Amendment 1

to the

North Carolina Estuarine Striped Bass Fishery Management Plan

Prepared By The

North Carolina Division of Marine Fisheries

and

North Carolina Wildlife Resources Commission

with assistance from the

Albemarle/Roanoke and Central Southern Management Area
Fishery Management Plan Advisory Committees

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February 2010	Joint Albemarle/Roanoke and Central Southern Management Area advisory committees appointed by N.C. Marine Fisheries Commission chairman
May 2010	Albemarle/Roanoke stock assessment presented to N.C. Marine Fisheries Commission
February 2011	Central Southern Management Area stock assessment presented to N.C. Marine Fisheries Commission
June 2011	Draft plan presented to joint advisory committees
September 2011	Draft plan approved for public comment by N.C. Marine Fisheries Commission
November 2011	Preferred management options selected by N.C. Marine Fisheries Commission
November 2011	Preferred management options selected by N.C. Wildlife Resources Commission
December 2011	Draft plan submitted to Department of Environment and Natural Resources for review
January 2012	Draft plan submitted to Joint Legislative Commission on Governmental Operations for review
February 2012	Draft plan approved to go forward for rulemaking by N.C. Marine Fisheries Commission
November 2012	Proposed rules approved for notice of text by N.C. Marine Fisheries Commission
January 2013	Public hearing held on proposed rules
February 2013	Final plan and rules approved by N.C. Marine Fisheries Commission
May 2013	Final plan and rules approved by N.C. Wildlife Resources Commission
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Aug. 1, 2013	Effective date of N.C. Wildlife Resources Commission rules

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A/R	Albemarle/Roanoke striped bass stock
AC	Advisory Committee
AFSA	Anadromous Fish Spawning Area
APAIS	Access-Point Angler Intercept Survey
ASMA	Albemarle Sound Management Area
ASMFC	Atlantic States Marine Fisheries Commission
BOD	Biochemical Oxygen Demand
CAHA	Cape Hatteras National Seashore
CAMA	Coastal Area Management Act
CFS	Cubic Feet Per Second
CHPP	Coastal Habitat Protection Plan
CHTS	Coastal Household Telephone Survey
CPI	Consumer Price Index
CPUE	Catch Per Unit Effort
CRFL	Coastal Recreational Fishing License
CSMA	Central Southern Management Area
DFS	Distance From Shore
DO	Dissolved Oxygen
DPS	Distinct Population Segments
EA	Environmental Assessment
EDC	Endocrine Disrupting Chemical
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EPA	Environmental Protection Agency
ESA	Endangered Species Act
F	Fishing Mortality
FERC	Federal Energy Regulatory Commission
FHS	For-Hire Survey
FIAP	Fishery Independent Assessment Program
FMP	Fisheries Management Plan
FRA	Fisheries Reform Act
FRG	Fisheries Resource Grant
G.S.	General Statutes
HSI	Habitat Suitability Index
IAG	Issue Advisory Group
IFIM	Instream Flow Incremental Analysis
IGNS	Independent Gill Net Survey
IHA	Indicators of Hydrologic Alteration
IJ	Interjurisdictional
IMPLAN	Impact Analysis for Planning
ISM	Inch Stretched Mesh

ITP	Incidental Take Permit
JAI	Juvenile Abundance Index
M	Natural Mortality
MBTA	Migratory Bird Treaty Act
MGD	Millions of Gallons per Day
MMPA	Marine Mammal Protection Act
MRFSS	Marine Recreational Fisheries Statistics Survey
MRIP	Marine Recreational Information Program
MSA	Magnuson Stevens Fisheries Conservation and Management Act
NCAC	North Carolina Administrative Code
NCCRC	North Carolina Coastal Resource Commission
NCDCM	North Carolina Division of Coastal Management
NCDENR	North Carolina Department of Environment and Natural Resources
NCDMF	North Carolina Division of Marine Fisheries
NCDWQ	North Carolina Division of Water Quality
NCDWR	Division of Water Resources
NCEMC	North Carolina Environmental Management Commission
NCMFC	North Carolina Marine Fisheries Commission
NCWRC	North Carolina Wildlife Resources Commission
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NSW	Nutrient Sensitive Waters
NSWS	Nutrient Sensitive Waters Strategy
ORW	Outstanding Resource Waters
PDT	Plan Development Team
PSE	Proportional Standard Error
PSGNRA	Pamlico Sound Gill Net Restricted Area
RCGL	Recreational Commercial Gear License
RM	River Mile
RO	Reverse Osmosis
RRMA	Roanoke River Management Area
RRWFC	Roanoke River Water Flow Committee
RVA	Range of Variability Approach
SAV	Submerged Aquatic Vegetation
SC	Special Concern
SHA	Strategic Habitat Area
SOC	Special Order of Consent
SPR	Spawning Potential Ratio
SSB	Spawning Stock Biomass
STAC	Sea Turtle Advisory Committee
TAC	Total Allowable Catch
TDS	Total Dissolved Solids
TED	Turtle Excluder Device

TEK	Traditional Ecological Knowledge
TL	Total Length
TRP	Take Reduction Plan
TTP	Trip Ticket Program
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
VGIF	Virginia Department of Game and Inland Fisheries
Z	Total Mortality

3.0 EXECUTIVE SUMMARY

3.1 BACKGROUND

There are two geographic management units and four striped bass (*Morone saxatilis)* stocks included in Amendment 1 to the North Carolina Estuarine Striped Bass Fishery Management Plan (FMP). The northern management unit is comprised of two harvest management areas; the Albemarle Sound Management Area (ASMA) and the Roanoke River Management Area (RRMA). The ASMA includes the Albemarle Sound and all its coastal, joint and inland water tributaries, (except for the Roanoke, Middle, Eastmost and Cashie rivers), Currituck, Roanoke and Croatan sounds and all their joint and inland water tributaries, including Oregon Inlet, north of a line from Roanoke Marshes Point across to the north point of Eagle Nest Bay in Dare county. The RRMA includes the Roanoke River and its joint and inland water tributaries, including Middle, Eastmost and Cashie rivers, up to the Roanoke Rapids Dam. The striped bass stock in these two harvest management areas is referred to as the Albemarle Sound/Roanoke River (A/R) stock, and its spawning grounds are located in the Roanoke River in the vicinity of Weldon, NC. Management of recreational and commercial striped bass regulations within the ASMA is the responsibility of the North Carolina Marine Fisheries Commission (NCMFC). Within the RRMA commercial regulations are the responsibility of the NCMFC while recreational regulations are the responsibility of the North Carolina Wildlife Resources Commission (NCWRC). The A/R stock is also included in the management unit of amendment 6 to the Atlantic States Marine Fisheries Commission (ASMFC) Interstate FMP for Atlantic Striped Bass.

The southern geographic management unit is the Central Southern Management Area (CSMA) and includes all internal coastal, joint and contiguous inland waters of North Carolina south of the ASMA to the South Carolina state line. There are spawning stocks in each of the major river systems within the CSMA; the Tar/Pamlico, the Neuse, and the Cape Fear. These stocks are collectively referred to as the CSMA stocks. Spawning grounds are not clearly defined in these systems as access to spawning areas may be influenced by river flows as well as impediments to migration. Management of striped bass within the CSMA is the sole responsibility of the NCMFC and the NCWRC, and is not subject to compliance with the ASMFC Interstate FMP for Atlantic Striped Bass.

3.2 GOALS AND OBJECTIVES

The goals of Amendment 1 to the North Carolina Estuarine Striped Bass FMP are to achieve sustainable harvest through science based decision-making processes that conserve adequate spawning stock, provide and maintain a broad age structure, and protect the integrity of critical habitats. To achieve these goals, the following objectives must be met:

1. Identify and describe population attributes, including age structure, necessary to achieve sustainable harvest.
2. Restore, improve, and protect striped bass habitat and environmental quality consistent with the Coastal Habitat Protection Plan (CHPP) to increase growth, survival and reproduction.
3. Manage the fishery in a manner that considers biological, social, and economic factors.

4. Initiate, enhance, and/or continue programs to collect and analyze biological, social, economic, fishery, habitat, and environmental data needed to effectively monitor and manage the fishery.
5. Initiate, enhance, and/or continue information and education programs to elevate public awareness of the causes and nature of issues in the striped bass stocks, habitat, and fisheries, and explain management programs.
6. Develop management measures, including regulations that consider the needs of all user groups and provide sustainable harvest.
7. Promote practices that minimize bycatch and discard mortality in recreational and commercial fisheries.

3.3 STOCK STATUS

Albemarle/Roanoke Stock

Currently the A/R stock is not experiencing overfishing and is producing a sustainable harvest. The trend of fishing mortality (F) shows an overall decline from the earliest part of the time series (1982-2008). The average F on ages 4-6 peaked in 1984 at 1.01. After 1988, there was a decline in F to one of the lowest in the time series in 1995 at 0.13. Fishing mortality then began to slowly increase as the stock rebuilt and harvest regulations were relaxed and reached a plateau from 2000 through 2004. Since 2004, the F has decreased from 0.34 to 0.10 in 2008, the lowest in the time series. The uncertainty associated with the precise level of spawning stock biomass (SSB) as estimated from the A/R stock assessment prevents a determination from being made on the overfished status of the stock (Appendix 14.6). However, based on 20 years of annual monitoring programs conducted by the NCDMF and NCWRC, the SSB appears to be healthy, with a good amount of age 6+ females in the population, and a broad age structure, with the current maximum age of 17 years observed on the spawning grounds.

Central Southern Management Area Stocks

As shown in the CSMA 2010 stock assessment the large confidence intervals and lack of precision in the total mortality rate makes the assessment model unsuitable for determining an appropriate stock status (Appendix 14.6). This view was supported by the North Carolina Estuarine Striped Bass Plan Development Team (PDT) members and external peer reviewers. The lack of adequate data causes the CSMA stocks to be quantitatively assessed as unknown and to be listed as “concern” in the NCDMF annual stock status report. The stocks may be reassessed during the next five year FMP amendment as more data becomes available through the completion of the numerous research recommendations. Improvements in the age structure of the CSMA striped bass stocks are expected from the regulatory restrictions implemented under the 2004 FMP and from the protective measures for endangered species implemented in May 2010 (see Section 8). The need for continued conservation management efforts at this time are supported by the truncated size and age distributions, low overall abundance, and the absence of older fish in the spawning ground surveys. Since the 2004 FMP, there has been little change in the size and age distribution with few age 6 and older fish observed in any system.

3.4 COMMERCIAL FISHERIES

To ensure harvest remains below the annual total allowable catch (TAC), the NCDMF Director has proclamation authority to establish seasons, authorize or restrict fishing methods and gear, limit quantities taken or possessed, and restrict fishing areas.

Albemarle Sound Management Area
In the ASMA the commercial harvest of striped bass is prosecuted as a bycatch fishery using set fall and spring seasons, an 18 inch minimum total length (TL) size limit, daily landing limits, daily dealer reporting requirements, and an annual TAC of 275,000 pounds. The bycatch provision means striped bass cannot exceed 50% by weight of the combined daily harvest. From 1991 through 2009, the ASMA accounted for 73% – 93% of the internal waters striped bass landings in North Carolina. The ASMA averaged approximately 407 fishermen reporting landings of striped bass for 1994 – 2002. From 2003 to 2009 the ASMA averaged 337 fishermen reporting striped bass landings annually. In 2009, 280 fishermen in the ASMA reported striped bass landings. The majority of harvest occurs during the spring American shad *Alosa sapidissima* gill net fishery, followed by the southern flounder *Paralichthys lethostigma* gill net fishery and the multi-species pound net fisheries. Minimal harvest comes from the various small mesh fisheries as the majority of striped bass caught in small mesh gill nets are under the legal minimum size limit. Gill net mesh size restrictions limit the harvest to mainly fish 4-6 years old. Since the last TAC increase in 2003, harvest has ranged from a high of 273,636 lbs in 2004, to a low of 74,921 lbs in 2008. Harvest was 96,134 lbs in 2009.

Roanoke River Management Area
Sale of striped bass harvested from what is now the RRMA has been prohibited since 1985.

Central Southern Management Area
In the CSMA the commercial harvest of striped bass is prosecuted as a low harvest level fishery using a set spring season, an 18 inch minimum TL size limit, daily landing limits, daily dealer reporting requirements, and a TAC of 25,000 lbs. In the CSMA between 1994 and 2000, there was an average of 211 fishermen reporting landings in a given year. Since 2001, the number of fishermen reporting annual landings has dropped to approximately 168. The Pamlico Sound and Pamlico/Pungo River complex has accounted for 9% of the state's internal waters striped bass landings since 1994, and since 2000 has averaged approximately 18,000 lbs. Since 1994, the Neuse River striped bass commercial landings increased from that of the 1970s and 1980s, but still only made up 3% of the state's internal waters striped bass landings. Neuse River landings since 2000 have averaged approximately 6,000 pounds. The Cape Fear River system striped bass fishery had historically been prosecuted as the other parts of the CSMA. However, due to extremely low numbers and the severely truncated age structure of fish sampled on the spawning grounds, a no harvest regulation was established for striped bass in the Cape Fear River and its tributaries starting July 1, 2008. Prior to the closure, the Cape Fear River season was only open to striped bass commercially harvested during the spring and landings primarily occurred as bycatch of the American shad fishery. Anchored gill nets accounted for 97% of the landings from 1994 to 2008, while driftnets composed about 3% of the landings. The average annual landings (1994-2008) were approximately 1,300 pounds, which is about 44% less than the average annual landings reported in the 1970s and about 62% less than the early 1980s.

3.5 RECREATIONAL FISHERIES

To ensure harvest is controlled and the annual TAC is not exceeded, the NCDMF Director utilizes proclamation authority to establish seasons, authorize or restrict fishing methods and gear, limit quantities taken or possessed, and restrict fishing areas. Likewise in the RRMA, the NCWRC Executive Director can close the season by emergency rule. The total contribution of striped bass harvested by Recreational Commercial Gear License (RCG)L gears was insignificant compared to the harvest by recreational anglers, contributing only 3% by number and weight to the total recreational harvest during the year 2002 through 2008 for inside waters.

Albemarle Sound Management Area
In the ASMA the recreational harvest of striped bass is prosecuted using set fall (October 1 – December 31) and spring (January 1 – April 30) seasons, an 18 inch minimum TL size limit, daily creel limits, and an annual TAC of 137,500 lbs. From 1991 through 2009 the ASMA accounted for 27% - 57% of the internal waters striped bass landings in North Carolina. Since 1998, angler hours exerted specifically targeting striped bass have ranged from 61,679 to 109,687 annually. Artificial bait is the most common bait used and is trolled or jigged along depth contours, bridges, or other underwater structure. Cut bait is used to a lesser degree and usually during the spring season intercepting fish migrating to the spawning grounds. Striped bass are also commonly encountered while anglers are fishing for largemouth bass *Micropterus salmoides* and black crappie (speckled perch) *Pomoxis nigromaculatus*, but are usually smaller fish that are under the minimum size. Harvest is dominated by 3-5 year old fish. In recent years more undersized fish have been caught and released in a season than 18 inch TL and greater fish harvested. Since the last TAC increase in 2003, harvest has ranged from a high of 97,097 lbs in 2004 to a low of 31,628 lbs in 2008. Harvest in 2009 was 37,313 lbs.

