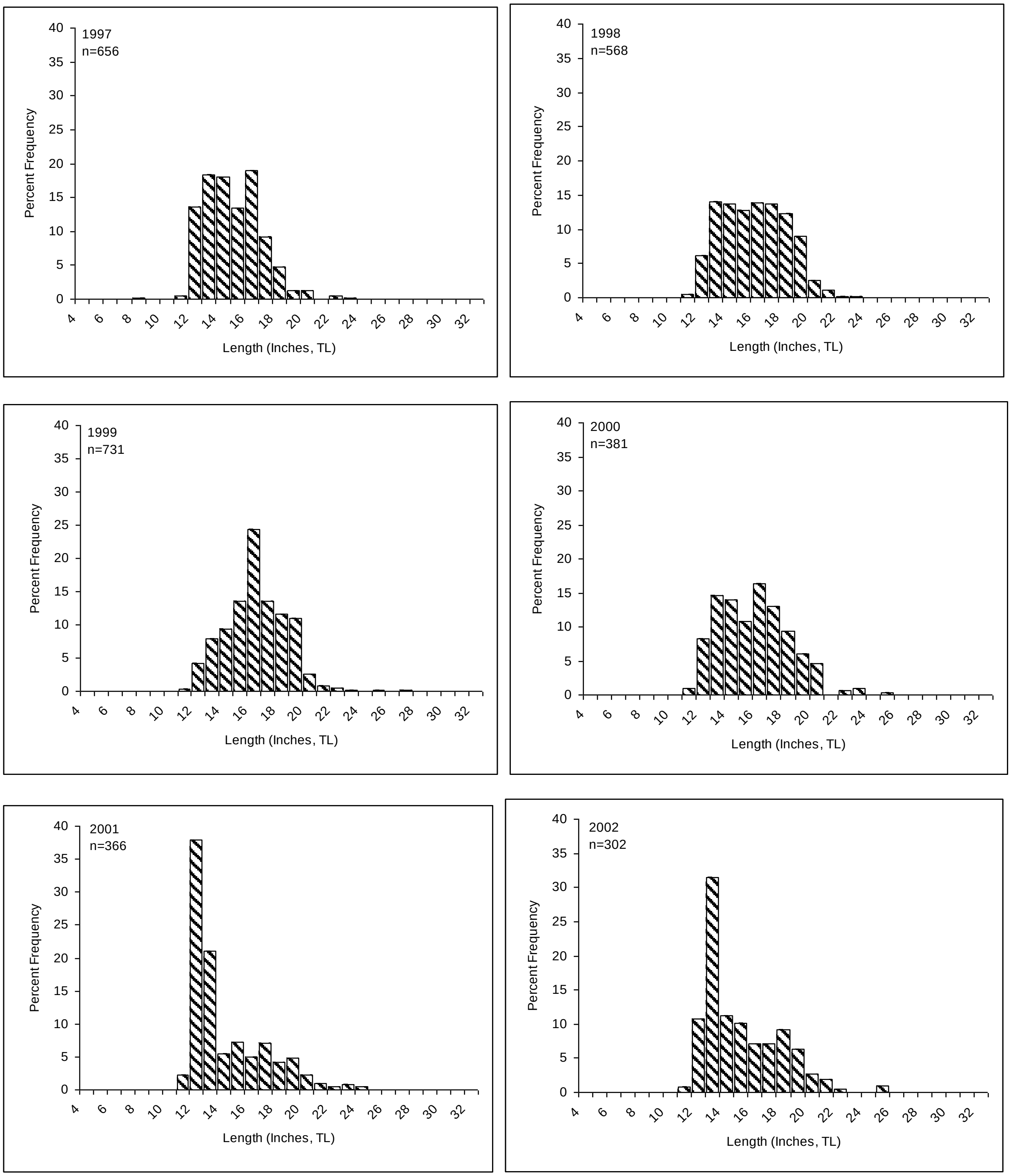


Figure 35. Length frequencies of spotted seatrout, 1997-2002.

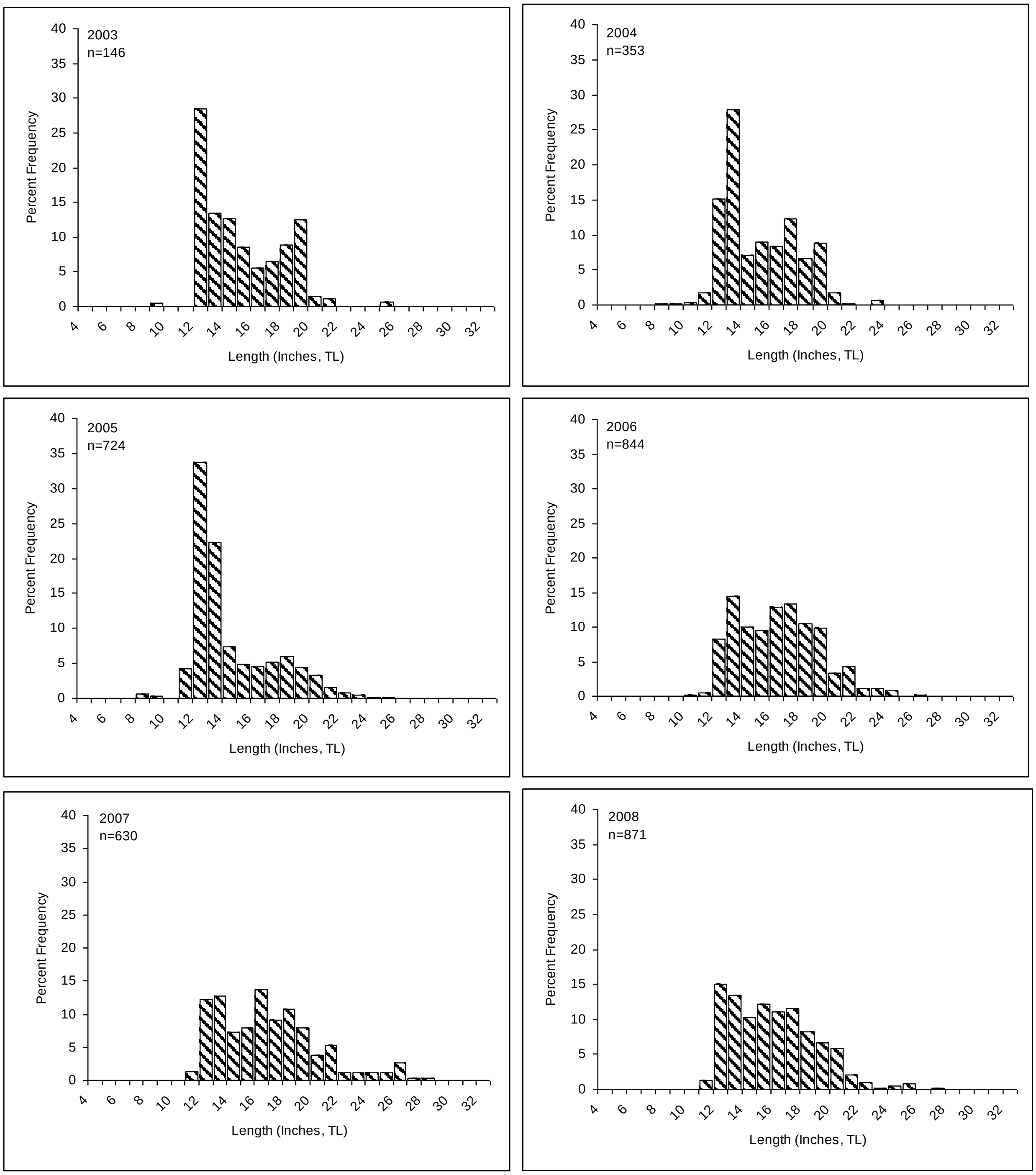


Figure 36. Length frequencies of spotted seatrout, 2003-2008.

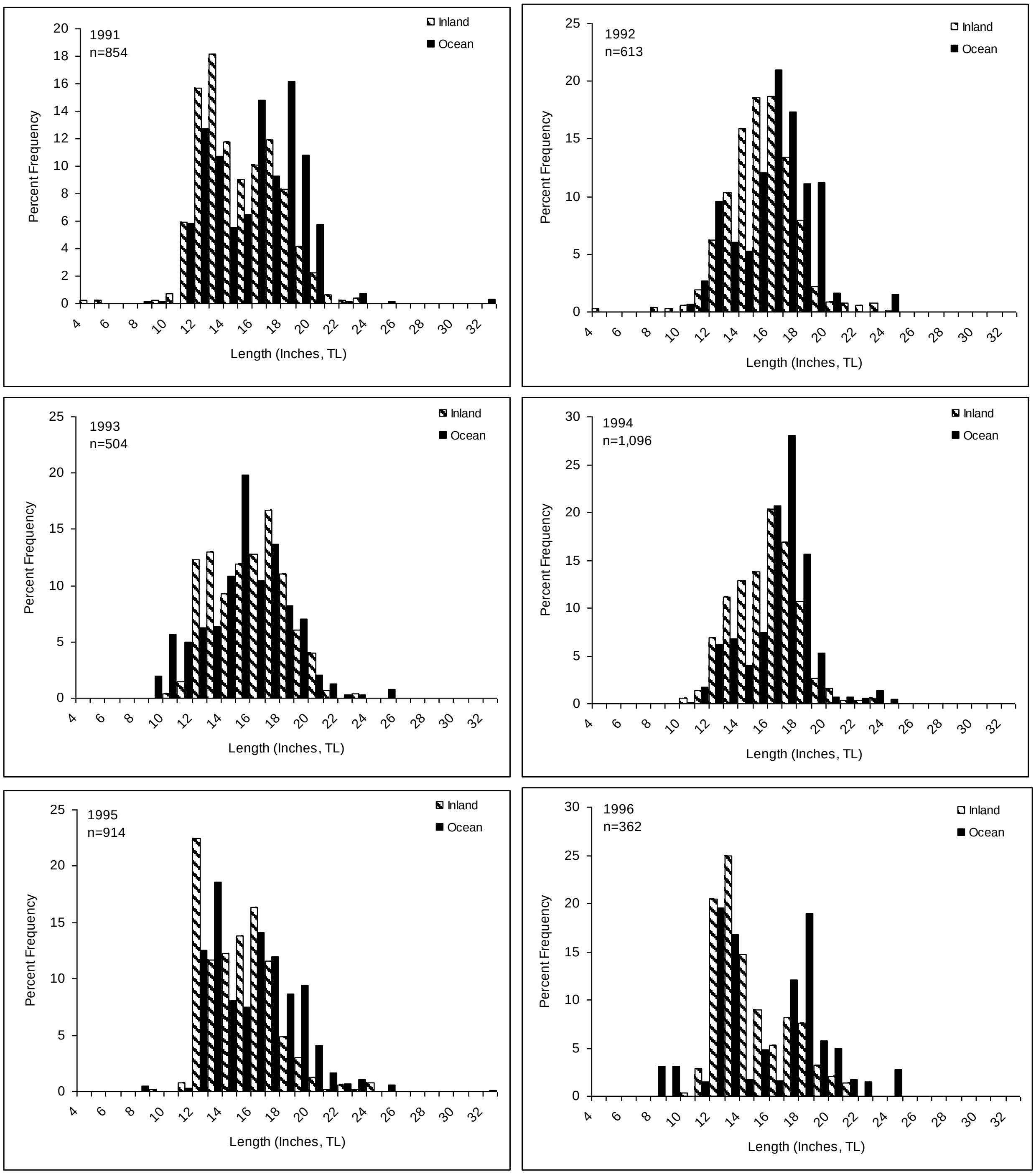


Figure 37. Length frequencies of spotted seatrout from internal and ocean waters, 1991-1996.

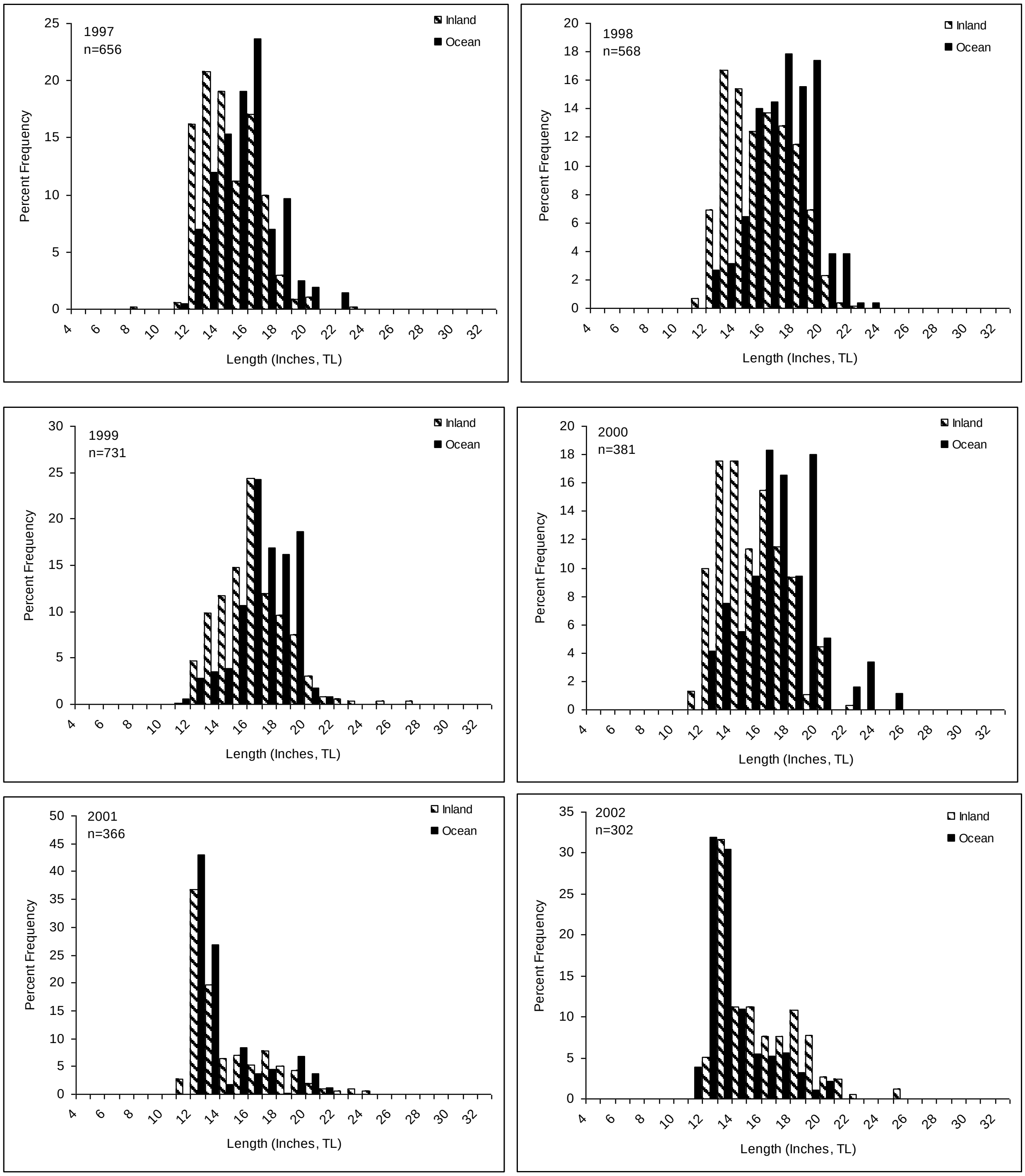


Figure 38. Length frequencies of spotted seatrout from internal and ocean waters, 1997-2002.

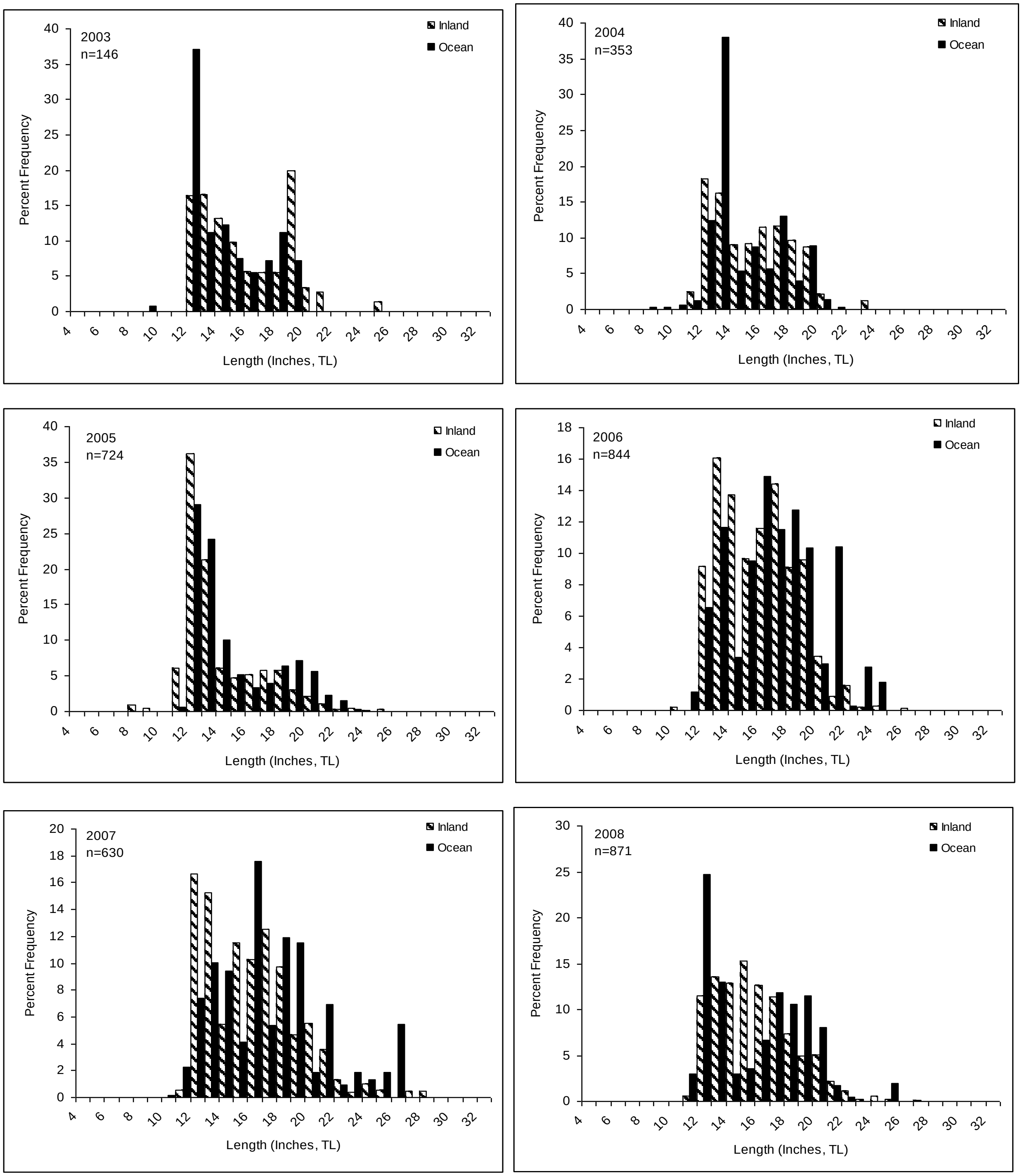


Figure 39. Length frequencies of spotted seatrout from internal and ocean waters, 2003-2008.

7.3.10 MRFSS Spotted Seatrout Directed Trips

The number of recreational spotted seatrout directed trips varied over the time series and reached its lowest level of 114,896 trips in 2003. The number of directed trips has continually increased since 2003 reaching a record level of 495,723 trips in 2008 (Figure 40). Directed trips are calculated by applying the ratio of samples where anglers target spotted seatrout or have spotted seatrout in their catch to the overall estimate of angler trips.

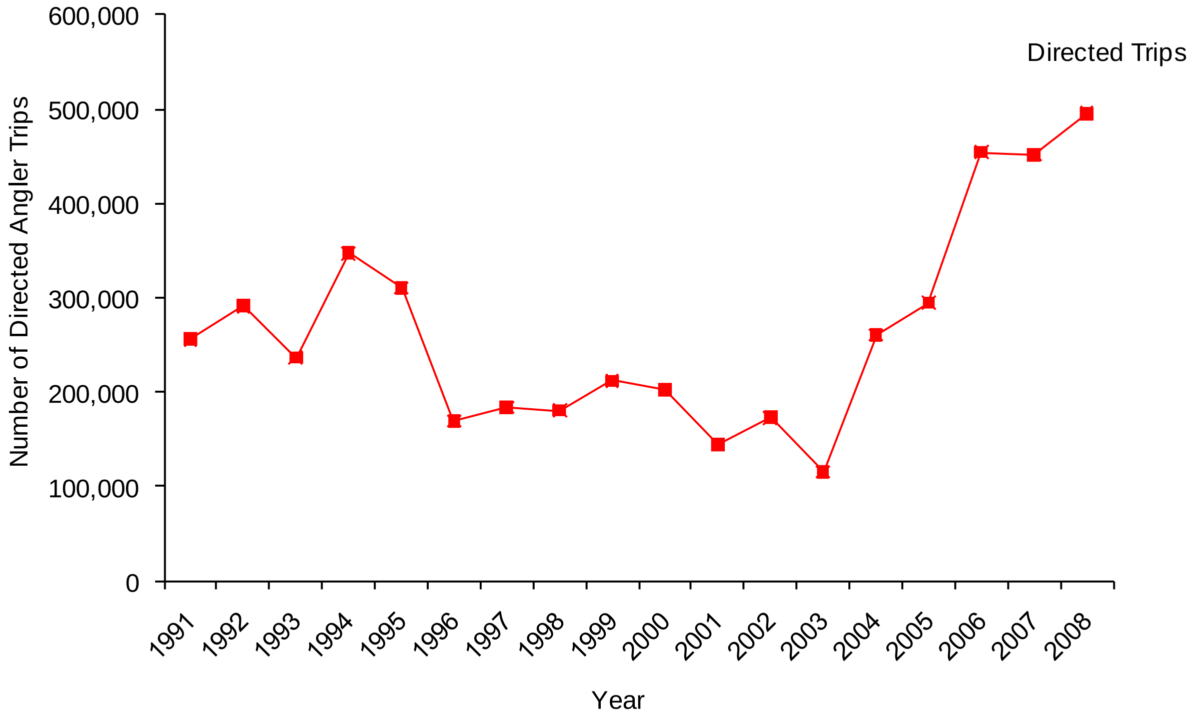


Figure 40. Number of directed angler trips where spotted seatrout were targeted or caught, 1991-2008.

7.3.11 Recreational Commercial Gear License

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 population. Approximately 45% of questionnaires distributed were completed and returned to the DMF. 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.

7.3.12 RCGL Harvest Estimates

The total contribution of spotted seatrout harvested by RCGL gears was insignificant compared to the harvest by recreational anglers, contributing only 2% by number and weight to the total recreational harvest during the years 2002 through 2008. The RCGL harvest of spotted seatrout exhibited a pattern, albeit less pronounced, similar to that observed from the MRFSS survey with a sharp decline in harvest occurring after 2002 when the largest number of spotted seatrout (13,718) were harvested. The decline in harvest continued until 2004 when less than 4,000 spotted seatrout were harvested. Spotted seatrout harvested by RCGL holders increased each year since 2004 (Figure 41).

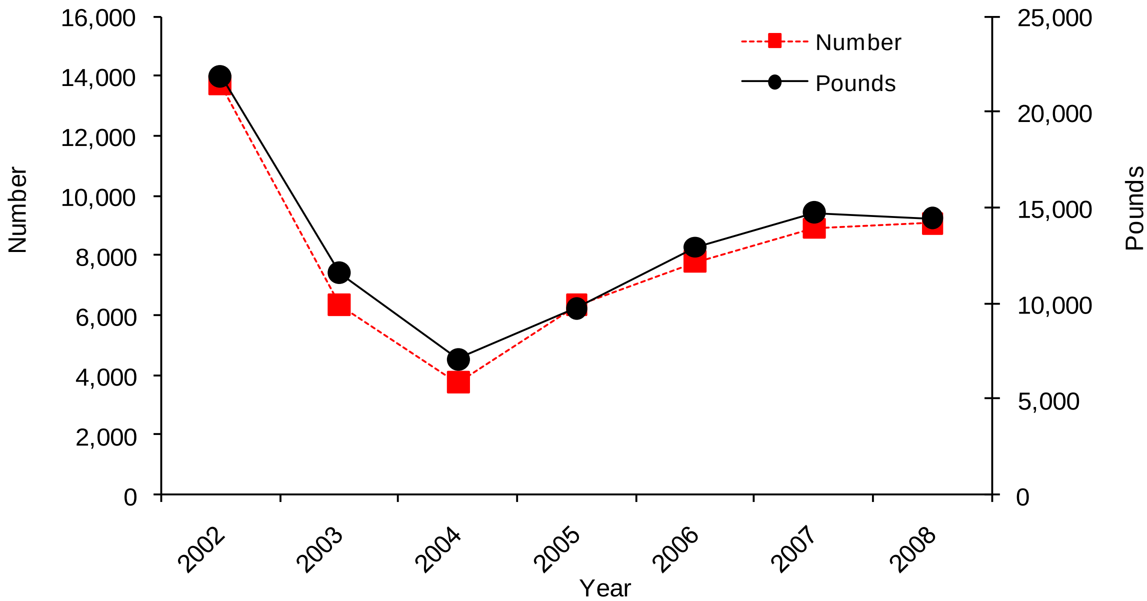


Figure 41. North Carolina harvest (number and pounds) of spotted seatrout by RCGL holders, 2002-2008.

Approximately 36,428 trips using four different gear types were responsible for landing 92,447 pounds of spotted seatrout during the period from 2002 to 2008 (Table 46). Small mesh gill nets accounted for 93% by pounds of all spotted seatrout harvested by RCGL holders followed by large meshed gill nets (4.7%), crab pots (2.3%), and seine (<0.1, Table 46).

7.3.13 RCGL Discard Estimates

Eighty-five percent of all discarded spotted seatrout by RCGL holders were initially captured in small mesh gill nets (Table 47). Crab pots contributed the next largest quantity of discards (6.8%) followed by shrimp trawls (5.3%) and large mesh gill nets (3.1%).

7.3.14 RCGL Seasonality of Harvest and Discard

During the period 2002 through 2008, 51% of the total harvest of spotted seatrout by number (Figure 42) occurred during the months of October (27%), November (13%), and May (11%). Spotted seatrout discards by RCGL holders was highest in October (20%) followed by April (15%), and discards in June, August, and December each contributed 10%.

7.3.15 RCGL Catch by Area

To more easily describe the spatial distribution of RCGL spotted seatrout harvest, the coast was divided into four regions; Northern, Pamlico, Central, and Southern (Figure 43). The contributions from each region to the total poundage of spotted seatrout harvested by weight were 39.0%, 37.2%, 17.4% and 4.1% respectively for the Pamlico, Southern, Central, and Northern regions (Table 48).

Table 46. Spotted seatrout harvested (number and lbs) by RCGL holders during the period 2002 through 2008.

		Trips		Harvest (number)		Harvest (lbs)	
Year	Gear	Number	Percent	Number	Percent	Pounds	Percent
2002	Crab Pot	251	3.2	50	0.4	72	0.3
	Large Mesh Gill Net	435	5.5	334	2.4	908	4.1
	Small Mesh Gill Net	7,178	91.3	13,335	97.2	20,896	95.5
	All	7,864	100.0	13,718	100.0	21,876	100.0
2003	Crab Pot	277	7.6	17	0.3	101	0.9
	Large Mesh Gill Net	363	10.0	386	6.1	813	7.0
	Small Mesh Gill Net	2,750	75.5	5,945	93.7	10,679	92.1
	Shrimp Trawl	253	6.9	0	0.0	0	0.0
	All	3,642	100.0	6,347	100.0	11,592	100.0
2004	Crab Pot	225	5.3	38	1.0	79	1.1
	Large Mesh Gill Net	207	4.8	28	0.7	112	1.6
	Small Mesh Gill Net	3,842	89.9	3,694	98.2	6,888	97.3
	All	4,274	100.0	3,760	100.0	7,079	100.0
2005	Crab Pot	204	4.7	237	3.7	290	3.0
	Large Mesh Gill Net	233	5.4	211	3.3	631	6.5
	Small Mesh Gill Net	3,919	90.0	5,888	92.9	8,831	90.6
	All	4,356	100.0	6,336	100.0	9,752	100.0
2006	Crab Pot	545	9.6	290	3.7	502	3.9
	Large Mesh Gill Net	231	4.1	315	4.0	430	3.3
	Small Mesh Gill Net	4,860	85.4	7,174	92.0	12,003	92.7
	Seine	16	0.3	16	0.2	16	0.1
	Shrimp Trawl	37	0.6	0	0.0	0	0.0
	All	5,688	100.0	7,795	100.0	12,950	100.0
2007	Crab Pot	308	5.6	510	5.7	980	6.6
	Large Mesh Gill Net	530	9.7	331	3.7	863	5.8
	Small Mesh Gill Net	4,481	82.3	8,060	90.5	12,899	87.5
	Seine	21	0.4	7	0.1	7	0.0
	Shrimp Trawl	105	1.9	0	0.0	0	0.0
	All	5,445	100.0	8,908	100.0	14,749	100.0
2008	Crab Pot	476	9.2	131	1.4	142	1.0
	Large Mesh Gill Nets	551	10.7	292	3.2	549	3.8
	Small Mesh Gill Nets	4,130	80.1	8,646	95.3	13,757	95.2
	All	5,157	100.0	9,070	100.0	14,448	100.0
All	Crab Pot	2,287	6.3	1,273	2.3	2,165	2.3
	Large Mesh Gill Net	2,550	7.0	1,896	3.4	4,306	4.7
	Small Mesh Gill Net	31,160	85.5	52,742	94.3	85,953	93.0
	Seine	37	0.1	23	0.0	23	0.0
	Shrimp Trawl	395	1.1	0	0.0	0	0.0
	All	36,428	100.0	55,934	100.0	92,447	100.0

Table 47. Spotted seatrout discard by RCGL gear type for the period 2002 through 2008.

Year	Number/ Percent	Crab Pot	Gill Nets Large Mesh	Gill Nets Small Mesh	Shrimp Trawl	Total
2002	#	78	86	2,336		2,501
	%	3.1	3.5	93.4		100.0
2003	#	54	95	2,886	292	3,327
	%	1.6	2.8	86.7	8.8	100.0
2004	#	88	28	1,127		1,243
	%	7.1	2.2	90.6		100.0
2005	#	31	0	1,171		1,202
	%	2.6	0.0	97.4		100.0
2006	#	107	151	1,615	74	1,946
	%	5.5	7.7	83.0	3.8	100.0
2007	#	475	48	1,726	381	2,629
	%	18.1	1.8	65.6	14.5	100.0
2008	#	124	36	1,157	.	1,317
	%	9.4	2.7	87.9	.	100.0
Total	#	957	443	12,018	747	14,164
	%	6.8	3.1	84.8	5.3	100.0

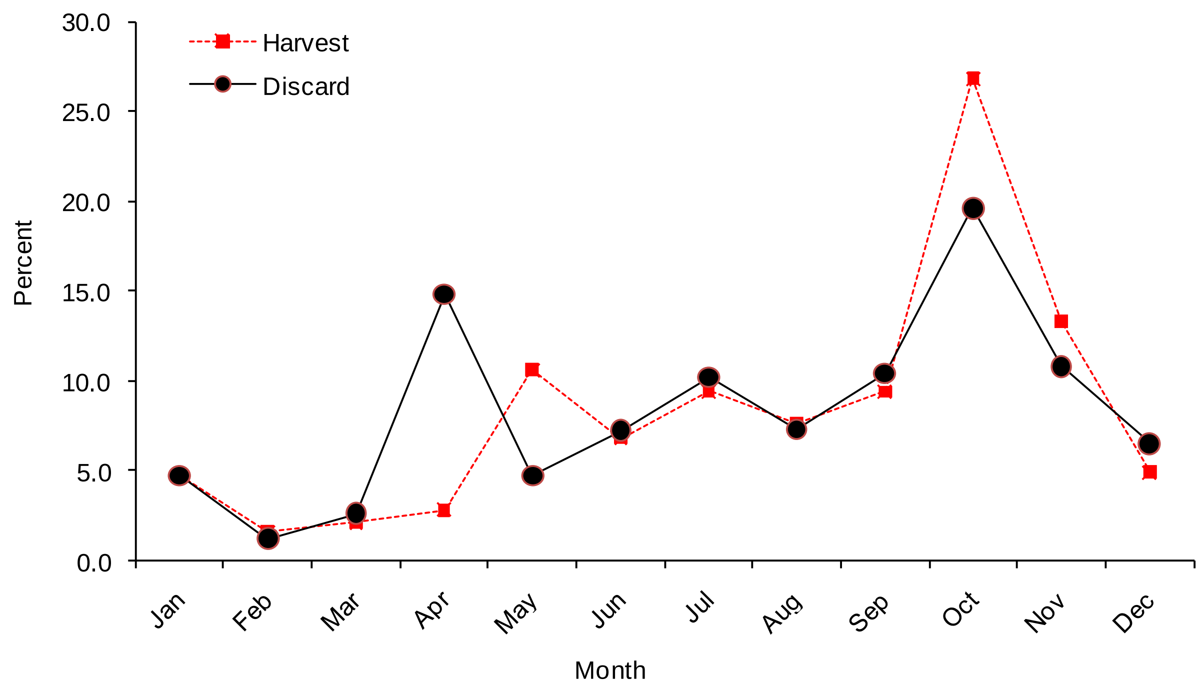


Figure 42. Monthly spotted seatrout harvest and discard by RCGL holders during the period 2002 through 2008.

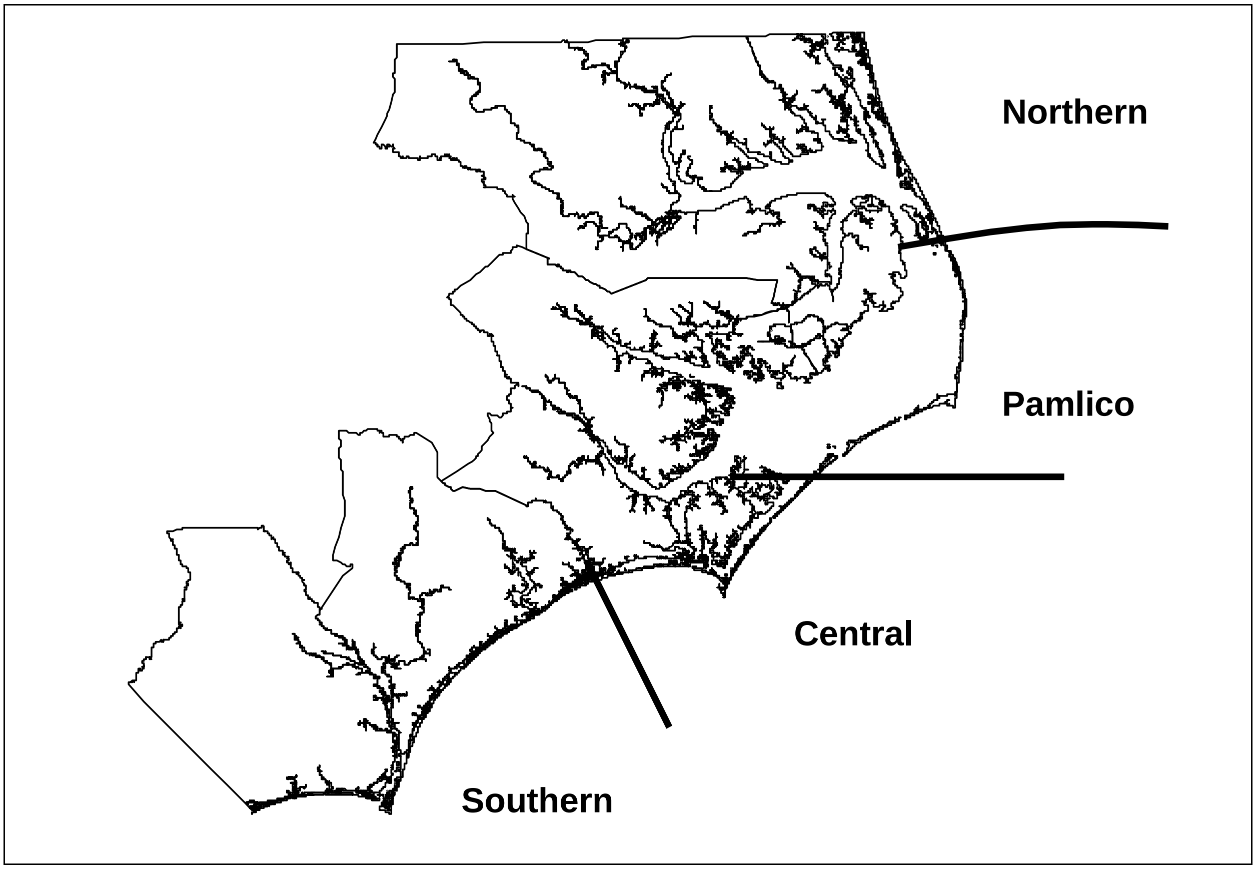


Figure 43. Regions used to describe the spatial distribution of spotted seatrout harvest from RCGL gears.

Table 48. Number of RCGL trips taken, harvested (number or lbs) and discarded spotted seatrout by area, 2002-2008.

		Trips		Harvest				Discard	
Year	Region	Number	Percent	Number	Percent	Pounds	Percent	Number	Percent
2002	Central	1,307	16.6	1,117	8.1	1,887	8.6	267	10.7
	North	225	2.9	113	0.8	233	1.1	105	4.2
	Pamlico	3,179	40.4	7,404	54.0	11,309	51.7	1,358	54.3
	South	3,153	40.1	5,084	37.1	8,448	38.6	770	30.8
	All	7,864	100.0	13,718	100.0	21,876	100.0	2,501	100.0
2003	Central	696	19.1	1,124	17.7	2,104	18.2	2,034	61.2
	North	211	5.8	46	0.7	108	0.9	291	8.7
	Pamlico	911	25.0	2,896	45.6	5,542	47.8	764	23.0
	South	1,825	50.1	2,281	35.9	3,838	33.1	237	7.1
	All	3,642	100.0	6,347	100.0	11,592	100.0	3,327	100.0
2004	Central	1,085	25.4	670	17.8	1,536	21.7	545	43.9
	North	188	4.4	81	2.1	141	2.0	36	2.9
	Pamlico	833	19.5	996	26.5	2,014	28.5	231	18.6
	South	2,103	49.2	1,995	53.1	3,322	46.9	421	33.9
	Unknown	65	1.5	18	0.5	65	0.9	9	0.8
	All	4,274	100.0	3,760	100.0	7,079	100.0	1,243	100.0
2005	Central	794	18.3	1,135	17.9	1,848	19.0	218	18.2
	North	214	4.9	126	2.0	140	1.4	63	5.2
	Pamlico	970	22.3	1,531	24.2	2,666	27.4	287	23.9
	South	2,248	51.8	3,255	51.4	4,726	48.5	554	46.1
	Unknown	115	2.6	282	4.5	361	3.7	79	6.6
	All	4,342	100.0	6,329	100.0	9,741	100.0	1,202	100.0
2006	Central	689	12.1	1,545	19.8	3,083	23.8	576	29.6
	North	344	6.1	398	5.1	827	6.4	22	1.1
	Pamlico	2,063	36.3	2,856	36.6	4,453	34.4	887	45.6
	South	2,286	40.2	2,640	33.9	4,104	31.7	425	21.8
	Unknown	306	5.4	355	4.6	485	3.7	36	1.8
	All	5,688	100.0	7,795	100.0	12,950	100.0	1,946	100.0
2007	Central	1,192	21.9	1,113	12.5	2,094	14.2	278	10.6
	North	411	7.5	403	4.5	867	5.9	131	5.0
	Pamlico	1,745	32.0	3,585	40.2	6,063	41.1	1,365	51.9
	South	1,934	35.5	2,932	32.9	5,221	35.4	814	31.0
	Unknown	164	3.0	874	9.8	503	3.4	41	1.6
	All	5,445	100.0	8,908	100.0	14,749	100.0	2,629	100.0
2008	Central	944	18.3	2,365	26.1	3,520	24.4	534	40.6
	North	656	12.7	865	9.5	1,469	10.2	202	15.3
	Pamlico	1,676	32.5	2,640	29.1	3,985	27.6	305	23.2
	South	1,466	28.4	2,773	30.6	4,706	32.6	184	14.0
	Unknown	415	8.1	427	4.7	768	5.3	92	7.0
	All	5,157	100.0	9,070	100.0	14,448	100.0	1,317	100.0
All	Central	6,707	18.4	9,069	16.2	16,073	17.4	4,454	31.4
	North	2,250	6.2	2,033	3.6	3,784	4.1	850	6.0
	Pamlico	11,377	31.2	21,908	39.2	36,033	39.0	5,197	36.7
	South	15,015	41.2	20,960	37.5	34,365	37.2	3,406	24.0
	Unknown	1,065	2.9	1,957	3.5	2,182	2.4	257	1.8
	All	36,414	100.0	55,927	100.0	92,436	100.0	14,164	100.0

8. SOCIOECONOMIC STATUS OF THE FISHERY

8.1 Commercial Fishery

8.1.1 Ex-Vessel Value and Price

DMF 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 economics in any particular fishery.

Spotted seatrout is a relatively low-volume commercial fishery in North Carolina, never exceeding 1% of the value of seafood landed overall in the state. In terms of value, the fishery clearly had a high point in the nineties, with landings sometimes nearing or exceeding $600,000 (Figure 44, Table 49).

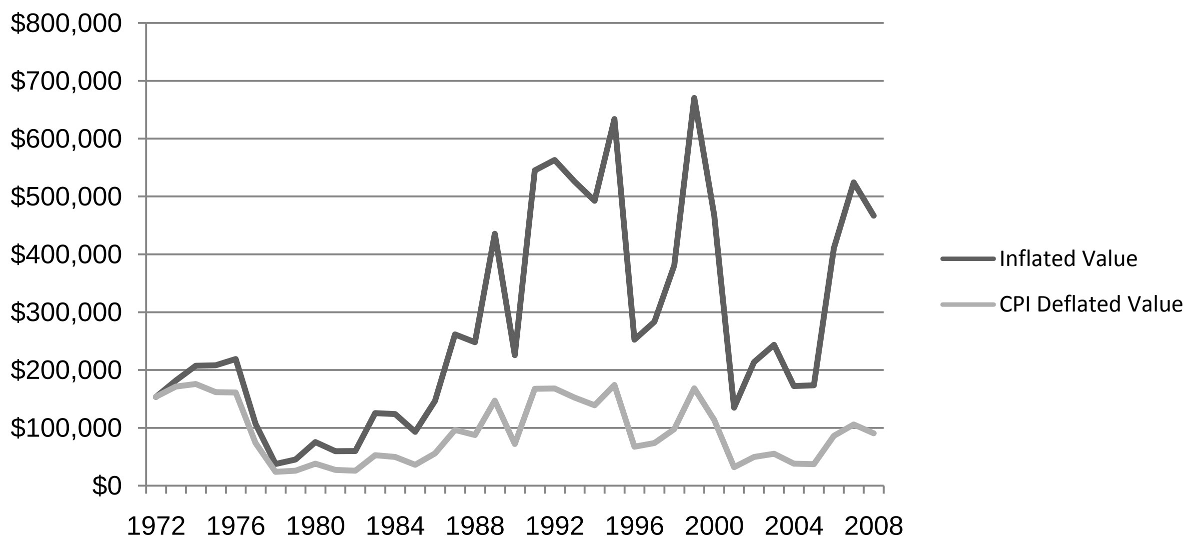


Figure 44. Value of spotted seatrout landings in North Carolina, 1972-2008.

The real price for spotted seatrout has not moved appreciably over the past 35 years, although it has kept up with inflation and has risen to over $1.50 since 2003 (Figure 45).[1] 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 flounder. If spotted seatrout is not readily available to a customer, 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 price increases in recent years as commercial supplies have been increasingly restricted.

[1] Inflation adjustments use the consumer price index of the Department of Commerce.

Table 49. Detail values of spotted seatrout landed, total value, deflated value, price per pound, and percent change from year to year for landings in North Carolina, 1972-2008.

Year	Pounds Landed	Inflated Value	Conversion	CPI Deflated Value	Inflated Price per Pound	CPI Price per Pound
1972	502,792	$153,421	1.0000	$153,421	$0.31	$0.31
1973	611,004	$181,902	0.9414	$171,250	$0.30	$0.28
1974	669,607	$207,154	0.8479	$175,640	$0.31	$0.26
1975	632,603	$207,963	0.7770	$161,577	$0.33	$0.26
1976	637,326	$219,007	0.7346	$160,887	$0.34	$0.25
1977	323,408	$106,695	0.6898	$73,595	$0.33	$0.23
1978	97,304	$37,356	0.6411	$23,949	$0.38	$0.25
1979	105,034	$44,977	0.5758	$25,896	$0.43	$0.25
1980	171,334	$75,216	0.5073	$38,156	$0.44	$0.22
1981	113,304	$59,371	0.4598	$27,302	$0.52	$0.24
1982	83,847	$59,896	0.4332	$25,945	$0.71	$0.31
1983	165,360	$125,482	0.4197	$52,662	$0.76	$0.32
1984	152,934	$123,686	0.4023	$49,760	$0.81	$0.33
1985	109,048	$93,076	0.3885	$36,158	$0.85	$0.33
1986	191,514	$146,254	0.3814	$55,779	$0.76	$0.29
1987	315,380	$261,455	0.3680	$96,204	$0.83	$0.31
1988	296,538	$247,852	0.3533	$87,576	$0.84	$0.30
1989	451,909	$435,504	0.3371	$146,807	$0.96	$0.32
1990	250,634	$225,553	0.3198	$72,136	$0.90	$0.29
1991	660,662	$545,164	0.3069	$167,312	$0.83	$0.25
1992	526,271	$563,136	0.2979	$167,777	$1.07	$0.32
1993	449,886	$525,840	0.2893	$152,112	$1.17	$0.34
1994	412,358	$492,461	0.2821	$138,899	$1.19	$0.34
1995	574,296	$634,061	0.2743	$173,909	$1.10	$0.30
1996	226,580	$252,404	0.2664	$67,243	$1.11	$0.30
1997	232,497	$283,425	0.2604	$73,814	$1.22	$0.32
1998	307,671	$380,724	0.2564	$97,633	$1.24	$0.32
1999	546,675	$670,460	0.2509	$168,219	$1.23	$0.31
2000	376,574	$467,122	0.2427	$113,390	$1.24	$0.30
2001	105,714	$134,848	0.2360	$31,827	$1.28	$0.30
2002	175,555	$213,668	0.2324	$49,646	$1.22	$0.28
2003	181,462	$243,394	0.2272	$55,293	$1.34	$0.30
2004	130,961	$172,033	0.2213	$38,068	$1.31	$0.29
2005	129,601	$173,533	0.2140	$37,141	$1.34	$0.29
2006	312,620	$410,695	0.2100	$86,246	$1.31	$0.28
2007	374,722	$524,465	0.2016	$105,732	$1.40	$0.28
2008	304,544	$466,760	0.1941	$90,598	$1.53	$0.30

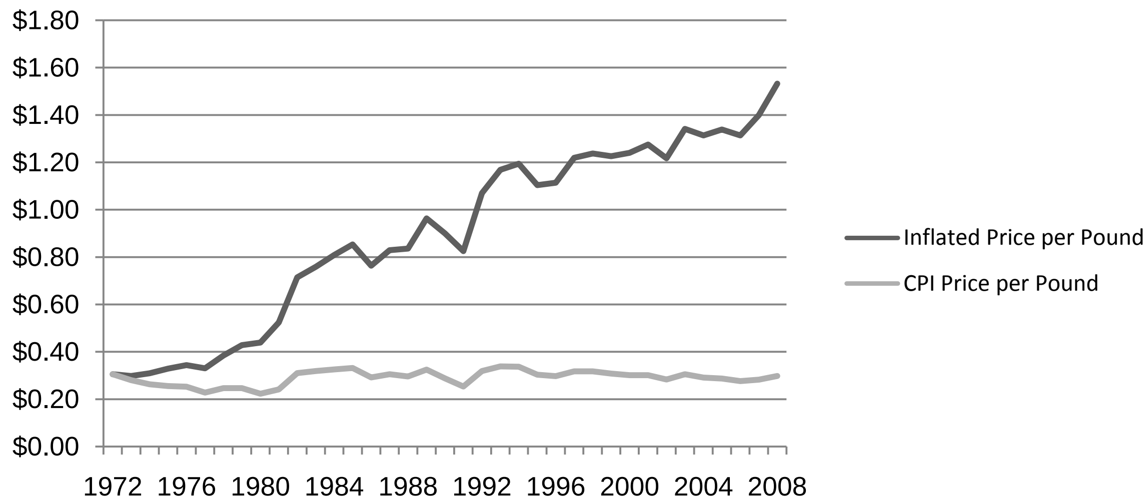


Figure 45. Average price per pound of spotted seatrout landings in North Carolina, 1972-2008.

8.1.2 Participants and Trips

The number of fishermen involved in the fishery since 1999 is reported in Table 50, broken down by the number of individual trips that resulted in catching spotted seatrout 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 spotted seatrout fishery; efforts to catch other fish commonly pursued by spotted seatrout fishermen (such as flounder) have also decreased by a similar proportion.

Table 50. Number of participants and the number of trips taken that landed spotted seatrout in North Carolina, 1999-2008.

	Number of Participants									
Number of Trips	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
1 Trip	319	313	284	266	242	214	205	206	186	189
% within Year	25%	27%	32%	27%	30%	30%	28%	24%	22%	21%
2 - 10 Trips	622	556	447	488	418	335	363	414	391	435
% within Year	48%	48%	50%	49%	51%	47%	50%	47%	46%	47%
11 - 20 Trips	154	121	86	125	82	78	87	111	118	139
% within Year	12%	11%	10%	13%	10%	11%	12%	13%	14%	15%
21 - 50 Trips	130	119	67	81	62	74	62	102	116	118
% within Year	10%	10%	7%	8%	8%	10%	9%	12%	14%	13%
51 - 100 Trips	53	38	14	24	11	7	13	36	34	34
% within Year	4%	3%	2%	2%	1%	1%	2%	4%	4%	4%
> 100 Trips	13	9	2	5	2	2	2	6	14	6
% within Year	1%	1%	0%	1%	0%	0%	0%	1%	2%	1%
Total	1291	1156	900	989	817	710	732	875	859	921

Income from the sale of spotted seatrout by most commercial fishermen is relatively low (Table 51). The numbers are relatively small, reflecting the bycatch nature of the fishery for most fishermen, for most of the year. For example in 2008, 57% of the participants earned less than $100 from spotted seatrout, and 81% earned $500 or less. However, in years when spotted seatrout are abundant, some fishermen target spotted seatrout during the winter season. These fishermen are representative of the 11% of participants who earned >$1000 per year (Table 51). From 1994 to 2008, the total value of spotted seatrout landings was slightly more than $5.5 million, compared to a value of $36.7 million from other species landed on those same trips.

Table 51. Number of participants in the spotted seatrout fishery by value of landings and year in North Carolina, 1999-2008.

	Number of Participants									
Landings Value	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
<$100	874	784	711	730	584	521	523	550	527	527
% within YEAR	68%	68%	79%	74%	72%	73%	71%	63%	61%	57%
$101 - $500	230	218	131	169	141	119	123	179	162	222
% within Year	18%	19%	15%	17%	17%	17%	17%	21%	19%	24%
$501 - $1000	61	48	24	42	40	26	39	53	51	67
% within YEAR	5%	4%	3%	4%	5%	4%	5%	6%	6%	7%
> $1000	126	106	34	48	52	44	47	93	119	105
% within YEAR	10%	9%	4%	5%	6%	6%	6%	11%	14%	11%
Total	1291	1156	900	989	817	710	732	875	859	921

As with any commercial fishery in the state since 1994, fishermen who land spotted seatrout may only sell their catch to licensed dealers. The number of dealers who handled spotted seatrout has remained stable for the past decade, fluctuating between 162 and 215 dealers in any single year (Figure 46). Recent years have tended towards the lower end of the scale, perhaps reflecting a drop in the number of fish houses in the state (Garrity-Blake and Nash, 2006).

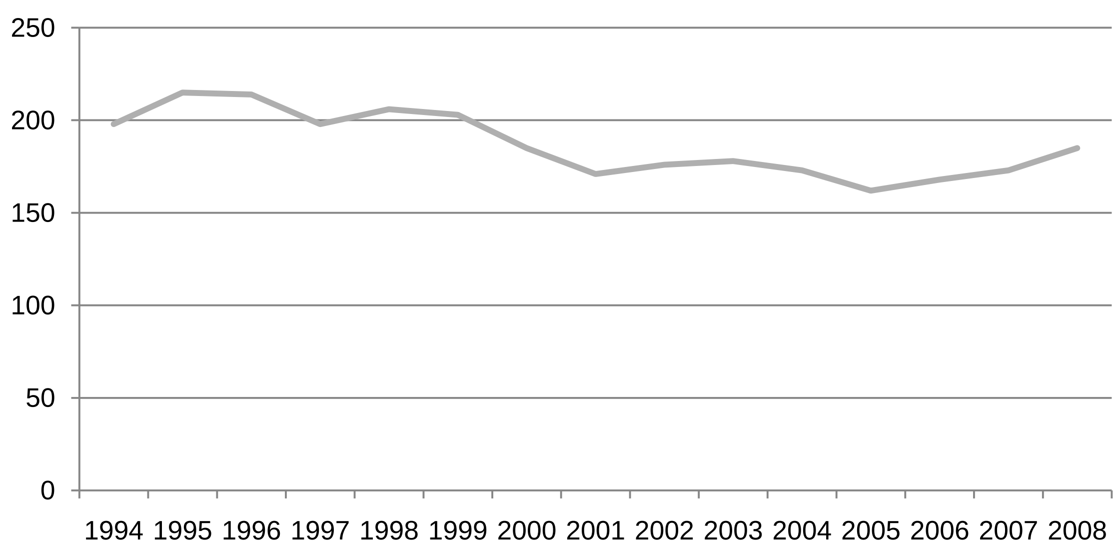


Figure 46. Number of dealers who purchased spotted seatrout from 1994 to 2008.

8.1.3 Economic Impact of Commercial Fishery

The economic impact of the commercial spotted seatrout harvest to North Carolina's economy for 2008 is shown in Table 52. 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.[2] Using recent expenditure data gathered from spotted-seatrout landing commercial fishermen in the inshore fisheries of the Sounds (Crosson 2007a, Crosson 2007b), total expenditures for spotted seatrout-landing commercial trips for 2008 were calculated by:

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

where t = number of spotted seatrout-landing trips, $\tilde{E}$=median per-trip expenditures, n = number of spotted seatrout-landing fishermen, $t$all = total trips taken by spotted seatrout-landing fishermen throughout the year, $\tilde{Y}$=median yearly fixed expenditures, and $\tilde{I}$=median proprietary income.[3]

Analysis using the 2006 IMPLAN model for North Carolina estimated a total economic impact of $3.9 million. Economic inputs are the costs associated with the fishing trips (such as fuel, insurance, and net purchases); proprietary income is the profit margin for the fishermens' businesses. The sum of these two factors is equal to the trip ticket value for the year.

Table 52. Economic impact of the spotted seatrout-landing commercial trips in North Carolina, 2008. DMF Trip Ticket Program, IMPLAN.

Economic inputs	$1,296,179
Proprietary income	$1,391,349
Additional economic activity generated	$1,211,025
Additional jobs generated	34
Total economic Impact	**$3,898,553**

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 spotted seatrout, only the business inputs from the commercial fishermen. The economic effect of spotted seatrout landings on dealers, seafood markets, restaurants, and shipping interests requires data that is not currently available.

[2] 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.

[3] 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.

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 are added to a growing database and used for fishery management plans, among other uses. A total of 338 of the fishermen in the socio economic database have reported commercial landings of spotted seatrout according to the trip ticket program. That group is used to provide a snapshot of North Carolina commercial fishermen who catch spotted seatrout.

The demographic characteristics of these commercial fishermen surveyed by the Socioeconomic Program over the past five years are shown in Table 53. Nearly all were white males, with an average age of 49 and over 26 years of commercial fishing experience. Three quarters of them had a high school diploma and 22% had at least some college education. Half had $30,000 or less in household income when surveyed, with 24% bringing in $50,000 or more. Only 10% had less than $15,000 in annual household income (Table 54).[4]

Fishing accounted for 73% of the household income from these fishermen, and 46% reported that fishing was their sole source of income. They are least likely to fish in January and February, which is the slowest time of the year for most fishermen. They own an average of 1.9 registered commercial fishing vessels.

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

Table 53. Demographic characteristics of spotted seatrout commercial fishermen. HS=High School.

	n = 338	Average or %
Years Fishing		26.4
Age		49.3
Gender		
	Male	97.3%
	Female	2.7%
Race		
	White	97.3%
	Black	1.8%
	other	0.9%
Education Level		
	Less than HS	31.0%
	HS Grad	47.3%
	Some College	14.9%
	College Graduate	6.8%
Marital Status		
	Married	76.2%
	Divorced	11.0%
	Widowed	3.3%
	Never Married	2.1%
	Separated	7.4%
Household Income		
	Less than $15,000	9.7%
	$15,001 - $30,000	37.7%
	$30,001 - $50,000	24.0%
	$50,001 - $75,000	16.7%
	More than $75,000	7.0%

8.1.5 Historical Importance of the Commercial Fishery

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 7.1. The statement "fishing is important economically in my community" drew an 8.3.

8.1.6 Other Targeted Species of the Commercial Fishery

Few commercial fishermen in North Carolina rely primarily on spotted seatrout to make a living; these fishermen are instead mostly flounder and striped mullet fishermen who land the occasional spotted seatrout in their nets, and target other species as well such as blue crabs, clams, and shrimp (Table 54). However, some fishermen target spotted seatrout seasonally (winter) in years when spotted seatrout are abundant.

Table 54. Prevalent species targeted by spotted seatrout commercial fishermen.

Species	% who land
Flounder	51.8%
Blue crabs	48.2%
Shrimp	27.2%
Spot	22.2%
Striped Mullet	21.6%
Oysters	17.5%
Clams	17.2%
Sea Mullet	12.2%
Croaker	10.0%
Striped Bass	9.8%

8.1.7 Perceived Conflicts

Spotted seatrout-landing commercial fishermen were asked about conflicts (in the year previous to being interviewed) 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 DMF is to balance the needs of different user groups. Only 29% of commercial fishermen reported conflicts with other commercial fishermen. A slightly larger percentage (33%) 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 55).

Table 55. Fishing related issues considered most important to commercial fishermen who landed spotted seatrout.

Ranking	Issue
1	Fuel Prices
2	Development of the coast
3	Losing Working Waterfronts
4	Low Prices for Seafood / Imports
5	Keeping up with Regulations
6	Business Costs
7	Size Limits
8	Gear restrictions

8.2 Recreational Fishery

8.2.1 Economic Impact of the Recreational Fishery

The DMF collects data about recreational fishing in conjunction with the federal government's 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 recreational expenditures per spotted seatrout-targeting and -landing recreational trips in 2008, the total expenditures are as follows:

Total recreational expenditures = (t*$\bar{E}$)

where t = number of spotted seatrout-landing trips and $\bar{E}$=mean per-trip expenditures.

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 56. Economic impact of the spotted seatrout-landing recreational angling trips in North Carolina, 2008.

Economic inputs	$32,280,394
Additional economic activity generated	$17,213,561
Additional jobs generated	490
Total economic Impact	**$49,493,807**

Spotted seatrout are also occasionally caught by holders of the RCGL. The RCGL fishermen use commercial gear (primarily gill nets and trawls) to catch fish and shrimp, but cannot sell their catch. A combination of the most recent socioeconomic data available (from 2007) with the average estimated expenditures per spotted seatrout-targeting and -landing recreational trips in 2008 is summarized in Table 57:

Table 57. Economic impact of the spotted seatrout-landing RCGL trips in North Carolina, 2008.

Economic inputs	$1,867,577
Additional economic activity generated	$1,134,709
Additional jobs generated	35
Total economic Impact	**$3,002,285**

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 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 DMF began gathering socioeconomic information on hook-and-line recreational fishermen in 2008. Some preliminary data is available, but more substantive reports will not be ready until 2009.

In the initial sample of 231 CRFL holders, 110 (48%) reported that they fish for spotted seatrout. 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 (see Table 58).

The 2007 survey of RCGL holders revealed some demographic and attitudinal statistics comparable to those of the CRFL holders (see Table 59).

8.2.3 Other Targeted Species of the Recreational Fishery

None of the recreational anglers surveyed to date exclusively target spotted seatrout. Most of the other species they commonly target are also inshore fisheries, with the exception of dolphin/mahi-mahi (Table 60).

8.2.4 Perception of Important Issues

The CRFL holders were asked to rate a series of issue on perceived importance to their fishing (Table 61). Water quality was the most important issue, followed by fuel prices. As with other recreational socio economic angling data, these results are preliminary.

The 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.

Table 58. Demographic characteristics of spotted seatrout CRFL fishermen (preliminary). HS=High School.

Variable	n = 110	Average or %
Years Fishing		35
Age		50
Gender		
	Male	89%
	Female	11%
Race		
	White	98%
	Black	1%
	other	2%
Education Level		
	HS Grad or less	23%
	Some College	31%
	College Graduate	26%
	Graduate School	21%
Marital Status		
	Married	82%
	Divorced	6%
	Widowed	1%
	Never Married	10%
	Separated	1%
Total Household Income		
	Less than $15,000	1%
	$15,001 - $30,000	3%
	$30,001 - $50,000	11%
	$50,001 - $75,000	16%
	More than $75,000	50%
	Prefer not to answer	21%

Table 59. Demographic characteristics of spotted seatrout RCGL fishermen. HS=High School.

Variable	**n = 292**	**Average or %**
Years with RCGL		4.1
Age		84% over 40
Gender		
	Male	95.9%
	Female	4.1%
Race		
	White	97.2%
	Other	2.8%
Education Level		
	Less than HS	11.7%
	HS Grad	26.6%
	Some College	31.8%
	College Graduate	28.8%
Marital Status		
	Married	82.5%
	Divorced	8.0%
	Widowed	2.8%
	Never Married	5.9%
	Separated	.7%
Total Household Income		
	Less than $15,000	6.3%
	$15,001 - $30,000	13.6%
	$30,001 - $50,000	22.4%
	$50,001 - $75,000	23.2%
	More than $75,000	34.6%

Table 60. Percent of occurrence of other species targeted by spotted seatrout recreational fishermen (preliminary).

Species	**% who land**
Flounder	82%
Red Drum	68%
Spot	59%
Bluefish	59%
Croaker	52%
Striped Bass	51%
Weakfish	50%
Black Drum	46%
Mullets	43%
Mahi-Mahi	39%

Table 61. Fishing related issues considered most important to recreational anglers who landed spotted seatrout (preliminary).

Ranking	Issue
1	Water Quality
2	Fuel Prices
3	Overfishing / Too Few Fish
4	Finding time to fish
5	Keeping up with Regulations
6	Weather
7	Access Issues
8	Trip / Bag Limits
9	Losing Piers
10	Competition with Commercial Fishermen
11	Competition with Other Recreational Fishermen

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. ENVIRONMENTAL FACTORS

9.1 Habitat

Spotted seatrout make use of a variety of habitats during their life history with variations in habitat preference due to location, season, and ontogenetic stage. Although primarily estuarine, spotted seatrout use habitats throughout estuaries and occasionally the coastal ocean. Spotted seatrout are found in most habitats identified by the North Carolina Coastal Habitat Protection Plan (CHPP) including: water column, wetlands, submerged aquatic vegetation (SAV), soft bottom, and shell bottom (Street et al. 2005). Each habitat is part of a larger habitat mosaic, which plays a vital role in the overall productivity and health of the coastal ecosystem. Additionally, these habitats function to provide the appropriate physicochemical and biological conditions necessary to maintain and enhance the spotted seatrout population. Protection of each habitat type is critical to the sustainability of the spotted seatrout stock. Information on the ecological value of each of these habitats to spotted seatrout and their current condition is provided below.

9.1.1 Water Column

Spotted seatrout use the water column habitat, defined as "the water covering a submerged surface and its physical, chemical and biological characteristics" (Street et al. 2005), for spawning, transport of progeny, foraging and movement throughout the estuary and nearshore coastal areas. Spotted seatrout spawning is generally limited to the waters within the confines of the estuary. Peak spawning activity occurs at temperatures between 21 and 29°C and at salinities typically greater than 15 ppt (ASMFC 1984; Mercer 1984; Saucier and Baltz 1992; Saucier and Baltz 1993; Holt and Holt 2003; Kupschus 2004). Spawning sites have been noted to include tidal passes, channels, river mouths, and waters in the vicinity of inlets with depths of spawning locations ranging from 2 to 10 m (Saucier and Baltz 1992; Saucier and Baltz 1993; Roumillat et al. 1997; Luczkovich et al. 2008). In North Carolina, spotted seatrout in spawning condition have been collected in southern Albemarle, Pamlico, and Core/Bogue sounds, as well as in the southern estuaries (Burns 1996). Spawning in the Pamlico Sound area has been confirmed using hydrophone and sonobuoy surveys (Luczkovich et al. 2008). Luczkovich et al. (2008) detected spotted seatrout spawning on both the eastern and western sides of Pamlico Sound including Rose Bay, Jones Bay, Fisherman's Bay, Bay River, and near Ocracoke and Hatteras inlets from May through September with peak activity in July. These spawning aggregations were primarily located in areas with depths less than 3 m. When spotted seatrout aggregations co-occurred with aggregations of weakfish, at Ocracoke Inlet, the habitat was partitioned with each species occupying different depth ranges: weakfish in waters greater than 3 m, spotted seatrout in waters less than 3 m.

Additional hydrophone surveys conducted from 2003 to 2005 in the Neuse River estuary noted large spawning aggregations of spotted seatrout in this area (Barrios et al. 2006; A. Barrios unpub. data). Although the survey was directed to locate spawning aggregations of red drum, spawning aggregations of spotted seatrout were also detected at sites ranging from Oriental to the mouth of the Neuse River (A. Barrios unpub. data). The locations of these aggregations were generally associated with moderate salinities (12-20 ppt), temperatures between 27 and 29°C, saturated dissolved oxygen levels (> 5 mg l^{-1} O_2), and water depths less than 5 m. Spawning was also reported to occur over both mud and subtidal shell bottoms in these areas. In areas south of Pamlico Sound, such as Beaufort Inlet, spotted seatrout larvae have been collected in moderate numbers indicating localized spawning (Hettler and Chester 1990). Information on spotted seatrout spawning from other areas in North Carolina is generally lacking.

The water column also provides a transport mechanism for spotted seatrout eggs and larvae. Eggs of spotted seatrout are positively buoyant at spawning salinities allowing for wind- and tidally-driven distribution throughout the estuary (Churchill et al. 1999; Holt and Holt 2003). However, sudden salinity reductions cause spotted seatrout eggs to sink, thus reducing dispersal and survival (Holt and Holt 2003). Larval spotted seatrout have been collected in surface and bottom waters of estuaries in North Carolina, Florida, and Texas (McMichael and Peters 1989; Hettler and Chester 1990; Holt and Holt 2000). In North Carolina, larval transport studies in the vicinity of Beaufort Inlet indicated that ocean and inlet spawned larvae are dependent on appropriate wind and tidal conditions to pass through inlets and be retained in the estuary (Churchill et al. 1999; Luettich et al. 1999; Hare et al. 1999). Although spotted seatrout spawning generally occurs within the confines of the estuary (ASMFC 1984; Mercer 1984; Saucier and Baltz 1992; Saucier and Baltz 1993), spawning aggregations have been located near inlets in North Carolina (A. Barrios unpub. data). Therefore, these physical processes appear to directly influence the retention and recruitment success of spotted seatrout to high salinity nursery areas (McMichaels and Peters 1989). Behaviors such as directional swimming and movement throughout the water column also provide mechanisms for estuarine dispersal and retention of larvae within the estuary (Rowe and Epifanio 1994; Churchill et al. 1999; Hare et al. 1999).

In addition to its role in spawning and larval transport, the water column provides an important source of food items and a migratory corridor for all life history stages of spotted seatrout. Larval and juvenile spotted seatrout feed primarily on planktonic prey such as copepods, mysids, and caridean shrimps (ASMFC 1984; Mercer 1984; Daniel 1988; McMichael and Peters 1989). Adult diets are somewhat different although the importance of food items in the water column remains. Adult spotted seatrout generally forage on pelagic fishes and penaeid shrimps with increased importance with increasing size (Lorio and Schafer 1966; ASMFC 1984; Mercer 1984; Daniel 1988). The water column also provides spotted seatrout with an important migratory corridor for movements between habitats. Spotted seatrout are known to be fairly non-migratory with most movements less than 50 km; however, movements of a few individuals in upwards of 500 km have been noted (Moffett 1961; Iverson and Tabb 1962; Tabb 1966; Overstreet 1983).

Spotted seatrout populations are affected by water quality conditions wherever they occur in estuaries and the coastal ocean. Variations in water conditions can have profound effects on spotted seatrout distribution, growth, and mortality (Tabb 1966; Kostecki 1984; McMichaels and Peters 1989; Kupschus 2003; Kupschus 2004). Spotted seatrout are most common in waters defined by the CHPP as moderate to high-salinity [> 5 ppt (Kostecki 1984; ASMFC 1984; Mercer 1984; McMichaels and Peters 1989; Street et al. 2005)]. Salinity, which is an important factor in determining species distributions, is affected by rainfall, season, estuarine morphology, wind, tides, and freshwater discharge (Street et al. 2005). Tabb (1966) noted that abrupt decreases in salinity caused by excessive rainfall and the associated freshet trigger spotted seatrout to seek habitats with more stable salinities. Other important water quality factors that affect spotted seatrout distribution include: water temperature, dissolved oxygen (DO), and pH. As generally non-migratory estuarine residents, spotted seatrout tolerate a wide range of temperatures (Tabb 1966; ASMFC 1984; Mercer 1984). However, spotted seatrout have been reported to move to deeper holes and channels in the estuary and occasionally to the nearshore ocean in response to declining water temperatures (Tabb 1966; ASMFC 1984; Mercer 1984). Additionally, sudden cold snaps have been found to stun and kill large numbers of spotted seatrout in estuarine habitats during winter (Tabb 1966; Perret et al. 1980; ASMFC 1984; Mercer 1984). These large mortality events are often associated with rapid declines (less than 12 h) in temperature, which numb fish before they can escape to warmer waters (Tabb 1958, 1966). However, more than one temperature associated fish kill per season is rare because once in warmer waters, the population tends to overwinter there (Tabb 1958). In North Carolina, significant spotted seatrout landings by hand harvest (suggesting the collection of stunned or recently deceased individuals) have generally been associated with extremely low water temperatures during winter (B. Burns, DMF, personal communication). Furthermore, commercial and recreational harvests during the summer after these cold stun events are usually lower than those after mild winters, suggesting the importance of such events on the regulation of spotted seatrout populations. (Refer to Section 10.2.5, Impacts of cold stun events on the population).

More information on water quality condition and stressors in North Carolina is given in Section 9.2.

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 on Earth (Teal 1962). The primary productivity associated with wetlands is converted into secondary production of fishes, including spotted seatrout, and invertebrates through detrital and microalgal pathways (Peterson and Howarth 1987). In coastal regions, wetlands typically are found in both estuarine and freshwater areas. Estuarine wetlands are tidal in nature and generally occur in low energy environments of bays, sounds, and rivers in polyhaline and mesohaline waters. Freshwater wetlands, including freshwater marshes, bottomlands hardwood forest and swamp forests, generally occur in low-salinity to freshwater areas of creeks, streams, and rivers.

Wetlands are particularly valuable as nurseries and foraging habitat for spotted seatrout as well as other fishes and shellfish (Graff and Middleton 2003). The combination of shallow water, thick vegetation, and high primary productivity provides juvenile and small fishes with appropriate physicochemical conditions for growth, refuge from predation, and abundant prey resources (Boesch and Turner 1984; Mitsch and Gosselink 1993, Beck et al. 2001). It is estimated that over 95% of finfish and invertebrates commercially harvested in the United States are wetland dependent (Feierabend and Zelazny 1987). Additionally, wetlands, predominantly riparian wetlands, have been recognized for their ability to slow and spread stormwater runoff as well as filter and trap pollutants entering surface waters (Mitsch and Gosselink 1993).

Juvenile spotted seatrout appear to use estuarine wetlands, principally salt/brackish marshes, as nurseries (Tabb 1966; ASMFC 1984; Mercer 1984). In North Carolina, juvenile spotted seatrout have been found to be abundant in tidal marshes and marsh creeks in eastern and western Pamlico Sound and Bogue Sound (Epperly 1984; Ross and Epperly 1985; Hettler 1989; Noble and Monroe 1991). Additionally, juvenile spotted seatrout have been found using salt marsh habitats in the Cape Fear River, although in less abundance than more northern estuaries (Weinstein 1979). Documentation of juveniles in wetlands in other North Carolina estuaries is somewhat sparse. Of particular importance to juvenile spotted seatrout is the marsh edge habitat (Hettler 1989; Rakocinski et al. 1992; Baltz et al. 1993; Peterson and Turner 1994). Studies in Texas and Florida estuaries found that juvenile spotted seatrout densities were higher in *Spartina alterniflora* marsh edge habitats than in soft bottom, shell bottom, and inner marsh habitats, and were equivalent to or higher than densities in SAV (Minello 1999; Tuckey and Dehaven 2006). However, recent meta-analysis has indicated that spotted seatrout densities were consistently higher in SAV than in vegetated marsh edge habitats (Minello et al. 2003).

The North Carolina Division of Coastal Management (DCM) mapped the extent of coastal wetlands in North Carolina in 1994. 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 region (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 unpub. data). Human population growth and the associated land use changes are the primary cause of wetland habitat loss today (Dahl 2000). Prior to the 1990's, wetland losses were principally related to ditching and draining for agriculture as well as deforestation and fill activities associated with silviculture. Since 1990, activities such as dredging, water control projects and hydrological alterations are the primary threats to wetland habitats.

One human alteration of particular concern for wetland habitats is shoreline stabilization. Hard structure stabilization techniques along estuarine shorelines cause gradual, long-term decreases in wetland vegetation through decreased sedimentation, accelerated erosion, increased wave scour, and by preventing landward migration of vegetation. Increased scour and turbulence was shown to cause a mortality rate of 63% for marsh vegetation waterward of newly constructed bulkheads (Garbisch et al. 1973). The added turbulence at the base of bulkhead structures and increased water depth prevents vegetative recolonization and expansion post bulkhead construction (Knutson 1977). Subsequently, the relative value of bulkheaded areas for fishes and invertebrates is lower than unaltered marsh and wetland habitats. Several studies have indicated lowered species richness, diversity, and abundances (80-300% less) of juvenile fishes and invertebrates adjacent to bulkheaded shorelines than adjacent to naturally vegetated shorelines (Mock 1966; Gilmore and Trent 1974; Peterson et al. 2000). The lower value of the bulkheaded shorelines to juvenile fishes and invertebrates was attributed to the reduction of benthic food resources and the deeper waters and lack of vegetated refuge allowing for the infiltration of large piscivorous fishes into these areas.