Roanoke River Management Area
In the RRMA the recreational harvest of striped bass is prosecuted using a set spring season (March 1 – April 30), an 18 inch TL minimum size limit with a no possession slot limit of 22-27 inches TL, a daily creel limit of two fish, only one of which may be greater than 27 inches, and an annual TAC of 137,500 lbs. From 1991 to 2009 the RRMA accounted for 43% - 67% of the internal waters striped bass landings in North Carolina. Since 1989 angler hours exerted specifically targeting striped bass have ranged from 23,139 to 145,782 annually. Before the river herring *Alosa spp.* no harvest provision enacted in 2007, river herring was by far the predominant bait used, especially in the lower Roanoke. It was used as cut bait or a whole fish was used when targeting large striped bass. Since then the use of cut bait has diminished significantly, although anglers still use various other species for cut bait or various types of minnows and/or juvenile fishes for live bait. Live and cut bait as well as artificial lures are all fished to some degree in various locations and seasons within the RRMA. In general, cut bait is prominent in the lower river and live bait is primarily used in the upper zone during the harvest season. During the post-harvest period in the upper river on the spawning grounds, artificial lures and live bait are the primary baits. Regardless of bait type, single barbless hooks are required to be used from April 1 to June 30 every year. The majority of harvest is usually male fish ages 3-5. Due to the narrow size of the Roanoke River, heavy angling pressure, and large quantities of striped bass during the spawning season, it is not uncommon for anglers to catch and release over a hundred fish in a day. A post-harvest season catch-and-release fishery has also increased in recent years. In some years estimates of catch-and-released fish during both the harvest and post-harvest period have exceeded 200,000 fish. Since the last TAC increase in 2003, harvest has ranged from a high of 107,530 lbs in 2005 to a low of 32,725 lbs in 2008. Harvest in 2009 was 69,581 lbs.

Central Southern Management Area
The 2004 North Carolina Estuarine Striped Bass FMP research recommendation for recreational fisheries landing statistics was met by implementing creel surveys in the CSMA in 2004. These creel surveys conducted by the NCDMF and NCWRC provided a reliable estimate of the recreational harvest for the CSMA for the first time. The survey area included the Pungo, Tar/Pamlico, and Neuse rivers. For the NCDMF creel survey, from January 2004 to December 2009 there were an estimated 41,708 striped bass trips totaling over 218,071 angling hours. Estimated striped bass catch was 110,733 fish, comprised of 92,861 discarded fish and 17,872 harvested fish weighing 62,463 pounds. Discarded striped bass were mostly sub-legal sized fish (83%) and the total discard to harvest ratio was 5.2:1. The NCWRC conducted three creel

surveys on the three primary rivers of the CSMA between 2002 and 2005 in separate fiscal years. Each creel survey was conducted from July to June and rotated on an annual basis beginning on the Neuse, then Cape Fear and finally, the Tar rivers. Data provided an estimated 66,520 angling hours in these systems during the combined survey period. Estimated striped bass catch was 34,273 striped bass with an estimated 10,017 striped bass harvested. The discard to harvest ratio was 2.4:1. During the time span of these creel surveys the recreational management regime in the CSMA changed. Prior to July 2008, the recreational fishery in coastal and joint waters was open year round with a 3 fish limit per person per day and an 18 inch TL minimum size. Inland waters required the same measures with the addition of a 22-27 inch TL no harvest slot limit during May and April in upstream inland waters. Significant changes in recreational regulations occurred in 2008, including the establishment of a set harvest season from October 1 through April 30. Reduction in the daily creel limit from 3 fish to 2 fish, and a protective no harvest slot limit of 22-27 inches TL was enacted throughout the Tar/Pamlico and Neuse river basins in joint and inland waters. The 18 inch total length minimum size limit for the recreational fisheries was maintained in coastal waters. A total no harvest provision was implemented in the Cape Fear River and its tributaries.

3.6 SOCIOECONOMIC STATUS

Striped bass are an important supplement to many estuarine commercial fishermen's income in North Carolina. Striped bass are also one of the most sought after recreational species in the state. Because striped bass are anadromous, they support local economies in cities on the coast, throughout the estuaries, and hundreds of miles inland. In 2009, the total economic impact of both commercial and recreational trips that landed striped bass in the ASMA and CSMA equaled approximately $45 million and supported an additional 526 jobs. In the most recent economic estimate for the RRMA (2006), mean total expenditures for striped bass anglers was $1,546,332. It is also very important to note that the models used for estimating the commercial economic impacts do not include the post-landings economic effects of striped bass, only the business inputs from the commercial fishermen. The economic effect of striped bass landings on dealers, seafood markets, restaurants, and shipping interests requires data that is not currently available. The economic impact from these additional sectors is likely substantial. The NCDMF is currently working to estimate expenditures of licensed seafood dealers in North Carolina to add to its economic impact modeling to further improve the total estimates for the economic impact of striped bass to the economy of North Carolina.

3.7 ENVIRONMENTAL FACTORS

Suitable and adequate habitat and water quality are critical elements in the ecology and productivity of estuarine systems. Degradation or improvement in one aspect of habitat may have a corresponding influence on water quality. Maintenance and improvement of suitable estuarine habitat and water quality is critical to the successful management of estuarine striped bass stocks. The NCMFC, North Carolina Coastal Resources Commission (NCCRC), North Carolina Environmental Management Commission (NCEMC), and NCWRC should adopt rules to protect critical habitats as outlined in the CHPP. The North Carolina General Assembly and divisions of the NCDENR should develop a strategy to fully support CHPP implementation with additional staff and funding. The involvement of federal agencies and increased funding (state and federal) may be necessary to accomplish these actions. The NCMFC, NCDMF, and NCWRC should continue to comment on activities that may impact aquatic habitats and work with permitting agencies to minimize impacts and promote restoration and research.

3.8 MANAGEMENT ISSUES AND RECOMMENDATIONS

The following striped bass management issues and recommendations were developed through the FMP process, by the NCDMF and NCWRC through cooperation with the United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS), and with advice solicited from the A/R and CSMA Advisory Committees (ACs), the public, the NCMFC Finfish and Regional ACs, as well as the scientific community. The following list of Issues includes the final management recommendations from the NCMFC and the NCWRC. For the complete Issue Papers and management recommendations from the NCDMF, NCWRC, the A/R AC, the CSMA AC, the regional and standing NCMFC ACs, and Public Comment, see section 11.0 and Appendix 14.9.

The goals that the issues and management recommendations address are indicated in parentheses following each issue.

ISSUE 1: RECREATIONAL STRIPED BASS HARVEST CLOSURE – OREGON INLET AREA/ATLANTIC OCEAN (3, 4, 5)

NCMFC and NCWRC Preferred Management Option:

Status Quo – Allow the fishery to continue with catch card survey (May – Oct).

ISSUE 2: STRIPED BASS STOCKING IN COASTAL RIVERS (3, 4, 5, 6)

NCMFC and NCWRC Preferred Management Option:

Status quo and research needs – Goal of 100,000 Phase II striped bass stocked annually per CSMA system (Tar-Pamlico, Neuse and Cape Fear) with 3,000 stocked fish tagged annually in each system.

ISSUE 3: USE OF SINGLE BARBLESS HOOKS DURING THE STRIPED BASS CLOSED SEASON (5, 6, 7)

NCMFC and NCWRC Preferred Management Option:

Status quo (don’t require barbless hooks) and continue to educate anglers on ethical angling practices, with the additional recommendation to include mortality statistics associated with various handling techniques when possible.

ISSUE 4: STRIPED BASS MANAGEMENT AREA - ALBEMARLE SOUND MANAGEMENT AREA SOUTHERN BOUNDARY LINE ADJUSTMENT (2, 3, 6)

NCMFC and NCWRC Preferred Management Option:

Support the necessary rule changes to create a new boundary point.

ISSUE 5: CASHIE RIVER – CHANGE IN JOINT AND COASTAL WATERS BOUNDARY LINE (3, 6)

NCMFC and NCWRC Preferred Management Option:

Support the necessary rule change to create a new boundary point.

ISSUE 6: DISCARD MORTALITY OF STRIPED BASS FROM COMMERCIAL SET GILL NETS CENTRAL SOUTHERN MANAGEMENT AREA (6, 7)

NCMFC and NCWRC Preferred Management Option:

Status Quo – continue the gill net requirement for tie downs and restricting gill net from within 50 yards of shore proclamation.

ISSUE 7: HOOK AND LINE AS COMMERCIAL GEAR IN ESTUARINE STRIPED BASS FISHERIES (3, 6, 7)

NCMFC and NCWRC Preferred Management Option:

Status Quo (don't allow hook and line as commercial gear) and support the necessary rule changes for adaptive management.

ISSUE 8: CENTRAL SOUTHERN MANAGEMENT AREA STRIPED BASS MANAGEMENT MEASURES (1, 2, 3, 4, 5, 6, 7)

NCMFC and NCWRC Preferred Management Option:

Status Quo with the addition of instituting a pound for pound payback provision for the commercial harvest TAC.

Status Quo for CSMA management measures maintain the following:

CSMA Recreational Harvest (Coastal, Joint, and Inland waters)
- Unified season Oct 1 – Apr 30
- 2 fish daily creel limit
- 18 inch TL minimum size limit
- Protective slot (no harvest) 22 – 27 inches TL (joint and inland waters only)
- Harvest moratorium for Cape Fear River and its tributaries

CSMA Commercial Harvest (Coastal and Joint waters)
- TAC of 25,000 lbs and commercial fishery, excluding Pamlico Sound, is not a bycatch fishery
- 18 inch TL minimum size limit
- 10 fish or less trip limit
- Spring season only, anytime between Jan 1 – Apr 30
- Gill net mesh size restrictions and yardage limits
- 18 inch TL minimum size limit
- Discards – maintain existing gill net tie-down and distance from shoreline (DFS) measures implemented by proclamation.
- Harvest moratorium for Cape Fear River and its tributaries

ISSUE 9: ALBEMARLE SOUND MANAGEMENT AREA AND ROANOKE RIVER MANAGEMENT AREA STRIPED BASS MANAGEMENT MEASURES (1, 2, 3, 4, 5, 6, 7)

The management measures for the Albemarle Sound Management Area (ASMA) and Roanoke River Management Area (RRMA) were not presented as a formal Issue Paper. The FMP Plan Development Team (PDT) recommended by consensus continuing with status quo for all current management measures for these two management areas. The following were presented to the Albemarle/Roanoke Advisory Committee as the PDT recommended management measures, which they voted to approve.

NCMFC and NCWRC Preferred Management Option:

Status Quo with the current management measures in the ASMA and RRMA.

Status Quo for ASMA and RRMA management measures maintain the following:

Biological Reference Points

- $F_{\text{Target}} = 0.25$
- $F_{\text{Threshold}} = 0.29$

A/R stock has been managed with a Total Allowable Catch (TAC) since 1990

- Maintain current TAC of 550,000 lbs
- The TAC will continue to be split evenly between commercial and recreational sectors
- ASMA commercial TAC = 275,000 lbs
- ASMA recreational TAC = 137,500 lbs
- RRMA recreational TAC = 137,500 lbs

ASMA Commercial Harvest (TAC = 275,000 lbs)

- 18 inch TL minimum size limit (ASMFC compliance requirement)
- Continue to operate as a bycatch fishery
- Spring season, anytime between Jan 1 – Apr 30
- Fall Season, anytime between Oct 1 – Dec 31
- Daily trip limits for striped bass
- Maintain gill net mesh size and yardage restrictions
- Maintain seasonal and area closures
- Maintain attendance requirements for small mesh nets (mid – May through late November)

ASMA Recreational Harvest (TAC = 137,500 lbs)

- 18 inch TL minimum size limit
- Daily creel limit (can be adjusted as necessary to keep harvest below the TAC)
- Open 7 days a week all season (can be adjusted as necessary to keep harvest below the TAC)
- Spring season, anytime between Jan 1 – Apr 30
- Fall season, anytime between Oct 1 – Dec 31

RRMA Recreational Harvest (TAC = 137,500 lbs)

- 18 inch TL minimum size limit
- Protective slot (no harvest): 22-27 inches TL
- 2 fish daily creel, only one of which can be greater than 27 inches TL

- Harvest season in entire river opens on March 1 and closes on April 30 by rule since 2008
- Single barbless hook regulation from April 1 – June 30 in Inland waters above the US 258 Bridge

Management of TACs for ASMA and RRMA

- Short-term Overages: if the harvest point estimate exceeds the total TAC by 10% in a single year, overage is deducted from the next year and restrictive measures implemented in the responsible fishery (ies)
- Long-term Overages: five-year running average of harvest point estimate exceeds the five-year running average of the total TAC harvest by 2%, the responsible fishery exceeding the harvest limit will be reduced by the amount of the overage for the next five years. Should the target F be exceeded, then restrictive measures will be imposed to reduce F to the target level

Proclamation Authority for the ASMA, RRMA, and CSMA striped bass stocks:

It should also be noted that under the provisions of this FMP the NCDMF Director and the NCWRC Chief of Inland Fisheries will maintain the ability to establish seasons, authorize or restrict fishing methods and gear, limit quantities taken or possessed, and restrict fishing areas as deemed necessary to maintain a sustainable harvest.

4.0 INTRODUCTION

4.1 LEGAL AUTHORITY FOR MANAGEMENT

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

North Carolina's existing fisheries management system is powerful and flexible, with rule-making authority vested in the North Carolina Marine Fisheries Commission (NCMFC) and the North Carolina Wildlife Resources Commission (NCWRC) within their respective jurisdictions. The North Carolina Division of Marine Fisheries (NCDMF) implements NCMFC rules and policies. The North Carolina General Assembly retains licensing and limited entry authorities. In the 1998 Amendment to the Fisheries Reform Act of 1997 (FRA), the General Assembly established a process for limiting entry for fisheries under the Fishery Management Plan (FMP) process. Federal authority under the Magnuson-Stevens Act applies to fisheries in the Exclusive Economic Zone (EEZ: the area from 3 to 200 miles offshore); it also applies to a limited extent in areas within state jurisdiction deemed Essential Fish Habitat (EFH). The Atlantic coast states work together through the Atlantic States Marine Fisheries Commission (ASMFC) to prepare and implement interstate FMPs, but the regulatory responsibility and authority remain with the states. Passage of the Atlantic Coastal Fisheries Cooperative Management Act in 1993 gave the ASMFC oversight for species with ASMFC plans, but plan actions are implemented by each state. Thus, the NCMFC/NCWRC (rules) and NCDMF/NCWRC (research, enforcement, etc.) utilize their authorities to manage the fisheries. The NCMFC and NCWRC have the ability to establish seasons, authorize or restrict fishing methods and gear, limit quantities taken or possessed, and restrict fishing areas. Thus, all necessary authority needed for management of the striped bass fisheries is available through the existing state fishery management process. Protection, enhancement and development of sustainable fisheries will require appropriate use of this authority, along with the cooperation of stakeholders.