Conservation and enhancement of wetlands is necessary for the overall health of aquatic ecosystems and the preservation of productive fishery species, such as the spotted seatrout. Emphasis should be placed on ongoing initiatives such as wetland restoration, land acquisition, and preservation, and agricultural cost-share best management practices (BMPs) to protect and enhance wetland habitat. The value of wetlands to fisheries and the many water quality functions provided by these habitats make their preservation and restoration a high priority along North Carolina's coast.

9.1.3 Submerged Aquatic Vegetation (SAV)

Of the available habitats, SAV is of critical importance to all life history stages of spotted seatrout. SAV habitat is "bottom that is recurrently vegetated by living structures of submerged, rooted vascular plants (i.e. roots, rhizomes, leaves, stems, propagules), as well as temporarily unvegetated areas between vegetated patches" (Street et al. 2005). SAV occurs in both subtidal and intertidal zones, and is generally separated into two types of communities: high salinity estuarine communities including species such as eelgrass (*Zostera marina*) and shoalgrass (*Halodule wrightii*), and low salinity/freshwater communities including species such as wild celery (*Vallisneria americana*) and sago pondweed (*Potamogeton pectinatus*). Eurasian watermilfoil (*Myriophyllum spicatum*), although non-native, is also an important component of the low salinity/freshwater SAV community, especially in the northeastern waters of North Carolina. 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). By nature, the extent of SAV coverage tends to fluctuate on the scale days to decades, depending on species and physical conditions (Fonseca et al. 1998). In addition, 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 MFC and the Coastal Resources Commission (CRC) are presently working to reword the definition of SAV to encompass both the seasonal and spatial complexity of this habitat. Under current MFC rule, SAV habitat is designated as a Fish Habitat Area [MFC rule 15A NCAC 03I .0101 (b)(20)].

The ecological services SAV provides maintain and enhance 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 cycle nutrients within the system (Thayer et al. 1984, SAFMC 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). Furthermore, 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 (Thayer et al. 1984).

In addition to their importance to ecosystem function, SAV also provides crucial structural habitat for fishes and invertebrates. Numerous species of commercially and recreationally important fishes and invertebrates, including spotted seatrout, use SAV as nurseries, foraging, and refuge habitats (Thayer et al. 1984; SAFMC 1998). The three dimensional structure of SAV affords a surface for epiphytic algae and animals to attach to, as well as a safe area for refuge and foraging for a number of species of fishes and invertebrates (SAFMC 1998). Additionally, SAV coverage provides a safe corridor for movement of fishes and invertebrates between adjacent foraging habitats (Irlandi and Crawford 1997; Micheli and Peterson 1999). Irlandi and Crawford (1997) found that abundance of pinfish (*Lagodon rhomboides*) was higher at intertidal marsh foraging areas adjacent to seagrass than areas adjacent to unvegetated bottom. SAV has also been shown to harbor higher or equivalent densities, growth, and survival of nekton to adjacent salt marshes, and higher densities, growth and survival of nekton as compared to macroalgae, oyster reefs or soft bottom habitats (Minello 1999; Minello et al. 2003). In North Carolina, over 150 species of fish and invertebrates, including juvenile and adult spotted seatrout, have been documented by DMF in seagrass beds in eastern Pamlico and Core sounds (DMF 1990).

The ASMFC lists SAV as a Habitat Area of Particular Concern (HAPC) for spotted seatrout (ASMFC 1984). Eggs, larvae, postlarvae, young-of-the-year, and adult spotted seatrout have been documented in mesohaline and polyhaline seagrass beds (Tabb 1966; ASMFC 1984; Mercer 1984; Thayer et al. 1984; McMichaels and Peters 1989; Rooker et al. 1998). Tabb (1958) indicated that the preferred habitat for spotted seatrout is low-flow areas with abundant seagrass. In Tampa Bay, McMichaels and Peters (1989) found that seagrass was the primary habitat for juvenile spotted seatrout. Habitat suitability models have indicated that spotted seatrout abundance is linearly related to percent seagrass cover until a plateau is reached at 60% coverage (Kupschus 2003). The composition of species in the seagrass beds may also influence the use of these habitats by juvenile spotted seatrout (Rooker et al. 1998). Additionally, meta-analyses indicated that juvenile spotted seatrout abundances were found to be greater in SAV than soft bottom and oyster reef, and were greater than or equivalent to abundances in wetland habitats (Minello 1999; Minello et al. 2003).

In North Carolina, SAV is used extensively by spotted seatrout as important nurseries and foraging grounds. Historical data collected by DMF through otter trawl and seine surveys have indicated that juveniles are abundant in high salinity SAV in both Pamlico and Core sounds (Purvis 1976; Wolff 1976; DMF 1990). Collections with long haul seines in eastern Pamlico Sound have documented an abundance of adult spotted seatrout in SAV from Oregon Inlet to Ocracoke Inlet (DMF 1990). Furthermore, the DMF Independent Gill net Survey (Program 915), Red Drum Juvenile Survey (Program 123), and Estuarine Trawl Survey (Program 120) have found that CPUE of spotted seatrout was generally greatest over high salinity SAV in eastern Pamlico Sound (DMF unpub. data; Figure 47).

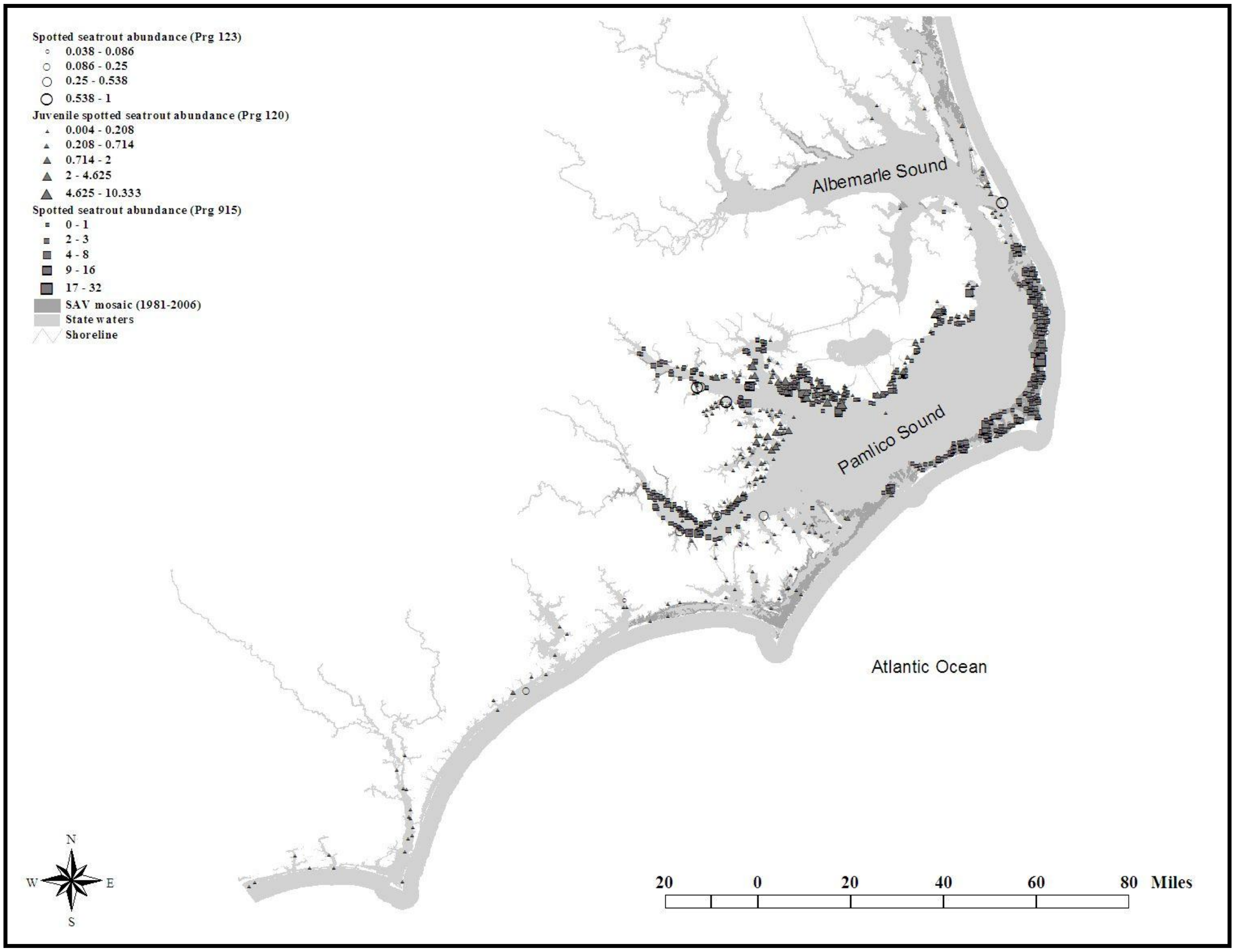


Figure 47. Distribution of known submerged aquatic vegetation in North Carolina, and mean abundance of spotted seatrout collected from Program 915, 123, and 120.

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 extent of SAV coverage in North Carolina was estimated to be between 134,000 and 200,000 acres in 1990 (Ferguson and Wood 1994). However, this estimation may not accurately represent the current spatial coverage of SAV in North Carolina because portions of Albemarle and western Pamlico sounds, and areas south of Bogue Sound were not suitably mapped. In addition, changes in the distribution of SAV may have occurred since the completion of the mapping. Nevertheless, the majority of SAV in North Carolina occurs in the high salinity, shallow (less than 1 m depth) waters of eastern Pamlico and Core Sounds (Figure 47). The persistence of these high salinity seagrass beds seems to be relatively stable over time (Ferguson and Wood 1994). In contrast, qualitative reports from the mid to late 1990’s indicated large-scale reductions of low salinity SAV habitats, primarily along the western shores of Albemarle and Pamlico sounds (North Carolina Sea Grant 1997). However, since approximately 2004, there have been observations of increasing low salinity SAV coverage in some areas of Albemarle and Pamlico sounds, and in the Neuse River. Due to the essential nature of SAV for the maintenance of spotted seatrout populations, variations in the spatial coverage of both high and low salinity SAV may have profound impacts on the productivity of the spotted seatrout fishery. Therefore, protection, enhancement and restoration of SAV are high priorities for the maintenance of spotted seatrout populations.

In order to gain a better understanding of the current spatial coverage of SAV in North Carolina, efforts are underway to quantitatively map high and low salinity SAV coverage using aerial photography, ground truth surveys, and GIS mapping (North Carolina's Cooperative Interagency SAV Mapping and Monitoring Program). This interagency effort coordinated by the Albemarle-Pamlico National Estuary Program (APNEP) is scheduled for completion by the end of 2009. The information provided by this mapping survey affords baseline information on the distribution of SAV in North Carolina, as well as allows for trend analysis in previously mapped areas such as Pamlico, Core, and Bogue sounds.

Globally, SAV habitat is declining. Rapid, large-scale SAV losses have been observed in the European Mediterranean, Japan, Chesapeake Bay, Florida Bay, and Australia (Orth et al. 2006). While threats to the stability of SAV health and distribution are many, water quality degradation, including nutrient enrichment and sediment loading, is the greatest threat to SAV (Orth et al. 2006). Nutrient and sediment loading into the water column can be traced to point source discharges, nonpoint source pollution, and the resuspension of bottom sediments. The impacts from the associated nutrient enrichment and sediment loading, such as increased turbidity, increased epiphytic loads, and sedimentation, and increased concentrations of toxic hydrogen sulfide directly reduce SAV growth, survival, and production (Dennison et al. 1993; Fonseca et al. 1998; SAFMC 1998). Effects of eutrophication are generally most severe in sheltered, low flow areas with concentrated nutrient loads and large temperature fluctuations (Burkholder et al. 1994). Areas such as this are designated Nutrient Sensitive Waters by DWQ and exist in the low salinity areas of North Carolina's estuaries and rivers where striking reductions in SAV coverage have occurred.

Once SAV habitat is lost, the associated sediments are destabilized which can result in accelerated shoreline erosion and increased turbidity. These are conditions that are not favorable to SAV recolonization and expansion in the affected area. SAV in adjacent areas may also be impacted by the resulting increase of turbidity in surrounding habitats, thus increasing the total area affected (Durako 1994; Fonseca 1996). Losses of SAV on much larger scales are particularly problematic because the rate of SAV recovery though propagation, recolonization, etc. is often much slower than the rate of SAV loss (Fonseca et al. 1998). Nevertheless, recovery of SAV habitat may be possible with improvements to water quality as evidenced by the net gain of SAV acreage in Tampa Bay, Florida and Hervey Bay, Australia following stricter water quality standards (Orth et al. 2006).

Actions associated with human water use also threaten SAV abundance and coverage. Dredging for navigational purposes, marinas, or infrastructure can directly impact SAV through large-scale removal or destruction of existing grass beds. Docks constructed over SAV and the associated shading can lead to the gradual loss of SAV both beneath and in a perimeter adjacent to the docking structure (Loflin 1995; Shafer 1999; Florida Department of Environmental Protection, unpub. data). In North Carolina, current dock designs have been found to result in the reduction of shoalgrass coverage and density when constructed over existing SAV habitat (Connell and Murphey 2004). In addition to the impacts of shoreline development and dredging on SAV, the associated increase in boating activity can lead to increased prop scarring through vegetated areas. The propeller cuts leaves, shoots, and roots structures and creates a narrow trench through the sediment. Recovery of SAV from prop scarring can take in upwards of 10 years, depending on SAV species and local conditions

(Zieman 1976). Wakes associated with the increase in boating activity can lead to the destabilization of sediments, which, in turn, can increase turbidity, thus impacting SAV growth potential.

Use of bottom disturbing fishing gears also have the potential to damage or destroy SAV. However, MFC imposed regulations that restrict the use of gears that severely damage SAV, including oyster, crab and hydraulic clam dredges; clam trawls; clam kicking; and bull rakes. To reduce the impacts of shrimp trawling on SAV, the no-trawl areas in Core Sound were extended in the Penaeid Shrimp Fishery Management Plan (DMF 2006a) to include additional SAV habitat. Bay scallop dredges, which are smaller dredges and contain no teeth, are allowed over SAV when bay scallop fishing is open (DMF 2007a). Although the damage from each gear varies in severity, shearing of leaves and stems, and uprooting whole plants are the most common impacts of bottom disturbing gears (ASMFC 2000). Shearing of leaves and stems does not necessarily result in mortality of SAV, but in general, productivity is reduced (ASMFC 2000). Gears that result in belowground disturbance may cause total loss of SAV and require months to years for the affected area to recover.

A newly emerging threat to SAV is the potential impacts of global climate change on this sensitive habitat. While climate change has occurred throughout history, the rate at which sea surface temperature, sea-level, and CO_2 concentrations are increasing is much faster than experienced in the last 100 million years (Orth et al. 2006). These changes may be occurring at a rate too fast to allow SAV species to adapt. This leads to the potential for further large-scale losses of SAV habitat globally. If SAV is indeed able to adapt to the pace of climate change, shoreline stabilization projects in many coastal areas impede the shoreward migration of SAV necessitated by rising sea-level (Orth et al. 2006). Additionally, the increased frequency and intensity of coastal storms and hurricanes, and the associated delivery of freshwater, nutrients, and sediments, threaten to further degrade water quality in estuaries and coastal rivers, thus reducing SAV health and potential distributional extent (Scavia et al. 2002; Orth et al. 2006).

9.1.4 Soft Bottom

Spotted seatrout also use shallow soft bottom as nurseries, foraging, and refuge habitats. Soft bottom 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). Underlying geology, basin morphology, and physical processes influence the physical and chemical makeup of the soft bottom habitat, which may influence spotted seatrout distribution. 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).

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 the sediments into the overlying water column through microbial processes. Increased nutrient and organic inputs exacerbate microbial activity, often leading to declining dissolved oxygen concentration, potentially affecting the distribution of spotted seatrout within this habitat.

One of the most important functions of soft bottom habitat is as a foraging area for herbivores, detritivores, secondary consumers (including spotted seatrout), and larger predators. This high value as foraging habitat is related to the high concentrations of organic matter transported to and produced on soft bottom, as well as the numerically abundant and diverse invertebrate fauna associated with this habitat. Soft bottoms are generally considered “unvegetated” and lack visible structure; however, the sediment surface supports an abundance of benthic microalgae (Peterson and Peterson 1979). The primary productivity derived from benthic microalgae supports a diverse array of benthic infauna and epifauna (Peterson and Peterson 1979; Hackney et al. 1996). Hackney et al. (1996) found over 300 species of benthic invertebrates inhabiting the soft bottoms of North Carolina. In addition to benthic microalgae, primary production in bottom sediments is also derived from deposition of detrital material derived from salt marsh vegetation, submerged grasses and macroalgae (Currin et al. 1995).

The benthic microalgae and deposited detrital material provide a rich food base for invertebrates, which are important forage for juvenile spotted seatrout (Peterson and Peterson 1979). The primary prey of juvenile spotted seatrout (less than 30 mm in length) consists mainly of benthic invertebrates, including copepods and mysid shrimps. As juvenile spotted seatrout grow (greater than 30 mm in length), the dominant prey shifts to penaeid and palaemonid shrimps, which remain important in the diet of adults (Daniel 1988; McMichael and Peters 1989).

Soft bottom habitats also function as important nurseries for juvenile spotted seatrout (Ross and Epperly 1985; Noble and Monroe 1991). These areas generally are located adjacent to wetlands and function to provide juveniles with abundant prey resources and appropriate physicochemical conditions for growth and survival. Additionally, shallow unvegetated estuarine shorelines may be used by spotted seatrout as important corridors between habitats, while reducing predation risk. Spotted seatrout can use shallow flats as migratory refuges from larger predators, which cannot access shallow waters (Peterson and Peterson 1979).

Marine soft bottom also has been noted to function as important habitat for spotted seatrout, especially during summer and winter estuarine temperature extremes (Tabb 1958; Mahood 1974; ASMFC 1984; Mercer 1984). Movements of spotted seatrout to soft bottom beaches in response to higher temperatures have been reported throughout much of their range. In Georgia, spotted seatrout were found to move to deeper waters and along beaches in response to temperatures greater than 25°C (Mahood 1974). These movements to marine soft bottom beaches have also been reported to occur in response to falling winter temperatures. Tabb (1958) noted that temperatures below 7°C caused spotted seatrout in Florida to move into inlets and offshore along beaches for brief periods of time. In North Carolina, it has been suggested that a portion of the population moves offshore to deeper marine soft bottom areas and beaches in response to falling temperatures in late autumn (ASMFC 1984; Mercer 1984).

Historical loss of structural habitats such as SAV and shell bottom has likely resulted in a net gain of soft bottom habitat. However, the shallow soft bottom habitat gained may not provide the same ecosystem functions as the highly productive structural habitats. Nevertheless, the greatest threats to soft bottom habitats are from human-induced alterations that lead to the deepening, loss, or chemical contamination of shallow and intertidal habitat.

The primary physical threat to the quality and condition of soft bottom is dredging for navigational purposes and the construction of marina basins. Dredging of inlets and navigational channels directly removes benthic infauna and epifauna, thus temporarily reducing or destroying prey resources for benthically oriented fish and invertebrates (Hackney et al. 1996; Peterson et al. 2000). Additionally, the associated increase in physical and acoustic disturbances can alter the spawning activity of summer spawning species, such as spotted seatrout (Luczkovich et al. 2008). Soft bottom habitat may also be affected by the construction of marina and docking facilities through shoreline stabilization, alteration of circulation patterns, and subsequent changes in bottom sediment characteristics (Wendt et al. 1990). The increase in depth and shading from docking structures reduce the light availability for benthic microalgae, thus reducing primary production of these soft bottom habitats (Iannuzzi et al. 1996). Within the confines of the marina basin, bottom DO conditions may become depleted or drop below biotic threshold concentrations with the associated increase in detrital material and biological oxygen demand. In North Carolina, a study of marina basins found that DO concentrations were significantly lower (less than 5 mg l^{-1} O_2) inside marina basins as compared to outside (DEHNR 1990). Shoreline stabilization associated with marina construction also can degrade soft bottom habitats used by spotted seatrout through the destruction of unvegetated intertidal zones and an increased in water depth altering the productivity and prey resources present in these habitats.

Sediment contamination is also of particular concern for soft bottom habitats. While toxins such as heavy metals, polycyclic aromatic hydrocarbons (PAHs), petroleum hydrocarbons, pesticides, polychlorinated biphenyls (PCBs), and ammonia can fluctuate between sediments and the water column, concentrations of toxins tend to accumulate in sediments to several orders of magnitude greater than the overlying waters (Kwon and Lee 2001). Toxic chemicals originate from both nonpoint source and localized point source pollution. Additionally, marina operation often leads to the introduction of heavy metals, petroleum hydrocarbons, and bacteria (Chmura and Ross 1978; Marcus and Stokes 1985; Voudrias and Smith 1986). Introduction of toxic chemicals into soft bottom habitats can have profound effects on the productivity of both benthic dwelling invertebrates and fish fauna. Exposure to hydrocarbons, heavy metals, and other toxins can cause direct mortality of benthic fish and invertebrates, as well as cause sublethal responses such as hormone alterations, mutations, and altered growth and reproduction (Weis and Weis 1989; Wilbur and Pentony 1999; White and Triplett 2002; Johnson et al. 2002).

Use of bottom disturbing fishing gear also has the potential to impact the productivity of soft bottom habitats and thus, spotted seatrout. Although dredges are considered the most destructive fishing gear used in North Carolina, the limited effort with this gear over soft bottom areas indicates the overall impact of dredges is low. More commonly used gears, such as trawls, have the potential to severely impact soft bottom habitat productivity in both the marine and estuarine environments. Trawling over soft bottom reduces habitat complexity and productivity by removing or damaging benthic invertebrates, smoothing sediment features, resuspending sediments, and increasing bottom water turbidity (Collie et al. 1997; Auster and Langton 1999; DMF 1999). In a literature review of the effects of trawling on estuarine soft bottom habitats, DMF (1999) noted a discrepancy in the conclusions of multiple studies, noting that minimal long-term effects were reported in some studies (Van Dolah et al. 1991; Currie and Parry 1996), while other studies reported significant long-term impacts to bottom communities (Collie et al. 1997; Engel and Kvitek 1998). In an effort to gain more information on the effects of bottom trawling in North Carolina, Cahoon et al. (2002) examined the changes in benthic micro- and macroalgae, and demersal zooplankton in the Pamlico River estuary. The authors concluded that trawling in this area was not detrimental to the benthic community. However, due to the discrepancies of conclusions among a number of studies, more long-term, spatially extensive studies are needed to accurately quantify the effects of bottom disturbing fishing gear on soft bottom communities in North Carolina.

Beach nourishment projects can have direct impacts on the quality and quantity of intertidal and subtidal oceanic soft bottom habitats, which serve as important foraging and refuge habitat for adult spotted seatrout. The immediate impacts of beach nourishment projects include the almost complete initial removal of benthic invertebrates from the intertidal and subtidal zones due to sediment smothering (Hackney et al. 1996; Peterson et al. 2000). Time to recovery for these habitats varies in length from one month to over one year and is dependent on sediment grain size of deposited material, depth of filled sand, time of year, alteration to beach geomorphology, as well as other factors (Reiley and Bellis 1983, Rakocinski et al. 1993; Peterson et al. 2000; COE 2001). Fish are directly impacted by beach nourishment projects not only by the immediate reduction in the availability of benthic prey, but also by alterations to bottom topography, disturbances prior to or during spawning, and reduced visibility (Street et al. 2005). In North Carolina, the effects of beach nourishment in Brunswick County were evaluated for impacts on surf zone fishes, benthic invertebrates, and water quality (COE 2003). Although no significant differences were found among disturbed, undisturbed, and reference sites for shore zone fishes due to the high mobility and schooling behavior of most fishes using this habitat, the abundance of gulf kingfish (*Menticirrhus littoralis*) was less at the disturbed site. The reduction in abundance was suggested to be partially due to the reduction of benthic invertebrates, the preferred prey of gulf kingfish, in the disturbed area (COE 2003).

9.1.5 Shell Bottom

Although use of shell bottom by spotted seatrout had been, until recently, infrequently documented due to the difficulty in sampling these areas, shell bottom has been recognized to function as an important nursery, foraging area, and refuge for this species. 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 to describe shell bottom in North Carolina include "oyster beds," "oyster rocks," "oyster reefs," "oyster bars," and "shell hash." Shell hash can be described as a mixture of sediments with unconsolidated broken shell (oyster, clam 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 have been several meters tall, while intertidal oyster reefs in the central and southern estuaries may be only a few oysters thick (Lenihan and Peterson 1998; DMF 2008). Generally, oyster spat attach to existing oyster beds and other hard structures, as well as *Spartina alterniflora* roots creating a conglomeration of individuals (DMF 2008).

The presence of shell bottom in estuarine systems provides a number of ecological services that enhance the health and productivity of the ecosystem. Oysters enhance the water quality of estuaries through filtration of sediments and pollutants from the water column (ASMFC 2007). Additionally, the structure provided by shell bottom decreases wave energy, stabilizes sediments, and decreases erosion of immediate and adjacent areas (Lowery and Paynter 2002). Oyster reefs also function as important sinks for nutrients and other pollutants (ASMFC 2007).

The complex three-dimensional structure of shell bottom habitats provides juvenile and adult spotted seatrout with areas for refuge, foraging, and growth. Juvenile and adult spotted seatrout have been documented using shell bottom habitats in Virginia (Harding and Mann 2001), North Carolina (Lenihan et al. 2001; Grabowski 2002), South Carolina (Daniel 1988), and Louisiana (MacRae 2006). The invertebrates and small resident finfish living on and among shell bottom provide juvenile and adult spotted seatrout with an important forage base (Coen et al. 1999; ASMFC 2007). Lenihan et al. (2001) found that adult spotted seatrout fed primarily on reef-associated fishes, such as Atlantic croaker (*Micropogonias undulatus*) and silver perch (*Bairdiella chrysoura*) while inhabiting subtidal oyster reefs in North Carolina. Spawning aggregations of spotted seatrout have also been found to occur over shell bottom habitats. In the lower Neuse River estuary, spawning aggregations of spotted seatrout occasionally were observed over subtidal (2-5 m) shell bottom habitats (A. Barrios unpub. data). In a review of fish use of shell bottom habitats, Peterson et al. (2003) found that spotted seatrout were documented to use oyster reef habitats as adults; however, data was inconclusive on whether spotted seatrout populations were enhanced by the presence of oyster reefs. Nevertheless, the ecosystem benefits provided by oyster reef habitats would still indirectly benefit both juvenile and adult spotted seatrout.

Much of the natural shell bottom in North Carolina is built by and consists primarily of oysters. Oyster distribution and abundance is generally limited by ambient water quality conditions, such as salinity and high temperatures (Funderburk et al. 1991). Additionally, predators such as boring sponges, oyster drills, and whelks further restrict the distribution of oysters, especially in higher salinity waters (Bahr and Lanier 1981). In North Carolina, oyster distribution is limited to areas between extreme southeastern Albemarle Sound and the South Carolina border (DMF 2008). In southeastern Albemarle and Pamlico sounds, oyster reefs consist primarily of subtidal beds concentrated along the western shore (Epperly and Ross 1986). Subtidal beds also are present in the Newport, White Oak and New rivers in the central estuaries. Intertidal beds dominate most areas south of Cape Lookout (DMF 2008).

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 (DMF 2008). Most of the losses of shell bottom were at the subtidal oyster reefs in Pamlico Sound, where over 90% of the oyster fishery was concentrated through the mid 20th century (Chestnut 1955; DMF 2008). Mechanical harvesting of oysters directly impacts oyster populations and health by removing both spawning stock biomass, as well as decreasing settlement areas for oyster larvae (Lenihan and Peterson 1998; Lenihan et al. 1999). Currently, mechanical harvesting of oysters is restricted by the MFC to approximately 222,224 acres of temporarily open shellfish bottom in the Neuse, Pamlico, Tar-Pamlico, and Albemarle management units. However, even with these restrictions, oyster populations have been extremely slow to recover. Hand harvest methods, such as rakes and tongs, can be just as destructive to shell bottom as mechanical harvest, only on a much smaller scale.

In addition to the direct impacts of shellfish harvesting on shell bottom, human development and the associated watershed alterations can indirectly impact shell bottom habitat distribution and health. Increased sediment load in stormwater runoff from construction, forestry, and agricultural activities can harm shellfish by clogging gills, increasing survival of pathogens, and increasing ingestion of non-food items (SAFMC 1998). Additionally, increased nutrient concentrations leading to an increase in phytoplankton blooms can lower bottom water DO concentrations, thus stressing or killing shellfish in the affected area (Funderburk et al. 1991). Of particular importance to oysters has been the increase in prevalence of the oyster parasites Dermo (*Perkinus marinus*) and MSX (*Haplosporidium nelsoni*), predominantly in areas of moderate salinity (16-20 ppt). Physiological stress induced by water quality alterations such as low dissolved oxygen increase the susceptibility of oysters to parasitism and disease (Lenihan et al. 1999).

9.2 Water Quality

Good water quality in North Carolina's coastal waters is necessary to maintain the appropriate physicochemical conditions for spotted seatrout growth and survival, as well as sustain habitats that spotted seatrout rely on, such as SAV. Although spotted seatrout can tolerate a wide range of abiotic conditions due to their estuary dependent life history, there are environmental optima that enhance spotted seatrout reproduction, growth, and survival. Optimum spawning conditions exist at a water temperature of 29°C for populations in Florida (Kupschus 2004), while spawning was found to occur primarily at temperatures between 24.5 and 33.5°C in Louisiana (Saucier and Baltz 1993). In Pamlico Sound, spawning activity from July through October was reported to frequently occur at temperatures between 27 and 29°C (A. Barrios unpub. data). Optimum water temperature for juvenile spotted seatrout inhabiting Floridian estuaries has been reported to be 28°C, indicative of summer spawning and juvenile nursery periods (Kupschus 2003). Although this species is euryhaline, salinity plays an important role in the buoyancy of eggs and larvae, which are negatively buoyant at salinities less than 20 ppt (Holt and Holt 2003). Documented spawning activity of spotted seatrout in western Pamlico Sound tributaries, such as Bay River, Jones Bay, and Neuse River, frequently experience salinities less than 20 ppt (Luczkovich et al. 2008; A Barrios unpub. data), which could result in the failed survival of eggs spawned in these areas. DO concentrations also affect spotted seatrout distribution, with decreasing abundance at concentrations less than saturation (Gelwick et al. 2001). Human activities that alter the preferred environmental conditions of spotted seatrout, as well as introductions of excessive nutrients, toxins, and sediment loads can severely impact the habitat value for spotted seatrout.

Over the past 20 years, there has been substantial human population growth in North Carolina's coastal river basins. Physical alterations to water bodies such as channelization and shoreline stabilization have increased with increasing human population, resulting in altered hydrography and change in temperature, salinity, and DO regimes. These alterations can have profound effects on the abundance and distribution of nekton (Peterson et al. 2000; Waters and Thomas 2001). Furthermore, the increase in population has resulted in increased stormwater runoff, the addition of new septic tanks, and the need for additional wastewater treatment capacities and water supply resources. Population impacts of coastal water quality are dependent on development locations, land use, and basin morphology (Street et al. 2005). Water pollution associated with human population growth can be classified into two categories: point source and nonpoint source pollution. Point source pollution originates from a defined point such as industrial waste discharges and requires a National Pollution Discharge Elimination System (NPDES) permit, while nonpoint source pollution, such as stormwater runoff, has an undefined origin. However, both types of pollution sources can substantially affect the overall water quality of a watershed through the addition of sediments, nutrients, and toxins.

Spotted seatrout in North Carolina occur in several coastal river basins including the Pasquotank, Tar-Pamlico, Neuse, White Oak, Cape Fear, and Lumber River basins (Figure 48). The status of water quality conditions is determined by the North Carolina Division of Water Quality's (DWQ) five-year use support assessments for each river basin. While DWQ rates water bodies based on five use support categories, the aquatic life and to a degree, the shellfish harvesting categories are the most ecologically pertinent in rating the water quality status of potential spotted seatrout habitats. The aquatic life use support category is rated based on biological monitoring of benthic invertebrates and fish communities, and physicochemical information, while the shellfish harvesting use support category is rated based on fecal coliform bacteria levels. If data exceed the water quality criteria, the water body is considered impaired.

Of the coastal river basins in North Carolina, the Pasquotank River basin in eastern Albemarle and northeastern Pamlico sounds contains relatively low amounts of impaired fresh and estuarine waters and few acres of shellfish closures (Table 62). Additionally, the Lumber River basin in extreme southeastern North Carolina has no impairments to freshwater and estuarine waters in terms of aquatic life use support. The Cape Fear River basin contains the most miles of impaired freshwater streams, while the Neuse River basin contains the most acreage of impaired estuarine waters. Waters impaired for shellfish harvesting peak in acreage in the White Oak River basin and increase in terms of percentage of total shellfish waters as one moves south. The magnitude and location of impairments tend to coincide with high population densities within a river basin.

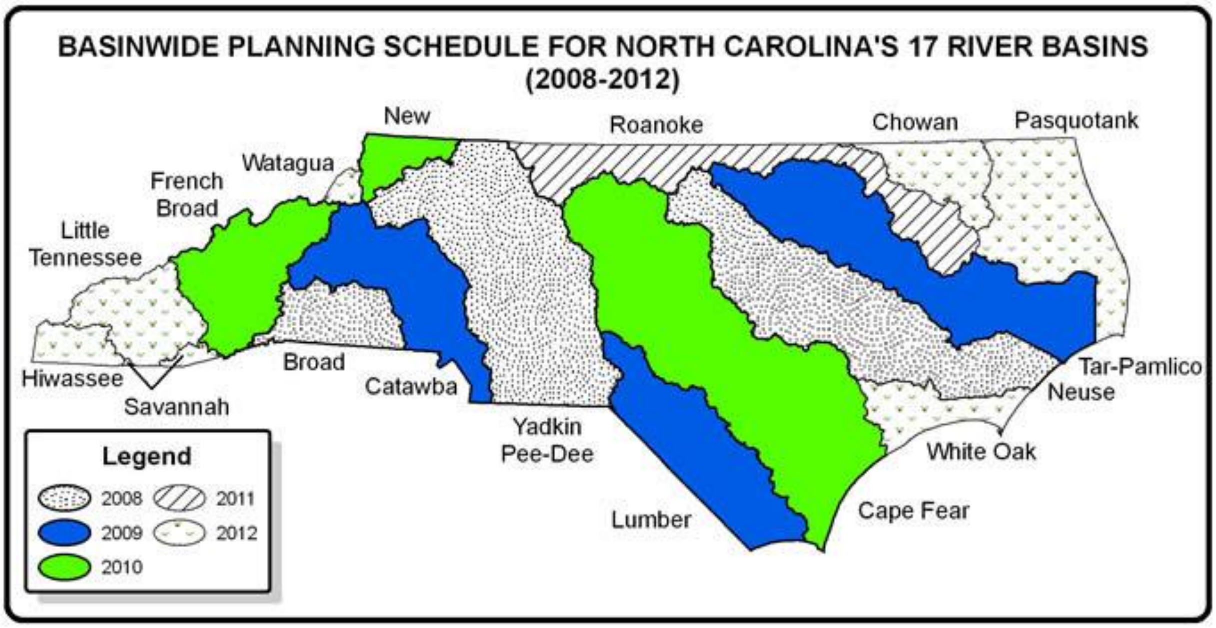


Figure 48. Location of North Carolina river basins (http://h2o.enr.state.nc.us/basinwide).

9.2.1 Nutrients

Nutrient enrichment poses a particularly large threat to the health and condition of coastal water resources, which can directly impact habitat quality for spotted seatrout. Nutrients include the elements nitrogen and phosphorous, as well as human and animal wastes. Nitrogen and phosphorous are essential to the health and productivity of phytoplankton, algae, and marine plants, and regulate the growth of flora depending on ambient concentrations (DeAngelis et al. 1989). While nutrients are necessary for growth of living organisms, excessive nutrient loading in the environment can lead to nuisance algal blooms, increased biological oxygen demand, hypoxia or anoxia, fish kills, and eventually, loss of biodiversity (Paerl 2002). Much of the nutrient enrichment in North Carolina's estuaries is caused by cultural eutrophication, or the rapid accumulation of nutrients and sediments caused by human land and water use activities (DWQ 2000a).

Table 62. Aquatic Life and Shellfish Harvest Use Support impaired waters in six coastal river basins in North Carolina (DWQ 2002, 2003, 2004, 2007 a,b).

	Aquatic life - streams			Aquatic life- estuarine			Shellfish harvest		
River Basin (year[1])	Impaired stream miles	% impaired of monitored streams	% monitored	Impaired estuarine acres	% impaired of monitored streams	% monitored	Impaired acres	% impaired of monitored streams	% monitored
Pasquotank (2007)	12.3	n/a	n/a	772.7	n/a	n/a	6,473.2	1.6	100
Tar-Pamlico (2004)	64.1	7.6	32.9	6,070.9	1	91.5	7,515.9	1.3	100
Neuse (2002)	278.6	22.3	36	31,767.3	9.1	91	3,710.6	1.1	100
White Oak (2007)	0	n/a	n/a	7,942	n/a	n/a	37,582	31.8	n/a
Cape Fear (2005)	425.4	6.9	n/a	6,527.4	20.6	n/a	6,500.7	41.4	n/a
Lumber (2003)	0	0	32	0.0	0	50	3,606.9	84	100

[1]Year of most recent DWQ Basinwide Plan

As discussed previously, nutrients enter surface waters through both point and nonpoint sources. Point sources of nutrients include municipal and industrial wastewater discharges, and have been identified as a source of impairment for 36 percent of North Carolina's impaired streams (DWQ 2000a). On the other hand, nonpoint sources, such as agricultural runoff, are believed to be one of the largest contributors to nutrient enrichment of the coastal areas of southeastern United States (SAFMC 1998). While runoff is usually identified as the major contributor to nonpoint source nutrient enrichment, atmospheric deposition of nitrogen (AD-N) has recently been shown to be a significant source of externally generated nitrogen entering estuaries (Paerl 2002). Additionally, there may be a link between acidic deposition (acid rain) and AD-N; both originate mostly from burning of fossil fuels and agricultural practices (Paerl 2002; Driscoll et al. 2003).

Nuisance algal blooms of toxic dinoflagellates have recently been linked to increased estuarine nutrient enrichment (Hallegraeff 1998). Many of these dinoflagellates release toxic chemicals into the environment, which can harm fish and shellfish (Tyler 1989). In North Carolina, sampling by DWQ, DMF and North Carolina State University was initiated in the Neuse, Tar-Pamlico and New rivers during 1998 to examine the distribution and species impacted by toxic dinoflagellates including *Pfisteria piscicida*. The Atlantic menhaden, *Brevoortia tyrannus*, was the predominant species affected with many individuals exhibiting the sublethal effects of exposure: tissue lesions. Additionally, toxic dinoflagellates have been identified to affect the health of spotted seatrout. Spotted seatrout were reported to have experienced extensive mortality during exposure to *Pfisteria* in their natural habitats (Burkholder et al. 1995). However, *Pfisteria* has not been reported to have caused fish kills in North Carolina's estuaries since Hurricane Floyd made landfall in 1999.

9.2.2 Oxygen Depletion

Growth and survival of spotted seatrout and other organisms depends heavily on a sufficient supply of DO. Although hypoxic and anoxic conditions develop naturally though flushing of swamp waters or from stratification of the water column, low-oxygen conditions are often exacerbated by human-induced eutrophication. Algal blooms associated with nutrient enrichment deplete DO in the water column as biological oxygen demand (BOD) increases at night via plant respiration. As the algal blooms die, plant material descends to the sediment surface where bacteria further deplete DO through increased BOD necessary for the decomposition of organic material (DWQ 2000b). Chronic low dissolved oxygen, lasting from weeks to months, often develops in shallow estuaries with low flushing rates, resulting in stratification of the water column (Tenore 1972). However, in well-mixed systems, diel-cycling hypoxia caused by the photosynthesis/respiration cycle of phytoplankton develops daily (Tyler and Targett 2007).

The spatial extent of hypoxia in North Carolina's estuaries is monitored by DWQ use support data. In estuarine waters, low DO was a major source of impairment only in the Cape Fear (6,527 acres) and Pasquotank river basins (6,264 acres). Although low dissolved oxygen events are often linked to eutrophication induced phytoplankton blooms, use support data did not consistently show low DO impairment where chlorophyll *a*, an indicator of phytoplankton biomass, was high. This was particularly true in the Neuse River basin where a significant amount of estuarine acreage is impaired by chlorophyll *a* (DWQ 2007).

Most demersal fishes experience low-oxygen induced mortality in waters having 1-2 mg l^{-1} O_2 and altered metabolism at concentration less than4 mg l^{-1} O_2 (Miller et al. 1985; Gray et al. 2002). Some estuarine organisms are capable of detecting and avoiding these low DO concentrations, but threshold vary among species (Wannamaker and Rice 2000). There are no reported oxygen thresholds for spotted seatrout; however, this species is often reported to be associated with habitats with saturated DO concentrations (Gelwick et al. 2001). A species similar to spotted seatrout, weakfish, has been studied extensively in its tolerances of low DO. Studies have shown that weakfish avoid areas with less than2 mg l^{-1} O_2 concentrations both in the laboratory (Brady et al. 2008) and the field (Tyler and Targett 2007). Additionally, this species reenters preferred habitats once DO concentrations rise above this threshold (Tyler and Targett 2007). This suggests that, due to the similarity between species, spotted seatrout may also be able to detect and avoid areas with low DO.

The most visible effect of oxygen depletion is large fish kill events. Low dissolved oxygen has been reported as the leading cause of fish kills in 22 coastal states (Lowe et al. 1991). From 2003 to 2008, there has been 132 fish kill events reported to DWQ, of which, spotted seatrout were present in three events (DWQ 2008). Dissolved oxygen depletion has been cited as the cause of 38% of the total number of fish kills reported over this time period. However, over 60% of the fish kills have been reported from freshwater where spotted seatrout are absent.

9.2.3 Turbidity and Sedimentation

Erosion and sedimentation of shorelines occurs naturally in estuarine systems, increasing the turbidity of the adjacent water column. These processes are mostly influenced by wave exposure, currents, and natural stormwater runoff. However, human land- and water-use activities have accelerated these processes. Human induced sediment loading is primarily related to nonpoint source stormwater runoff from urban areas, agriculture, silviculture, and animal operations. Sedimentation from agriculture has been cited as one of the largest contributors to water pollution in the southeastern United States (SAFMC 1998). The removal of vegetated buffers in these areas helps to hasten sediment loading and increases turbidity in the surrounding water (DWQ 2000 b). Additionally, water based activities such as dredging, boating, and use of bottom disturbing fishing gears generate turbidity in the water column.

Increased sedimentation in water column habitats can have significant impacts on aquatic life. Increased turbidity can shade out productive flora such as phytoplankton and SAV (North Carolina Sea Grant 1997), resulting in trophic impacts for secondary and tertiary consumers. In addition, the increased sediment load in the water column can clog gills and pores of fish and invertebrates, resulting in reduced feeding capacities or even mortality (Ross and Lancaster 1996; DWQ 2000a). Tabb et al. (1962) reported that excessively turbid waters in Everglades National Park following Hurricane Donna resulted in mass mortalities of spotted seatrout when their gill chambers became packed with suspended sediments.

9.2.4 Toxic Chemicals

Toxic chemicals in the water column and sediments can occur naturally (e.g. heavy metals), but most originate from human activities. Toxins include heavy metals, pesticides, dioxins, polycyclic aromatic hydrocarbons (PAHs), polychloroinated biphenyls (PCBs), petroleum hydrocarbons, chlorine, antifoulants, ammonia, and pharmaceuticals. These toxins originate from localized point and nonpoint sources, including municipal and agricultural runoff, dock and marina development, boating activity, automotive transportation, industrial shipping, and industrial emissions (Wilbur and Petony 1999). Although found in both the water column and sediments, toxins can accumulate to several orders of magnitude higher in the sediments (Kwon and Lee 2001). Fine-grained sediments act as a reservoir for heavy metals and pesticides (Riggs et al. 1991). Resuspension of contaminated sediments can thus be problematic, particularly in the small trunk estuaries and deeper regions of the larger estuaries in North Carolina where fine –grained sediments dominate.

Studies examining sediment contamination in North Carolina’s estuaries have found various levels of contamination, although the extent of this contamination is not well known. The EPA Environmental Assessment Program surveyed 165 sites in North Carolina’s sounds and rivers during 1994-1997 to evaluate environmental conditions (Hackney et al. 1998). The highest levels of contamination occurred in low salinity areas with low flushing and high river discharge. Benthic communities in these areas were typically species poor and were dominated by a few opportunistic species, while in many areas sediments were toxic to biological life. Additional studies in the Neuse and Pamlico River estuaries assessed sediment concentrations of heavy metals (Riggs et al. 1989; Riggs et al. 1991). In general, the Neuse River was more severely contaminated with heavy metals including zinc, copper, lead, and arsenic. Seventeen sites in the Neuse River were identified as “contaminated areas of concern.” However, concentrations of arsenic, cobalt, and titanium in the Pamlico River exceeded levels reported in the Neuse River. Collectively, these studies suggest that sediment contamination in North Carolina’s estuaries could affect fish populations through toxicity and altered food web structures.

The presence of toxic chemicals in the water column or sediments can inhibit or alter reproduction of aquatic organisms, or even cause mortality (Weis and Weis 1989; Gould et al. 1994). Exposure to DDT in Laguna Madre, Texas concentrated residues in the gonads of spotted seatrout and prevented spawning of the population during a few years (Butler 1969; Butler et al. 1970). The early life history stages, however, are the most susceptible to toxins (Funderburk et al. 1991; Rice et al. 2001). Considerable larval spotted seatrout mortality was observed after exposure to sodium hypochlorite (Johnson et al. 1977). Johnson et al. (1979)

observed a general decrease in total body length and an increased incidence of unpigmented eyes of larval spotted seatrout subjected to sublethal concentrations of fuel oil. In addition to direct mortality and the sublethal effects on growth, toxins may bioaccumulate to toxic levels in the tissues of surviving organisms. Numerous authors have correlated sediment toxin concentrations with that in fish and invertebrates (Kirby et al. 2001; Marburger et al. 2002). Strom and Graves (2001) found that spotted seatrout residing in Florida Bay had high enough levels of mercury to be placed on consumption advisory.

Recent attention has focused on the presence and effects of endocrine disrupting chemicals (EDC) entering surface waters of freshwater and marine environments (Cooper et al. 2008). EDCs are exogenous substances which alter an organism's reproductive physiology and morphology (WHO 2002). EDCs include natural and synthetic estrogens, dioxin, PCBs, as well as other chemicals. These chemicals originate mostly from wastewater treatment plant discharge and industrial effluent, but sources also include runoff from animal operations and use of sewage sludge as fertilizers (Cooper et al. 2008). Exposure of freshwater and marine teleost fish to EDCs has been reported to result in a high prevalence of gonadal intersex (Kavanagh et al. 2004; Liney et al. 2005) and reproductive failure (Nash et al. 2004). Additionally, EDCs act together in an additive manner, resulting in reproductive consequences at low concentrations of several chemicals in combination (Brian et al. 2005). Several xenobiotics were found to bind to the hepatic estrogen receptors in spotted seatrout, suggesting possible reproductive consequences when exposed to EDCs (Thomas and Smith 1993). More information on the effects of EDCs on spotted seatrout reproductive physiology and morphology is needed for populations in North Carolina.

9.2.5 Weather Events

Weather events directly influence habitat quality for fish and invertebrates along North Carolina's coast. Hurricanes, although considered an important natural perturbation necessary for the long-term maintenance of estuarine systems (Meeder and Meeder 1989), can have a cascading effect on the physical, chemical, and ecological characteristics of coastal fish habitat (Paerl et al. 2001; Mallin et al. 2002). Increased loss of wetlands and hydrological modifications intensify these effects, resulting in increased sediment and nutrient loading (Paerl et al. 2001; Mallin et al. 2002), and higher costs for storm repair (Costanza et al. 2008). After the passage of three consecutive hurricanes (Dennis, Floyd, and Irene) in September and October 1999, the Pamlico Sound was reported to have salinities reduced by three-fourths, vertical stratification of the water column, bottom water hypoxia, increased algal biomass, displacement of marine organisms, and an increase in the presence of fish disease (Paerl et al. 2001). Because of the timing of these events in late summer and early autumn, the large changes in flushing, salinity, temperature, DO, and turbidity associated with hurricanes could be most problematic for summer spawning species, such as spotted seatrout, whose larvae and early juveniles may be flushed from the system or unable to escape physiologically unsuitable conditions. However, there is no conclusive evidence that hurricanes have a measurable impact on the spotted seatrout population in North Carolina (Burgess et al. 2007).

Winter water temperature dynamics are of particular importance to habitat quality for spotted seatrout. Generally, spotted seatrout overwinter in estuaries, only moving to deeper channels or to nearshore ocean habitats in response to water temperatures below 10°C (Tabb 1966; ASMFC 1984). However, extreme cold waves accompanied by strong winds mix and chill the water column, causing sudden drops in water temperature. The abrupt temperature decline numb spotted seatrout and can result in mass mortality (Tabb 1966). Many estuarine temperature refuges, such as deep holes and channels, are often far from inlets and become death traps as spotted seatrout are cold stunned before they can escape (Tabb 1966). This suggests that the severity and duration of cold weather events can have profound effects on the spotted seatrout population in North Carolina's estuaries. Refer to Section 10 for an Issue Paper on the effect of cold stun on spotted seatrout populations.

9.3 Habitat and Water Quality Protection

9.3.1 MFC Authority

Presently, the MFC has authority for the following actions with regard to marine and estuarine resources: manage, restore, develop, cultivate, conserve, protect, and regulate. Marine and estuarine resources are "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 MFC's primary responsibilities are management of fisheries (season, size and bag limits, licensing, etc.), the MFC has the authority to comment on state permit applications that may have an effect on marine and estuarine resources or water quality, regulator placement of fishing gear, develop and improve mariculture, and regulate location and use of artificial reefs. Authority for the MFC is found at G.S. 143B-289.51 and 52.

9.3.2 Authority of Other Agencies

The North Carolina Department of Environment and Natural Resources (DENR) has 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 DCM is responsible for development permits along the estuarine shoreline in 20 coastal counties. Wetland development activity throughout North Carolina is permitted through the US Army Corps of Engineers (COE) and DWQ (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 DMF, evaluate projects proposed for permitting and provide comments and recommendations to the DCM, DWQ, and COE on potential habitat and resource impacts. 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.

9.3.3 Coastal Habitat Protection Plan

The FRA of 1997 mandated the DENR to prepare CHPPs (CHPPs -- G. S. 143B-279.8). The legislative goal for the CHPPs is long-term enhancement of the coastal fisheries associated with coastal habitats and provides a framework for management actions to protect and restore habitats critical to North Carolina's coastal fishery resources. There are three commissions that have regulatory jurisdiction over the coastal resources, water, and marine fishery resources including: MFC, CRC, and the Environmental Management Commission (EMC). The CHPP was completed in December 2004 and implementation plans for each Division and the Department were approved in July 2005. The plan is to be reviewed every five years. 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). Fish habitat also includes land areas that are adjacent to, and periodically flooded by riverine and coastal waters. Six fish habitats are discussed and designated based on distinctive physical properties, ecological functions, and habitat requirements for living components of the habitat: wetlands, SAV, soft bottom, shell bottom, ocean hard bottom, and water column.

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 spotted seatrout. 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.

9.4 Recommended Management Strategy

Suitable and adequate habitat is a critical element in the ecology and productivity of estuarine systems. Degradation or improvement in one aspect of habitat may have a corresponding impact on water quality. Maintenance and improvement of suitable estuarine habitat and water quality is critical to successfully managing spotted seatrout stocks.

9.4.1 Habitat

Habitat and water quality protection, conservation, and restoration are essential to accomplish the goal and objectives of this plan. The MFC, CRC and EMC should adopt rules to protect critical habitats for spotted seatrout as outlined in the CHPP. The N.C. 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 MFC and DMF 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 MFC and DENR to accomplish the actions outlined below. Most of the actions can be implemented by DMF/MFC as CHPP-related actions. The other actions would need to be implemented through the cooperative efforts of the

N.C. General Assembly and/or several divisions within DENR. The involvement of federal agencies and increased funding (state and federal) may also be necessary to accomplish these actions.

Strategic Habitat Areas

1. Identify and designate Strategic Habitat Areas (SHAs) that will enhance protection of spotted seatrout.

Wetlands

2. Prevent loss of additional riparian wetlands through the permitting process, land acquisition, and land use planning.
3. Restore coastal wetlands to enhance water quality conditions for spotted seatrout.
4. Minimize loss of wetlands to shoreline stabilization by revising CRC estuarine and public trust shoreline stabilization rules using the best available information, incorporating erosion rates, and promoting incentives for use of alternatives to vertical shoreline stabilization measures.

SAV

5. Continue mapping of SAV in North Carolina to assess distribution and change over time.
6. Expand nursery sampling to include high and low salinity SAV beds to adequately evaluate their use by spotted seatrout and other species, and trends in those species.
7. Conduct research to evaluate the role of SAV in the spawning success of spotted seatrout and other economically important species.
8. Determine the spatial and biological characteristics of SAV beds that maximize their ecological value to spotted seatrout for restorative purposes.
9. Examine the effect of spatial connectivity between SAV, wetlands and shell bottom on spotted seatrout use, survival, growth and abundance.
10. Aggressively reduce point and non-point nutrient and sediment loading in estuarine waters, to levels that will sustain SAV, using regulatory and nonregulatory actions.
11. Evaluate dock sitting criteria and construction to determine if existing requirements are adequate for SAV survival and growth, and modify if necessary.
12. Develop and implement a comprehensive coastal marina and dock management plan and policy to minimize impacts to SAV and other fish habitats.
13. Evaluate and adjust as necessary dredging and trawling boundaries to protect existing SAV and allow some recovery where it historically occurred.
14. Seek additional resources to enhance enforcement of, and compliance with, bottom disturbing fishing gear restrictions that protect SAV and other fish habitats.
15. Work with NOAA and DWQ to determine appropriate levels of total suspended solids (TSS), turbidity, chlorophyll *a*, and other water clarity parameters to achieve adequate water quality conditions for SAV growth, and model potential SAV habitat.

Soft bottom

16. Protect shallow soft bottom habitat through proper sitting and construction of docks, marinas, and shoreline stabilization structures.
17. Assess the distribution, concentration, and threat of heavy metals and other toxic contaminants in freshwater and estuarine sediments and identify the areas of greatest concern to focus water quality improvement efforts.
18. Evaluate the effects of clam kicking and trawling on soft bottom habitat and spotted seatrout.

Shell bottom

19. Conduct research to evaluate the role of shell hash and shell bottom in spotted seatrout recruitment and survival, particularly where SAV is absent.
20. Accelerate and complete mapping of all shell bottom in coastal North Carolina.
21. Continue support for the oyster shell recycling and oyster hatchery programs to provide areas of enhanced or restored shell bottom habitat.

9.4.2 Water Quality

Suitable water quality is a critical element in the ecology and productivity of estuarine systems. Degradation or improvement in one aspect of water quality may have corresponding impact on habitat. Maintenance and improvement of suitable estuarine water quality and habitat are probably the most important factors in providing a sustainable spotted seatrout stock.

The MFC has no regulatory authority over water quality impacts other than the effects of fishing practices. The MFC and DMF should highlight problem areas and advise other regulatory agencies (EMC, DWQ, DEH – Shellfish Sanitation, Division of Land Resources, COE, and local governments) on preferred options and potential solutions. The MFC and DMF should continue to comment on activities (state, federal, and local permits) that may impact estuarine water quality and work with permitting agencies to minimize impacts. Additionally, the MFC and DMF should solicit and support Fishery Resource Grant (FRG) projects that may provide information necessary for protection, management, and restoration of water quality. Water quality standards should be based on the assimilative capacity of, and impacts to, the entire system. Several plans for water quality management have recommended strategies that need to be implemented to improve water quality. A strategy should be developed and adopted by the MFC and DENR to accomplish the actions outlined in Section 11, and to assure that recommendations of existing and future water quality plans are addressed in a timely manner. The DENR should develop a strategy to fully support CHPP implementation with needed staff and funding. Water quality protection and restoration are essential to accomplish the goal and objectives of this plan.

Actions would need to be implemented through the cooperative efforts of the N.C. General Assembly and several divisions within the DENR. The involvement of federal agencies and funding may also be needed to accomplish these actions. Many of the following actions were taken directly from the CHPP.

1. Improve methods to reduce sediment and nutrient pollution from construction sites, agriculture, and forestry.
2. Increase on-site infiltration of stormwater through voluntary or regulatory measures.
3. Provide more incentives for low-impact development.
4. Work with DWQ and EMC to modify stormwater rules to more effectively reduce runoff volume and pollutant loading to coastal waters to levels that protect and enhance fish habitats vital to spotted seatrout.
5. Reduce impervious surfaces associated with new development as much as possible and reduce the maximum amount of impervious surfaces allowed in the absence of engineered stormwater controls.
6. Aggressively reduce point source pollution from wastewater through improved inspections of wastewater treatment facilities, improved maintenance of collection infrastructure, and establishment of additional incentives to local governments for wastewater treatment plant upgrading.

10. PRINCIPAL ISSUES AND MANAGEMENT OPTIONS

10.1 Identification of Issues

Major issues and management options developed during the FMP process are summarized in this section. Management issues in the North Carolina spotted seatrout fishery have been solicited from the public, MFC Spotted Seatrout Advisory Committee, MFC, Finfish and Regional Advisory committees, DMF, DENR, and the scientific community.

10.1.1 Issues Addressed in this Plan

1. Determining Appropriate Harvest Reductions Necessary to End Overfishing and Rebuild the Spotted Seatrout Stock

2. Achieving Sustainable Harvest

3. Enforcement of Size, Creel Limit and Gear Regulations in Joint, Coastal or Inland Fishing Waters

4. Management Measures to Address User Group Competition in the Spotted Seatrout Fisheries

5. Impacts of Cold Stun Events on the Spotted Seatrout Population

6. Bycatch in the Flounder, Striped Mullet and Spot Directed Fisheries

7. Achieving Sustainable Harvest-Commercial Fishery Alternatives

10.2 Issues and Management Stategies

10.2.1 Determining Appropriate Harvest Reductions Necessary to End Overfishing and Rebuild the Stock

Issue

This information paper gives guidance on selecting an appropriate strategy for ending overfishing and rebuilding the spotted seatrout stock.

Background

If a fishery is considered overfished, the Fisheries Reform Act (FRA) requires that the Fishery Management Plan (FMP) must "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" (G.S. 113-182.1(b)(4)). Spotted seatrout in North Carolina are currently overfished and undergoing overfishing (Figure 49 and Figure 50); thus, management measures must be implemented that will reduce fishing mortality to a level that will allow the spawning stock biomass (SSB) to grow and rebuild to a threshold level associated with a 20% spawning potential ratio (SPR) within 10 years of the implementation of the FMP. To assure that management options selected have a reasonable chance of success, the Marine Fisheries Commission (MFC) adopted a guideline in

May 2009 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" (MFC Guidelines III(B)(3)(a)(2)).

Stock projections are the primary tool used to determine how a stock may respond to management changes (size limits, bag limits, trip limits, season closures, quotas, etc.) by predicting population growth and catches in future years using standard population models. Projections are also used to identify the fishing mortality rate ($F_{rebuild}$) that has a 50% likelihood of rebuilding the spawning stock biomass to the threshold level to satisfy the MFC guideline quoted above. However, the biology of spotted seatrout, environmental conditions, and lack of sufficient spotted seatrout data make it unwise to rely on projections to specify an $F_{rebuild}$ rate that is compatible with professional standards for fisheries management. This means harvest reductions that give a 50% probability of success cannot be reliably calculated for this species, which complicates the job that managers have to implement a management strategy that will rebuild the stock within the 10-year timeframe. This paper explains why the projections are unreliable and gives guidance on selecting an appropriate strategy for ending overfishing and rebuilding the spotted seatrout stock.

Discussion

Rebuilding the Stock

In stock projections, future recruitment is based on the estimates provided by the assumed underlying stock-recruitment relationship (e.g., Beverton-Holt curve). Most often, the general principle behind a stock-recruit relationship is that if there are a large amount of spawners, there will be a large amount of recruits the following year. Likewise, if there are a low amount of

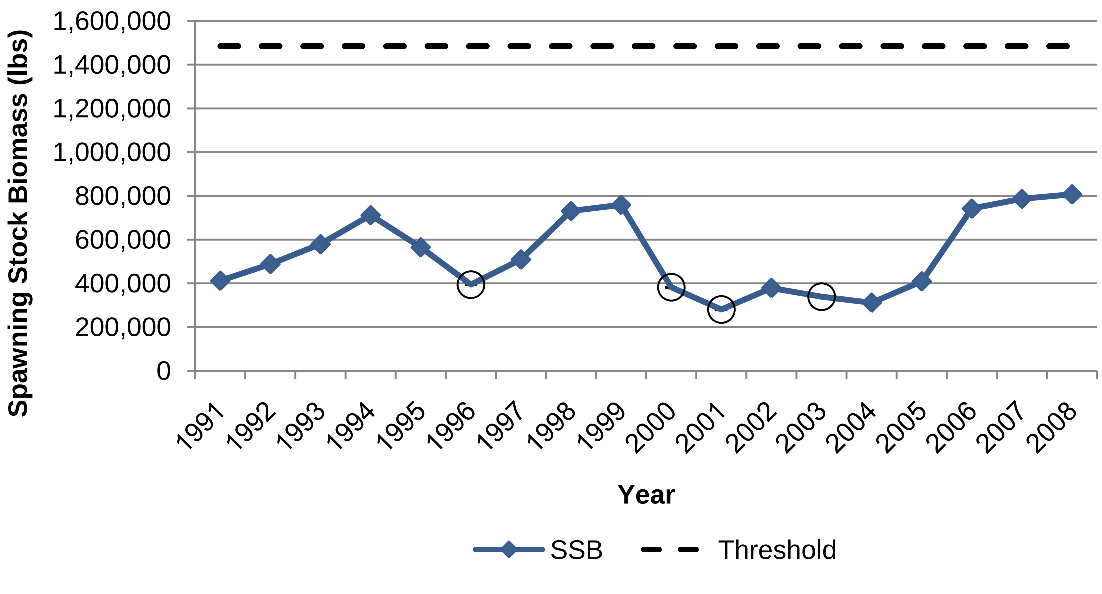


Figure 49. Spawning stock biomass (lbs) of the spotted seatrout stock from 1991 to 2008 and the threshold indicating the stock is overfished at a level consistent with a 20% spawning potential ratio. Open circles indicate years associated with a cold stun event.

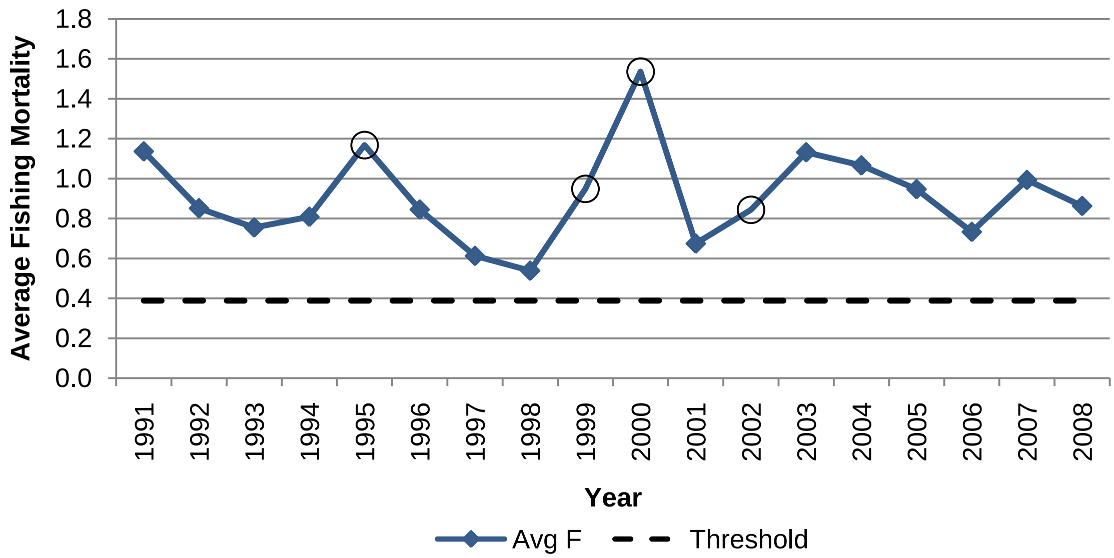


Figure 50. Average fishing mortality (ages 1-6+ weighted by population abundance at age) on spotted seatrout from 1991 to 2008 and the threshold indicating that the stock is undergoing overfishing at a level consistent with a 20% spawning potential ratio. Open circles indicate years associated with a cold stun event.

spawners, there will be a low amount of recruits the following year. At some point, if there are no spawners, there will be no recruits. It cannot be stressed enough that the assumed or estimated future recruitment values will greatly influence the results, especially in later years. Generally, short-term projections are fairly reliable since the first few years of any projection are based on estimated initial abundances at age. Results of longer-term projections become increasingly dominated by the assumed recruitments and therefore increasingly uncertain. This basic tenet of stock projections is especially important for stocks that are relatively short-lived with highly variable recruitment such as spotted seatrout.

Unfortunately, spotted seatrout do not have a definable stock-recruitment relationship over the observed time series. A plot of spotted seatrout recruitment versus spawning stock biomass (Figure 51) indicates essentially a random scattering of recruitment over the range of observed spawning stock biomass. The best estimate of future recruitment is in the middle of those points. This does not mean that recruitment does not depend on SSB (it must at some point) but that the relationship was not discernable with the available data. Because there is very little contrast in the SSB, it is possible that we have only observed the population over a narrow range over a relatively short time period (18 years), thus we may only be able to see part of the stock-recruit relationship. It may also be possible that environmental factors such as cold stuns, temperature, or salinity, could have a larger impact on recruitment than does spawning stock biomass. For example, three of the highest years of spawning stock biomass coincided with cold stun years and subsequently produced the lowest levels of recruitment the following year (see open circles in Figure 51).

In addition to the lack of a stock-recruit relationship, there is also a large amount of variability in observed age-0 recruitment from 1991 to 2008 (Figure 51). Recruitment ranged from a low of 1.4 million fish in 1999 to a high of 5.9 million fish in 2005. A 'medium' level of recruits over all years is around 2.5-3 million fish. However, one factor does appear to be consistent: no matter the level of spawning stock biomass, recruitment following a cold stun event is probably going to be very low (mean = 1.6 million fish). This high level of variability is especially important in the case of spotted seatrout because the total population abundance is largely dependent on levels of recruitment (age-0 fish) since age-0 fish made up an average of 78% of the total population over the past six years (Table 63).

Both commercial and recreational harvest are also heavily dependent on recruitment since these recruits made up the bulk of the commercial and recreational harvest the following year when they turn 1 year old. Age-1 fish make up an average of 50% of the commercial catch and 69% of the recreational harvest (Jensen 2009, Appendix 4). This heavy dependence on year class strength can lead to a highly variable fishery because of the dependence on the previous year's recruitment (i.e., if there are a large number of age-0 fish one year, there will likely be a large number of age-1 fish available to the fishery the following year and vice versa). The spawning stock biomass is also influenced heavily by this variability in year-class strength because it is heavily dominated by age-1 fish [77% (Table 63)].

Because there is no clear stock-recruitment relationship and there is a large amount of variability in observed recruitment (Figure 51), there is a large amount of uncertainty in the response of the spotted seatrout stock to management measures. This uncertainty increases with each additional year added to the projection.

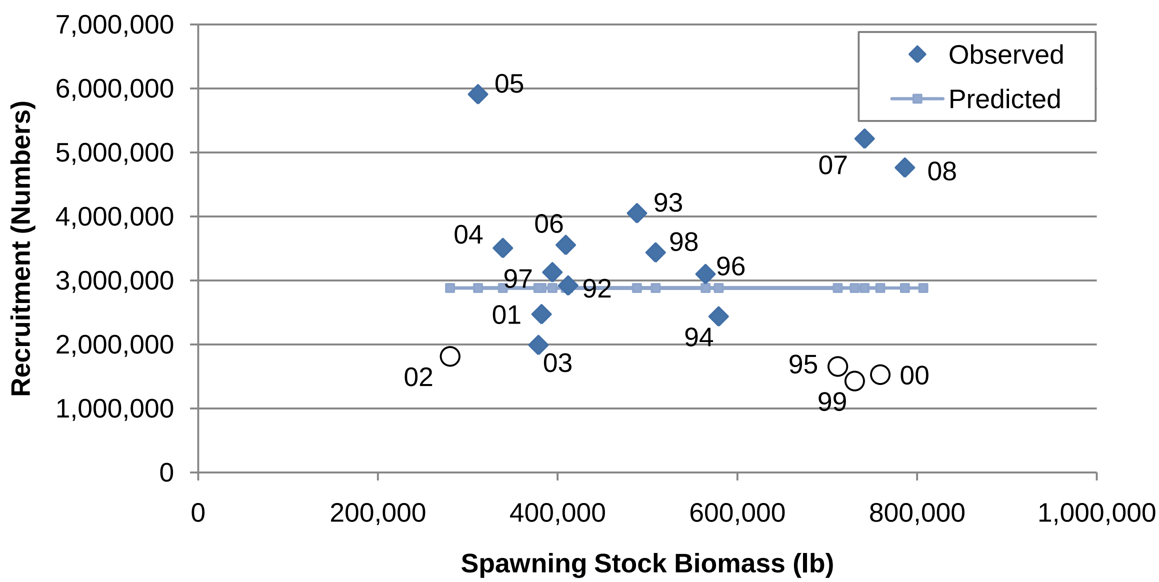


Figure 51. Beverton-Holt stock-recruitment relationship for spotted seatrout in North Carolina and Virginia compared to observed values, 1991-2008. Data labels indicate year of recruitment. Open circles represent years affected by cold stun events.

Table 63. Age composition of the spotted seatrout population and spawning stock biomass (SSB) in numbers over the past six years, 2003-2008.

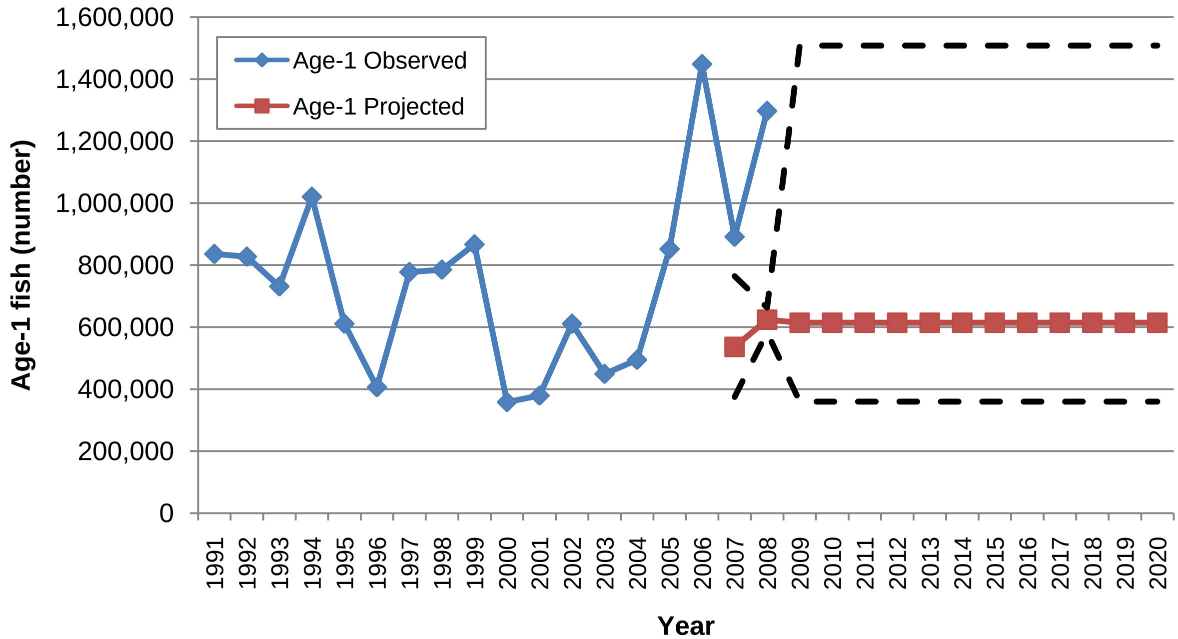
	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+
Population	78%	17%	5%	1%	0%	0%	0%
SSB	1%	77%	18%	3%	0%	0%	0%

Projections

To explain why the lack of a stock-recruit relationship and high variability in recruitment is important and how it influences the reliability of projections, it helps to follow along with an example illustrating how projections work (Table 64). The stock assessment provides actual 'observed' numbers of fish at each age in 2008 (i.e., in row 1, all ages are 'known' or observed (Obs)). In the first year of the projection (Row 2 of Table 64), all the fish observed in row 1 become one year older (follow the arrows). At this point all the fish age 1-6+ are still based on observed values. However, the numbers of age-0 fish are estimated (labeled 'Est' in Table 64). This estimate is usually based on the stock-recruit relationship, but in this case, the median number of recruits is the best estimate of future recruitment. The SSB in the first year of the projection will likely be fairly accurate because the SSB includes mostly 'observed' fish ages 1 through 6+. However, in the second year of the projection (row 3), both age-0 and age-1 fish are now estimated based on the assumed stock-recruit relationship and have a large degree of uncertainty. Because the SSB is made up largely of Age-1 fish (77%), the estimate of SSB in the second year of projections also has a large amount of uncertainty and is likely to be inaccurate. Currently, few fish older than age 2 are present in the population or the SSB (Table 63). Therefore, once a projection has been extended out 3 years, the abundance of the dominant ages (ages 1 and 2, total 95% of the SSB) in the spawning stock biomass is directly dependent on the assumed recruitment value. Clearly, for this stock, the accuracy of even relatively short-term projections is heavily dependent on the accuracy of future recruitment assumptions. Since there is no identifiable stock-recruit relationship and high variability in recruitment, projections of the spotted seatrout stock are unreliable and must be viewed with extreme caution.

Projections were attempted using AgePro Version 3.2 (NOAA Fisheries Toolbox 2008) and data from 1991 to 2006 to see how well it predicted SSB observed in 2007 and 2008 (Figure 52). Management was assumed to be implemented in 2011, and the population parameters were the same as those used in the stock assessment (Jensen 2009, Appendix 4). One hundred Monte Caro Markov Chain iterations were simulated 100 times each for a total of 10,000 projections. Replicates the 5th, 50th (median), and 90th percentiles were computed for the spawning stock biomass. Given the inability to define a stock-recruit relationship, projections assumed that the resulting recruitment did not depend on levels of spawning stock biomass. The rebuilding criterion was instead based on the empirical recruitment of age-0 spotted seatrout from the previous 18 years (1991-2008). In other words, this means that no matter how high or low the spawning stock biomass is, the recruitment assumed the following year is always the same (i.e., median of the data points). This time period includes both years with and without cold stun events to account for the likelihood that similar events could occur in the future with the same frequency and impact as they have in the past. It further assumes that future recruitment will be no higher or lower than those extremes observed in the past.

The projection of SSB was fairly accurate the first year (2007), but greatly underestimated the second year (2008) where it was outside the bounds of the 95% confidence interval (Figure 52). The projected spawning stock biomass in the first year of the projection was only slightly underestimated by 3,609 lbs as the observed, ‘known’ number of fish that were age 0 in 2006 entered the SSB at age 1 in 2007. However, the stock experienced a large year-class of age-0 fish in 2007 of just over 5 million fish, which is considerably higher than normal levels (Figure 51). The estimated numbers of age-0 fish in 2007 were grossly underestimated by 2.7 million fish (Figure 53). This underestimation of 2007 recruits also caused the predicted SSB to be grossly underestimated the following year when they became age-1 fish in 2008. In 2008, the numbers of age-1 fish, which make up 77% of the SSB (Table 63), were underestimated by 673,300 fish, again outside of the bounds of the 95% confidence interval (Figure 55).



In the absence of reliable projections, it is difficult to say with confidence the ultimate reduction in harvest that will achieve our goal within the given time frame. Although it would provide short-term information, a juvenile abundance index in conjunction with the age composition of the catch would give an indication of the number of fish at age entering the fishery the following year; however, a juvenile index for spotted seatrout does not exist at this time. Without these sources of information, the alternative is to try some level of harvest reduction that achieves a sizeable reduction in harvest. The stock can then be reassessed in the near future to see how effective the measures were in bringing the stock closer to the threshold, and management measures can be adjusted as necessary to achieve the goal within the 10-year time rebuilding period.

Ending Overfishing

Aside from the level of harvest reductions required to rebuild the stock, managers are also mandated to end overfishing within 10 years. Harvest reductions required to end overfishing are not dependent on projections and their inherent uncertainty. Instead harvest reductions needed to end overfishing are based on a spawning stock biomass-per-recruit (SSB/R) analysis. Changes in size limits and gear modifications alter the selectivity inputs into the SSB/R analysis; therefore, thresholds and the harvest reductions required to reach those thresholds may change slightly based on various management scenarios. Under regulations in place in 2008 (12 inch minimum size limit, 10 fish bag limit), the average fishing mortality rate must be reduced from an F rate of 0.86 (2008) to below a threshold of 0.41 to end overfishing (Figure 50). Interim measures implemented on October 5, 2009 increased the minimum size limit to 14 inch. Under the selectivity associated with a 14 inch size limit, a 57% reduction in harvest is required to end overfishing immediately. If any strategy incorporates the 14 inch size limit and results in reductions less than 57%, it is likely that additional restrictions will have to be implemented within 10 years to end overfishing.

Conclusion

Projections have been deemed unusable for management, and as such it is not possible to identify with relative certainty a level of harvest reduction that will give a 50% likelihood of success preferred by the MFC. While it is not unique to spotted seatrout to lack a stock-recruit relationship, this stock differs from other species because of its large amount of variability in recruitment and the fact that, currently, most fish only live to age 1 or 2 (a very short generation time). In addition, we know that if we have a cold stun we are very likely to have very poor recruitment, but we cannot predict future cold stun events. These factors make it nearly impossible to predict with even relative certainty what the recruitment will be next year and the SSB in two years.

The spotted seatrout stock assessment indicated that spotted seatrout are overfished and are undergoing overfishing. Despite the absence of reliable projections, the MFC is still faced with choosing a level of harvest reduction that will end overfishing and achieve sustainable harvest within 10 years. The interim rule that raised the minimum size limit from 12 inch to 14 inch will protect recent year classes by giving more fish an opportunity to spawn at least once before being caught and may result in a boost to the SSB. Any further reduction in harvest is likely to get the stock closer to the goal. The larger the reduction, the greater chance there is of reaching that goal. The suggested strategy of action is to implement management measures that appear to give a reasonable reduction in harvest. The stock can then be reassessed in a few years to evaluate how well that management strategy has worked. At that point management can be adjusted to keep the stock on track with the rebuilding timeline of 10 years (mandated by the FRA).

Aside from rebuilding the stock, managers are also required to end overfishing within 10 years. Harvest reductions determined to end overfishing are not dependent upon projections and their inherent uncertainty. For example, under the interim measures currently in place (14 inch minimum size limit), a 57% reduction in harvest is required to end overfishing immediately. At this size limit, any strategy chosen that results in reductions less than 57% will likely not end overfishing and additional restrictions may have to be implemented when the stock is reassessed in the near future.

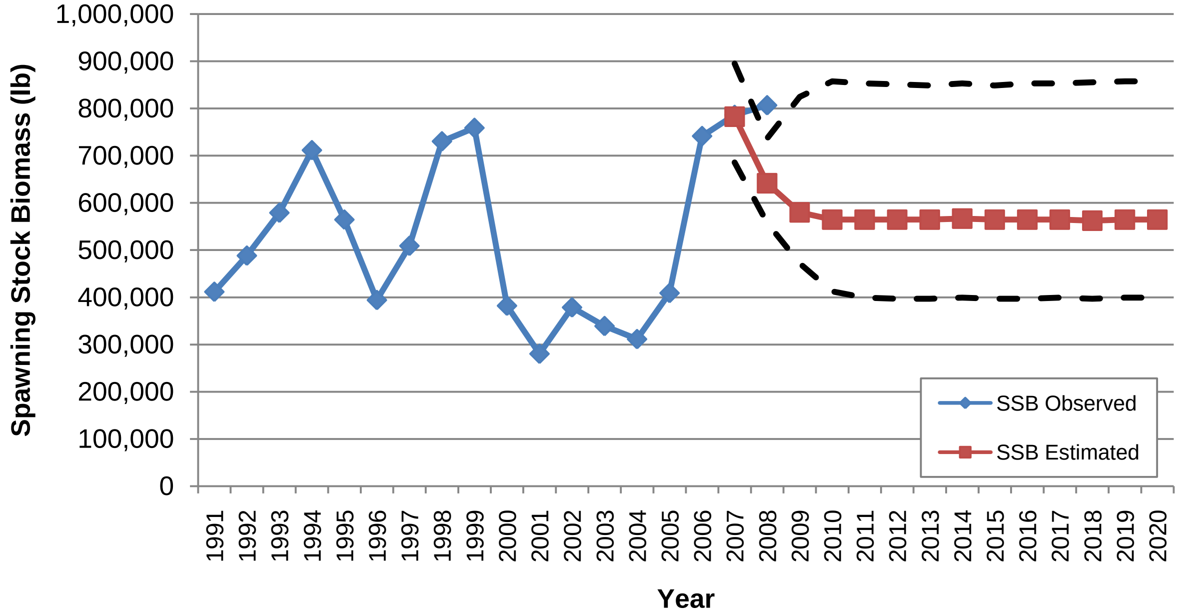


Figure 52. Observed spotted seatrout spawning stock biomass from 1991 to 2008 overlaid with attempted projections from 2007 to 2020. *Dashed lines indicate 90% confidence intervals.

Table 64. Progression of observed (Obs) population levels to Estimated (Est) levels that rely on assumed recruitment in projections.

Projection Year	Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+
0	2008	Obs	Obs	Obs	Obs	Obs	Obs	Obs
1	2009	Est	Obs	Obs	Obs	Obs	Obs	Obs
2	2010	Est	Est	Obs	Obs	Obs	Obs	Obs
3	2011*	Est	Est	Est	Obs	Obs	Obs	Obs
4	2012	Est	Est	Est	Est	Obs	Obs	Obs
5	2013	Est	Est	Est	Est	Est	Obs	Obs
6	2014	Est	Est	Est	Est	Est	Est	Obs
7	2015	Est	Est	Est	Est	Est	Est	Est
8	2016	Est	Est	Est	Est	Est	Est	Est
9	2017	Est	Est	Est	Est	Est	Est	Est
10	2018	Est	Est	Est	Est	Est	Est	Est
11	2019	Est	Est	Est	Est	Est	Est	Est
12	2020	Est	Est	Est	Est	Est	Est	Est

*Management assumed to take effect.

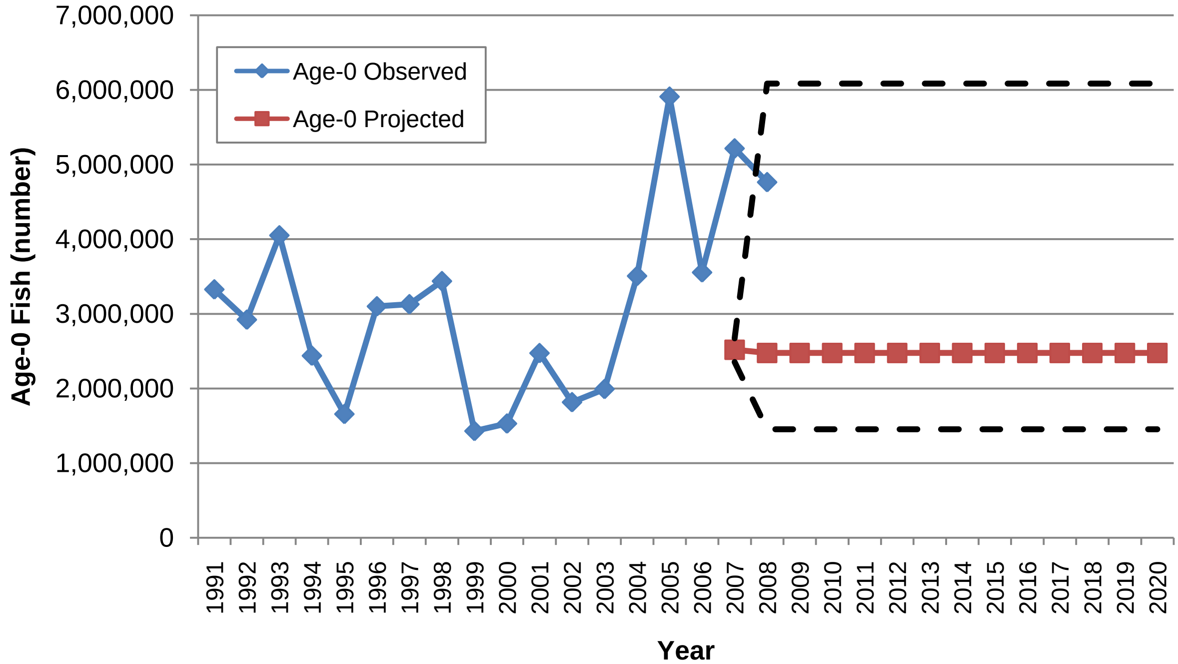


Figure 53. Observed recruitment of age-0 spotted seatrout from 1991 to 2008 overlaid with attempted projections from 2007 to 2020. Dashed lines indicate 90% confidence intervals.

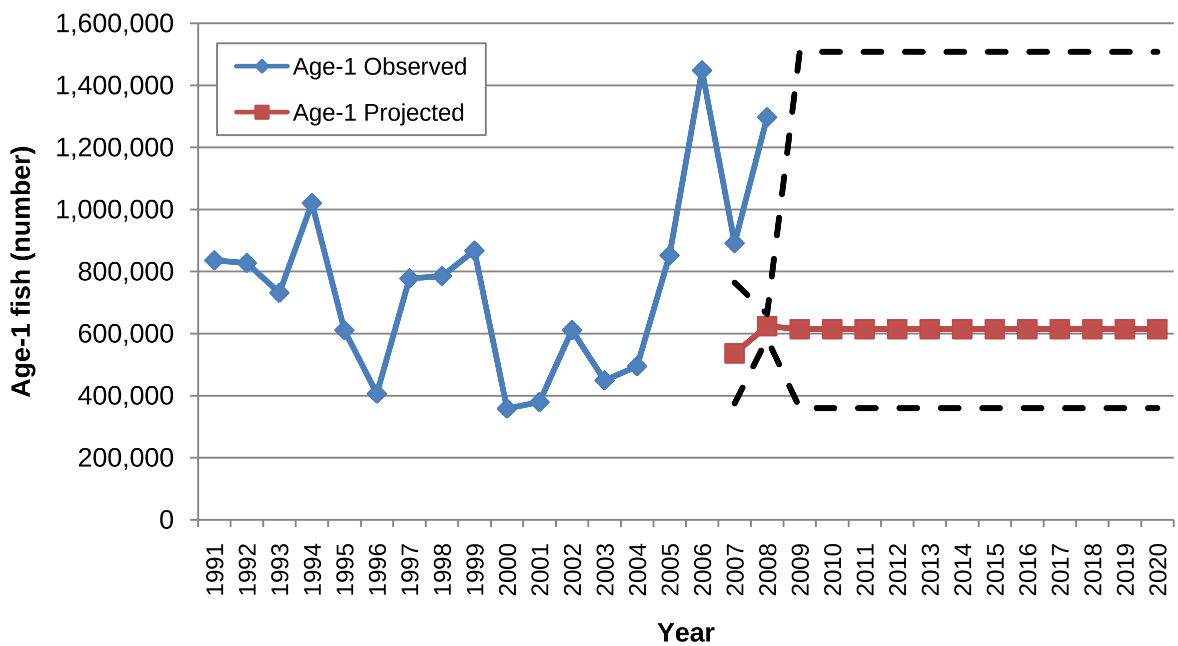


Figure 54. Observed abundance of age-1 spotted seatrout from 1991 to 2008 overlaid with attempted projections from 2007 to 2020. Dashed lines indicate 90% confidence intervals.

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
15A NCAC 3M .0504 TROUT
15A NCAC 3M .0512 COMPLIANCE WITH FISHERY MANAGEMENT PLANS

Research Recommendations

1. Batch fecundity estimates are needed for spotted seatrout in North Carolina. Estimates of batch fecundity from North Carolina could result in a clearer stock recruitment relationship, and may provide better estimates of spawning potential ratios.

2. Investigation of the relationship of temperature with both adult and juvenile mortality could contribute more information to the model. The feasibility of including measures of temperature or salinity into the stock-recruitment relationship could be researched; although, these comparisons should be attempted with caution to avoid spurious correlations between environmental variables and resulting recruitment.

3. Juvenile abundance index is needed to develop a better understanding of a stock recruitment relationship.

10.2.2 Achieving Sustainable Harvest

Issue

Establish harvest reductions that achieve sustainable harvest by rebuilding the spawning stock biomass above the threshold level and end overfishing within 10 years.

Background

The 2009 North Carolina spotted seatrout stock assessment indicated that the spotted seatrout stock in North Carolina/Virginia has been overfished and that overfishing has been occurring throughout the entire 18-year time series (1991-2008) (Jensen 2009, Appendix 4). Under current regulations, the spawning stock biomass (SSB) must be rebuilt from the current level of 806,890 pounds (2008) to 1,484,594 pounds within 10 years of the Fishery Management Plan (FMP) adoption (Figure 55). Aside from the level of harvest reductions required to rebuild the stock, managers are also mandated to end overfishing within 10 years. The average fishing mortality rate (F) must be reduced from the current rate of 0.86 (2008) to a threshold of $F_{20\%\ SPR}$ =0.41 to end overfishing (Figure 56). The current F rate is more than twice the rate necessary to produce a sustainable harvest. Under a 14 inch minimum size limit with no maximum size limit, a 57% reduction in harvest is required to end overfishing.

The population abundance of spotted seatrout is largely dependent on levels of recruitment (age-0 fish) since age-0 fish make up an average of 74% of the total population (Jensen 2009, Appendix 4). Both commercial and recreational harvests are heavily dependent on age-1 fish. This age class made up an average of 50% of the commercial catch and 69% of the recreational harvest. Overfishing has led to a truncated age structure and a reliance on the age-1 and age-2 fish for a successful fishing year. However, the relationship between SSB and recruitment for spotted seatrout in North Carolina/Virginia remains unknown. Environmental factors such as cold stuns, temperature, or salinity, could have a larger impact on recruitment than does the size of the spawning stock biomass. For example, three of the highest years of spawning stock biomass coincided with cold stun years and subsequently produced the lowest levels of recruitment the following year.

Recreational and commercial fishing mortality rates were similar in the 1990s, but beginning in the early 2000s, recreational fishing mortality rate began to increase while commercial fishing mortality rate decreased (Figure 56). In recent years, the fishing mortality rate associated with the recreational fishery has been high in comparison to that of the commercial fishery. In years not affected by cold stun events, the average fishing mortality rate in the recreational fishery has maintained a high average of 0.71 since 2002 compared to 0.51 in years prior. In contrast, the fishing mortality associated with the commercial fishery has decreased steadily to a low of 0.23. Managers should be concerned with this trend because the recreational fishery uses hook and line which selects for smaller, younger fish than does the commercial fishery (Jensen 2009, Appendix 4).

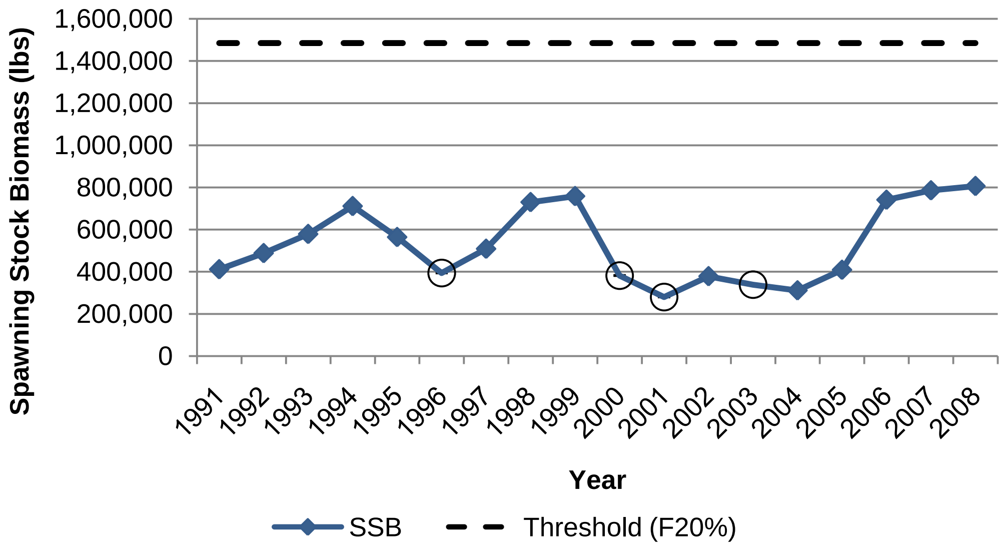


Figure 55. Spawning stock biomass (lbs) of the spotted seatrout stock from 1991 to 2008 and the threshold indicating the stock is overfished at a level consistent with a 20% spawning potential ratio. Open circles represent years associated with a cold stun event.

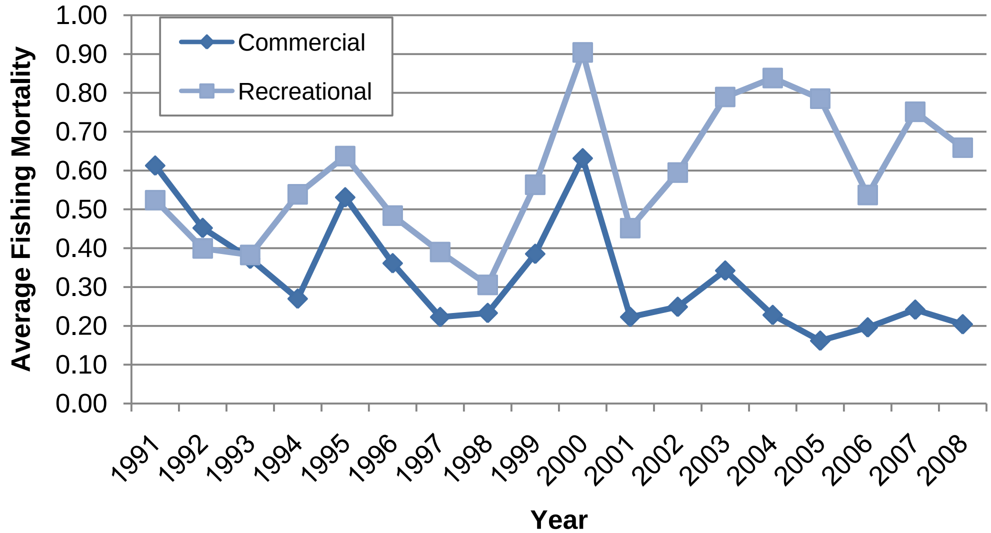


Figure 56. Estimated average fishing mortality rates (weighted by population number at age) for spotted seatrout ages 1-6+ in the commercial and recreational fishing sectors in North Carolina and Virginia, 1991-2008.

The Fisheries Reform Act (FRA) requires that each FMP "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" [G.S. 113-182.1(b)(3)]. 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" [G.S. 113-129(14a)]. If a fishery is considered overfished, the FMP must "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" [G.S. 113-182.1(b)(4)].

A spawning potential ratio (SPR) of 20% was chosen by the DMF based on available data. Spawning potential ratio goals set by managers typically range between 20 and 40%. Spotted seatrout grow quickly, mature early, and spawn repeatedly over a long protracted spawning season (April-October). Thus, a threshold benchmark toward the lower range associated with a $F_{20\%}$ SPR was chosen for spotted seatrout. This corresponds to the recommended minimum SPR set by the Atlantic States Marine Fisheries Commission to minimize the possibility of recruitment failure. No target SPR has been set at this time.

The Marine Fisheries Commission (MFC) 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. 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" [MFC Guidelines III(B)(3)(a)(2)]. However, for the spotted seatrout stock, the biology of the fish, environmental conditions, and lack of sufficient data make it unwise to rely on projections to specify a $F_{rebuild}$ rate that is compatible with professional standards for fisheries management.

Because there is no clear stock-recruitment relationship and there is a large amount of variability in observed recruitment, projections have been deemed unusable for management. For this reason, it is not possible to adequately determine the level of harvest reduction that provides a 50 percent likelihood of achieving the management benchmark. Without projections to provide guidance on selecting an appropriate strategy, the alternative is to try some management strategy that achieves a sizeable reduction in harvest. The stock can be reassessed in the near future to determine if that management strategy contributed to rebuilding the stock. Management measures can be adjusted as necessary at that time. Thus, if the selected management strategies do not show sufficient rebuilding, it is possible that additional restrictions will have to be implemented in the future. In this paper, harvest reductions achieved by various restrictions are presented to aid in selecting a rebuilding strategy.

The MFC 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 (e.g., net attendance, use of circle hooks, net yardage restrictions, etc.) but the resulting reduction may not be quantifiable using existing data sources. In such cases, the MFC 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”.

All analyses assumed regulations would impact only fishermen in North Carolina, while all future harvest and dead discards from Virginia were assumed to remain the same. Virginia’s harvest and dead discards were subtracted from the total, thus, all reduction values shown apply to North Carolina only. That is, North Carolina is bearing all of the reductions to rebuild the interstate stock. All calculations were based on input data averaged from 2003 to 2008. Essentially, the following analyses show the average reduction in the North Carolina total kill (harvest + dead discards) that would have been observed from 2003 to 2008 if a size limit or other management change had been in place during those years.

Changes in size limits and gear modifications alter the selectivity inputs into models used to determine fishing mortality and spawning stock biomass thresholds. Selectivity is the probability that fish will exist in the area where people are fishing and get caught when they encounter their fishing gear (e.g., attempt to bite their hook, swim into their net, etc.). Therefore, F thresholds may change slightly based on various management options.

Changes to commercial and recreational harvest and dead discards were predicted for changes from the size limit of 12 inches to proposed limits of 13, 14, and 15 inches. Input data included weighted length frequencies at age for North Carolina and Virginia commercial landings, recreational harvest, and recreational releases.

Weighted length frequencies at age were examined to determine the new catch at age and release estimates expected under each proposed size limit. A weighted average of undersized harvest from 2003 to 2008 was used to determine the proportion harvested in one inch size increments that would be illegal under the proposed size limits. These data were then used to calculate a new proportion of fish that would be released under each size limit scenario. The new release proportions were used to calculate new F (fishing mortality) rates for each fishery and their associated discards. These F rates were then used to calculate the new predicted harvest and discards, in both numbers and pounds, associated with each proposed size limit increase. Percent reduction was calculated for each fishery and percent increases were determined for the dead discards expected in each fishery.

This analysis assumes noncompliance with proposed size limits in the future recreational fishery based on past history of undersized fish in the harvest observed in MRFSS estimates. The commercial fishery does not typically harvest fish less than the size limit of 12 inches and currently has no associated discard component; therefore, a 10% noncompliance rate was assumed with future increases in size limits for the commercial fishery.

A release mortality of 10% was assumed for the recreational fishery to mirror the recent stock assessment (Jensen 2009, Appendix 4), and a 60% release mortality estimate was assumed for the commercial fishery based on a study of small mesh gill nets in North Carolina (Price and Gearhart 2002b) and DMF small mesh gill net studies.

Discussion

Management Measures
This issue paper presents a variety of management strategies for reducing overall harvest. Harvest reduction calculations are based on past landings and harvest. The reliability of these calculations to adequately predict future harvest reductions depends on environmental parameters, recruitment, and fishing effort to remain similar to the past base years (2003-2008). There are a range of management measures available that could be used in combination with one another to decrease the fishing mortality and rebuild the fishery to the threshold level.

Life History Information

The interim management measure to increase the minimum size to 14 inches was based on basic life history information available for spotted seatrout *(*refer to section 5, General Life History and Appendix 3, Interim Management Measures to Achieve Sustainable Harvest for a complete description).

Size Limits

Increasing the minimum size limit is a common management measure used to end overfishing (lower F), rebuild the SSB, and allow a greater portion of fish an opportunity to spawn before they are harvested.

The short term effects of a minimum size increase would be to diminish the pool of younger and smaller fish immediately available for harvest, which would in turn produce a decrease in overall landings. The drop in landings, however, may not produce a corresponding drop in the fishing mortality rate initially since the annual fishing mortality for spotted seatrout is measured from the age one and older year classes. Spotted seatrout are fully recruited to the fishery by the time they are two years of age, and an increase in minimum size would predominately affect age-0 and 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 two 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 has occurred for multiple years and has contributed 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-0 and 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 SSB and should increase the number of recruits to the fishery in subsequent years. Size limits were addressed due to the high occurrence of age-1 spotted seatrout in the overall catch, of which 89% of females are mature. Increasing the minimum size limit from 12 inches to 14 inches or greater enables a higher percentage of spotted seatrout to spawn at least once and reduces fishing mortality rates.

Implementing an increase in the minimum size limit in the commercial fisheries may affect some fisheries and regions of the state more adversely than others. The long haul seine fishery and ocean gill net fisheries would be more affected than other fisheries, as is evident by looking at the composition of the commercial harvest (Figure 57), as well as reduction in harvest by one inch size bins (Table 66). However, because long haul seines and ocean gill nets account for only 3-15% of the landings (Table 65), the overall decrease in harvest is less for these fisheries than in the estuarine gill net fishery. An increase in the minimum gill net mesh size used might become necessary to minimize discards of undersized spotted seatrout in these fisheries.

Estuarine gill nets are by far the dominant gear used to harvest spotted seatrout commercially, but they rarely catch small fish (Figure 57, Table 65, Table 66). Although estuarine gill nets rarely catch small fish, the magnitude of landings by estuarine gill nets would result in the highest reduction in harvest (Table 66). The gill net fishery in Albemarle Sound catches smaller spotted seatrout while those in other areas of the state would be less affected (Table 67), but landings from the Albemarle Sound area represent only 8% of total harvest (Figure 58).

The commercial fishery, which is largely composed of gill nets, tends to catch larger, older fish than the recreational hook-and-line fishery. As a result, the recreational fishery is predicted to experience 2.5 to 4 times more reduction in harvest than the commercial fishery under size limit restrictions (refer to Section 10.2.1). In addition, the average recreational fishing mortality rate from 2004 to 2006 is over 3 times greater than the commercial fishery (Jensen 2009, Appendix 4) (Figure 56). Therefore, the recreational fishery will experience a much larger reduction under size limit increases than the commercial fishery. An increase in the size limit can play an important role in reducing the overall harvest and allowing smaller fish the chance to spawn at least once before being harvested. The practice of releasing spotted seatrout in the recreational fishery has increased considerably in recent years. An increase in the minimum size would likely further increase the number of released undersized fish. Fishing tackle and fishing techniques could be modified to decrease the amount of discard mortality of released fish.

The minimum size limit can be combined with other management measures to achieve the desired level of harvest reduction in the spotted seatrout fishery.

Slot Limits

The Spotted Seatrout Advisory Committee suggested DMF consider a slot limit as a management measure to reduce harvest. Possible Slot limit combinations considered were 12, 13, 14, 15 inches through 22, 23, and 24 inches.

Since relatively few large fish were represented in the sampling, the harvest reductions including a slot limit was negligible (Table 67). A slot limit of 14-24 inches would result in only a 0.7% reduction in the recreational fishery.

The relative abundance of large fish (greater than or equal to 21 inches) in the commercial fisheries was only slightly higher in the estuarine gill nets than the long haul and beach seine fisheries (Table 66). However, due to the predominance of gill net landings, the estimated reduction in landings would be greatest in the estuarine gill net fishery. The estimated harvest of large fish was highest in the gill net fisheries in Pamlico Sound followed by the Rivers (Table 67). The Southern Area ranked second in the relative abundance of large fish, but the Southern Area only accounted for an average of 8% of the landings while Pamlico Sound and the Rivers Areas accounted for 48% and 27% of the landings (Figure 58).

Because spotted seatrout are typically caught as a bycatch in multispecies commercial fisheries, as well as their high estimated release mortality of 60%, slot limits are not a preferred management measure for the commercial fishery. The protection of these large fish might be better approached through seasonal or area closures during the spawning season.

Trophy Fish

A harvest restriction commonly used in combination with slot limits is to allow the take of one fish, a "trophy fish", over a maximum size per day. This option was endorsed by the Spotted Seatrout Advisory Committee. Because of the limitations of so few fish sampled greater than the proposed slot limits, the reduction in harvest with a trophy fish allowance are likely to be negligible. The concept of a trophy fish option is desirable, but the option does not appear to result in a quantifiable reduction in harvest.

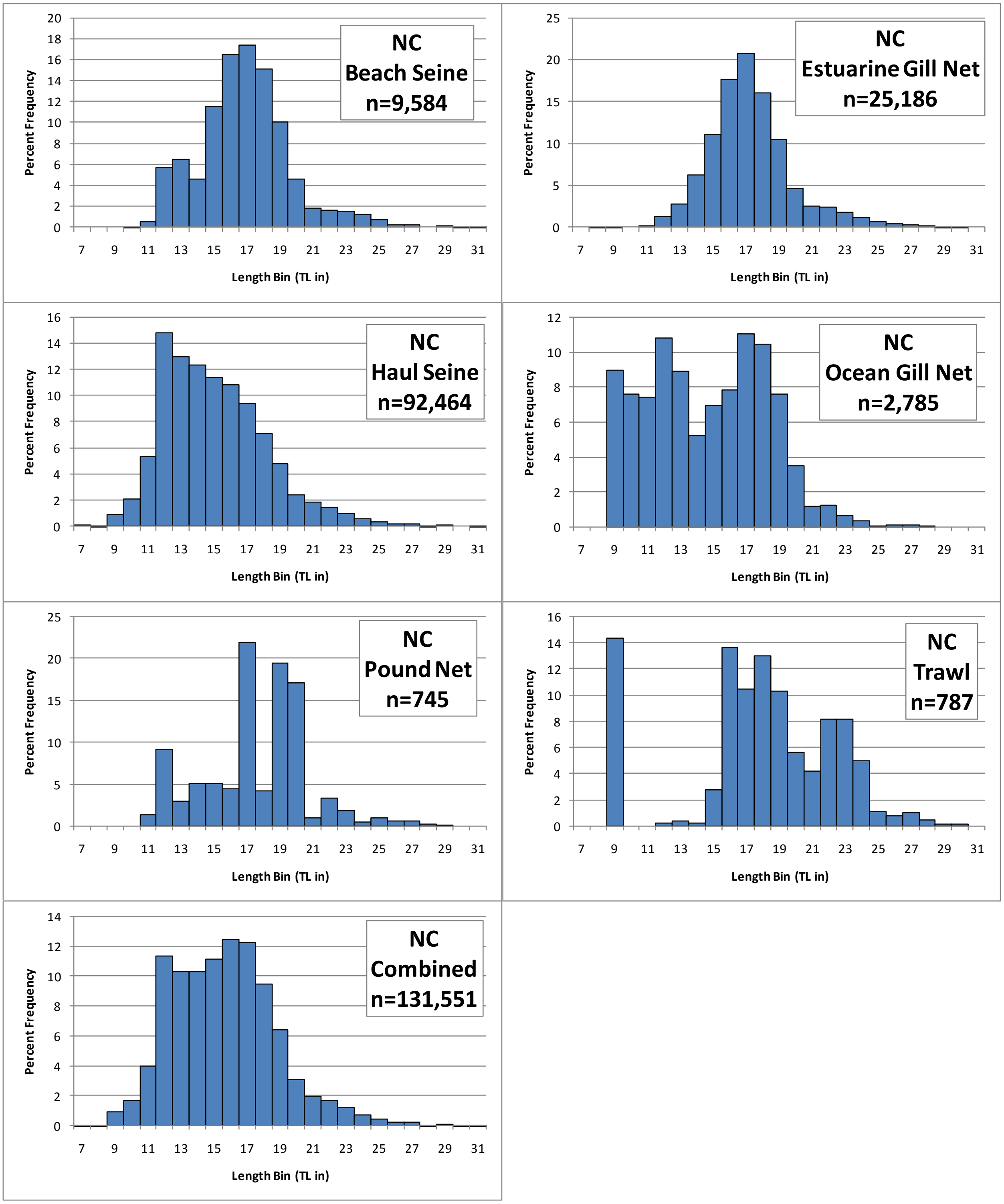


Figure 57. Annual length-frequency distributions of North Carolina commercial fisheries, 1994-2008.

Table 65. Annual landings (numbers) of spotted seatrout by commercial fishing gear* in North Carolina, 2003-2008.

	E Gill Net		Long Haul		Beach Seine		O Gill Net		Other		Total
Year	number	%	number	%	number	%	number	%	number	%	number
2003	112,583	73	25,373	16	4,738	3	4,451	3	7,515	5	154,661
2004	46,280	67	8,755	13	6,194	9	4,427	6	2,932	4	68,589
2005	42,112	69	6,288	10	8,080	13	2,317	4	2,340	4	61,136
2006	110,506	67	30,379	18	13,748	8	4,957	3	5,600	3	165,190
2007	137,348	75	26,868	15	6,533	4	3,349	2	8,220	5	182,319
2008	120,093	76	19,313	12	7,229	5	2,844	2	8,328	5	157,807
Mean	94,820	72	19,496	15	7,754	6	3,724	3	5,822	4	131,617

Table 66. Reduction in harvests associated with an increase in the minimum size and slot limits for the primary commercial fishing gear* (2003-2008 average).

	E Gill Nets			Long Hauls			Beach Seines			O Gill Nets			All Combined		
Size Limit (inches)	%	Cum %	Number	%	Cum %	Number	%	Cum %	Number	%	Cum %	Number	%	Cum %	Number
12	1.38	1.38	1,311	13.69	13.69	2,668	7.62	7.62	591	14.32	14.32	533	7.72	7.72	10,156
13	2.95	4.33	4,106	9.76	23.44	4,570	7.23	14.85	1,152	10.66	24.98	930	6.63	14.34	18,878
14	6.41	10.74	10,188	9.81	33.26	6,484	3.81	18.67	1,447	5.65	30.63	1,141	7.23	21.57	28,396
15	10.94	21.69	20,563	11.61	44.87	8,747	9.82	28.49	2,209	7.05	37.68	1,403	10.80	32.37	42,607
21	2.48	8.28	7,854	2.09	7.78	1,517	2.35	7.59	588	1.40	4.80	179	2.28	8.06	10,609
22	1.90	5.80	5,502	1.56	5.69	1,109	1.37	5.24	406	1.88	3.40	127	1.73	5.78	7,602
23	1.65	3.91	3,704	1.73	4.13	804	1.35	3.86	300	0.92	1.52	57	1.68	4.04	5,321
24	2.26	2.26	2,140	2.40	2.40	468	2.52	2.52	195	0.60	0.60	22	2.37	4.89	3,119

*E Gill Nets=Estuarine Gill Nets, Long Hauls=Long Hauls/Swipe Nets, Beach Seines=Beach Seines/Stop Nets, O Gill Nets=Ocean Gill Nets.

Bag Limits

Recreational fishermen are currently restricted to a 10-fish bag limit. This bag limit was requested by recreational fishermen in an effort to decrease the amount of excessive catches and was adopted in rule effective January 1st, 1991 (15A NCAC 03M.0504). Reductions in bag limits were empirically-based predictions using the average catch per angler trip estimated from 2003 to 2008 from the MRFSS survey (Table 68; Appendix 3). Any trips that landed over the proposed new limit in the past were assumed to land the maximum amount allowed under the proposed new limit. This analysis assumed 100% compliance with proposed regulations.

Bag limits only impact the recreational fishery and, because of the size of the recreational fishery, they can be effective at reducing the overall harvest. Approximately 73% of the trips that anglers took from 2003 to 2008 landed 3 or fewer spotted seatrout (Figure 59). Of all trips that landed spotted seatrout, 5% attained the 10 fish bag limit, and less than2% of the trips exceeded the legal limit. The percent reduction achieved under various combinations of management options in the North Carolina recreational spotted seatrout fishery are presented in Table 69.

Trip Limits

Trip or vessel harvest limits for commercial fisheries 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. Reductions in trip limits were empirically-based predictions using the average catch per trip reported on trip tickets from 2003 to 2008 (Table 70, Table 71; Appendix 3). Any trips that landed over the proposed new limit in the past were assumed to land the maximum amount allowed under the proposed new limits. This analysis assumed 100% compliance with proposed regulations.

Spotted seatrout are not targeted by the majority of commercial fishermen, with the vast majority of trips (65%) landing 10 pounds or less per trip from 2003 to 2008 (Figure 60). Nearly 90% of trips landed 50 pounds or less per trip. However, 16-27% of the annual harvest is by catches greater than500 pounds per trip (Figure 61). These occasional large catches occur in the long haul seine/swipe net, stop net, and strike net gill net fisheries that target spotted seatrout during the fall months. The long haul/swipe net fisheries occasionally catch greater than 500 pounds of spotted seatrout in one catch, while the strike net fisheries make several sets that collectively add up to over 500 pounds. Catches of spotted seatrout by area fished were similar, with the exception of larger catches (200-500 lbs) in the ocean (Figure 62). These were primarily by beach seines in the northern beaches and stop nets in Carteret County.

Table 67. Percent reductions in harvest from an increase in the minimum size limit for the estuarine gill net fishery by area*. (Reductions based on 2003-2008 biological sampling data, n=number of spotted seatrout measured).

	Percent Reduction											
Size Limit (TL, inches)	Albemarle Sound Gill Nets			Pamlico Sound Gill Nets			Southern Area Gill Nets			Rivers Gill Nets		
	(n= 304)			(n= 6,597)			(n= 3,135)			(n= 1,073)		
	%	cum %	number	%	cum %	number	%	cum %	number	%	cum %	number
12	4.93	4.93	376	0.56	0.56	275	1.82	1.82	118	2.61	2.61	903
13	8.12	13.04	995	2.08	2.64	1,263	1.70	3.52	229	4.64	7.25	2,507
14	13.62	26.67	2,034	6.45	9.08	4,354	4.69	8.21	535	6.43	13.68	4,731
15	15.07	41.74	3,184	9.64	18.72	8,974	10.79	19.00	1,238	13.20	26.87	9,297
21	1.16	5.22	398	3.01	9.85	4,724	2.52	7.97	520	1.53	5.54	1,917
22	1.74	4.06	310	2.04	6.84	3,280	2.52	5.45	355	1.44	4.01	1,389
23	1.45	2.32	177	2.06	4.80	2,301	0.88	2.93	191	1.10	2.57	891
24	0.87	0.87	66	2.74	2.74	1,313	2.05	2.05	134	1.47	1.47	509

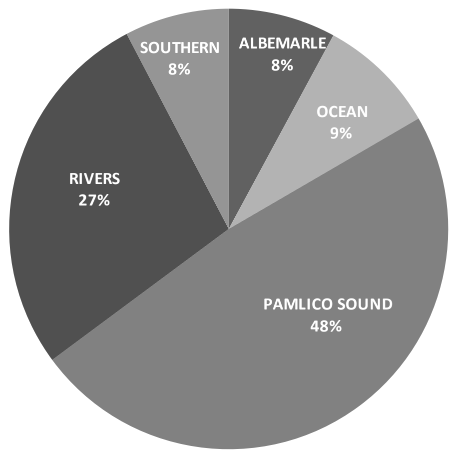


Figure 58. The percentage of all commercial landings (2003-2008) by area*.

**The Albemarle Sound Area includes the Albemarle Sound, Alligator River, Chowan River, Croatan Sound, Currituck Sound, Alligator River, Chowan River, Croatan Sound, Currituck Sound, Pasquatank River, Perquimans River, Roanoke River, and Roanoke Sound. The Pamlico Sound Area includes the Pamlico Sound, Bay River, Core Sound, and Newport River. The Rivers Area includes the Neuse River, New River, Pamlico River, and Pungo River. The Southern Area includes Bogue Sound, Cape Fear River, the Inland Waterway, Lockwood Folly, Masonboro Sound, North River, Shallotte River, Stump Sound, Topsail Sound, and White Oak River.*

Table 68. Reductions (%) in total removals associated with changes in recreational (Rec) bag limits, 2003-2008.

Bag Limit (#)	Rec
1	-67.2
2	-48.0
3	-35.4
4	-26.5
5	-19.4
6	-13.9
7	-9.6
8	-6.2
9	-3.7
10	-1.5

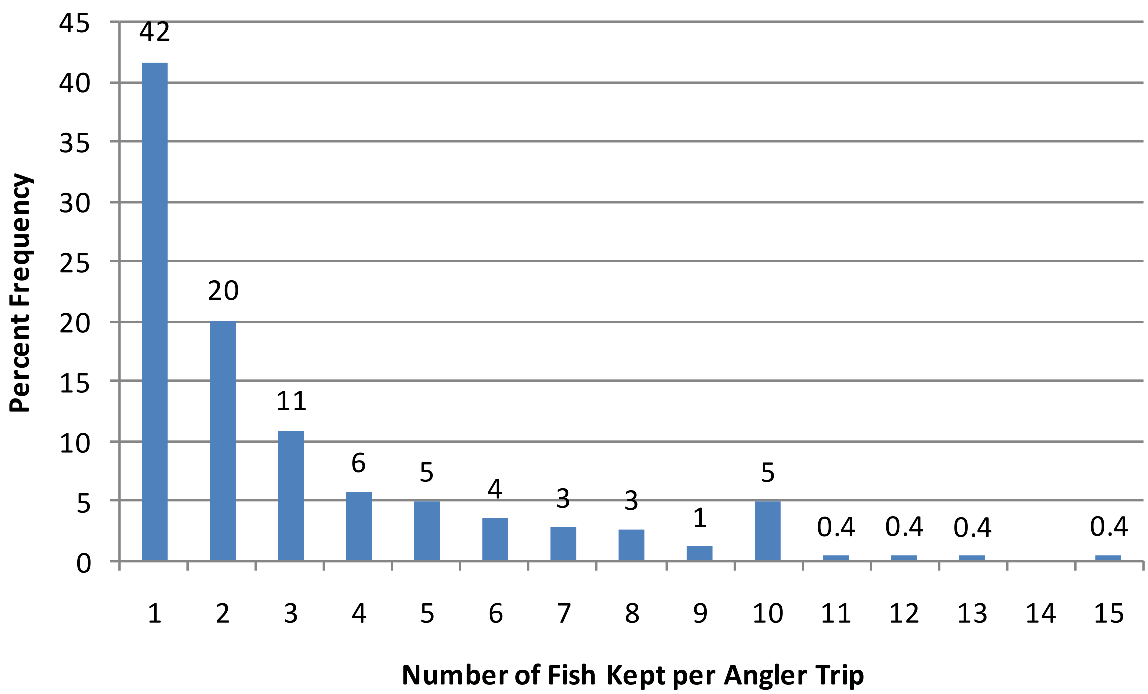


Figure 59. Average frequency of angler trips harvesting 1-10+ spotted seatrout per angler trip in North Carolina, 2003-2008.

Table 69. Percent reduction achieved under various combinations of management options in the North Carolina recreational spotted seatrout fishery, 2003-2008.

Min Size Limit = 12"

	Max Size Limit			
Bag Limit	22"	23"	24"	None
1	-67.9	-67.8	-67.6	-67.2
2	-49.2	-49.0	-48.7	-48.0
3	-36.9	-36.6	-36.3	-35.4
4	-28.2	-27.8	-27.5	-26.5
5	-21.2	-20.8	-20.5	-19.4
6	-15.9	-15.5	-15.1	-13.9
7	-11.7	-11.2	-10.8	-9.6
8	-8.4	-7.9	-7.5	-6.2
9	-5.9	-5.4	-5.0	-3.7
10	-3.8	-3.3	-2.8	-1.5

Min Size Limit = 13"

	Max Size Limit			
Bag Limit	22"	23"	24"	None
1	-70.7	-70.6	-70.4	-70.0
2	-53.6	-53.4	-53.1	-52.4
3	-42.4	-42.1	-41.8	-40.9
4	-34.4	-34.1	-33.7	-32.7
5	-28.1	-27.7	-27.3	-26.2
6	-23.2	-22.8	-22.4	-21.2
7	-19.4	-18.9	-18.5	-17.3
8	-16.3	-15.9	-15.4	-14.2
9	-14.1	-13.6	-13.2	-11.8
10	-12.1	-11.7	-11.2	-9.9

Min Size Limit = 14"

	Max Size Limit			
Bag Limit	22"	23"	24"	None
1	-73.7	-73.5	-73.4	-72.9
2	-58.3	-58.1	-57.8	-57.1
3	-48.3	-48.0	-47.7	-46.8
4	-41.1	-40.7	-40.4	-39.4
5	-35.4	-35.0	-34.6	-33.5
6	-31.0	-30.6	-30.2	-29.0
7	-27.5	-27.1	-26.7	-25.4
8	-24.8	-24.4	-23.9	-22.6
9	-22.8	-22.3	-21.9	-20.5
10	-21.1	-20.6	-20.1	-18.8

Min Size Limit = 15"

	Max Size Limit			
Bag Limit	22"	23"	24"	None
1	-75.3	-75.2	-75.0	-74.5
2	-60.9	-60.7	-60.4	-59.7
3	-51.5	-51.2	-50.9	-50.0
4	-44.7	-44.4	-44.0	-43.0
5	-39.4	-39.0	-38.6	-37.5
6	-35.3	-34.9	-34.5	-33.3
7	-32.1	-31.6	-31.2	-29.9
8	-29.5	-29.0	-28.6	-27.3
9	-27.6	-27.1	-26.7	-25.3
10	-26.0	-25.5	-25.0	-23.7

Table 70. Reductions (%) in total removals associated with various commercial (Com) trip limits, 2003-2008.

Trip Limit (lbs)	Com
10	-79.9
25	-66.5
50	-53.4
100	-39.1
150	-30.7
200	-24.9
250	-20.8
300	-17.6
350	-15.1
400	-13.0
450	-11.2
500	-9.9
None	0.0

Table 71. Percent reduction achieved under various combinations of management options in the North Carolina commercial spotted seatrout fishery, 2003-2008.

Min Size Limit = 12"

	Max Size Limit			
Trip Limit (lb)	22"	23"	24"	None
10	-79.8	-79.7	-79.7	-79.9
25	-66.3	-66.3	-66.3	-66.5
50	-53.2	-53.1	-53.1	-53.4
100	-38.7	-38.6	-38.6	-39.1
150	-30.3	-30.2	-30.2	-30.7
200	-24.5	-24.4	-24.4	-24.9
250	-20.3	-20.2	-20.2	-20.8
300	-17.2	-17.0	-17.1	-17.6
350	-14.6	-14.4	-14.5	-15.1
400	-12.5	-12.3	-12.4	-13.0
450	-10.7	-10.6	-10.6	-11.2
500	-9.4	-9.2	-9.3	-9.9
None	0.5	0.7	0.7	0.0

Min Size Limit = 13"

	Max Size Limit			
Trip Limit (lb)	22"	23"	24"	None
10	-79.9	-79.9	-79.9	-80.0
25	-66.6	-66.5	-66.6	-66.8
50	-53.6	-53.5	-53.5	-53.8
100	-39.2	-39.1	-39.1	-39.6
150	-30.9	-30.8	-30.8	-31.3
200	-25.1	-25.0	-25.0	-25.5
250	-21.0	-20.8	-20.9	-21.4
300	-17.9	-17.7	-17.7	-18.3
350	-15.3	-15.1	-15.2	-15.8
400	-13.2	-13.0	-13.1	-13.7
450	-11.5	-11.3	-11.3	-11.9
500	-10.1	-10.0	-10.0	-10.6
None	-0.3	-0.1	-0.1	-0.8

Min Size Limit = 14"

	Max Size Limit			
Trip Limit (lb)	22"	23"	24"	None
10	-80.1	-80.1	-80.1	-80.3
25	-66.9	-66.9	-66.9	-67.1
50	-54.1	-54.0	-54.0	-54.3
100	-39.9	-39.7	-39.8	-40.2
150	-31.6	-31.5	-31.5	-32.0
200	-25.9	-25.7	-25.8	-26.3
250	-21.8	-21.6	-21.7	-22.2
300	-18.7	-18.5	-18.6	-19.1
350	-16.2	-16.0	-16.0	-16.6
400	-14.1	-13.9	-14.0	-14.6
450	-12.4	-12.2	-12.2	-12.8
500	-11.1	-10.9	-10.9	-11.5
None	-1.3	-1.1	-1.2	-1.8

Min Size Limit = 15"

	Max Size Limit			
Trip Limit (lb)	22"	23"	24"	None
10	-80.4	-80.4	-80.4	-80.5
25	-67.4	-67.4	-67.4	-67.6
50	-54.7	-54.6	-54.7	-55.0
100	-40.7	-40.6	-40.6	-41.1
150	-32.6	-32.5	-32.5	-33.0
200	-27.0	-26.8	-26.9	-27.4
250	-22.9	-22.8	-22.8	-23.4
300	-19.9	-19.7	-19.8	-20.3
350	-17.4	-17.2	-17.3	-17.9
400	-15.4	-15.2	-15.2	-15.8
450	-13.7	-13.5	-13.5	-14.1
500	-12.4	-12.2	-12.2	-12.8
None	-2.7	-2.5	-2.6	-3.3

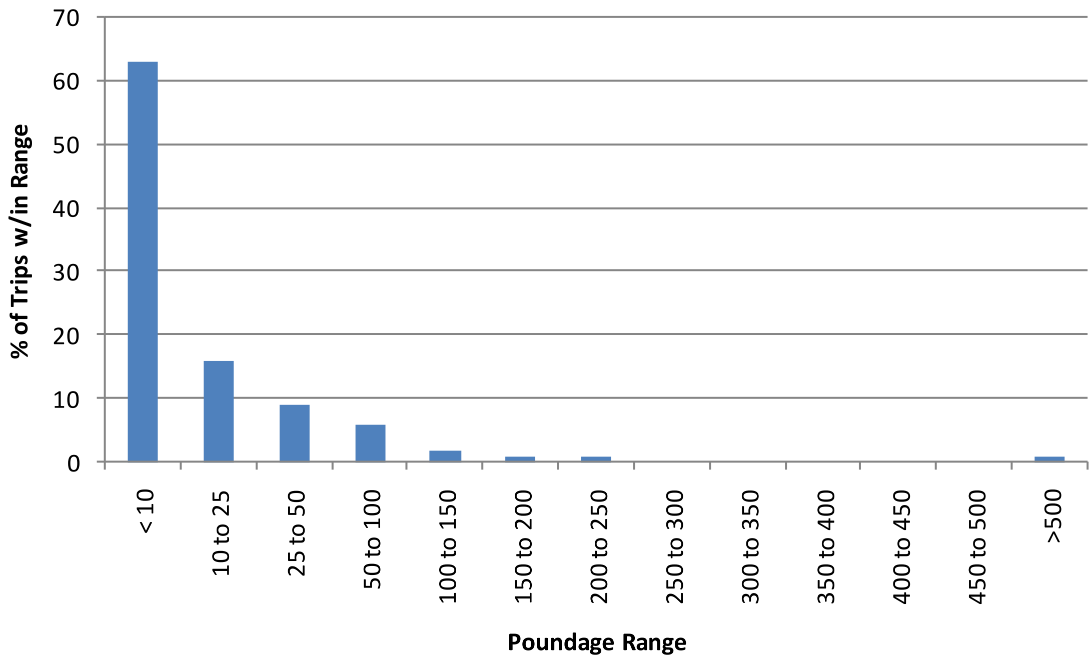


Figure 60. Average frequency of spotted seatrout commercial trips landing within a given poundage range in North Carolina, 2003-2008.

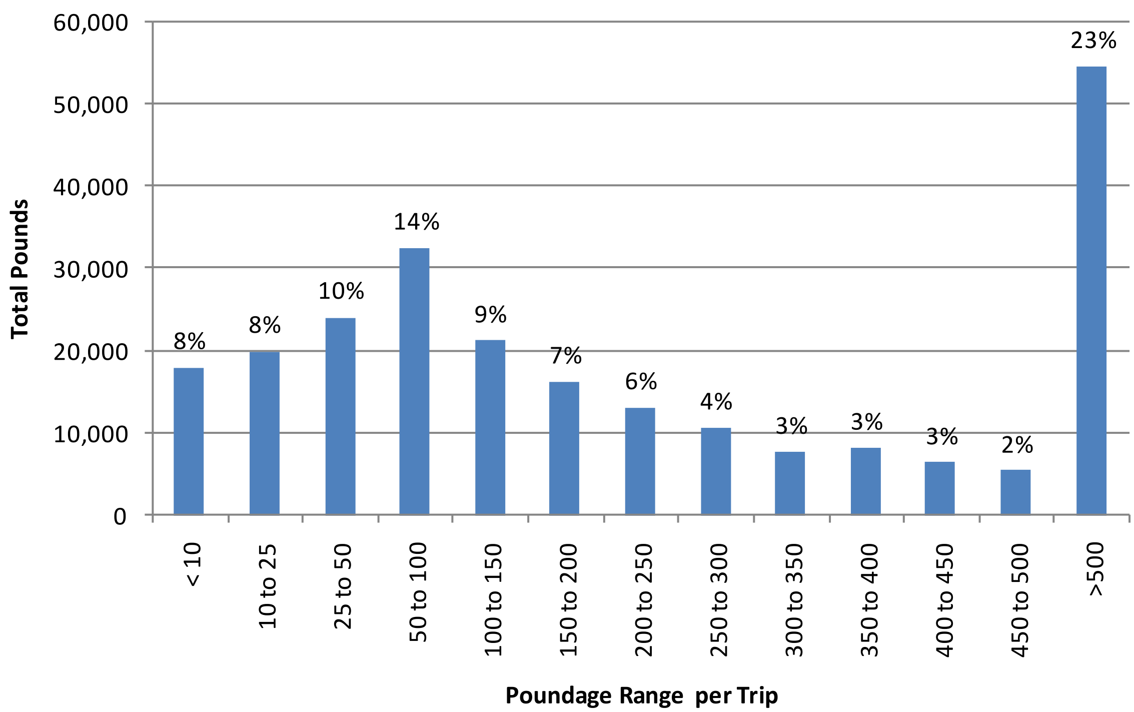


Figure 61. Total pounds of spotted seatrout commercially landed within given poundage ranges in North Carolina, 2003-2008.

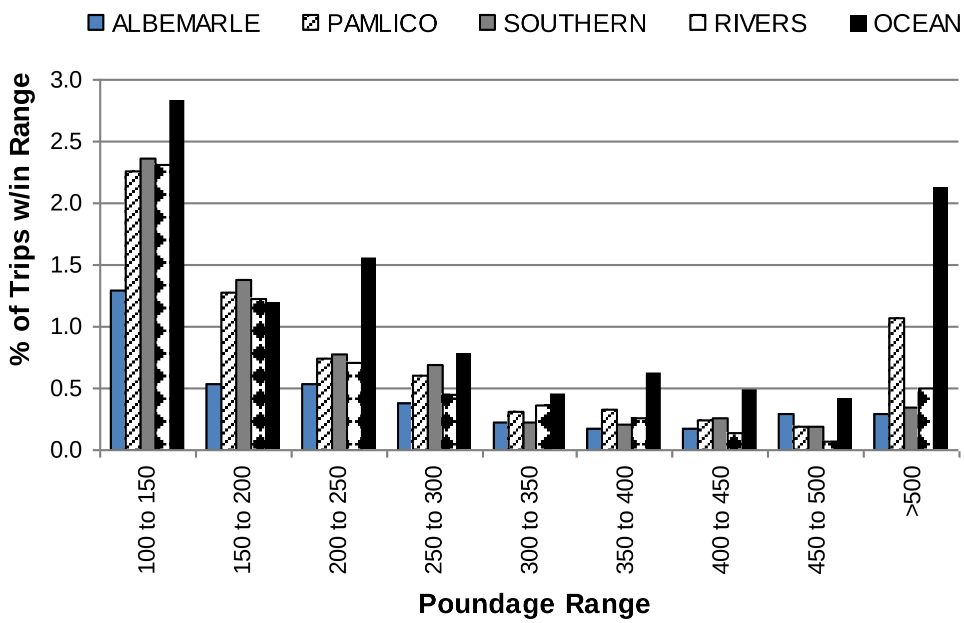


Figure 62. Average frequency of spotted seatrout commercial trip landings within given poundage ranges (trips $\geq$ 100 lbs), by area*, 2003-2008.

**The Albemarle Sound Area includes the Albemarle Sound, Alligator River, Chowan River, Croatan Sound, Currituck Sound, Alligator River, Chowan River, Croatan Sound, Currituck Sound, Pasquatank River, Perquimans River, Roanoke River, and Roanoke Sound. The Pamlico Sound Area includes the Pamlico Sound, Bay River, Core Sound, and Newport River. The Rivers Area includes the Neuse River, New River, Pamlico River, and Pungo River. The Southern Area includes Bogue Sound, Cape Fear River, the Inland Waterway, Lockwood Folly, Masonboro Sound, North River, Shallotte River, Stump Sound, Topsail Sound, and White Oak River.*

Area Closures

Area closures, such as nursery or spawning area closures, were not considered because data collection methods do not enable estimating the harvest from specific bodies of water. Estimates are available only on a very broad scale (e.g., Neuse River, Pamlico Sound, Pamlico River, etc.) and would likely not be useful for spotted seatrout management.

Seasonal Closures

A seasonal closure can be used to restrict harvest during certain times of the year and to reduce landings to sustainable levels. Seasonal closures are periods of time during which no landings of the target species are permitted. Because 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. Seasonal closures should only be used if other available management options fail to meet harvest reductions needed.

It is possible that a seasonal closure could cause an increase in effort during the open period. A closure early in the year could lead to increased amounts of nets being fished once the season opens, increasing both effort and spatial conflict among fishermen. 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 shuts down for the year. In either instance, the effectiveness of the closed season at maintaining the fishing mortality at or below the target level would be reduced. The season selected may also be used to protect spawning females, or to protect spotted seatrout during winter cold spells when they are particularly susceptible to harvest, which would concurrently help alleviate user conflict issues during the cold winter months. The season chosen will need to be a compromise which balances economic impact concerns with meeting the management goal. Seasons selected may be different for the recreational and commercial fisheries.

The highest percent daily harvest in the commercial and recreational fisheries occurs during the months of November and December. The commercial catch peaks in November and December represent an average of 41% of the annual harvest. The recreational catch peaked in wave 6 (November-December) representing approximately 45% of the total spotted seatrout harvest.

If season is selected as a management measure for the recreational fishery, managers typically select a summer season when hooking mortality is highest. Another option would be to select a closed season during the cold weather months (November through March) which would also help to resolve conflict issues between recreational and commercial fishermen. It may be helpful if the season selected included the same cold water months (November through March) identified as peak conflict months between fishermen. A possible commercial closed season option is to prohibit commercial fishing or landing of spotted seatrout on weekends during the months of November through February. This management measure would be similar to the weekend closure for shrimp trawling in estuarine waters (DMF 2006a). Management measures taken in the Southern Flounder FMP may influence management decisions such as closed seasons for spotted seatrout. Seasons are not a preferred management option because of the probable increase in regulatory discards in both the commercial and recreational fisheries, as well as inevitable enforcement issues.

Quotas

A quota refers to the maximum amount of fish that can be legally landed within a specified time period. The objective of a quota would be to prevent further expansion of the fishery and reduce harvest; however, due to the recruitment dependence of the fishery and the resulting variability in available fish for harvest between years, a quota may not be sufficient in preventing overfishing during years of poor recruitment based on the level of fishing mortality.

Another potential problem with regulating the spotted seatrout commercial fishery using a quota is the variability in daily landings. A quota would have to be monitored daily or weekly with landing reports if the fishery is to be closed prior to exceeding the harvest limit. However, the potential magnitude of daily landings in both the gill net and haul seine fishery would make it very easy to surpass the quota before the fishery could be closed.

A quota system would be an additional burden on both the commercial dealers and the DMF. Spotted seatrout are caught as a bycatch in a number of multispecies fisheries. The spotted seatrout fishery consists of almost 1,548 participants and 215 dealers. Quotas currently monitored by the DMF (striped bass, summer flounder, black sea bass) have only between 150 to 700 participants and less than 100 dealers involved. The monitoring of an additional species is currently beyond the capabilities of the DMF given the existing level of personnel and available resources, and additional resources would have to be investigated. It would not be possible to implement a quota system until the necessary resources and personnel could be in place.

Estimates of possible commercial quota values are not included here because they are dependent on harvest reduction allocations. Once the allocation has been decided, quota options can be calculated and presented if desired.

Managing the recreational fishery with a quota is not feasible due to the lag time between the time of fishing and the time the harvest estimates become available through the MFRSS. There is no system in place for monitoring recreational landings on a real-time basis that would allow for the fishery to be closed upon reaching the harvest limit.

Gear Restrictions

Maintaining effort at a stable level in the spotted seatrout fishery could be partially achieved by implementing specific gear limitations. These measures will only control effort provided the fishery does not expand much beyond its current level of participants. Currently, gill nets account for 76% of the commercial harvest (estuarine and ocean combined). Estuarine gill nets are by far the predominant gear (73%). Thus, any limitations would need to focus on this gear. Landings by long haul seines had historically been important. They continued to be the second most important gear, but accounted for only 13% of the 2003-2008 harvest.

Yardage Limit

Limiting the yardage of gill nets would help reduce and control effort within the gill net fishery for spotted seatrout. Although spotted seatrout can be caught in a variety of mesh sizes, they are primarily harvested with small mesh set nets (< 5 inch mesh). Data collected from a fishery dependent sampling program was used to characterize this fishery. Mesh sizes used varied by region, but overall ranged from 3 ¼ to 5 ¾ inch stretched mesh, with 4 inch webbing most common. Of the catches sampled (n=126) that targeted seatrout (at least 50% of the catch was spotted), the number of yards fished ranged from 67 to 3,000 yards with an average of 1,042 yards. Limiting the fishery to a specified yardage will reduce the effort in the fishery, but may or may not achieve the target fishing mortality level.

Limited Entry

There are limitations to establishing a limited entry system for fisheries in North Carolina. Section 2.1 of theFRA (G.S. 113-182.1) concerning FMPs states that the MFC can only recommend that the General Assembly limit participation in a fishery if the DMF determines that sustainable harvest in the fishery cannot otherwise be achieved. Currently, there are other options available for achieving sustainable harvest and ending overfishing for the spotted seatrout fishery. Therefore, limited entry is not a viable option for consideration at this time.

Conclusions

- Spotted seatrout are overfished and overfishing is occurring therefore harvest must be reduced.
- Because there is no stock-recruitment relationship, and large variability in recruitment, projections, which are used to determine harvest reduction necessary to achieve a 50 percent likelihood of success, are deemed unusable for management.
- For the spotted seatrout stock, the biology of the fish, environmental conditions, and lack of sufficient data make it unwise to rely on projections to specify an $F_{rebuild}$ rate that is compatible with professional standards for fisheries management.
- A range of reductions can be met with combinations of size limits (minimum, with or without a slot), bag limits and trip limits (Table 72).

- The stock can be reassessed in the near future to determine if the management strategy is enabling the stock to rebuild.
- Area specific closures are impossible to quantify and difficult to enforce.
- Managing the recreational fishery with a quota is not feasible, and managing the commercial fishery with a quota would be difficult as well as an additional burden to commercial dealers and the DMF.

Table 72. Range of possible reductions (27-57%) and associated management options to end overfishing.

GOALS	REDUCTIONS		MANAGEMENT OPTIONS	
	14 "	14-24" slot	14 "	14-24" slot
to end overfishing:	57.0 (~60%)	53.0 (~50%)	2 fish bag, 50 lb trip limit	2 fish bag, 50 lb trip limit
3/4 way to end overfishing:	42.8 (~40%)	39.8 (~40%)	3 fish bag, 100 lb trip limit	4 fish bag, 100 lb trip limit
1/2 way to end overfishing:	28.5 (~30%)	26.5 (~30%)	6 fish bag, 150 lb trip limit	7 fish bag, 150 lb trip limit

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
15A NCAC 3M .0504 TROUT
15A NCAC 3M.0512 COMPLIANCE WITH FISHERY MANAGEMENT PLANS

Management Options

1) end overfishing immediately:

- 14”: 2 fish bag limit, 50 lbs trip limit
- 14-24”: 2 fish bag limit, 50 lbs trip limit

A. Modify Size Limits

Size limits alone are not likely to achieve the reduction necessary to achieve sustainable harvest and should be combined with other management options.

(i) Increase minimum size limit (size limit is 12 inches)

\+ Increase in the spawning stock biomass and the overall yield to the fishery
\+ Allows more immature fish the opportunity to spawn at least once before being caught
\+ Reduces landings and harvest closer to a sustainable level
\+ Reduces harvest levels closer to the target fishing mortality level
\+ Could be applied to both the commercial and recreational fisheries
\- Decrease in the yield to the fishery in the short-term
\- Some regions may be impacted more than others
\- Overfishing could still occur if fishing mortality increases on legal sized fish
\- Effectiveness diminished if proportion of undersized fish in the catch increases due to release mortality
\- Increase in regulatory discards in the commercial and recreational fisheries

(ii) Establish maximum size (slot limits)

\+ Protects the largest fish in the spawning stock
\+ Potentially protects fish with the highest egg production

- \+ Will allow more fish to survive as size and age structure expands
- \- Very little reduction in commercial and recreational landings
- \- May increase pressure on fish in the slot limit
- \- Increase in regulatory discards due to bycatch in commercial fishery
- \- Increase in regulatory discards in the recreational fishery
- \- Data collection for future assessments on largest, potentially oldest fish becomes more limited

(iii) Establish maximum size (slot limits) with a trophy fish

- \+ Provides some protection for the largest fish in the spawning stock
- \+ Potentially reduces harvest on fish with the highest egg production
- \+ Will allow more fish to survive as size and age structure expands than managing with no slot limit
- \+ Enables data collection for future assessments on largest, potentially oldest fish
- \- Reduces the effectiveness of slot limit due to harvest of the trophy fish
- \- Reduction in commercial and recreational landings is not quantifiable
- \- May increase pressure on fish in the slot limit
- \- Increase in regulatory discards due to bycatch in commercial fishery
- \- Increase in regulatory discards in the recreational fishery
- \- Fishermen may high grade to keep the largest trophy fish

B.) Trip/creel limits

Trip/creel limits alone are not likely to achieve the reduction necessary to achieve sustainable harvest and should be combined with other management options.

- \+ Reduces harvest in the fishery
- \+ Potential management measure for both the commercial and recreational fisheries
- \+ Combined with size limit can achieve sustainability threshold with no seasonal closure
- \- May lead to increased regulatory discards in the commercial fishery
- \- May adversely impact some fisheries and fishermen more than others
- \- Potential for high grading as fishermen reach creel limit

2) Three-quarters way to end overfishing

- 14”: 3 fish bag limit, 100 lbs trip limit
  +/-Same as 1a-1b above
  \+ ¾ reduction allows for larger bag limit
  \+ ¾ reduction allows for larger trip limit
  \- Further to go to end overfishing

- 14-24”: 4 fish bag limit, 100 lbs trip limit
  +/-Same as 1a-1b above
  \+ ¾ reduction allows for larger bag limit than ending overfishing immediately
  \+ ¾ reduction allows for larger trip limit than ending overfishing immediately
  \+ Allows for larger bag limit than without a slot limit
  \+ Allows for larger trip limit than without a slot limit
  \- Further to go to end overfishing

3) Halfway to end overfishing

- 14”: 6 fish bag limit, 150 lbs trip limit

+/-Same as 1a-1b above
+ ½ reduction allows for larger bag limit than ending overfishing ¾ way
+ ½ reduction allows for larger trip limit than ending overfishing ¾ way
- Further to go to end overfishing

- 14-24”: 7 fish bag limit, 150 lbs trip limit
  +/-Same as 1a-1b above
  + ½ reduction allows for larger bag limit than ending overfishing ¾ way
  + ½ reduction allows for larger trip limit than ending overfishing ¾ way
  + Allows for larger bag limit than without a slot limit
  + Allows for larger trip limit than without a slot limit
  - Further to go to end overfishing

Management Recommendations

SST AC: Take the reductions necessary to end overfishing half way and reassess within 3 years, with a 6 fish bag limit, 14 inch minimum size, and a weekend closure (no possession) for the commercial fishery & gear will be removed on weekends November-February. No use of gill nets as RCGL gear to harvest spotted seatrout.
DMF: Take the reductions necessary to end overfishing half way and reassess in 5 years, with a 6 fish bag limit and 14 inch minimum size, and weekend closure (no possession) for the commercial fishery & gear will be removed on weekends November-February. Western Albemarle Sound & Currituck Sounds exempt from the weekend gear removal.
MFC : Take the reductions necessary to end overfishing half way and reassess in 5 years, with a 6 fish bag limit and 14 inch minimum size, and weekend closure (no possession) for the commercial fishery. The small mesh gill net attendance requirement is extended to include weekends, December through February. A maximum of 2 fish over 24 inches for recreational fishermen.

Research Recommendations:

1. Batch fecundity estimates are needed for spotted seatrout in North Carolina. Estimates of batch fecundity from North Carolina could help to identify a stock-recruitment relationship, and may provide better estimates of spawning potential ratios and future recruitment.

2. Research the feasibility of including measures of temperature and/or salinity into the stock-recruitment relationship.

3. Area specific spawning surveys could help in the delineation of area specific closures to protect females in spawning condition.

4. Juvenile index of abundance is needed to develop a better understanding of a stock recruitment relationship.

5. A very robust release mortality study needs to be conducted, especially for the recreationally caught spotted seatrout.

10.2.3 Enforcement of Size, Creel Limit and Gear Regulations in Joint, Coastal or Inland Fishing Waters

Issue

Improving public compliance with and agency enforcement of spotted seatrout management measures in joint and coastal or inland fishing waters.

Background

The Marine Fisheries Commission (MFC) is responsible for managing, protecting, preserving and enhancing the marine and estuarine resources under its jurisdiction. In support of these responsibilities, the Division of Marine Fisheries (DMF) conducts management, enforcement, research, monitoring, statistics and licensing programs to provide information on which to base decisions on rule making. The “North Carolina Rules for Coastal Fishing Waters 2009” is a collection of state rules and statutes governing activities impacting marine and estuarine resources in coastal and joint fishing waters, including the brackish waters of the state’s rivers and their tributaries, sounds and bays, and in saltwater extending out to three miles offshore in the Atlantic Ocean. The NC Wildlife Resources Commission (WRC) is responsible for regulating fishing activities in inland waters (see 15A NCAC 03Q .0200 for boundary descriptions). The NC General Assembly enacts fisheries statutes, or laws, and provides the authority to adopt rules to implement those statutes. These rules are found in Title 15A of the NC Administrative Code; Chapter 3 for the MFC and Chapter 10 for WRC.

The DMF Marine Patrol Officers and WRC Wildlife Enforcement Officers may be faced with problems with the enforcement of spotted seatrout regulations between different spotted seatrout management areas at or near the jurisdictional boundaries of joint and coastal or inland fishing waters due to different size limits, creel limits, and gear regulations.

Spotted seatrout can conceivably be caught legally within a short distance of the jurisdiction between joint and coastal or inland fishing waters but in the vicinity of the boundary lines between spotted seatrout management areas. Joint and coastal fishing designated waters are managed by DMF, inland fishing waters are managed by the WRC, and the two different resource agencies may have separate management regulations in the different areas.

Differences in regulatory size and legal possession (creel) limits are allowed in the joint or coastal fishing designated waters than in the inland fishing water management areas. A 12 inch total length (TL) minimum size and 10 fish bag limit has been allowed by DMF since 1991(15A NCAC 3M.0504), but a recent interim measure increased the minimum size to 14 inches TL (FF-53-2009; effective 10/5/09). The MFC Spotted Seatrout AC has also proposed a management recommendation to decrease the bag limit from 10 fish to 6 fish and to make the 14 inch TL size limit permanent. Currently, a 12 inch TL and 10 fish bag limit is allowed by the WRC (15A NCAC 10C .0305).

There are also differences in the gear allowed to take spotted seatrout in the joint / coastal fishing designated waters than in the inland fishing waters management areas. The WRC has designated spotted seatrout as gamefish in inland fishing waters (15A NCAC 10 C .0301). As such, spotted seatrout may be taken only with a hook and line (15A NCAC 10 C .0302). During the coldest winter months when spotted seatrout are most susceptible to harvest, commercial fishermen reportedly follow the fish into the inland fishing water areas and use commercial gill nets to illegally catch spotted seatrout during the late night hours. This illegal activity is difficult to enforce because gill net fishermen can quickly fish the illegal gill nets in inland fishing waters, and return to joint/coastal fishing waters before an officer arrives. Fishing activities in inland fishing waters are only enforced by WRC Wildlife Enforcement Officers, and DMF Marine Patrol Officers only have enforcement capabilities in joint/coastal fishing waters.

The different minimum sizes, creel limits, and gear regulations may apply in the joint and coastal fishing waters and in inland fishing waters. An example would be the upper Pungo River where anglers could possess a 12 inch fish and/or 10 fish creel limit allowed in inland fishing waters. If the fisherman then crosses into joint/coastal fishing waters managed by DMF, the fisherman would be required to adhere to DMF regulations which currently are a 14 inch fish. Also, it would not be legal for a commercial fisherman to catch the fish with a gill net in areas under WRC's management, but legal in the lower Pungo River under DMF's management. The public's lack of understanding of the various jurisdictional boundaries and differing restrictive measures may decrease the effectiveness of management measures.