The FRA established a process for preparation of coastal FMPs for 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 (CHPP) adopted pursuant to G.S. 143B-279.8, social and economic impact of the fishery to the State, and user conflicts.

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

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

d. Specify a time period, not to exceed two years from the date of the adoption of the plan, for ending overfishing. This subdivision shall only apply to a plan for a fishery that is not producing a sustainable harvest.

e. Specify a time period, not to exceed 10 years from the date of adoption of the plan, for achieving a sustainable harvest. This subdivision shall not apply if the Fisheries Director determines the biology of the fish, environmental conditions, or lack of sufficient data make implementing the requirement of this subdivision incompatible with professional standards for fisheries management.

f. Include a standard of at least fifty percent (50%) probability of achieving sustainable harvest for the fishery or fisheries. This subdivision shall not apply if the Fisheries Director determines the biology of the fish, environmental conditions, or lack of sufficient data make implementing the requirement of this subdivision incompatible with professional standards for fisheries management.

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 goals of Amendment 1 to the North Carolina Estuarine Striped Bass FMP are to achieve sustainable harvest through science based decision-making processes that conserve adequate spawning stock, provide and maintain a broad age structure, and protect the integrity of critical habitats. To achieve these goals, the following objectives must be met:

1. Identify and describe population attributes, including age structure, necessary to achieve sustainable harvest.
2. Restore, improve, and protect striped bass habitat and environmental quality consistent with the Coastal Habitat Protection Plan to increase growth, survival and reproduction.
3. Manage the fishery in a manner that considers biological, social, and economic factors.
4. Initiate, enhance, and/or continue programs to collect and analyze biological, social, economic, fishery, habitat, and environmental data needed to effectively monitor and manage the fishery.
5. Initiate, enhance, and/or continue information and education programs to elevate public awareness of the causes and nature of issues in the striped bass stocks, habitat, and fisheries, and explain management programs.
6. Develop management measures, including regulations that consider the needs of all user groups and provide sustainable harvest.
7. Promote practices that minimize bycatch and discard mortality in recreational and commercial fisheries.

4.3 SUSTAINABLE HARVEST

The FRA mandates that fishery stocks be managed to allow for sustainable harvest and prevent overfishing. Another piece of legislation, House Bill 1713, provides …"that each FMP must specify time periods for ending overfishing and achieving a sustainable harvest and include a standard of at least 50 percent probability of achieving a sustainable harvest".

4.3.1 Albemarle/Roanoke Stock

The Stock Status of A/R striped bass (Takade-Heumacher 2010) indicated the stock was not undergoing overfishing. Other findings from the stock assessment included:

- The stock has significantly increased in numbers and overall biomass since the late 1990s.
- Overall recruitment has increased.
- Fishing mortality has increased with total allowable catch (TAC) increases.
- Fishing mortality has declined since 2004.
- The spawning stock biomass (SSB) has steadily increased since 1991; however, there is a large margin of error associated with the model's current estimate of SSB that is currently a point of concern.
- Overfishing is not occurring and has not been occurring since 2004.
- Due to the large amount of uncertainty associated with the SSB estimates, it is not possible to use the model results to make a determination on the overfished status of the stock.

The NCDMF and the NCWRC position on Amendment 1 of the North Carolina Estuarine Striped bass FMP recommends Fishing Mortality Reference Points of $F_{TARGET} = 0.25$ and $F_{THRESHOLD} = 0.29$. These Reference Points are based on Spawner Potential Ratio (SPR) calculations of 45% and 40% respectively. Due to the large amount of uncertainty associated with the SSB estimates produced from the model, the NCDMF and NCWRC recommends not setting SSB Target and Threshold Reference Points. A more thorough description of the current status of the stock is included in Section 6.0.

4.3.2 Central Southern Management Area Stocks

The current stock assessment (NCDMF 2010) indicates striped bass abundance in each system persists at relatively low levels, with size and age distributions in these systems showing no signs of improvement since the 2003 assessment, and with few fish > age 6 collected from a given cohort. Fish fully recruited to the sampling gear (age 3 or age 4) compose the majority of annual survey catches with these fish declining rapidly in abundance in subsequent years. This rapid decline is responsible for highly volatile estimates of total mortality (Z). Large confidence intervals around estimates of Z indicate a disturbing lack of precision in routine catch curve analysis. It is suspected that improvements in stock dynamics would only be detected as a result of large changes in population characteristics. The large confidence intervals and lack of precision in the catch curve estimates of Z made them unusable for stock status determination (NCDMF 2010). Sustainable harvest cannot be determined at this time because the CSMA striped bass stock assessment did not produce reliable estimates of F. The A/R recommended Fishing Mortality Reference Points of $F_{TARGET} = 0.25$ and $F_{THRESHOLD} = 0.29$ will be used as a proxy for the CSMA stocks. A more thorough description of the current status of the stock is included in Section 6.0. For a complete review of the CSMA stock assessment see Appendix 14.7.

4.4 MANAGEMENT UNITS

Striped bass are recorded from all of North Carolina's coastal river ecosystems (Menhinick 1991). Coastal basins with striped bass spawning, nursery and adult/subadult habitat, which are situated wholly or primarily in North Carolina are: Albemarle Sound and its tributaries; including the Roanoke River, Pamlico Sound and its tributaries, including the Tar/Pamlico River, Pungo River, the Neuse River; the Newport River; the White Oak River; the New River; the Cape Fear and Northeast Cape Fear rivers and estuary; and the Shallotte River. Additional rivers, which enter the Atlantic Ocean in South Carolina, also host striped bass, and some spawning and nursery habitat for these populations may exist in North Carolina. These include the Waccamaw, Lumber, and Pee Dee river systems. The North Carolina portions of these latter systems, whose striped bass populations are largely within South Carolina jurisdiction, will be regulated under this plan, but the biology of those populations will not be reviewed in the plan at this time.

There are three geographic management units for this estuarine striped bass FMP and the fisheries throughout the coastal systems of North Carolina. The management units are defined as follows:

Albemarle Sound Management Area (ASMA) - which includes Albemarle Sound and all its Joint and Inland Water tributaries, (except for the Roanoke, Middle, Eastmost and Cashie rivers), Currituck, Roanoke, and Croatan sounds and all their Joint and Inland Water tributaries, including Oregon Inlet, north of a line from Roanoke Marshes Point 35° 48'.5015' N - 75° 44'.1228' W across to the north point of Eagle Nest Bay 35° 44'.1710' N - 75° 31'.0520' W (Figure 4.1).

Roanoke River Management Area (RRMA) - Roanoke River and its Joint and Inland Water tributaries, including Middle, Eastmost and Cashie rivers, up to the Roanoke Rapids Dam (Figure 4.1).

Central Southern Management Unit (CSMA) - All internal Coastal, Joint and contiguous Inland waters of North Carolina south of a line from Roanoke Marshes Point across to Eagle Nest Bay to the South Carolina State line (Figure 4.1).

4.5 GENERAL PROBLEM STATEMENT

Striped bass are distributed throughout the coastal waters of North Carolina and have been harvested historically (Table 4.1) from virtually all coastal systems. Over the last 40 to 50 years; however, the fisheries have been overwhelmingly concentrated in the Albemarle Sound area. In addition, historical landing data (Section 14, Appendix 1) indicated that the striped bass fisheries have always been concentrated in the Albemarle Sound area, with minor fisheries in other coastal systems. Data collection on the A/R stock has been ongoing since the 1950s and was intensified in the 1980s when the stock nearly collapsed. Significant restrictions in harvest of A/R striped bass along with improvements in Roanoke River flow conditions since the late 1980s brought about remarkable improvements in spawning success. In 1997, the A/R stock was declared recovered by the ASMFC. The spawning stock biomass has since increased and the age structure of the stock has expanded to include fish at least 17 years old (Godwin et al. 2010). The stock status of A/R Striped Bass (Takade-Heumacher 2010) indicated the stock is not currently experiencing overfishing and stock abundance and recruitment is stable. Since the stock was declared recovered in 1997 the TAC has increased 350%, from 156,800 lbs to the current TAC of 550,000 lbs. For comparison, historical commercial landings from the Albemarle

Sound for the years just prior to stock collapse (1972 -1978) averaged 505,852 lbs (Table 4.1). In order to ensure sustainable harvest for the A/R striped bass stock, and as mandated by the FRA, a reevaluation of current management regimes is necessary.

Outside the ASMA, the NCDMF has conducted spawning and nursery area surveys, and commercial fish house sampling for size, age and sex composition data for most coastal streams, but this work ended 15-20 years ago, varying with area, as federal aid funds were decreased (Table 4.2). The NCDMF 2010 stock assessment indicates the CSMA stocks are experiencing excessive total mortality (NCDMF 2010) and sustainable harvest cannot be determined at this time. Commercial landing data for striped bass in these areas are available (Table 4.1) and creel surveys were initiated in 2003 for the Tar/Pamlico, Neuse, and Cape Fear rivers. In addition to studies in the Roanoke River, the NCWRC has been monitoring spawning stock status of striped bass in the Neuse (1994) and Tar rivers since 1996 and in the Cape Fear River since 2003 (Table 4.3). Results from the electrofishing survey show few fish on the spawning grounds and very few fish over age six. An independent gill net survey was also started by the NCDMF in the Pamlico Sound, Pamlico, and Neuse rivers in 2003 and in the Cape Fear area in 2008. The results from these surveys also show very few fish over age six, indicating low overall survival of these fish. There is a need for additional surveys to be conducted in order to gain a more comprehensive assessment of the CSMA stocks (NCDMF 2010).

4.6 EXISTING PLANS AND AGREEMENTS, STATUTES, AND RULES

4.6.1 Existing Plans and Agreements

In 1986, the North Carolina Department of Natural Resources and Community Development (known today as the Department of Environment and Natural Resources), NCWRC and United States Fish and Wildlife Service (USFWS) entered into a cooperative agreement (Agreement No. 14-16-0004-87-904) for anadromous species restoration in North Carolina's coastal river basins. The cooperative program's intent was to restore self-sustaining stocks of anadromous fishes in coastal North Carolina waters through a combination of fishery techniques including stocking, regulations, and assessment. This cooperative program continues today and has resulted in numerous cooperative fishery management ventures between state and federal agencies.

In November 1990, a memorandum of agreement between the NCMFC and NCWRC was signed to provide stewardship and continuity of management for striped bass. Through this agreement, two distinct management zones were established: the Albemarle Sound and Roanoke River Management Areas. Under an additional agreement the NCMFC, NCWRC, and USFWS established a cooperative for the purpose of restoring all inter-jurisdictional anadromous fishery stocks in North Carolina.

The ASMFC was directed, under the federal Striped Bass Conservation Act (1984) to develop a management plan, which would address all striped bass populations from the South Carolina/North Carolina border northward. The Act, during reauthorization in 1988, was amended to include Section 5, which provided that the USFWS, in consultation with the National Marine Fisheries Service (NMFS), would provide a report to Congress summarizing the findings of a study to be conducted on North Carolina striped bass. The Act specifically instructed the USFWS to include: a description of the Albemarle Sound-Roanoke River Basin; an investigation and analysis of the effects of land and water use practices on the A/R striped bass stock, determination of the abundance, age, geographic distribution and amount and location of migration and spawning habitat; the extent and causes of mortality at successive life stages, including fishing; the effects of pollution and other alterations including water withdrawals, discharges and flows on A/R stock migration, spawning, viability and condition of eggs and larvae; the effectiveness of current fishery and reservoir management measures; an analysis of whether additional measures are needed to halt the decline of the A/R stock and initiate recovery; and a recommendation of whether conservation could be improved by managing the A/R stock under the ASMFC Interstate Fisheries Management Plan for Striped Bass and the Act.

The report of the USFWS, Albemarle Sound and Roanoke River Basin North Carolina Striped Bass Study, was submitted to Congress in May 1992. The report contained recommendations for restoration of the A/R stock. One of the recommendations was that North Carolina be allowed to continue management of its striped bass fisheries prosecuted on the A/R stock in the ASMA and RRMA, under the ASMFC plan but with its own separate management provisions. The CSMA was not specifically addressed in the ASMFC plan.

Under the ASMFC Amendment 6 to the Interstate FMP for Atlantic Striped Bass, states were required to implement a variety of regulations and monitoring programs within their jurisdictions. These included a preferred minimum size of 20 inches TL in bays and estuaries and 28 inches TL in ocean waters. States may deviate from these preferred options, but any alternative measures must be reviewed by the Striped Bass Technical Committee for conservation equivalency and approved by the Striped Bass Management Board (ASMFC 2003). Maryland, Virginia, and North Carolina made a conservation equivalency proposal that instituted an 18 inch minimum TL size limit in the Chesapeake Bay and the ASMA. Due to the smaller size limit the F-target for these areas was reduced from $F_{TARGET} = 0.30$ (coastwide F based on a 28 inch minimum TL) to $F_{TARGET} = 0.27$. The ASMFC Amendment 6 to the Interstate FMP for Atlantic Striped Bass, explicitly states that …"under no circumstances will states be allowed to institute minimum sizes below 18 inches in alternative management regimes".

The plan also requires annual submittal of a fishing plan as well as a compliance report on the previous year's fishery. Both the annual fishing plan and annual fishery compliance report for the A/R stock must be accepted and approved by the ASMFC Striped Bass Technical Committee and also by the ASMFC Striped Bass Management Board. Management of striped bass fisheries in the CSMA do not currently fall under the ASMFC jurisdiction.

The first North Carolina Estuarine Striped Bass FMP was developed and approved by the NCMFC and NCWRC in 1994. The plan set forth measures necessary for continuing the recovery of the A/R stock, and advised the ASMFC of measures which North Carolina was taking in that regard. It also put in place a commercial quota and recreational size and bag limits for the CSMA. This coastwide plan also satisfied the recommendation, contained in the Report to Congress, that such a plan be prepared.

Under the mandate of the FRA, the 2004 North Carolina Estuarine Striped Bass Fishery Management Plan was adopted by the NCMFC and NCWRC in May and July 2004 respectively. For the A/R stock, the plan focused management on a recovered stock and replaced in full the 1994 North Carolina Striped Bass FMP. For the CSMA stocks, the plan focused management on gaining adequate information on recreational harvest through the implementation of creel surveys and reducing discard mortality in the CSMA set gill net fisheries, including the Neuse and Tar/Pamlico river gill net fisheries.