Discussion

The MFC has two rules which dictate how DMF Marine Patrol Officers enforce the size and creel limits. The first rule is 3M .0504 (a) it is unlawful to possess spotted seatrout less than 12 inches total length. Proclamation FF- 53-2009 (October 5, 2009) suspended this rule such that it is now unlawful to possess spotted seatrout less than 14 inches in total length. Rule 3M .0504 (b) further states that it is unlawful to posses more than 10 spotted seatrout per person per day taken by hook-and-line or for recreational purposes. This is a possession limit and does not consider where the fish were caught. The second rule is 3I .0120 (a) which states "It is unlawful to possess any species of fish which is subject to size or harvest restrictions, while actively engaged in a fishing operation, unless all fish are in compliance with the restrictions for the waterbody and area being fished".

The WRC Wildlife Enforcement Officers follow the same policy, i.e. allow the daily possession limit for the body of water in which they are fishing. A legal limit could be caught in inland fishing waters and a legal limit could be caught in coastal fishing waters, however, you would have to take the first catch home before being caught in possession of the second one. *Possession* is the key word in both WRC and DMF enforcement. (15A NCAC 10C.0304)

The simplest solution to this confusion is to publicize to anglers in the vicinity of these boundaries that when you are checked by an enforcement officer of either agency, an angler cannot have in possession more than the minimum size and creel limit for the waterbody you are in while actively engaged in fishing. In order to promote complete clarity, encourage the WRC Wildlife Enforcement Officers to implement a rule similar to the MFC Rule that states you must be in compliance with the restrictions in place at the point you are checked. The MFC Rule reads, "It is unlawful to possess any species of fish which is subject to size or harvest restrictions, while actively engaged in a fishing operation, unless all fish are in compliance with the restrictions for the waterbody and area being fished". If DMF Marine Patrol Officers find a violation in inland fishing waters, their current option is to make contact with a WRC Wildlife Enforcement Officer, hold the suspect or gather the appropriate information and relay to the WRC Wildlife Enforcement Officer, and serve as a witness to the violation. To better address this situation, the DMF and WRC are currently in the process of considering a "mutual aid agreement" (DMF attorney and WRC attorney) such that the DMF has general policy power to enforce laws when commercial gear is involved in inland fishing waters. The authority for such an agreement is provided by G.S. 143-251.

Current Authority

Jurisdiction Statute

§ 113-132. Jurisdiction of fisheries agencies.

(a) The Marine Fisheries Commission has jurisdiction over the conservation of marine and estuarine resources. Except as may be otherwise provided by law, it has jurisdiction over all activities connected with the conservation and regulation of marine and estuarine resources, including the regulation of aquaculture facilities as defined in G.S. 106-758 which cultivate or rear marine and estuarine resources.

(b) The Wildlife Resources Commission has jurisdiction over the conservation of wildlife resources. Except as may be otherwise provided by law, it has jurisdiction over all activities connected with the conservation and regulation of wildlife resources.

(c) Notwithstanding the provisions of this Article, this Subchapter does not give the Marine Fisheries Commission or the Wildlife Resources Commission jurisdiction over matters clearly within the jurisdiction vested in the Department of Agriculture and Consumer Services, the North Carolina Pesticide Board, the Commission for Public Health, the Environmental Management Commission, or other division of the Department regulating air or water pollution.

(d) To the extent that the grant of jurisdiction to the Marine Fisheries Commission and the Wildlife Resources Commission may overlap, the Marine Fisheries Commission and the Wildlife Resources Commission are granted concurrent jurisdiction. In cases of conflict between actions taken or regulations promulgated by either agency, as respects the activities of the other, pursuant to the dominant purpose of such jurisdiction, the Marine Fisheries Commission and the Wildlife Resources Commission are empowered to make agreements concerning the harmonious settlement of such conflict in the best interests of the conservation of the marine and estuarine and wildlife resources of the State. In the event the Marine Fisheries Commission and the Wildlife Resources Commission cannot agree, the Governor is empowered to resolve the differences.

(e) Those coastal fishing waters in which are found a significant number of freshwater fish, as agreed upon by the Marine Fisheries Commission and the Wildlife Resources Commission, may be denominated joint fishing waters. These waters are deemed coastal fishing waters from the standpoint of laws and regulations administered by the Department and are deemed inland fishing waters from the standpoint of laws and regulations administered by the Wildlife Resources Commission. The Marine Fisheries Commission and the Wildlife Resources Commission may make joint regulations governing the responsibilities of each agency and modifying the applicability of licensing and other regulatory provisions as may be necessary for rational and compatible management of the marine and estuarine and wildlife resources in joint fishing waters.

(f) The granting of jurisdiction in this section pertains to the power of agencies to enact regulations and ordinances. Nothing in this section or in G.S. 113-138 is designed to prohibit law-enforcement officers who would otherwise have jurisdiction from making arrests or in any manner enforcing the provisions of this Subchapter. (1965, c. 957, s. 2; 1973, c. 476, s. 128; c. 1262, ss. 18, 28, 38; 1977, c. 771, s. 4; 1979, c. 830, s. 1; 1987, c. 641, s. 5; 1989, c. 281, s. 3; 1997-261, s. 109; 2007-182, s. 2.)

§ 143-251. Cooperative agreements.

In furtherance of the purposes of this Article the Commission is hereby authorized and empowered to enter into cooperative agreements pertaining to the management and development of the wildlife resources with federal, State, and other agencies, or governmental subdivisions. (1947, c. 263, s. 15.)

Rules and Regulations:

FF-53-2009

PROCLAMATION

RE: SPOTTED SEATROUT

Dr. Louis B. Daniel III, Director, Division of Marine Fisheries, hereby announces that effective 12:01 A.M., Monday, October 5, 2009, the following will apply to spotted seatrout:

I. SPOTTED SEATROUT RULE SUSPENSION

North Carolina Marine Fisheries Rule 15A NCAC 3M .0504 (a) is suspended.

II. MINIMUM SIZE LIMIT

It is unlawful to possess spotted seatrout (speckled trout) less than 14 inches total length.

III. GENERAL INFORMATION:

A. This proclamation is issued under the authority of N.C.G. S. 113-170.4; 113-170.5; 113-182; 113-221.1; 143B-289.52 and N.C. Fisheries Rules 15A NCAC 3H .0103, 3M .0504 and 3M .0512.

B. It is unlawful to violate the provisions of any proclamation issued by the Fisheries Director under his delegated authority pursuant to N.C. Marine Fisheries Rule 15A NCAC 3H .0103.

C. It is unlawful to possess more than 10 spotted seatrout per person per day taken by hook-and-line or for recreational purposes pursuant to Marine Fisheries Rule 15A NCAC 3M .0504 (b).

D. On September 24, 2009, the Marine Fisheries Commission authorized an interim management measure to ensure the viability of spotted seatrout while the Spotted Seatrout Fishery Management Plan is being developed.

E. Dealers have until Monday, October 12, 2009 to sell, offer for sale, transport or have in possession unfrozen spotted seatrout.

September 29, 2009
11:15 A.M.
FF-53- 2009

SUBCHAPTER 3I – GENERAL RULES
SECTION .0100 - GENERAL RULES

.0120 POSSESSION OR TRANSPORTATION LIMITS

(a) It is unlawful to posses any species of fish which is subject to size or harvest restrictions, while actively engaged in a fishing operation, unless all fish are in compliance with the restrictions for the waterbody and area being fished.

History Note: Authority G.S. 113-134; 113-170; 113-170.4; 113-170.5; 113-182; 143B-289.52;
Temporary Adoption Eff. July 1, 1999;
Eff. August 1, 2000;
Temporary Amendment Eff. October 1, 2001;
Amended Eff. September 1, 2005; April 1, 2003;

SUBCHAPTER 3M – FINFISH
SECTION .0500 – OTHER FINFISH

.0504 Trout

(a) Spotted seatrout (speckled trout).

(1) It is unlawful to possess spotted seatrout less than 12 inches total length.

(2) It is unlawful to possess more than 10 spotted seatrout per person per day taken by hook-and-line or for recreational purposes.

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. March 1, 1996; March 1, 1995; February 1, 1992;
Temporary Amendment Eff. September 9, 1996;
Temporary Amendment Eff. October 1, 1996;
Amended Eff. April 1, 1997;
Temporary Amendment Eff. July 1, 1999;
Amended Eff. August 1, 2000.

SUBCHAPTER 3Q - JURISDICTION OF AGENCIES: CLASSIFICATION OF WATERS
SECTION .0100 - GENERAL REGULATIONS: JOINT

.0102 INLAND FISHING WATERS

Inland fishing waters are all inland waters except private ponds; and all waters connecting with or tributary to coastal sounds or the ocean extending inland from the diving line between coastal fishing waters and inland fishing waters agreed upon by the Marine Fisheries Commission and the Wildlife Resources Commission. All waters which are tributary to inland fishing waters and which are not otherwise designated by agreement between the Marine Fisheries Commission and the Wildlife Resources Commission are inland fishing waters. The regulation and licensing of fishing in inland fishing waters is under the jurisdiction of the Wildlife Resources Commission. Regulations and laws administered by the Wildlife Resources Commission regarding fishing in inland fishing waters are enforced by wildlife enforcement officers.

History Note: Authority G.S. 113-132; 113-134; 143B-289.52;
Eff. January 1, 1991.

.0103 COASTAL FISHING WATERS

Coastal fishing waters are the Atlantic Ocean; the various coastal sounds; and estuarine waters up to the dividing line between coastal fishing waters and inland fishing waters agreed upon by the Marine Fisheries Commission and the Wildlife Resources Commission. All waters which are tributary to coastal fishing waters and which are not otherwise designated by agreement between the Marine Fisheries Commission and the Wildlife Resources Commission are coastal fishing waters. The regulations and licensing of fishing in coastal fishing waters is under the jurisdiction of the Marine Fisheries Commission; except that inland game fish (**exclusive of spotted seatrout**, weakfish, and striped bass) are subject to regulations by the Wildlife Resources Commission in coastal fishing waters. Regulations and laws administered by the Marine Fisheries Commission regarding fishing in coastal waters are enforced by fisheries enforcement officers. Regulations regarding inland game fish in coastal fishing waters are enforced by wildlife enforcement officers unless otherwise agreed to by the Wildlife Resources Commission.

History Note: Authority G.S. 113-132; 113-134; 143B-289.52;
Eff. January 1, 1991.

.0104 JOINT FISHING WATERS

Joint fishing waters are those coastal fishing waters, hereinafter set out, denominated by agreement of the Marine Fisheries Commission and the Wildlife Resources Commission pursuant to G.S. 113-132(e) as joint fishing waters. All waters which are tributary to joint fishing waters and which are not otherwise designated by agreement between the Marine Fisheries Commission and the Wildlife Resources Commission are classified as joint fishing waters. The regulation and licensing of fishing in joint waters shall be slated in 15A NCAC 3Q.0106.

History Note: Authority G.S. 113-132; 113-134; 143B-289.52;
Eff. January 1, 1991.

.0105 POSTING DIVIDING LINES

The dividing lines of all major bodies of water and watercourses which are divided by the agreement of the Marine Fisheries Commission and the Wildlife Resources Commission so that portions of the same are constituted inland fishing waters, coastal fishing waters, or joint fishing waters shall be marked with signs in so far as may be practicable. Unmarked and undesignated tributaries shall have the same classification as the designated waters to which they connect or into which they flow. No unauthorized removal or relocation of any such marker shall have the effect of changing the classification of any body of water or portion thereof, nor shall any such unauthorized removal or relocation or the absence of any marker affect the applicability of any regulation pertaining to such body of water or portion thereof.

History Note: Authority G.S. 113-132; 113-134; 143B-289.52;
Eff. January 1, 1991.

.0106 APPLICABILITY OF RULES: JOINT WATERS

(a) All coastal fishing laws and regulations administered by the Department of Environment and Natural Resources and the Marine Fisheries Commission apply to joint waters except as otherwise provided, and shall be enforced by fisheries enforcement officers.
(b) The following inland fishing laws and regulations administered by the Wildlife Resources Commission apply to joint waters and shall be enforce by wildlife enforcement officers:

(1) all laws and regulations pertaining to inland game fishes,
(2) all laws and regulations pertaining to inland fishing license requirements for hook and line fishing,
(3) all laws and regulations pertaining to hook and line fishing except as hereinafter provided.

History Note: Authority G.S. 113-132; 113-134; 143B-289.52;
Eff. January 1, 1991.
Amended Eff. July 1, 1999.

.0107 SPECIAL REGULATIONS: JOINT WATERS

In order to effectively manage all fisheries resources in joint waters and in order to confer enforcement powers on both fisheries enforcement officers and wildlife enforcement officers with respect to certain rules, the Marine Fisheries Commission and the Wildlife Resources Commission deem it necessary to adopt special rules for joint waters. Such rules supersede any inconsistent rules of the Marine Fisheries Commission or the Wildlife Resources Commission that would otherwise be applicable in joint waters under the provisions of 15A NCAC 03Q .0106:

(1) Striped Bass

(a) It is unlawful to possess any striped bass or striped bass hybrid that is less than 18 inches long (total length).

(b) It is unlawful to possess striped bass or striped bass hybrids between the lengths of 22 and 27 inches (total length) in joint fishing waters of the Central Southern Management Area as designated in 15A NCAC 03R .0201.

(c) It is unlawful to possess striped bass or striped bass hybrids May through September in the joint fishing waters of the Central Southern Management Area and the Albemarle Sound Management Area.

(d) It is unlawful to possess striped bass or striped bass hybrids taken from the joint fishing waters of the Cape Fear River.

(e) It is unlawful to possess more than one daily creel limit of striped bass or striped bass hybrids, in the aggregate, per person per day, regardless of the number of management areas fished.

(f) Possession of fish shall be assessed for the creel and size limits of the management area in which the individual is found to be fishing, regardless of the size or creel limits for other management areas visited by that individual in a given day.

(g) It is unlawful to engage in net fishing for striped bass or striped bass hybrids in joint waters except as authorized by rules of the Marine Fisheries Commission.

(2) Lake Mattamuskeet:

(a) It is unlawful to set or attempt to set any gill net in Lake Mattamuskeet canals designated as joint waters.

(b) It is unlawful to use or attempt to use any trawl net or seines in Lake Mattamuskeet canals designated as joint waters.

(3) Cape Fear River. It is unlawful to use or attempt to use any net, net stakes or electrical fishing device within 800 feet of the dam at Lock No.1 on the Cape Fear River.

(4) Shad: It is unlawful to possess more than 10 American shad or hickory shad, in the aggregate, per person per day taken by hook-and-line.

History Note: Authority G.S. 113-132; 113-134; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. July 1, 1993; November 1, 1991;

Temporary Amendment Eff. May 1, 2000;
Amended Eff. July 1, 2008; September 1, 2005; April 1, 2001; August 1,2000.

.0202 DESCRIPTIVE BOUNDARIES FOR COASTAL-JOINT-INLAND WATERS
(refer to rule book, pages 81-106)

History Note: Authority G.S. 113-132; 113-134; 143B-289.52;
Eff. January 1, 1991.
Amended Eff. April 1, 2009; August 1, 2004; July 1, 1993; September 1, 1991.

SUBCHAPTER 10C - INLAND FISHING REGULATIONS

SECTION .0300 - GAMEFISH

.0301 INLAND GAME FISHES DESIGNATED
The following fishes are classified and designated as inland game fishes:

(7) spotted seatrout (speckled trout), when found in inland fishing waters;

History Note: Authority G.S. 113-134; 113-129;
Eff. February 1, 1976;
Amended Eff. June 1, 2005; June 1, 2004; July 1, 1996; July 1, 1990; July 1, 1983; January 1, 1981; January 1, 1980.

.0302 MANNER OF TAKING INLAND GAME FISHES
(a) Except as provided in this Rule, it is unlawful for any person to take inland game fishes from any of the waters of North Carolina by any method other than with hook and line. Landing nets may be used to land fishes caught on hook and line. Game fishes taken incidental to commercial fishing operations in joint fishing waters or coastal fishing waters shall be immediately returned to the water unharmed. Game fishes taken incidental to the use of licensed special devices for taking nongame fishes from inland fishing waters as authorized by 15A NCAC 10C .0407 shall be immediately returned to the water unharmed, except that a daily creel limit of American and hickory shad may be taken with dip nets and bow nets from March 1 through April 30 in those waters where such gear may be lawfully used.
(b) In the inland waters of the Roanoke River upstream of U.S. 258 bridge, only a single barbless hook or a lure with a single barbless hook may be used from 1 April to 30 June. Barbless as used in this Rule, requires that the hook does not have a barb or the barb is bent down.

History Note: Authority G.S. 113-134; 113-273; 113-292; 113-302;
Eff. February 1, 1976;
Amended Eff. July 1, 1996; October 1, 1994; July 1, 1993; May 1, 1992; January 1, 1982;
Temporary Amendment Eff. November 1, 1998;
Amended Eff. August 1, 2002; April 1, 1999.

.0304 TAKING AND POSSESSION OF INLAND GAME FISHES

(a) It is unlawful to take in one day more than the daily creel limit of those species of inland game fish having a specified creel limit; to possess more fish than the daily creel limit in effect on those waters being fished; to possess any fish outside of the size limit in effect on those waters being fished; to possess more fish than the daily creel limit while boating or afield; or to possess at any place more than three days creel limit. It is unlawful to destroy unnecessarily any inland game fish taken from public fishing waters.
(b) No person while fishing shall remove the head or tail or otherwise change the appearance of any game fish having a minimum size limit so as to render it impracticable to measure its total original length. No person while fishing shall change the appearance of any game fish having a daily creel limit so as to obscure its identification or render it impracticable to count the number of fish in possession.

History Note: Authority G.S. 113-134; 113-135; 113-135.1; 113-292;
Eff. February 1, 1976;
Amended Eff. July 1, 1998; July 1, 1991; July 1, 1988; January 1, 1981.

.0305 OPEN SEASONS: CREEL AND SIZE LIMITS

GAME FISHES	DAILY CREEL LIMITS	MINIMUM SIZE LIMITS	OPEN SEASON
Seatrout (Spotted or Speckled)	10	12 in.	ALL YEAR

Management Options

1. *Status quo*. No change in present situation.
   - \- continued confusion in boundary areas
   - \+ no change in proclamation or rule

2. Standardize possession limits between jurisdictions
   - \- would still be confusion over whether the limits were additive
   - \- takes time due to regulatory cycles
   - \+ would eliminate confusion over limits

3. Develop a “mutual aid agreement” such that the DMF has general policy power to enforce laws in inland fishing waters.
   - \- more responsibilities for DMF Marine Patrol in terms of enforcement area and regulations
   - \+ would help to enforce laws at the time of violation
   - \+ would aid in the effectiveness of management measures

4. Develop a rule for special regulations in joint fishing waters (similar to 15A NCAC 03Q .0107).
   - \- more responsibilities for DMF Marine Patrol in terms of enforcement area and regulations
   - \+ would help to enforce laws at the time of violation
   - \+ would aid in the effectiveness of management measures
   - \+ would aid in the inconsistencies of rules of the MFC and WRC

Management Recommendations

SST AC: Development of a mutual aid agreement between DMF Marine Patrol officers and WRC Wildlife Enforcement officers for inland fishing waters.
DMF: Development of a mutual aid agreement between DMF Marine Patrol and Wildlife Enforcement officers for inland fishing waters.
MFC: Development of a mutual aid agreement between DMF Marine Patrol and Wildlife Enforcement officers for inland fishing waters.

Research/Process Recommendations:

1. Any rules adopted by DMF as a result of the Fishery Management Plan need to be adopted by WRC as soon as regulatory cycles can allow.

2. Develop public outreach materials to improve public understanding of fishing waters jurisdictions and respective regulations.

10.2.4 Management Measures to Address User Group Competition

Issue

Determine management measures to reduce conflicts between recreational hook and line and gill net spotted seatrout fisheries.

Background

The Fisheries Reform Act (FRA) requires Fishery Management Plans (FMPs) contain necessary information that pertain to several issues including user conflicts. Two user groups in the spotted seatrout fishery, commercial gill net and recreational hook and line fishermen, have been in competition for spotted seatrout and in some instances the competition has escalated to conflicts between the two groups. Conflict results from one or two parties trying to undermine another party's ability to achieve their goal (Maiolo 1993).

Competition and conflict in the spotted seatrout fishery typically occurs in the fall and winter in years when spotted seatrout abundance is high (Figure 63). The Division of Marine Fisheries (DMF) received an increase in the amount of complaints between these two user groups from several areas in 1993 and 1994, 1999 and 2000, and since 2007. The specific areas were listed in the interim issue paper on area specific management measures to reduce user conflicts (Appendix 2). This interim conflict management measures paper focused on area specific measures. However, the area specific management measures were not supported by any advisory committee nor the MFC except the spotted seatrout advisory committee recommended closing a small portion of the New River to gill netting during the day. This motion was not endorsed by any other committee and was not endorsed by the MFC. Each of the advisory committees and the MFC did agree with using mediation as a viable tool for reducing or eliminating conflict and competition between user groups but only on a case by case basis. Other possible options that were suggested to DMF staff to reduce competition and/or conflict between the two user groups was to reduce the amount of small mesh gill net that is allowed to be fished in one gill net operation, establish a maximum yardage of a continuous net, or to separate the fishermen using seasonal or day of the week closures. A more extreme option included shutting down specific areas to both recreational and commercial fishing until a resolution could be reached between the user groups.

Management measures that will be described in greater detail in this issue paper include mediation, gear restrictions, seasonal closure, and day of week closure. The option to close a specific waterbody to recreational and commercial fishing should only be used when the other methods of conflict resolution have been explored and exhausted.

Mediation is a conflict resolution process that is designed to achieve a lasting resolution to the user groups involved in the conflict. Mediation can be used to settle disputes among fishermen when the conflicts involve gear, space, allocation, and perceptual issues.

Gear restrictions may be able to resolve some conflict issues by reducing the amount of gear that is used to catch a particular species. Another alternative is to limit the continuous length of a net combined with minimum distance between nets to allow better access to other user groups into the area.

Seasonal closures can be used to separate fishermen when there is overlap in the timing of fishing between two user groups. Seasonal landings were extracted from the Marine Recreational Statistics Survery (MRFSS) and North Carolina Trip Ticket Program (NCTTP). The MRFSS was designed to give estimates of yearly landings but can be used to separate landings out by waves (2 month sampling periods). The NCTTP daily landings and trips landing spotted seatrout were used to calculate the impact of a weekend closure on the commercial spotted seatrout fishery. Although direct estimates of recreational fishing effort is not available based on day of landing, a logical assumption is to assume more recreational trips and landings of spotted seatrout occur on weekends than during the weekday.

In addition to considering the competition and conflict between the two user groups, the stock of spotted seatrout is overfished and overfishing is occurring. Some management measures used to reduce conflict can have the added benefit of reducing harvest. This reduction in harvest can be combined with rule changes in the size and bag/trip limit to achieve a greater reduction in fishing effort and enable the spotted seatrout population to rebuild to a sustainable level more quickly.

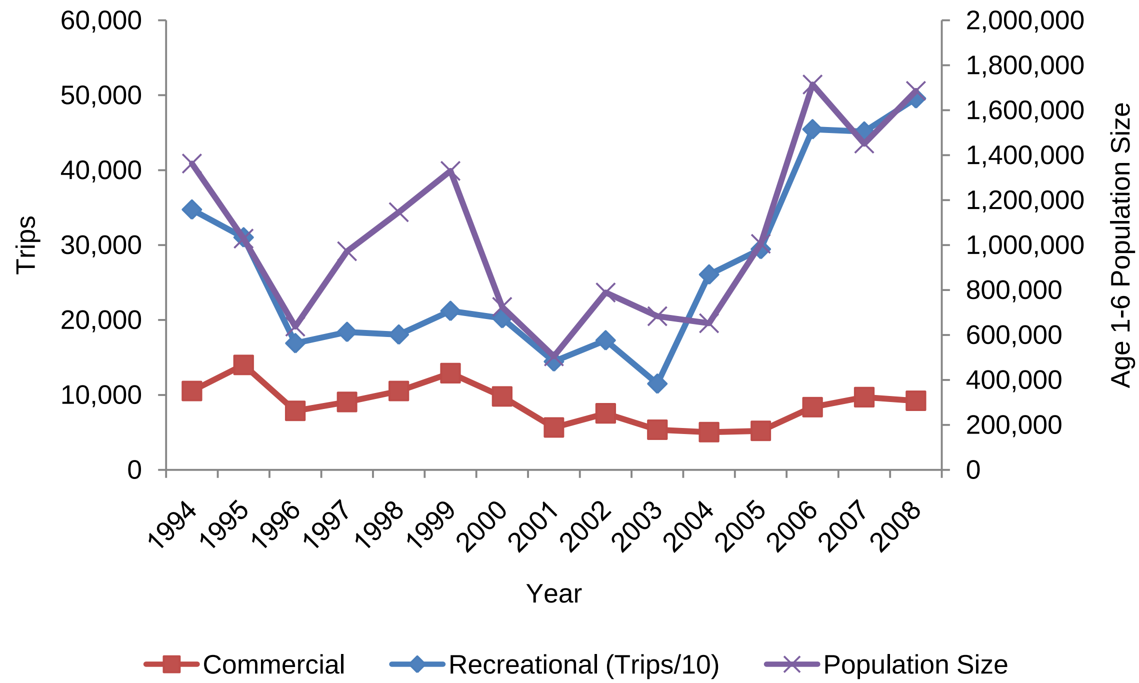


Figure 63. Commercial gill net (number of gill net trips landing spotted seatrout) and recreational trips (number of trips targeting or harvesting spotted seatrout/10 for scaling) catching spotted seatrout plotted with estimated number of age 1 to age 6+ spotted seatrout from 1994 to 2008.

Estuarine Small Mesh Gill Net Fisheries (<5 inch stretched mesh)

Small mesh gill net fisheries (<5 inch stretched mesh) target a variety of species in North Carolina's estuarine waters including spotted seatrout, bluefish, menhaden, sea mullet, Spanish mackerel, spot, striped mullet, weakfish, and white perch. These fisheries use different size mesh and lengths of net depending on the species that is being targeted (Table 18, Section 7). A trip was defined for each species based on the species accounted for 50% or greater of the landings for each trip. Since spotted seatrout are a bycatch species during the spring, summer, and fall, small mesh gill net regulations developed in this fishery management plan may impact other fisheries. The trips that were designated as targeting spotted seatrout used nets with mesh sizes commonly between 3 ¼ to 5 ¾" stretched mesh with a mesh size of 4" stretched being the most common. This net size was typically larger than many other small mesh gill net fisheries targeting estuarine species.

The length of small mesh gill nets associated with trips targeting spotted seatrout ranged from 67 to 3,000 yards with a mean of 1,042 yards. [refer to Table 18 (Section 7)].

Seasonal Landings of Spotted Seatrout

Season closures are a potential management measure to alleviate user conflicts if they occur when the user conflicts happen. Many of the documented user conflicts in the spotted seatrout fishery occurred in the fall and winter so a season closure for either the commercial gill net or recreational spotted seatrout fishery during the fall/winter could alleviate some of the user conflicts. However the fishing groups would need to come to some agreement on which season or time period would be appropriate to separate the user groups.

The peak in number of commercial gill net trips that landed spotted seatrout occurred in October and November of most years (Figure 64). However peak spotted seatrout landings occurred in January, November, and December. This disparity between peak in trips and landings indicates that spotted seatrout are possibly a bycatch of the striped mullet gill net fishery in the fall/winter. In years when spotted seatrout are abundant, fishermen may switch from targeting striped mullet and having a bycatch of spotted seatrout in the fall to targeting primarily spotted seatrout in the winter (November through January). This change in target species requires slightly larger nets (in yardage and mesh size).

Recreational harvest of spotted seatrout generally occurs in the September/October and November/December waves (Figure 65). Information on the winter fishery for spotted seatrout (January/February) over the entire time series is only available since 2005 (the first year when wave 1 was sampled) and when the population size of age 1 to age 6 fish has been increasing. Recreational fishing effort has been increasing since 2005 (Figure 63) yet the number of trips during the January/February wave has remained relatively low compared to other waves (Figure 65). This indicates that recreational fishing effort is not increasing in the January/February wave as quickly as it has during other waves.

Day of Week Closure

Recreational fishing effort tends to increase on the weekends. This increase in effort increases conflicts with commercial fishermen who currently are allowed to fish gill nets on weekends. Closing gill net fishing on weekends could be considered to reduce conflicts. Commercial fishermen tend to land more pounds per day and fish more trips on weekdays than weekends although the differences are minor (Figure 66). In order to have a reciprocal closure for the recreational fishery, hook and line fishing would need to be closed during the week.

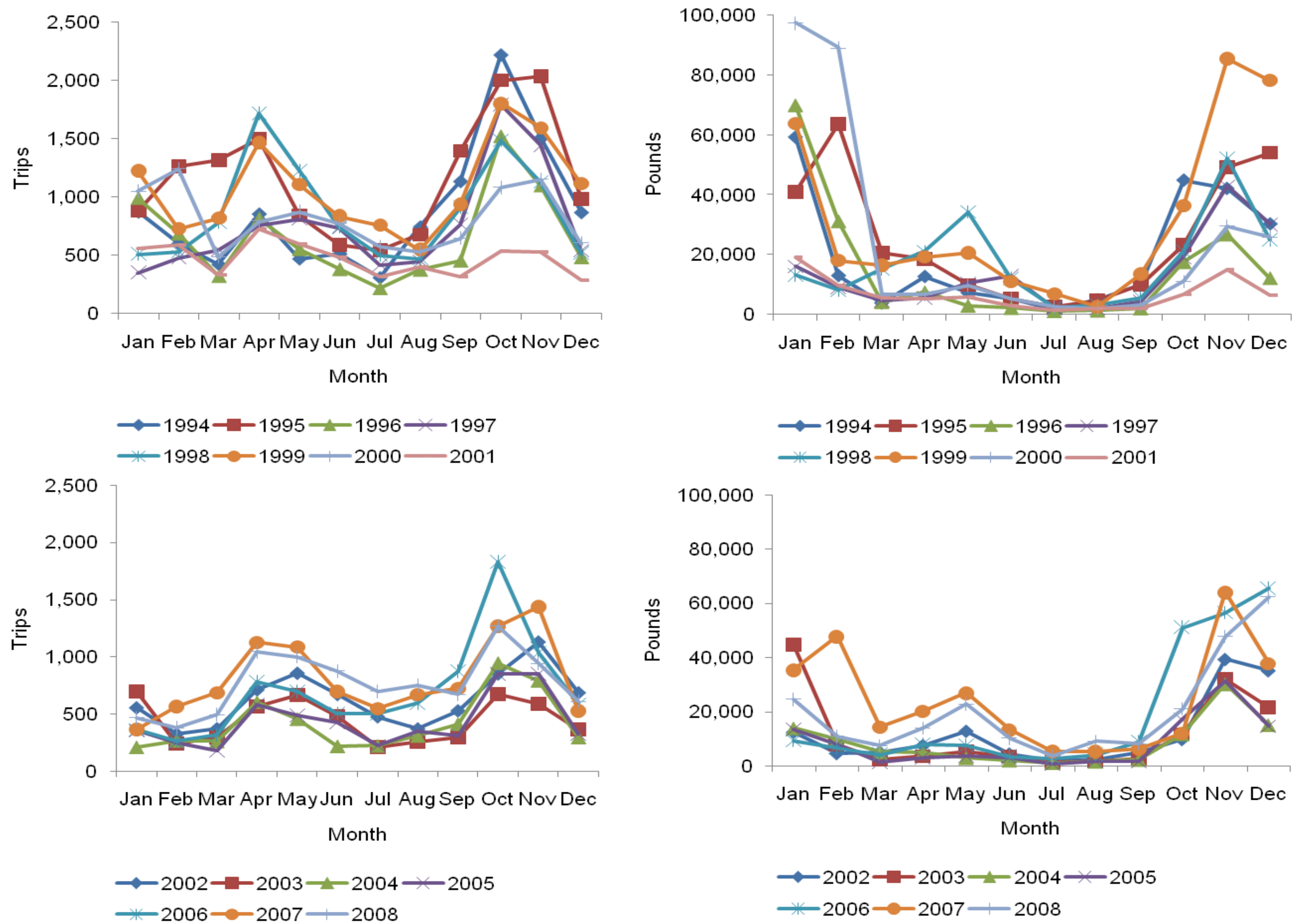


Figure 64. Trips landings spotted seatrout and landings of spotted seatrout from commercial gill net trips from 1994 to 2008.

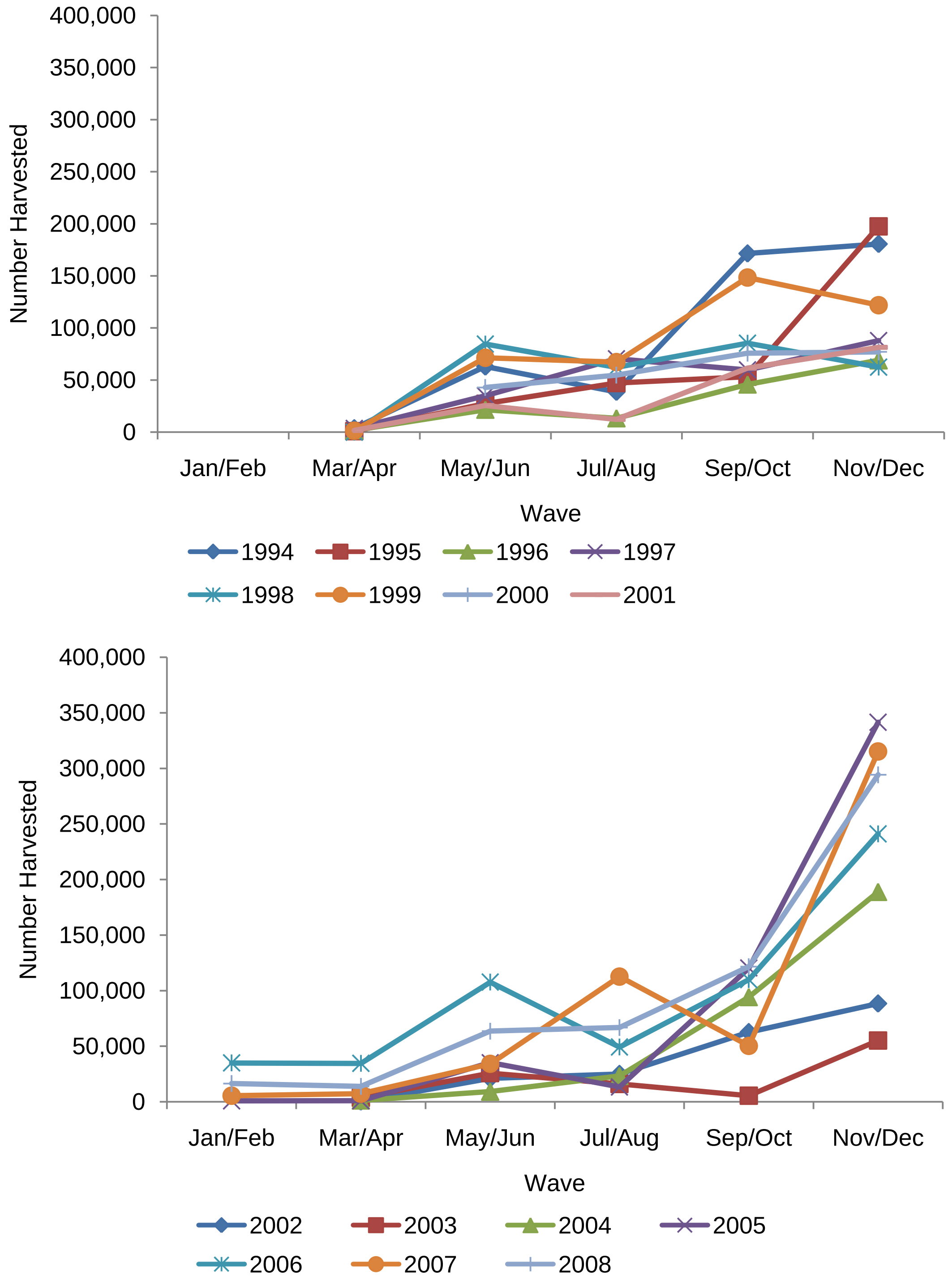


Figure 65. Number of spotted seatrout harvested in the recreational fishery that targeted or caught spotted seatrout by wave from 1994 to 2008.

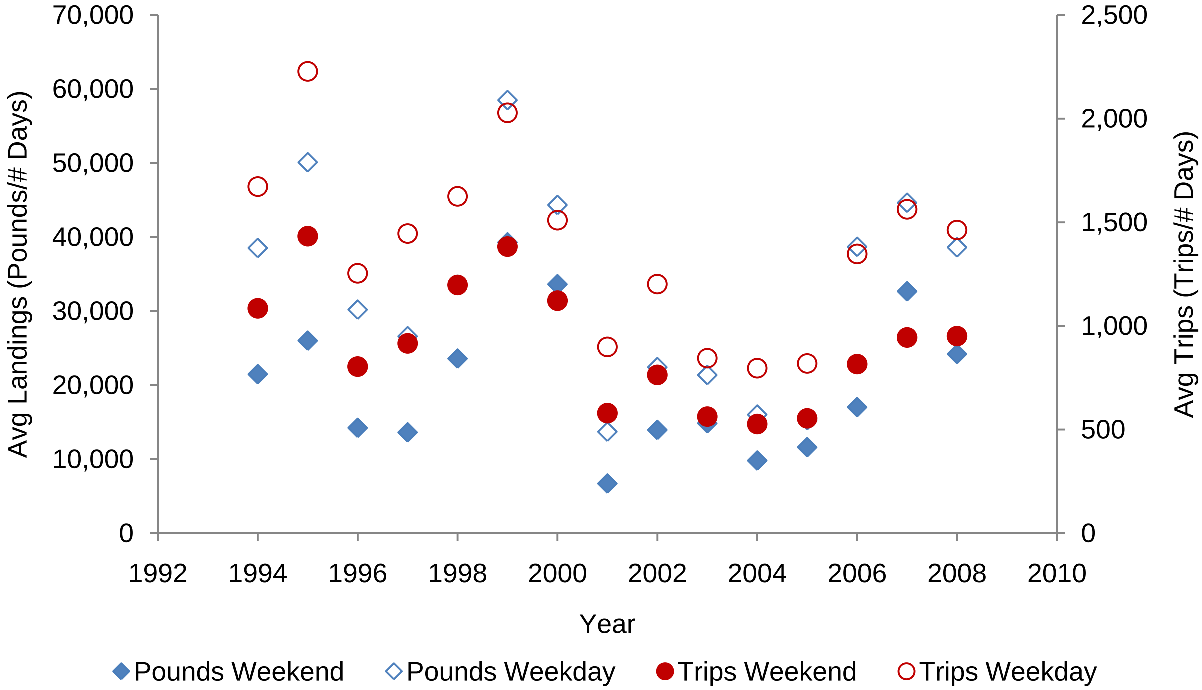


Figure 66. Average landings of spotted seatrout in gill net fisheries and average number of trips on weekend (fish landed on Saturday and Sunday) and weekdays.

Discussion

The previous sections described options to help make decisions for management measures to reduce competition and conflict in spotted seatrout fisheries. The General Assembly has charged the state conservation agencies to be stewards of marine and estuarine resources and to manage those resources for the benefit of the people of the state as a whole. During the development of theFRA the following was noted in regards to public trust: “Under the Public Trust Doctrine, all citizens have the right to use North Carolina's navigable waters for a variety of purposes, including fishing. As sovereign, the State is the owner and manager of the marine and estuarine resources that reside in North Carolina, and is vested with all necessary authority to regulate fishing practices in order to conserve and perpetuate those fisheries”. The North Carolina Marine Fisheries Commission (MFC) and North Carolina Division of Marine Fisheries (DMF) are specifically charged with conserving and protecting the State's coastal fishery resources. Such a charge includes the duty to appropriately control the use of fishing gears to minimize their adverse effects on fish stocks and fishery habitats, ensuring that coastal fisheries remain productive and viable for future generations. As sovereign, the State also has the responsibility to manage conflicts between citizens using its public waters and is vested with the general police power necessary to resolve such user conflicts. It was clearly recognized that it is within the State's responsibility and authority to control fishing gears in order to adequately conserve and manage North Carolina's marine and estuarine resources, and to resolve user competition/conflicts. However the DMF data collection methods were not designed to collect data on specific creeks but were designed to determine overall trends in the State’s resources. Therefore the management measures to reduce competition and conflict in the spotted seatrout fishery should be based on the expertise from the DMF, MFC, and advisory committees or from conversations with fishermen involved in the issue.

Status Quo

This management option does not address the conflict and competition between spotted seatrout recreational and gill net fishermen. Currently, the director has the authority to manage for spotted seatrout through size, seasons, areas, quantity, means and methods, and require submission of statistical and biological data. If the status quo option is selected by the advisory committees, then the DMF Director may be required to respond to complaints without input from spotted seatrout advisory committee or fishermen involved in the conflict.

Mediation

Conflict resolution has been and is required to be considered within fishery management plans. Several fishery management plans have addressed varying conflicts between user groups such as the blue crab, shrimp, and striped mullet fishery management plans. These plans considered several management measures to reduce conflicts between user groups but usually recommended managing conflicts on a case by case basis. One way to resolve such conflict issues is through the mediation process. Mediation is a process to develop a long lasting resolution for two or more parties that have differing goals through an independent party. In October 2004, the MFC adopted a Conflict Management Policy that 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.” Mediation can be used to select the most appropriate strategy to resolve conflict and competition among user groups on a case by case basis. Several basic strategies have been employed by the MFC and the DMF in the past to address user competition:

- Separate parties spatially (no trawl areas, designated crab pot areas)
- Separate parties temporally (no trawl on weekends, menhaden season)
- Restrict the amount or deployment of gear (net limits, attendance time periods)
- Combination of the three

In the evaluation of possible actions, consideration needs to be given to administration and enforcement needs as well as the likelihood of a proposed measure to successfully address the competition issue.

The Advisory Committees are being asked to consider whether the small mesh gill net and recreational fishing competition/conflict issue should be addressed through mediation. This process allows for flexibility in the outcome of the mediation which can result in unofficial resolutions or policy through DMF’s Directors Proclamation Authority or MFC rule.

Attached is the Standard Operational Manual for Mediation as adopted by the MFC in October of 2004.

Gear Restrictions

A cap on the maximum yardage for a small mesh gill net operation could match the 3,000 yard maximum length for large mesh gill net operation (<5” stretched mesh) and ideally would reduce conflicts between the gill net and recreational fishermen. However the current cap in the large mesh gill net fishery is larger than the maximum yardage observed for spotted seatrout trips in fishery dependent sampling program for most waterbodies.

Other options include restricting the continuous length of a net combined with a minimum distance between nets. This would allow recreational fishermen access to shore areas between nets similar to proclamation M-15-2008 which limits gill nets to a maximum length of 200 yards. Currently data collected by the DMF on gill net fisheries does not record how many nets are fished, waterbody designation where fish were caught (primary or secondary nursery areas), size of the waterbody where fish were caught, or the targeted species for a trip. The length of net fished is based on the total amount of yardage fished by mesh size as described by the boat's captain. Since many of the waterbodies with complaints are small creeks off larger waterbodies, it would be beneficial to gather information on the size of creeks and where in the creeks targeted spotted seatrout fisheries are operating. Finally determining a targeted spotted seatrout trip would be beneficial in accurately describing effort and gear parameters in the fishery. Some of the conflicts between gill net and recreational fishermen may be the result of recreational fishermen incorrectly identifying striped mullet fishermen as spotted seatrout fishermen.

Seasonal Closure

There is an overlap in the recreational and gill net fisheries for spotted seatrout based on landings data. The period with the greatest commercial effort occurred during October. However there is evidence that some of these trips were not targeting spotted seatrout. The recreational fishery has had the greatest number of trips in November and December. This peak in trips coincides with a peak in commercial landings. To reduce conflict between recreational and commercial fishermen trying to reduce interactions between recreational and commercial fishermen might have the greatest benefit if it is targeted during these two months.

Weekday/Weekend Closure

Separation of recreational and commercial fishermen could be achieved by reducing days of the week when the two user groups overlap. Commercial fishermen tend not to fish as many trips over the weekend which likely led to reduced landings over the weekend. Currently days of the week when recreational spotted seatrout fishermen effort and landings is highest is not known. Weather and personal conflicts may prevent some fishermen from fishing during the open period for the user group. Options for closing range from not allowing harvest during the closure period to closing waterbodies to gear types.

Most of the competition and conflict in the spotted seatrout has occurred during the fall and winter when storms are frequent. This may prevent some fishermen from being able to retrieve their gear under unsafe conditions. If the gear remains in the water and complaints are received, then NC Marine Patrol will be called upon to remove the gear during these same unsafe conditions.

Current Authority
15A NCAC 03J .0103
15A NCAC 03M .0512
15A NCAC 03R .0112

Management Options

1) Status Quo
   - \+ No impact to commercial or recreational fishermen.
   - \+ No new regulations or enforcement is needed.
   - − Conflict issues are not resolved.
   - − No reduction in harvest which will benefit the overfished stock.

2) Mediation for Specific Areas to Reduce Conflict Among Gill net and Recreational Fishermen
   - \+ Groups involved in competition assist in developing rules for area.
   - \+ Promotes a long-lasting cooperation among user groups.
   - \+ Rules can be designed to meet the needs of the local user groups involved in the conflict
   - − Conflict not resolved immediately.
   - − Only works if both parties are willing to comprise.
   - − May take a series of meeting to develop appropriate strategy.

3) Gear Restrictions
   - \+ Reduces the amount of gill net in water
   - \+ Potential to reduce harvest and enable stock to rebuild more quickly
   - \+ Could be designed based on current proclamation (200 yard limit) or rules (3,000 yard limit)
   - \+ Could eliminate discrepancies between small and large mesh gill net restrictions
   - \+ Potential to reduce dead discards of finfish such as red drum
   - − Competition may not be resolved immediately.
   - − Prevents increases in the length of gill nets fished
   - − Only has an impact on one user group in the conflict
   - − Gear restrictions could impact fisheries that are currently sustainable (striped mullet)

4) Season Closures
   - \+ Minimizes user conflicts by closing the commercial spotted seatrout fishery during months when user conflicts occur
   - \+ Can be applied statewide, which could prevent future user conflicts in other parts of the State
   - \+ Reduce the number of incidents of anglers damaging small mesh gill nets
   - \+ Potential to reduce dead discards of finfish such as red drum
   - \+ Reduces landings of spotted seatrout
   - − Increased enforcement responsibilities for Marine Patrol
   - − May have a significant impact on commercial and guide fisheries
   - − Would impact areas where no user conflicts occur
   - − Reductions are not quantifiable due to possible recoupment when season reopened

5) Weekday/Weekend Closures

- \+ Minimizes user conflicts by closing the commercial spotted seatrout fishery over the weekend and recreational fishery during the week
- \+ Can be applied statewide, which could prevent future user conflicts in other parts of the State
- \+ Reduce the amount of incidents of anglers damaging small mesh gill nets
- \+ Potential to reduce dead discards of finfish such as red drum
- \+ Reduces landings of spotted seatrout
- − Increases enforcement responsibilities for Marine Patrol
- − May have a significant impact on commercial and guide fisheries
- − Would impact areas where no user conflicts occur
- − Would punish individuals not involved in conflict if closures are enforced throughout the State
- − Need to increase public awareness of new regulations
- − Reductions are not quantifiable due to possible recoupment when fishing is allowed
- − Fishermen and NC Marine Patrol may be required to remove nets in unsafe conditions

Management Recommendations

SST AC: Move forward with the mediation process to resolve conflict between spotted seatrout fishermen as the "least odiferous" option.
DMF: Move forward with the mediation policy process to resolve conflict between spotted seatrout fishermen.
MFC Selected Management Strategy: Move forward with the mediation policy process to resolve conflict between spotted seatrout fishermen.

Research Needs

1. Distribution of spotted seatrout in nursery and non-nursery areas.
2. Survey of fishing effort in creeks with complaints.
3. Determine targeted species in nursery areas and creeks with complaints.
4. Survey commercial and recreational fishermen in the spotted seatrout fishery to determine the extent and specific areas of conflict.
5. Development of public education materials to improve understandings of gill net markings and avoidance.

10.2.5 Impacts of Cold Stun Events on the Population

(sections of this Issue Paper have been updated since the AC meeting on 1/7/10)

Issue

Periodic increases in mortality associated with cold stun events can have a considerable negative impact on spotted seatrout population size. Should information and quantification of cold stun events be considered for incorporation into fisheries models and/or management decisions?

Background

Spotted seatrout natural mortality accounted for a greater portion of the total mortality than fishing mortality throughout the range of spotted seatrout in the early 1980s (Mercer 1984). However, over the period of the North Carolina spotted seatrout assessment, fishing mortality has accounted for a larger portion of total mortality spotted seatrout experience (see Appendix 4). Natural mortality for spotted seatrout, which includes predation, starvation, disease, and other natural causes, is an estimated value that was based on the Lorenzen weight specific mortality model scaled to the maximum age of spotted seatrout (12 years). Although many environmental factors can impact the mortality of spotted seatrout, cold shock or winter-kill has been the most catastrophic (Merriner 1980). Due to the random nature of the cold shock events, these sources mortality are rarely included in the natural mortality estimate and should be included with caution.

The phenomenon we refer to in this paper as "cold stun events" may also be referred to in the literature as winter shock, cold shock, winter kill, winter mortality, and thermal shock. Cold shock can be defined as an acute decrease in ambient temperature that has the potential to cause a rapid reduction in body temperature, resulting in a cascade of physiological and behavioral responses (Donaldson et al. 2008). There is usually only one kill per season in a particular area since once driven into deeper water the fish stay there for the remainder of the winter (Tabb 1958).

The death of large numbers of trout following severe cold spells has been documented by several authors including: Smith (1907), Hildebrand and Cable (1930), Storey and Gudger (1936), Gunter (1941), Gunter and Hildebrand (1951), Tabb (1958), Tabb and Manning (1961), Wells (1961), Moore (1976), Holt and Holt (1983), and McEachron et al. (1994). These winter shocks of juveniles and adults have been cited as a primary factor in local and coastwide declines in spotted seatrout (Merriner 1980). Mass mortalities of spotted seatrout in North Carolina have also been attributed to the episodic occurrence of extreme low temperatures. A review of the landings and associated winter temperatures suggest winter freeze substantially reduced the North Carolina spotted seatrout population in those years. Wenner identified five years within the period 1981-2004 when low water temperature conditions would have been likely to result in mortality in South Carolina:1981, 1984, 1988, 1990 and 2001 (de Silva Draft). The South Texas Coast is known for its "Texas northers" which have been well documented in 1856, 1868, 1879, 1917, 1930, 1940, 1942, 1951, and 1982. The event described in 1951 was catastrophic with an estimated 60-90 million pounds of fish killed. Simmons and Breuer (1962) stated that periodic freezes in Texas, which occur about every 10 years, have destroyed more fish than had been harvested commercially for the previous 50 years.

Observations indicate that the amount of destruction caused by cold stun events depends on several things beside the low temperature attained (Gunter 1951). The physiographic features of the Texas Coast and the quick onset of the northers explain to some extent the prevalence of fish kills in this region. The shallowness of Texas bay waters, their practically landlocked condition and the rapidity with which cold northers strike the coast are factors making the marine life of this area particularly subject to mortality from cold waves every few years (Gunter 1951). It seems that if the damaging cold waves are preceded by other freezes, their destructive effect is lessened. Some animals escape to deeper water if the onset of the cold wave is slow and the rapidity with which the northers strike is a factor influencing the amount of mortality (Gunter 1951).

The scenario for North Carolina's cold stun events are quite similar to those described in Texas.

North Carolina has relatively mild winters but abrupt cold fronts periodically cause drastic changes in temperature. North Carolina's bays and tributaries are shallow, and when they suddenly freeze, spotted seatrout do not have the ability to escape to deeper warmer waters, are trapped, and succumb to the cold water temperatures. The North Carolina coastline is less landlocked than that of Texas, which probably allows for more escapement of spotted seatrout through the inlets to the nearshore ocean waters.

Natural occurrences of cold shock are thought to be quite common, yet there are relatively few examples of these events that have been described in the literature (Donaldson et al. 2008). It is likely that cold stun events are confined to small areas, but more extreme coastwide events have occurred. It would be useful to quantify these mortality events, and given the intensity of the mortality event, regulatory actions may become necessary.

Lethal Temperature

Water temperature has been described as the 'abiotic master factor' for fishes (Brett, 1971). Acute cold temperature is a stressor that has consequences for fish at all biological levels (i.e. cellular to population level effects) (Donaldson et al. 2008). Gunter (1945) noted that "the destructiveness of cold waves depended upon the rapidity of the temperature drop more than upon the low attained" and impacts vary substantially depending on rapidity of temperature drop, severity and duration of cold, and physiographic characteristics of the affected area (McEachron et al. 1994).

Temperatures below 39 °F (4 °C) appear to be lethal for spotted seatrout, although mortalities may occur at higher temperatures (< 45 °F or 7°C) if a temperature decrease to this level is abrupt or persists (Moore 1976, Storey and Grudger 1936; Gunter and Hildebrand 1951; Tabb 1958; de Silva Draft).

North Carolina water temperature data infers a critical temperature for spotted seatrout to occur when water temperatures are below 36 °F (2 °C). Water temperature data was provided by North Carolina Division of Water Quality (DWQ) from a station (#O982500) located at the mouth of the Pamlico and Pungo rivers, western Pamlico Sound. Although the data was from just one location and may not be representative of the lowest water temperature reached, it does give us a consistent index over time. With the exception of 1995, water temperatures were recorded at this site annually from 1989 to 2008. Estimates of population number (Jensen 2009, Appendix 4) were plotted with the lowest temperature recorded each year from 1991 through 2008 (Figure 67). Although water temperature data was not documented in 1995, many clearly recall a major freeze event in 1995, and estimates of the number of spotted seatrout in the population were below 3 million fish in 1995. The lowest temperature recorded in the time series occurred in 2003 (33.8°F or 1°C), and temperatures near this low occurred in 2000 (35.6°F or 2°C) and 2001 (35.4°F or 1.9 °C), with consecutive cold stun events reported in 2000, 2001 and 2003. Estimates of the number of spotted seatrout in the population remained below 3 million fish during 1999 through 2003. Temperatures reached 36.9 °F (2.7 °C) in 2005 but did not result in a widespread cold stun event, and population numbers were highest in the time series from 2005 through 2008.

Similar lethal temperatures have been documented for other Sciaenid species. Atlantic croakers remained intolerant of temperatures of 3°C (37 °F) or less even when these temperatures were approached gradually (Lankford 2001). Cold tolerance was described for red drum in Texas; mortality began when temperature reached 5°C (41 °F) (Saillant et al. 2007).

Although winter temperatures of the inshore waters of North Carolina frequently go below this lethal limit, winter trout kills do not occur every year in the state. Acclimation and migration (to deeper estuarine waters or offshore ocean waters) likely permit spotted seatrout to routinely deal with temperature stress. In the relatively high salinity waters of Pamlico Sound, spotted seatrout are known to lie in the shallow waters of mud-flats during the day seeming to take advantage of the warmer waters of the shallow waters (personal observation and communication with fishermen). However, when very rapid temperature drops occur, trout in shallow creeks may become trapped and unable to acclimate to the sudden fall in temperature. Climate change and its resulting warmer average winters may reduce the frequency of episodic cold stun events in some species, as has been observed for spotted seatrout in North Carolina and Texas (Hurst 2007).

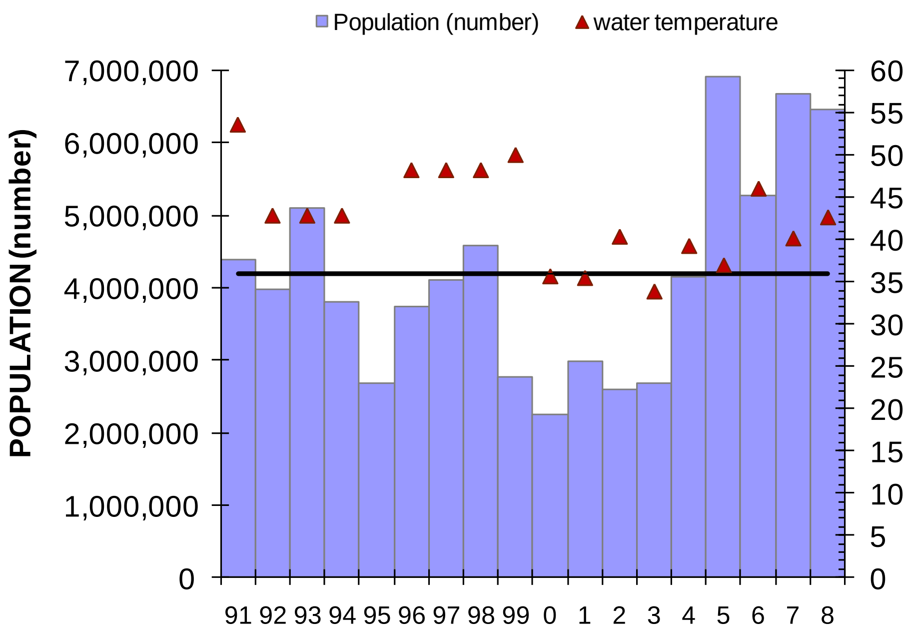


Figure 67. Population estimates of spotted seatrout (Jensen 2009, Appendix 4) and water temperature data from DWQ station #O982500, located at the mouth of Pamlico and Pungo Rivers, Pamlico Sound, 1991-2008.

Salinity

Estuarine residency presents an interesting set of circumstances for overwintering fish in North Carolina where spotted seatrout can be found overwintering in high and low salinity waters. These salinity gradients present different challenges for spotted seatrout surviving a cold stun event. The lack of a density maximum of salt water allows the entire water column to cool uniformly, and bottom waters can reach temperatures as low as -1.5° C (29 °F) when wind aids in mixing the water column (Koutitonsky and Bugden, 1991). Therefore, coastal marine fishes are often exposed to freezing temperatures.

It is important to recognize that in addition to the salinity gradient through the estuary, there is often a corresponding temperature gradient, and the combination of salinity and temperature gradients through the estuary may present a trade-off between factors beneficial to survival. The rate of temperature reduction and salinity concentration probably both influence the tolerance of seatrout to low temperature (Overstreet 1974, 1983). Studies have been conducted to determine the overall effect of salinity and temperature with varying results for estuarine fishes. It has been speculated that intermediate salinities near iso-osmotic to the blood of fishes should offer the greatest chance for survival by alleviating osmotic stress (Allanson et al., 1971). There seems to be more tolerance to cold stun mortality in higher salinity waters: Overstreet (1974) reported that the most stress occurs in low saline water where the low temperatures likely lead to a breakdown in the fishes' ion-osmoregulatory mechanisms; Prentice (1989) reported higher mortality of young-of-the-year southern flounder, *Paralichthys lethostigma*, in freshwater than in saltwater; the ability of age-0 Atlantic croaker to survive low temperatures increased with increasing salinity (Lankford and Targett 2000); and larval Atlantic menhaden, *Brevoortia tyrannus*, suffered reduced cold tolerance under low-salinity conditions (Lewis 1965, 1966).

Latitudinal Patterns

North Carolina is near the northern limit of the range for spotted seatrout and individuals here are more likely to encounter life-threatening winter conditions. The most widely held belief is that winter mortality will be most severe near the northern limits of a species' distribution. The threat of winter mortality has been indicated to play a dominant role in the evolution of growth rates (Conover, 1992), age at maturity (Fox and Keast, 1991) and spawning times (Conover, 1992; Trexler et al.,1992), and may be basis for spotted seatrout to have fast growth rates, early age of maturity, and protracted spawning seasons throughout their range.

At lower, subtropical latitudes, winters are characterized by warmer average temperatures but are still subject to infrequent rapid cooling events. These events result in the well-documented winterkills of sub-tropical species in Florida and Texas (Hurst 2007). In these regions, the critical characteristic of winter is the unpredictability of extreme conditions. For example, spotted seatrout are common in near shore waters of the Chesapeake Bay to the Gulf of Mexico, but winterkills appear more common in Florida and Texas than in the Chesapeake Bay (Vanderkooy and Muller, 2003). In the northern part of the range, seasonal southward migrations and access to deeper offshore waters appear to protect fish from predictably harsh winter conditions.

Migration

Many marine fish migrate from the coastal zone to warmer offshore areas, while others avoid the stress of low temperatures by migrating to warmer waters at lower latitudes (Able and Fahay, 1998). Spotted seatrout are a prime example as they are known to migrate from the inshore estuarine waters to near shore ocean waters, as well as southerly from Virginia's Chesapeake Bay to North Carolina waters (J.Lucy, Virginia Institute of Marine Science, personal communication). While alleviating thermal stress, these migrations can incur significant energetic costs and may expose fish to new predator fields (Hurst 2007).

Effects of Body Size on Survival

Until recently, the idea that winter mortality, if selective, would select against smaller fish was almost universally accepted (Hurst 2007). Several authors have suggested that small fish would be more vulnerable to low temperature-induced osmotic stress than larger fish (Johnson and Evans, 1996), but a number of experiments have observed no size-based pattern of osmotic stress within cohorts. Although larger individuals generally resist starvation better than smaller individuals, they may be more vulnerable to acute thermal stress (Hildebrand and Cable

1930; Otwell and Merriner 1975; Shafland and Pestrak 1982; Prentice 1989; Lankford and Targett 2001). Observations in North Carolina and South Carolina (Wenner 2006) are that cold stun events affect all sizes of spotted seatrout and is not size selective.

Discussion

Population Level Effects

Despite the recognition that winterkill events of varying magnitude occur with moderate frequency, there has still been little coordinated research on the impact of these events on population dynamics (Hurst 2007). Early attempts to determine the effects of winterkills on fish populations involved estimating the numbers of fish killed (Storey and Gudger, 1936; Gunter, 1941; Moore, 1976). However, when winter mortality episodes occur in routinely assessed populations, the significance of these losses can be evaluated relative to stock size (Hurst 2007).

North Carolina's stock assessment illustrated the fact that cold stun events seem to have a large influence on spotted seatrout population dynamics. Cold stun events appeared as increases in fishing mortality in the model and it was not possible to quantify the increase in mortality associated with these events (Jensen 2009, Appendix 4). That is, fishing mortality rates during 1995, 1999, 2000, and 2002 were probably influenced by cold stuns and were not completely due to fishing. It should be noted that cold stun events that occurred in 2000, 2001, and 2003 are reflected as increases in fishing mortality the year prior to the event (Appendix 4, Figure 21). The effects of cold stun were also evident in depressed population abundance (Appendix 4, Figure 16), recruitment (Appendix 4, Figure 17) and spawning stock biomass (Appendix 4, Figure 18) that occurred in 1995 and remained depressed during the early 2000s. There have been no cold stun events since 2003, and spawning stock biomass (Appendix 4, Figure 18) appeared to be recovering at the end of the time series with strong recruitment years in 2005 and 2007-2008 (Appendix 4, Figure 17).

It is possible to build the relationship of environmental parameters into a stock-recruitment model; however, this was not possible for the "ASAP" model that was used in the North Carolina assessment and would require a customized model using software such as AD Model Builder in order to do this (Jensen 2009, Appendix 4).

The impact of cold stun events is a function of the severity of the decline as well as the population's response to such a decline. In North Carolina, cold stun event kills of adult spotted seatrout have generally resulted in increased population size within two to three years when the subsequent strong year-class enters the fishery (Figure 67; Appendix 4, Figure 17). Recovery time may be longer in the case of consecutive cold stun events such as post 2000, 2001 and 2003.

Quantification

Cold stun events likely have a notable impact on the spotted seatrout population, particularly in localized areas; but without quantification of the mortality event, it is not possible to quantify the increase in mortality associated with these events. To date, there have been no estimates of spotted seatrout cold stun mortality in North Carolina and what looks to be catastrophic by the numbers of dead fish may be small when examined at the population level. If possible, the quantification of the extent of such events, as well as age and size classes of fish affected, would be helpful in incorporating the data into stock assessments.

Validation
Verification of cold stun event episodes could be confirmed through a variety of existing data bases. Such events could be documented by water temperature records (DWQ), DMF staff and Pamlico River Rapid Response Team investigations, NC DMF fishery independent sampling programs, DMF fishery dependent sampling programs, NC DMF trip ticket landings data, and various anecdotal reports.

Water Temperature Data
The NC Division of Water Quality monitors water temperature at specific ambient monitoring stations (AMS) coastwide. Currently there are 340 active AMS stations, and the stations are located in all seventeen major river basins of the state, and in 95 of North Carolina's 100 counties (Figure 68). All data collected as part of the AMS over the last 30+ years are readily available online from the U.S. EPA's STORET database. The warehouse currently contains over 5 million AMS results, and approximately 100,000 new records are added annually. Unfortunately, this data is not available in “real time”, but would be available ~ 3-6 months after the date it was recorded.

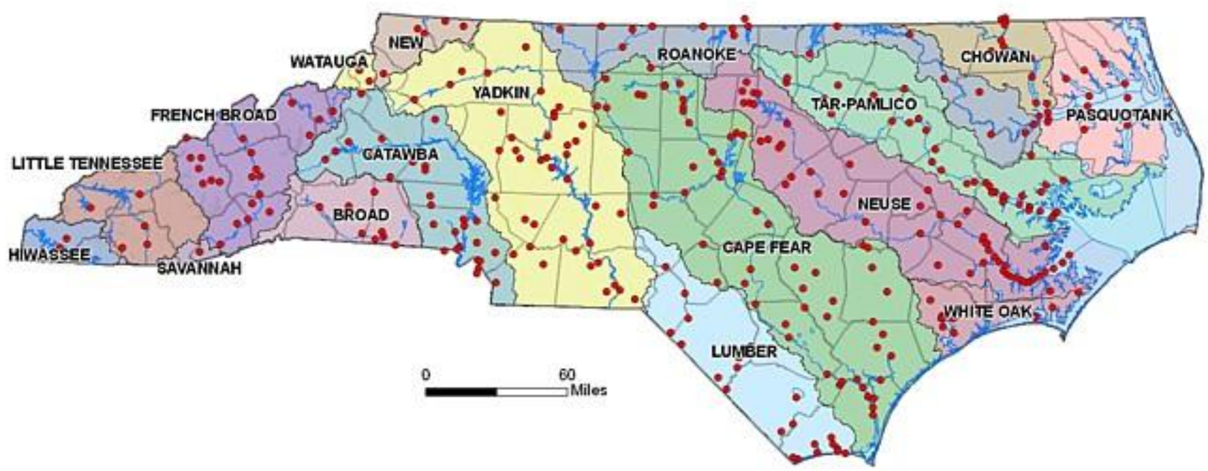


Figure 68. NC Division of Water Quality (DWQ) ambient monitoring stations.

Pamlico River Rapid Response Team, located in Washington, NC, is responsible for monitoring water quality conditions in the lower Pamlico River watershed. The team's primary charge is rapid evaluation of acute water quality related events like fish kills and algal blooms. During routine operations, the team performs regular monitoring duties along the river, collecting twice-monthly ambient water quality monitoring at long term sites and works collaboratively with other research agencies in monitoring field parameters. The DMF should work cooperatively with the Pamlico River Rapid Response Team in the detection, verification, and sampling of cold stun events should they occur.

Fishery Independent Data
(This section was changed post the AC meeting to allow additional years of data to be collected before values of the age specific CPUEs are presented).

The effect of a cold stun event on population size could be estimated in conjunction with fishery independent sampling data from before and after freezes. Determining an exact level of mortality that should be attributed to a cold stun will be difficult to estimate and likely varies spatially. Therefore an overall estimate of the total change in the population size or an abundance index may provide some insight into the overall impact of a cold stun event.

The DMF currently has an independent sampling program (program 915) in the Pamlico Sound and Pamlico, Neuse, New, and Cape Fear rivers that is designed to estimate relative abundance for many estuarine species. Program 915 uses mesh sizes from 3 up to 6 ½ inch stretched mesh and spotted seatrout are observed in the survey (255 spotted seatrout per year 2003-2008). Spotted seatrout peak retention in a 3 inch gill net has been estimated to be between 350 and 370 mm FL [fork length (Hesler et al. 1991, Hesler et al. 1998)]. Most of the spotted seatrout captured from 2003 to 2008 in this study have been 350 mm FL and larger (14.4%) and 370 mm FL and larger (27.8%). Additionally, most of the spotted seatrout aged from 2003 to 2008 collected in this study were 1 and 2 year old fish (87.7%).

An estimate of total mortality based on the changes in abundance between year classes of spotted seatrout can be developed for years when cold stuns occur and for years when cold stuns were not reported since this is a continuing survey with known age fish. The estimate for total mortality can be simply calculated by comparing the CPUE of recruits (age 1) to the CPUE of age 2 spotted seatrout the following year (Graham 1934, as presented in Hoenig and Gedamke 2007) or by comparing the CPUE of age 1 fish and older age classes to the following years CPUE of age 2 fish and older (Hoenig and Gedamke 2007). The equations are:

Total Mortality= $-\ln(S) = CPUE2_{t+1}/CPUE1_{t}$
or
Total Mortality= $-\ln(S) = CPUE2+_{t+1} / CPUE1+_{t+1}$

Where s is survivorship, CPUE2 is the CPUE of age 2 spotted seatrout, CPUE1 is the CPUE of age 1 spotted seatrout, t refers to a year, $CPUE2+_{t+1}$ is the CPUE of age 2 and older spotted seatrout, and $CPUE1+_{t+1}$ is the CPUE of age 1 and older spotted seatrout. The goal of this exercise would provide an estimate of total mortality when cold stuns were not reported. A separate estimate of mortality would be calculated for years when cold stuns have been reported. However due to the short time series 2003 to 2008 and limited in spatial coverage (New and Cape Fear rivers were added in 2008), the current data are not sufficient for determining an average value for mortality for spotted seatrout.

Given enough time, an average mortality for spotted seatrout could be able to be calculated and an estimate of cold stun mortality should be able to be calculated. There are several assumptions that are needed for this technique to work correctly. The relative catch rates of spotted seatrout in each gill net mesh size and migration in and out of the system needs to be consistent through time. Fishing mortality and fishing effort will need to be relatively stable and not change due to changes in fish abundance.

Fishery Dependent Data
Fishermen often remove a number of dead or dying fish during the freezes and many of these fish appear in commercial landings as fish landed by dip nets, trawls, gigs, and a variety of hand harvest gear, and can be accounted for there. As many fish as possible should be sampled that are harvested by these gear during the episode. These fish will be sampled for length, weight, and age information, as well as harvest gear types and location.

Cold Stun Event Protocol
The Division of Marine Fisheries (DMF) has recently developed a cold stun event protocol (January 2010). The protocol establishes a coast wide communication hierarchy so that information can be adequately relayed between all districts and to lead personnel. Information will be relayed within DMF (Marine Patrol, biologists, technicians, managers), and between DMF and the DWQ Rapid Response Team. The protocol also serves as a reference for appropriate data collection from each investigation.

Future Research
North Carolina State University is currently funded through the NC Marine Resources Fund to study the movement and mortality of spotted seatrout using a combination of conventional tag and telemetry work. An objective of the work is to provide precise estimates of natural mortality during winter months, as well as information on winter movement in response to temperature stress. The work may provide precise estimates of mortality attributed to winter kills; a critical component to an accurate stock assessment of the species in North Carolina.

Management Options/Considerations
Despite evidence that winter mortality can influence population dynamics, these effects have rarely been incorporated into fisheries models or management decisions (North Sea sole and Texas spotted seatrout being notable exceptions) (Hurst 2007). Periodic increases in mortality associated with cold stuns should be considered when implementing management measures as they are likely to continue to occur on a periodic basis and are largely unpredictable. Once it has been verified that an extensive cold stun episode has occurred, effective control of fishing effort following a severe cold stun event can be an integral part of any management strategy. Managers may respond by reducing subsequent fishing mortality through reduced bag and possession limits, increased size limits, gear restrictions, and closed areas immediately following a large-scale kill. The strategy is to reduce fishing mortality on spawning stock adult fish to allow many of them to spawn (McEachron et al. 1994).

Managers might also consider the development of a public awareness program on the need to follow the regulations following a substantial cold stun event, emphasizing the important role in helping in rebuilding the stock after such an event. For example, after a cold stun event, the incidence of undersized fish being kept may increase and needs to be discouraged.

Current Authority

Management Options

If and when a catastrophic cold stun event has been known to occur, the event will be documented through sampling (if possible), and verification of the extreme cold temperatures can be determined through the DWQ Ambient Temperature Site, as well as Pamlico Sound Rapid Response Team.

1) *Status quo*. No change in present situation.
   + no change in proclamation or rule
   - continued mortality of spotted seatrout
   - possibly longer time for population to recover from impact of cold stun
   - population is more susceptible to overfishing if fishing effort does not shift away from spotted seatrout
   - difficult to quantify

2) Give the sustainable harvest options (14 inch minimum size, 6 fish bag limit, and 150 lbs trip limit) an opportunity to work in rebuilding the stock to 20% SPR so that SSB is large enough to recover more easily from cold stun events.
   + population should recover faster, providing more fishing opportunities in shorter time span.
   + less likely the population will experience overfishing.
   - more responsibilities for DMF Marine Patrol in terms of enforcement area and regulations

3) Limit harvest through quotas/caps.
   + partial decrease in the harvest mortality of spotted seatrout
   - more responsibilities for DMF Marine Patrol in terms of enforcement area and regulations
   - difficult to quantify

4) Limit harvest through increased minimum size limits.
   + partial decrease in the harvest mortality of spotted seatrout
   - partial increase in the number of discards
   - more responsibilities for DMF Marine Patrol in terms of enforcement area and regulations
   - difficult to quantify

5) Limit harvest through decreased harvest limits (bag limits, trip limits).
   + partial decrease in the harvest mortality of spotted seatrout
   - more responsibilities for DMF Marine Patrol in terms of enforcement area and regulations
   - difficult to quantify

6) Close the spotted seatrout fishery immediately
   + total decrease in the harvest mortality of spotted seatrout
   - enforcement would be difficult and maybe impossible
   - lost fishing opportunities for both commercial and recreational fishermen
   - potential increase in the number of discards
   - difficult to quantify

Management Recommendations

SST AC: Management options to remain status quo with the assumption that the Director will intervene in the event of a catastrophic event and do what is necessary in terms of temporary closures by waterbody, but the Director's proclamation needs to be an informed decision based on quantifiable data and the outcome needs to be quantified

post the closure. More extensive research on cold stun events.
DMF : If a cold stun occurs in 4 counties or more, then the spotted seatrout will close until June 15th.
MFC : Management options to remain status quo with the assumption that the Director will intervene in the event of a catastrophic event and do what is necessary in terms of temporary closures by waterbody. More extensive research on cold stun events.

Research Recommendations

1. Obtain samples (length, age, weight, quantification) of the cold stun events as they occur.
2. Incorporate cold stun event information into the modeling of the population.
3. Define overwintering habitat requirements of spotted seatrout.
4. Determine factors that are most likely to influence the severity of cold stun events in North Carolina. Factors should be separated into low and high salinity areas.
5. Estimate or develop a model to predict the impact of cold stun events on local and statewide spotted seatrout abundances.

10.2.6 Bycatch in the Flounder, Striped Mullet and Spot Directed Fisheries

Issue

Spotted seatrout are a bycatch in a number of fisheries directing on other species. This paper investigates the bycatch of spotted seatrout in the southern flounder, spot and striped mullet fisheries in order to understand the impact regulations imposed by the spotted seatrout Fishery Management Plan (FMP) may have on those fisheries.

Background

Spotted seatrout have traditionally been harvested as bycatch in fisheries targeting other sciaenid species (red drum, weakfish, Atlantic croaker, spot), and in the striped mullet, bluefish and southern flounder fisheries. A small directed fishery for spotted seatrout exists during the fall and winter in years when the stock is abundant (refer to the Commercial Fishery Section 7.1). Given its status as a mostly bycatch fishery, no commercial fishermen in North Carolina rely primarily on spotted seatrout to make a living; these fishermen are instead mostly southern flounder and striped mullet fishermen who land the occasional spotted seatrout in their nets (refer to the Socioeconomic Section, 8.1, Table 54).

Spotted seatrout are harvested throughout the year with a large peak in the fall/winter (October – February), and a small peak in the spring (April – May). Estuarine gill nets are by far the predominant commercial gear used to harvest spotted seatrout (refer to the Commercial Fishery Section 7.1.4.1.1).

The targeted species on a gill net trip must be inferred from the catch composition to be able to place a trip into a fishery. For this purposes of this issue paper, trips were identified that specifically targeted southern flounder, spot, striped mullet and spotted seatrout. Trips were defined through the analysis of trip ticket data for the most recent years, 2006-2008. If the species composition of a trip consisted of 50% or more of one of these species, then the trip was considered to be a targeted trip for that species. Because fishermen may target both striped mullet and spotted seatrout on the same trip, dual species trips were also considered. That is, when spotted seatrout and striped mullet constituted at least 60% of a trip, and each one constituted at least 30% of that trip, then that trip was considered to be a dual targeting trip. In the Commercial Bycatch Section 9.1, data collected from 2001 to 2008 was analyzed to determine the target species for each individual trip made. For each of the target fisheries defined, information specific to mesh sizes used, yards of net fished, soak times and depths fished were described (refer to the Commercial Bycatch Section 9.1.3.1, Table 17 and Table 18). Available information was also separated by region, and monthly landings by region for each of the target species were also provided (refer to the Commercial Bycatch Section 9.1.3.1, Figure 26 and Figure 27).

Discussion

Southern Flounder Targeted Trips

Southern flounder is the primary species targeted by gill netters in estuarine waters of North Carolina based on number of trips (Commercial Bycatch Section 9.1, Table 15 and Table 16). According to the socioeconomic data, 51.8% of those fishermen who land flounder also land spotted seatrout (refer to the Socioeconomic Section, 8.1, Table 54).

From 2006 to 2008, landings of southern flounder and the number of trips targeting southern flounder were greater than 1,000 trips from May through October and peaked in October (Table 73, Figure 69). Landings of spotted seatrout in the southern flounder targeted trips were also highest from May through October, but the total poundage of spotted seatrout landed is not very large in comparison. Annual landings of spotted seatrout from trips targeting southern flounder ranged from 13,085 to 14,124 pounds. The relative composition of spotted seatrout averaged only 4% of the total pounds landed by those trips (Table 73 and Table 74).

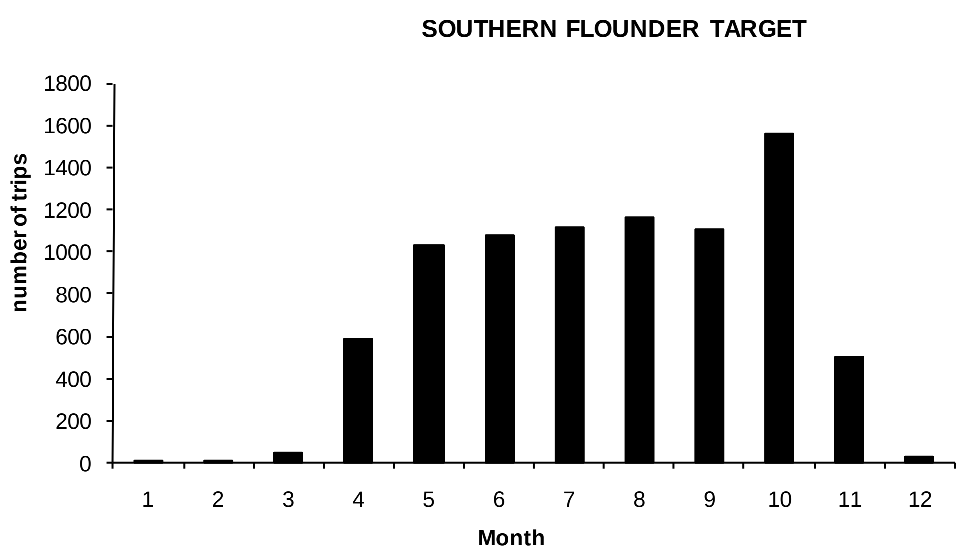


Figure 69. The number of trips that targeted southern flounder (southern flounder comprised 50% or greater of the catch composition), by month, 2006-2008 combined.

Table 73. Commercial landings of southern flounder and spotted seatrout in trips that targeted southern flounder (50% or greater of the catch was southern flounder), by month, and the percent composition of spotted seatrout (%SST) in those trips, 2006-2008 landings combined.

	LANDINGS (lbs)				
Month	Southern Flounder	Spotted Seatrout	Other	ALL	% SST
Jan	1,095	73	345	1,513	5
Feb	75	15	33	123	12
Mar	2,409	330	958	3,697	9
Apr	39,891	3,490	9,865	53,246	7
May	67,456	6,668	17,271	91,394	7
Jun	75,119	5,368	15,486	95,974	6
Jul	88,339	4,159	15,493	107,990	4
Aug	92,469	4,164	19,193	115,826	4
Sep	110,092	4,713	30,562	145,367	3
Oct	195,094	7,850	55,006	257,950	3
Nov	55,406	3,533	14,217	73,156	5
Dec	2,613	121	409	3,142	4
ALL	730,057	40,484	178,837	949,378	4

Table 74. Commercial landings of flounder and spotted seatrout in trips that targeted southern flounder (50% or greater of the catch was flounder), and the percent composition of spotted seatrout (%SST) in those trips, annually, 2006-2008.

	LANDINGS (lbs)				
Year	Southern Flounder	Spotted Seatrout	Other	ALL	% SST
2006	264,207	14,125	62,213	340,545	4
2007	207,516	13,085	55,731	276,332	5
2008	258,334	13,273	60,894	332,501	4
ALL	730,057	40,483	178,838	949,378	5

Spot Targeted Trips

According to the socioeconomic data, of those fishermen who land spot, 22.2% also land spotted seatrout (refer to the Socioeconomic Section, 8.1, Table 8.6). Spot were the fourth highest species landed in estuarine gill nets from 2004 to 2006 (DMF 2007b). The gill net fishery for spot occurs primarily during the fall months, with trips and landings peaking during the month of October (Figure 70, Table 75).

From 2006 to 2008, landings of spotted seatrout in the trips targeting spot were also highest in

October, but the total poundage of spotted seatrout landed is small. The total weight of spotted seatrout in trips targeting spot ranged from 3,914 pounds to 7,874 pounds annually. The relative composition of seatrout averaged only 4% of the total pounds of fish landed in trips targeting spot (Table 75 and Table 76).

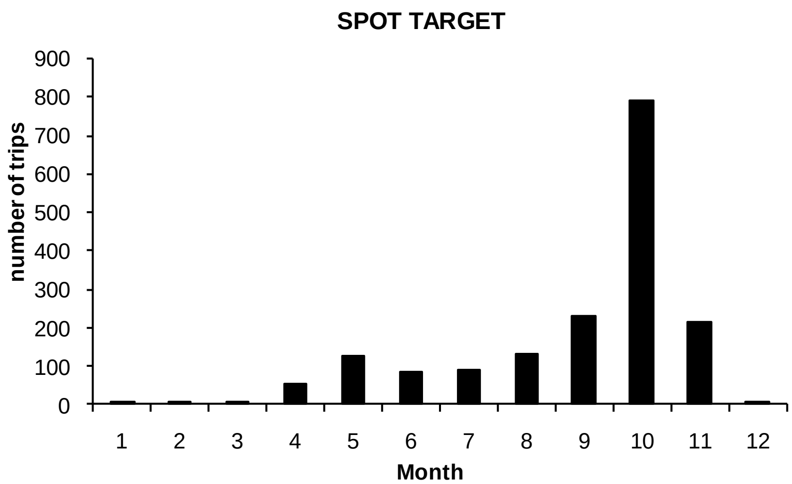


Figure 70. The number of trips that targeted spot (spot comprised 50% or greater of the catch composition), by month, 2006-2008 combined.

Table 75. Commercial landings of spot and spotted seatrout in trips that targeted spot (50% or greater of the catch was spot), by month, and the percent composition of spotted seatrout (%SST) in those trips, 2006-2008 landings combined.

	LANDINGS (lbs)				
Month	Spot	Spotted Seatrout	Other	ALL	% SST
Jan	477	62	30	569	1
Feb	630	115	233	978	12
Mar	292	61	114	466	13
Apr	4,638	370	2,345	7,353	5
May	22,226	1,703	8,432	32,362	5
Jun	17,284	642	3,018	20,944	3
Jul	8,479	713	3,192	12,384	6
Aug	23,777	1,680	9,453	34,910	5
Sep	33,048	2,078	8,888	44,014	5
Oct	204,204	8,630	32,215	245,049	4
Nov	56,407	2,079	9,178	67,664	3
Dec	1,103	62	111	1,276	5
ALL	372,563	18,195	77,209	467,967	4

Table 76. Commercial landings of spot and spotted seatrout in trips that targeted spot (50% or greater of the catch was spot), and the percent composition of spotted seatrout (%SST) in those trips, annually, 2006-2008.

	LANDINGS (lbs)				
Year	Spot	Spotted Seatrout	Other	ALL	% SST
2006	181,186	7,874	31,053	220,113	4
2007	87,839	3,914	19,686	111,438	4
2008	103,539	6,407	26,470	136,416	5
ALL	372,563	18,195	77,209	467,967	4

Striped Mullet Targeted Trips

According to the socioeconomic data, of those fishermen who land striped mullet, 21.6% also landed spotted seatrout (refer to the Socioeconomic Section, 8.1, Table 54). From 2004-2006, striped mullet was the second highest finfish species landed in all estuarine gill nets and comprised 21–24% of the overall estuarine gill net landings by weight in the entire state (DMF 2007d).

The striped mullet fishery takes place year round, but the number of trips and landings peak during October and November (Figure 71, Table 77). Landings of spotted seatrout in striped mullet directed trips also peak in October and November.

From 2006 to 2008, landings of spotted seatrout in the trips targeting striped mullet ranged from 15,896 to 21,713 pounds annually. The relative composition of spotted seatrout averaged only 4% of the total pounds of fish landed in trips targeting striped mullet (Table 77 and Table 78). The relative abundance of spotted seatrout in the striped mullet targeted trips is highest during the months of December through February (9-10%) as landings of striped mullet decline (Table 77).

Spotted Seatrout Targeted Trips

No commercial fishermen in North Carolina rely primarily on spotted seatrout to make a living (refer to the Socioeconomic Section, 8.1), but some rely on spotted seatrout during the winter season. From 2004 to 2006, spotted seatrout contributed 1.4-3.7% to the annual estuarine gill net landings and were the ninth highest species landed in estuarine gill nets (DMF 2007b).

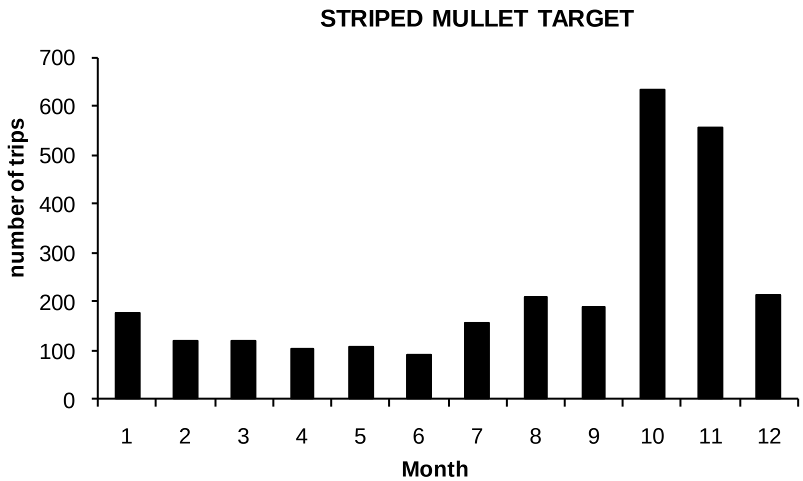


Figure 71. The number of trips that targeted striped mullet (striped mullet comprised 50% or greater of the catch composition), by month, 2006-2008 combined.

Table 77. Commercial landings of striped mullet and spotted seatrout in trips that targeted striped mullet (50% or greater of the catch was striped mullet), by month, and the percent composition of spotted seatrout (%SST), 2006-2008 landings combined.

	LANDINGS (lbs)				
Month	Striped Mullet	Spotted Seatrout	Other	ALL	% SST
Jan	56,452	4,911	4,809	66,172	9
Feb	31,595	3,345	2,871	37,811	9
Mar	21,392	1,593	2,664	25,648	6
Apr	26,864	1,078	3,568	31,511	3
May	28,529	822	3,144	32,494	3
Jun	25,210	711	2,301	28,221	3
Jul	69,370	1,003	5,233	75,606	1
Aug	80,425	1,396	6,895	88,716	2
Sep	90,686	2,391	8,077	101,153	2
Oct	505,495	14,695	17,893	538,084	3
Nov	322,708	15,017	15,567	353,292	4
Dec	62,289	7,586	4,531	74,406	10
ALL	1,321,015	54,548	77,551	1,453,114	4

Table 78. Commercial landings of spotted seatrout in trips that targeted striped mullet (50% or greater of the catch was striped mullet), and the percent composition of spotted seatrout (%SST) in those trips, annually, 2006-2008.

	LANDINGS (lbs)				
Year	Striped Mullet	Spotted Seatrout	Other	ALL	% SST
2006	550,965	21,713	28,020	600,698	4
2007	341,216	16,939	23,416	381,571	4
2008	428,834	15,896	26,116	470,845	3
ALL	1,321,015	54,548	77,551	1,453,114	4

The spotted seatrout fishery takes place year round, but the number of trips and landings peak during November and December (937-973 trips), followed by January and February (Figure 72, Table 79).

From 2006 to 2008, landings of spotted seatrout in trips targeting spotted seatrout ranged from 253,311 to 1,030,313 pounds annually, and their relative abundance averaged 86% of the total pounds landed in those trips (Table 81). The relative abundance of spotted seatrout in the trips that targeted spotted seatrout is highest during the months of November through February (83-87%), and lowest in August and September (64-67%) as landings of spotted seatrout decline Table 79).

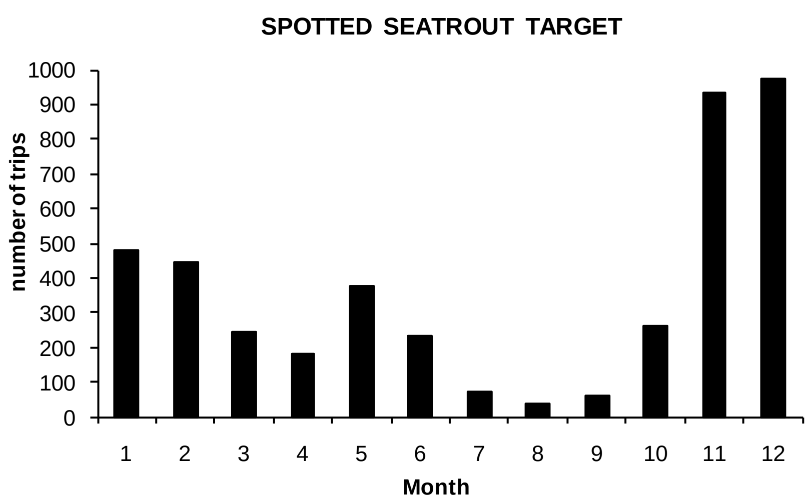


Figure 72. The number of trips that targeted spotted seatrout (spotted seatrout comprised 50% or greater of the catch composition), by month, 2006-2008 combined.

Table 79. Commercial landings of striped mullet and spotted seatrout in trips that targeted spotted seatrout (50% or greater of the catch was spotted seatrout), by month, and the percent composition of spotted seatrout (%SST), 2006-2008 landings combined.

	LANDINGS (lbs)			
Month	Spotted Seatrout	Other	ALL	% SST
Jan	57,103	8,416	65,519	87
Feb	52,685	11,089	63,773	83
Mar	13,609	4,660	18,269	74
Apr	14,480	4,731	19,212	75
May	30,913	7,439	38,352	81
Jun	12,965	3,858	16,823	77
Jul	2,912	1,230	4,142	70
Aug	4,000	2,258	6,258	64
Sep	5,298	2,575	7,873	67
Oct	35,771	8,271	44,042	81
Nov	121,344	22,299	143,643	84
Dec	149,327	21,626	170,953	87
ALL	500,407	98,451	598,857	84

Table 80. Commercial landings of spotted seatrout in trips that targeted spotted seatrout (50% or greater of the catch was spotted seatrout), and the percent composition of spotted seatrout (%SST) in those trips, annually, 2006-2008.

Year	Spotted Seatrout	Other	ALL	% SST
2006	253,311	41,664	294,975	86
2007	506,331	83,195	589,526	86
2008	1,030,313	168,784	1,199,097	86
ALL	1,789,956	293,643	2,083,598	86

Spotted Seatrout and Striped Mullet Dual Targeted Trips

During the winter months in years when spotted seatrout are most abundant, it is common for fishermen to make trips that are directed towards both spotted seatrout and striped mullet. In order to best characterize these dual targeted trips, trip ticket data was analyzed by including only those trips when spotted seatrout and striped mullet constituted at least 60% of a trip, and each species constituted at least 30% of that trip.

From 2006 to 2008, the number of dual targeted trips peaked during the month of November (Figure 73), followed by December, with parallel trends in landings of spotted seatrout and striped mullet (Table 81). The relative abundance of spotted seatrout in the catches ranged from 38% to 42% and averaged 39% (Table 81 and Table 82). In the catches identified as dual targeted trips, landings of spotted seatrout and striped mullet were quite similar (Table 81 and Table 82).

The peak month for trips targeting striped mullet is October (632 trips; Figure 71), while the peak month for trips that target spotted seatrout/striped mullet is November (83 trips; Figure 73). The spotted seatrout target fishery peaks in October and November (937-973 trips; Figure 72). It is difficult to be able to utilize the trip ticket data alone to formulate conclusions as to whether the striped mullet are being targeted on the same trip or whether striped mullet and spotted seatrout are being caught in the same trip because they inhabit the same areas.

These dual targeted trips are the types of trip that have been in the center of many of the conflicts over fishing areas in years when spotted seatrout are abundant, and the information provided here may be useful when making management recommendations for spotted seatrout. The data illustrates the fact that fishermen are not just fishing for striped mullet and incidentally catching spotted seatrout, but rather both species are important contributions to their catch. It is also important to note that the total number of dual targeted trips from 2006 to 2008 was quite small (222) and only ~ 5% of the number of spotted seatrout targeted trips (4,305).

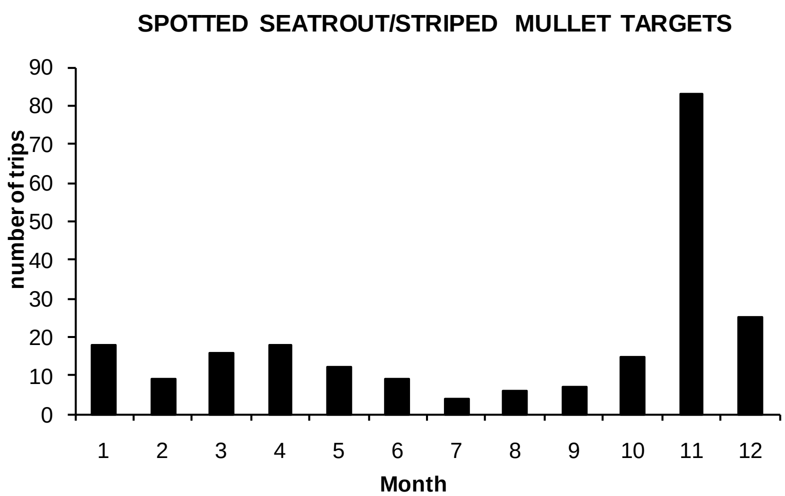


Figure 73. The number of trips that targeted both spotted seatrout and striped mullet (30% or greater of the catch was spotted seatrout and 30% or greater of the catch was striped mullet), by month, 2006-2008 combined.

Table 81. Commercial landings of striped mullet and spotted seatrout in trips that targeted both spotted seatrout and striped mullet (30% or greater of the catch was striped mullet and 30% or greater of the catch was spotted seatrout), by month, and the percent composition of spotted seatrout (%SST), 2006-2008 landings combined.

	LANDINGS (lbs)				
Month	Striped Mullet	Spotted Seatrout	Other	ALL	% SST
Jan	549	526	258	1,332	39
Feb	379	382	243	1,004	38
Mar	408	455	220	1,083	42
Apr	549	521	298	1,367	38
May	622	583	248	1,452	40
Jun	317	302	169	788	38
Jul	111	123	75	309	40
Aug	383	396	283	1,061	37
Sep	403	462	256	1,121	41
Oct	635	539	214	1,387	39
Nov	5,079	4,808	2,323	12,210	39
Dec	1,168	1,174	692	3,034	39
ALL	10,601	10,268	5,277	26,146	39

Table 82. Commercial landings of spotted seatrout in trips that targeted both striped mullet and spotted seatrout (30% or greater of the catch was striped mullet and 30% or greater of the catch was spotted seatrout), and the percent composition of spotted seatrout (%SST) in those trips, annually, 2006-2008.

	LANDINGS (lbs)				
Year	Striped Mullet	Spotted Seatrout	Other	ALL	% SST
2006	3,782	3,648	1,669	9,099	40
2007	3,203	3,159	1,777	8,138	39
2008	3,616	3,462	1,831	8,910	39
ALL	10,601	10,268	5,277	26,146	39

Current Authority

Management Options

1) *Status quo*. No change in present situation.
   + no change in proclamation or rule

2) Recommend management measures to reduce bycatch of spotted seatrout in the flounder, spot, and/or striped mullet fisheries.

+ may decrease spotted seatrout fishing mortality.
+ may concurrently help to decrease conflict issues.
- more responsibilities for DMF Marine Patrol in terms of enforcement area and regulations.
- may result in increased waste in these fisheries.

Management Recommendations

SST AC: No discussion, no recommendations.
DMF: Not an issue, no recommendations.
MFC: No discussion, no recommendations.

10.2.7 Closing the Spotted Seatrout Gig Fishery from December 1 through March 31

Issue

The Spotted Seatrout AC voted for a closure of the commercial gig fishery from December 1st to March 31st. This paper will describe recent fishery characteristics of the gig fishery (2006-2008).

Background

Spotted seatrout are gigged in recreational and commercial fisheries. Currently there is not an estimate of yearly harvest in the recreational fishery. The new Marine Recreational Intercept Program (MRIP) has a night sampling component to obtain estimates of recreational gigging effort and harvest. The commercial gig fishery for spotted seatrout typically operates during the winter when water clarity and spotted seatrout are more available. During these months, spotted seatrout can be lethargic due to the cold temperatures and some fishermen feel the gig fishery should not be allowed to operate during the winter.

The commercial gig fishery has been small relative to other fisheries that catch spotted seatrout. The commercial gig fishery has averaged 8,771 pounds per year from 2006 to 2008 (Table 83). This fishery accounted for two to three percent of the spotted seatrout commercial landings by year.

Spotted seatrout landings from gigs were harvested almost exclusively during the winter (Figure 74). Eighty-one percent were harvested from December through March and averaged 7,076 pounds per year. Average landings from April through November summed up to less than 1,700 pounds per year.

Table 83. Gig and total landings of spotted seatrout landed in North Carolina from 2006 to 2008, the yearly percent the gig fishery contributed to total spotted seatrout landings, and estimated number of spotted seatrout harvested in the gig fishery.

Year	Gig Landings	Total Commercial Landings	Percent	Number of Fish
2006	6,603	312,604	2.1	-
2007	11,321	374,701	3	5,852
2008	8,391	304,516	2.8	4,131
Total	26,314	991,821	2.7	

In addition to occurring primarily during the winter, the gig fishery occurred in a very limited area. Although gig landings of spotted seatrout were observed in fifteen of the twenty-eight waterbodies listed on trip tickets from 2006 to 2008 [excluding the ocean, (Table 84)], most of the landings (96%) and effort/trips (84%) occurred in three areas: Bogue, Masonboro, and Topsail sounds. Overall effort from 2006 to 2008 ranged from 141 to 233 trips across 22 to 32 fishermen.

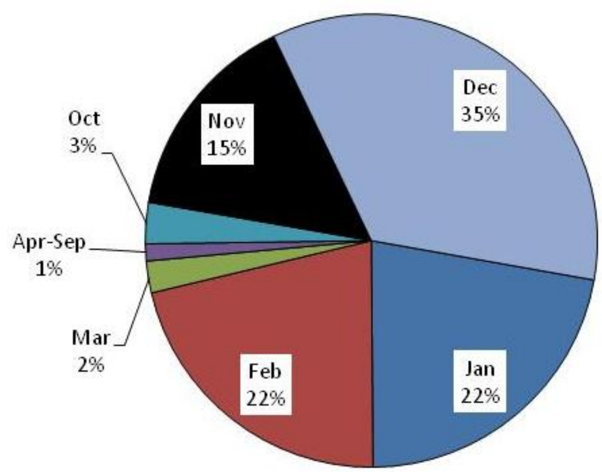


Figure 74. Monthly commercial gig landings of spotted seatrout from 2006 to 2008.

Table 84. Landings of spotted seatrout by trip ticket waterbody code, 2006-2008.

Area	2006	2007	2008	Total
Bogue Sound	1,723	5,338	3,611	10,672
Cape Fear River	*	35	208	*
Core Sound	*	*	*	*
Inland Waterway (Brunswick)			*	*
Inland Waterway (Onslow)		*		*
Lockwood Folly		*	139	*
Masonboro Sound	2,121	2,844	2,176	7,141
Neuse River		*		*
New River	*	*	*	*
Newport River	*	*	*	*
North River/Back Sound		*		*
Pamlico River		*		*
Pamlico Sound	*			*
Stump Sound		*		*
Topsail Sound	2,689	2,600	2,062	7,351
Total	6,603	11,321	8,391	26,314
Number of Fishermen	22	27	32	
Number of Trips	141	233	177	

*Confidential data.

Spotted seatrout have been observed while sampling the commercial flounder gig fishery (Program 476) although the number of trips observed are low. Only 10 trips in 2007 and 15 gig trips in 2008 had spotted seatrout listed as an observed species in the sampling of the commercial gig fishery. No trips were sampled with catches of spotted seatrout in 2006. The expanded length frequency of spotted seatrout in the gig fishery is displayed in Figure 75. Please note that the samples are taken in fork length, while size limit regulation is total length. The one 11" fish was measured at 304 mm or 11.98 inches fork length. The maximum observed size of spotted seatrout in the commercial gig fishery was 24 inches fork length. Greater than 90% of the seatrout measured would be longer than the interim size limit of 14 inches total length for spotted seatrout.

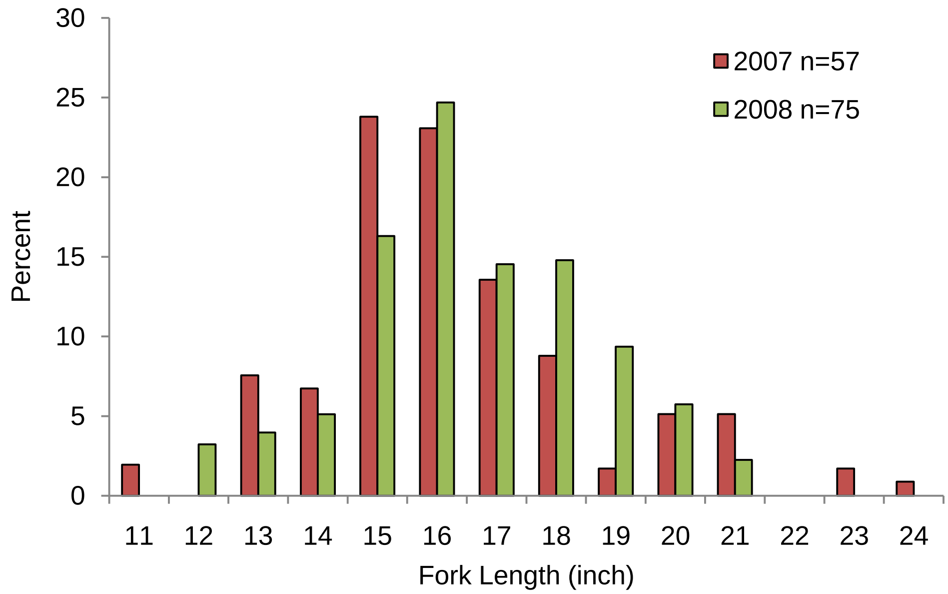


Figure 75. Length frequency of spotted seatrout in the commercial gig fishery from 2007 and 2008.

*Note that lengths are fork length not total length. All lengths were rounded down to the nearest whole inch.

Discussion

Landings of spotted seatrout in the gig fishery are low overall and averaged less than three percent of the commercial landings of spotted seatrout from 2006 to 2008. Closing this gear for use as a commercial gear from December 1st through March 31st will have an impact on the gig fishermen in the Bogue, Masonboro, and Topsail sounds. Little effect of this management measure will be noticed in others areas. Although projections cannot be calculated for changes in the gig fishery alone, reductions in the total amount of landings of spotted seatrout based on the 2006 to 2008 data would suggest a very minor reduction in fishing mortality of spotted seatrout.

The gig fishery differs from many other commercial gears used to catch fish. Each fish that is caught in the fishery is targeted by the gear and should have very little bycatch compared to other gears. The species fishermen are allowed to target are also limited. Currently red drum cannot be harvested with gigs (targeted fishery not allowed) and blue crabs cannot be harvested at night when the fishery operates. The only source of discards would result from gigging undersized fish. This could be a problematic since it is likely that undersized gigged seatrout have a high discard mortality rate. However there are no studies on the quantity and size of discards for the commercial spotted seatrout gig fishery. One important observation that can be deduced from the length frequency plots is that the overall distribution of the lengths was not bumping against the minimum size limit (12 inch total length). Based on the current sampling (which is low), no fish were observed less than the old 12 inch minimum size limit total length. If discards were likely to be a problem, then the lengths would be shifted closer to the minimum size limit.

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

Management Options

1) *Status quo*. No change to gig regulations
   + no change in proclamation or rule.
   + allows a fishery with little incidental bycatch to continue operating.
   - no additional reduction in fishing mortality.
   - perception of killing lethargic seatrout not remedied.

2) Close the gig fishery to spotted seatrout harvest
   + minor decrease in the fishing mortality of spotted seatrout (commercial).
   + eliminates the harvest of lethargic spotted seatrout.
   - more responsibilities for DMF Marine Patrol in terms of enforcement area, regulations, and time.
   - disproportionally affects fishermen from Bogue, Masonboro and Topsail sounds.
   - eliminates a revenue source when few other fisheries are active.

3) Close the gig fishery to spotted seatrout from December 1st through March 31st.
   + minor decrease in the fishing mortality of spotted seatrout (commercial).
   + eliminates the harvest of lethargic spotted seatrout.
   - more responsibilities for DMF Marine Patrol in terms of enforcement area, regulations, and time.
   - disproportionally affects fishermen from Bogue, Masonboro and Topsail sounds.
   - eliminates a revenue source when few other fisheries are active.

Management Recommendations

SST AC: Status quo. DMF to continue to track contributions of gigs to overall landings.
DMF: Status quo. DMF to continue to track contributions of gigs to overall landings.
MFC: Status quo. DMF to continue to track contributions of gigs to overall landings.

Research Recommendations:

1. Obtain biological samples (length, age, weight, quantification) from the spotted seatrout recreational gig fishery.

2. Determine discard and mortality rates of spotted seatrout in the recreational and commercial gig fisheries.

10.2.8. Achieving Sustainable Harvest – Commercial Fishery Alternatives

Issue

Establish harvest reductions in the commercial fishery that will move towards achieving sustainable harvest by taking one half of the reduction needed to end overfishing.

Background

The North Carolina Fisheries Reform Act (FRA) requires that if a fishery is considered overfished, the Fishery Management Plan (FMP) must "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" [G.S. 113-182.1(b)(4)]. In order to end overfishing immediately, a 57% reduction in harvest would be required with a 14-inch minimum size limit. Because this would result in severe reductions in harvest, coupled with uncertainties in the projections, the Division of Marine Fisheries (DMF) thought it would be more reasonable to take one half of the reduction needed to end overfishing at this time, or a 28.5% with a 14-inch minimum size limit. The stock can be reassessed in the near future to determine if the management strategy contributed to rebuilding the stock, and management measures can be adjusted as necessary at that time. Thus, if the selected management strategies do not show sufficient rebuilding, it is possible that additional restrictions will have to be implemented in the future. In this paper, harvest reductions achieved by various restrictions are presented to aid in selecting a preferred rebuilding strategy. The MFC guidelines state that "quantifiable management options that do not meet the minimum standard shall be eliminated from consideration as soon as their deficiency is discovered".

Discussion

Management Measures

This issue paper presents a variety of management strategies that achieve the necessary harvest reduction of 28.5%. Harvest reduction calculations are based on landings from the recent past (2003-2008). The reliability of these calculations to adequately predict future harvest reductions depends upon environmental parameters, recruitment, and fishing effort to remain similar to the past base years (2003-2008). The management measures presented are to be used in combination with the 14-inch minimum size to allow fish the opportunity to spawn at least once before being caught, decrease the fishing mortality, and rebuild the fishery towards the threshold level.

Trip/Participant Limit Analysis Methods

A total harvest reduction of 28.5% is required by both the recreational and commercial fishing sectors in order to take one half of the reduction needed to end overfishing at this time. In the commercial sector, only a small part (<2%) of the reduction is achieved by increasing the minimum size limit from 12 to 14-inches. When the 14-inch minimum size limit is combined with a trip limit, the trip limit must produce the additional 27.2% reduction to achieve an overall harvest reduction of 28.5%.

Harvest reductions associated with daily trip limits were empirically-based predictions (i.e., based on actual data) using the average annual number of trips reported daily on trip tickets from 2003 to 2008 within given poundage ranges (Table 85). Trips that were less than or equal to the potential new poundage limit in the past were assumed to occur in the future at the same rate. Any trips that landed over the proposed new limit in the past were assumed to continue to occur in the future but only land the maximum allowed under the new limits.

Spotted seatrout are not targeted by the majority of commercial fishermen, with the vast majority of trips (63%) landing less than 10 pounds per trip from 2003 to 2008 (Figure 60). Nearly 90% of trips landed less than 50 pounds per trip. However, 23% of the annual harvest is from trips landing more than 500 pounds per trip (Figure 61). These occasional large catches occur in the beach seine, long haul seine/swipe net, stop net, and runaround gill net (a.k.a., strike net) fisheries. Spotted seatrout are targeted by fishermen using beach seines in the early spring (April-May), long haul/swipe nets and stop nets during the fall, and runaround gill nets during the late fall and winter months. The average catch of spotted seatrout by commercial gear is less than 500 pounds (Figure 76), but some of these fisheries occasionally catch of over 500 pounds of spotted seatrout in one trip. Runaround gill net fishermen can have a rare catch over 500 pounds in a single set, but typically make several sets that may collectively add up to over 500 pounds. From 2003 to 2008, the average number of trips that landed over 1,000 pounds was 32 runaround trips, 22 long haul/swipe net trips, 22 set gill net trips, 7 stop net trips, and 4 beach seine trips.

At the request of the Spotted Seatrout Advisory committee (SST AC), and in order to address potentially large catches in these high volume commercial fisheries, a similar analysis was done by participant (as opposed to trip) to determine a weekly limit (as opposed to daily limit) that would allow fishermen to land more per trip, but still maintain the required 28.5% harvest reduction. Trip ticket data was used to determine the average number of participants landing spotted seatrout within given poundage ranges each week (Table 86).

It is difficult to predict changes in fishermen behavior under potential new regulations in both the spotted seatrout fishery and in other fisheries that may redirect effort into or out of the spotted seatrout fishery (e.g., large-mesh gill net restrictions, net attendance rules, area closures, etc.). Important assumptions of the analysis are that: fishing behavior will continue in the future as it has in the past, there will be 100% compliance with proposed regulations and no dead discards. Changes in fishermen behavior in the future will violate some of these assumptions and could bias the results of this analysis in either a positive or negative way.

There is concern over dead discards in the high volume fisheries [stop net, long haul seine, beach seine, and runaround gill nets (a.k.a., strike nets)]. Runaround gill nets typically target spotted seatrout in the late fall and winter months and make several sets to complete a trip. It may be possible for fishermen using this gear to avoid the majority of large catches seen in the past. Long haul seines/swipe nets also target spotted seatrout in the fall, and beach seines target spotted seatrout in the spring, but both fisheries could stop targeting spotted seatrout to avoid the majority of large catches. However, even if targeting ceased, some incidental dead discards associated with these fisheries are likely to continue. The stop net fishery targets striped mullet, but on rare occasions, large catches of spotted seatrout are taken when a school is sited within the net. Thus, annual quotas were examined for the stop net, long haul seine, and beach seine high volume fisheries, as well as for all fisheries combined. An annual quota was not calculated exclusively for runaround gill nets because this fishery’s execution should enable it to avoid high volume catches, and also because it would be impossible to enforce different trip limits for runaround gill nets and set gill nets.

Table 85. Average annual number of daily commercial trips per year landing spotted seatrout by poundage range from 2003 to 2008, all commercial gear types combined.

Range (lb)	Avg Trips
< 10	5,159
10 to 25	1,324
25 to 50	698
50 to 100	472
100 to 150	178
150 to 200	95
200 to 250	60
250 to 300	40
300 to 350	24
350 to 400	22
400 to 450	15
450 to 500	12
>500	62
Total	8,161

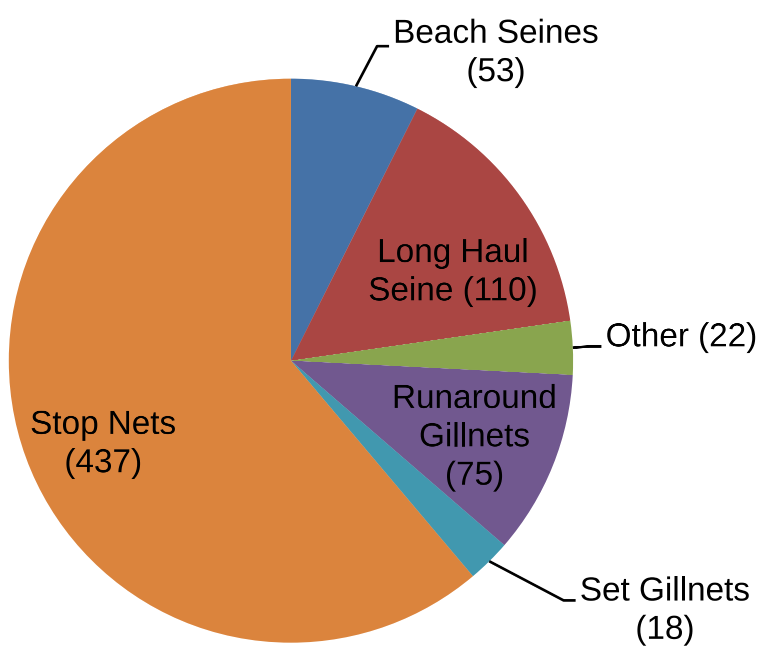


Figure 76. Average spotted seatrout catch (lbs per trip) by gear, 2003-2008.

Table 86. Average number of participants landing spotted seatrout in a given poundage range each week from 2003 to 2008, all commercial gear types combined.

Range (lbs)	Avg # participants
<100	4,148
100-200	217
200-300	91
300-400	52
400-500	32
500-600	21
600-700	17
700-800	12
800-900	7
900-1,000	7
1,000-1,100	3
1,100-1,200	4
1,200-1,300	3
1,300-1,400	2
1,400-1,500	2
1,500-1,600	2
1,600-1,700	1
1,700-1,800	1
1,800-1,900	2
1,900-2,000	1
2,000-2,100	1
2,100-2,200	0
2,200-2,300	1
2,300-2,400	1
2,400-2,500	1
>=2,500	4
Total	4,632

Quotas were determined assuming a 14-inch minimum size limit would remain in place, thus resulting in the remaining reduction of 27.2% required to take one half of the reduction needed to end overfishing at this time. Quotas were calculated by determining the average harvest from 2003 to 2008 and reducing that amount by 27.2% (Table 87).

An annual commercial quota (all gear combined) of 173,981 pounds would result in the required 27.2% reduction. If chosen, the season would start September 1st, prior to the bulk of the harvest. The proposed annual commercial quota is much less than annual commercial landings in most years (Figure 77), and would likely result in an extended closure later in the season. Quotas are more effectively managed when they are used in conjunction with known participation and trip limits. A trip limit would be included to help keep the quota from being grossly exceeded.

Annual commercial quotas were also calculated for the stop net, long haul seine, and beach seine high volume fisheries. The required 27.2% reduction would be met if stop nets, beach seines, and long haul seines/swipe nets were limited to 4,595 pounds, 5,139 pounds, and 22,930 lbs, respectively, and all other gear would be limited to 100 pounds/day/operation or 200 pounds/person/week. An annual commercial quota for the high volume fisheries would require dealer reporting for the high volume fisheries only, as well as a DMF state permit. The proposed annual quotas for the high volume gear are less than the annual landings in some years (Figure 78). To be effective, the high volume fishery in question would have to cease operation once the quota was met, and any overages would be deducted from the following year's quota. It may be necessary for DMF to develop specific definitions of the long haul seine, beach seine, and stop net gear in order to prevent selective harvest of the quota by interchangeable gear.

Seasonal closures could be used to restrict harvest during certain times of the year. For example, a December and January closure would result in a projected reduction of 29.9%, and a February through August closure would result in a 31.8% reduction. Both of these examples exceed the 28.5% goal and are simply presented to provide examples of how much it would take to meet the goal. Other seasonal closures could also be considered as long as they meet the required reduction.

Other harvest reduction options could be developed that combine size limits with trip limits and season limits. A possible option might be to have the 14-inch minimum size coupled with varying trip limits by season. For example in the gill net fishery, a 300 pounds/operation/day trip limit could be allowed during the winter season (November-February) when the fish are targeted and large catches are more common, while a smaller trip limit of 25 pounds/operation/day trip limit would be allowed during the remainder of the year (March-October) when spotted seatrout are a small bycatch in other multispecies fisheries. From March through October, 64% of the landings are from trips landing over 25 pounds, and 10% of the trips landed over 25 pounds. Given that discard mortality from gill nets is highest in the summer time, this option could result in a large number of dead discards that are not accounted for in the analysis. If an option was chosen specific to the gill net fishery, appropriate limits would have to be assigned to all other gear. Various combinations of management options are possible, as long as they meet the required reduction.

A final option was to close the commercial harvest of spotted seatrout on the weekends. That is, no possession of spotted seatrout from commercial gear from 5 p.m. Friday through 5 p.m. on Sunday. In combination with the 14-inch minimum size, this option would result in a projected reduction of 29.7%. Commercial gear would be allowed to fish during the weekends from March through October. Most nets have to be attended during this "summer" season when spotted seatrout are primarily a bycatch in other fisheries, therefore all spotted seatrout could be released as they are caught. However no commercial gear would be allowed to fish on the weekends from November through February, which is the "winter" season, when spotted seatrout are primarily harvested as a target species. More specifically, "no commercial gear" means that no long haul seines, beach seines, gill nets (drift, set, runaround), or recreational commercial gear license (RCGL) gear would be allowed to fish during the weekends (5 p.m. Friday through 5 p.m. Sunday). Stop nets would be allowed to be set, but no hauls or "strikes" may be made on the weekends. The only exceptions to this option are that areas in the western Albemarle Sound [west of a line 36°09.928' N 75 54.695' W (northern end); 35° 57.559 N, 75°56.820 W (southern end)] and the Currituck Sound [north of a line 36°04.828' N, 75°47.405'W (western end); 36°05.577'N, 75°44.858'W (eastern end)] are exempt from the weekend closure of commercial gear in the water option due to the low numbers of spotted seatrout found in those areas.

The DMF proposes an adaptive management framework for sustainable harvest in the spotted seatrout fishery. Given the uncertainty in the actual level of harvest reductions that will be realized once these measures are put in place, and the continuing evolution of fishing restrictions from the Endangered Species Act, the DMF and MFC may consider new information brought forward and revise the FMP sustainability measures accordingly. The pending "sea turtle settlement", for example, will likely result in quantifiable reductions in the commercial harvest. As such, the DMF/MFC may find it possible to loosen the recommended management restrictions and still maintain the recommended reductions in harvest. Another scenario may be that weekend closures are not be as effective as anticipated due to recoupment fishing behavior. As such, the DMF/MFC may find it necessary to increase harvest restrictions in order to meet the recommended harvest reductions. Possible management actions would include changes in bag/trip limits, season and/or area closures.

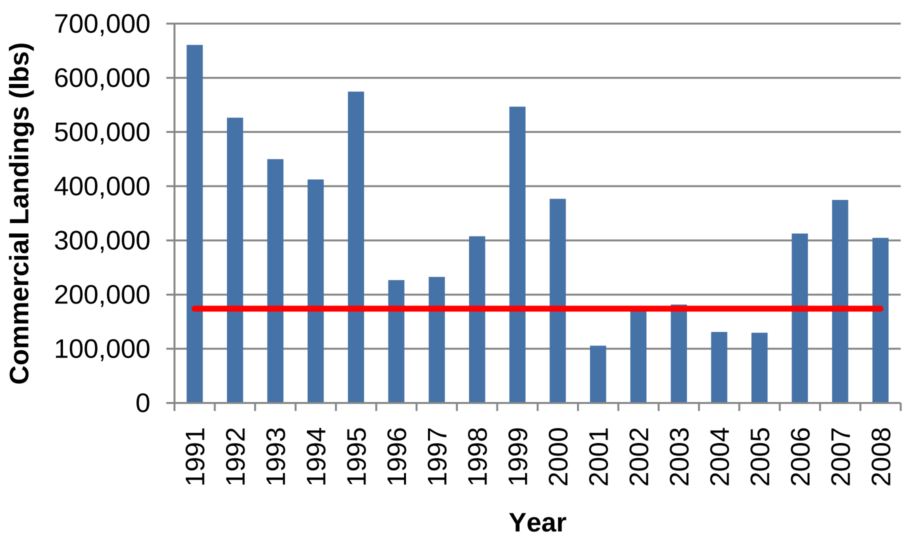


Figure 77. Commercial landings of spotted seatrout in North Carolina, 1991-2008, and proposed annual commercial quota of 173,981 pounds.

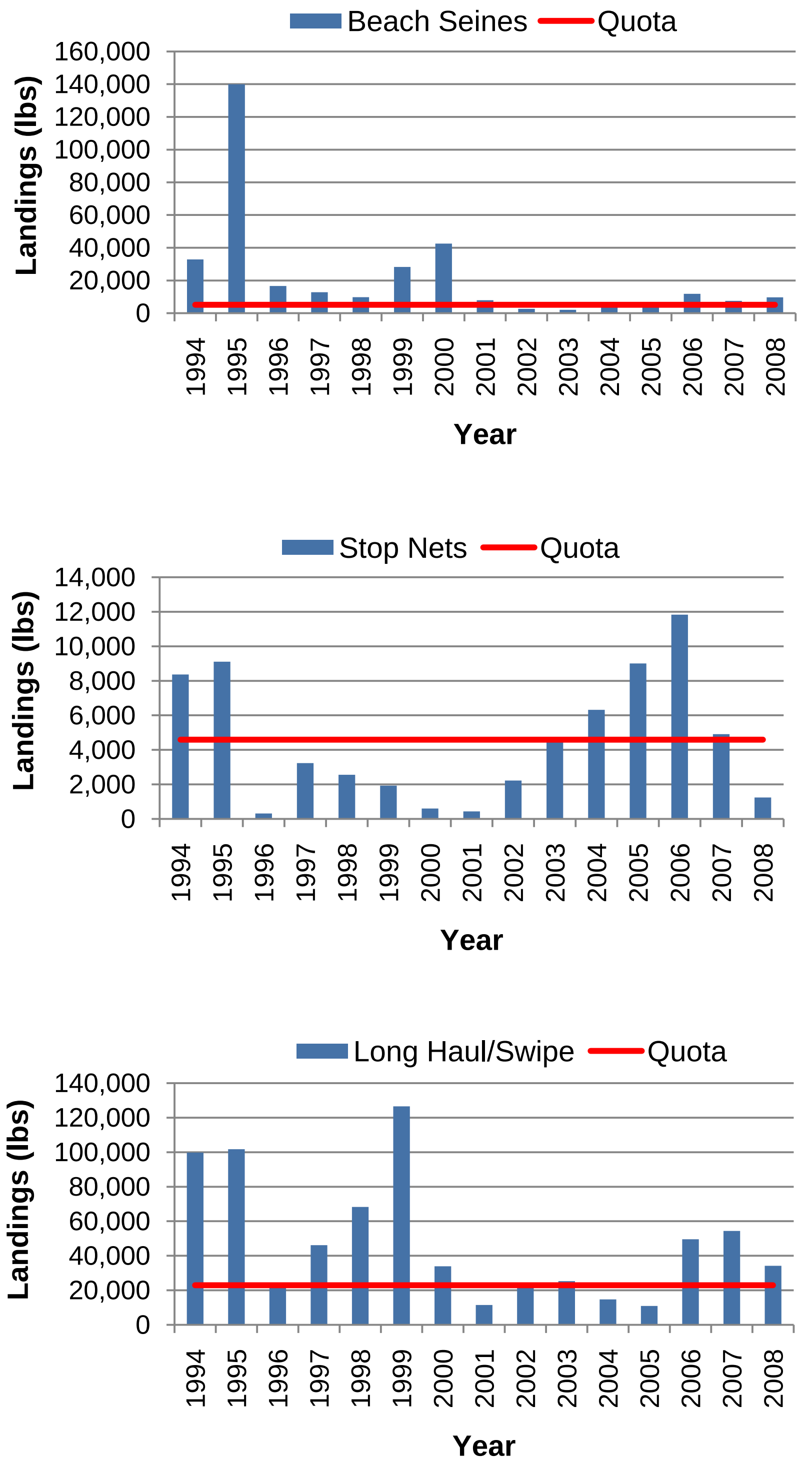


Figure 78. North Carolina commercial landings of spotted seatrout in potential high volume fisheries; beach seines, stop nets, and long haul seines/swipe nets, 1991-2008, and proposed annual commercial quotas.

Table 87. Comparison of the daily trip limit (lbs/operation/day), weekly trip limit (lbs/participant/week), and commercial quota options that would result in the additional 27.2% required to take one half of the reduction needed to end overfishing, assuming the 14-inch minimum size limit would remain in place. Commercial quotas are provided only for high volume gear (beach seines, long haul seines, and stop nets), and all commercial gears combined. All calculations were based on average landings from 2003 to 2008.

FISHERY	Daily Trip Limit lbs/operation/day	Weekly Trip Limit lbs/participant/week	Average (03-08) lbs	27.2% Reduction lbs	Quota lbs
All Gears Combined	150	300	238,986	-65,004	173,981
Beach Seine	150	300	7,059	-1,920	5,139
Long Haul Seine	350	700	31,497	-8,567	22,930
Stop Nets	btwn 500 and No Limit	2,100	6,312	-1,717	4,595
Other (all except beach seine, long haul seine, & stop net)	100	200	194,118	-52,800	-

FISHERY	Daily Trip Limit lbs/operation/day	Weekly Trip Limit lbs/participant/week
Runaround Gill Nets	—	400
Set Gill Nets	—	100
Runaround & Set Gill Nets Combined	—	200

**due to difficulties in distinguishing between runaround and set gill nets in landings and enforcement, it is recommended to utilize management options that combine all types of gill nets (drift, runaround, & set).*

IV. 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
15A NCAC 3M .0504 TROUT
15A NCAC 3M.0512 COMPLIANCE WITH FISHERY MANAGEMENT PLANS

V. MANAGEMENT OPTIONS (list pros and cons of each management option)

1) 14-inch minimum size limit *and* 150 lbs/day/operation trip limit

+ Reduces harvest in the fishery
+ Reaches goal of one half of the reduction needed to end overfishing
+ Can end overfishing halfway with no seasonal closure
+ Consistent trip limit among commercial fishermen
- May lead to increased regulatory discards in the commercial fishery, particularly in the high volume fisheries
- May adversely impact some fisheries and fishermen more than others

2) 14-inch minimum size limit *and* 200 lbs/day/operation trip limit

+ Reduces harvest in the fishery
+ Consistent trip limit among commercial fishermen
- May lead to increased regulatory discards in the commercial fishery, particularly in the high volume fisheries
- May adversely impact some fisheries and fishermen more than others
- Does not reach goal of one half of the reduction needed to end overfishing

3) 14-inch minimum size limit *and*
Seasonal closures of:

○ Dec 1st - Jan 31st *or* Feb 1st - Aug 31st

+ Reduces harvest in the fishery
+ Winter closure may help resolve user conflict issues
- May lead to increased regulatory discards in the commercial fishery
- May adversely impact some fisheries and fishermen more than others
- Could cause an increase in effort during the open period

+/- Exceeds the goal of one half of the reduction needed to end overfishing

4) 14-inch minimum size limit *and*
Annual quota for all fisheries combined of 173,981 lbs *and*
Fishing year starts Sep 1st and 150 lbs/day/operation

+ Reduces harvest in the fishery
+ Reaches goal of one half of the reduction needed to end overfishing
+ May prevent further expansion of the fishery as large mesh gill net fishery is restricted
- May lead to increased regulatory discards in the commercial fishery
- May adversely impact some fisheries and fishermen more than others
- Could cause an increase in effort during the open period
- Likely to result in season closure for most of the year
- Annual quota much smaller than historical annual landings
- Would have to be monitored daily or weekly with landing reports
- Additional burden for commercial dealers, DMF trip ticket staff & Marine Patrol

- Potential magnitude of daily harvest would make it possible to surpass the quota before the fishery could be closed

5) 14-inch minimum size limit *and*
Annual quotas for high volume fisheries:
  - Stop Nets - 4,595 lbs
  - Beach Seines - 5,139 lbs
  - Long Haul Seines/Swipe Nets - 22,930 lbs *and*

Limits for all other gears:
100 lbs/day/operation *or* 200 lbs/person/week

+ Reduces harvest in the fishery
+ Reaches goal of one half of the reduction needed to end overfishing
+ Can end overfishing halfway with no seasonal closure
- May lead to increased regulatory discards in the commercial fishery
- May adversely impact some fisheries and fishermen more than others
- Additional burden on commercial dealers, DMF trip ticket staff & law enforcement
- Fishery would have to cease once the quota was caught
- Shifts in fisheries and/or gear types could lead to quotas being reached earlier than anticipated

6) 14-inch minimum size limit *and*
Trip limits for high volume fisheries:
  - Stop Nets – 500 lbs-no limit lbs/operation/day or 2,100 lbs/person/week
  - Beach Seines – 150 lbs/operation/day or 300 lbs/person/week
  - Long Haul Seines/Swipe Nets - 350 lbs/operation/day or 700 lbs/person/week *and*

Limits for all other gears: 100 lbs/day/operation *or* 200 lbs/person/week

+ Reduces harvest in the fishery
+ Reaches goal of one half of the reduction needed to end overfishing
+ Can end overfishing halfway with no seasonal closure
- May lead to increased regulatory discards in the commercial fishery
- May adversely impact some fisheries and fishermen more than others
- Additional burden on commercial dealers, DMF trip ticket staff & law enforcement

7) 14-inch minimum size limit *and*
Weekly Trip limits for Gill Nets:
  - Runaround Gill Nets – 400 lbs/person/week
  - Set Gill Nets – 100 lbs/person/week
  - All Gill Nets Combined (drift, set, runaround) – 200 lbs/person/week *and*

Annual quota or trip limits for high volume fisheries
Limits for all other gears: 100 lbs/person/week

+ Reduces harvest in the fishery
+ Reaches goal of one half of the reduction needed to end overfishing
+ Can end overfishing halfway with no seasonal closure
- May lead to increased regulatory discards in the commercial fishery
- May adversely impact some fisheries and fishermen more than others
- Additional burden on commercial dealers, DMF trip ticket staff & law enforcement
- Would have to combine all gill net types for a lower trip limit due to enforcement issues of specific gill net gear types

8) 14-inch minimum size limit and
Seasonal Trip limits for Gill Nets (all gill nets combined):

- Summer (March-October) – 25 lbs/operation/day
- Winter (November-February) – 300 lbs/operation/day and

Annual quota or trip limits for high volume fisheries
Limits for all other gears: 100 lbs/person/week

+ Reduces harvest in the fishery
+ Reaches goal of one half of the reduction needed to end overfishing
+ Can end overfishing halfway with no seasonal closure
+ Allows for larger harvest during targeted fishing season and lower harvest during bycatch fishing season
- May lead to increased regulatory discards in the commercial fishery
- May adversely impact some fisheries and fishermen more than others
- Additional burden on commercial dealers, DMF trip ticket staff & law enforcement

9) 14-inch minimum size limit and
Weekend closures for all commercial gear (no possession).

- Summer (March-October) – gear may be in water & attended on weekends
- Winter (November-February) – no gear in water on weekends

+ Projected to reduce landings of spotted seatrout 29.7% (w. 14-inch min)
+ Simultaneously would minimize user conflict issues during the weekends when most user conflicts occur
+ Can be applied statewide, which could prevent future user conflicts in other parts of the State
+ Reduce the amount of incidents of anglers damaging gill nets
+ Potential to reduce dead discards of other finfish such as red drum
+ Gear may not have to be removed during net attendance season/areas
- May have a significant impact on commercial fisheries
- Seasonal gear removal would impact other fisheries
- Increased number of discards
- Reductions may not be met due to possible recoupment during the weekdays
- Increased enforcement responsibilities for Marine Patrol
- Fishermen and NC Marine Patrol may be required to remove nets in unsafe conditions

MANAGEMENT RECOMMENDATIONS

SST AC: 14-inch minimum size limit and weekend closures (no possession) for all commercial gear. Summer (March-October) gear may be in water and attended on weekends if not in violation of the Endangered species Act or “sea turtle settlement”. Gear will need to be removed on weekends in the winter (November-February).

DMF: 14-inch minimum size limit and weekend closures (no possession) for all commercial gear. Summer (March-October) gear may be in water and attended on weekends if not in violation of the Endangered species Act or “sea turtle settlement”. Gear will need to be removed on weekends in the winter (November-February). Western Albemarle Sound & Currituck Sound exempt from weekend commercial gear removal.

MFC: 14-inch minimum size limit and weekend closures (no possession) for all commercial gear. Gear may be in water and attended on weekends if not in violation of the Endangered species Act or “sea turtle settlement”. Extend the small mesh gill net attendance requirement to include weekends, December through February. A maximum of 2 fish over 24-inches for recreational fishermen.

10.2.2.B Achieving Sustainable Harvest

I. ISSUE

Establish harvest reductions that end overfishing within two years of the Spotted Seatrout Fishery Management Plan adoption and achieve sustainable harvest within 10 years of management plan adoption as required by law [G.S. 113-182 .1(b) (4-5)].

II. BACKGROUND

The 2009 North Carolina spotted seatrout stock assessment indicated that the spotted seatrout stock in North Carolina/Virginia has been overfished and that overfishing has been occurring throughout the entire 18-year time series (1991-2008) (Jensen 2009, Appendix 4). This was based on the NCDMF threshold of a 20% spawning potential ratio. Spawning potential ratio is the potential spawning stock biomass (SSB) under a theoretical scenario of an unfished population compared to the current spawning stock biomass based on exploitation rates. Under current regulations, the SSB must be rebuilt from the current level of 806,890 pounds (2008) to 1,484,594 pounds within 10 years of the Fishery Management Plan (FMP) adoption (Figure 55). The average fishing mortality rate (F) must be reduced from the current rate of 0.86 (2008) to a threshold of $F_{20\%\ SPR}$ =0.41 to end overfishing (Figure 5680). The current F rate is more than twice the rate necessary to produce a sustainable harvest. Under a 14 inch minimum size limit with no maximum size limit, a 57% reduction in harvest is required to end overfishing.

The Fisheries Reform Act (FRA) requires that each FMP “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” [G.S. 113-182.1(b)(3)]. 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” [G.S. 113-129(14a)]. If a fishery is considered overfished, the FMP must “specify a time period, not to exceed 10 years from the date of the adoption of the plan, for achieving a sustainable harvest” [G.S. 113-182.1(b)(6)]. A modification to the statute in 2010 occurred that reduced the allowable time for ending overfishing from 10 years to 2 years after the date of the adoption of the fishery management plan [G.S. 113-182.1(b)(5)]. The reduction needed to end overfishing for spotted seatrout is 57% with a 14 inch minimum size limit regulation.

The Marine Fisheries Commission (MFC) 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. 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” [MFC Guidelines III(B)(3)(a)(2)]. Projections were not developed for spotted seatrout stock because the biology of the fish, environmental conditions, and lack of sufficient data make it unwise to rely on projections to specify an $F_{rebuild}$ rate that is compatible with professional standards for fisheries management. However the terminal F rate can be based on the output of the stock assessment model to determine if current fishing mortality rate meets the 20% SPR threshold for spotted seatrout overfishing.

The $F_{20\% \, SPR}$ threshold estimated by the stock assessment depends on some key parameters either provided by the NCDMF or estimated by the model. Some of the parameters include growth rates, reproductive schedule, selectivity, steepness in the stock recruitment relationship, and natural mortality. Growth rates and reproductive schedule were developed based on fish collected in North Carolina. These estimates provided to the model were similar to estimates from other states and published studies.

Selectivity is the probability that fish will exist in the area where people are fishing and get caught when they encounter their fishing gear (e.g., attempt to bite their hook, swim into their net, etc.). Changes in size limits and gear modifications alter the selectivity inputs into models used to determine fishing mortality and spawning stock biomass thresholds. Therefore, F thresholds may change slightly based on various management options. Changes to commercial and recreational harvest and dead discards were predicted for changing the original size limits of 12 inches to proposed limits of 14 (current through proclamation) and 15 inches. Input data included weighted length frequencies at age for North Carolina and Virginia commercial landings, recreational harvest, and recreational releases.

The steepness parameter in the stock recruitment curve was estimated by the stock assessment model. This parameter is indicative of how quickly a population will respond to changes in management or exploitation rates. The population abundance of spotted seatrout is largely dependent on levels of recruitment (age-0 fish) since age-0 fish make up an average of 74% of the total population (Jensen 2009, Appendix 4). However, the relationship between SSB and recruitment for spotted seatrout in North Carolina/Virginia remains unknown. Environmental factors such as cold stuns, temperature, or salinity, could have a larger impact on recruitment than does the size of the spawning stock biomass. For example, three of the highest years of spawning stock biomass coincided with cold stun years and subsequently produced the lowest levels of recruitment the following year. Given the low recruitment at high biomass, the model may lower the stocks predicted recovery rate due to lower recruitment caused by the cold stun.

Natural mortality in the stock assessment model was estimated based on methods described in peer reviewed research articles: Lorenzen (1996) and Hoenig (1983). The Lorenzen method estimates an age-specific natural mortality rates based on weight (Lorenzen 1996). The Hoenig method estimates natural mortality based on longevity or maximum age of the species (Hoenig 1983).   Both of these methods combined natural mortality rates from a variety of taxa and size of animals. A natural mortality rate based on empirical data may be more appropriate for spotted seatrout in North Carolina since spotted seatrout are at the northern end of their distribution and cold stun events can be a considerable source of natural mortality.

The stock assessment model did not explicity include the effects of cold stun events because no quantifiable data were available to estimate the increase in natural mortality. Since natural mortality was fixed at a constant rate for all years, the impacts of cold stun events appeared as increases in fishing mortality. The impact of periodic increases in natural mortality on sustainability benchmarks was not evaluated because estimates of cold stun mortality events in North Carolina could not be quantified. However, mark/recapture experiments can be used to describe fluctuating natural mortality rates (Pine et al. 2003; Jiang et al. 2007).

The Coastal Recreational Fishing License (CRFL) Grant funded North Carolina State University (NCSU) researchers to study the movement and mortality of spotted seatrout in North Carolina using a combined conventional tag and telemetry approach, September 2009-August 2012. Telemetry tagging can directly estimate natural mortality, which is indirectly estimated through life history parameters, and can also provide more appropriate estimates of mortality attributed to winter kills: a critical component to an accurate stock assessment of spotted seatrout in North Carolina. Once the research is concluded and peer reviewed, the natural mortality rate used in the stock assessment model can be compared to the stock-specific natural mortality rates to determine a range of natural mortality rates the spotted seatrout stock in North Carolina is likely to experience. If there are significant differences between the two methods to estimate mortality rates, then the NCDMF should consider which method is more appropriate to estimate spotted seatrout natural mortality rate and determine if more or less restrictive management measures are needed to end overfishing.

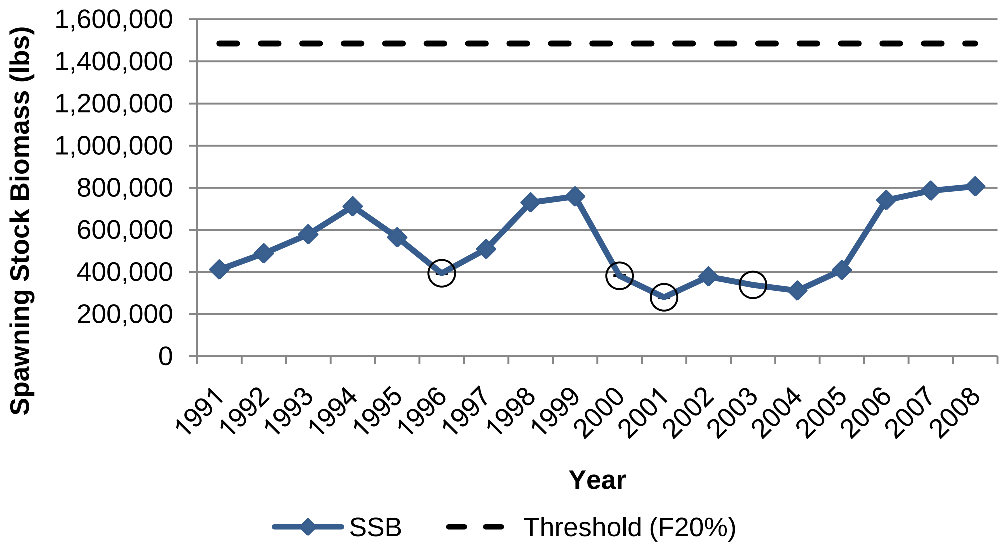


Figure 79.Spawning stock biomass (lbs) of the spotted seatrout stock from 1991 to 2008 and the threshold indicating the stock is overfished at a level consistent with a 20% spawning potential ratio. Open circles represent years associated with a cold stun event.

All analyses assumed regulations would impact only fishermen in North Carolina, while all future harvest and dead discards from Virginia were assumed to remain the same. Virginia's harvest and dead discards were subtracted from the total, thus, all reduction values shown apply to North Carolina only. That is, North Carolina is bearing all of the reductions to rebuild the interstate stock. All calculations were based on input data averaged from 2003 to 2008. Essentially, the following analyses show the average reduction in the North Carolina total kill (harvest + dead discards) that would have been observed from 2003 to 2008 if a size limit or other management change had been in place during those years.

The following analyses are based on reducing F from a 12 inch size limit, 10 fish recreational bag limit, no commercial trip limit (except for hook and line gear), and no seasonal closure, which were the regulations in place when the stock assessment was conducted. The analyses also assume noncompliance with proposed size limits in the future recreational fishery based on past history of undersized fish in the harvest observed in MRFSS estimates. The commercial fishery does not typically harvest fish less than the size limit of 12 inches and currently has no associated discard component; therefore, a 10% noncompliance rate was assumed with future increases in size limits for the commercial fishery.

A release mortality of 10% was assumed for the recreational fishery to mirror the recent stock assessment (Jensen 2009, Appendix 4), and a 60% release mortality estimate was assumed for the commercial fishery based on a study of small mesh gill nets in North Carolina (Price and Gearhart 2002b).

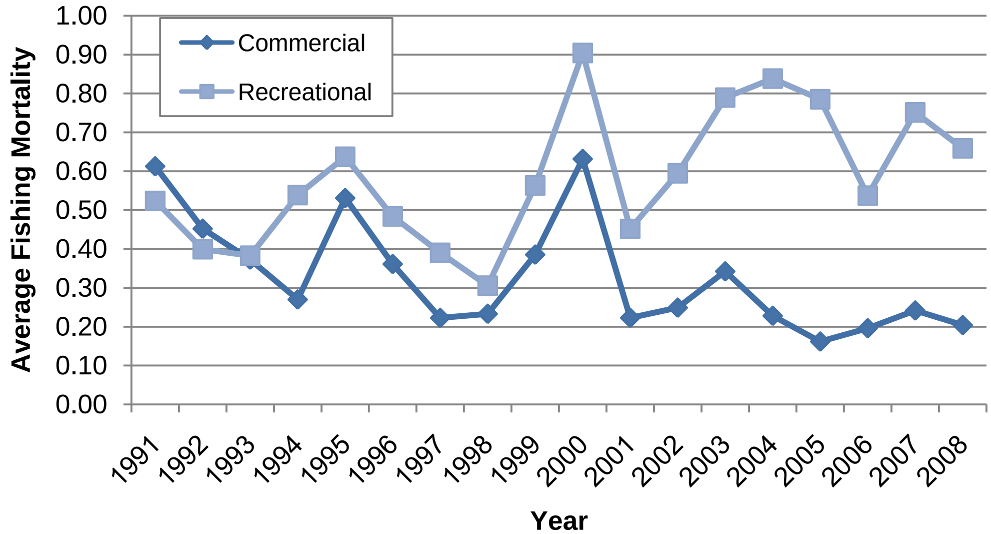


Figure 80. Estimated average fishing mortality rates (weighted by population number at age) for spotted seatrout ages 1-6+ in the commercial and recreational fishing sectors in North Carolina and Virginia, 1991-2008.

III. DISCUSSION

Management Measures

This issue paper presents a variety of management strategies for reducing overall harvest. Harvest reduction calculations are based on past landings and harvest. The reliability of these calculations to adequately predict future harvest reductions depends on environmental parameters, recruitment, and fishing effort to remain similar to the base years (2003-2008). There are a range of management measures available that could be used in combination with one another to decrease the fishing mortality and rebuild the fishery to the threshold level.

Life History Information

The interim management measure to increase the minimum size to 14 inches was based on basic life history information available for spotted seatrout (refer to section 5, General Life History and Appendix 3, Interim Management Measures to Achieve Sustainable Harvest for a complete description).

Size Limits

The current minimum size limit of 14 inches is a result of interim measures imposed by the NCMFC during the development of this FMP. The reductions that are listed in the document are based on changing from the previous minimum size limit of 12 inches. The estimate of F in the stock assessment was based on a 12 inch minimum size limit, so reductions will be based on changing from the 12 inch minimum size limit to a new proposed minimum size limit of 14 or 15 inches.

Increasing the minimum size limit is a common management measure used to end overfishing (lower F), rebuild the SSB, and allow a greater portion of fish an opportunity to spawn before they are harvested. The short term effects of a minimum size increase would be to diminish the pool of younger and smaller fish immediately available for harvest, which would in turn produce a decrease in overall landings. The drop in landings, however, may not produce a corresponding drop in the fishing mortality rate initially since the average annual fishing mortality for spotted seatrout is measured using fish from age classes one and older. Spotted seatrout are fully recruited to the fishery by the time they are two years of age, and an increase in minimum size would predominately protect age-0 and age-1 fish from harvest. Therefore, the benefit to the fishery of an increase in minimum size would not be realized until the increased survival of age-1 fish has occurred for multiple years and has contributed 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-0 and 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 SSB and should increase the number of recruits to the fishery in subsequent years. Size limits were addressed due to the high occurrence of age-1 spotted seatrout in the overall catch, of which 89% of females are mature. The past increase in the minimum size limit from 12 inches to 14 inches enabled a higher percentage of spotted seatrout to spawn at least once.

Implementing an increase in the minimum size limit (12 inch limit) in the commercial fisheries may affect some fisheries and regions of the state more adversely than others. The long haul seine fishery and ocean gill net fisheries would be more affected than other fisheries, as is evident by looking at the composition of the commercial harvest (Figure 5781), as well as reduction in harvest by one inch size bins (Table 89). However, because long haul seines and ocean gill nets account for only 3-15% of the landings (Table 88), the overall decrease in harvest is less for these fisheries than in the estuarine gill net fishery. An increase in the minimum gill net mesh size used might become necessary to minimize discards of undersized spotted seatrout in these fisheries.

Estuarine gill nets are by far the dominant gear used to harvest spotted seatrout commercially, but they rarely catch small fish (Figure 81,Table 88, Table 89). Although estuarine gill nets rarely catch small fish, the magnitude of landings by estuarine gill nets would result in the highest reduction in harvest (Table 88). The gill net fishery in Albemarle Sound catches smaller spotted seatrout while those in other areas of the state would be less affected (Table 90), but landings from the Albemarle Sound area represent only 8% of total harvest (Figure 82).

The commercial fishery, which is largely composed of gill nets, tends to catch larger, older fish than the recreational hook-and-line fishery. As a result, the recreational fishery is predicted to experience 2.5 to 4 times more reduction in harvest than the commercial fishery under size limit restrictions (refer to Section 10.2.1). In addition, the average recreational fishing mortality rate from 2004 to 2006 is over 3 times greater than the commercial fishery (Jensen 2009, Appendix 4) (Figure 80). Therefore, the recreational fishery will experience a much larger reduction under size limit increases than the commercial fishery. An increase in the size limit can play an important role in reducing the overall harvest and allowing smaller fish the chance to spawn at least once before being harvested. The practice of releasing spotted seatrout in the recreational fishery has increased considerably in recent years. An increase in the minimum size would likely further increase the number of released undersized fish. Fishing tackle and fishing techniques could be modified to decrease the amount of discard mortality of released fish and listed in the Ethical Angling guide.

The minimum size limit can be combined with other management measures to achieve the desired level of harvest reduction in the spotted seatrout fishery.

Slot Limits

The Spotted Seatrout Advisory Committee suggested DMF consider a slot limit as a management measure to reduce harvest. Possible Slot limit combinations considered were 14 and 15 inches through 22, 23, and 24 inches.