4.6.1.1 A/R Stock Management Measures Approved From 2004 FMP

Biological Reference Points

- Support a fishing mortality rate (F) no higher than 0.22 and a SSB no lower than 400,000 lbs. for the A/R stock.

Discard Mortality of Striped Bass in Multi-Species Gill Net Fishery

- Maintain status quo, existing gill net proclamation authority, with the requirement that small mesh nets be sunk after river herring gill net season closes. Small mesh gill nets (3 ¼ inch stretched mesh (ISM)) would be restricted to no more than 25 – 30 meshes deep and set in no less than 7 feet of water unless attended. These requirements would remain in effect when attendance was not required[1]. Also, consider area closures to gill netting. The following qualifications will also apply: 1. NCDMF will evaluate existing Independent Gill Net Survey (IGNS) small mesh data to determine differences between striped bass catches in float and sink nets and 2. Observer data, current and future will be collected and analyzed to assess the benefits. Should the discard reductions not be within the estimated range of the other options in Table 10.14, then NCDMF may implement other options presented in the FMP, or other options that may be developed over time.

Management of Harvest Targets in the ASMA

- Supports no payback for overages in RRMA due to underage in 2003.
- Supports TAC allocation: 25% Roanoke River/NCWRC recreational, 25% Albemarle Sound/NCDMF recreational and 50% Albemarle Sound/NCDMF commercial.
- Penalties/Triggers for Overages: Short-term Overage: point harvest estimate exceeds the total TAC by 10% in a single year, overage deducted from the next year and restrictive measures implemented in the responsible fishery (ies). Long-term Overages: five year running average of point estimate exceeds the five year running average of the total TAC harvest by 2%, the responsible fishery exceeding the harvest limit will be reduced by the amount of the overage for the next five years. Should the target F be exceeded, then restrictive measures will be imposed to reduce F to the target level.

4.6.1.2 CSMA Stocks Management Measures Approved From 2004 FMP

Biological Reference Points

- Manage the CSMA stocks under the same exploitation rate targets and thresholds as selected for the A/R stock (F= 0.22, SSB 400,000 lbs.). Improve data collection on these stocks so that biomass thresholds and targets can be developed for these stocks.

Striped Bass Stocking in Coastal River Systems

- Continue Phase II stocking program, with two systems in the CSMA (Tar-Pamlico, Neuse and Cape Fear rivers) being stocked annually, with a goal of 100,000 fish per drainage.
- Continue the Phase I striped bass stocking program, with a goal of 100,000 fish per year, per system in the CSMA.

Management Options for Recreational Striped Bass Harvest in CSMA

- Adequate information to evaluate specific recreational measures are lacking in the CSMA. Regulations should remain at status quo for 2004. A one year creel survey is being developed by NCDMF and NCWRC for the Tar-Pamlico and Neuse systems. This survey will collect data on recreational striped bass fisheries in these waters. The NCWRC will be conducting a creel survey in the Cape Fear system in 2004. After completion of the creel surveys and data analysis, appropriate regulations will be developed and implemented to distribute the reductions in fishing mortality necessary for stock recovery among the various recreational fisheries.

[1] Since the adoption of the River Herring FMP in 2007 this gill net rule has not been utilized.

Discard Mortality of Striped Bass from Set Gill Nets in the CSMA
Management Options for Neuse River and Pamlico River Areas Gill Net Fishery

- Require “tie-downs” to reduce striped bass bycatch. NCDMF is currently evaluating the effectiveness of various tie- down configurations.
- Rivers- Increase the commercial possession limit to 10 fish per day per operation in the rivers during the open striped bass season. Require that gill nets in the shad and flounder fisheries operating in the Pamlico, Pungo and Neuse river areas (west of 76° 30’W long.[2]) be tied down after the striped bass quota is reached and the season closed.
- Pamlico Sound- commercial possession limit would remain at 5 fish in the Pamlico Sound. Landings of striped bass will be limited to 50% by weight of the total catch, not to exceed 5 fish per day per fishing operation. Gill nets with a mesh length of 6 inches (stretched mesh) and greater would be prohibited during the striped bass season.
- Other portions of the CSMA- Maintain striped bass seasons, opening and closing through proclamation and operating under the 25,000 lb. TAC. This option is intended to allow the sale of striped bass bycatch resulting from gill net fisheries. As data are collected, more restrictive measures may be implemented as needed.

<u>4.6.1.3 Proposed Management Measures for the A/R Stock</u>

After reviewing the A/R Striped Bass Stock Assessment, recreational and commercial landings data, and all of the independent monitoring programs conducted by the NCDMF and NCWRC, the North Carolina Estuarine Striped Bass FMP Plan Development Team (PDT) unanimously proposed to maintain status quo with all current management measures for the ASMA and RRMA. The only change from the management measures approved in the 2004 FMP is relative to the Biological Reference Points. A new stock assessment model was used which necessitated the recalculation of fishing mortality (F) and spawning stock biomass (SSB) targets and thresholds. For a complete review of the A/R stock assessment see Appendix 14.6.

It should also be noted that the NCDMF Director and NCWRC will maintain the ability to establish seasons, authorize or restrict fishing methods and gear, limit quantities taken or possessed, and restrict fishing areas as deemed necessary to maintain a sustainable harvest.

<u>PROPOSED MANAGEMENT MEASURES</u>

Biological Reference Points

- $F_{Target} = 0.25$
- $F_{Threshold} = 0.29$

A/R stock has been managed with a Total Allowable Catch (TAC) since 1990

- Maintain current TAC of 550,000 lbs
- The TAC will continue to be split evenly between commercial and recreational sectors
- ASMA commercial TAC = 275,000 lbs
- ASMA recreational TAC = 137,500 lbs
- RRMA recreational TAC = 137,500 lbs

ASMA Commercial Harvest (TAC = 275,000 lbs)

- 18 inch TL minimum size limit (ASMFC compliance requirement)
- Continue to operate as a bycatch fishery
- Spring season, anytime between Jan 1 – Apr 30

[2] This changed to 76° 28’W in 2008; see proclamation M-9-2008.

- Fall Season, anytime between Oct 1 – Dec 31
- Daily trip limits for striped bass
- Maintain gill net mesh size and yardage restrictions
- Maintain seasonal and area closures
- Maintain attendance requirements for small mesh nets (mid – May through late November)

ASMA Recreational Harvest (TAC = 137,500 lbs)
- 18 inch TL minimum size limit
- Daily creel limit (can be adjusted as necessary to keep harvest below the TAC)
- Open 7 days a week all season (can be adjusted as necessary to keep harvest below the TAC)
- Spring season, anytime between Jan 1 – Apr 30
- Fall season, anytime between Oct 1 – Dec 31

RRMA Recreational Harvest (TAC = 137,500 lbs)
- 18 inch TL minimum size limit
- Protective slot (no harvest): 22-27 inches TL
- 2 fish daily creel, only one of which can be greater than 27 inches TL
- Harvest season in entire river opens on March 1 and closes on April 30 by rule since 2008
- Single barbless hook regulation from April 1 – June 30 in Inland waters above the US 258 Bridge

Management of TACs for ASMA and RRMA
- Short-term Overages: if the harvest point estimate exceeds the total TAC by 10% in a single year, overage is deducted from the next year and restrictive measures implemented in the responsible fishery (ies)
- Long-term Overages: five-year running average of harvest point estimate exceeds the five-year running average of the total TAC harvest by 2%, the responsible fishery exceeding the harvest limit will be reduced by the amount of the overage for the next five years. Should the target F be exceeded, then restrictive measures will be imposed to reduce F to the target level

<u>RECOMMENDATIONS</u>

PDT - Supports status quo on all proposed Management Recommendations

A/R AC – Supports status quo on all proposed Management Recommendations

NCDMF – Supports status quo on all proposed Management Recommendations

NCMFC - Supports status quo on all proposed Management Recommendations

NCWRC - Supports status quo on all proposed Management Recommendations

4.6.1.4 Proposed Management Measures for the CSMA Stocks

The North Carolina Estuarine Striped Bass FMP Plan Development Team (PDT) proposed to maintain status quo with all current management measures for the CSMA and provide a payback provision for any overage of the commercial TAC.

It should also be noted that under the provisions of this plan amendment the NCDMF Director and NCWRC will maintain the ability to establish seasons, authorize or restrict fishing methods and gear, limit quantities taken or possessed, and restrict fishing areas as deemed necessary to maintain a sustainable harvest.

PROPOSED MANAGEMENT MEASURES

CSMA Recreational Harvest (Coastal, Joint, and Inland waters)
- Unified season Oct 1 – Apr 30
- 2 fish daily creel limit
- 18 inch TL minimum size limit
- Protective slot (no harvest) 22 – 27 inches TL (joint and inland waters only)
- Harvest moratorium for Cape Fear River and its tributaries

CSMA Commercial Harvest (Coastal and Joint waters)
- TAC of 25,000 lbs and commercial fishery, excluding Pamlico Sound, is not a bycatch fishery
- 18 inch TL minimum size limit
- 10 fish or less trip limit
- Spring season only, anytime between Jan 1 – Apr 30
- Gill net mesh size restrictions and yardage limits
- 18 inch TL minimum size limit
- Discards – maintain existing gill net tie-down and distance from shoreline (DFS) measures implemented by proclamation.
- Harvest moratorium for Cape Fear River and its tributaries

RECOMMENDATIONS

The need for continuing conservation management efforts at this time are supported by the constrained size and age distributions, low abundance, and the absence of older fish in the spawning ground surveys. The management measures implemented in July 2008 have substantially reduced harvest but have not been in place long enough to fully evaluate their long-term benefit to stock improvement.

PDT - Supports status quo on all proposed Management Recommendations with the addition of a pound for pound pay back provision for the commercial harvest TAC.

CSMA AC – Supports status quo on all proposed Management Recommendations with the addition of a pound for pound pay back provision for the commercial harvest TAC.

NCDMF – Supports status quo on all proposed Management Recommendations with the addition of a pound for pound pay back provision for the commercial harvest TAC.

NCMFC - Supports status quo on all proposed Management Recommendations with the addition of a pound for pound pay back provision for the commercial harvest TAC.

NCWRC - Supports status quo on all proposed Management Recommendations with the addition of a pound for pound pay back provision for the commercial harvest TAC.

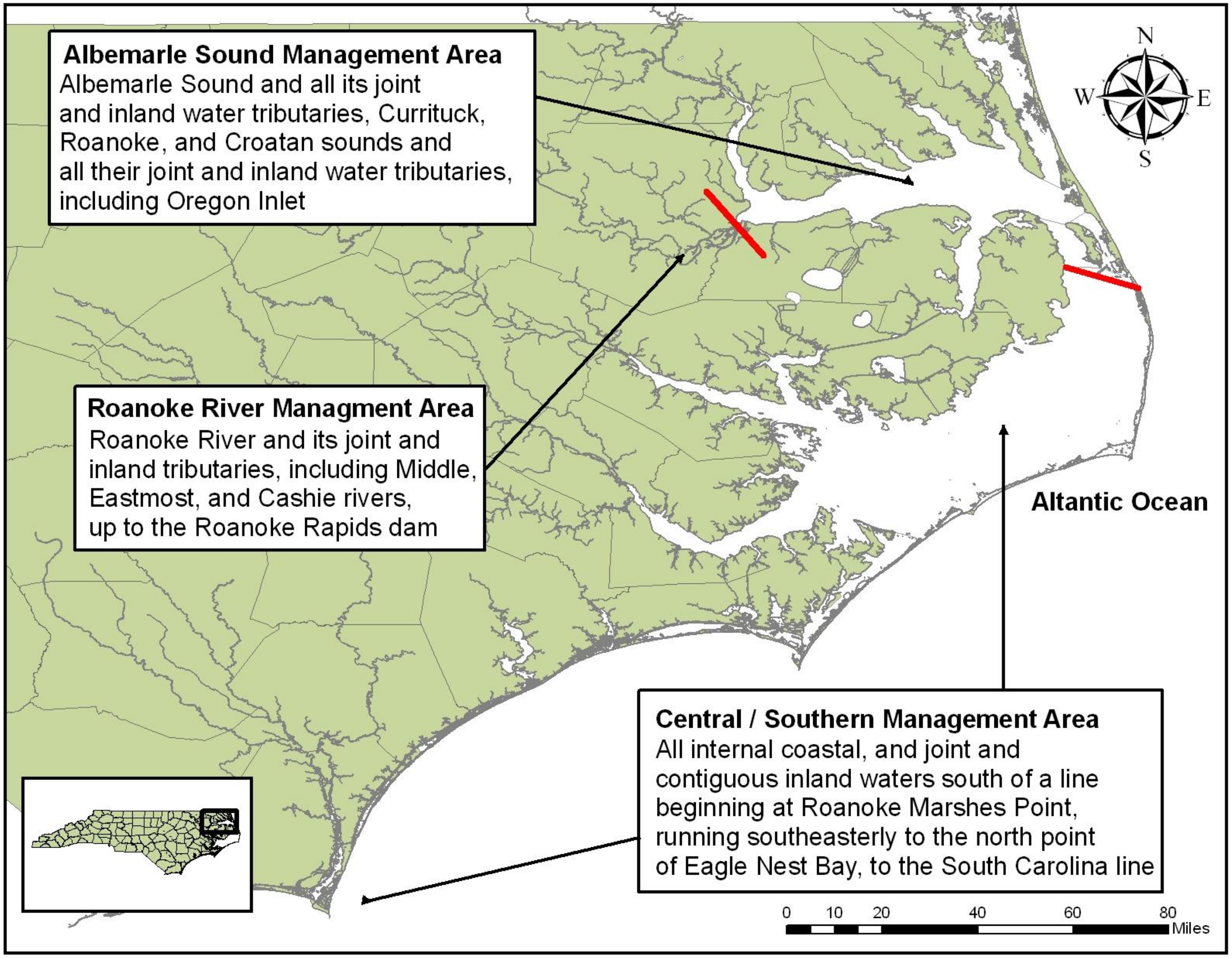


Figure 4.1 Boundary lines between the Albemarle Sound Management Area, Central Southern Management Area, and the Roanoke River Management Area.

Table 4.1 North Carolina striped bass commercial landings (lbs) 1972-2009. (NCDMF Trip Ticket Program).

YEAR	ASMA	Pamlico Sound	Pamlico & Pungo rivers	Neuse River	Cape Fear River	Confidential and Other Inside Waters	Atlantic Ocean	Total
1972	304,809	64,978	49,294	500	3,033	11,399	827,047	1,261,060
1973	529,156	27,587	73,638	4,928	1,376	7,082	1,108,169	1,751,936
1974	427,940	19,618	41,865	456	729	32,267	493,316	1,016,191
1975	615,752	17,217	55,870	7,280	1,538	20,545	584,995	1,303,197
1976	668,903	7,117	11,904	8,625	1,814	7,498	332,293	1,038,154
1977	469,402	561	9,839	0	831	316	90,702	571,651
1978	524,999	3,920	2,754	0	1,326	287	164,578	697,864
1979	326,208	6,500	32,945	0	7,811	640	240,080	614,184
1980	372,482	5,282	50,655	141	17,418	4,691	21,834	472,503
1981	333,376	3,556	20,612	427	7,394	418	51,541	417,324
1982	227,626	4,345	11,045	228	1,815	378	92,873	338,310
1983	288,677	1,184	15,035	1,018	2,500	65	52,796	361,275
1984	475,607	690	16,539	3,445	2,081	33	14,501	512,896
1985	269,671	2,842	5,919	988	337	0	183	279,940
1986	172,683	6,104	8,766	687	741	0	11	188,992
1987	228,861	24,797	6,571	1,433	559	0	0	262,221
1988	108,791	3,609	2,538	198	306	434	39	115,915
1989	97,061	940	1,987	56	679	15	92	100,830
1990	103,757	373	235	148	728	28	8,670	113,939
1991	108,460	4,034	321	1,967	1,585	263	6,186	122,816
1992	100,549	6,019	774	9,053	2,746	14,166	27,702	161,009
1993	109,475	8,134	374	1,797	1,439	65,557	75,671	262,447
1994	102,370	9,974	866	8,288	480	250	139,672	261,900
1995	87,836	6,981	2,439	3,950	264	692	344,627	446,789
1996	90,133	17,321	4,230	6,965	4,139	595	58,217	181,600
1997	96,122	16,434	4,450	5,344	2,187	106	463,144	587,786
1998	123,927	11,520	7,514	5,537	501	903	272,969	422,869
1999	162,870	15,478	10,452	6,094	1,001	936	391,482	588,311
2000	214,029	8,894	16,749	4,808	567	64	162,396	407,505
2001	220,233	8,821	8,934	6,943		219	381,445	626,595
2002	222,856	8,632	8,205	4,121	173	16,454	441,018	701,459
2003	323,337	11,239	7,387	5,777	68	16,912	201,199	565,919
2004	273,636	8,055	14,197	7,820	2,364	44	605,358	911,473
2005	232,693	7,981	11,258	5,173	2,721	0	604,464	864,289
2006	186,399	7,478	5,402	7,090	1,057	123	74,189	281,736
2007	171,682	7,369	9,295	6,731	1,601	12	379,694	576,384
2008	74,926	732	3,718	4,828	831	6	288,410	373,450
2009	96,134	1,330	14,892	8,285	0	0	189,963	310,604

Table 4.2 Striped bass research and monitoring by the NCDMF in the coastal rivers and sounds of North Carolina.

	Survey Type						
System	Spawning areas	Juvenile abundance	Adult size, age, and sex	Migration & Tagging	Creel survey	Commercial harvest §	Other
Albemarle Sound Area	1973, 1974, 1978, 1993, 2005, 2006-present	1972-present	1972-present	1974-present	1990-present: NCDMF *MRIP 1987-present ¥RCGL survey 2001, 2004, 2007, 2002-2008	1978-present	Socioeconomic survey 2000, 2003, 2004, 2009
Tar/Pamlico River and Pamlico Sound	1975, 1976, 1980, 1981	1974-1980	1974-1981, 1998-present 2003-present	1975, 1976, 1979-1981, 1998-2001 2003-present	2003-present: NCDMF *MRIP 1987-present ¥RCGL survey 2001, 2004, 2007, 2002-2008	1978-present	Socioeconomic survey 2001, 2003, 2004, 2009
Neuse	1977-1979	1976-1980	1976-1981 Sep 1998-Jan 2001 2003-present	1977-1981, Sep 1998-Jan 2001 2003-present	2003-present: NCDMF *MRIP 1987-present ¥RCGL survey 2001, 2004, 2007, 2002-2008	1978-present	Socioeconomic survey 2001, 2003, 2004, 2009
White Oak	1974, 1975	1973-1975	1974, 1975		*MRIP 1987-present	1978-present	Socioeconomic survey 2003, 2004, 2009
New	1974, 1975	1973-1975	Sep 1998-Jan 2001		*MRIP 1987-present	1978-present	Socioeconomic survey 2003, 2004, 2009
Cape Fear	1976-1981	1975-1981	1976-1981	1976-1981	*MRIP 1987-present	1978-present	Socioeconomic survey 2003, 2004, 2009

* MRIP was formerly MRFSS and is ongoing in the coastal waters of these systems but geographic coverage is limited to the extreme eastern portions of these areas.
§ Commercial harvest available for earlier years by the National Marine Fisheries Service (NMFS) and preceding agencies.
¥Recreational Commercial Gear License.

Table 4.3 Striped bass research and monitoring by the NCWRC in the coastal rivers of North Carolina.

System	Spawning stock survey	Egg and larvae	Juveniles	Adult size, age and sex	Creel survey	Catch and release mortality
Roanoke	1991- present 1957, 1959	1980-1991		1991- present 1984	1982, 1988- present	1994, 1995 2000
Tar- Pamlico	1994-present	1970-1975 1988-1989, 1996		1970-1975	2004-2005	
Neuse	1994- present	1970-1975 1988-1989	2006-2007	1970-1975	2002-2003	
Cape Fear	2003-present	1999-2000		1992-1993	2003-2004	
Chowan					2001-2002	
White Oak		2000		1998, 2000		
Northeast Cape Fear		2000		1998		
Albemarle Sound					1977-1980	
Inland waters of NC		1966-1968			1966-1968	

4.6.2 Statutes

All management authority for North Carolina's striped bass fishery is vested in the State of North Carolina. General authorities that are noted in Section 4.1 provide the NCMFC, NCDMF, and NCWRC with the regulatory powers to manage the striped bass fishery. There are few general statutes that govern specific aspects of finfish management in North Carolina or that focus specifically on striped bass. Also the statutory licensing and reporting requirements for fishing activities apply equally to all types of finfish harvest and there are few statutes that would affect striped bass directly.

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

Selected North Carolina General Statutes pertaining to the management of striped bass and the enforcement of applicable regulations include:

G.S. 113-129.	Definitions relating to resources.
G.S. 113-132.	Jurisdiction of fisheries agencies.
G.S. 113-168.2.	Standard Commercial Fishing License.
G.S. 113-168.3.	Retired Standard Commercial Fishing License.
G.S. 113-168.4.	Sale of Fish.
G.S. 113-168.6.	Commercial fishing vessel registration.
G.S. 113-169.1.	Permits for gear, equipment, and other specialized activities authorized.
G.S. 113-173.	Recreational Commercial Gear License.
G.S. 113-174.2.	Coastal Recreational Fishing License.
G.S. 113-182.	Regulations of fishing and fisheries
G.S. 113-182.1.	Fishery Management Plans
G.S. 113-183.	Unlawful possession, transportation and sale of fish.
G.S. 113 261.	Taking fish and wildlife for scientific purposes; permits to take in normally unauthorized manner; cultural and scientific operations.
G.S. 113-267.	Replacement costs of marine, estuarine, and wildlife resources; rules authorized; prima facie evidence.
G.S. 113-268.	Injuring, destroying, stealing, or stealing from nets, seines, buoys, pots, etc.
G.S. 113 292	Authority of the Wildlife Resources Commission in regulation of inland fishing and the introduction of exotic species.
G.S. 113-316.	General statement of purpose and effect of revisions of Subchapter IV made in 1965 and 1979.
G.S. 143B-279.8	Coastal Habitat Protection Plans

4.6.3 Rules

The following rules are used in the management of all striped bass stocks in North Carolina, including the Atlantic Ocean, coastal, joint, and inland waters of the state, through the authority vested in the NCMFC and NCWRC. North Carolina Administrative Code (NCAC) 15A, Chapter 3 Marine Fisheries and Chapter 10 Wildlife Resources and Water Safety. Striped bass rules are unique in that a number of rules are jointly adopted by both the NCMFC and the NCWRC. Some rules in Subchapters 03Q and 10C are adopted by reference and are essentially the same for both agencies. Many rules, like the statutes, apply equally to all types of finfish harvest and there are relatively few rules that would affect striped bass directly. These rules were in place at the beginning of the Estuarine Striped Bass FMP Amendment 1 development. Rules necessary to implement the selected management strategies for this plan and selected by the NCMFC and NCWRC are listed in Appendix 18.

4.6.3.1 Marine Fisheries Commission Rules

North Carolina Rules for Coastal Fishing Waters – 15A NCAC
15A NCAC 03H .0103 PROCLAMATION AUTHORITY OF FISHERIES DIRECTOR
(a) The proclamation authority granted to the Fisheries Director by the Marine Fisheries Commission within this Chapter includes the authority to close as well as open seasons and areas, to establish conditions governing various activities, and to reduce or increase the size and harvest limits from those stated in rule when specifically authorized. It is unlawful to violate the provisions of any proclamation issued by the authority of Marine Fisheries Commission Rule.

(b) Unless specific variable conditions are set forth in a rule granting proclamation authority to the Fisheries Director, variable conditions triggering the use of the Fisheries Director's proclamation authority may include any of the following: compliance with changes mandated by the Fisheries Reform Act and its amendments, biological impacts, environmental conditions, compliance with Fishery Management Plans, user conflicts, bycatch issues and variable spatial distributions.

History Note: *Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;*
Eff. January 1, 1991;
Amended Eff. March 1, 1994; September 1, 1991;
Temporary Amendment Eff. July 1, 1999;
Amended Eff. August 1, 2000.

15A NCAC 03I .0115 REPLACEMENT COSTS OF MARINE AND ESTUARINE RESOURCES - FISH

(a) Fish, as used throughout this Rule, is defined in G.S. 113-129(7).

(b) Replacement Costs Distinguished. As it applies to fishes the term "replacement costs" must be distinguished from the "value" of the fish concerned. Except in cases where fish may lawfully be sold on the open market, as with commercially reared species, the monetary value of the specimens cannot be determined easily. The degree of special interest or concern in a particular species by the public, including not only anglers, but conservationists and those to whom the value of fishes is primarily aesthetic, cannot be measured in dollar amounts. The average cost of fish legally taken by anglers including travel and lodging, fishing equipment and bait, excise taxes on equipment, licenses and other fees, may fairly be estimated. This too, however, is a reflection on the value of existing fishery resources rather than a measure of the cost of their replacement. Thus, the relative value of fish species shall be considered only as they may bear on the necessity or desirability of actual replacement.

(c) Determining replacement costs. The replacement costs of species of fishes that have been taken, injured, removed, harmfully altered, damaged, or destroyed shall be determined as follows. The weight of each undersized fish shall be adjusted to the average weight of a fish on the minimum legal size established by the Marine Fisheries Commission for that species. The replacement cost shall be calculated based on the greater of either:

(1) the cost of propagating and rearing the species in a hatchery and the cost of transporting them to areas of suitable habitat; or

(2) the average annual ex-vessel value of fish species per pound.

(d) The cost of propagating, rearing and transporting the fish and the average annual ex-vessel value of fish species per pound shall be taken from the Division of Marine Fisheries annual statistical report for the calendar year next preceding the year in which the offense was committed. When the cost of propagating, rearing or transporting a particular species is not available, replacement costs shall be calculated based upon the average annual ex-vessel value of the species. When neither the cost of propagating, rearing or transporting a particular species, nor the average annual ex-vessel value of the species is available, replacement costs shall be determined according to the following factors:

(1) whether the species is classified as endangered or threatened;
(2) the relative frequency of occurrence of the species in the state;
(3) the extent of existing habitat suitable for the species within the state;
(4) the dependency of the species on unique habitat requirements;
(5) the cost of improving and maintaining suitable habitat for the species;
(6) the cost of capturing the species in areas of adequate populations and transplanting them to areas of suitable habitat with low populations;
(7) the availability of the species and the cost of acquisition for restocking purposes;
(8) the cost of those species which, when released, have a probability of survival in the wild;
(9) the ratio between the natural life expectancy of the species and the period of its probable survival when, having been reared in a hatchery, it is released to the wild.

(e) Replacement costs will be assessed for the following fish:

(# 50 out of 76 total) Striped Bass;

(f) Cost of Investigations:

(1) Factors to be Considered. Upon any investigation required as provided by G.S. 143-215.3(a)(7) or by court order for the purpose of determining the cost of replacement of marine and estuarine resources which have been killed, taken, injured, removed,

harmfully altered, damaged, or destroyed, the factors to be considered in determining the cost of the investigation are as follows:

(A) the time expended by the employee or employees making the investigation, including travel time between the place of usual employment and the site of the investigation, and the time required in formulating and rendering the report;

(B) the cost of service to the state of each employee concerned, including annual salary, hospitalization insurance, and the state's contribution to social security taxes and to the applicable retirement system;

(C) subsistence of the investigating personnel, including meals, reasonable gratuities, and lodging away from home, when required;

(D) the cost of all necessary transportation;

(E) the use or rental of boats and motors, when required;

(F) the cost of cleaning or repairing any uniform or clothing that may be damaged, soiled or contaminated by reason of completing the investigation;

(G) the cost of necessary telephonic communications;

(H) any other expense directly related to and necessitated by the investigation.

(2) Computation of Costs. In assessing the cost of time expended in completing the investigation, the time expended by each person required to take part in the investigation shall be recorded in hours, the value of which shall be computed according to the ratio between the annual cost of service of the employee and his total annual working hours (2087 hours reduced by holidays, annual leave entitlement, and earned sick leave). Other costs shall be assessed as follows:

(A) subsistence: the per diem amount for meals, reasonable gratuities, and lodging away from home, not to exceed the then current maximum per diem for state employees;

(B) transportation: total mileage by motor vehicle multiplied by:

(i) the then current rate per mile for travel by state-owned vehicle; or

(ii) the then current rate per mile for travel by privately owned vehicle, as applicable;

(C) boat and motor: ten dollars ($10.00) per hour;

(D) uniform and clothing cleaning and repair: actual cost;

(E) telephonic communications: actual cost;

(F) other expenses: actual cost.

History Note: Authority G.S. 113-134; 113-267; 143B-289.52;
Eff. March 1, 1995;
Recodified from 15A NCAC 3I .0015 Eff. December 17, 1996.

15A NCAC 03J .0101 FIXED OR STATIONARY NETS

It is unlawful to use or set fixed or stationary nets:

(1) In the channel of the Intracoastal Waterway or in any other location where it may constitute a hazard to navigation;

(2) So as to block more than two-thirds of any natural or manmade waterway, sound, bay, creek, inlet or any other body of water;

(3) In the middle third of any marked navigation channel;

(4) In the channel third of the following rivers: Roanoke, Cashie, Middle, Eastmost, Chowan, Little, Perquimans, Pasquotank, North, Alligator, Pungo, Pamlico, and Yeopim.