Since relatively few large fish were represented in the sampling, the harvest reductions including a slot limit was negligible (Table 91 and Table 93). A slot limit of 14 to 24 inches would result in only a 0.7% reduction in the recreational fishery compared to just a size limit of 14 inches (no upper limit). Although this is a low percentage of the catch currently, protecting these larger, more fecund fish can result in a more productive spawning stock biomass per unit body weight.

The relative abundance of large fish (greater than or equal to 21 inches) in the commercial fisheries was only slightly higher in the estuarine gill nets than the long haul and beach seine fisheries (Table 89). However, due to the predominance of gill net landings, the estimated reduction in landings would be greatest in the estuarine gill net fishery. The estimated harvest of large fish was highest in the gill net fisheries in Pamlico Sound followed by the Rivers (Table 90). The Southern Area ranked second in the relative abundance of large fish, but the Southern Area only accounted for an average of 8% of the landings while Pamlico Sound and the Rivers Areas accounted for 48% and 27% of the landings (Figure 82).

Because spotted seatrout are typically caught as a bycatch in multispecies commercial fisheries, as well as their high estimated release mortality of 60%, slot limits are not a preferred management measure for the commercial fishery.   The protection of these large fish might be better approached through seasonal or area closures during the spawning season.

Trophy Fish

A harvest restriction commonly used in combination with slot limits is to allow the take of one fish, a “trophy fish”, over a maximum size per day. This option was endorsed by the Spotted Seatrout Advisory Committee (SST AC) and NCMFC. Because of the limitations of so few fish sampled greater than the proposed slot limits, the reduction in harvest with a trophy fish allowance are likely to be negligible. The concept of a trophy fish option is desirable because it protects the largest and potentially more fecund female fish. This option does not result in a quantifiable harvest reduction.

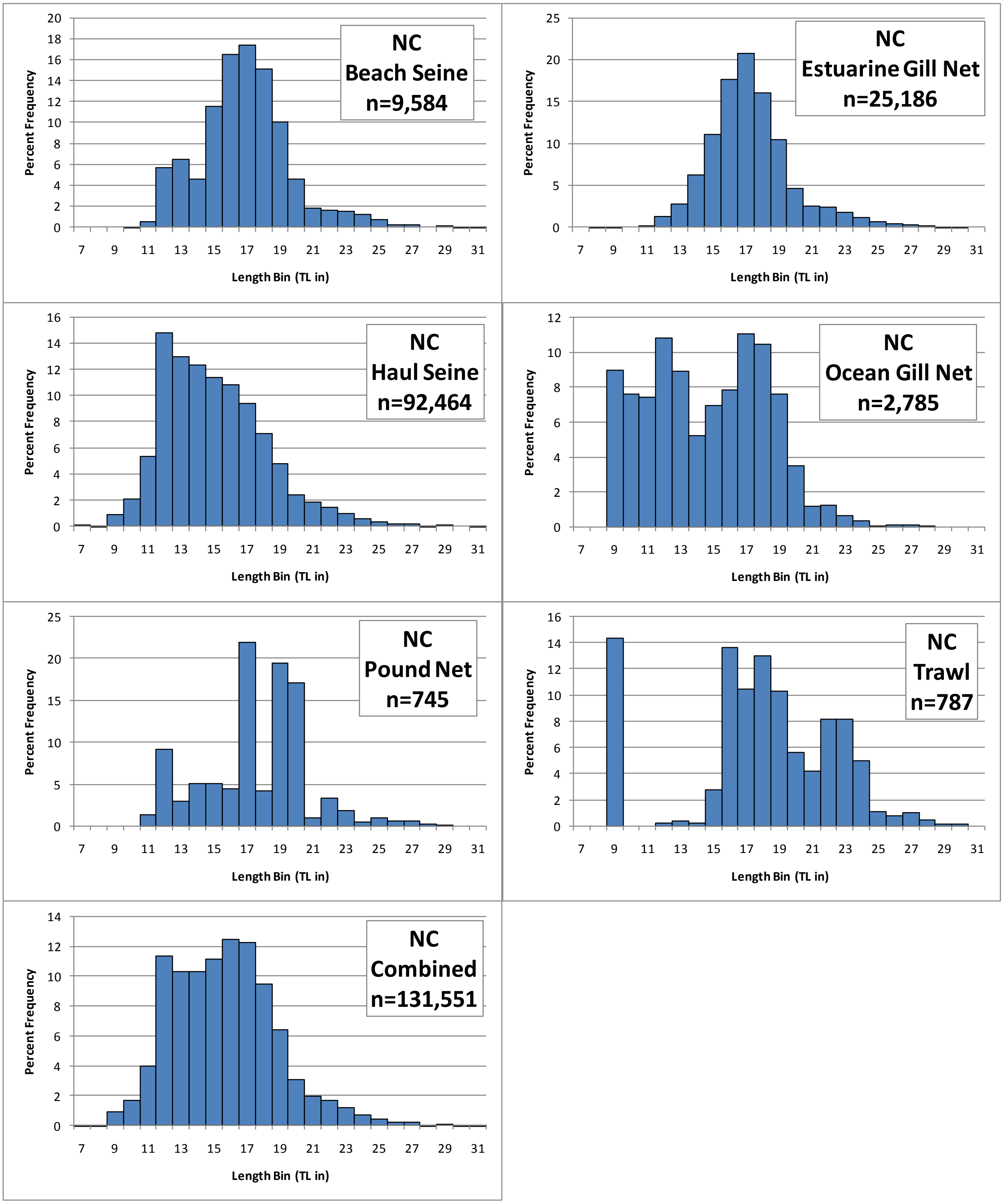


Figure 81. Annual length-frequency distributions of North Carolina commercial fisheries, 1994-2008.

Table 88.Annual landings (numbers) of spotted seatrout by commercial fishing gear* in North Carolina, 2003-2008.

	E Gill Net		Long Haul		Beach Seine		O Gill Net		Other		Total
Year	number	%	number	%	number	%	number	%	number	%	number
2003	112,583	73	25,373	16	4,738	3	4,451	3	7,515	5	154,661
2004	46,280	67	8,755	13	6,194	9	4,427	6	2,932	4	68,589
2005	42,112	69	6,288	10	8,080	13	2,317	4	2,340	4	61,136
2006	110,506	67	30,379	18	13,748	8	4,957	3	5,600	3	165,190
2007	137,348	75	26,868	15	6,533	4	3,349	2	8,220	5	182,319
2008	120,093	76	19,313	12	7,229	5	2,844	2	8,328	5	157,807
Mean	94,820	72	19,496	15	7,754	6	3,724	3	5,822	4	131,617

Table 89. Reduction in harvests associated with an increase in the minimum size and slot limits for the primary commercial fishing gear* (2003-2008 average).

	E Gill Nets			Long Hauls			Beach Seines			O Gill Nets			All Combined		
Size Limit (inches)	%	Cum %	Number	%	Cum %	Number	%	Cum %	Number	%	Cum %	Number	%	Cum %	Number
12	1.38	1.38	1,311	13.69	13.69	2,668	7.62	7.62	591	14.32	14.32	533	7.72	7.72	10,156
13	2.95	4.33	4,106	9.76	23.44	4,570	7.23	14.85	1,152	10.66	24.98	930	6.63	14.34	18,878
14	6.41	10.74	10,188	9.81	33.26	6,484	3.81	18.67	1,447	5.65	30.63	1,141	7.23	21.57	28,396
15	10.94	21.69	20,563	11.61	44.87	8,747	9.82	28.49	2,209	7.05	37.68	1,403	10.80	32.37	42,607
21	2.48	8.28	7,854	2.09	7.78	1,517	2.35	7.59	588	1.40	4.80	179	2.28	8.06	10,609
22	1.90	5.80	5,502	1.56	5.69	1,109	1.37	5.24	406	1.88	3.40	127	1.73	5.78	7,602
23	1.65	3.91	3,704	1.73	4.13	804	1.35	3.86	300	0.92	1.52	57	1.68	4.04	5,321
24	2.26	2.26	2,140	2.40	2.40	468	2.52	2.52	195	0.60	0.60	22	2.37	4.89	3,119

*E Gill Nets=Estuarine Gill Nets, Long Hauls=Long Hauls/Swipe Nets, Beach Seines=Beach Seines/Stop Nets, O Gill Nets=Ocean Gill Nets.

Bag Limits

Recreational fishermen are currently restricted to a 6-fish bag limit. The 6-fish bag limit was a result of the previous sustainable harvest management strategy which reduced harvest halfway to the sustainable benchmarks. A ten fish bag limit was requested by recreational fishermen in an effort to decrease the amount of excessive catches and was adopted in rule effective January 1st, 1991 (15A NCAC 03M.0504). Reductions in bag limits were empirically-based predictions using the average catch per angler trip estimated from 2003 to 2008 from the MRFSS survey (Table 91; Appendix 3). Any trips that landed over the proposed new limit in the past were assumed to land the maximum amount allowed under the proposed new limit. This analysis assumed 100% compliance with proposed regulations.

Bag limits only impact the recreational fishery and, because of the size of the recreational fishery, they can be effective at reducing the overall harvest. Approximately 73% of the trips that anglers took from 2003 to 2008 landed 3 or fewer spotted seatrout (Figure 83). The percent reduction achieved under various combinations of management options in the North Carolina recreational spotted seatrout fishery are presented in Table 92.

Trip Limits

Trip or vessel harvest limits for commercial fisheries 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. Reductions in trip limits were empirically-based predictions using the average catch per trip reported on trip tickets from 2003 to 2008 (Table 93, Table 94; Appendix 3). Any trips that landed over the proposed new limit in the past were assumed to land the maximum amount allowed under the proposed new limits. This analysis assumed 100% compliance with proposed regulations.

Spotted seatrout are not targeted by the majority of commercial fishermen, with the vast majority of trips (65%) landing 10 pounds or less per trip from 2003 to 2008 (Figure 84). Nearly 90% of trips landed 50 pounds or less per trip. However, 16-27% of the annual harvest was by catches greater than 500 pounds per trip (Figure 85). These occasional large catches occur in the long haul seine/swipe net, stop net, and strike net gill net fisheries that targeted spotted seatrout during the fall months. The long haul/swipe net fisheries occasionally caught greater than 500 pounds of spotted seatrout in one catch, while the strike net fisheries made several sets that collectively add up to over 500 pounds. Catches of spotted seatrout by area fished were similar, with the exception of larger catches (200-500 lbs) in the ocean (Figure 86). These were primarily by beach seines in the northern beaches and stop nets in Carteret County.

Table 90. Percent reductions in harvest from an increase in the minimum size limit for the estuarine gill net fishery by area*. (Reductions based on 2003-2008 biological sampling data, n=number of spotted seatrout measured).

	Percent Reduction											
Size Limit (TL, inches)	Albemarle Sound Gill Nets (n= 304)			Pamlico Sound Gill Nets (n= 6,597)			Southern Area Gill Nets (n= 3,135)			Rivers Gill Nets (n= 1,073)		
	%	cum %	number	%	cum %	number	%	cum %	number	%	cum %	number
12	4.93	4.93	376	0.56	0.56	275	1.82	1.82	118	2.61	2.61	903
13	8.12	13.04	995	2.08	2.64	1,263	1.70	3.52	229	4.64	7.25	2,507
14	13.62	26.67	2,034	6.45	9.08	4,354	4.69	8.21	535	6.43	13.68	4,731
15	15.07	41.74	3,184	9.64	18.72	8,974	10.79	19.00	1,238	13.20	26.87	9,297
21	1.16	5.22	398	3.01	9.85	4,724	2.52	7.97	520	1.53	5.54	1,917
22	1.74	4.06	310	2.04	6.84	3,280	2.52	5.45	355	1.44	4.01	1,389
23	1.45	2.32	177	2.06	4.80	2,301	0.88	2.93	191	1.10	2.57	891
24	0.87	0.87	66	2.74	2.74	1,313	2.05	2.05	134	1.47	1.47	509

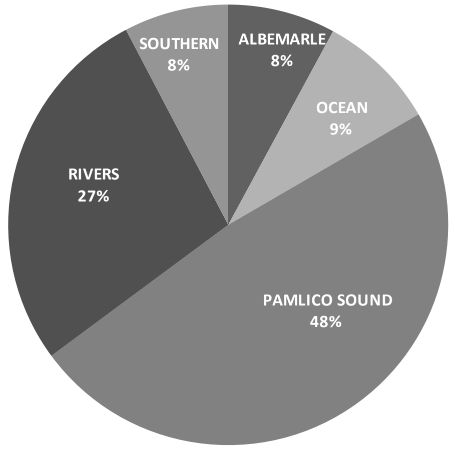


Figure 82. The percentage of all commercial landings (2003-2008) by area*.

**The Albemarle Sound Area includes the Albemarle Sound, Alligator River, Chowan River, Croatan Sound, Currituck Sound, Alligator River, Chowan River, Croatan Sound, Currituck Sound, Pasquatank River, Perquimans River, Roanoke River, and Roanoke Sound. The Pamlico Sound Area includes the Pamlico Sound, Bay River, Core Sound, and Newport River. The Rivers Area includes the Neuse River, New River, Pamlico River, and Pungo River. The Southern Area includes Bogue Sound, Cape Fear River, the Inland Waterway, Lockwood Folly, Masonboro Sound, North River, Shallotte River, Stump Sound, Topsail Sound, and White Oak River.*

Table 91. Reductions (%) in total removals associated with changes in recreational (Rec) bag limits, 2003-2008.

Bag Limit (#)	Rec
1	-67.2
2	-48.0
3	-35.4
4	-26.5
5	-19.4
6	-13.9
7	-9.6
8	-6.2
9	-3.7
10	-1.5

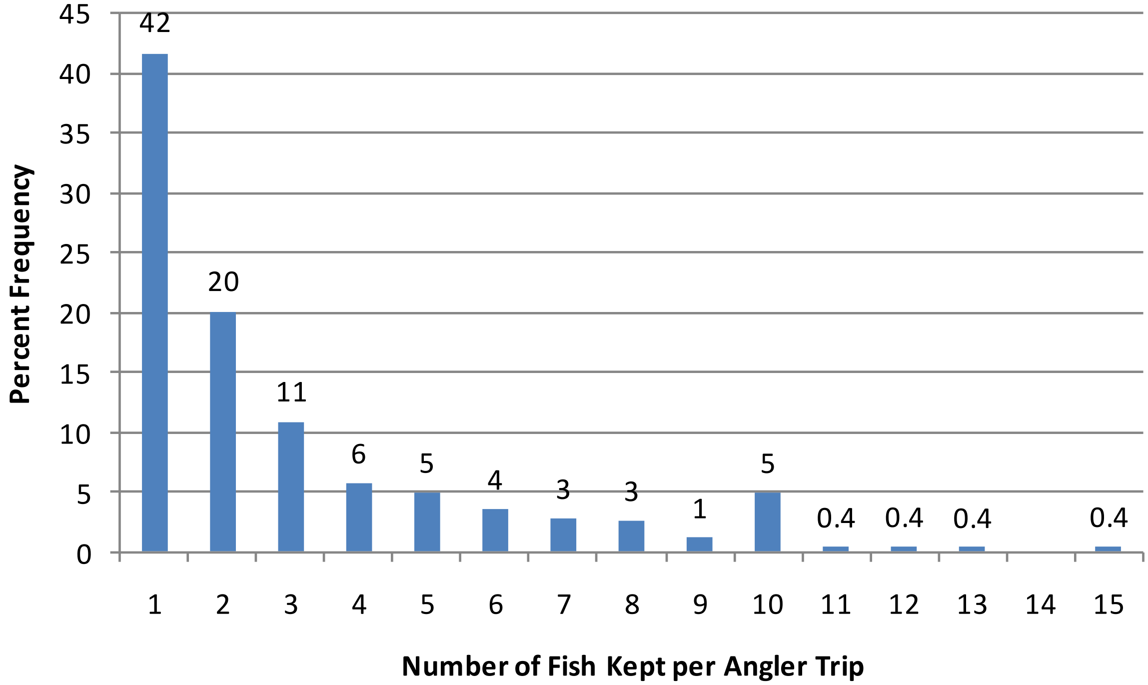


Figure 83. Average frequency of angler trips harvesting 1-10+ spotted seatrout per angler trip in North Carolina, 2003-2008.

Table 92. Percent reduction achieved under various combinations of management options in the North Carolina recreational spotted seatrout fishery, 2003-2008.

			Maximum Size Limit			
Size Limit	Bag Limit	No Slot	22	23	24	25
14 Inch Minimum Size Limit	1	72.9%	73.7%	73.5%	73.4%	73.3%
	2	57.1%	58.3%	58.1%	57.8%	57.6%
	3	46.8%	48.3%	48.0%	47.7%	47.4%
	4	39.4%	41.1%	40.7%	40.4%	40.1%

Size Limit	Bag Limit	No Slot	22	23	24	25
15 Inch Minimum Size Limit	1	74.5%	75.3%	75.2%	75.0%	74.9%
	2	59.7%	60.9%	60.7%	60.4%	60.2%
	3	50.0%	51.5%	51.2%	50.9%	50.6%
	4	43.0%	44.7%	44.4%	44.0%	43.7%

Table 93. Reductions (%) in total removals associated with various commercial (Com) trip limits, 2003-2008.

Trip Limit (lbs)	Com
10	-79.9
25	-66.5
50	-53.4
100	-39.1
150	-30.7
200	-24.9
250	-20.8
300	-17.6
350	-15.1
400	-13.0
450	-11.2
500	-9.9
None	0.0

Table 94. Percent reduction achieved under various combinations of management options in the North Carolina commercial spotted seatrout fishery, 2003-2008.

			Maximum Size Limit				
Size Limit	Trip Limit (lb)	Trip Limit (Number)	No Slot	22	23	24	25
14 Inch Minimum Size Limit	10	5	82.8%	82.7%	82.7%	82.7%	82.7%
	25	12	71.4%	71.3%	71.2%	71.2%	71.3%
	50	25	60.3%	60.1%	60.0%	60.0%	60.1%
	100	50	48.0%	47.7%	47.6%	47.6%	47.7%
	150	75	40.9%	40.5%	40.4%	40.5%	40.5%

Size Limit	Trip Limit (lb)	Trip Limit (Number)	No Slot	22	23	24	25
15 Inch Minimum Size Limit	10	5	83.1%	83.0%	83.0%	83.0%	83.0%
	25	12	71.8%	71.7%	71.6%	71.6%	71.7%
	50	25	60.9%	60.6%	60.6%	60.6%	60.6%
	100	50	48.8%	48.5%	48.4%	48.4%	48.5%
	150	75	41.7%	41.4%	41.3%	41.3%	41.4%

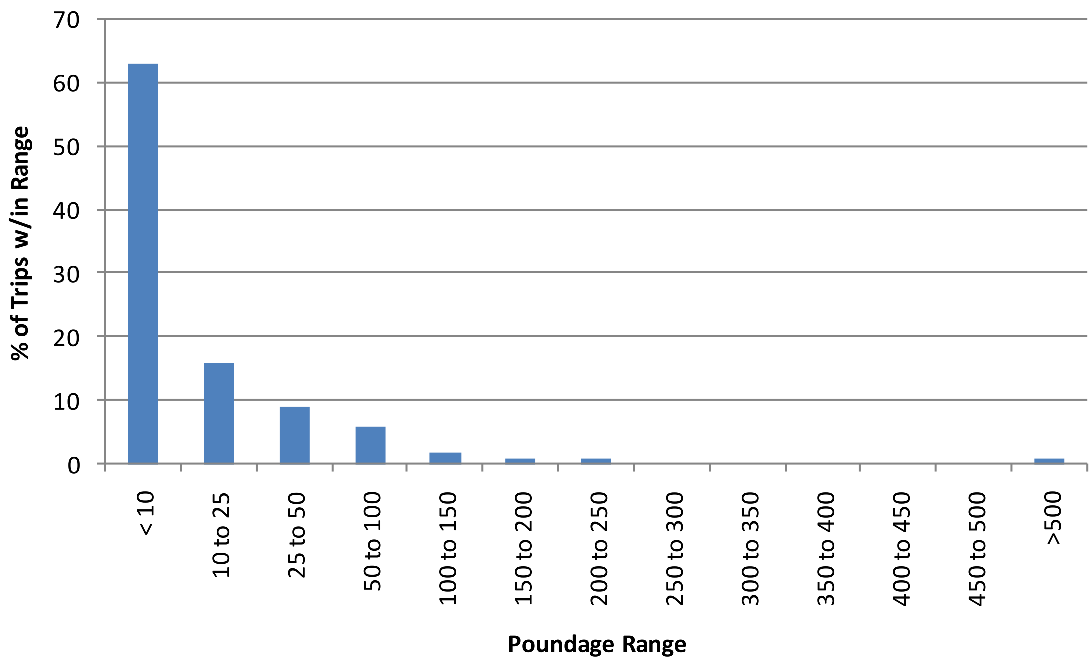


Figure 84. Average frequency of spotted seatrout commercial trips landing within a given poundage range in North Carolina, 2003-2008.

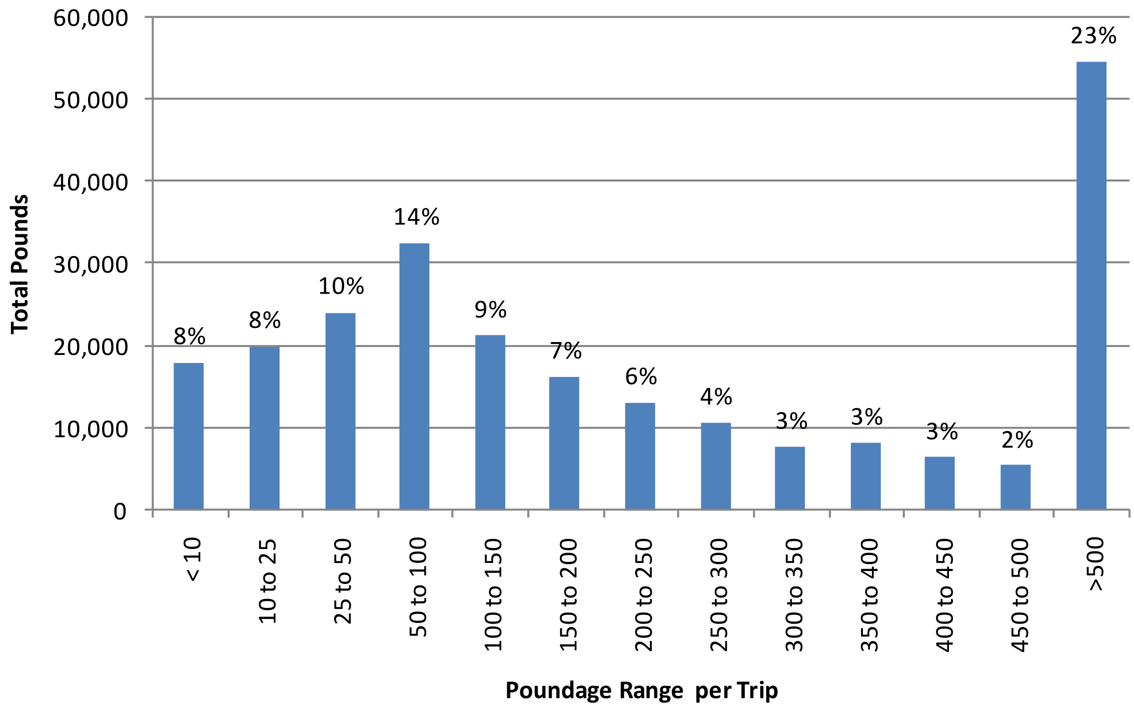


Figure 85. Total pounds of spotted seatrout commercially landed within given poundage ranges in North Carolina, 2003-2008.

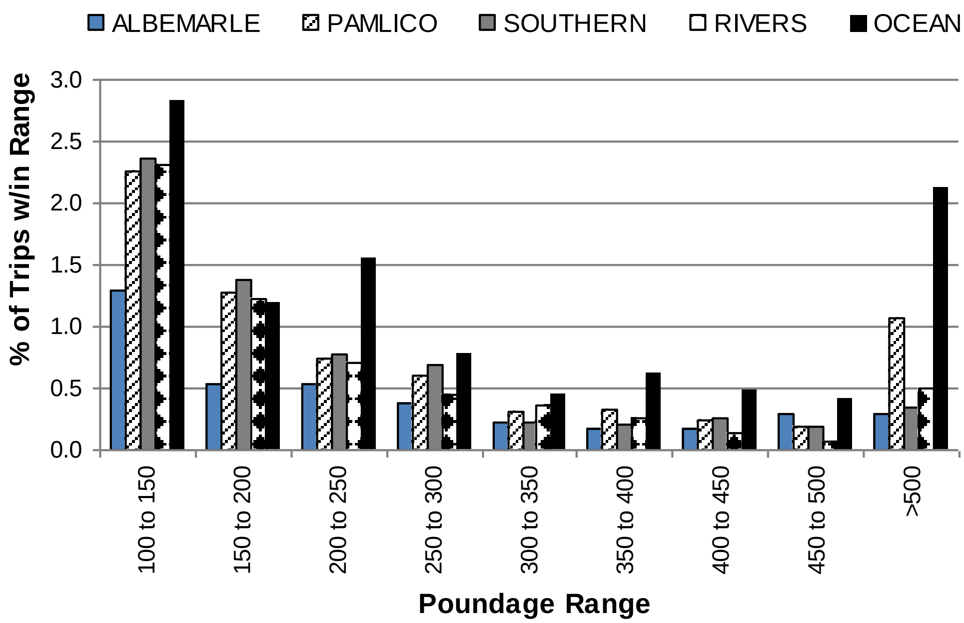


Figure 86. Average frequency of spotted seatrout commercial trip landings within given poundage ranges (trips ≥ 100 lbs), by area*, 2003-2008.

**The Albemarle Sound Area includes the Albemarle Sound, Alligator River, Chowan River, Croatan Sound, Currituck Sound, Alligator River, Chowan River, Croatan Sound, Currituck Sound, Pasquatank River, Perquimans River, Roanoke River, and Roanoke Sound. The Pamlico Sound Area includes the Pamlico Sound, Bay River, Core Sound, and Newport River. The Rivers Area includes the Neuse River, New River, Pamlico River, and Pungo River. The Southern Area includes Bogue Sound, Cape Fear River, the Inland Waterway, Lockwood Folly, Masonboro Sound, North River, Shallotte River, Stump Sound, Topsail Sound, and White Oak River.*

Area Closures

Area closures, such as nursery or spawning area closures, were not considered because data collection methods do not enable estimating the harvest from specific bodies of water. Estimates are available only on a very broad scale (e.g., Neuse River, Pamlico Sound, Pamlico River, etc.) and would likely not be useful for spotted seatrout management.

Seasonal Closures

A seasonal closure can be used to restrict harvest during certain times of the year and to reduce landings to sustainable levels. Seasonal closures are periods of time during which no landings of the target species are permitted. Because 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. Seasonal closures should only be used if other available management options fail to meet harvest reductions needed especially in the commercial fisheries where spotted seatrout are bycatch in several fisheries.

It is possible that a seasonal closure could cause an increase in effort during the open period. A closure early in the year could lead to increased amounts of nets being fished once the season opens, increasing both effort and spatial conflict among fishermen. 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 shuts down for the year. In either instance, the effectiveness of the closed season at maintaining the fishing mortality at or below the target level would be reduced. The season selected may also be used to protect spawning females, or to protect spotted seatrout during winter cold spells when they are particularly susceptible to harvest, which would concurrently help alleviate user conflict issues during the cold winter months. The season chosen will need to be a compromise which balances economic impact concerns with meeting the management goal. Seasons selected may be different for the recreational and commercial fisheries.

The highest percent daily harvest in the commercial and recreational fisheries occurs during the months of November and December. The commercial catch peaks in November and December represent an average of 41% of the annual harvest. The recreational catch peaked in wave 6 (November-December) representing approximately 45% of the total spotted seatrout harvest.

A spawning season closure can be used to protect fish while they are spawning. Spotted seatrout have a protracted spawning season which extends from April through October. The peak of the spawn occurs in May and June and was used as a management measure to protect spotted seatrout after two successive winters with documented cold stun events. The estimated reduction in harvest due to the closure from February 17th through June 15th, 2010 was 6.7% recreational and a maximum 16.9% commercial. The maximum reduction for the commercial fishery is based on no harvest. Commercial fishermen were allowed a bycatch harvest of 10% of the catch being spotted seatrout up to a maximum of 50 pounds per operation. However commercial landings are not available for 2011.

If season is selected as a management measure for the recreational fishery, managers should consider seasonality of hooking and discard mortality. Typically discard mortality is highest during the summer when water temperatures are highest and spotted seatrout spawn. The commercial fisheries that land spotted seatrout during the summer typically catch spotted seatrout as bycatch. Closing harvest during the summer would likely lead to increase regulatory discards with little benefit to the stock.

Another option would be to select a closed season during the cold weather months (November through March). Discard mortality is typically lowest during the fall and winter. Additionally a closure during cold weather months would help resolve conflict issues between recreational and commercial fishermen. It may be helpful if the season selected included the same cold water months (November through March) identified as peak conflict months between fishermen.

Days of the week could be considered for both recreational and commercial fishermen. A possible commercial closed season option is to prohibit commercial fishing or landing of spotted seatrout on weekends. Set gill nets with stretched mesh sizes between 4 and 6 ½ inches cannot be fished from Friday one hour after sunrise until Monday one hour before sunset due to the management measure put in place to reduce interactions with sea turtles. This restriction was estimated to reduce spotted seatrout landings by 11.7%. A recreational closure could occur during the week. The combined closed days of the week for recreational and commercial fishermen could reduce conflicts by reducing days that the fisheries overlap.

Quotas

A quota refers to the maximum amount of fish that can be legally landed within a specified time period. The objective of a quota would be to prevent further expansion of the fishery and reduce harvest; however, due to the recruitment dependence of the fishery and the resulting variability in available fish for harvest between years, a quota may not be sufficient in preventing overfishing during years of poor recruitment based on the level of fishing mortality.

Another potential problem with regulating the spotted seatrout commercial fishery using a quota is the variability in daily landings. A quota would have to be monitored daily or weekly with landing reports if the fishery is to be closed prior to exceeding the harvest limit. However, the potential magnitude of daily landings in both the gill net and haul seine fishery would make it very easy to surpass the quota before the fishery could be closed.

A quota system would be an additional burden on both the commercial dealers and the DMF. Spotted seatrout are caught as a bycatch in a number of multispecies fisheries. The spotted seatrout fishery consists of almost 1,548 participants and 215 dealers. Quotas currently monitored by the DMF (striped bass, summer flounder, black sea bass) have only involved between 150 to 700 participants and less than 100 dealers. The monitoring of an additional species is currently beyond the capabilities of the DMF given the existing level of personnel and available resources, and additional resources would have to be investigated. It would not be possible to implement a quota system until the necessary resources and personnel could be in place.

Estimates of possible commercial quota values are not included here because they are dependent on harvest reduction allocations. Once the allocation has been decided, quota options can be calculated and presented if desired.

Managing the recreational fishery with a quota is not feasible due to the lag time between the time of fishing and the time the harvest estimates become available through the Marine Recreational Intercept Program (MRIP). There is no system in place for monitoring recreational landings on a real-time basis that would allow for the fishery to be closed upon reaching the harvest limit.

Gear Restrictions

Maintaining effort at a stable level in the spotted seatrout fishery could be partially achieved by implementing specific gear limitations. These measures will only control effort provided the fishery does not expand much beyond its current level of participants. Currently, gill nets account for 76% of the commercial harvest (estuarine and ocean combined). Estuarine gill nets are by far the predominant gear (73%). Thus, any limitations would need to focus on this gear. Landings by long haul seines had historically been important. They continued to be the second most important gear, but accounted for only 13% of the 2003-2008 harvest.

Set gill nets from 4 to 6 ½ inches stretched mesh are managed under proclamation authority to reduce interactions with endangered sea turtles. Fishermen cannot possess or use greater than 2,000 yards of gill nets north of Highway 58 or 1,000 yards of gill nets south of Highway 58. Nets cannot be greater than 100 yards in length and must have a minimum of 25 yards between each net. Nets can be no greater than 15 meshes deep. Nets can only be fished during designated times. Currently the time restriction allows fishing one hour before sunset and nets must be retrieved one after sunrise. Fishermen are allowed to set nets Monday through Thursday night and the gear must be retrieved the following morning. These restrictions on set gill nets were estimated to reduce harvest in the commercial fishery by 13.1%.

Yardage Limit

Limiting the yardage of gill nets would help reduce and control effort within the gill net fishery for spotted seatrout. Although spotted seatrout can be caught in a variety of mesh sizes, they are primarily harvested with small mesh set nets (< 5 inch mesh). Data collected from a fishery dependent sampling program was used to characterize this fishery. Mesh sizes used varied by region, but overall ranged from 3 ¼ to 5 ¾ inch stretched mesh, with 4 inch webbing most common. Of the catches sampled (n=126) that targeted seatrout (at least 50% of the catch was spotted seatrout), the number of yards fished ranged from 67 to 3,000 yards with an average of 1,042 yards. Set gill nets with mesh sizes from 4 to 6 ½ inches stretched mesh are under proclamation authority which limits yardage using three restrictions: 1) fishermen cannot possess or use greater than 2,000 yards of gill nets north of Highway 58 or 1,000 yards of gill nets south of Highway 58, 2) set gill nets cannot be greater 100 yards in length, and 3) set gill nets must have a minimum of 25 yards between each net. This restriction was estimated to reduce harvest of spotted seatrout in the commercial fishery by 1.4%.

Limited Entry

There are limitations to establishing a limited entry system for fisheries in North Carolina. Section 2.1 of the FRA (G.S. 113-182.1) concerning FMPs states that the MFC can only recommend that the General Assembly limit participation in a fishery if the DMF determines that sustainable harvest in the fishery cannot otherwise be achieved. Currently, there are other options available for achieving sustainable harvest and ending overfishing for the spotted seatrout fishery. Therefore, limited entry is not a viable option for consideration at this time.

Combination of Management Options

A combination of management options may be the best approach to accommodate several different fisheries. The current proclamation uses a combination of size limit, creel limit, and closed days to achieve the previously approved management goal of achieving 50% of sustainable harvest. However additional reductions are now required due to the change in G.S. 113-182.1 (b) 4 which reduced the time frame to end overfishing from ten years to two years. Varying combinations of size limits, trip/creel limit, and seasonal closures were explored for recreational (Table 95) and commercial fisheries (Table 96). Areas shaded do not meet the required reductions estimated by the stock assessment model given the size selectivity. The primary assumption of the seasonal closure is that fish are not encountered during the closed seasons. Since this is not likely to occur and very little data were available to base recommendations, the values presented likely overestimate the total reductions due to seasonal closures. All of the reductions assume a 10% noncompliance for the size limit in the commercial fishery and the recreational fishery is based on past encounters of undersized spotted seatrout from the recreational survey. Additionally, seasonal closures will have some overlap with the reductions due to the restrictions enacted to reduce sea turtle interactions. The overall reduction was reduced by the month contribution due to overlap between seasonal closure and gill net restrictions. The required reductions in the commercial fishery can be met with a 14 inch size limit, 150 pound trip limit, and a seasonal closure from November 1st through December 10th. The required recreational reductions can be met with a 14 inch minimum size limit, 3 fish bag limit, and a seasonal closure from November 1st through December 10th. If the encounter rate increases from 0, a lower trip limit or longer seasonal closure would be required.

Timing of Implementation

The new regulation to end overfishing within two years requires the NCMFC to enact rules to achieve sustainable harvest in a timely fashion. However the regulation does not state at what time within the two years the rules should be enacted. The commission can decide to have the regulations enacted shortly after approval, one year after approval, or wait until November 2013.

A key piece of information for determining the sustainability of spotted seatrout should become available before the deadline to end overfishing in November 2013. NCSU is conducting a study to estimate natural and fishing mortality using telemetry and mark/recapture. The research being conducted on the natural mortality rate for spotted seatrout should provide a more accurate estimate of natural mortality (Pine et al. 2003; Jiang et al. 2007) than the natural mortality rate used in the Spotted Seatrout Stock Assessment (Jensen 2009). Spotted seatrout have a broad range of natural mortality due to the fish's susceptibility to cold stun as was experienced in most recently January/February and December of 2010. Data were not available to neither estimate the percent of the population nor total numbers lost during past cold stuns for the stock assessment. Therefore the increase in mortality due to cold stun was lumped into fishing mortality. These periodic spikes in fishing mortality rate likely have an impact on sustainability benchmarks. The natural and fishing mortality rate developed in the NSCU tagging and telemetry study can be compared with the current rate to determine if more or less restrictive management measures are needed after the study has been peer reviewed.

Table 95. Recreational reductions achieved with a combination of size limit, creel limit, and season/day of week closure.

						Seasons					
Size Limit	Bag Limit	No Closure	Nov 1 to Nov 30	Dec 1 to Dec 31	Apr 1 to Jun 30	Nov 1 to Dec 10	Dec 1 to Jan 31	Feb 1 to Aug 31	Dec 15 to Feb 28	72 hour	48 hour
14 Inch Minimum Size Limit	1	72.9%	78.4%	80.0%	75.2%	80.5%	80.0%	79.7%	80.1%	84.5%	80.7%
	2	57.1%	65.8%	68.3%	60.7%	69.2%	68.3%	67.8%	68.4%	75.4%	69.4%
	3	46.8%	57.6%	60.7%	51.2%	61.7%	60.7%	60.0%	60.8%	69.4%	62.0%
	4	39.4%	51.7%	55.2%	44.4%	56.4%	55.2%	54.4%	55.3%	65.2%	56.7%
	5	33.5%	47.0%	50.9%	39.0%	52.2%	50.9%	50.0%	51.0%	61.8%	52.5%
	6	29.0%	43.4%	47.6%	34.9%	49.0%	47.6%	46.7%	47.7%	59.2%	49.3%
	7	25.4%	40.6%	44.9%	31.6%	46.4%	45.0%	44.0%	45.1%	57.2%	46.8%

Size Limit	Bag Limit	No Closure	Nov 1 to Nov 30	Dec 1 to Dec 31	Apr 1 to Jun 30	Nov 1 to Dec 10	Dec 1 to Jan 31	Feb 1 to Aug 31	Dec 15 to Feb 28	72 hour	48 hour
15 Inch Minimum Size Limit	1	74.5%	79.7%	81.2%	76.7%	81.7%	81.2%	80.9%	81.3%	85.4%	81.8%
	2	59.7%	67.9%	70.2%	63.0%	71.0%	70.2%	69.7%	70.3%	76.9%	71.2%
	3	50.0%	60.1%	63.1%	54.1%	64.0%	63.1%	62.4%	63.1%	71.3%	64.3%
	4	43.0%	54.6%	57.9%	47.7%	59.0%	57.9%	57.2%	58.0%	67.3%	59.3%
	5	37.5%	50.2%	53.8%	42.7%	55.1%	53.9%	53.1%	54.0%	64.1%	55.4%
	6	33.3%	46.8%	50.7%	38.8%	52.0%	50.7%	49.9%	50.8%	61.7%	52.3%
	7	29.9%	44.2%	48.2%	35.7%	49.6%	48.3%	47.4%	48.4%	59.8%	50.0%

Table 96. Commercial reductions achieved with a combination of size limit, trip limit and season/day of week closure. This also includes a 13.1% reduction due to regulations designed to reduce interactions with sea turtles. Trip limit can be based on weight or number of fish. The average weight of spotted seatrout in the commercial fishery was 1.8 lbs.

Seasons

Size Limit	Trip Limit (lbs)	Trip Limit (Number)	No Closure	Nov 1 to Nov 30	Dec 1 to Dec 31	Apr 1 to Jun 30	Nov 1 to Dec 10	Dec 1 to Jan 31	Feb 1 to Aug 31	Dec 15 to Feb 28	Weekend Closures	Closure Dec 15 to Jan 31 and Weekends
14 inch minimum size limit	10	5	82.8%	86.8%	85.9%	85.1%	87.9%	87.9%	87.9%	87.5%	86.1%	89.0%
	25	12	71.4%	78.1%	76.5%	75.2%	79.9%	79.9%	79.9%	79.3%	76.9%	81.6%
	50	25	60.3%	69.5%	67.4%	65.6%	72.0%	72.0%	72.1%	71.2%	67.9%	74.5%
	100	50	48.0%	60.1%	57.3%	54.9%	63.4%	63.4%	63.4%	62.3%	58.0%	66.6%
	150	75	40.9%	54.6%	51.4%	48.7%	58.3%	58.4%	58.4%	57.1%	52.2%	62.0%
	200	100	35.9%	50.8%	47.4%	44.5%	54.9%	54.9%	54.9%	53.5%	48.3%	58.8%

Size Limit	Trip Limit (lbs)	Trip Limit (Number)	No Closure	Nov 1 to Nov 30	Dec 1 to Dec 31	Apr 1 to Jun 30	Nov 1 to Dec 10	Dec 1 to Jan 31	Feb 1 to Aug 31	Dec 15 to Feb 28	Weekend Closures	Closure Dec 15 to Jan 31 and Weekends
15 inch minimum size limit	10	5	83.1%	87.0%	86.1%	85.3%	88.1%	88.1%	88.1%	87.7%	86.3%	89.1%
	25	12	71.8%	78.4%	76.9%	75.6%	80.2%	80.2%	80.2%	79.6%	77.3%	81.9%
	50	25	60.9%	70.0%	67.9%	66.1%	72.4%	72.4%	72.5%	71.6%	68.4%	74.8%
	100	50	48.8%	60.7%	57.9%	55.6%	63.9%	63.9%	64.0%	62.8%	58.6%	67.1%
	150	75	41.7%	55.3%	52.1%	49.5%	59.0%	59.0%	59.0%	57.7%	52.9%	62.5%
	200	100	36.9%	51.5%	48.2%	45.3%	55.5%	55.6%	55.6%	54.2%	49.0%	59.4%
	250	125	33.4%	48.9%	45.3%	42.2%	53.1%	53.1%	53.1%	51.6%	46.2%	57.2%

IV. CONCLUSIONS

- Spotted seatrout are overfished and overfishing is occurring therefore harvest must be reduced.
- Projections, which are used to determine harvest reduction necessary to achieve a 50 percent likelihood of success, were deemed unusable for management because there was no discernable stock-recruitment relationship for spotted seatrout and large annual recruitment variability.
- For the spotted seatrout stock, the biology of the fish, environmental conditions, and lack of sufficient data make it unwise to rely on projections to specify an $F_{rebuild}$ rate that is compatible with professional standards for fisheries management.
- A range of reductions can be met with combinations of size limits (minimum, with or without a slot), bag limits and trip limits (Table 95 and Table 96).
- The stock can be reassessed in the near future to determine if the management strategy is enabling the stock to rebuild.
- Area specific closures cannot be quantified with the available data.
- Managing the recreational fishery with a quota is not feasible, and managing the commercial fishery with a quota would be difficult as well as an additional burden to commercial dealers and the NCDMF.

V. 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
15A NCAC 3M .0504 TROUT
15A NCAC 3M.0512 COMPLIANCE WITH FISHERY MANAGEMENT PLANS

VI. MANAGEMENT OPTIONS

End overfishing immediately:

Examples

- 14”: 2 fish bag limit, 50 lbs trip limit
- 14-24”: 2 fish bag limit, 100 lbs trip limit, weekend commercial closure
- 14-24”: 4 fish bag limit, 150 lbs trip limit, and a recreational and commercial closure November 1- December 10th

A. Modify Size Limits

Size limits alone are not likely to achieve the reduction necessary to achieve sustainable harvest and should be combined with other management options.

(i) Increase minimum size limit (size limit is 14 inches)

+ Increase in the spawning stock biomass and the overall yield to the fishery
+ Allows more immature fish the opportunity to spawn at least once before being caught
+ Reduces landings and harvest closer to a sustainable level
+ Reduces harvest levels closer to the target fishing mortality level

+ Could be applied to both the commercial and recreational fisheries
- Decrease in the yield to the fishery in the short-term
- Some regions may be impacted more than others
- Overfishing could still occur if fishing mortality increases on legal sized fish
- Effectiveness diminished if proportion of undersized fish in the catch increases due to release mortality
- Increase in regulatory discards in the commercial and recreational fisheries

(ii) Establish maximum size (slot limits)

+ Protects the largest fish in the spawning stock
+ Potentially protects fish with the highest egg production
+ Will allow more fish to survive as size and age structure expands
- Very little reduction in commercial and recreational landings
- May increase pressure on fish in the slot limit
- Increase in regulatory discards due to bycatch in commercial fishery
- Increase in regulatory discards in the recreational fishery
- Data collection for future assessments on largest, potentially oldest fish becomes more limited

(iii) Establish maximum size (slot limits) with a trophy fish

+ Provides some protection for the largest fish in the spawning stock
+ Potentially reduces harvest on fish with the highest egg production
+ Will allow more fish to survive as size and age structure expands than managing with no slot limit
+ Enables data collection for future assessments on largest, potentially oldest fish
- Reduces the effectiveness of slot limit due to harvest of the trophy fish
- Reduction in commercial and recreational landings is not quantifiable
- May increase pressure on fish in the slot limit
- Increase in regulatory discards due to bycatch in commercial fishery
- Increase in regulatory discards in the recreational fishery
- Fishermen may high grade to keep the largest trophy fish

B.) Trip/creel limits

Trip/creel limits alone are not likely to achieve the reduction necessary to achieve sustainable harvest and should be combined with other management options.

+ Reduces harvest in the fishery
+ Potential management measure for both the commercial and recreational fisheries
+ Combined with size limit can achieve sustainability threshold with no seasonal closure
- May lead to increased regulatory discards in the commercial fishery
- May adversely impact some fisheries and fishermen more than others
- Potential for high grading as fishermen reach creel limit

C.) Seasonal closure

+ Reduces harvest in the fishery
+ Flexibility to close among fisheries
+ Combined with size and/or creel/trip limits can achieve sustainability threshold
+ Potential to close fishery when discard mortality rate is lowest
+ Potential to close during spawning season

- − May lead to increased regulatory discards in some fisheries
- − May adversely impact some fisheries and fishermen more than others
- − Potential for recoupment if closed season is not sufficiently long

D.) Timing of Implementation

(i) End Overfishing Immediately

- \+ Provides the longest time period for the stock to rebuild after overfishing has ended
- \+ Update stock assessment has a longer terminal management regime
- − Limited time to publish and disperse new regulations
- − Does not consider research from NCSU study on spotted seatrout natural and fishing mortality
- − Impacts fishermen immediately

(ii) End Overfishing in One Year

- \+ Provides moderate time period to end overfishing
- \+ Stock assessment is better able to determine effects of current management regulations compared to immediately ending overfishing
- \+ Size limits, creel limits, bag limits, and seasons are able to be published and dispersed
- \+ Fishermen are able to prepare for new regulations
- − Does not consider research from NCSU study on spotted seatrout natural and fishing mortality
- − Overfishing continues for an additional year

(iii) End Overfishing in November 2013

- \+ Can consider published results from NCSU study on spotted seatrout natural and fishing mortality before enacting management regulations
- \+ Provides longest time period for publishing and dispersing regulations
- \+ Fishermen are able to prepare for regulations
- − Provides shortest time period for stock to rebuild
- − Overfishing continues for two additional years
- − Most risk prone action

Management Recommendations to End Overfishing Within Two Years

SST AC: 14 minimum size limit, two fish recreational bag limit, 50 fish commercial trip limit, no commercial possession on weekends, estuarine gill nets and long hauls out of the water on weekends, reassess in 3 years or when new information becomes available, implement management measures immediately, and eliminate the use of treble hooks with natural bait in estuarine waters and areas where spotted seatrout are typically targeted.
DMF: 14 inch minimum size limit, two fish recreational bag limit, 25 fish commercial trip limit, adaptive management to review and respond to new information regarding any aspect of the plan, implement immediately.
DMF: 14 inch minimum size limit, three fish recreational bag limit, 75 fish commercial trip limit, no commercial possession on weekends, allow gear on weekend (assumes 25% encounter rate with 60% mortality), recreational and commercial closure December 15- January 31, adaptive management to review and respond to new information regarding any aspect of the plan, implement immediately.

MFC: Immediately: 14 inch minimum size limit, 4 fish recreational bag limit, 75 fish commercial trip limit, no gillnetting in joint waters on weekends (~40% reduction for both recreational and commercial sectors).
February 2014: 14 inch minimum size limit, 3 fish recreational bag limit and closure December 15-January 31, 25 fish trip commercial trip limit (no seasonal or area closure).
If Cold Stun Occurs: Close through June 1 and reopen with 4 fish recreational bag limit, 75 fish commercial trip limit.
Adaptive Management Consideration: The Stop Net Fishery requested a quota as opposed to the 75 trip limit (see Appendix). This was to limit a potential discard issue. The stop net fishermen agreed to limit their sets and if they reached their quota they would remove their gear from the water.

VII. RESEARCH RECOMMENDATIONS

6. Estimates of natural mortality (research currently underway).

7. Batch fecundity estimates are needed for spotted seatrout in North Carolina. Estimates of batch fecundity from North Carolina could help to identify a stock-recruitment relationship, and may provide better estimates of spawning potential ratios and future recruitment.

8. Research the feasibility of including measures of temperature and/or salinity into the stock-recruitment relationship.

9. Area specific spawning surveys could help in the delineation of area specific closures to protect females in spawning condition.

10. Juvenile index of abundance is needed to develop a better understanding of a stock recruitment relationship.

11. A very robust release mortality study needs to be conducted for recreationally and commercially caught spotted seatrout.

11. MANAGEMENT PROGRAM

A management program has been developed in an effort to meet the goals and objectives of this FMP as listed in Section 4.2. This section outlines the need for additional data in order to improve our ability to assess the status of the spotted seatrout stocks, details the recommended management actions of the PDT and the Spotted Seatrout Advisory Committee, and summarizes the research needs covered in this plan.

11.1 Data Needs

Additional data are needed to improve spotted seatrout stock assessments, to better evaluate the effects of current management actions, and to identify additional management actions that will allow for the long-term sustainability of the North Carolina spotted seatrout stock. A listing of data needs is provided below.

1. Improved Fishery-Dependent Sampling.

Available catch statistics may not be complete for the reasons described in detail below.

There is limited sampling of at-sea discarding in commercial fisheries which should be continued and expanded. Although spotted seatrout are considered a bycatch species for most of the year and sometimes targeted seasonally (Section 7.1, Section 7.2), they are encountered by many different fisheries throughout the state. Observer coverage has focused on large mesh gill net fisheries (>=5 inch stretched mesh), while spotted seatrout are primarily caught in small mesh gill nets (< 5 inch stretched mesh). Observer coverage needs to be increased in the small mesh gill net fishery, and in a variety of commercial fisheries, and over a wider area.

If spotted seatrout from Virginia continue to be included in future spotted seatrout stock assessments for North Carolina, sampling of the recreational fishery in Virginia should be improved. In recent years, recreational harvest accounts for approximately 60% of the total North Carolina harvest, and approximately 80% of the total Virginia harvest. All estimates generated through MRFSS include the proportional standard error (PSE), which is a measure of the precision of the estimate. 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 (DMF 2007). Precision of harvest estimates in terms of the PSE were below 20 in all years for North Carolina while Virginia had only four years (1994, 1995, 2007, and 2008) of the 18-year time series with a PSE less than 20.

In 2004, the DMF 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 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 unpredictable distribution of spotted seatrout due to changes in salinity in upper estuarine and inland regions will make results from this survey a useful addition in future assessment of the overall harvest of this species.

2. Improved Fishery-Independent Sampling

Surveys at age are needed to better monitor the abundance of spotted seatrout. The DMF initiated an independent gill net survey in estuarine waters designed to provide an index of abundance for spotted seatrout in North Carolina. The survey was initiated in 2001, and relatively few spotted seatrout were captured in the independent gill net survey. A longer time series and additional sources of fishery-independent information are needed.

3. Improved Estimates of Vital Rates

Assessment and population model results are sensitive to input parameters such as natural mortality, fecundity, and growth rates. Research should be directed at estimating these important vital rates for spotted seatrout in North Carolina.

4. Improved Tagging Programs

The ASMFC has emphasized advanced tagging techniques as the methodology for obtaining precise estimates needed for accurate stock assessments. A spotted seatrout tagging program has been initiated by North Carolina State University in 2009, funded by the NC Marine Resources Fund. The project combines conventional and telemetry tagging to provide estimates of fishing mortality, natural mortality, and stock boundaries. Conventional tagging and telemetry approaches have been used successfully to estimate fishing and natural mortality rates and movement on another important estuarine fish in North Carolina, red drum (Bacheler et al. 2008). Telemetry tagging can directly estimate natural mortality which is often indirectly estimated through life history parameters, as was done for spotted seatrout in North Carolina (Jensen 2009, Appendix 4). These estimates will be invaluable in determining if the North Carolina stock assessment used appropriate values. For example, if we are currently using too high a natural mortality rate then this would result in lost production that would otherwise go to fishers. Telemetry data can also provide precise estimates of mortality attributed to cold stun events; a critical component to an accurate stock assessment.

11.2 Management Strategies and Proposed Actions

Management strategies and management recommendations will be updated upon MFC selection of approved management options.

11.3 Habitat and Water Quality Management Recommendations

Habitat and Water Quality management recommendations will be updated upon MFC approval.

11.4 Research Needs Summary

The following research needs were compiled from those listed in the issue papers in Section 10, as well as those outlined in Section 11.1 Data Needs, and in Appendix 4 Stock Status. Improved management of spotted seatrout is dependent upon research needs being met. Research needs are not listed in order of priority**.**

- Develop a juvenile abundance index to develop a better understanding of a stock recruitment relationship.

- Research the feasibility of including measures of temperature or salinity into the stock-recruitment relationship could be researched.

- Determine batch fecundity estimates for North Carolina.

- Size specific fecundity estimates for North Carolina spotted seatrout.

- Area specific spawning surveys could help in the delineation of area specific closures to protect females in spawning condition.

- Investigation of the relationship of temperature with both adult and juvenile mortality.
- Incorporate cold stun event information into the modeling of the population.
- Estimate or develop a model to predict the impact of cold stun events on local and statewide spotted seatrout abundances
- Obtain samples (length, age, weight, quantification) of the cold stun events as they occur.
- Define overwintering habitat requirements of spotted seatrout.
- Determine factors that are most likely to influence the severity of cold stun events in North Carolina, and separate into low and high salinity areas.
- Investigate the distribution of spotted seatrout in nursery and non-nursery areas.
- Further research on the possible influences of salinity on release mortality of spotted seatrout
- Survey of fishing effort in creeks with conflict complaints.
- Determine targeted species in nursery areas and creeks with conflict complaints.
- Microchemistry, genetic, or tagging studies are needed to verify migration patterns, mixing rates, or origins of spotted seatrout between North Carolina and Virginia.
- Tagging studies to verify estimates of natural and fishing mortality.
- Tagging studies to determine if there are localized populations within the state of North Carolina (e.g., a southern and northern stock).
- A longer time series and additional sources of fishery-independent information.
- Increased observer coverage in a variety of commercial fisheries over a wider area.
- Expand nursery sampling to include SAV bed sampling in high and low salinity areas during the months of July through September.
- Evaluate the role of shell hash and shell bottom in spotted seatrout recruitment and survival, particularly where SAV is absent.
- Evaluate the role of SAV in the spawning success of spotted seatrout.

11.4 Review Cycle

As provided in the FRA of 1997, the Spotted Seatrout Fishery Management Plan will be reviewed and revised at least every three to five years with the support of advisors. The adaptive management option selected at this time was to achieve one half of the reductions necessary and to reassess after three years to evaluate the effectiveness of the measures to reduce harvest.

12. LITERATURE CITED

Able, K.W. and Fahay, M.P. 1998. The first year in the life of estuarine fishes in the middle Atlantic bight. New Brunswick, New Jersey: Rutgers University Press.

Allanson, B.R., Bok, A., and van Wyk, N.I. 1971. The influence of exposure to low temperature on *Tilapia mossambica* Peters (Cichlidae). II. Changes in serum osmolarity, sodium and chloride ion concentrations. Journal of Fish Biology 3, 181-185.

Asher, J. 2001. Comparison of sampling methodology during the October-November 2000 stop net fishery season. Masters Thesis for Duke University-Nicholas School of the Environment. 10 pp.

ASMFC (Atlantic States Marine Fisheries Commission). 1984. Fishery Management Plan for Spotted seatrout. Fisheries Management Report No. 4. ASMFC, Washington, DC. 101 p.

ASMFC (Atlantic States Marine Fisheries Commission). 1993. Proceedings of the workshop on spotted seatrout (*Cynosion nebulous*). Atlantic States Marine Fisheries Commission, Special Report No. 27, Washington, D.C.

ASMFC (Atlantic States Marine Fisheries Commission). 2000. Evaluating fishing gear impacts to submerged aquatic vegetation and determining mitigation strategies. Habitat Management Series No. 5. ASMFC, Washington, DC. 38 p.

ASMFC (Atlantic States Marine Fisheries Commission). 2007. The importance of habitat created by molluscan shellfish to managed species along the Atlantic coast of the United States. Habitat Management Series No. 8. ASMFC, Washington, DC. 108 p.

ASMFC (Atlantic States Marine Fisheries Commission). 2008. 2008 Review of the Atlantic States Marine Fisheries Commission Fishery Management Plan for Spotted Seatrout (*Cynoscion nebulosus*).

Auster, P.J. and R.W. Langton. 1999. The effects of fishing on fish habitat. p. 150-187. *In* L.R. Benaka (ed.), Fish Habitat: Essential Fish Habitat and Rehabilitation. American Fisheries Society, Symposium 22, Bethesda, MD.

Bacheler, N.M., J.E. Hightower, L.M. Paramore, J.A. Buckel, and J.H. Pollock. 2008. An Age-Dependent Tag Return Model for Estimating Mortality and Selectivity of an Estuarine-Dependent Fish with High Rates of Catch and Release. Transactions of the American Fisheries Society, 137: 1422-1432.

Bahr, L.N. and W.P. Lanier. 1981. The ecology of intertidal oyster reefs of the South Atlantic coast: a community profile. FWS/OBS-81/15. U.S. Fish and Wildlife Service, Washington, DC. 105 p.

Baltz, D.M., C. Rakocinski, and J.W. Fleeger. 1993. Microhabitat use by marsh-edge fishes in a Louisiana estuary. Environmental Biology of Fishes 36: 109-126.

Barrios, A.T., G.H. Beckwith, Jr., and P.S. Rand. 2006. Identification of critical spawning habitat and male courtship vocalization characteristics of red drum, *Sciaenops ocellatus*, in the lower Neuse River estuary of North Carolina. Final Report 05-EP-05. North Carolina Sea Grant Fishery Research Grant Program. 39 p.

Batsavage, C. 2007. Winter trawl fishery assessment. *In* Assessment of North Carolina Commercial Finfisheries, 2004-2007, Final Performance Report NA 04 nmf4070216, North Carolina Department of Natural Resources, Division of Marine Fisheries, Morehead City, NC, USA. 45 pp.

Beck, M.W., K.L. Heck Jr., K.W. Able, D.L. Childers, D.B. Eggleston, B.M. Gillanders, B. Halpern, C.G. Hays, K. Hoshino, T.J. Minello, R.J. Orth. P.F. Sheridan, and M.P. Weinstein. 2001. The identification, conservation, and management of estuarine and marine nurseries for fish and invertebrates. Bioscience 51(8): 633-641.

Bennett, A.F. 1990. Thermal dependence of locomotor capacity. American Journal of Physiology. 259, R253-R258.

Boesch, D.F. and R.E. Turner. 1984. Dependence of fishery species on salt marshes: the role of food and refuge. Estuaries 7(4): 460-468.

Brady, D.C., T.E. Targett, and D.M. Tuzzolino. 2008. Behavioral responses of juvenile weakfish (*Cynoscion regalis*) to diel-cycling hypoxia: swimming speed, angular correlation, expected displacement and effects of hypoxia acclimation. Canadian Journal of Fisheries and Aquatic Sciences: *In press*.

Brett, J. R. 1971. Energetic responses of salmon to temperature. A study of some thermal relations in the physiology and freshwater ecology of sockeye salmon (*Oncorhynchus nerka*). American Zoology 11, 99–113.

Brian, J.V., C.A. Harris, M. Scholze, T. Backhaus, P. Booy, M. Lamoree, G. Pojana, N. Jonkers, T. Runnalls, A. Bonfa, A. Marcomini, and J.P. Sumpter. 2005. Accurate prediction of the response of freshwater fish to a mixture of estrogenic chemicals. Environmental Health Perspectives 113(6): 721-728.

Brown, K. 2009. Characterization of the near-shore commercial shrimp trawl fishery from Carteret County to Brunswick County, North Carolina, Completion Report for NOAA Award No. NA05NMF4741003. 29 pp

Brown, N.J. 1981. Reproductive biology and recreational fishery for spotted seatrout, *Cynoscion nebulosus*, in the Chesapeake Bay area, M.A. thesis, College of William and Mary, Gloucester Point, VA.

Brown-Peterson, N.J. 2003. The reproductive biology of spotted seatrout. *In* Biology of the spotted seatrout (S.A. Bortone, ed.) p. 99-133. CRC Press, Boca Raton, FL.

Brown-Peterson, N.J., P. Thomas, and D.R. Arnold. 1988. Reproductive biology of female spotted seatrout, *Cynoscion nebulosus*, in south Texas. Fish. Bull., U.S., 86:373-388.

Brown-Peterson, N.J. and J.R.Warren, 2001. The reproductive biology of spotted seatrout, *Cynoscion nebulosus*, along the Mississippi Gulf coast, Gulf Mex. Sci., 19:61-73.

Brown-Peterson, N.J., M.S. Peterson, D.L. Nieland, M.D. Murphy, R.G. Taylor, and J.R. Warren. 2002. Reproductive biology of female spotted seatrout, *Cynoscion nebulosus,* in the Gulf of Mexico: differences among estuaries? Environmental Biology of Fishes 63: 405-415.

Burgess, C.C., A.J. Bianchi, J. Murauskas, and S. Crosson. 2007. Impacts of hurricanes on North Carolina fisheries. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 233 p.

Burkholder, J.M., H.B. Glasgow Jr., and J.E. Cooke. 1994. Comparative effects of water-column nitrate enrichment on eelgrass *Zostera marina*, shoalgrass *Halodule wrightii*, and widgeongrass *Ruppia maritima*. Marine Ecology Progress Series 105: 121-138.

Burkholder, J.M., H.B. Glasgow Jr., and C.W. Hobbs. 1995. Distribution and environmental conditions for fish kills linked to a toxic ambush predator dinoflagellates. Marine Ecology Progress Series 124: 43-61.

Burns, B. 1996. Life history and population dynamics of spotted seatrout (*Cynoscion nebulosus)* in North Carolina. Life History of Selected Marine Recreational Fishes in North Carolina Completion Report Grant F-43 Study 4. NC DNR. Morehead City, NC 29pp.

Butler, P.A. 1969. The significance of DDT residues in estuarie fauana. p. 205-220. *In* M.W. Miller and G.B. Berg (eds.), Chemical Fallout. Chalres C. Thomas Publishers, Springfield, IL.

Butler, P.A., R. Childress, and A.J. Wilson Jr. 1970. The association of DDT residues with losses in marine productivity. FAO Technical Conference on Marine Pollution and its Effects on Living Resources and Fishing. 13 p.

Cahoon, L.B., M.H. Posey, T.D. Alphin, D. Wells, S. Kissling, W.H. Daniels, and J. Hales. 2002. Shrimp and crab trawling impacts on estuarine soft-bottom organisms. University of North Carolina-Wilmington, Wilmington, NC. 17 p.

Chestnut, A.F. 1955. The distribution of oyster drills in North Carolina. Proceedings of the National Shellfishing Association 46: 134-139.

Chesnut, A. and H. Davis 1975. Synopsis of Marine Fisheries of North Carolina. Part 1: Statistical Information, 1880-1973. North Carolina Sea Grant Award No. UNC-SG-75-12. 425 p.

Chmura, G.L. and N.W. Ross. 1978. Environmental impacts of marinas and their boats. RIU-T-78-005. Rhode Island Sea Grant, Narragansett, RI. 675 p.

Churchill, J.H., R.B. Forward, R.A. Luettich, J.J. Hench, W.F. Hettler, L.B. Crowder, and J.O. Blanton. 1999. Circulation and larval fish transport within a tidally dominated estuary. Fisheries Oceanography 8 (Suppl. 2): 173-189.

COE (U.S. Army Corps of Engineers). 2001. The New York District's biological monitoring program for the Atlantic coast of New Jersey, Asbury Park to Manasquan section beach erosion control project. Final Report. COE, Vicksburg, MS. 103 p.

COE (U.S. Army Corps of Engineers). 2003. Effects of dredged material beach disposal on surf zone and nearshore fish and benthic resources on Bald Head Island, Caswell Beach, Oak Island and Holden Beach, North Carolina: interim study findings. Versar, Inc., Columbia, MD.

Coen, L.E., M.W. Luckenbach, and D.L. Breitburg. 1999. The role of oyster reefs as essential fish habitat: a review of current knowledge and some new perspectives. p. 438-454. *In* L.R. Benaka (ed.), Fish Habitat: Essential Fish Habitat and Rehabilitation. American Fisheries Society, Symposium 22, Bethesda, MD.

Collie, J.S., G. A. Escanero, and P.C. Valentine. 1997. Effects of bottom fishing on the benthic megafauna of Georges Bank. Marine Ecology Progress Series 155: 159-182.

Colura, R.L., A. Mach., and R. Buckley. 1994. Comparison of Texas spotted seatrout growth among year classes and bay systems, Final Report for Federal Aid in Fisheries Restoration Act Project F-36-R, in Marine Resources Culture and Enhancement, Texas Parks and Wildlife Department, Austin.

Connell, B. and T. Murphey. 2004. A preliminary evaluation of the effects of dock shading on density and coverage of shoal grass (*Halodule wrightii*). North Carolina Department of Environment and Natural Resources, North Carolina Division of Marine Fisheries, Morehead City, NC. 13 p.

Conover, D. O. 1992. Seasonality and the scheduling of life history at different latitudes. Journal of Fish Biology 41 (Suppl. B), 161–178.

Cooper, E.R., T.C. Siewicki, and K. Phillips. 2008. Preliminary risk assessment database and risk ranking of pharmaceuticals in the environment. Science of the Total Environment 398: 26-33.

Costanza, R., O. Perez-Maqueo, M.L. Martinez, P. Sutton, S.J. Anderson, and K. Mulder. 2008. The value of coastal wetlands for hurricane protection. Ambio 37(4): 241-248.

Crabtree R.E., and D.H. Adams 1998. Spawning and fecundity of spotted seatrout, *Cynoscion nebulosus,* in the Indian River Lagoon, Florida. *In* Investigations into nearshore and estuarine gamefish abundance, ecology, and life history in Florida, p. 526-566. Tech. Rep. For Fed. Aid in Sport Fish Rest. Act Project F-59. Florida Marine Research Institute, Department of Environmental Protection, 100 Eight Ave. SE, ST. Petersburg, FL 33701.

Crosson, S. 2007a. A social and economic analysis of commercial fisheries in North Carolina: Albemarle and Pamlico Sounds. North Carolina Department of Environment, Health, and Natural Resources, Division of Marine Fisheries, Morehead City, NC.

Crosson, S. 2007b. A social and economic analysis of commercial fisheries in North Carolina: Core Sound. North Carolina Department of Environment, Health, and Natural Resources, Division of Marine Fisheries, Morehead City, NC.

Cunningham, P.A., R.J. Curry, R.W. Pratt, S.J. Stichter, K. West, L.Mercer, P.Phalen, S. Sherman, B. Burns and S. Winslow. 1992. Long haul seining (and swipe netting). Pp. 209-213. In: Watershed Planning in the Albemarle-Pamlico Estuarine System. Report 5-Fishing Practices. Prepared by the Albemarle-Pamlico Estuarine Study, Raleigh, NC, U.S. Env. Protection Agency and NC Dept. Environ. Health Nat. Res., Rep. No. 92-05. 227 pp.

Currie, D.R. and G.D. Parry. 1996. Effects of scallop dredging on a soft sediment community: a large-scale experimental study. Marine Ecology Progress Series 121: 99-116.

Currin, C.A. S.Y. Newell, and H.W. Paerl. 1995. The role of standing dead *Spartina alterniflora* and benthic microalgae in salt marsh food webs: considerations based on multiple stable isotope analysis. Marine Ecology Progress Series 121: 99-116.

Dahl, T.E. 2000. Status and trends of wetlands in the conterminous United States 1986 to 1997. U.S. Fish and Wildlife Service, Washington, DC. 82 p.

Daniel, L. B. III. 1988. Aspects of the biology of juvenile red drum, *Sciaenops ocellatus* and spotted seatrout, *Cynoscion nebulosus* (Pisces: Sciaenidae) in South Carolina. M.S. Thesis. College of Charleston, Charleston, SC. 58 p.

Dawes, C.J., D. Hanisak, and W.J. Kenworthy. 1995. Seagrass biodiversity in the Indian River Lagoon. Bulletin of Marine Science 57: 59-66.

DeAngelis, D., P.J. Mulholland, A.V. Palumbo, A.D. Steinman, M.A. Hutson, and J.W. Elwood. 1989. Nutrient dynamics and food-web stability. Annual Review of Ecology and Systematics 20: 71-95.

DEHNR (North Carolina Department of Environment, Health and Natural Resources). 1990. North Carolina coastal marinas: water quality assessment. Project Report No. 90-01. North Carolina Department of Environment, Health and Natural Resources, Raleigh, NC. 69 p.

Dennison, W.C., R.J. Orth, K.A. Moore, J.C. Stevenson, V. Carter, S. Kollar, P.W. Bergstrom, and R. Batiuk. 1993. Assessing water quality with submerged aquatic vegetation. Bioscience 43: 86-94.

DeSilva J.A. Draft. Stock assessment of spotted seatrout, *Cynoscion nebulosus*, in South Carolina with recommendations on the management of the recreational fishery. South Carolina Department of Natural Resources, Marine Research Institute, Charleston, South Carolina.

DeVries, D.A. and S.W. Ross. 1983. Brief description of the long haul seine fishery in North Carolina. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC, USA.

DeVries, D.A. et al., 1997. Age, growth, maturity, and size composition of spotted seatrout, Cynoscion nebulosus, in the panhandle region of Florida, Final Report for the Florida Department of Environmental Protection, Marine Resources Grants MR014 and MR024, Tallahassee, Florida.

Diamond-Tissue, S. L. 1999. Characterization and estimation of shrimp trawl bycatch in North Carolina waters. Doctorate dissertation, North Carolina State University, Department of Zoology, Raleigh, NC 27695. 54 pp.

DMF (North Carolina Division of Marine Fisheries). 1990. Justification for submerged aquatic vegetation critical habitat designation. Unpub. rep. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 15 p.

DMF (North Carolina Division of Marine Fisheries). 1999. Shrimp and crab trawling in North Carolina's estuarine waters. Report to North Carolina Marine Fisheries Commission. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 121 p.

DMF (North Carolina Division of Marine Fisheries). 2004a. Blue Crab Fishery Management Plan, North Carolina Department of Natural Resources, Division of Marine Fisheries, Morehead City, NC, USA. 671 pp.

DMF (North Carolina Division of Marine Fisheries). 2004b. North Carolina Recreational Use of Commercial Gear, Pilot Study. Final Report. License and Statistics, North Carolina Department of Environment and Natural Resources. Division of Marine Fisheries, Morehead City NC.

DMF (North Carolina Division of Marine Fisheries). 2006a. Shrimp Management Plan, North Carolina Department of Natural Resources, Division of Marine Fisheries, Morehead City, NC, USA. 384 pp.

DMF (North Carolina Division of Marine Fisheries). 2006b. Striped Mullet Fishery Management Plan. North Carolina Department of Natural Resources, Division of Marine Fisheries, Morehead City, NC. 115 p.

DMF (North Carolina Division of Marine Fisheries). 2007a. North Carolina Bay Scallop Fishery Management Plan. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 198 p.

DMF (North Carolina Division of Marine Fisheries). 2007b. Assessment of North Carolina Commercial Finfisheries, 2004-2007,Completion Report NA 04 NMF4070216, North Carolina Department of Natural Resources, Division of Marine Fisheries, Morehead City, NC, USA, 380 pp.

DMF (North Carolina Division of Marine Fisheries). 2007c. Long haul seine fishery assessment *in* Assessment of North Carolina commercial finfisheries 2004-2007, Completion Report NA 04 NMF 4070216, North Carolina Department of Natural Resources, Division of Marine Fisheries, Morehead City, NC, USA, p1-1.

DMF (North Carolina Division of Marine Fisheries). 2007d. North Carolina License and Statistics Section Summary Statistics of License and Permit Program, Commercial Trip Ticket Program, Marine Recreational Fishery Statistics Survey, Recreational Commercial Gear Survey, Striped Bass Creel Survey in the Central and Southern Management Area. North Carolina Department of Natural Resources, Division of Marine Fisheries, Morehead City, NC, November 2007.

DMF (North Carolina Division of Marine Fisheries). 2008. Assess the effects of hurricanes on North Carolina's Blue Crab Resource. North Carolina Department of Environment and Natural Resources, Raleigh, North Carolina. 179p.

DMF (North Carolina Division of Marine Fisheries). 2008. North Carolina Oyster Fishery Management Plan. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 282 p.

Donaldson, M.R., Cooke, S.J., Patterson, D.A., and J.S. MacDonald, 2008. Cold shock and fish. Journal of Fish Biology (2008) 73, 1491–1530.

Doxey, R. 2000. Bycatch in the Crab Pot Fishery. NC 99FRG-45.

Driscoll, C.H., D. Whitall, J. Aber, E. Boyer, M. Castro, C. Cronan, C.L. Goodale, P. Groffman, C. Hopkinson, K. Lambert, G. Lawrence, and S. Ollinger. 2003. Nitrogen pollution in the Northeastern United States: sources, effects, and management. Bioscience 53: 357-374.

Durako, M.J. 1994. Seagrass die-off in Florida Bay (USA): changes in shoot demographic characteristics and population dynamics in *Thalassia testudinum*. Marine Ecology Progress Series 110: 59-66.

DWQ (North Carolina Division of Water Quality). 2000a. Water quality progress in North Carolina in 1998-1999, 305(b) report. North Carolina Department of Environment and Natural Resources, Division of Water Quality, Raleigh, NC. 34 p.

DWQ (North Carolina Division of Water Quality). 2000b. A citizen's guide to water quality management in North Carolina. North Carolina Department of Environment and Natural Resources, Division of Water Quality, Planning Branch, Raleigh, NC. 156 p.

DWQ (North Carolina Division of Water Quality). 2007. Final North Carolina Water Quality Assessment and Impaired Waters List (2006 Integrated 305(b) and 303(d) Report). North Carolina Department of Environment and Natural Resources, Division of Water Quality, Raleigh, NC. 88 p.

DWQ (North Carolina Division of Water Quality). 2008. North Carolina Division of Water Quality Annual Report of Fish Kill Events 2008. NCDWQ Environmental Sciences Division, Raleigh, NC. 26 p.

Epperly, S.P. 1984. Fishes of the Pamlico-Albemarle Peninsula, N.C., Area Utilization and Potential Impacts. Special Scientific Report 42. North Carolina Department of Natural Resources and Community Development, Division of Marine Fisheries, Morehead City, NC. 129 p.