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

15A NCAC 03J .0102 NETS OR NET STAKES

It is unlawful to use nets or net stakes:

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

(2) Within 300 yards of any highway bridge crossing Albemarle Sound, Chowan River, Croatan Sound, Currituck Sound and Roanoke Sound;
(3) If such net stakes are of metallic material.

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

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

(a) It is unlawful to use gill nets:

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

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

(1) Specify area.
(2) Specify season.
(3) Specify gill net mesh length.
(4) Specify means/methods.
(5) Specify net number and length.

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

(1) Owner's N.C. motor boat registration number, or
(2) Owner's U.S. vessel documentation name.

(d) It is unlawful to use gill nets:

(1) Within 200 yards of any flounder or other finfish pound net set with lead and either pound or heart in use, except from August 15 through December 31 in all coastal fishing waters of the Albemarle Sound, including its tributaries to the boundaries between coastal and joint fishing waters, west of a line beginning at a point 36° 04.5184' N - 75° 47.9095' W on Powell Point; running southerly to a point 35° 57.2681' N - 75° 48.3999' W on Caroon Point, it is unlawful to use gill nets within 500 yards of any pound net set with lead and either pound or heart in use;
(2) From March 1 through October 31 in the Intracoastal Waterway within 150 yards of any railroad or highway bridge.

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

(1) No more than two gill nets per vessel may be used at any one time;
(2) Any net used must be attended by the fisherman from a vessel who shall at no time be more than 100 yards from either net; and
(3) Any individual setting such nets shall remove them, when necessary, in sufficient time to permit unrestricted boat navigation.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

    (A) Gear owner's current motor boat registration number; or

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

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

(e) Escape Panels:

(1) The Fisheries Director may, by proclamation, require escape panels in pound net sets and may impose any or all of the following requirements or restrictions on the use of escape panels:

    (A) Specify size, number, and location.

    (B) Specify mesh length, but not more than six inches.

    (C) Specify time or season.

    (D) Specify areas.

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

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

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

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

15A NCAC 03M .0101 MUTILATED FINFISH

It is unlawful to possess aboard a vessel or while engaged in fishing from the shore or a pier any species of finfish that is subject to a size or harvest restriction without having head and tail attached, except for mullet when used for bait. Blueback herring, hickory shad and alewife shall be exempt from this Rule when used for bait provided that not more than two fish per boat or fishing operation may be cut for bait at any one time.

History Note: Authority G.S. 113-134; 113-185; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. January 1, 1991;
Temporary Amendment Eff. May 1, 2001;
Amended Eff. July 1, 2006; August 1, 2002.

15A NCAC 03M .0201 GENERAL

(a) Striped bass is defined as striped bass (Morone saxatilis) and its hybrids taken in coastal and joint waters.

(b) Hook-and-line fishing equipment is not commercial fishing equipment in the striped bass fishery. It is unlawful to sell or purchase striped bass taken by hook-and-line. Striped bass taken legally with hook-and-line may be possessed and transported.

(c) It is unlawful to possess striped bass imported from other states less than 18 inches long (total length).

(d) It is unlawful to import, buy, sell, transport, offer to buy or sell, or possess striped bass except during any:

(1) open striped bass season established for internal coastal waters;
(2) open striped bass season established for the Atlantic Ocean; or
(3) open striped bass season of another state without possession of the following:
    (A) A bill of lading as described in 15A NCAC 03I .0114;
    (B) A numbered, state-issued tag from the State of origin affixed through the mouth and gill cover. This tag must remain affixed until processed for consumption by the consumer.

(e) The management units and recreational fishery management areas for estuarine striped bass fisheries in coastal North Carolina are designated in 15A NCAC 03R .0201.

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. March 1, 1994; September 1, 1991;
Temporary Amendment Eff. May 1, 2000;
Amended Eff. October 1, 2008; October 1, 2004; April 1, 2001.

15A NCAC 03M .0202 SEASON, SIZE AND HARVEST LIMIT: INTERNAL COASTAL WATERS

(a) It is unlawful to possess striped bass from the coastal fishing waters of the Cape Fear River and its tributaries.

(b) The Fisheries Director may, by proclamation, impose any or all the following restrictions on the taking of striped bass in a commercial fishing operation or for recreational purposes in internal coastal waters during the period from October 1 through April 30:

(1) Specify fishing days and times,
(2) Specify areas,
(3) Specify quantity, except possession for recreational purposes shall not exceed:
    (A) more than three fish in any one day in the Albemarle Sound Management Area as designated in 15A NCAC 03R .0201, and
    (B) more than two fish in any one day in the joint and coastal fishing waters of the Central Southern Management Area as designated in 15A NCAC 03R .0201.
(4) Specify means/methods,
(5) Specify size, but the minimum size specified shall not be less than 18 inches total length, and
(6) Require submission of statistical and biological data.

Fish that do not meet the minimum size limit specified by proclamation shall immediately be returned to the waters from which taken regardless of condition.

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. March 1, 1996; November 1, 1991;

Temporary Amendment Eff. September 1, 1996;
Amended Eff. April 1, 1997;
Temporary Amendment Eff. July 1, 1999;
Amended Eff. July 1, 2008; August 1, 2000.

15A NCAC 03M .0203 SIZE AND CREEL LIMIT: INTERNAL COASTAL WATERS

History Note: Authority G.S. 113-134; 113-182; 143B-289.4;
Eff. January 1, 1991;
Repealed Eff. November 1, 1991.

15A NCAC 03M .0204 SEASON, SIZE AND HARVEST LIMIT: ATLANTIC OCEAN
It is unlawful to possess striped bass taken from the Atlantic Ocean less than the size limit as determined by the Atlantic States Marine Fisheries Commission in their Interstate Fisheries Management Plan for striped bass. The Fisheries Director shall issue proclamations necessary to bring North Carolina's size limit in compliance with the Interstate Fisheries Management Plan.

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;
Temporary Amendment Eff. October 1, 1996;
Amended Eff. October 1, 2008; July 1, 1998.

15A NCAC 03M .0205 PROHIBITED TRAWLING
(a) It is unlawful to possess striped bass on a vessel with a trawl net on that vessel in internal coastal waters except during transit from ocean fishing grounds to port during any open striped bass trawl season in the Atlantic Ocean established by proclamation. Striped bass so possessed must meet the minimum size limit set by proclamation.
(b) It is unlawful to possess striped bass on a vessel in the Atlantic Ocean with a trawl net on that vessel except during any open striped bass trawl season in the Atlantic Ocean established by proclamation.

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. December 1, 2007.

15A NCAC 03M .0206 HYBRID STRIPED BASS CULTURE
Culture and sale of hybrid striped bass conducted in accordance with Rule 15A NCAC 10H Section .0700 of the North Carolina Wildlife Resources Commission shall be exempt from rules of the North Carolina Marine Fisheries Commission concerning striped bass.

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

15A NCAC 03M .0512 COMPLIANCE WITH FISHERY MANAGEMENT PLANS
(a) In order to comply with management requirements incorporated in Federal Fishery Management Council Management Plans or Atlantic States Marine Fisheries Commission Management Plans or to implement state management measures, the Fisheries Director may, by proclamation, take any or all of the following actions for species listed in the Interjurisdictional Fisheries Management Plan:
(1) Specify size;
(2) Specify seasons;
(3) Specify areas:
(4) Specify quantity;
(5) Specify means and methods; and
(6) Require submission of statistical and biological data.

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

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

15A NCAC 03N .0101 SCOPE AND PURPOSE
To establish and protect those fragile estuarine and marine areas which support juvenile and adult populations of economically important fish species, as well as forage fish utilized in the food chain, the Rules in this Subchapter set forth permanent fish habitat areas in all coastal fishing waters as defined through extensive estuarine and marine survey sampling conducted by the Division.

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. December 1, 2007.

15A NCAC 03N .0106 ANADROMOUS FISH SPAWNING AREA BOUNDARIES
(a) Anadromous fish spawning areas are defined in 15A NCAC 03I .0101 and designated in 15A NCAC 03R .0115.
(b) Anadromous fish spawning areas described in 15A NCAC 03R .0115 encompass all waters, including tributaries from the described line in the direction indicated in Rule up to the headwaters of the waterbody or Inland-Coastal boundary lines, whichever area is first encountered and except when:
(1) otherwise specified by 15A NCAC 03R .0115; or
(2) the waterbody is impassable to fish migration due to manmade obstructions such as dams and causeways.

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. December 1, 2007.

15A NCAC 03O .0301 ELIGIBILITY FOR RECREATIONAL COMMERCIAL GEAR LICENSES
(a) It is unlawful for any individual to hold more than one Recreational Commercial Gear License.
(b) Recreational Commercial Gear Licenses shall only be issued to individuals.

History Note: Filed as a Temporary Adoption Eff. August 9, 1994, for a period of 180 days or until the permanent rule becomes effective, whichever is sooner;
Authority G.S. 113-134; 113-170.4; 113-173; 113-221; 143B-289.52;
Eff. February 1, 1995;
Temporary Amendment Eff. July 1, 1999;
Amended Eff. August 1, 2000.

15A NCAC 03O .0302 AUTHORIZED GEAR
(a) The following are the only commercial fishing gear authorized (including restrictions) for use under a valid Recreational Commercial Gear License:
(1) One seine 30 feet or over in length but not greater than 100 feet with a mesh length less than 2 1/2 inches when deployed or retrieved without the use of a vessel or any other mechanical methods. A vessel may be used only to transport the seine;
(2) One shrimp trawl with a headrope not exceeding 26 feet in length per vessel.
(3) With or without a vessel, five eel, fish, shrimp, or crab pots in any combination, except only two pots of the five may be eel pots. Peeler pots are not authorized for recreational purposes;
(4) One multiple hook or multiple bait trotline up to 100 feet in length;

(5) Gill Nets:

(A) Not more than 100 yards of gill nets with a mesh length equal to or greater than 2 1/2 inches except as provided in (C) of this Subparagraph. Attendance is required at all times;

(B) Not more than 100 yards of gill nets with a mesh length equal to or greater than 5 1/2 inches except as provided in (C) of this Subparagraph. Attendance is required when used from one hour after sunrise through one hour before sunset in internal coastal fishing waters east and north of the Highway 58 Bridge at Emerald Isle and in the Atlantic Ocean east and north of 77° 04.0000' W. Attendance is required at all times in internal coastal fishing waters west and south of the Highway 58 Bridge at Emerald Isle and in the Atlantic Ocean west and south of 77° 04.0000' W; and

(C) Not more than 100 yards of gill net may be used at any one time, except that when two or more Recreational Commercial Gear License holders are on board, a maximum of 200 yards may be used from a vessel;

(D) It is unlawful to possess aboard a vessel more than 100 yards of gill nets with a mesh length less than 5 1/2 inches and more than 100 yards of gill nets with a mesh length equal to or greater than 5 1/2 inches identified as recreational commercial fishing equipment when only one Recreational Commercial Gear License holder is on board. It is unlawful to possess aboard a vessel more than 200 yards of gill nets with a mesh length less than 5 1/2 inches and more than 200 yards of gill nets with a mesh length equal to or greater than 5 1/2 inches identified as recreational commercial fishing equipment when two or more Recreational Commercial Gear License holders are on board;

(6) A hand-operated device generating pulsating electrical current for the taking of catfish in the area described in 15A NCAC 03J .0304;

(7) Skimmer trawls not exceeding 26 feet in total combined width.

(8) One pound net used to take shrimp with each lead 10 feet or less in length and with a minimum lead net mesh of 1 1/2 inches, and enclosures constructed of net mesh of 1 1/4 inches or greater and with all dimensions being 36 inches or less. Attendance is required at all times and all gear must be removed from the water when not being fished. Gear is to be marked and set as specified in 15A NCAC 03J .0501.

(b) It is unlawful to use more than the quantity of authorized gear specified in Subparagraphs (a)(1) through (a)(8) of this Rule, regardless of the number of individuals aboard a vessel possessing a valid Recreational Commercial Gear License.

(c) It is unlawful for a person to violate the restrictions of or use gear other than that authorized by Paragraph (a) of this Rule.

(d) Unless otherwise provided, this Rule does not exempt Recreational Commercial Gear License holders from the provisions of other applicable rules of the Marine Fisheries Commission or provisions of proclamations issued by the Fisheries Director as authorized by the Marine Fisheries Commission.

History Note: Authority G.S. 113-134; 113-173;
Temporary Adoption Eff. August 9, 1994, for a period of 180 days or until the permanent rule becomes effective, whichever is sooner;
Eff. February 1, 1995;
Temporary Amendment Eff. August 1, 1999; July 1, 1999;
Amended Eff. August 1, 2000;
Temporary Amendment Eff. August 1, 2000;
Amended Eff. April 1, 2009; July 1, 2006; November 1, 2005; August 1, 2002.

15A NCAC 03O .0303 RECREATIONAL COMMERCIAL GEAR LICENSE POSSESSION LIMITS

(a) It is unlawful to possess more than a single recreational possession limit when only one person aboard a vessel
possesses a valid Recreational Commercial Gear License and recreational commercial fishing equipment as defined in 15A NCAC 03O .0302(a) is used, regardless of the number of persons on board.

(b) It is unlawful to possess individual recreational possession limits in excess of the number of individuals aboard a
vessel holding valid Recreational Commercial Gear Licences except as provided in Paragraph (f) of this Rule.

(c) It is unlawful for any person who holds both a Recreational Commercial Gear License and a Standard or Retired
Standard Commercial Fishing License and who is in possession of identified recreational commercial fishing equipment as defined in 15A NCAC 03O .0302(a), to exceed the single recreational possession limit.

(d) It is unlawful for persons aboard a vessel collectively holding only one Recreational Commercial Gear License and any Standard Commercial Fishing License or Retired Standard Commercial Fishing License and who are in possession of any identified recreational commercial fishing equipment as defined in 15A NCAC 03O .0302(a), to exceed one recreational possession limit.

(e) It is unlawful to possess more than 48 quarts, heads on, or 30 quarts, heads off, of shrimp when only one person
aboard a vessel possesses a valid Recreational Commercial Gear License and recreational commercial fishing equipment as defined in 15A NCAC 03O .0302(a) is used.

(f) It is unlawful to possess more than 96 quarts, heads on or 60 quarts, heads off, of shrimp if more than one person
aboard a vessel possesses a valid Recreational Commercial Gear License and recreational commercial fishing equipment as defined in 15A NCAC 03O .0302(a) is used.

History Note: Authority G.S. 113-134; 113-170.4; 113-173; 143B-289.52;
Temporary Adoption Eff. August 9, 1994, for a period of 180 days or until the permanent rule becomes
effective, whichever is sooner;
Eff. February 1, 1995;
Temporary Amendment Eff. June 7, 1998;
Amended Eff. April 1, 1999;
Temporary Amendment Eff. July 1, 1999;
Amended Eff. July 1, 2006; August 1, 2000.