Epperly, S.P. and S.W. Ross. 1986. Characterization of the North Carolina Pamlico-Albemarle Estuarine Complex. NMFS-SEFC-175. National Marine Fisheries Service, Southeast Fisheries Center, Beaufort, NC. 55 p.

Feierabend, S. J. and J.M. Zelazny. 1987. Status report on our nation's wetlands. National Wildlife Federation, Washington, DC. 50p.

Ferguson, R.L. and L.L. Wood. 1994. Rooted vascular aquatic beds in the Albemarle-Pamlico estuarine system. Project Report No. 94-02. National Marine Fisheries Service, Southeast Fisheries Center, Beaufort, NC. 103 p.

Fonseca, M.S. 1996. The role of seagrasses in nearshore sedimentary processes: a review. p. 261-286. *In* C. Roman and K. Nordstrom (eds.), Estuarine Shores: Hydrological, Geomorphological and Ecological Interactions. Blackwell, Boston, MA.

Fonseca, M.S., W.J. Kenworthy, and G.W. Thayer. 1998. Guidelines for the conservation and restoration of seagrasses in the United States and adjacent waters. NOAA Coastal Ocean Program Decision Analysis Series No. 12. National Oceanographic and Atmospheric Administration, Silver Spring, MD. 222 p.

Fox, M. G. and Keast, A. 1991. Effect of overwinter mortality on reproductive life history characteristics of pumpkinseed (Lepomis gibbosus) populations. Canadian Journal of Fisheries and Aquatic Sciences 48, 1792–1799.

Francesconi, J. 1994. Effect of stop nets on pier and beach angler catch rates and general fish movement along Bogue Banks, NC. North Carolina Department of Environment, Health and Natural Resources, Division of Marine Fisheries. 17 pp.

Froese, R. and D. Pauly, Editors. 2008. Fishbase. World Wide Web electronic publication. www.fishbase.org. version (01/2008).

Funderburk, S.L., J.A. Mihursky, S.J. Jordan, and D. Riley. 1991. Habitat requirements for Chesapeake Bay living resources. Habitat Objectives Workgroup, Resource Subcommittee and Chesapeake Research Consortium with assistance from Maryland Department of Natural Resources, Solomons, MD.

Garbisch, E.W., P.B. Woller, W.J. Bostian, and R.J. McCallum. 1973. Biotic techniques for shore stabilization. p. 405-407. *In* L.E. Cronin (ed.), Estuarine Research. Academic Press Inc., New York, NY.

Garrity-Blake, Barbara and Barry Nash (2006). An Inventory of Fish Houses along Coastal North Carolina. North Carolina Sea Grant.

Gearhart, J. and P. Lewis. 2001. Selectivity of large mesh back nets in the long haul fishery of North Carolina. Final Report to NC Sea Grant. North Carolina Department of Environment, Health and Natural Resources, Division of Marine Fisheries. 18 pp.

Gelwick, F.P., S. Akin, D.A. Arrington and K.O. Winemiller. 2001. Fish assemblage structure in relation to environmental variation in a Texas Gulf Coastal wetland. Estuaries 24(2): 285-296.

Georgia Coastal Resources Division (GA CRD). 2003. Management Plan: Spotted Seatrout. Report CN MP 2003. Available at: http://crd.dnr.state.ga.us/assets/documents/SpottedSeatroutFMP04.pdf

Gilmore, G. and L. Trent. 1974. Abundance of benthic macroinvertebrates in natural and altered estuarine areas. Fisheries Service Special Scientific Report No. NOAA-TR-NMFS-SSRF-677. National Marine Fisheries Service, Silver Spring, MD. 20 p.

Gloeckner, D. 2004. Long haul seine fishery assessment *in* Assessment of North Carolina commercial finfisheries 2001-2003, Completion Report NA 06 Fl 0321, North Carolina Department of Natural Resources and Community Development, Division of Marine Fisheries, Morehead City, NC, USA, 27p.

Goode, G.B. 1884. The fisheries and fishery industries of the United States. Section I. Natural History of Useful Aquatic Animals. Text, p. 365-367. Govt. Print. Off., Wash.

Gould, E., P.E. Clark, and F.P. Thurberg. 1994. Pollutant effects on demersal fishes. p. 30-40. *In* R.W. Langton, J.B. Pearce, and J.A. Gibson(eds.), Selected Living Resources, Habitat Conditions, and Human Perturbations of the Gulf of Maine. NMFS-NE-106. National Marine Fisheries Service, Woods Hole, MA.

Grabowski, J.H. 2002. The influence of trophic interactions, habitat complexity, and landscape setting on community dynamics and restoration of oyster reefs. PhD dissertation. University of North Carolina-Chapel Hill, Chapel Hill, NC.

Graff, L. and J. Middleton. 2003. Wetlands and fish: catch the link. National Marine Fisheries Service, Silver Spring, MD. 48p.

Gray, C. A. 2002. Management implications of discarding in an estuarine multi-species gill net fishery. Fisheries Research 56 (2002): 177-192.

Gray, J. S., R. S. Wu, and Y.Y. Or. 2002. Effects of hypoxia and organic enrichment on the coastal marine environment. Marine Ecology Progress Series 238: 249-279.

Guderley, H. and P. Blier. 1988. Thermal acclimation in fish: conservative labile properties of swimming muscle. Canadian Journal of Zoology 66, 1105-1115.

Guillory, V. 1993. Ghost fishing by blue crab traps. North American Journal of Fisheries Management. 13:459-466.

Gunter 1941. Death of fishes due to cold on the Texas coast. Ecology 22:203-208.

Gunter, G. and H.H. Hildebrand. 1951. Destruction of the fishes and other organisms on the south Texas coast by the cold wave of January 28-February 3, 1951. Ecology 32:731-735.

Guthrie, J.F., R.L. Kroger, H.R. Gordy, and C.W. Lewis. 1973. The long haul fishery of North Carolina. Mar. Fish. Rev. 10254:27-33.

Hackney, C.T., J. Grimley, M. Posey, T. Alphin, and J. Hyland. 1998. Sediment contamination in North Carolina's estuaries. Publication No. 198. University of North Carolina-Wilmington, Center for Marine Science, Wilmington, NC. 59 p.

Hackney, C.T., M.H. Posey, S.W. Ross, and A.R. Norris. 1996. A review and synthesis of data on surf zone fishes and invertebrates in the South Atlantic Bight and the potential impacts from beach renourishment. Prepared for U.S. Army Corps of Engineers, Wilmington District. University of North Carolina-Wilmington, Wilmington, NC. 111 p.

Hallegraef, G.M. 1998. Transport of toxic dinoflagellates via ships' ballast water: bioeconomic risk assessment and efficacy of possible ballast water management strategies. Marine Ecology Progress Series 168: 297-308.

Harding, J.M. and R. Mann. 2001. Oyster reefs as habitat: opportunistic use of restored reefs by transient fishes. Journal of Shellfish Research 20(3): 951-959.

Hare, J.A., J.A. Quinlan, F.E. Werner, B.O. Blanton, J.J. Govoni, R.B. Forward, L.R. Settle, and D.E. Hoss. 1999. Larval transport during winter in the SABRE study area: results of a coupled vertical larval behaviour-three-dimensional circulation model. Fisheries Oceanography 8 (Suppl. 2): 57-76.

Hassell and Bonner 2008. Quantifying finfish bycatch in crab pots in the Pamlico River. NC Sea Grant Blue Crab Grant 07-ECON-06. 17pp.

Hesler, T.E., J.P. Geaghan, and R.E. Condrey. 1998. Estimating gill net selectivity using nonlinear response surface regression. Canadian Journal of Fisheries and Aquatic Sciences 55: 1328-1337.

Hesler, T.E., R.E. Condrey, and J.P. Geaghan. 1991. A new method for estimating gill net selectivity, with an example for spotted seatrout, Cynoscion nebulosus. Canadian Journal of Fisheries and Aquatic Sciences 48: 487-492.

Hettler, W.F. Jr. 1989. Nekton use of regularly-flooded saltmarsh cordgrass habitat in North Carolina, USA. Marine Ecology Progress Series 56: 111-118.

Hettler, W.F. Jr. and A.J. Chester. 1990. Temporal distribution of ichthyoplankton near Beaufort Inlet, North Carolina. Marine Ecology Progress Series 68: 157-168.

Hildebrand, S. F. and L.E. Cable. 1930. Development and life history of fourteen teleostean fishes at Beaufort, North Carolina. Bulletin of United States Bureau of Fisheries 46, 383–488.

Hildebrand, S. F. and L.E. Shroeder. 1928. Fishes of Chesapeake Bay. Bulletin of United States Bureau of Fisheries 43 (1), 296-299.

Hoenig, J.M. and T. Gedamke. 2007. A simple method for estimating survival rate from catch rates from multiple years. Transactions of the American Fisheries Society 136: 1245-1251.

Holt, G.J. and S.A. Holt. 2000. Vertical distribution and the role of physical processes in the feeding dynamics of two larval sciaenids *Sciaenops ocellatus* and *Cynoscion nebulosus*. Marine Ecology Progress Series 193: 181-190.

Holt, G.J. and S.A. Holt. 2003. Effects of variable salinity on reproduction and early life stages of spotted seatrout. p. 135-145. *In* S.A. Bortone (ed.), Biology of the Spotted Seatrout. CRC Press. Boca Raton, FL.

Holt, S.A. and G.J. Holt. 1983. University of Texas Science Institute, Port Aransas Marine Laboratory, Port Aransas, Texas, The University of Texas Marine Science Institute Contribution No. 565, The Southwestern Naturalist, Vol 28, pp464-466.

Hurst, T.P. 2007. Causes and consequences of winter mortality in fishes. Journal of Fish Biology (2007) 71, 315-345.

Iannuzzi, T.J., M.P. Weinstein, K.G. Sellner, and J.C. Barret. 1996. Habitat disturbance and marina development: an assessment of ecological effects. I. Changes in primary production due to dredging and marina construction. Estuaries 19(2A): 257-271.

Ihde, T.F. Biology of the spotted seatrout, Cynoscion nebulosus, in the Chesapeake Bay region, M.S. thesis, Virginia Institute of Marine Science, Gloucester Point, Virginia.

Idhe, T.F. and M.E. Chittenden, Jr. 2003. Validation of presumed annual marks on sectioned otoliths of spotted seatrout, *Cynoscion nebulosus*, in the Chesapeake Bay Region. Bulletin of Marine Science 72: 77-87.

IMPLAN PRO version 2.0 (2000). Stillwater, MN: Minnesota IMPLAN Group. Atlantic States Marine Fisheries Commission (ASMFC) 1994. Acronyms, abbreviations and technical terms used in ASMFC fishery management programs. Special Report No. 33. October 1994.

Ingraham, B. 2003. Night Vs. Day Bycatch Comparison for Shrimp Trawling in the Southern District of North Carolina. North Carolina Fisheries Resource Grant. FRG-98-FEG-46.

Irlandi, E.A. and M.K. Crawford. 1997. Habitat linkages: the effect of intertidal saltmarshes and adjacent subtidal habitats on abundance, movement, and growth of an estuarine fish. Oecologia 110(2): 222-230.

Iverson, E.S. and D.C. Tabb. 1962. Subpopulations based on growth and tagging studies of spotted seatrout, *Cynoscion regalis*, in Florida. Copeia 3: 544-548.

Jannke, T.E. 1971. Abundance of young sciaenid fishes in Everglades National Park, Florida, in relation to season and other variables. University of Miami SeaGrant Technical Bulletin 11:128 pp.

Jensen, C. C. 2009. Stock Status of Spotted Seatrout, *Cynoscion nebulosus*, in North Carolina, 1991-2008. North Carolina Division of Marine Fisheries, Morehead City, North Carolina.

Jiang, H., K.H. Pollock, C. Brownie, J.M. Hoenig, R.J. Latour, B.K. Wells, J.E. Hightower. 2007. Tag return models allowing for harvest and catch and release: Evidence of environmental and management impacts on striped bass fishing and natural mortality rates. North American Journal of Fisheries Management 27: 387-396.

Johnson, A.G, T.D. Williams, and C.R. Arnold. 1977. Chlorine-induced mortality of eggs and larvae of spotted seatrout (*Cynoscion nebulosus*). Transactions of the American Fisheries Society 106(5): 466-469.

Johnson, A.G, T.D. Williams, and C.R. Arnold. 1979. Larval spotted seatrout (*Cynoscion nebulosus*): a bioassay subject for the marine subtropics. Contributions to Marine Science 22: 57-62.

Johnson, D.R. and Seaman, Jr. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (south Florida)—spotted seatrout. US Fish and Wildlife Service Biological Report 82(11.43). US Army Corps of Engineers 18pp.

Johnson, G. A. 2003. The role of trawl discards in sustaining blue crab populations. North Carolina Fisheries Resource Grant. FRG-99-EP-07.

Johnson, L.L., T.K. Collier, and J.E. Stein. 2002. An analysis in support of sediment quality thresholds for polycyclic aromatic hydrocarbons (PAHs) to protect estuarine fish. Aquatic Conservation: Marine and Freshwater Ecosystems 12(5): 517-538.

Johnson, T.B. and D.O. Evans. 1996. Temperature constraints on overwinter survival of age-0 white perch. Transactions of the American Fisheries Society 125, 466-471.

Kavanagh, R.J., G.C. Balch, Y. Kiparissis, A.J. Niimi, J. Sherry, C. Tinson, and C.D. Metcalfe. 2004. Endocrine disruption and altered gonadal development in white perch (*Morone americana*) from the lower Great Lakes region. Environmental Health Perspectives 112(8): 898-902.

Kirby, J., W. Maher, and F. Krikowa. 2001. Selenium, cadmium, copper, and zinc concentrations in sediments and mullet (*Mugil cephalus*) from the southern basin of Lake Macquarie, NSW Australia. Archives of Environmental Contamination and Toxicology 40(2): 246-256.

Knutson, P.L. 1977. Planting guidelines for marsh development and bank stabilization. U.S. Army Corps of Engineers, Fort Belvoir, VA.

Kostecki, P.T. 1984. Habitat suitability index models: spotted seatrout. FWS/OBS-82/10.75. U.S. Fish and Wildlife Service, Washington, DC. 22 p.

Koutitonsky, V.G. and G.L. Bugden. 1991. The physical oceanography of the Gulf of St. Lawrence: a review with emphasis on the synoptic variability of the motion. Canadian Special Publication of Fisheries and Aquatic Sciences 113, 57-90.

Kupschus, S. 2003. Development and evaluation of statistical habitat suitability models: an example based on juvenile spotted seatrout *Cynoscion nebulosus*. Marine Ecology Progress Series 265: 197-212.

Kupschus, S. 2004. A temperature-dependent reproductive model for spotted seatrout (*Cynoscion nebulosus*) explaining spatio-temporal variations in reproduction and young-of-the-year recruitment in Florida estuaries. ICES Journal of Marine Science 61: 3-11.

Kwon, Y. and C. Lee. 2001. Ecological risk assessment of sediment in wastewater discharging area by means of metal speciation. Microchemical Journal 70: 255-264.

Lankford, T.E. and T.E. Targett. 2001. Low-Temperature Tolerance of Age-0 Atlantic Croakers:Recruitment Implications for U.S. Mid-Atlantic Estuaries. Transactions of the American Fisheries Society 130:236–249.

Lenihan, H.S. and C.H. Peterson. 1998. How habitat degredation through fishery disturbance enhances impacts of hypoxia on oyster reefs. Ecological Applications 8(1): 128-140.

Lenihan, H.S., C. H. Peterson, J.E. Byers, J.H. Grabowski, G.W. Thayer, and D.R. Colby. 2001. Cascading of habitat degredation: oyster reefs invaded by refugee fishes escaping stress. Ecological Applications 11(3): 764-782.

Lenihan, H.S., F Micheli, S.W. Shelton, and C.H. Peterson. 1999. The influence of multiple environmental stressors on susceptibility to parasites: an experimental determination with oysters. Limnology and Oceanography 44: 910-924.

Lewis, R.M. 1965. The effect of minimum temperature on the survival of larval Atlantic menhaden, *Brevoortia tyrannus*. Transactions of the American Fisheries Society. 94:409-412.

Lewis, R.M. 1966. Effects of salinity and temperature on survival and development of larval Atlantic menhaden, *Brevoortia tyrannus.* Transactions of the American Fisheries Society. 95:423-426.

Liney, K.E., S. Jobling, J.A. Shears, P. Simpson, and C.R. Tyler. 2005. Assessing the sensitivity of different life stages for sexual disruption in roach (*Rutilus rutilus*) exposed to effluents from wastewater treatment works. Environmental Health Perspectives 113(10): 1299-1307.

Loflin, R.K. 1995. The effects of docks on seagrass beds in the Charlotte Harbor estuary. Florida Scientist 58(2): 198-205.

Logothetis, E. and D. McCuiston. 2008. An assessment of the bycatch generated in the inside commercial shrimp fishery in southeastern North Carolina, 2004 and 2005. NC Sea Grant, Fishery Resource Grant Program, Final Report 05-EP-03. 97p.

Lorio, W.J. and H.E. Schafer. 1966. A food habit study of the spotted seatrout, *Cynoscion* *nebulosus*, in the Biloxi Marsh area, Louisiana. Proceedings of the Annual Conference of Southeastern Association Game and Fish Commissioners 19:289-296.

Lowe, A.J., D.R.G. Farrow, A.S. Pait, S.J. Arenstam, and E.F. Lavan. 1991. Fish kills in coastal waters. National Oceanic and Atmospheric Administration, Rockville, MD, 190-1989 p.

Lowerre-Barbieri S.K., L.R. Barbieri, and J.J. Alberts. 1999. Reproductive parameters needed to evaluate recruitment overfishing of spotted seatrout in the southeastern U.S., Final report to the Saltonstall-Kennedy (S-K) Grant Program (Grant No. NA77FD0074). 24p.

Lowery, J. and K.T. Paynter. 2002. The importance of molluscan shell substrate. Unpub. rep. National Marine Fisheries Service, Silver Spring, MD. 17 p.

Lucy, J.A and Claude Bain III. 2007. Virginia Game Fish Tagging Program Annual Report 2006. Virginia Marine Resources, Gloucester, VA. VMR Report Number 2007-1. Maceina, M.J. et al., 1987. Age and growth analysis of spotted seatrout from Galveston Bay, Texas, Trans. Am Fish. Soc., 116:54-59.

Luczkovich, J. J. R. C. Pullinger, S. E. Johnson and M. W. Sprague. Identifying the critical spawning habitats of sciaenids using passive acoustics. Transactions of the American Fisheries Society, 137: 576–605.

Luettich, R.A. Jr., J.L. Hench, C.W. Fulcher, F.E. Werner, B.O. Blanton, and J.H. Churchill. 1999. Barotropic tidal and wind-driven larval transport in the vicinity of a barrier island inlet. Fisheries Oceanography 8 (Suppl. 2): 190-209.

Lupton, O., Jr. 1996. Bycatch reduction in the estuarine crab trawl industry through manipulation of tailbag sizes. Pamlico Co. Schools, Bayboro, NC. N.C. FRG-94-11. Final report. 43p.

Maceina, M.J., D.N. Hata, T.L. Linton, and A.M. Landry, Jr. 1987. Age and growth analysis of spotted seatrout from Galveston Bay, Texas. Trans. Am. Fish. Soc. 116-54-59.

MacRae, P.S.D. 2006. A community approach to identifying essential fish habitat for spotted seatrout, *Cynoscion nebulosus*, in Barataria Bay, LA. PhD Dissertation. Louisiana State University, Baton Rogue, LA. 161 p.

Mahood, R.K. 1974. Seatrout of the genus *Cynoscion* in coastal waters of Georgia. Project No. 2-116-R. Georgia Department of Natural Resources, Game and Fish Division, Brunswick, GA. 35 p.

Maiolo, J.R. 1993. Managing competition and conflict in the coastal zone. Presented to Managing the Coastal Ocean for the 21st Century: North Carolina's Role. The University of North Carolina, Wilmington.

Mallin, M. A., M.H. Posey, M.R. McIver, D.C. Parsons, S.H. Ensign, and T.D. Alphin. 2002. Impacts and recovery from multiple hurricanes in a Piedmont-Coastal Plain river system. Bioscience 52: 999-1010.

Marburger, J. E., W.E. Johnson, T.S. Gross, D.R. Douglas, and J. Di. 2002. Residual organochlorine pesticides in soils and fish from wetland restoration areas in central Florida. Wetlands 22(4): 705-711.

Marcus, J.M. and T.P. Stokes. 1985. Polynuclear aromatic hydrocarbons in oyster tissue around three coastal marinas. Bulletin of Environmental Contamination and Toxicology 35: 835-844.

Matson, E.A. and M.M. Brinson. 1985. Sulfate enrichments in estuarine waters of North Carolina. Estuaries 8(3): 279-289.

Matson, E.A. and M.M. Brinson. 1990. Stabile carbon isotopes and the C:N ratio in the estuaries of the Pamlico and Neuse Rivers, North Carolina. Limnology and Oceanography 35(6): 1290-1300.

McEachron, L. W., G.C. Matlock, C.E. Bryan, P. Unger, T.J. Cody, and J.H. Martin. 1994. Winter mass mortality of animals in Texas bays. Northwest Gulf Science 13, 121–138.

McKenna, S., and J. T. Camp. 1992. An examination of the blue crab fishery in the Pamlico River estuary. Albemarle-Pamlico Estuarine Study Rep. No. 92-08. 101p.

McKenna, S. and A.H. Clark. 1993. An examination of alternative fishing devices for the estuarine shrimp and crab trawl fisheries. Final Report to the Albemarle/Pamlico Estuarine Study, Project No. 93-11. 34 pp.

McMichael, R.H. Jr. and K.M. Peters. 1989. Early life history of spotted seatrout, *Cynoscion nebulosus* (Pices: Sciaenidae), in Tampa Bay, Florida. Estuaries 12(2): 98-110.

Meeder, J. F. and L.B. Meeder. 1989. Hurricanes in Florida: a dominant physical process. Bulletin of Marine Science 44(1): 518.

Mercer, L.P. 1984. A biological and fisheries profile of spotted seatrout, *Cynoscion nebulosus*. Special Scientific Report No. 40. North Carolina Department of Natural Resources and Community Development, Division of Marine Fisheries, Morehead City, NC. 87 p.

Merriner 1980. History and management of the spotted seatrout fishery. Proc. Colloq. on the biology and management of red drum and spotted seatrout. Gulf States Mar. Fish. Comm. Spec. Rep.No. 5:55-61.

Micheli, F.M. and C.H. Peterson. 1999. Estuarine vegetated habitats as corridors for predator movement. Conservation Biology 13(4): 869-881.

Miller, J.M., L.B. Crowder, and M.L. Moser. 1985. Migration and utilization of estuarine nurseries by juvenile fishes: an evolutionary perspective. p. 338-352. *In* M.A. Rankin (ed.). Migration: mechanisms and adaptive significance. Contributions to Marine Science (Supplement 27).

Minello, T.J. 1999. Nekton densities in shallow estuarine habitats of Texas and Louisiana and the identification of Essential Fish Habitat. p. 43-75. *In* L.R. Benaka (ed.), Fish Habitat: Essential Fish Habitat and Rehabilitation. American Fisheries Society, Symposium 22, Bethesda, MD.

Minello, T.J., K.W. Able, M.P. Weinstein, and C.G. Hays. 2003. Salt marshes as nurseries for nekton: testing hypotheses on density, growth and survival through meta-analysis. Marine Ecology Progress Series 246: 39-59.

Mitsch, W.J. and J.G. Gosselink. 1993. Wetlands, Second Edition. Van Nostrand Reinhold, New York, NY. 772 p.

Mock, C.R. 1966. Natural and altered estuarine habitats of penaeid shrimp. Proceedings of the Gulf and Caribbean Fisheries Research Institute 19: 86-98.

Moffett, A.W. 1961. Movements and growth of spotted seatrout, *Cynoscion nebulosus* (Cuvier), in west Florida. Florida Board of Conservation Technical Series 36. 35 pp.

Monaghan, J.P. 2001. Winter trawl fishery assessment. *In* Assessment of North Carolina Commercial Finfisheries, 1997-2000, Final Performance Report NA 76 FI 0286, North Carolina Department of Natural Resources, Division of Marine Fisheries, Morehead City, NC, USA. 165 pp.

Moody, W.D. 1950. A study of the natural history of the spotted seatrout, *Cynoscion nebulosus,* in the Cedar Key, Florida area, *Q.J.* Fla. Acad. Sci., 12:147-172.

Moore, R.H. 1976. Observations on fishes killed by cold at Port Aransas, Texas, 11-12 January 1973. Southwest. Nat. 20(4):461-466.

MRFSS (Marine Recreational Finfish Statistics Survey). 2008. Personal communication from the National Marine Fisheries Service, Fisheries Statistics Division.

Murphy, M.D., C.B. Guenther, and B. Mahmoudi. 2006. An assessment of the status ofspotted. seatrout in Florida waters through 2005. Florida Fish and Wildlife Conservation Commission. Fish and Wildlife Research Institute St. Petersburg, FL.

Murphy, M.D., G.A. Nelson, and R.G. Muller. 1999. An update of the stock assessment of spotted seatrout, *Cynoscion nebulosus.* Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute St. Petersburg, FL.

Murphy,M.D. and R.G.Taylor. 1994. Age, growth, and mortality of spotted seatrout in Florida waters, Tans. Am. Fish. Soc., 123:482-497.

Myers, R.A. and G. Mertz. 1998. The limits of exploitation: a precautionary approach.The Biological Limits of Exploitation, The Ecological Society of America, Ecological Applications, 8(1) Supplement. pp. S 165-S 169.

Nash, J.P., D.E. Kime, L.T.M. Van der Ven, P.W. Wester, F. Brion, G. Maack, P. Stahlschmidt-Allner, and C.R. Tyler. 2004. Long-term exposure to environmental concentrations of the pharmaceutical ethynylestradiol causes reproductive failure in fish. Environmental Health Perspectives 112(17): 1725-1733.

NCCRFL (North Carolina Marine Resources Fund - Coastal Recreational Fishing License Revenues). Research ongoing. Movement and mortality of spotted seatrout (*Cynoscion nebulosus*) in North Carolina: a combined conventional tag and telemetry approach. NC State University-CMAST. Morehead City, NC.

NCFRG (North Carolina Fisheries Resource Grant Program). 2010. The feasibility of conducting a long-term conventional tagging and telemetry study on spotted seatrout (Cynoscion nebulosus) in North Carolina. NC State University-CMAST. Morehead City, NC.

Newell, R.I.E. 1988. Ecological changes in the Chesapeake Bay: are they the result of overharvesting the American oyster? p. 536-546. *In* M.P. Lynch and E.C. Krome (eds.), Understanding the estuary: advances in Chesapeake Bay research. Publication 129. Chesapeake Bay Research Consortium, Baltimore, MD.

Nieland, D.L. and C.A. Wilson. 1993. Reproductive biology and annual variation of reproductive variables of black drum in the northern Gulf of Mexico. Trans. Am. Fish.Soc., 123:482-497.

Nieland, D.L., R.G. Thomas, and C.A. Wilson. 2002. Age, growth, and reproduction of spotted seatrout in Barataria Bay, Louisiana. Transactions of the American Fisheries Society 131: 245-259.

NMFS (National Marine Fisheries Service). 1996. Fisheries Sampling Branch-Observer Manual. Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA 02543-1026. 33 pp.

NMFS (National Marine Fisheries Service). 2004. Taking of marine mammals incidental to commercial fishing operations: bottlenose dolphin take reduction plan; sea turtle conservation; restrictions to fishing activities; proposed rule. Fed. Regist. 69(217) November 10: 65127-65142.

NMFS (National Marine Fisheries Service). 2006. Taking of marine mammals incidental to commercial fishing operations: bottlenose dolphin take reduction plan; sea turtle conservation; restrictions to fishing activities; final rule. Fed. Regist. 71(80) April 26: 24776-24797.

NOAA (National Oceanographic and Atmospheric Administration). 2008. Age Structured Projection Model (AgePro), version 3.2.2. NOAA Fisheries Toolbox, http://nft.nefsc.noaa.gov.

Noble, E.B. and R.J. Monroe. 1991. Classification of Pamlico Sound Nursery Areas: Recommendations for Critical Habitat Criteria. A/P Project No. 89-09. North Carolina Department of Environment, Health, and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 70 p.

North Carolina Sea Grant. 1997. Coastal water quality. UNC-SG-97-04. North Carolina State University, Raleigh, NC. 72 p.

Orth, R.J., T.J.B. Carruthers, W.C. Dennison, C.M. Duarte, J.W. Fourqurean, K.L. Heck Jr., A.R. Hughes, G.A. Kendrick, W.J. Kenworthy, S. Olyarnik, F.T. Short, M. Waycott, and S.L. Williams. 2006. A global crisis for seagrass ecosystems. Bioscience 56(12): 987-996.

Otwell, W.S., and J.V. Merriner. 1975. Survival and growth of juvenile striped bass, Morone saxatilis, in a factorial experiment with temperature, salinity, and age. Transactions of the American Fisheries Society 104:560-566.

Overstreet, R.M. 1983. Aspects of the biology of the spotted seatrout, *Cynoscion nebulosus*, in Mississippi. Gulf Research Reports Supplement. 1: 1-43.

Overstreet, R.M. 1974. An estuarine low-temperature fish-kill in Mississippi, with remarks on restricted necropsies. Gulf Res. Rept. 4(3):328-350.

Padgett, E.H. 1995. Bogue Banks stop net fishery: A case study in coastal resource use conflict. Masters Project, Nicholas School of the Environment, Duke University, Durham, NC. 32 pp.

Paerl, H.W. 2002. Connecting atmospheric nitrogen deposition to coastal eutrophication. Environmental Science and Technology 36: 323A-326A.

Paerl, H.W., J.D. Bales, L.W. Ausley, C.P. Buzzelli, L.B. Crowder, L.A. Eby, J.M. Fear, M. Go, B.L. Peierls, T.L. Richardson, and J.S. Ramus. 2001. Ecosystem impacts of three sequential hurricanes (Dennis, Floyd, and Irene) on the United States' largest lagoonal estuary, Pamlico Sound, NC. Proceedings of the National Academy of Sciences, USA 98(10): 5655-5660.

Paerl, H.W., J. Pickney, J. Fear, and B. Peierls. 1998. Ecosystem response to internal watershed organic matter loading: consequences for hypoxia in the eutrophying Neuse River Estuary, North Carolina. Marine Ecology Progress Series 166: 17-25.

Perret, W.S., J.E. Weaver, R.O. Williams, P.L. Johansen, T.D. McIlwain, R.C. Raulerson, and W.M. Tatum. 1980. Fishery profiles of red drum and spotted seatrout. Report No. 6. Gulf States Marine Fisheries Commission. 60 p.

Peterson, B.J. and R.W. Howarth. 1987. Sulfur, carbon, and nitrogen isotopes used in trace organic matter flow in the salt-marsh estuaries of Sapelo Island, Georgia. Limnology and Oceanography 32: 1195-1213.

Peterson, C.H., D.H.M. Hickerson, and G.G. Johnson. 2000. Short-term consequences of nourishment and bulldozing on the dominate large invertebrates of a sandy beach. Journal of Coastal Research 16(2): 368-378.

Peterson, C.H., J.H. Grabowski, and S.P. Powers. 2003. Estimated enhancement of fish production resulting from restoring oyster reef habitat: quantitative evaluation. Marine Ecology Progress Series 264: 249-264.

Peterson, C.H. and N.M. Peterson. 1979. The ecology of intertidal flats of North Carolina: a community profile. OBS-79/39. U.S. Fish and Wildlife Service, Washington, DC. 73 p.

Peterson, G.W. an R.E. Turner. 1994. The value of salt marsh edge vs. interior as a habitat for fish and decapod crustaceans in a Louisiana tidal marsh. Estuaries 17(1B): 235-262.

Peterson, M.S., B.H. Comyns, J.R. Hendon, P.J. Bond, and G.A. Duff. 2000. Habitat use by early life-stages of fishes and crustaceans along a changing estuarine landscape: difference between natural and altered shoreline sites. Wetland Ecology and Management 8(2-3): 209-219.

Pine, W.E., K.H. Pollock, J.E. Hightower, T.J. Kwak, J.A. Rice. A review of tagging methods for estimating fish population size and components of mortality. Fisheries Research 28: 10-23.

Prentice, J.A. 1989. Low-temperature tolerance of southern flounder in Texas. Transactions of the American Fisheries Society 118:30-35.

Price, A. B., and J. Gearhart. 2002a. Interstate fisheries management program implementation for North Carolina, Study II: documentation and reduction of bycatch in North Carolina Fisheries. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Completion Report, Cooperative Agreement No. NA 87FG0367/1, Morehead City, North Carolina.

Price, A. B. and J.L. Gearhart. 2002b. Small Mesh (< 4.5-inch) Gill net Discard Mortality of spotted seatrout (*Cynoscion nebulosus*), weakfish (*Cynoscion regalis*), southern flounder (*Paralichthys lethostigma*), and red drum (*Sciaenops ocellata*) in Roanoke Sound, Core Sound, and the Neuse River, North Carolina. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, North Carolina. Completion Report for Cooperative Agreement No. NA 87FG0367/1.

Purvis, C. 1976. Nursery area survey of northern Pamlico Sound and tributaries. Completion Report No. 2-230-R. North Carolina Division of Marine Fisheries, Morehead City, NC. 62 p.

Rakocinski, C.F., D.M. Baltz, and J.W. Fleeger. 1992. Correspondence between environmental gradients and the community structure of marsh-edge fishes in a Louisiana estuary. Marine Ecology Progress Series 80: 135-148.

Rakocinski, C.F., S.E. LeCroy, J.A. McLelland, and R.W. Heard. 1993. Responses by macroinvertebrate communities to beach renourishment at Perdido Key, Florida: benthic recovery. US Department of the Interior, National Parks Service, Washington, DC.

Reilly, F.J. Jr. and B.J. Bellis. 1983. The ecological impact of beach nourishment with dredged materials on the intertidal zone at Bogue Banks, North Carolina. U.S. Army Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, VA.

Rice, S. D., R.E. Thomas, G. Carls, R.A. Heintz, A.C. Wertheimer, M.L. Murphy, J.W. Short, and A. Moles. 2001. Impacts to pink salmon following the Exxon Valdez oil spill: persistence, toxicity, sensitivity, and controversy. Reviews in Fisheries Science 9(3): 165-211.

Riggs, S.R. 1996. Sediment evolution and habitat function of organic-rich muds within the Albemarle estuarine system, North Carolina. Estuaries 19(2A): 169-185.

Riggs, S.R., J.T. Bray, E.R. Powers, C. Hamilton, D. Ames, D. Yeates, K. Owens, S. Lucas, J. Watson, and M. Williamson. 1991. Heavy metal pollutants in organic-rich muds of the Neuse River Estuary: their concentration and distribution. Albemarle-Pamlico Estuarine Study Report. Project no. 90-07. North Carolina Department of Environment and Natural Resources, Raleigh, NC. 168 p.

Riggs, S.R., E.R. Powers, J.T. Bray, P.M. Stout, C. Hamilton, D. Ames, R. Moore, J. Watson, S. Lucas, and M. Williamson. 1989. Heavy metal pollutants in organic rich muds of the

Pamlico River estuarine system: their concentration, distribution, and the effects upon benthic environments and water quality. Albemarle-Pamlico Estuary Study. Project No. 89-06. U.S. Environmental Protection Agency and North Carolina Department of Natural Resources and Community Development, Raleigh, NC. 108 p.

Rooker, J.R., S.A. Holt, M.A. Soto, and G.J. Holt. 1998. Post settlement patterns of habitat use by sciaenid fishes in subtropical seagrass meadows. Estuaries 21(2): 318-327.

Ross, J.L. 1989. Assessment of the sink net fishery along North Carolina's Outer Banks, Fall 1982-Spring 1987, with notes on other coastal gill net fisheries. Special Scientific Report No. 50 for North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC, USA. 51 pp.

Ross, S.W. and J.E. Lancaster. 1996. Movements of juvenile fishes using surf zone nursery habitats and the relationship of movements to beach nourishment along a North Carolina beach: Pilot project. Final Report to NOAA Office of Coastal Resource Management and the US Army Corps of Engineers (Wilmington District) for NOAA Award No. NA570Z0318. 31 pp.

Ross, S.W. and S.P. Epperly. 1985. Utilization of shallow estuarine nursery areas by fishes in Pamlico Sound and adjacent tributaries, North Carolina. p. 207-232. *In* A. Yanez-Arancibia (ed.), Fish Community Ecology in Estuaries and Coastal Lagoons: Towards an Ecosystem Integration. DR (R) UNAM Press, Mexico.

Roumillat, W.A and Myra Brouwer. 2004. Reproductive dynamics of female spotted seatrout (*Cynoscion nebulosus*) in South Carolina, Fish. Bull. 102:473-487 (2004).

Roumillat, W.A., S. Tyree, and G. Reikirk. 1997. Spawning times and locations of spotted seatrout in the Charleston Harbor estuarine system from acoustic surveys. Final Report to Charleston Harbor Project. South Carolina Department of Natural Resources, Marine Resources Research Institute, Charleston, SC. 10 p.

Rowe, P.M. and C.E. Epifanio. 1994. Tidal stream transport of weakfish larvae in Delaware Bay, USA. Marine Ecology Progress Series 110: 105-114.

SAFMC (South Atlantic Fishery Management Council). 1998. Final habitat plan for the South Atlantic region: Essential Fish Habitat requirements for fishery management plans of the South Atlantic Fishery Management Council. SAMFC, Charleston, SC. 457 p.

Saucier, M.H. and D.M. Baltz. 1992. Hydrophone identification of spawning sites of spotted seatrout *Cynoscion nebulosus* (Osteichthys: Sciaenidae) near Charleston, South Carolina. Northeast Gulf Science 12(2): 141-146.

Saucier, M.H. and D.M. Baltz. 1993. Spawning site selection by spotted seatrout, *Cynoscion nebulosus*, and black drum, *Pogonias cromis*, in Louisiana. Environmental Biology of Fishes 36: 257-272.

Saillant, E., L. Ma, Gatlin, D, W.H.Neill, R.R. Vega, and J.R. Gold. 2007. Heritability of cold tolerance in red drum, North American Journal of Aquaculture 69:381–387, Copyright by the American Fisheries Society 2007, DOI: 10.1577/A06-038.1

Scavia, D., J.C. Field, D.F. Boesch, R.W. Buddemeier, V. Burkett, D.R. Cayan, M. Fogarty, M.A. Harwell, R.W. Howarth, C. Mason, D.J. Reed, T.C. Royer. A.H. Sallenger, and J.G. Titus. 2002. Climate change impacts on U.S. coastal and marine ecosystems. Estuaries 25(2): 149-164.

Schafer, D.J. 1999. The effects of dock shading on the seagrass *Halodule wrightii* in Perdido Bay, Alabama. Estuaries 22(4): 936-943.

Shafland, P.L., and J.M. Pestrak. 1982. Lower lethal temperatures for fourteen non-native fishes in Florida. Environmental Biology of Fishes 7:149-156.

Simmons, E. G., and J. P. Breuer. 1962. A study of redfish, *Sciaenops ocellata* Linnaeus, and black drum, *Pogonias cromis* Linnaeus. Publ. Inst. Mar. Univ. Tex. 8:184-211.

Smith , H.M. 1907. The Fishes of North Carolina. N.C. Geol. Econ. Survey 2, 449 p.

Steve, C., J. Gearhart, D. Borggaard, L. Sabo, and A.A. Hohn. 2001. Characterization of North Carolina commercial fisheries with occasional interactions with marine mammals, NOAA Technical Memorandum NMFS-SEFSC-458. 60pp.

Storey, M., and E.W. Grudger. 1936. Mortality of fishes due to cold at Sanibel Island, Florida, 1886-1936. Ecology 7(4):640-648.

Strom, D.G. and G.A. Graves. 2001. A comparison of mercury in estuarine fish between Florida Bay and Indian River Lagoon, Florida, USA. Estuaries 24(4): 597-609.

Street, M.W., A.S. Deaton, W.S. Chappell, and P.D. Mooreside. 2005. North Carolina Coastal Habitat Protection Plan. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 656 p.

Sundararaj B. I and Royal Suttkus. 1962. Fecundity of the spotted seatrout, Cynoscion nebulosus (Cuvier), from Lake Borgne Area, Louisiana. Trans. Am. Fish. Soc. 91:84-88.

Tabb, D.C. 1958. Differences in the estuarine ecology of Florida waters and their effect on populations of spotted weakfish, *Cynoscion nebulosus* (Cuvier and Valenciennes). Proc. N. Am. Wildl. Conf. 23:392-401.

Tabb, D.C. 1961. A contribution to the biology of the spotted seatrout, Cynoscion nebulosus (Cuvier), of east-central Florida*, Fla. Bd. Cons. Tech. Ser.*, 35.

Tabb, D.C. 1966. The estuary as a habitat for spotted seatrout, *Cynoscion nebulosus*. American Fisheries Society Special Publication No. 3: 59-67.

Tabb, D.C., D.L. Dubrow, and R.O. Manning. 1962. The ecology of north Florida Bay and adjacent estuaries. Florida Board of Conservation Technical Series 39. 81 pp.

Tabb, D.C. and R.B. Manning. 1961. A checklist of the flora and fauna of northern Florida Bay and adjacent brackish waters of the Florida mainland collected during the period July, 1957 through September, 1960. Bull. Mar. Sci. Gulf Caribb. 11(4):552-649.

Tayloe, W.B. and F.S. Scharf. 2006. Age, growth, and feeding habits of spotted seatrout (*Cynoscion nebulosus*) in the lower Cape Fear River. Poster presented at the Tidewater Chapter (AFS) annual meeting, Atlantic Beach, NC, February 2006.

Teal, J. 1962. Energy flow in salt marsh macrophyte production: a review. Ecology 43: 614-624.

Tenore, K.R. 1972. Macrobenthos of the Pamlico Estuary, North Carolina. Ecological Monographs 42: 51-69.

Thayer, G.W., W.J. Kenworthy, and M.S. Fonseca. 1984. The ecology of eelgrass meadows of the Atlantic coast: a community profile. FWS/OBS-84/02. U.S. Fish and Wildlife Service, Washington, DC. 147 p.

Thayer, V.G. Thayer, D.M. Waples, and A.J. Read. 2007. Monitoring bycatch in the North Carolina stop net fishery. Final Report Submitted to the National Marine Fisheries Service, Southeast Regional Office. 26 pp.

Thomas, P. and J. Smith. 1993. Binding of xenobiotics to the estrogen receptor of spotted seatrout: a screening assay for potential estrogenic effects. Marine Environmental Research 35(1-2): 147-151.

Thorpe T., D. Beresoff, and M. Hooper. 2004. Bycatch potential, discard mortality, and condition of fish and turtles associated with the North Carolina commercial blue crab (Callinectes sapidus) pot fishery. North Carolina Sea Grant Blue Crab Grant 03-POP-04. 37 pp.

Trexler, J. C., J. Travis and M. McManus. 1992. Effect of habitat and body size on mortality rates of Poecilla latipinna. Ecology 73, 2224–2236.

Tucker, J.W., Jr. and B.E. Faulkner. 1987. Voluntary spawning pattern of captive spotted seatrout. Northeast Gulf Sciences 9: 59-63.

Tuckey, T.D. and M. Dehaven. 2006. Fish assemblages found in tidal-creek and seagrass habitats in the Suwannee River estuary. Fishery Bulletin 104: 102-117.

Tyler, M. 1989. Potential for long-term persistence of the red tide dinoflagellates *Ptychodiscus brevis* in North Carolina coastal waters. Project Report No. 88-09. Albemarle-Pamlico Estuarine study prepared for North Carolina Department of Natural Resources and Community Development, Raleigh, NC. 14 p.

Tyler, R.M. and T.E. Targett. 2007. Juvenile weakfish Cynoscion regalis distribution in relation to diel-cycling dissolved oxygen in an estuarine tributary. Marine Ecology Progress Series 333:257-269.

Van Engel, W.A. 1962. The blue crab and its fishery in Chesapeake Bay. Pt. 2. Types of gear for hard crab fishing. Comm. Fish. Rev. 24:1-10.

Vanderkooy, S.J. and Muller, R.G. 2003. Management of spotted seatrout and fishery participants in the U.S. In Biology of the Spotted Seatrout (Bortone, S.A., ed.), pp. 227-245. Boca Raton: CRC Press.

Van Dolah, R.H., P.H. Wendt, and M.V. Levisen. 1991. A study of the effects of shrimp trawling on benthic communities in two South Carolina sounds. Fisheries Research 12: 139-156.

Voudrias, E.A. and C.L. Smith. 1986. Hydrocarbon pollution from marinas in estuarine sediments. Estuarine and Coastal Shelf Science 22: 271-284.

Waters, C.T. and C.D. Thomas. 2001. Shoreline hardening effects on associated fish assemblages in five North Carolina coastal rivers. North Carolina Wildlife Resources Commission, Raleigh, NC, 20 p.

Wannamaker, C.M. and J.A. Rice. 2000. Effects of hypoxia on movements and behavior of selected estuarine organisms from the southeastern United States. Journal of Experimental Marine Biology and Ecology 249: 145-163.

Weinstein, M.P. 1979. Shallow marsh habitats as primary nurseries for fishes and shellfish, Cape Fear River, NC. Fishery Bulletin 2: 339-357.

Weis J.S. and P. Weis. 1989. Effects of environmental pollutants on early fish development. Aquatic Sciences 1(1): 45-55.

Wells, J.T. 1989. A scoping study of the distribution, composition, and dynamics of water-column and bottom sediments: Albemarle-Pamlico estuarine system. Report No. 89-09. University of North Carolina-Chapel Hill, Institute of Marine Science, Morehead City, NC. 39 p.

Wells, H.W., M.J. Wells, and I.E. Gray. 1961. Winter mortality in Pamlico Sound, North Carolina. Department of Zoology, Duke University, Durham, North Carolina., Ecology 42, 217-219.

Wendt, P.H., R.F. Van Dolah, M.Y. Bobo, and J.J. Manzi. 1990. Effects of marina proximity on certain aspects of the biology of oysters and other benthic macrofauna in a South Carolina estuary. South Carolina Marine Resources Center Technical Report No. 74. South Carolina Wildlife and Marine Resources Department, Charleston, SC. 49 p.

Wenner, C.A. et al.,1990. Investigations on the life history and population dynamics of marine recreational fishes in South Carolina: Part I, Chapter 3. Mar. Resour. Research Inst., SC Wildl. Mar. Resourc. Dept., Charleston, SC.

Wenner, C. 2006. Specs and cold. Message post.

White, J.C. and T. Triplett. 2002 Polycyclic aromatic hydrocarbons (PAHs) in the sediments and fish of the Mill River, New Haven, Connecticut. Bulletin of Environmental Contamination and Toxicology 68(1):104-110.

WHO (World Health Organization). 2002. Global assessment of the state-of-the-science of endocrine disruptors. International Programme On Chemical Safety.

Wilbur, A.R. and M.W. Pentony. 1999. Human-induced nonfishing threats to essential fish habitat in the New England region. p. 299-321. *In* L.R. Benaka (ed.), Fish Habitat: Essential Fish Habitat and Rehabilitation. American Fisheries Society, Symposium 22, Bethesda, MD.

Wiley, B.A. and R.W. Chapman. 2003. Population structure of spotted seatrout, Cynoscion nebulosus, along the Atlantic coast of the U.S., Pages 31-40 *in* S.A. Bortone, editor. Biology of the spotted seatrout. CRC Press, Boca Raton, Florida.

Wilson, C.J. 1997. Estuarine gill net fishery assessment. *In* Assessment of North Carolina Commercial Finfisheries, 1994-1996, Completion Report for Project 2-IJ-51, North Carolina Department of Natural Resources, Division of Marine Fisheries, Morehead City, NC, USA. 356 pp.

Wolff, M. 1976. Nursery area survey of the Outer Banks region. Completion report No. 2-222-R. North Carolina Division of Marine Fisheries, Morehead City, NC. 47 p.

Wuenschel, M.J., R.G. Werner, and D.E. Hoss. 2004. Effect of body size, temperature, and salinity on the routine metabolism of larval and juvenile spotted seatrout. Journal of Fish Biology 64: 1088-1102. Waters, C.T. and C.D. Thomas. 2001. Shoreline hardening effects on associated fish assemblages in five North Carolina coastal rivers. North Carolina Wildlife Resources Commission, Raleigh, NC. 20 p.

Zieman, J.C. 1976. The ecological effects of physical damage from motor boats on turtle grass beds in southern Florida. Aquatic Botany 2: 127-139.

Appendix 1   Proposed Rule Changes to Implement Recommendations

MFC Recommendation:

SUBCHAPTER 03M - FINFISH

SECTION .0500 - OTHER FINFISH

15A NCAC 03M .0504 TROUT

~~(a) It is unlawful to possess spotted seatrout (speckled trout) less than 12 inches total length.~~

~~(b) It is unlawful to possess more than 10 spotted seatrout per person per day taken by hook-and-line or for recreational purposes~~.

History Note: *Authority G.S. 113-134; 113-182; ~~113-221;~~ 113-221.1; 143B-289.52;*
Eff. January 1, 1991;
Amended Eff. March 1, 1996; March 1, 1995; February 1, 1992;
Temporary Amendment Eff. September 9, 1996;
Temporary Amendment Eff. October 1, 1996;
Amended Eff. April 1, 1997;
Temporary Amendment Eff. July 1, 1999;
Amended Eff. October 1, 2008; August 1, ~~2000.~~ 2000;
Repealed Eff. April 1, 2012.

[15A NCAC 03M .0512 is provided for information only. There are no proposed changes.]

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.

Appendix 2 Interim Management Measures to Address Specific Area User Group Competition from November through March

Issue

Determine if area/creek specific interim management measures are needed for spotted seatrout.

Background

Gill nets can be a controversial gear used to harvest finfishes due to issues with overfishing, bycatch of undersized fish, bycatch of non-targeted fish, and user group interactions. These issues have led to gill net restrictions in all states along the Atlantic Coast. Florida has been the only state on the Atlantic Coast to have a complete ban on the use of gill nets in internal waters (Appendix 2A). The MFC has deliberated numerous gill net issues in each of the various finfish FMPs (striped mullet, striped bass, kingfish, red drum, and, southern flounder) and with the adoption of these plans implemented various gill net measures. North Carolina limits the use of gill nets by fishing sector, mesh size, season, waterbody, and net length. Listed below are several rules used to regulate gill net fishing.

- All gill nets must have a stretched mesh greater than or equal to 2 ½ inches. (Prevent overfishing and bycatch of non-targeted and undersized species)
- Gill nets with stretched meshes between 5 and 5 ½ inches are not allowed from April 15th to December 15th. (Prevent overfishing and bycatch of undersized fish)
- Large mesh gill nets (>=5 inches stretched mesh) are limited to 3,000 yards year round and cannot be within 10 feet of shoreline from June to October unless attended. (Prevent overfishing and bycatch of non-targeted fish)
- Small mesh gill nets (<5 inches stretched mesh) must be attended year round in areas designated in 15A NCAC 03R .0112 (a) and from May 1st to November 30th in designated areas in 15A NCAC 03R .0112(b). (Prevent bycatch of non-targeted and undersized species)
- Fishermen with a RCGL are limited to 100 yards of gill net per fishermen and cannot exceed a maximum of 200 yards per boat if two or more RCGL holders are on board, and identified by pink buoys. (Prevent overfishing and bycatch of non-targeted and undersized species, separates recreational purpose from commercial nets)
- Commercial fishing gear may not be used within 750 feet of licensed fishing piers when open to public in Nags Head. Rule 15A NCAC 03J .0402 Includes many more examples. (User group interaction)
- Other permanent rules for gill nets can be found in the North Carolina Rules for Coastal Fishing Waters 2009 (http://www.ncfisheries.net/download/2009_MFC_Rulebook.pdf).
- Proclamations, which can be temporary management tools to regulate gill net fisheries, can be found at DMF's website (http://www.ncfisheries.net/procs/index.html).

This issue paper will focus on area specific competition among gill net and recreational fishermen that harvest spotted seatrout and whether interim measures under the spotted seatrout FMP should be considered. The interim management measure process is set out in law - G.S. 113-182.1(c1). If the MFC determines temporary management measures are necessary to ensure the viability of a species or fishery while an FMP is being developed, any interim rules considered must go through the MFC's regional advisory committees before the MFC can vote on interim management measures. The MFC is soliciting advice on interim measures because a recent stock assessment shows spotted seatrout is overfished. At the May 2009 MFC meeting the following motion passed unanimously: the MFC to take to the regional advisory committees and the Finfish Advisory Committee a list of specific conflict areas and dates provided by the DMF for consideration.

The interactions between gill net and recreational fishermen that harvest spotted seatrout for the most part have not escalated to a conflict, which involves one or two parties trying to undermine another party's ability to achieve their goal (Maiolo 1993). Gill net and recreational fishermen, the most common user groups reported in complaints involving spotted seatrout, are in competition for spotted seatrout.

This competition for spotted seatrout is not a new issue. Attached to the back of this issue paper is a previous issue paper from 1994 regarding the use of gill nets to harvest spotted seatrout (Appendix 2B). Recreational fishermen felt the gill net harvest of spotted seatrout in several creeks should be eliminated from September/October through March/April to be equitable with the 10 fish bag limit. Commercial fishermen felt the regulations were sufficient. Additionally if gill nets were restricted in the creeks then recreational fishermen should not be allowed to harvest spotted seatrout in these areas. Many of the areas mentioned in the issue paper still receive complaints today including Trent, Chapel, Vandemere, Dawson, Upper Broad, and Goose creeks. An updated list is provided below and includes areas that were identified by DMF staff and Marine Patrol (Table 1). Additional areas where complaints have been received are located in Inland Waters. Since 2001 gill nets are not permitted in these areas and will not be discussed in this paper.

Often recreational fishermen complain about the number of gill net fishermen in different waterbodies. The number of gill net trips landing spotted seatrout (Figure 1) and the number of directed recreational (targeted, harvested, or released) spotted seatrout can be tracked over the past 15 years (Figure 2). The highest number of trips catching spotted seatrout with gill nets was reported in 1995. Since 1995, the number of gill net trips has fluctuated with an increase in number of trips in 2006 to 2008 compared to the lows in 2003 to 2005. The use of runaround gill nets increased with the change in net attendance laws. Runaround gill nets comprised 25% of all estuarine gill net catches from 2001-2004, but increased to as much as 47% of the estuarine gill net harvest in 2006. Recreational effort also had relatively high number of trips in 1994 and 1995 compared to most years. However the highest number of targeted spotted seatrout trips occurred from 2006 to 2008.

Table 1. Areas where complaints have been reported between spotted seatrout recreational and gill net fishermen in coastal or joint fishing waters. SNA=Secondary or Special Secondary Nursery Area, PNA=Primary Nursery Areas. Restrictions refer to rules included in the 2009 North Carolina Rules for Coastal Fishing Waters. Proclamation refers to proclamation made by the DMF director to restrict fishing in the area (past or present). VL=Very limited area.

Competition Areas in Coastal/Joint Waters for Spotted Seatrout

Area	Major Waterbody	SNA	PNA	Restrictions
Chapel Creek	Bay River	No	Yes	
Trent Creek	Bay River	No	No	
Vandemere Creek	Bay River	No	No	
Broad Creek	Neuse River	Yes	Yes	
Dawson Creek	Neuse River	No	Yes	
Goose Creek	Neuse River	No	Yes	
Greens Creek	Neuse River	No	Yes	
Kershaw Creek	Neuse River	No	Yes	
Smith Creek	Neuse River	No	Yes	
South River	Neuse River	No	Yes	
Bell Creek	Newport River	No	Yes	
Oyster Creek	Newport River	No	Yes	
Cape Lookout Rock Jetty		No	No	Yes
Spooners Creek	Bogue Sound	No	No	Yes
Sound Side of Hammocks Beach	Intracostal Waterway	No*	No*	
Alligator Gut	White Oak River	No	Yes	Proclamation
Northeast Creek	New River	Yes	Yes	
Southwest Creek	New River	Yes	Yes	
Brunswick River	Cape Fear River	No	Yes	
Fort Fisher Bays	Cape Fear River	VL	No	Proclamation

*Only waters behind Hammocks Beach State Park considered.

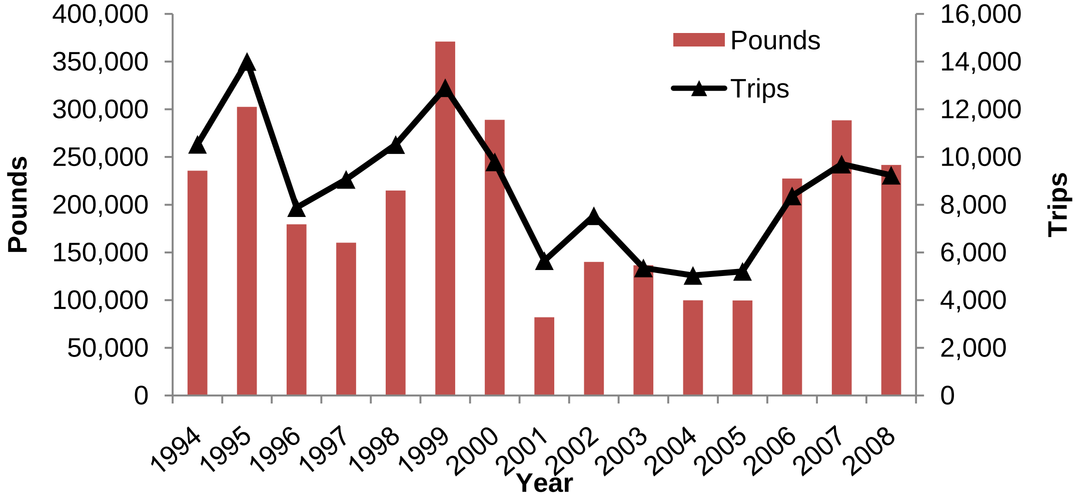


Figure 1. Landings (lb) and number of trips landing spotted seatrout from gill nets in estuarine and ocean waters, 1994-2008. Source: Spotted Seatrout FMP Commercial Section.

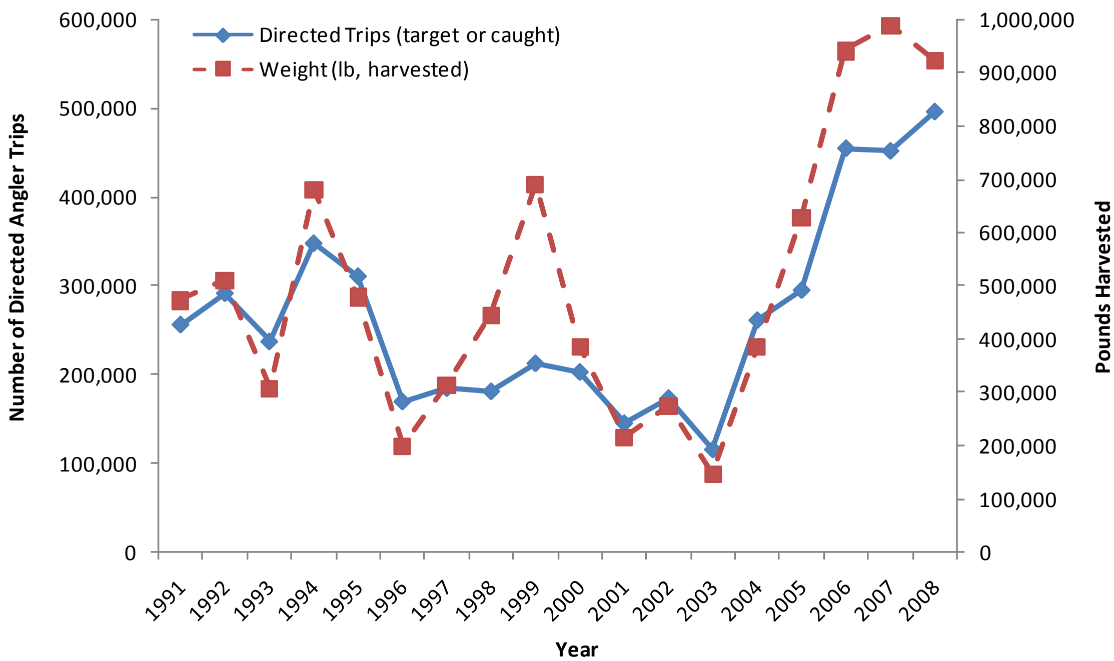


Figure 2. Number of directed angler trips where spotted seatrout (*Cynoscion nebulosus*) were targeted or caught and pounds harvested, 1991-2008. Source: Spotted Seatrout FMP Recreational Section.

Since there has been an increase in both the number of commercial and recreational trips targeting spotted seatrout, competition between gill net and recreational for spotted seatrout has increased. The North Carolina Marine Fisheries Commission (MFC) has tasked the DMF and Advisory Committees to determine if area/creek specific management measures are needed as an interim rule for spotted seatrout from November to March.

Methods

Data limitations of both the NCTTP and MRFSS preclude our ability to describe fishing activities in specific creeks. However, a general description of fishing activities in larger waterbodies that landed spotted seatrout can provide some insight into overall effort, catch rates, and landings. There are 29 waterbodies listed in the NCTTP and data specific to these waterbodies can be used to describe the number of participants, landings, trips, and catch per unit effort (CPUE).

MRFSS was originally designed to produce reliable estimates of catch and angler participation at a regional level (i.e., Mid-Atlantic, South-Atlantic). DMF began supplying additional funds in 1987 to increase sample for providing estimates of catch at a statewide level. MRFSS was not intended to estimate the number of fish caught within any specific waterbody and caution should be used when making inference from analyses of MRFSS data summarized below the statewide level. In an attempt match with the NCTTP, the MRFSS used trips that targeted, harvested, or released spotted seatrout for each waterbody and expanded based weighted averages, number of intercepts, and total number of trips. The CPUE calculated in this issue paper will be for summed pounds or observations over the total period (1994 to 2006) due to limitations of data to describe waterbodies. Only a few trips were sampled some years and may skew the analysis. Therefore all data were summed across years.

Results

Commercial Landings, CPUE, and Trips by Waterbody

Gill nets were the dominant commercial gears that were used to harvest spotted seatrout in North Carolina from 1994 to 2006 accounting for 67% of the total spotted seatrout commercial landings. The amount of spotted seatrout harvested with gill nets, the number of gill net trips that caught spotted seatrout, and the number of participants catching seatrout with gill nets varied in the 29 waterbodies listed in the NCTTP. Pamlico Sound was the waterbody with the highest catch (35.0%), trips (38.6%), and participants (38.7%) and was likely due to the size of the waterbody. The remaining water bodies in the top five in descending order of trips landing spotted seatrout were Neuse River, Core Sound, Pamlico River, and Albemarle Sound. These five waterbodies accounted for 71.1% of the landings of spotted seatrout occurred, 71.5% of the trips, and 71.4% of the participants.

The waterbody with the highest CPUE (total spotted seatrout pounds summed from 1994 to 2006/number of trips landings spotted seatrout from 1994 to 2006) of spotted seatrout in the commercial gill net occurred in Bay River (Table 2). Core Sound, Atlantic Ocean, Bogue Sound, and White Oak River were all ranked in the top five of number of trips catching spotted seatrout. Most waterbodies with high to moderate CPUEs were located in the central (Pamlico Sound to White Oak River) to southern (New River to South Carolina) waterbodies of the North Carolina. The waterbodies in the northern (Virginian to Pamlico Sound) area usually had comparatively low CPUEs of spotted seatrout.

The highest number of commercial trips landing spotted seatrout occurred in 1995 and was used as the maximum effort likely to have occurred in North Carolina from 1994 to 2008. The highest number of trips in 1995 occurred in Pamlico Sound followed by Neuse River, Core Sound, Pamlico River, and the Atlantic Ocean. Most waterbodies with high to moderate number of trips landing spotted seatrout occurred in the central and northern areas. The waterbodies in the southern area tended to have the fewest trips landing spotted seatrout.

Recreational CPUE and Trips by Waterbody

The average recreational CPUE (total number of observed spotted seatrout/total number of samples from 1994 to 2006 to match commercial) was highest in the Pamlico Sound (Table 2).

The next highest CPUE occurred in Topsail Sound followed by Pamlico River, Bogue Sound, and Bay River.   High CPUEs were observed in both the recreational and commercial gill net fisheries in Bay River and Bogue Sound. When waterbodies were grouped into general geographic categories, the central waterbodies tended to have waterbodies with high to moderate CPUEs of spotted seatrout. The northern waterbodies tended to have low CPUEs. The southern waterbodies had variable CPUEs.

The number of directed recreational spotted seatrout trips was highest in 2008 (Figure 2; Table 2). Therefore, only 2008 will be described in this section. The highest number of trips occurred in Pamlico Sound accounting for 37.1% of the trips (Table 3). The remaining waterbodies in the top five in descending order of trips were Intracoastal Waterway, Bogue Sound, Newport River, and Tar-Pamlico River. These waterbodies accounted for 79.7% of the trips. Interestingly, only two of the top five waterbodies (Pamlico Sound and Pamlico River) were in the top five of both lists.

Table 2. Average CPUE (1994-2006) of spotted seatrout in commercial gill net (pounds) and recreational (number) fisheries, the number of trips that landed spotted seatrout in gill nets in 1995*, directed spotted seatrout recreational trips in 2008*, percent area classified as primary nursery area (PNA), secondary nursery area (SNA), and special secondary nursery area (SSNA), and total area by the 29 NC TTP waterbodies from 1994 to 2006. Also presented is the general area where the waterbodies are located. N=Northern Area (Virginia line to Pamlico Sound), C=Central Area (Pamlico Sound to White Oak River), S=Southern Area (New River to South Carolina Line), O=Ocean, and Other includes the Chowan, Perquimans, and Roanoke rivers and Back Bay.

		Commercial		Recreational					
Waterbody	Area	Avg CPUE	Trips	Avg CPUE	Trips	% PNA	% SNA	% SSNA	Total Area
Albemarle Sound	N	11.2	837	2.7	2,327	0.00%	0.00%	0.40%	349,182
Alligator River	N	7.6	434			0.00%	0.00%	0.00%	68,825
Croatan Sound	N	8.6	472	2.2	2,311	0.00%	0.00%	0.00%	27,981
Currituck Sound	N	8.3	100		13	0.00%	0.00%	0.00%	103,126
North River/Back Sound	N	13.3	16	4.5	515	5.40%	0.00%	8.20%	19,369
Pasquotank River	N	4.1	42			0.00%	0.00%	0.00%	22,349
Roanoke Sound	N	12.5	248	3.2	14,288	0.70%	0.70%	2.10%	21,532
Pamlico Sound	N/C	20.6	6,428	5.0	133,146	0.50%	2.70%	0.20%	1,070,478
Bay River	C	42.3	534	4.7	3,555	11.70%	13.20%	0.00%	14,261
Bogue Sound	C	30.5	322	4.7	55,149	0.80%	0.00%	0.00%	23,809
Core Sound	C	33.9	956	4.0	3,655	2.80%	0.00%	9.60%	68,610
Neuse River	C	26.6	1,061	3.7	7,407	2.20%	1.90%	0.80%	123,165
Newport River	C	11.5	19	4.4	23,106	17.60%	0.00%	5.20%	11,073
Pamlico River	C	24.4	923	4.9	16,155	1.50%	13.00%	3.20%	86,786
Pungo River	C	29.1	13			2.00%	6.40%	5.00%	31,877
Cape Fear River	S	12.4	144	2.6	9,149	21.90%	0.00%	7.20%	33,724
Inland Waterway	S	16.7		3.9	58,761	20.30%	1.00%	0.30%	11,868
Lockwood Folly	S	13.1	29	2.9	956	39.40%	0.00%	60.30%	792
Masonboro Sound	S	16.7	25	4.4	1,683	34.40%	2.10%	0.00%	5,094
New River	S	20.3	352	3.6	3,254	16.20%	0.00%	65.80%	22,131
Shallotte River	S	10.7	12		43	59.30%	0.00%	0.00%	867
Stump Sound	S	12.0	7		85	89.90%	0.00%	7.40%	3,499
Topsail Sound	S	25.5	14	5.0	485	35.30%	0.50%	0.00%	3,651
White Oak River	S	29.9	47	2.4	11,603	18.40%	0.00%	0.00%	5,242
Ocean	O	33.2	870			<0.1%	0.00%	0.00%	630,529
Other		5.4	101		11,546	0.00%	0.00%	0.00%	47,390

**peak years selected for commercial (1995) and recreational (2008) trips*

Table 3. Number of directed recreational private boat spotted seatrout trips during 2008 by waterbody and wave. Directed trip definition is any trip where spotted seatrout were targeted, harvested, or released.

		Wave						
Water Location	Area	Jan/Feb	Mar/Apr	May/Jun	Jul/Aug	Sep/Oct	Nov/Dec	Annual
Albemarle Sound	N	63	207	307	302	566	882	2,327
Chowan River	N	1	4	6	6	10	16	43
Croatan Sound	N	62	206	305	300	562	876	2,311
Currituck Sound	N	0	1	2	2	3	5	13
North River (Currituck)	N	14	46	68	67	125	195	515
Roanoke Sound	N	386	1,274	1,885	1,852	3,476	5,415	14,288
Pamlico Sound	N/C	3,596	11,870	17,565	17,259	32,391	50,465	133,146
Bay River	C	96	317	469	461	865	1,347	3,555
Bogue Sound	C	1,490	4,917	7,275	7,149	13,416	20,902	55,149
Core Sound	C	99	326	482	474	889	1,385	3,655
Neuse	C	200	660	977	960	1,802	2,808	7,407
Newport River	C	624	2,060	3,048	2,995	5,621	8,758	23,106
North River (Carteret)	C	276	912	1,350	1,326	2,490	3,879	10,233
Tar-Pamlico River	C	436	1,440	2,131	2,094	3,930	6,124	16,155
White Oak River	C	313	1,034	1,531	1,504	2,823	4,398	11,603
Cape Fear River	S	247	816	1,207	1,186	2,226	3,467	9,149
Lockwood Folly River	S	26	85	126	124	233	362	956
Masonboro Sound	S	45	150	222	218	410	638	1,683
New River	S	88	290	429	422	792	1,233	3,254
Shallotte River	S	1	4	6	6	10	16	43
Stump Sound	S	2	8	11	11	21	32	85
Topsail Sound	S	13	43	64	63	118	184	485
Inland (other)		34	113	168	165	309	481	1,270
Intracoastal Waterway		1,587	5,239	7,752	7,617	14,295	22,271	58,761
Total		9,699	32,022	47,386	46,563	87,383	136,139	359,192

Seasonal Landings of Spotted Seatrout by Waterbody

In addition to varying by waterbody, the landings of spotted seatrout in the gill net fishery varied seasonally (Figure 3). In general, spotted seatrout had higher catch rates during the fall and winter (October through February). The highest catch rate expressed here as a monthly CPUE (lb/trip) averaged from 1994 to 2006 occurred December in Core Sound. The next highest catch rate occurred in January in Core Sound followed by Bogue Sound in February. Average catch rates were usually less than 100 pounds per trip in the rest of the state throughout the year.

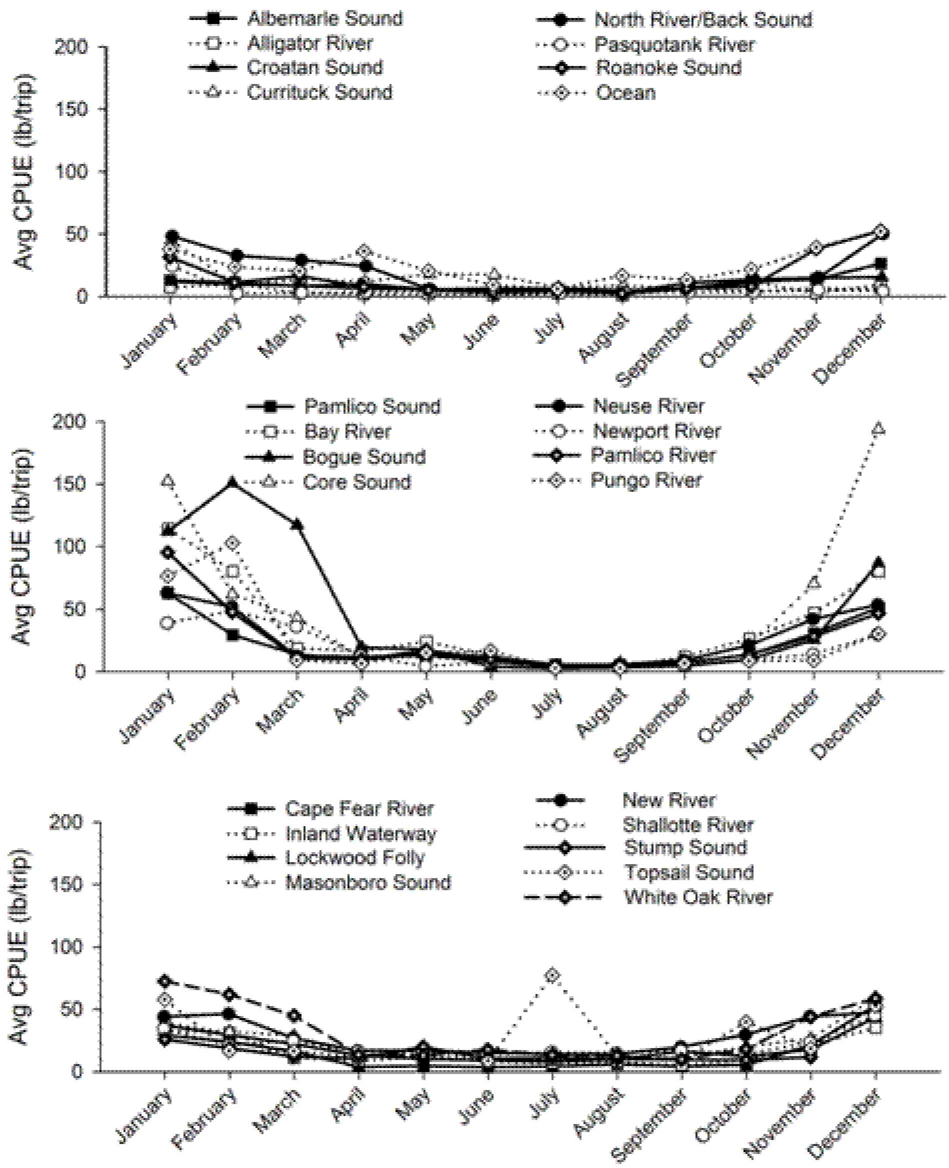


Figure 3. Catch per unit effort (CPUE) from 1994 to 2006 averaged for each month by 25 of the 29 NC TTP waterbodies. Waterbodies are separated into general areas of northern, central, and southern. Ocean is included in northern area for convenience. Pamlico Sound is included in the central plot but the waterbody is located in both areas.