15A NCAC 03O .0501 PROCEDURES AND REQUIREMENTS TO OBTAIN PERMITS

(a) To obtain any Marine Fisheries permit, the following information is required for proper application from the applicant, a responsible party or person holding a power of attorney:

(1) Full name, physical address, mailing address, date of birth, and signature of the applicant on the application. If the applicant is not appearing before a license agent or the designated Division contact, the applicant's signature on the application shall be notarized;

(2) Current picture identification of applicant, responsible party and, when applicable, person holding a power of attorney; acceptable forms of picture identification are driver's license, current North Carolina Identification card issued by the North Carolina Division of Motor Vehicles, military identification card, resident alien card (green card) or passport or if applying by mail, a copy thereof;

(3) Full names and dates of birth of designees of the applicant who shall be acting under the requested permit where that type permit requires listing of designees;

(4) Certification that the applicant and his designees do not have four or more marine or estuarine resource convictions during the previous three years;

(5) For permit applications from business entities, the following documentation is required:

(A) Business Name;

(B) Type of Business Entity: Corporation, partnership, or sole proprietorship;

(C) Name, address and phone number of responsible party and other identifying information required by this Subchapter or rules related to a specific permit;
(D) For a corporation, current articles of incorporation and a current list of corporate officers when applying for a permit in a corporate name;
(E) For a partnership, if the partnership is established by a written partnership agreement, a current copy of such agreement shall be provided when applying for a permit;
(F) For business entities, other than corporations, copies of current assumed name statements if filed and copies of current business privilege tax certificates, if applicable.

(6) Additional information as required for specific permits.

(b) A permittee shall hold a valid Standard or Retired Standard Commercial Fishing License in order to hold a:

(1) Pound Net Permit;
(2) Permit to Waive the Requirement to Use Turtle Excluder Devices in the Atlantic Ocean; or
(3) Atlantic Ocean Striped Bass Commercial Gear Permit.

(c) A permittee and his designees shall hold a valid Standard or Retired Standard Commercial Fishing License with a Shellfish Endorsement or a Shellfish License in order to hold a:

(1) Permit to Transplant (Prohibited) Polluted Shellfish;
(2) Permit to Transplant Oysters from Seed Management Areas;
(3) Permit to Use Mechanical Methods for Oysters or Clams on Shellfish Leases or Franchises;
(4) Permit to Harvest Rangia Clams from Prohibited (Polluted) Areas; or
(5) Depuration Permit.

(d) A permittee shall hold a valid:

(1) Fish Dealer License in the proper category in order to hold Dealer Permits for Monitoring Fisheries Under a Quota/Allocation for that category; and
(2) Standard Commercial Fishing License with a Shellfish Endorsement, Retired Standard Commercial Fishing License with a Shellfish Endorsement or a Shellfish License in order to harvest clams or oysters for depuration.

(e) Aquaculture Operations/Collection Permits:

(1) A permittee shall hold a valid Aquaculture Operation Permit issued by the Fisheries Director to hold an Aquaculture Collection Permit.
(2) The permittee or designees shall hold appropriate licenses from the Division of Marine Fisheries for the species harvested and the gear used under the Aquaculture Collection Permit.

(f) Atlantic Ocean Striped Bass Commercial Gear Permit:

(1) Application for an Atlantic Ocean Striped Bass Commercial Gear Permit must be made prior to November 1 of each year. A person shall declare one of the following gears for an initial Atlantic Ocean Striped Bass Commercial Gear Permit and at intervals of three consecutive license years thereafter:
(A) gill net;
(B) trawl; or
(C) beach seine.

For the purpose of this Rule, a beach seine is defined as a swipe net constructed of multi-filament or multi-fiber webbing fished from the ocean beach that is deployed from a vessel launched from the ocean beach where the fishing operation takes place.

Gear declarations are binding on the permittee for three consecutive license years without regard to subsequent annual permit issuance.

(2) A person is not eligible for more than one Atlantic Ocean Striped Bass Commercial Gear Permit regardless of the number of Standard Commercial Fishing Licenses, Retired Standard Commercial Fishing Licenses or assignments held by the person.
(3) The annual, nonrefundable permit fee is ten dollars ($10.00).

(g) For Hire Fishing Permit:

(1) The permittee shall hold a valid certification from the United States Coast Guard (USCG) that allows carrying six or fewer passengers or a certification from the USCG that allows carrying more than six passengers;

(2) The permittee shall provide valid documentation papers or current motor boat registration or copies thereof for the vessel engaged as for-hire. If an application for transfer of documentation is pending, a copy of the pending application and a notarized bill of sale may be submitted.

(h) Applications submitted without complete and required information shall not be processed until all required information has been submitted. Incomplete applications shall be returned to the applicant with deficiency in the application so noted.

(i) A permit shall be issued only after the application has been deemed complete by the Division of Marine Fisheries and the applicant certifies to abide by the permit general and specific conditions established under 15A NCAC 03J .0501, 03J .0505, 03K .0103, 03K .0104, 03K .0107, 03K .0206, 03K .0303, 03K .0401, 03O .0502, and 03O .0503 as applicable to the requested permit.

(j) The Fisheries Director, or his agent may evaluate the following in determining whether to issue, modify or renew a permit:

(1) Potential threats to public health or marine and estuarine resources regulated by the Marine Fisheries Commission;

(2) Applicant's demonstration of a valid justification for the permit and a showing of responsibility as determined by the Fisheries Director;

(3) Applicant's history of habitual fisheries violations evidenced by eight or more violations in 10 years.

(k) The applicant shall be notified in writing of the denial or modification of any permit request and the reasons therefore. The applicant may submit further information, or reasons why the permit should not be denied or modified.

(l) Permits are valid from the date of issuance through the expiration date printed on the permit. Unless otherwise established by rule, the Fisheries Director may establish the issuance timeframe for specific types and categories of permits based on season, calendar year, or other period based upon the nature of the activity permitted, the duration of the activity, compliance with federal or state fishery management plans or implementing rules, conflicts with other fisheries or gear usage, or seasons for the species involved. The expiration date shall be specified on the permit.

(m) To renew a permit, the permittee shall file a certification that the information in the original application is still valid, or a statement of all changes in the original application and any additional information required by the Division of Marine Fisheries.

(n) For initial or renewal permits, processing time for permits may be up to 30 days unless otherwise specified in this Chapter.

(o) It is unlawful for a permit holder to fail to notify the Division of Marine Fisheries within 30 days of a change of name or address.

(p) It is unlawful for a permit holder to fail to notify the Division of Marine Fisheries of a change of designee prior to use of the permit by that designee.

(q) Permit applications shall be available at all Division Offices.

History Note: Authority G.S. 113-134; 113-169.1; 113-169.3; 113-182; 113-210; 143B-289.52;
Temporary Adoption Eff. September 1, 2000; May 1, 2000;
Eff. April 1, 2001;
Temporary Amendment Eff. October 1, 2001;
Amended Eff. April 1, 2009; July 1, 2008; December 1, 2007; September 1, 2005; April 1, 2003; August 1, 2002.

15A NCAC 03O .0503 PERMIT CONDITIONS; SPECIFIC

(b) Dealers Permits for Monitoring Fisheries under a Quota/Allocation:

(1) During the commercial season opened by proclamation or rule for the fishery for which a Dealers Permit for Monitoring Fisheries under a Quota/Allocation permit is issued, it is unlawful for fish dealers issued such permit to fail to:

(A) Fax or send via electronic mail by noon daily, on forms provided by the Division, the previous day's landings for the permitted fishery to the dealer contact designated on the permit. Landings for Fridays or Saturdays shall be submitted on the following Monday. If the dealer is unable to fax or electronic mail the required information, the permittee shall call in the previous day's landings to the dealer contact designated on the permit but shall maintain a log furnished by the Division;

(B) Submit the required log to the Division upon request or no later than five days after the close of the season for the fishery permitted;

(C) Maintain faxes and other related documentation in accordance with 15A NCAC 03I .0114;

(D) Contact the dealer contact daily regardless of whether or not a transaction for the fishery for which a dealer is permitted occurred;

(E) Record the permanent dealer identification number on the bill of lading or receipt for each transaction or shipment from the permitted fishery.

(2) Striped Bass Dealer Permit:

(A) It is unlawful for a fish dealer to possess, buy, sell or offer for sale striped bass taken from the following areas without first obtaining a Striped Bass Dealer Permit validated for the applicable harvest area:

(i) Atlantic Ocean;

(ii) Albemarle Sound Management Area as designated in 15A NCAC 03R .0201; and

(iii) The joint and coastal fishing waters of the Central/Southern Management Area as designated in 15A NCAC 03R .0201.

(B) No permittee shall possess, buy, sell or offer for sale striped bass taken from the harvest areas opened by proclamation without having a North Carolina Division of Marine Fisheries issued valid tag for the applicable area affixed through the mouth and gill cover, or, in the case of striped bass imported from other states, a similar tag that is issued for striped bass in the state of origin. North Carolina Division of Marine Fisheries striped bass tags shall not be bought, sold, offered for sale, or transferred. Tags shall be obtained at the North Carolina Division of Marine Fisheries Offices. The Division of Marine Fisheries shall specify the quantity of tags to be issued based on historical striped bass landings. It is unlawful for the permittee to fail to surrender unused tags to the Division upon request.

(f) Aquaculture Operations/Collection Permits:

(1) It is unlawful to conduct aquaculture operations utilizing marine and estuarine resources without first securing an Aquaculture Operation Permit from the Fisheries Director.

(2) It is unlawful:

(A) To take marine and estuarine resources from coastal fishing waters for aquaculture purposes without first obtaining an Aquaculture Collection Permit from the Fisheries Director.

(B) To sell, or use for any purpose not related to North Carolina aquaculture, marine and estuarine resources taken under an Aquaculture Collection Permit.

(C) To fail to submit to the Fisheries Director an annual report due on December 1 of each year on the form provided by the Division the amount and disposition of marine and estuarine resources collected under authority of this permit.

(3) Lawfully permitted shellfish relaying activities authorized by 15A NCAC 03K .0103 and .0104 are exempt from requirements to have an Aquaculture Operation or Collection Permit issued by the Fisheries Director.

(4) Aquaculture Operations/Collection Permits shall be issued or renewed on a calendar year basis.

(5) It is unlawful to fail to provide the Division of Marine Fisheries with a listing of all designees who will be acting under an Aquaculture Collection Permit at the time of application.

(g) Scientific or Educational Collection Permit:

(1) It is unlawful for individuals or agencies seeking exemptions from license, rule, proclamation or statutory requirements to collect for scientific or educational purposes as

approved by the Division of Marine Fisheries any marine and estuarine species without first securing a Scientific or Educational Collection Permit.

(2) It is unlawful for persons who have been issued a Scientific or Educational Collection Permit to fail to submit a report on collections to the Division of Marine Fisheries due on December 1 of each year unless otherwise specified on the permit. The reports shall be filed on forms provided by the Division. Scientific or Educational Collection Permits shall be issued on a calendar year basis.

(3) It is unlawful to sell marine and estuarine species taken under a Scientific or Educational Collection Permit:

(A) without the required license(s) for such sale;

(B) to anyone other than a licensed North Carolina fish dealer; and

(C) without authorization stated on the permit for such sale.

(4) It is unlawful to fail to provide the Division of Marine Fisheries a listing of all designees who will be acting under Scientific or Educational Collection Permits at the time of application.

(5) The permittee or designees utilizing the permit shall call or fax the Division of Marine Fisheries Communications Center not later than 24 hours prior to use of the permit, specifying activities and location.

(i) Atlantic Ocean Striped Bass Commercial Gear Permit:

(1) It is unlawful to take striped bass from the Atlantic Ocean in a commercial fishing operation without first obtaining an Atlantic Ocean Striped Bass Commercial Gear Permit.

(2) It is unlawful to use a single Standard Commercial Fishing License, including assignments, to obtain more than one Atlantic Ocean Striped Bass Commercial Gear Permit during a license year.

(k) For Hire Fishing Permit:

(1) It is unlawful to operate a For Hire Vessel unless the vessel operator possesses either the For Hire Blanket Coastal Recreational Fishing License (CRFL) for the vessel as provided in 15A NCAC 03O .0112 or a Division of Marine Fisheries For Hire Fishing Permit for the vessel.

(2) It is unlawful for a For Hire vessel operator to operate under the For Hire Fishing Permit without:

(A) Holding the USCG certification required in 15A NCAC 03O .0501(g)(1);

(B) Having the For Hire Fishing Permit for the vessel or copy thereof in possession and ready at hand for inspection;

(C) Having current picture identification in possession and ready at hand for inspection.

(3) It is unlawful for the permittee to fail to notify the Division within five days of any changes to information provided on the permit.

(4) It is unlawful to fail to display a current For Hire Fishing Permit decal mounted on an exterior surface of the vessel so as to be visible when viewed from the port side while engaged in for-hire recreational fishing.

(5) The For Hire Fishing Permit is valid for one year from the date of issuance.

History Note: Authority G.S. 113-134; 113-169.1; 113-169.3; 113-182; 113-210; 143B-289.52;
Temporary Adoption Eff. September 1, 2000; August 1, 2000; May 1, 2000;
Eff. April 1, 2001;
Amended Eff. April 1, 2009; July 1, 2008; January 1, 2008; September 1, 2005; October 1, 2004; August 1, 2004; August 1, 2002.

15A NCAC 03Q .0101 SCOPE AND PURPOSE

The rules in this Section pertain to the classification of the waters of North Carolina as coastal fishing waters, inland fishing waters and joint fishing waters. These rules are adopted jointly by the Marine Fisheries Commission and the Wildlife Resources Commission. In addition to the classification of the waters of the state these joint rules set forth guidelines to determine which fishing activities in joint waters are regulated by the Marine Fisheries Commission and which are regulated by the Wildlife Resources Commission. Finally, the joint rules set forth special fishing regulations applicable in joint waters that can be enforced by officers of the Division of Marine Fisheries and the Wildlife Resources Commission. These regulations do not affect the jurisdiction of the Marine Fisheries Commission and the Wildlife Resources Commission in any matters other than those specifically set out.

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

15A NCAC 03Q .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 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 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.

15A NCAC 03Q .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.

15A NCAC 03Q .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.

15A NCAC 03Q .0108 MANAGEMENT RESPONSIBILITY FOR ESTUARINE STRIPED BASS IN JOINT WATERS

(a) The management areas for estuarine striped bass fisheries in coastal North Carolina are designated in 15A NCAC 03R .0201.