Although the gill net catches have a general trend of increasing catch rates during the fall and winter, the amount of effort varied by waterbody throughout the year and generally had two peaks in number of trips landing spotted seatrout (Figure 4). One peak was in the fall/winter between September through January which corresponds to fisheries that target striped mullet (*Mugil cephalus*), southern flounder (*Paralichthys lethostigma*), and to a lesser extent speckled trout. The other peak tended to be between April and May. This peak in number of trips corresponds to fisheries that target striped mullet, spot (*Leiostomus xanthurus),* croaker (*Micropogonias undulatus*), and southern flounder.

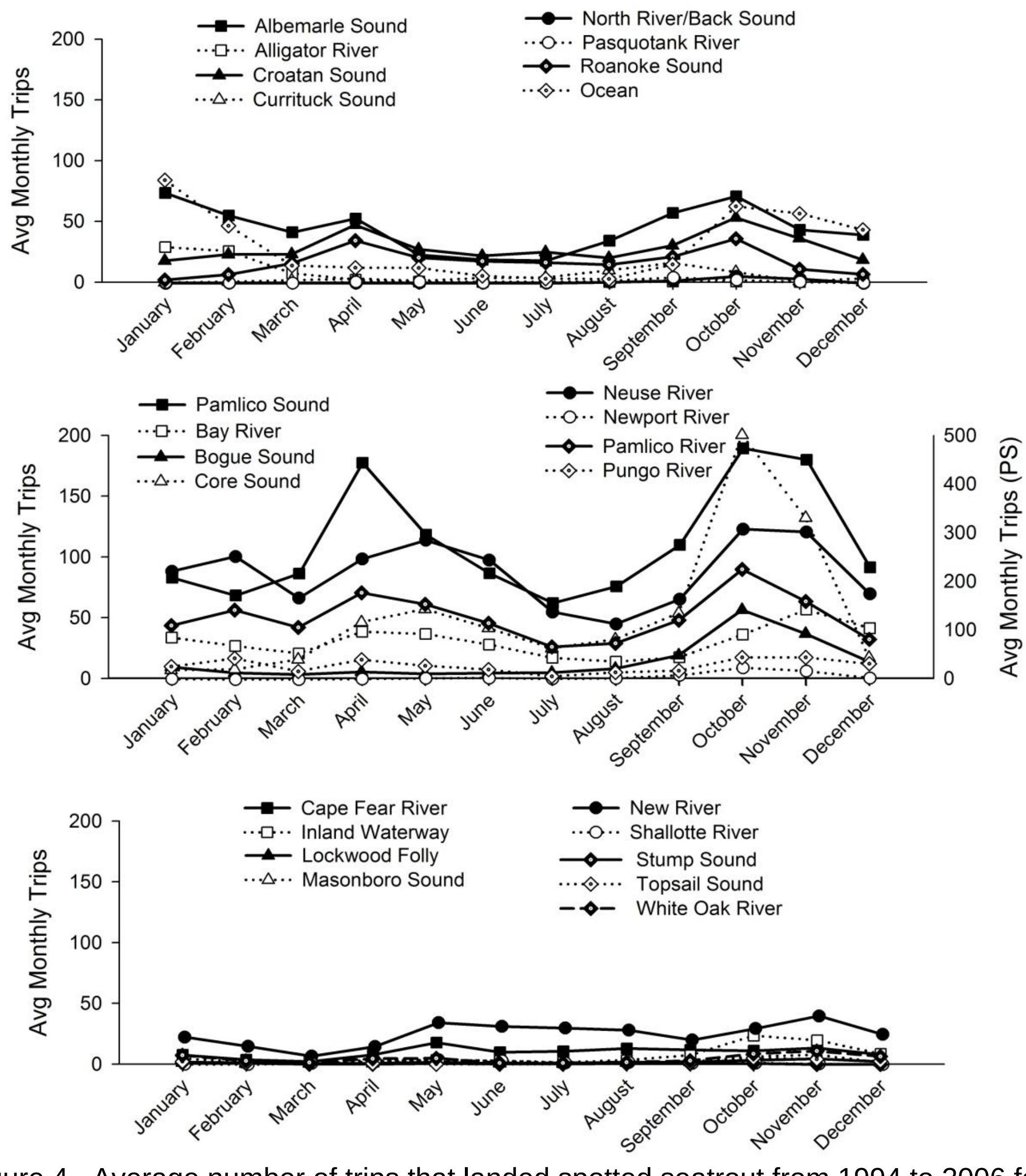


Figure 4. Average number of trips that landed spotted seatrout from 1994 to 2006 for the 25 of the 29 NCTTP waterbodies. Waterbodies are separated into general areas of northern, central, and southern. Ocean is included in northern area for convenience. Pamlico Sound's average monthly trips are plotted with values associated with the right axis. All other waterbodies' average monthly trips are plotted with values associated with the left axis.

Neuse and Pamlico river systems were analyzed in the Red Drum FMP Amendment to determine the impact of set nets on red drum harvest (does not include strike nets). In these two systems, striped mullet appear to be the one of the targeted species year round (Table 4).

Spotted seatrout catches were highest in the Neuse River from November to January. In the Pamlico River, the highest catches were in January, May, and November.
Recreational trips targeting spotted seatrout in 2008 were highest in the November and December wave for each waterbody (Table 3). This wave also corresponded to when commercial trips began to decline. The highest competition for area between recreational and commercial fishermen likely occurred during October and November when commercial fishermen appear to be targeting species other than spotted seatrout based on the CPUE (Figure 3) and average landings (Table 4).

Table 4. Species composition of small mesh gill net trips in Neuse and Pamlico Rivers. Borrowed from Red Drum FMP Amendment

Table 45. Average monthly landings (pounds) for targeted small mesh gill net species in the Neuse River, NC 2001 – 06, set nets only.

	Month												
Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Bluefish	.	1	76	2,854	579	59	16	434	872	819	53	2	5,764
Red drum	465	395	412	601	1,190	899	716	838	1,330	1,179	577	178	8,780
Sea mullet	.	0	6	74	9	0	2	3	5	48	10	1	159
Spanish mackerel	.	8	.	1	30	4	65	7,724	4,813	1,011	18	.	13,673
Atlantic menhaden	3,341	35,380	30,923	15,109	1,406	3	36	247	269	674	595	825	88,807
Mullets	5,987	3,649	2,224	4,063	2,406	1,999	1,846	2,338	3,791	6,589	5,045	2,167	42,103
White perch	63	202	275	92	5	3	4	8	7	8	84	112	864
Spotted sea trout	1,458	898	669	1,212	1,129	491	160	277	375	818	2,183	1,822	11,491
Spot	11	1	94	2,672	1,633	551	506	398	1,049	4,003	761	13	11,691
Weakfish	40	75	179	801	130	17	10	26	105	364	284	190	2,221
All	11,365	40,608	34,860	27,479	8,518	4,026	3,360	12,292	12,614	15,512	9,610	5,310	185,554

Table 46. Average monthly landings (pounds) for targeted small mesh gill net species in the Pamlico, Pungo rivers, NC 2001 – 06, set nets only.

	Month												
Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Bluefish	.	.	1	968	326	81	2	97	220	34	2	.	1,731
Red drum	184	144	119	131	163	259	486	689	618	778	437	168	4,175
Sea mullet	.	3	0	6	6	1	0	1	4	14	9	16	60
Spanish mackerel	.	.	.	2	289	144	147	1,303	2,199	393	1	.	4,477
Atlantic menhaden	2,717	13,520	24,530	2,603	58	114	31	28	11	7	47	35	43,702
Mullets	12,594	4,517	7,395	5,488	4,226	4,005	1,760	3,179	5,107	13,009	8,701	9,026	79,007
White perch	2,328	2,528	3,162	767	234	60	25	185	156	290	1,338	1,078	12,150
Spotted sea trout	2,430	251	254	464	1,297	571	111	128	253	543	1,281	898	8,480
Spot	.	3	48	1,893	1,505	702	142	436	640	866	44	2	6,282
Weakfish	3	8	112	508	63	6	2	17	142	578	851	258	2,546
All	20,255	20,973	35,620	12,829	8,165	5,941	2,706	6,064	9,351	16,514	12,709	11,481	162,609

Discussion

The previous sections described data to help make decisions based on area specific management measures to reduce competition for spotted seatrout. Since the assessment (to be updated this summer) determined spotted seatrout were overfished and experiencing overfishing, management measures may be needed to be taken to reduce harvest. Interim measures are not required to achieve the new FMP guideline for a FMP to achieve at least a 50% criterion to maintain a sustainable harvest. Additionally, the management measures below would likely not be calculated in any reductions due to limitations of current data to describe harvest in specific creeks and the likelihood of effort shifting to different areas.
The General Assembly has charged the state conservation agencies to be stewards of marine and estuarine resources and to manage those resources for the benefit of the people of the state was a whole. During the development of the FRA the following was noted in regards to public trust: "Under the Public Trust Doctrine, all citizens have the right to use North Carolina's navigable waters for a variety of purposes, including fishing. As sovereign, the State is the owner and manager of the marine and estuarine resources that reside in North Carolina, and is vested with all necessary authority to regulate fishing practices in order to conserve and perpetuate those fisheries. The Marine Fisheries Commission and Division of Marine Fisheries are specifically charged with conserving and protecting the State's coastal fishery resources. Such a charge includes the duty to appropriately control the use of fishing gears to minimize their adverse effects on fish stocks and fishery habitats, ensuring that coastal fisheries remain productive and viable for future generations. As sovereign, the State also has the responsibility to manage conflicts between citizens using its public waters and is vested with the general police power necessary to resolve such user conflicts." It was clearly recognized that it is within the State's responsibility and authority to control fishing gears in order to adequately conserve and manage North Carolina's marine and estuarine resources, and to resolve user competition/conflicts,

In October 2004 the MFC adopted a Conflict Management Policy that 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**." Several basic strategies have been employed by the MFC and the Division in the past to address user competition:

- Seperate parties spatially (no trawl areas, designated crab pot areas)
- Separate parties temporally (no trawl on weekends, menhaden season)
- Restrict the amount or deployment of gear (net limits, attendance time periods)
- Combination of the three

The likelihood of a proposed measure to successfully address the competition issue as well as administration and enforcement needs to be considered in the evaluation of possible actions. The Advisory Committees are being asked to consider whether the small mesh gill net and recreational fishing competition issue should be addressed as an interim measure, and if so provide advice on possible actions that should be implemented.

Status Quo

This management option keeps the management regime the same for area specific management. Currently, the director has the authority to close specific areas to harvest by gear or season if there is necessity to do so. Other management options are/or will be considered to reduce the overall harvest of spotted seatrout including season, minimum size limit increase, reduction in bag limit, and commercial trip limit through the ongoing FMP process and size limit interim management measures.

Close Nursery Areas to All Fishing for Spotted Seatrout

Landings of spotted seatrout cannot be directly attributed to any nursery area. Additionally, the designation of a nursery area was designed to protect juvenile (usually < 3 inches) estuarine species and was based on five indicator species (brown shrimp, blue crab, Atlantic croaker, spot and southern flounder). Some of the attributes that make the waterbodies preferable habitats for juvenile estuarine species may make nursery areas preferable for spotted seatrout during certain seasons. The northern waterbodies have very little area classified as primary or secondary nursery areas (Table 2). Additionally there have very few reports of competition for space to fish for spotted seatrout in the northern waterbodies (Table 1). The central waterbodies had the most complaints concerning spotted seatrout. The Bay and Neuse rivers both received complaints and had high CPUEs for both recreational and commercial fisheries. The creeks where complaints were reported in these two river systems were not all classified as nursery areas. The closing of the nursery areas will only eliminate harvest of spotted seatrout in those creeks and may increase competition in creeks where harvest is allowed. The southern area of the state has the highest overall percentage of nursery areas. Most areas outside of the Intracoastal Waterway from New River to Cape Fear River would be impacted. This would eliminate recreational and commercial fishing in many of the tidal creeks in an area where human densities are highest along the coast.

Close Nursery Areas to Gill net Fishing for Spotted Seatrout

Much of the same concerns discussed above would pertain to this section. Gill nets would be concentrated in creeks that are not classified as nursery areas or just outside of the boundary. This may cause increased competition in these areas leading to additional complaints and regulatory action. The attendance requirement for small mesh gill nets changed in 2008 to require attendance in all primary and permanent secondary nursery areas, shallow grass beds along ‘Outer Banks’, and within 200 yards of any shoreline from May 1 to November 30 in areas designated in 15A NCAC 03R .0112(b). This may eliminate some of competition for space in nursery areas due to the attendance requirement when recreational fishing has peaked in the past.

Recommend Areas to Be Considered for Management in the Spotted Seatrout Fishery Management Plan

The Advisory Committee for the Spotted Seatrout FMP is composed of recreational and commercial fishermen from Nags Head to Hampstead and westward to Raleigh. The members have a diverse background but all have a vested interest in spotted seatrout. Allowing these members to develop and consider area specific management measures enables the management regime to be thoroughly considered and debated before passing. Additionally this would enable the Regional, Finfish, and Spotted Seatrout Advisory Committees to provide guidance to the DMF on areas that need to be considered for area specific management.

Recommend Mediation for Specific Areas to Reduce Competition Among Gill net and Recreational Fishermen

Mediation is a process to achieve an acceptable long, lasting resolution to a conflict through an independent third party. Mediation works best when the parties involved in the dispute are acceptable to resolutions that meet both parties' needs or goals. The process works best when it is voluntary but can be used in other disputes. Factors that can be used to determine if mediation will be successful are described in Table 5. If gill net and recreational fishermen are willing to discuss the possibility of management measures to reduce competition then mediation has a chance to work. There are 12 steps in the development of the mediation process. Five steps are done prior to an independent mediator being involved including initial contact with parties, selecting a strategy to resolve conflict, analyzing data, designing a plan for mediation, and developing trust and cooperation. After the first five steps have been accomplished then the mediator can meet with both groups to assist in the development of a successful dispute resolution. However if one group decides they do not want to compromise then the success of the mediation process will be limited. More information on the mediation process is available in the Marine Fisheries Mediation Standard Operations Procedures.

Table 5. Key factors in mediation. Source: Marine Fisheries Mediation Standard Operations Procedures

Not all conflicts can be resolved through mediation. Certain key factors that determine the success of mediation include:

1. The disputing parties can be identified and involved in the mediation process, they have a vested interest in seeing the dispute resolved, and can benefit from a solution.
2. Parties are not too polarized and productive, face-to-face discussions are possible.
3. Parties don't view alternative procedures or outcomes to mediation as desirable or viable.
4. Deadlines or time constraints provide an incentive for a prompt solution.
5. Any agreement that is likely to be reached can be implemented within a time frame that makes it relevant and can be confined to a geographic scope that enables implementation and enforcement.
6. Implementation of any agreement that is likely to be reached is within the purview of the Marine Fisheries Commission and the Division of Marine Fisheries to enforce and regulate.
7. Any agreement that is likely to be reached does not negatively affect resource management actions of the DMF.
8. Implementation of any agreement that is likely to be reached does not violate other laws, rules or policies.

Current Authority
15A NCAC 03J .0103
15A NCAC 03M .0512
15A NCAC 03R .0112

Management Options

1) Status Quo
   + No impact to commercial or recreational fishermen.
   + The FMP Process is allowed to develop a plan to deal with area specific management.
   − Competition issues are not resolved.
   − No reduction in harvest.

2) Close Nursery Areas to All Fishing for Spotted Seatrout
   + Would reduce competition in nursery areas.
   + Reduces harvest in nursery areas.
   − Overall harvest reduction unknown.
   − Fishermen would be displaced into other areas.
   − Different regions of the state would be impacted at varying levels.
   − Nursery areas not designated based on presence or absence of spotted seatrout.

3) Close Nursery Areas to Gill net Fishing for Spotted Seatrout
   + Would reduce competition in nursery areas.
   + Reduces harvest in nursery areas.

- – Overall harvest reduction unknown.
- – Gill net fishermen displaced into other areas.
- – May cause increased competition in non-nursery areas.
- – Nursery areas not designated based on presence or absence of spotted seatrout.

4) Recommend Areas to Be Considered for Management in the Spotted Seatrout Fishery Management Plan

- + Advisory Committees provide input to DMF for issue development
- + Area specific management to reduce competition in nursery and non-nursery areas.
- – Competition not resolved immediately.
- – Increases time to develop Spotted Seatrout FMP.

5) Recommend Mediation for Specific Areas to Reduce Competition Among Gill net and Recreational Fishermen

- + Area specific management to reduce competition in nursery and non-nursery areas.
- + Groups involved in competition assist in developing rules for area.
- + Promotes a long-lasting cooperation among user groups.
- – Competition not resolved immediately.
- – Only works if both parties are willing to comprise.

Management Recommendations

Spotted Seatrout Advisory Committee:
Endorse and encourage the mediation process, and back it up with area closures or license suspension by the Director. Address a specific conflict area, such that no fixed gill nets would be allowed from 2 hours after sunrise to 2 hours before sunset in the New River from the bypass bridge to the Inland waters designation.

DMF: Address through the FMP process. The FMP will contain a Conflict Issue Paper which will include the mediation policy process as a management option.

MFC: Sent the issue back to the Spotted Seatrout Advisory Committee for further advisement.

Research Recommendations

• Distribution of spotted seatrout in nursery and non-nursery areas.
• Survey of fishing effort in creeks with complaints.
• Determine targeted species in nursery areas and creeks with complaints.

Appendix 2A Gill net regulations along the Atlantic Coast by state.

State	Commercial								Recreational			
	Large Mesh				Small Mesh							
	Legal	Net Length Limit	Attendance	Limited Entry	Legal	Net Length Limit	Attendance	Limited Entry	Legal	Net Length Limit	Attendance	Limited Entry
Maine	No	n/a	n/a	n/a	Yes/bait	2,000 ft	no	no	No	n/a	n/a	n/a
New Hampshire	Yes	25 nets @ 300 ft	No	No	Yes	100 ft	Yes	No	Yes/bait	100 ft	Yes	No
Massachusetts	Yes	No	No	Yes	Yes	No	Yes	No	Yes	200 sq ft	Yes	No
Rhode Island	Yes	No	No	No	Yes	No	No	No	Yes/bait	100 ft	Yes	No
Connecticut	Yes	Varies	No	Yes	Yes	Varies	No	Yes	Yes/bait	60 ft	Yes	No
New York	Yes	Varies	Varies	Varies	Yes	Varies	Varies	Varies	Yes/bait	25 ft	n/a	No
New Jersey	Yes	No	Varies	Yes	Yes	No	Varies	Yes	No	n/a	n/a	n/a
Pennsylvania	Yes/ very limited	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No	n/a	n/a	n/a
Delaware	Yes	3,000 ft	No	111 permits	Yes	3,000 ft	No	111 permits	Yes	200 ft	No	No
Maryland	Yes/ Striped bass	1,800 ft	No	No	Yes	No	Yes	No	No	n/a	n/a	n/a
Virginia	Yes	Yes	Varies	No	Yes	Yes	Varies	No	Yes	1 net @ 300 ft	Varies	No
North Carolina	Yes	Varies	Varies	Yes+	Yes	Varies	Varies	Yes+	Yes	300 ft	Varies	No
South Carolina	Yes	100 ft++	Yes	No	Yes	Yes	Yes	No	Yes*	*	*	No
Georgia	Yes**	n/a	n/a	n/a	Yes**	n/a	n/a	n/a	No	n/a	n/a	n/a
Florida	No	n/a	n/a	n/a	No	n/a	n/a	n/a	No	n/a	n/a	n/a

+Limited number of commercial licenses in North Carolina.
++100 yards of net is allowed in specific areas.
*A person may use a lawful gill net non-commercially without a commercial saltwater fishing license; however, an equipment license is required.
**Shad fishing with gill nets is allowed above the saltwater demarcation line.

Appendix 2B 1994 Issue Paper discussing area specific management measures.

DATE: 27 September 1994

SUBJECT: Gill Net/Speckled Trout

The Division has essentially no data to help make a decision, so input from fishermen will be critical in order to be fair. After meeting with small groups of recreational and commercial fishermen, there are presently few options available that are acceptable to both groups.

The issue appears to come down to allocation . Speckled trout begin moving during fall into some of the deeper creeks. Both commercial and sport fishermen want to catch these fish. Presently there is a 10 fish limit on sport fishermen and a 12 inch size limit on all fishermen. Nets cannot be used to take speckled trout in inland waters (WRC) beginning October 9, 1994. Commercial fishermen say this will substantially impact them. The WRC did allow retention of speckled trout caught with gill nets Dec 1 - June 5 if one had a special device license. Alot of the creeks in the Neuse River have substantial inland waters.

Meetings and discussions with officers, principally Officer Mitchell, but also Officer Syers have helped clarify several aspects of the issue. Fishermen had asked for gill nets to be prohibited in several creeks (Trent, head of Bay River, Chapel, Vandemere, Dawson, Upper Broad and Goose). We have no authority to regulate gill nets in Dawson Creek (Inland waters). Goose Creek and Upper Broad stand apart from the other creeks: not as deep, different use by gill netters and sport fishermen. With present information I would not recommend prohibiting gill nets in these creeks.

A summary of discussion so far:

> Recreational fishermen: 1) want all gill nets prohibited in these creeks from Sept/Oct - March/Apr; 2) feel that gill nets exploit too heavily speckled trout in these creeks; 3) feel that they are conserving speckled trout with a 10 fish creel, but commercial fishermen are not.
>
> Commercial fishermen: 1) want no further restrictions on netting; 2) do not understand why recreational fishermen should get sole access; 3) claim that the netting because it is done by just a few individuals do not impact resource; 4) can not use gill nets in Inland creeks to catch speckled trout - already restricted; 5) if gill nets are restricted then make these areas 0-fish creel for sport fishermen.

The 0-creel limit in areas zoned free of netting was recommended to be discussed by the Proclamation Committee of the MFC, but the full MFC voted not to take it to hearing. Also, these areas were voted by the Proclamation Committee to be taken and discussed by the full MFC. The MFC voted not to take to hearing.

Potential options at this time:

1) No action - no data, rely heavily on social input

2) Some restriction of gill nets

   use night only - out of view of recreational fishermen

   limit amount of net - WRC limits to 100 yd sets - 50 yds apart

   prohibit on weekends - prevents weekend effort, time when most recreational fishermen fish

3) No nets - 0 creel

Appendix 3 Interim Management Measures to Achieve Sustainable Harvest

Issue

Establish interim management measures to enable a higher proportion of spotted seatrout to reproduce while the spotted seatrout stock assessment is being updated and the fishery management plan is being developed.

Background

The first stock assessment of NC's spotted seatrout, "Stock Status of Spotted Seatrout in North Carolina, 1991-2006", determined that the stock is overfished and overfishing is occurring (Jensen 2009). A statistical catch-at-age model was used to determine fishing mortality rates and stock abundance levels, and yield per recruit and biomass per recruit analyses were used to identify appropriate fishing mortality and spawning stock biomass benchmark thresholds. The models indicated that the population of spotted seatrout has been overfished for the entire time series and that overfishing occurred in all but one year.

The FRA mandates that fishery stocks be managed to allow for sustainable harvest and prevent overfishing. Sustainable harvest is defined as the amount of harvest, including release and discard mortality, that can be taken on a continuing basis without reducing the stock biomass of the fishery or causing the fishery to become overfished.

Because the status of spotted seatrout has been determined to be overfished and overfishing is occurring, and while the spotted seatrout FMP is in the process of being developed, the MFC could choose to adopt interim management measures to reduce harvest and help to increase spawning stock biomass.

All Atlantic states that have a proclaimed interest in spotted seatrout have established at least a 12 inch minimum total length size limit (Table 1). Most states have a recreational bag limit ranging from 4 to 15 fish, with the exception of no bag limit in Delaware. The commercial fisheries are limited using several different control measures ranging from total commercial closure (SC) to quotas (VA), seasonal closures, and gear limits. The current size limit of spotted seatrout is 12 inches in NC and 14 inches in VA, and the current bag limit is 10 fish in both NC and VA. There are currently no trip limits in NC, while the state of VA adopted a 51,104 pound quota in August 1995 (this value represents an average of the 1993 and 1994 commercial landings plus 25%). To date, this quota has not been met. Size limit data and analyses are presented herein. Further analyses of bag limits and trip limits are attached in Appendix 3-A.

Methods

All analyses assumed regulations would impact only fishermen in North Carolina, while all future harvest and dead discards from Virginia were assumed to remain the same. Numbers shown include both North Carolina and Virginia harvest. All calculations were based on input data averaged from 2004 to 2006. Essentially, the following analyses show the average reduction that would have been observed from 2004 to 2006 if a size limit change was in place during those years.

Size Limit Analysis

Changes to commercial and recreational harvest and dead discards were predicted for changes from the current size limit of 12 inches to proposed limits of 13, 14, and 15 inches. Input data included weighted length frequencies at age for North Carolina commercial landings, recreational harvest, and recreational releases and Virginia commercial and recreational catch at age data (Appendix 3B). Other estimated inputs which were developed for the stock assessment included natural mortality at age, proportion released, and weight at age of the catch were included. Selectivity at age, population numbers at age, and F_{mult} parameter estimates were output by the assessment (Jensen 2009, Appendix 4). Equations used in the calculations were standard equations used in the ASAP model (NOAA Fisheries Toolbox 2008).

Weighted length frequencies at age were examined to determine the new catch at age and release estimates expected under each proposed size limit. A weighted average of undersized harvest from 2004 to 2006 was used to determine the proportion harvested in size bins that would be illegal under the proposed size limits. These data were then used to calculate a new proportion of fish that would be released under each size limit scenario. The new release proportions were used to calculate new F rates for each fishery and their associated discards. These F rates were then used to calculate the new predicted harvest and discards, in both numbers and pounds, associated with each proposed size limit increase. Percent reduction was calculated for each fishery and percent increases were determined for the dead discards expected in each fishery.

This analysis assumes noncompliance with proposed size limits in the future recreational fishery based on past history of undersized fish in the harvest observed in MRFSS survey estimates. The commercial fishery does not typically harvest fish less than the current size limit of 12 inches and currently has no associated discard component; therefore, a 10% noncompliance rate was assumed with future increases in size limits for the commercial fishery.

A release mortality of 10% was assumed for the recreational fishery to mirror the recent stock assessment (Jensen 2009, Appendix 4), and an 80% release mortality estimate was assumed for the commercial fishery based on a study of small mesh gill nets in North Carolina (Price and Gearhart 2002b).

Size and Age at Maturity

Life history information has been collected for NC spotted seatrout since 1991. When possible macroscopic determinations of the reproductive condition of male (n=2,385) and female (n=5,527) spotted seatrout were made in the laboratory. During 1991-1995, a representative subsample was selected for microscopic (histological) confirmation of macroscopic determinations.

Fecundity

Unfortunately, accurate annual fecundity estimates for use in stock assessments are not available for spotted seatrout in North Carolina. This research is very labor intensive, and results can be highly variable. The need for fecundity estimates for NC spotted seatrout will be a research recommendation of the FMP since fecundity estimates would help to improve calculations of the spawning potential ratio (SPR), which is crucial to the determination of sustainability of the stock. However, general fecundity trends for spotted seatrout from other states and can be assumed for NC's stock.

Results

Size Limit Analysis

The commercial fishery, which is largely composed of gill nets, tends to catch larger, older fish than the recreational hook-and-line fishery. As a result, the recreational fishery is predicted to experience 2.5 to 4 times more reduction in harvest than the commercial fishery under size limit restrictions (Table 2). In addition, the average recreational fishing mortality rate from 2004 to 2006 is over 3 times greater than the commercial fishery (Jensen 2009, Appendix 4). Therefore, the recreational fishery will experience a much larger reduction under size limit increases than the commercial fishery. An increase in the size limit can play an important role in reducing the overall harvest and allowing smaller fish the chance to spawn at least once before being harvested.

Life History Information

Since the stock assessment for spotted seatrout is being updated to include 2007 and 2008 landings data, it might be best to base interim management options on the basic life history information available for spotted seatrout. Myers et al. (1998) used a simple model to demonstrate that a spawn-at-least once policy may prevent the collapse of the stock. The spawn-at-least once policy requires that fish be permitted to spawn at least once before they become vulnerable to fishing gear, and the stock will not collapse if fishing mortality targets are breached.

Maturity data is presented herein by length, age, and sex (Figure 1, Tables 3 and 4). There is a large size range in each year class due to the extended spawning season. Therefore maturity and fecundity data are best based on fish size rather than age.

Size and Age at Maturity

Spotted seatrout mature at an early age, with most fish mature by 12 inches (age 1) (Figure 1, Tables 3 and 4). Males mature at a smaller size, younger age, and earlier in the season, with 50% mature by 8 inches, and 100% mature by 12 inches (age 1). Females mature a little later, with 59% mature by around 10 inches, 95% mature by 13 inches (age 1), and 98% mature by 14 inches (age 2), and 99% mature by 15 inches (age 2). Any increase in minimum size at or above 14 inches would essentially allow all of the female spotted seatrout to mature, increasing the reproductive potential of the stock.

Fecundity

The reproductive biology of spotted seatrout throughout their range has been summarized as being incredibly prolific due to the early age of maturity and females releasing eggs in several batches over a protracted spawning season. Annual fecundity in this species is determined by the number of eggs released during each spawning event (batch fecundity) and the number of spawning events occurring during the course of the spawning season (spawning frequency) to estimate the reproductive output for an entire spawning season (Brown-Peterson et al. 1988; Brown-Peterson and Warren 2001; Nieland et al. 2002). Most estimates of spawning frequency suggest that spotted seatrout spawn, on average, once every 4 to 5 days. Estimates of the number of times an individual spawn varies but in most regions, spotted seatrout appear to have the ability to spawn 40 to 50 times in a single season (Brown-Peterson 2003).

Fecundity research has shown that older (larger) females spawn more frequently than younger fish (Roumillat and Brouwer 2004, Crabtree and Adams 1998, Sundararaj and Suttkus 1962). Most of these studies only include ages 1 to 4 fish due to small sample sizes of older fish. A South Carolina study estimated fecundity for age classes 1 to 3 were approximately 3.2, 9.5, and 17.6 million eggs for each age class, respectively (Roumillat and Brouwer 2004).

Harvest by Length

Recreational Fishery

Length frequency distributions of the recreational hook and line harvest (Type A and B1) and live releases (Type B2) were obtained through MRFSS surveys for North Carolina and Virginia.

In North Carolina, where the size limit is 12 inches TL, the majority of the length frequency distribution of the recreational harvest (Type A and B1) ranged between 12 and 19 inches TL and averaged approximately 15 inches TL (Figure 4). Most of North Carolina's releases (Type B2) were small fish, with most of the released fish below the 12 inch TL minimum size.

In Virginia, the length frequency distribution of the recreational harvest (Type A and B1) was slightly larger since Virginia has a larger size limit of 14 inches TL (Figure 5). The majority of the Virginia recreational harvest ranged between 12 and 19 inches TL. Virginia's releases were also primarily small fish, with most of the released fish just below the 14 inches TL minimum size.

Commercial Fishery

DMF commercial fish house sampling data were used to characterize the length composition of each major commercial fishery (Figure 2). Spotted seatrout less than 12 inches, the current minimum size limit in North Carolina, are likely to pass through mesh sizes in the estuarine gill nets that dominate the commercial fishery (74% of the 2006-2008 commercial catch was by estuarine gill nets). The majority of spotted seatrout caught in the beach seine, estuarine gill net, pound net, and trawl fisheries ranged from 14 to 20 inches TL and averaged around 17 to 18 inches TL. Spotted seatrout harvested with ocean gill nets and haul seines was slightly smaller, but these fisheries contributed 2 to 14% of the total commercial harvest in recent years (2006-2008).

Virginia commercial fish house sampling data, provided by the Virginia Marine Resources Commission staff, were used to characterize the length composition of major commercial fisheries in Virginia (Figure 3). Virginia's commercial harvest of spotted seatrout was only a fraction of the North Carolina commercial harvest. Most of Virginia's landings were by a haul seine fishery that operates in both the Chesapeake Bay and nearshore ocean waters. Larger spotted seatrout were harvested in Virginia's haul seine and ocean gill net fisheries, with the majority of the catch from 15 to 23 inches TL and averaged 18 to 19 inches TL. Virginia's commercial harvest by hook and line had the smallest fish, with most of the harvest from 10 to 19 inches TL and averaged 14 and 15 inches TL.

Discussion

There is evidence that the population levels of spotted seatrout have increased since the terminal year in the last stock assessment (2006). The stock assessment showed that spotted seatrout population dynamics are largely driven by cold stun events (Jensen 2009, Appendix 4). There have not been any cold stuns observed since 2003 and, as a result, this may have allowed the population to expand.

When interpreting the percent reductions presented in this paper, it should be noted that recruitment is highly variable and, when combined with the vulnerability to environmental influences such as cold stuns, the resulting catch is also highly variable. Thus, the harvest reductions predicted here only hold true if environmental parameters, recruitment, and fishing pressure in the future are similar to that seen in 2004 to 2006. Future catches next year are assumed to be similar to the recent past.

Spotted seatrout population dynamics are naturally variable. Reliance on only a few age classes leads to variability in population size and a higher potential for over-exploitation in the long-term. Expansion in the age structure is required to provide the best chance for a sustainable fishery.

Increasing the minimum size limit would protect young fish from being harvested before they had the opportunity to spawn. This would especially help to increase the size of the spawning stock biomass since age-1 fish make up the largest percentage of the spawning stock. Although older fish may produce more eggs per spawning season, egg production by the predominant age groups may overshadow contributions by older bigger fish. The historical view was that age-1 fish contributed very little to the overall yearly reproductive effort (Moody, 1950; Tabb, 1961; Sundararaj and Suttkus, 1962), but recent research suggest that age 0 and 1 females do make an important contribution to the total spawning biomass (Brown-Peterson 2003, Roumillat 2003, Lowerre-Barbieri et al., 1999, Crabtree and Adams 1998, Wenner et al. 1990). The importance of age- 1 spotted seatrout spawning is considerable due to the high percentage of age-1 fish in the overall age distribution of spotted seatrout populations throughout the southeastern US and in NC.

An increase in minimum size will likely increase the number of discarded spotted seatrout in the commercial and recreational fisheries. For the commercial fishery, an increase from 12 inches to 14 inches would result in a slight increase in discards (11,516 fish; Table 2). An increase in the minimum gill net mesh size used might become necessary to minimize discards of undersized spotted seatrout, particularly in the ocean gill net fishery. Because of the cost involved in gear replacement, increases in minimum mesh size requirements might be better received as addressed through the fishery management plan rather than interim management measures. The practice of releasing spotted seatrout in the recreational fishery has increased considerably in recent years. An increase in the minimum size would likely further increase the number of released undersized fish. Fishing tackle and fishing techniques could be modified to decrease the amount of discard mortality of released fish.

Given the potential changes to the stock, we cannot say with much certainty how much of a reduction is required until the stock assessment is updated; however, fishing rates likely remain high. It makes biological sense to raise the size limit to allow fish to spawn at least once before being caught.

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

15A NCAC 3M .0504 TROUT

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

1) Status quo
   + No additional burden on fishermen, dealers, or managers
   - Does not address historical trend of overfishing
   - Does not address dependence of fishery on year-class strength
   - Maintenance of fishing mortality at or below $F_{Threshold}$, as required by the FRA, will likely not be achieved

2) Size limit increase
   + Allows opportunity for fish to spawn at least once before they are harvested
   + Gets closer to goal of ending overfishing
   - Given potential change in stock dynamics, it is uncertain what level of harvest reduction is needed to rebuild the stock
   - Additional burden on fishermen, dealers, and managers

Management Recommendations

Spotted Seatrout Advisory Committee: Implement a 14 inch size limit, 10 fish bag limit.
DMF:
• Implement a 14 inch size limit.
• Get results of updated stock assessment through 2008.
• Additional changes should be made through the FMP process (bag limits, slot limits, trip limits, gear restrictions, seasonal closures, etc).
MFC:
• Implement a 14 inch size limit.
• Get results of updated stock assessment through 2008.
• Additional changes should be made through the FMP process (bag limits, slot limits, trip limits, gear restrictions, seasonal closures, etc).

Research Recommendations

- The stock assessment needs to be updated through 2008 to determine the harvest reduction required to end overfishing and achieve an appropriate F rate to rebuild the stock.

- Size specific fecundity estimates for North Carolina spotted seatrout would help to improve calculations of spawning potential ratio (SPR) crucial to the determination of sustainability of the stock.

Appendix 3A Changes in Bag Limits and Trip Limits

Introduction

There is evidence that the population levels of spotted seatrout have increased since the terminal year in the last stock assessment (2006). This evidence suggests that the spawning stock biomass (SSB) could be closer to the threshold than was seen in the terminal year of the stock assessment (2006). As a result, the stock assessment is being updated with 2007 and 2008 data. Given the potential changes to the stock, we cannot say with much certainty how much of a reduction is required until the stock assessment is updated; however, fishing rates will likely remain high. Possible harvest and reduction estimates are presented for proposed bag limit changes in the recreational fishery (Table 3A-1; Figure 3A-1) and commercial trip limits in the commercial fishery (Table 3A-2; Figure 3A-2).

Examination of the MRFSS and the commercial gill net indices updated through 2008 show that the current catch rates are high relative to the rest of the time series and are near levels seen in the late 1990s (Figure 3A-3). A graph of the catch-at-age matrix updated through 2008 also reveals large numbers of spotted seatrout being caught in the past few years (Figure 3A-4). Large year classes of age-0 recruits were observed 2007 and 2008. In addition, there is also evidence of some age expansion in the population with age-3 fish now being observed in the catch in noticeable amounts for the first time since 2000.

Methods

All analyses assumed regulations would impact only fishermen in North Carolina, while all future harvest and dead discards from Virginia were assumed to remain the same. Numbers shown include both North Carolina and Virginia harvest. All calculations were based on input data averaged from 2004 to 2006.

Bag Limit Analysis

Reductions in bag limits were empirically-based predictions using the average catch per angler trip estimated from 2004 to 2006 from the MRFSS survey (Table 3A-1; Appendix 3B). Any trips that landed over the proposed new limit in the past were assumed to land the maximum amount allowed under the proposed new limit. This analysis assumed 100% compliance with proposed regulations. Bag limits affected only the recreational fishery.

Trip Limit Analysis

Reductions in trip limits were empirically-based predictions using the average catch per trip reported on trip tickets from 2004 to 2006 (Table 3A-2; Appendix 3B). Any trips that landed over the proposed new limit in the past were assumed to land the maximum amount allowed under the proposed new limits. This analysis assumes 100% compliance with proposed regulations. Trip limits affect only the commercial fishery.

Results

Bag Limit Analysis

Bag limits only impact the recreational fishery and, because of the size of the recreational fishery, they can be effective at reducing the overall harvest. Approximately 70% of the trips that anglers took from 2004 to 2006 landed 3 or fewer spotted seatrout (Figure 3A-1). Of all trips that landed spotted seatrout, 6% attained the 10 fish bag limit, and 1% of the trips exceeded the legal limit. The bag limit must be reduced from 10 to 5 fish to get at least a 10% reduction in total harvest (Table 3A-1).

Trip Limit Analysis

Spotted seatrout are not targeted by the majority of commercial fishermen. The vast majority of trips (65%) landed 10 pounds or less per trip from 2004 to 2006 (Figure 3A-2). Nearly 90% of trips landed 50 pounds or less per trip. Therefore, North Carolina commercial fishermen land so few spotted seatrout per trip and make up a smaller portion of the overall harvest that commercial trip limits alone have limited effectiveness in reducing the overall harvest.

Table 3A-1. Predicted harvest and percent reductions under various bag limit changes in the recreational spotted seatrout fishery. Values are based on average MRFSS survey estimates from 2002 to 2006. Assumes 100% compliance.

Numbers

Bag limit	Rec Harvest	% Reduction in Rec Harvest	Total Harvest (Rec & Com) + Dead Discards	% Reduction in Total Harvest + Dead Discards
1	205,045	-62	414,219	**-44**
2	295,312	-45	504,486	**-32**
3	357,729	-33	566,903	**-24**
4	403,873	-24	613,047	**-18**
5	440,453	-18	649,627	**-13**
6	467,809	-12	676,983	**-9**
7	489,301	-8	698,475	**-6**
8	505,707	-5	714,881	**-4**
9	517,675	-3	726,849	**-2**
10	528,102	-1	737,276	**-1**

Pounds

Bag limit	Rec Harvest	% Reduction in Rec Harvest	Total Harvest (Rec & Com) + Dead Discards	% Reduction in Total Harvest + Dead Discards
1	304,299	-62	588,904	**-45**
2	438,261	-45	722,865	**-33**
3	530,891	-33	815,496	**-24**
4	599,371	-24	883,975	**-18**
5	653,658	-18	938,262	**-13**
6	694,256	-12	978,861	**-9**
7	726,151	-8	1,010,756	**-6**
8	750,499	-5	1,035,103	**-4**
9	768,259	-3	1,052,864	**-2**
10	783,734	-1	1,068,339	

Table 3A-2. Predicted harvest and percent reductions under various commercial trip limits for spotted seatrout. Values are based on average landings reported on trip tickets from 2004 to 2006. Assumes 100% compliance.

Numbers

Trip Limit	Com Harvest	% Reduction in Com Harvest	Total Harvest (Rec & Com) + Dead Discards	% Reduction in Total Harvest + Dead Discards
10	35,233	-69	558,147	**-12**
25	48,301	-57	571,215	**-10**
50	60,638	-46	583,553	**-8**
100	74,004	-34	596,918	**-6**
150	82,077	-27	604,991	**-5**
200	87,745	-22	610,659	**-4**
250	91,931	-19	614,846	**-3**
300	95,107	-16	618,021	**-3**
350	97,780	-13	620,695	**-2**
400	99,950	-11	622,864	**-2**
450	101,800	-10	624,714	**-2**
500	103,335	-8	626,249	**-1**
None	112,825	0	635,739	**0**

Pounds

Trip Limit	Com Harvest	% Reduction in Com Harvest	Total Harvest (Rec & Com) + Dead Discards	% Reduction in Total Harvest + Dead Discards
10	63,329	-70	831,635	**-15**
25	88,728	-59	857,034	**-13**
50	112,706	-47	881,012	**-10**
100	138,683	-35	906,989	**-8**
150	154,373	-28	922,679	**-6**
200	165,389	-23	933,695	**-5**
250	173,525	-19	941,831	**-4**
300	179,697	-16	948,003	**-4**
350	184,893	-14	953,199	**-3**
400	189,110	-12	957,416	**-3**
450	192,705	-10	961,011	**-2**
500	195,689	-9	963,995	**-2**
None	214,132	0	982,438	**0**

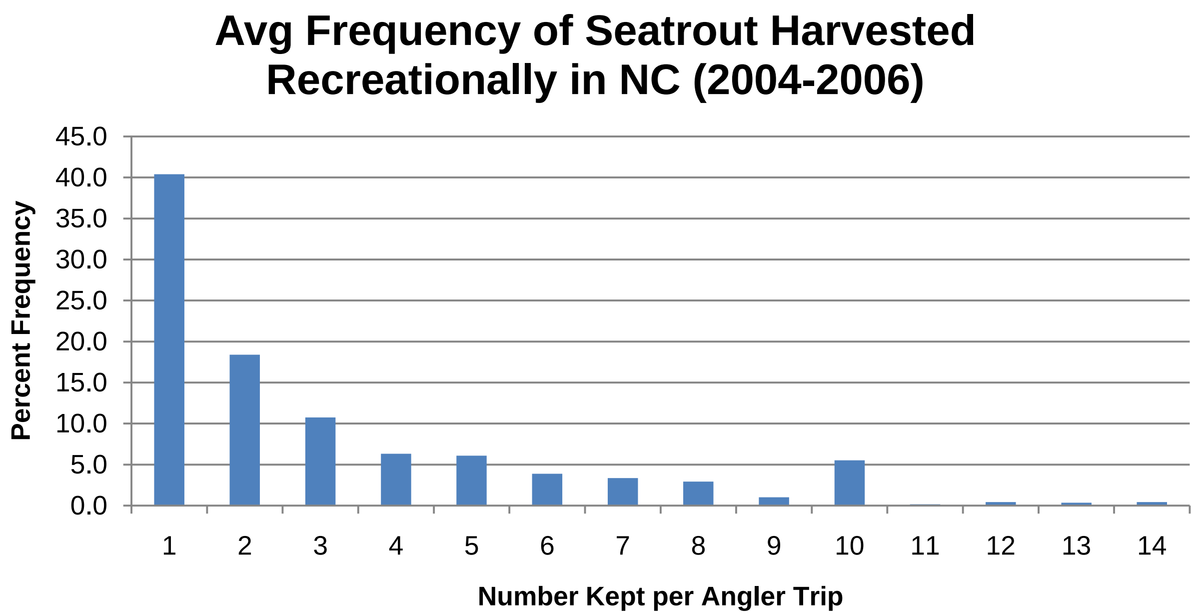


Figure 3A-1. Average Frequency of Spotted Seatrout harvested in the North Carolina recreational fishery from 2004 to 2006.

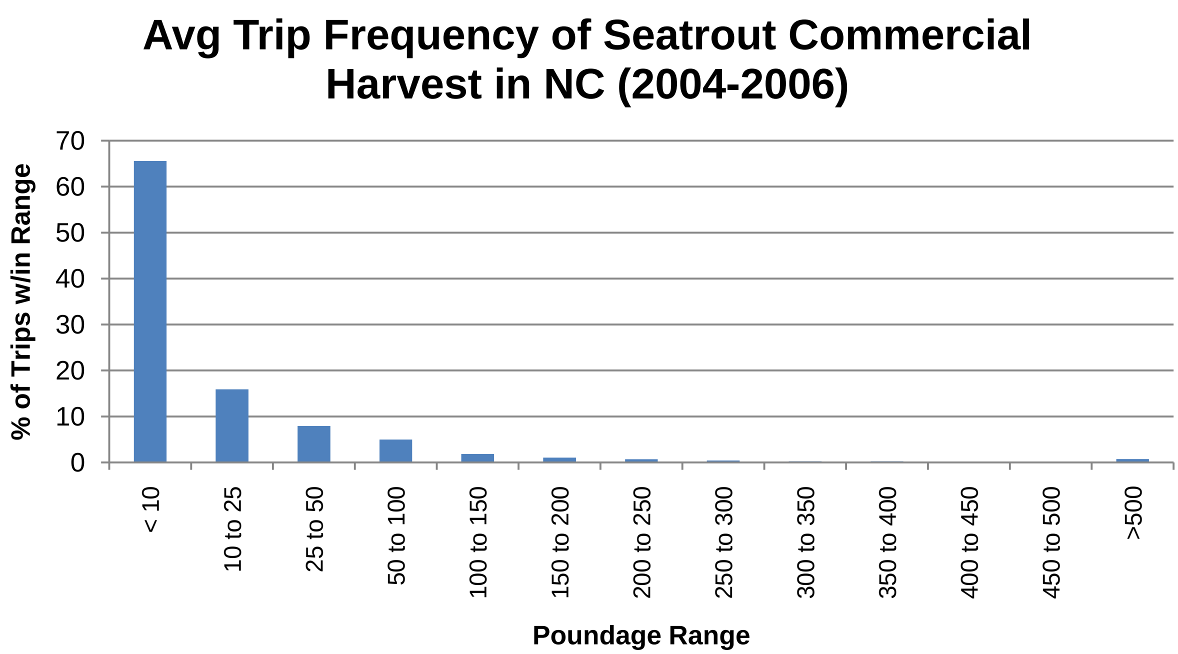


Figure 3A-2. Average frequency of amount of spotted seatrout landed (lb) per trip from 2004 to 2006.

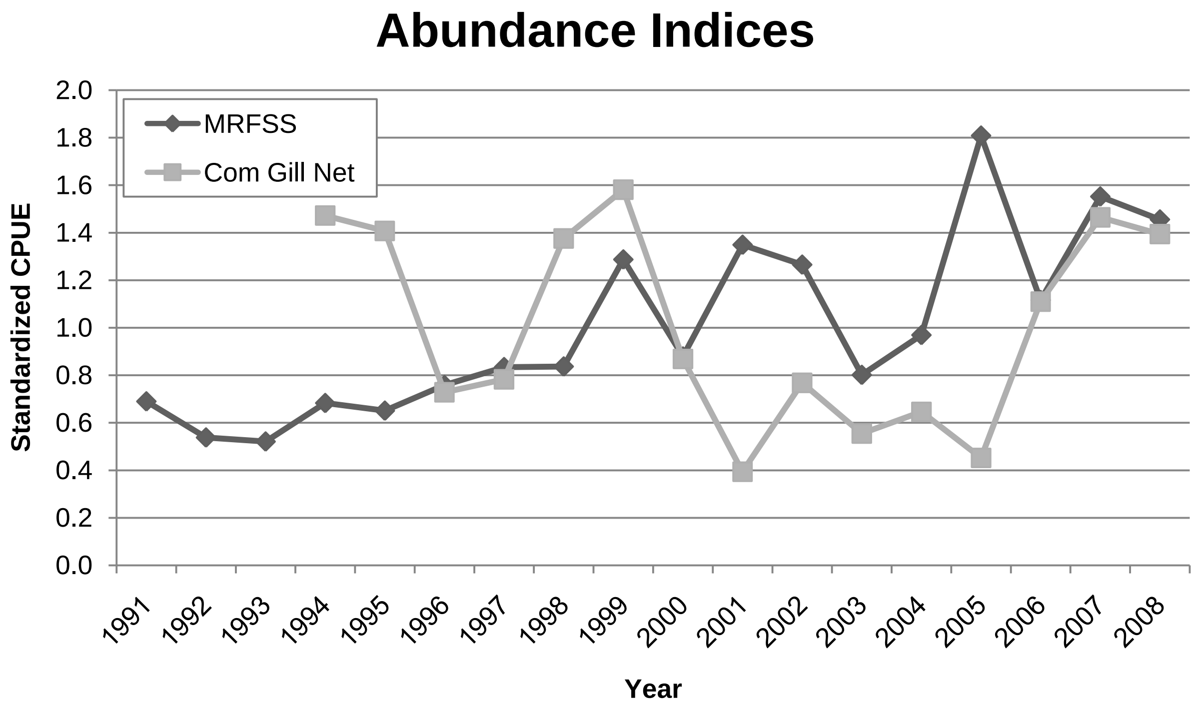


Figure 3A-3. Standardized abundance indices of spotted seatrout from the MRFSS survey and the commercial gill net fishery, 1991-2008

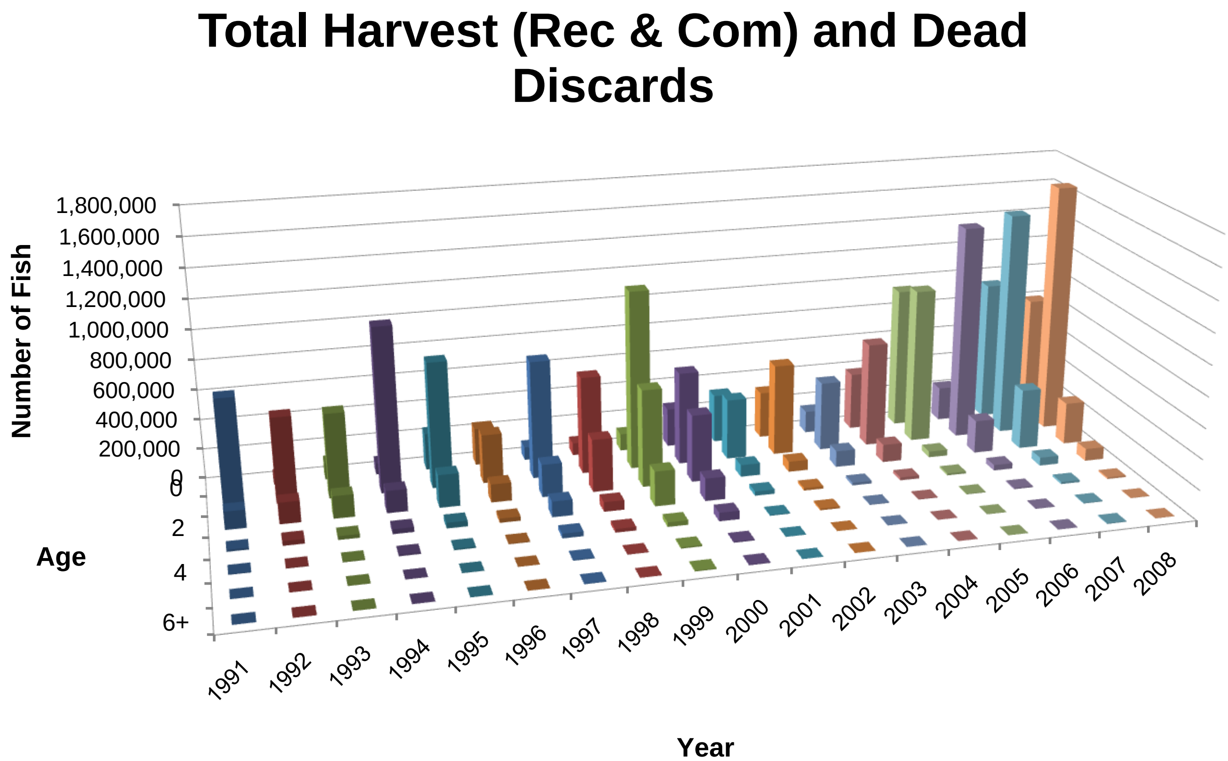


Figure 3A-4. Catch at age matrix for total harvest (recreational and commercial) and recreational dead discards, 1991-2008.

Appendix 3B Weighted Length Frequency at Age for Commercial Landings, Recreational Harvest and Releases and Virginia Data.

(Input data used in harvest reduction analyses).

Table 3B-1. Average weighted length frequency (in numbers) of North Carolina recreational spotted seatrout harvest, 2004-2006.

Length Bin	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+
4	.	.	.	.	.	.	.
6	.	.	.	.	.	.	.
7	.	.	.	.	.	.	.
8	1,588	196	.	.	.	.	.
9	752	269	.	.	.	.	.
10	528	360	.	.	.	.	.
11	6,674	3,131	26	.	.	.	.
12	41,856	46,888	754	.	.	.	.
13	26,457	76,005	1,893	.	.	.	.
14	3,327	35,154	2,930	.	6	.	.
15	.	33,725	2,496	16	.	.	.
16	.	37,224	5,893	.	.	.	.
17	.	41,918	5,575	84	.	.	.
18	.	31,008	6,185	.	.	.	.
19	.	22,543	9,873	2,968	590	.	.
20	.	7,801	4,217	1,374	211	322	.
21	.	6,168	4,892	1,484	443	135	58
22	.	583	1,422	2,449	634	101	17
23	.	97	2,244	756	212	200	32
24	.	.	2,831	761	251	180	71
25	.	.	277	433	.	.	54
26	.	.	.	.	345	197	46

Table 3B-2. Average weighted length frequency (in numbers) of North Carolina recreational spotted seatrout releases 2004-2006.

Length Bin	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+
4	.	.	.	.	.	.	.
6	.	.	.	.	.	.	.
7	11,507	.	.	.	.	.	.
8	5,005	616	.	.	.	.	.
9	75,117	30,652	70	.	.	.	.
10	133,544	149,924	.	.	.	.	.
11	110,846	120,699	910	.	.	.	.
12	21,387	26,009	561	.	.	.	.
13	10,695	39,091	1,579	.	.	.	.
14	1,112	17,979	2,532	.	18	.	.
15	.	15,391	2,593	45	.	.	.
16	.	15,740	3,683	.	.	.	.
17	.	17,390	5,220	116	.	.	.
18	.	13,602	3,499	.	.	.	.
19	.	9,635	5,992	1,739	379	.	.
20	.	3,678	2,916	895	130	240	.
21	.	2,835	2,412	906	256	107	30
22	.	310	654	1,674	371	68	12
23	.	73	913	413	93	96	20
24	.	.	1,139	429	131	104	40
25	.	.	154	241	.	.	30
26	.	.	.	.	257	147	34

Table 3B-3. Average weighted length frequency (in numbers) of North Carolina commercial spotted seatrout harvest 2004-2006.

Length Bin	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+
7	.	.	.	.	.	.	.
8	6	1	.	.	.	.	.
9	21	54	1	.	.	.	.
10	39	161	.	.	.	.	.
11	256	607	5	.	.	.	.
12	1,038	2,871	28	.	.	.	.
13	906	7,436	273	.	.	.	.
14	459	8,745	407	.	5	.	.
15	.	10,317	579	11	.	.	.
16	.	13,143	2,198	.	.	.	.
17	.	13,090	3,487	62	.	.	.
18	.	10,201	3,837	542	.	.	.
19	.	5,617	2,699	808	106	.	.
20	.	2,171	1,092	418	49	36	.
21	.	491	785	362	88	38	10
22	.	82	490	288	92	14	2
23	.	22	490	473	113	56	19
24	.	.	355	225	99	40	22
25	.	.	42	174	98	15	20
26	.	.	4	138	124	45	12
27	.	.	.	13	14	5	2
28	.	.	.	2	20	34	25
29	.	.	.	26	79	28	1
30	.	.	.	.	.	4	16
31	.	.	.	.	.	.	.

Table 3B-4. Average catch at age (in numbers) of Virginia recreational spotted seatrout harvest 2004-2006.

Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+
320	40,878	9,797	2,113	400	29	59

Table 3B-5. Average catch at age (in numbers) of Virginia recreational spotted seatrout releases 2004-2006.

Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+
88,053	128,696	19,462	2,630	420	140	25

Table 3B-6. Average weight (lb) at age of spotted seatrout discards 2004-2006.

Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+
0.42	0.78	2.26	3.32	3.52	4.02	4.09

Table 3B-7. Average number of angler trips and number of spotted seatrout harvested in the recreational fishery used in the bag limit analysis, 2004-2006.

Seatrout Bagged	# of Angler Trips	# Seatrout Harvested
0	6,879,603	0
1	61,182	61,182
2	27,850	55,700
3	16,274	48,821
4	9,563	38,253
5	9,224	46,119
6	5,865	35,188
7	5,085	35,598
8	4,439	35,510
9	1,540	13,860
10	8,357	83,572
11	238	2,621
12	644	7,729
13	528	6,859
15	660	9,903

Table 3B-8. Average number of pounds and trips in the North Carolina spotted seatrout fishery used for the trip limit analysis, 2004-2006.

Trip Limit	% of Trips	Avg Trips	Avg Pounds	Cumulative Pounds
10	65.6	4,644	15,917	15,917
25	15.9	1,126	17,039	32,956
50	7.9	562	19,378	52,334
100	5.0	352	23,877	76,211
150	1.9	132	15,790	92,001
200	1.0	73	12,516	104,517
250	0.7	48	10,686	115,203
300	0.4	30	8,122	123,325
350	0.3	18	5,946	129,271
400	0.3	18	6,767	136,038
450	0.2	12	5,245	141,283
500	0.2	11	5,334	146,617
None	0.7	52	44,443	191,060

Appendix 3C Determining Impacts of Size Limit Changes

Equations used to determine harvest:

$$F_{harvest} = F_{mult} \times selectivity \times (1 - proportion\ released)$$

$$F_{dead\ discard} = F_{mult} \times selectivity \times (proportion\ released) \times (release\ mortality)$$

For recreational fishing, only proportion released will change – not selectivity.

$$Proportion\ Released = \frac{B2}{A + B1 + B2}$$

$$Proportion\ Harvested = \frac{A + B1}{A + B1 + B2}$$

Some undersized fish are still harvested, so a weighted average will be used to get the average proportion of undersized harvest.

Future B2 harvest

For size classes that don't change:

$$B2_{future\ no\ change} = (A + B1 + B2) \times Current\ Proportion\ Released$$

For size classes that do change:

$$B2_{future\ change} = (A + B1 + B2) \times (1 - Avg\ Proportion\ of\ Undersized\ Harvest)$$

$$Total\ B2_{future} = B2_{future\ no\ change} + B2_{future\ change}$$

$$Future\ Proportion\ Released = \frac{Total\ B2_{future}}{A + B1 + B2}$$

Average future proportion released for years of interest (e.g., last 3 years) for further analysis.

To find out what a size limit change equates to in Ffull (for input into projections) use the following equations (apply to all cells for each age in each year):

$$F_{harvest} = F_{mult} \times selectivity \times (1 - future\ proportion\ released)$$

$$F_{dead\ discard} = F_{mult} \times selectivity \times (future\ proportion\ released) \times (release\ mortality)$$

$$F_{total} = F_{harvest} + F_{dead\ discard}$$

To get projected harvest in <u>numbers</u>, use the Baranov Catch Equation (apply to all cells for each age in each year):

$$C_{numbers} = N \times \left(\frac{F_{harvest}}{M + F_{total}}\left[1 - e^{-(M+F_{total})}\right]\right)$$

To get projected harvest in <u>pounds</u>, multiply the catch in numbers by the mean weight at age (apply to all cells for each age in each year):

$$C_{pounds} = C_{numbers} \times mean\ weight\ at\ age$$

Enter into AGEPRO the new selectivity and F_{full}:

$$new\ selectivity_a = \frac{F_a}{\underbrace{maximum\ F_a\ at\ age\ for\ a\ given\ year}_{\text{a.k.a. } F_{full}}}$$

Appendix 4 Stock Status of Spotted Seatrout, *Cynoscion nebulosus*, in North Carolina 1991-2008.

Attached

Appendix 5. Recommendations from the DMF, SST AC, Regional, Habitat, and Finfish committees on issues developed for the management plan.

* *Additional recommendations or comments from the committees in italics and underlined.*

****** Items underlined in DMF or AC recommendations to show variation between the two

RECOMMENDATIONS

ISSUE	DMF	SST AC	SOUTHEAST	CENTRAL	NORTHEAST	INLAND	HABITAT	FINFISH
Achieving Sustainable Harvest (1/2 way to ending overfishing)	• ½ reduction needed, 6 fish bag, 14-inch minimum size, and weekend closure for commercial gears (no possession on weekends)	• Same as DMF (commercial & recreational); *• Promote the use of barbless hooks;* *• No use of gill nets as RCGL gear to harvest spotted seatrout*	• ½ reduction needed, *10 fish bag*, 14-inch minimum size, and *May-September closure;* *• Promote the use of barbless hooks*	• Commercial: same as DMF; • Recreational: ½ reduction needed, 12-inch minimum size, 4 fish bag, May-June closure	*• Commercial: ½ reduction needed, 14-inch minimum size;* *• Recreational: ½ reduction needed, 5 fish bag, 14-inch minimum size*	• ½ reduction needed, 6 fish bag, 14-inch minimum size, and *December-January closure for commercial gears;* *•Promote the use of circle hooks and natural baits*	-	• Recreational: same as DMF, *Commercial: 14-inch size limit and 150 lb trip limit per operation*
Achieving Sustainable Harvest (Ending overfishing)	14-inch minimum size limit, 2 fish recreational limit, 25 fish commercial limit, adaptive management **OR** 14-minimum size limit, closure Dec 15- Jan 31 for both sectors, 3 fish recreational bag limit, 75 fish commercial trip limit, weekend no commercial possession, adaptive management, implement immediately	14-inch size limit, 2 fish bag, *50 fish commercial trip limit, weekend commercial no possession, estuarine gillnets and longhauls out of the water, implement regulations immediately, reassess in 3 years, promote ethical angling*	Same as SST AC; *Requested additional research on gigging, cold stun, and hooking mortality*	14-inch size limit, *7 fish bag limit, recreational closure Tuesday-Thursday, 50 fish commercial trip limit, weekend closure, gear allowed on weekends to target other species*, promote ethical angling	*Recreational- 15-inch size limit, 4 fish bag limit, Dec 1- Dec 31 closure Commercial-14-inch size limit, 25 fish trip limit.*	Same as SST AC; *Considerable discussion on natural mortality and uncertainity in the model*	-	Same as SST AC

ISSUE	DMF	SST AC	SOUTHEAST	CENTRAL	NORTHEAST	INLAND	HABITAT	FINFISH
Enforcement of Size, Creel Limit and Gear Regulations in Joint, Coastal or Inland Fishing Waters	• Development of a mutual aid agreement between DMF marine Patrol and WRC Wildlife enforcement officers for Inland fishing waters	• Same as DMF	• Same as DMF; • Endorsed AC original recommendation for general police authority	• Same as DMF	• Same as DMF	• Same as DMF	-	• Same as DMF
Management Measures to Address User Group Competition	• Move forward with the mediation policy process to resolve conflict between spotted seatrout fishermen	• Same as DMF	• Same as DMF	• Same as DMF	• Same as DMF	• Same as DMF	-	• Same as DMF
Impacts of Cold Stun Events on the Population	• Give the sustainable harvest options the opportunity to work in rebuilding the stock to 20% SPR. If a cold stun event is observed in 4 counties, then the spotted seatrout fishery will be closed through June 15th.	• Remain status quo with the assumption that the Director will intervene in the event of a catastrophic event and do what is necessary in terms of temporary closures by water body, but the Director's proclamation needs to be an informed decision based on quantifiable data and the outcome needs to be quantified post the closure	• Same as SSTAC	• Same as SSTAC	• Same as SSTAC	• Same as SSTAC	• Same as DMF	• Same as SSTAC

ISSUE	DMF	SST AC	SOUTHEAST	CENTRAL	NORTHEAST	INLAND	HABITAT	FINFISH
	• More extensive research on cold stun events by DMF, Universities, etc.	• Same as DMF	• Same as DMF	• Same as DMF	• Same as DMF	• Same as DMF	• Same as DMF; • More research on habitat requirements	
Use of Gigs to Harvest Spotted Seatrout December-March	• Status quo. DMF to continue to track contributions of gigs to overall landings.	• Same as DMF	• No gigging December-March	• Same as DMF	• Same as DMF	• Same as DMF	• Same as DMF	• Same as DMF

Appendix 6 Alternatives for High Volume Commercial Fisheries that Capture Spotted Seatrout.

I. Issue

High volume commercial fisheries may prefer a quota as opposed to the 75 fish trip limit. These alternatives are resource neutral and are being considered to reduce potential discard issues.

II. Background

The North Carolina Spotted Seatrout Fishery Management Plan recommended a management strategy consistent among all commercial gear (excluding hook and line) for a trip limit of 75 fish per operation. Some high volume fisheries may have considerable waste if they accidentally set on a large school of spotted seatrout. There was no input from the fishermen in the long haul, beach seine, or stop net fisheries at public meetings when the 75 fish trip limit was being developed. The stop net fishermen requested a special consideration to allow their fishery to operate under a quota and to possess spotted seatrout on the weekend during the 2011 weekend closure (Proclamation FF-82-2010). The stop net fishermen agreed to remove their gear from the water if the quota for spotted seatrout was reached. In this paper, quotas were calculated for beach seine, stop net, and long haul fisheries, and fishermen were interviewed to determine their preference.

III. Discussion

Management Measures

This issue paper presents management strategies that achieve harvest reductions of 38.9% (currently in place) and 57.0% (effective 2014). All harvest reduction calculations are based on the average landings from 2003 to 2008. The management measures are to have a resource neutral effect and be used in combination with the 14-inch minimum size limit to decrease the fishing mortality and rebuild the stock to sustainable levels.

Quota/Trip Limit Analysis Methods

A total harvest reduction of 57.0% is required by both the recreational and commercial fishing sectors in order to end overfishing by 2014. The Marine Fisheries Commission chose to take a step down approach in reducing the fishing mortality on spotted seatrout. Management measures were selected in November 2011 to reduce harvest by approximately 40% in both the recreational and commercial fisheries. The current commercial regulations are a 14 inch size limit, 75 fish trip limit for commercial fisheries, and a weekend closure in Joint Fishing Waters to gill netting and commercial spotted seatrout possession. In 2014, more restrictive management measures are set to become effective to end overfishing completely: a 14 inch minimum size limit and 25 fish trip limit. Both estimates of total reduction include reduction due to the Sea Turtle Settle Agreement, which was estimated to be 13.1%

Spotted seatrout are not targeted by the majority of commercial fishermen, with the vast majority of trips (63%) landing 10 pounds or less per trip from 2003 to 2008. Nearly 90% of trips landed 50 pounds or less per trip. However, 23% of the annual harvest is from trips landing more than 500 pounds per trip. These occasional large catches occur in the beach seine, long haul seine/swipe net, stop net, and runaround gill net fisheries. Beach seine fishermen target spotted seatrout in the early spring (April-May), while long haul seine/swipe net and stop net fishermen are known to target spotted seatrout during the fall months, and runaround gill net fishermen are known to target spotted seatrout during the late fall and winter months. The average trip catching spotted seatrout by high volume gear is less than 500 pounds (Figure 1), but some of these fisheries occasionally catch over 500 pounds of spotted seatrout in one trip. These high volume trips would result in high discard mortality if spotted seatrout are caught incidentally as bycatch while targeting other species.

The release of a large numbers of dead discards in the high volume fisheries (stop net, haul seine, and beach seine) is a concern. It may be possible for fishermen using these gears to avoid the majority of large catches seen in the past. Haul seines/swipe nets have been used to target spotted seatrout in the fall and beach seines in the spring. Potentially both fisheries could avoid targeting spotted seatrout in certain areas or times of the year. However, even if fishermen ceased targeting spotted seatrout, the incidental dead discards associated with these other fisheries are likely to continue. For example, the stop net fishery targets striped mullet and not spotted seatrout, but large catches of spotted seatrout have occurred on rare occasions. Thus, annual quotas were examined for each of the high volume fisheries.

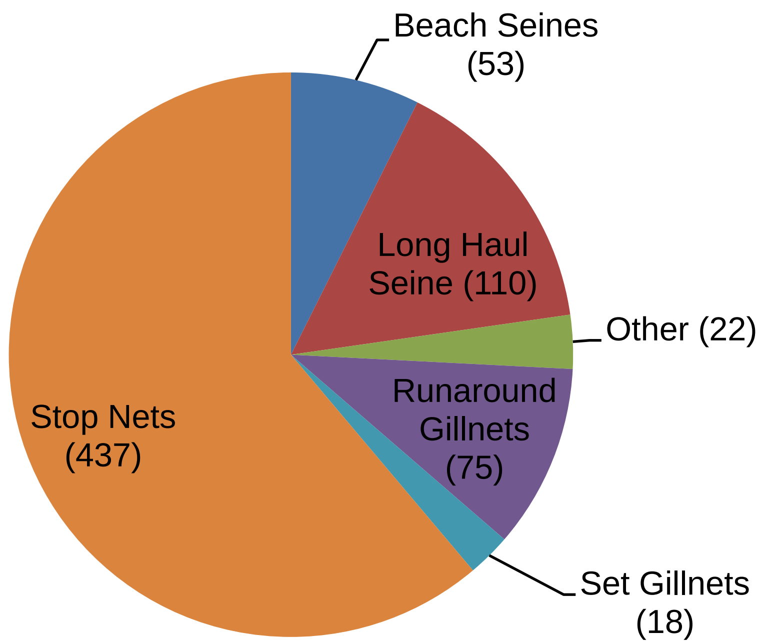


Figure 4-1. Average spotted seatrout catch (lbs per trip) by gear, 2003-2008.

The quotas under the current 38.9% reduction in the stop net, beach seine, and long haul seine/swipe net fisheries are 3,926 lbs, 4,391 pounds, and 19,591 lbs, respectively, and all other gear would be limited to the current 75 fish trip limit. The quotas under the 57.0% reduction to end overfishing in the stop net, beach seine, and long haul seine/swipe net fisheries are 2,765 lbs, 3,092 lbs, and 13,796 lbs, respectively and all other gear limited to a 25 fish trip limit. An annual commercial quota for the high volume fisheries would also require daily reporting for the high volume fisheries only and may require a DMF state dealer permit. If the quota is met in a fishery operating under a quota, that high volume fishery would have to cease operation and pull the gear out of the water.

Table 4-1. Average landings (2003 - 2008) and quotas for spotted seatrout in stop net, beach seine, and long haul seine/swipe net based on 38.9% and 57.0% reductions.

Fishery	Avg Landings (03-08) (lbs)	38% Reduction Quota	57% Reduction Quota
Beach Seine	7,059	4,391	3,092
Haul Seine	31,497	19,591	13,796
Stop Net	6,312	3,926	2,765

Because these fisheries have very few participants operating, each fisherman that landed spotted seatrout in 2010 with either a beach seine, haul seine/swipe net, or stop net was called to get their preferred alternative. They were asked for their opinions on both the reduction levels (38.9% and 57.0%) and corresponding management options (75 fish trip limit or quota and 25 fish trip limit or quota). There were two attempts to contact each fisherman by phone. If a message could be left, a contact number was given for them to return the call.
There were 22 fishermen that landed spotted seatrout in the haul seine fishery in 2010 (Table 2). Twelve fishermen were able to be interviewed. One fishermen did not prefer either management measure, one fisherman suggested closing spotted seatrout for both recreational and commercial fishermen for two years or areas of aggregation, one fisherman preferred a quota, and nine fishermen preferred the 75/25 fish trip limit. The biggest concern with quota was the fishery closing down before the spot and croaker season in the fall. Most fishermen commented that it is very difficult to count the number of fish when landing with this operation and there is potential for discards on some sets. The catches of spotted seatrout are generally low but some sets may catch from 200 to 3,000 lbs.

There were 16 fishermen that landed spotted seatrout in the beach seine fishery in 2010 (Table 2). Eleven fishermen were able to be interviewed. One fishermen stated he did not use that gear, two fishermen did not prefer either management measure, eight fishermen preferred the 75/25 fish trip limit, and none preferred the quota. Concerns similar to the one listed above were expressed by the fishermen in this fishery.

Fishermen in the stop net fishery were attempted to be contacted. There was no response, but the fishermen agreed to fish under the quota regulations in the past.

Table 4-2. Number of fishermen that caught spotted seatrout operating in each of the beach seine and haul seine fisheries in 2010 with number of fishermen interviewed and no responses and the management options selected by the fishermen.

	Beach Seines	Haul Seine	Total
Number of Fishermen	16	22	38
Interviewed	11	12	23
No Response	5	10	15

Management Options	Beach Seines	Haul Seine
Trip Limit	8 (72%)	9 (75%)
Quota	0	1 (8%)

Neither	2 (18%)	1 (8%)
Does Not Fish	1 (9%)	
Close Fishery		1 (8%)

IV. 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
15A NCAC 3M.0512 COMPLIANCE WITH FISHERY MANAGEMENT PLANS

V. MANAGEMENT OPTIONS (list pros and cons of each management option)

1) 14-inch minimum size limit, 75 or 25 fish trip limit depending on reduction

+ Reduces harvest in the fishery
+ Consistent trip limit among commercial fishermen
+ Fishery remains open for target species
+ Enforcement is based on number of fish
- May lead to increased regulatory discards in the commercial fishery
- It will be difficult for fishermen to keep track of the number fish in the catch
- May adversely impact some fisheries and fishermen more than others

2) 14-inch minimum size limit, quota for high volume fisheries

+ Reduces harvest in the fishery
+ Daily harvest reporting
+ Reduces regulatory discards that would be associated with a trip limit
+ Enforcement burden is eased because possession in the fishery is either opened or closed
- May lead to lost income in target species if quota for spotted seatrout is reached
- May adversely impact some fisheries and fishermen more than others
- Increased reporting burden on fishermen, fishhouse, and DMF

ADAPTIVE MANAGEMENT RECOMMENDATIONS

NC DMF- Defer to fishermen operating in the fishery.

VI. Research Recommendations

None