(b) In order to effectively manage the recreational hook and line harvest in joint waters of the Albemarle Sound-Roanoke River stock of striped bass, the Marine Fisheries Commission and the Wildlife Resources Commission deem it necessary to establish two management areas; the Albemarle Sound Management Area and the Roanoke River Management Area as designated in 15A NCAC 03R .0201. The Wildlife Resources Commission shall have principal management responsibility for the stock when it is in the joint and inland fishing waters of the Roanoke River Management Area. The Marine Fisheries Commission shall have principal management responsibility for the stock in the coastal, joint and inland waters of the Albemarle Sound Management Area. The annual quota for recreational harvest of the Albemarle-Roanoke striped bass stock shall be divided equally between the two management areas. Each commission shall implement management actions for recreational harvest within their respective management areas that will be consistent with the North Carolina Estuarine Striped Bass Fishery Management Plan.

History Note: Authority G.S. 113-132; 113-134; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. October 1, 2004; September 1, 1991.

15A NCAC 03Q .0109 IMPLEMENTATION OF ESTUARINE STRIPED BASS MANAGEMENT PLANS: RECREATIONAL FISHING

The Marine Fisheries and Wildlife Resources Commissions shall implement their respective striped bass management actions for recreational fishing pursuant to their respective rule-making powers. To preserve jurisdictional authority of each Commission, the following means are established through which management measures can be implemented by a single instrument in the following management areas:

(1) In the Roanoke River Management Area, the exclusive authority to open and close seasons and areas, and establish size and creel limits whether inland or joint fishing waters shall be vested in the Wildlife Resources Commission. An instrument closing any

management area in joint waters shall operate as and shall be a jointly issued instrument opening or closing seasons or areas to harvest in the Roanoke River management area.

(2) In the Albemarle Sound Management Area, the exclusive authority to open and close seasons and areas and establish size and creel limits, whether coastal or joint fishing waters shall be vested in the Marine Fisheries Commission. The season shall close by proclamation if the quota is about to be exceeded. In the Albemarle Sound Management Area administered by the Marine Fisheries Commission, a proclamation affecting the harvest in joint and coastal waters, excluding the Roanoke River Management Area, shall automatically be implemented and effective as a Wildlife Resources Commission action in the inland waters and tributaries to the waters affected.

History Note: Authority G.S. 113-132; 113-134; 113-182; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. October 1, 2004; September 1, 1991.

15A NCAC 03R .0201 STRIPED BASS MANAGEMENT AREAS

(a) The Albemarle Sound Management Area is designated as Albemarle Sound and all its joint and inland water tributaries, (except for the Roanoke, Middle, Eastmost and Cashie rivers), Currituck, Roanoke and Croatan sounds and all their joint and inland water tributaries, including Oregon Inlet, north of a line beginning at a point 35° 48 .5015'N - 75° 44 .1228'W on Roanoke Marshes Point, running southeasterly to a point 35° 44 .1710'N - 75° 31 .0520'W on the north point of Eagle Nest Bay.

(b) The Roanoke River Management Area is designated as Roanoke River and its joint and inland tributaries, including Middle, Eastmost and Cashie rivers, up to the Roanoke Rapids dam.

(c) The Central/Southern Management Area is designated as all internal coastal, and joint and contiguous inland waters south of a line beginning at a point 35° 48 .5015'N - 75° 44 .1228'W on Roanoke Marshes Point, running southeasterly to a point 35° 44 .1710'N - 75° 31 .0520'W on the north point of Eagle Nest Bay, to the South Carolina line.

History Note: Authority G.S. 113-132; 113-134; 113-182; 143B-289.52;
Eff. October 1, 2004.

4.6.3.2 Wildlife Resources Commission Rules

North Carolina Inland Fishing Waters Regulations – 15A NCAC

15A NCAC 10C .0101 SCOPE AND PURPOSE

The following rules pertain to the classification of the waters of North Carolina as coastal fishing waters, inland fishing waters and joint fishing waters. These rules are adopted jointly by the MFC and the NCWRC. In addition to the classification of the waters of the state these joint rules set forth guidelines to determine which fishing activities in joint waters are regulated by the MFC and which are regulated by the NCWRC. Finally, the joint rules set forth special fishing regulations applicable in joint waters that can be enforced by officers of the NCDMF and the NCWRC. These regulations do not affect the jurisdiction of the MFC and the NCWRC in any matters other than those specifically set out.

History Note: Authority G.S. 113-134; 113-132; 113-136;
Eff. February 1, 1976;
Amended Eff. January 1, 1977.

15A NCAC 10C .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 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 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.
Note: A private pond is a body of water arising within and lying wholly upon the lands of a single owner or a single group of joint owners or tenants in common, and from which fish cannot escape, and into which fish of legal size cannot enter from public waters at any time. This does not include any impoundment located on land owned by a public body or governmental entity.

History Note: Authority G.S. 113-134; 113-129; 113-132;
Eff. February 1, 1976;
Amended Eff. January 1, 1977.

15A NCAC 10C .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 sea trout, red drum, flounder, white perch, yellow perch, 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 marine fisheries inspectors. Regulations regarding inland game fish in coastal waters are enforced by wildlife protectors unless otherwise agreed to by the Wildlife Resources Commission.

History Note: Authority G.S. 113-129; 113-132; 113-134; 113-292;
Eff. February 1, 1976;
Amended Eff. July 1, 1991; January 1, 1977.

15A NCAC 10C .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 as stated in 15A NCAC 10C .0106.

History Note: Authority G.S. 113-132; 113-134; 113-292;
Eff. February 1, 1976;
Amended Eff. January 1, 1977.

15A NCAC 10C .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 insofar 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 regulations pertaining to any such body of water or portion thereof.

History Note: Authority G.S. 113-132; 113-134;
Eff. January 1, 1977.

15A NCAC 10C .0106 APPLICABILITY OF REGULATIONS: JOINT WATERS

(a) All coastal fishing laws and regulations administered by the Department of Environment, Health, 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 enforced 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; 113-271; 113-275; 113-292;
Eff. January 1, 1977;
Amended Eff. April 1, 1990; April 15, 1979.

15A NCAC 10C .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 10C .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 their 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; 113-138; 113-292;
Eff. January 1, 1977;
Amended Eff. July 1, 2008; May 1, 2005; August 1, 2000; July 1, 1993; November 1, 1991; January 1, 1991; August 1, 1985.

15A NCAC 10C .0108 SPECIFIC CLASSIFICATION OF WATERS
The several sounds and estuarine and tributary waters all or portions of which are specifically classified as inland, joint, or coastal fishing waters by agreement of the Marine Fisheries Commission and the Wildlife Resources Commission are listed in the regulations of the Marine Fisheries Commission under 15A NCAC 3Q .0200 and such list and classification is incorporated herein by reference, shall include any later amendments, and is made a part of this Section to the same extent as if the same were fully set forth herein.

History Note: Authority G.S. 113-129; 113-132; 113-134; 150B-14;
Eff. January 1, 1977;
Amended Eff. July 1, 1993; January 1, 1981; January 1, 1978.

15A NCAC 10C .0110 MANAGEMENT RESPONSIBILITY FOR ESTUARINE STRIPED BASS IN JOINT WATERS
(a) The management areas for estuarine striped bass fisheries in coastal North Carolina are designated in 15A NCAC 03R .0201.
(b) In order to effectively manage the recreational hook and line harvest in joint waters of the Albemarle Sound-Roanoke River stock of striped bass, the Marine Fisheries Commission and the Wildlife Resources Commission deem it necessary to establish two management areas: the Albemarle Sound Management Area and the Roanoke River Management Area as designated in 15A NCAC 03R .0201. The Wildlife Resources Commission shall have principal management responsibility for the stock when it is in the joint and inland fishing waters of the Roanoke River Management Area. The Marine Fisheries Commission shall have principal management responsibility for the stock in the coastal, joint and inland waters of the Albemarle Sound Management Area. The annual quota for recreational harvest of the Albemarle Sound-Roanoke River striped bass stock shall be divided equally between the two management areas. Each Commission shall implement management actions for recreational harvest within their respective management areas that shall be consistent with the North Carolina Estuarine Striped Bass Fishery Management Plan.

History Note: Authority G.S. 113-132; 113-134; 113-138; 113-292;
Eff. January 1, 1991;
Amended Eff. June 1, 2005.

15A NCAC 10C .0111 IMPLEMENTATION OF ESTUARINE STRIPED BASS MANAGEMENT PLANS: RECREATIONAL FISHING
The Marine Fisheries and Wildlife Resources Commissions shall implement their respective striped bass management plans for recreational fishing pursuant to their respective rulemaking powers. To preserve jurisdictional authority of each Commission, the following means are established through which management measures can be implemented by a single instrument in the following management areas:

(1) In the Roanoke River Management Area, the exclusive authority to open and close seasons and areas and establish size and creel limits, whether inland or joint fishing waters, shall be vested in the Wildlife Resources Commission. An instrument closing any management area in joint waters shall operate as a jointly issued instrument opening or closing seasons or areas to harvest in the Roanoke River Management Area.

(2) In the Albemarle Sound Management Area, the exclusive authority to open and close seasons and areas and establish size and creel limits, whether coastal or joint fishing waters shall be vested in the Marine Fisheries Commission. The season shall close by Marine Fisheries Commission proclamation if the quota is about to be exceeded. In the Albemarle Sound Management Area administered by the Marine Fisheries Commission, a proclamation affecting the harvest in joint and coastal waters, excluding the Roanoke River Management Area shall automatically be implemented and effective as a Wildlife Resources Commission action in the inland waters and tributaries to the waters affected.

History Note: Authority G.S. 113-132; 113-134; 113-138; 113-292;
Eff. January 1, 1991;
Amended Eff. June 1, 2005.

SECTION .0200 - GENERAL REGULATIONS

15A NCAC 10C .0201 IDENTIFICATION

It is unlawful to fish without having on one's person a means of identification indicating the current residence of such person.

History Note: Authority G.S. 113-134; 113-276.1;
Eff. February 1, 1976.

15A NCAC 10C .0209 TRANSPORTATION OF LIVE FISH

(a) Fish Transport: It shall be unlawful for any person, firm, or corporation to transport live freshwater nongame fishes, or live game fishes in excess of the possession limit, or fish eggs without having in possession a permit obtained from the North Carolina Wildlife Resources Commission.

(b) Fish Stocking: It shall be unlawful for any person, firm, or corporation to stock any life stage of any species of fish in the inland fishing waters of this State without having first procured a stocking permit from the North Carolina Wildlife Resources Commission.

(c) Permits for stocking fish shall be issued as follows:

(1) Application for a stocking permit shall be made on a form provided by the Commission. The applicant shall specify the purpose for the stocking, species to be stocked, the source of the stock, the number of individual specimens to be released, and the location where release is desired.

(2) Before issuing a stocking permit, the Executive Director shall review the application and determine, based on principles of wildlife management and biological science, that the proposed stocking will not:

- (A) threaten the introduction of epizootic disease or
- (B) create a danger to or an imbalance in the environment inimical to the conservation of wildlife resources.

(3) Based on the determination made in Subparagraph (2):

- (A) If the Executive Director determines that either or both conditions cannot be met under any circumstances, the application shall be denied.
- (B) If the Executive Director determines that both conditions may be met only by the introduction of fewer than the number requested, a permit only for the number that may be safely released shall be issued.
- (C) If the Executive Director determines that the number requested may be safely released, he shall issue the permit.

(4) Any stocking permit issued by the Commission may impose the following conditions or restrictions:

- (A) Location where the permitted number of fish may be stocked.
- (B) Certification that fish are free of certifiable diseases by the vendor or a laboratory qualified to make such determination.
- (C) Documentation of the date, time and location of the release.
- (D) Access by the Commission to the property where fish introductions occur to assess impacts of the introduction.
- (E) All conditions required shall be included in writing on the permit.

(5) Based on the criteria in Subparagraph (2), no permit shall be issued to stock any of the following species in the areas indicated:

SPECIES	LOCATION
Salmonids except brown, brook, and rainbow trout	Statewide
Flathead catfish	Statewide

(d) For purposes of this Rule, stocking is the introduction or attempted introduction of one or more individuals of a particular species of live fish into public waters for any purpose other than:

(1) As bait affixed to a hook and line, or

(2) A release incidental to "catch and release" fishing in an area within the same body of water where the fish was caught, or within an adjacent body of water not separated from that body by any natural or manmade obstruction to the passage of that species.

(e) The release of more than the daily creel limit, or if there is no established creel limit for the species, more than five individuals of the species, shall constitute prima facie evidence of an intentional release.

History Note: Authority G.S. 113-134; 113-135; 113-274; 113-292;
Eff. February 1, 1976;
Amended Eff. June 1, 2005.

15A NCAC 10C .0213 SNAGGING FISH

It is unlawful to take fish from any inland fishing waters by snagging. As used in this Rule, "snagging" means pulling or jerking a device equipped with one or more hooks through the water for the purpose of impaling fish thereon.

History Note: Authority G.S. 113-134; 113-292;
Eff. January 1, 1977;
Amended Eff. July 1, 1989; January 1, 1981; January 1, 1979; January 1, 1978.

15A NCAC 10C .0215 REPLACEMENT COSTS OF WILDLIFE RESOURCES - FISH

(a) Replacement Costs Distinguished. As it applies to fishes the term "replacement costs" must be distinguished from the "value" of the fish concerned. Except in cases where fish may lawfully be sold on the open market, as with commercially reared species, the monetary value of the specimens cannot be determined easily. The degree of special interest or concern in a particular species by the public, including not only anglers, but conservationists and those to whom the value of fishes is primarily aesthetic, cannot be measured in dollar amounts. The average cost per fish legally taken by anglers including travel and lodging, fishing equipment and bait, excise taxes on equipment, licenses and other fees, may fairly be estimated. This too, however, is a reflection of the value of existing fishery resources rather than a measure of the cost of their replacement. Thus, the relative value of fish species should be considered only as they may bear on the necessity or desirability of actual replacement.

(b) Factors to be Considered. The factors which should be considered in determining the replacement costs of resident species of fishes that have been taken, injured, removed, harmfully altered, damaged, or destroyed include the following:

(1) whether the species is classified as endangered or threatened;
(2) the relative frequency of occurrence of the species in the state;
(3) the extent of existing habitat suitable for the species within the state;
(4) the dependency of the species on unique habitat requirements;
(5) the cost of improving and maintaining suitable habitat for the species;
(6) the cost of capturing the species in areas of adequate populations and transplanting them to areas of suitable habitat with low populations;
(7) the cost of propagating and rearing the species in a hatchery and the cost of transporting them to areas of suitable habitat with low populations;
(8) the availability of the species and the cost of acquisition for restocking purposes;
(9) the cost of those species which, when released, have a probability of survival in the wild;
(10) the ratio between the natural life expectancy of the species and the period of its probable survival when, having been reared in a hatchery, it is released to the wild;
(11) the change in the value of money as reflected by the consumer price index.

(c) Costs of Replacement. Based on the factors listed in Paragraph (b) of this Rule, including the June, 1980, consumer price index of 247.6 percent of the 1967 base, the following fishes are listed with the estimated replacement cost:

Specie	Weight	Replacement Cost
Striped bass and	up to 5 lbs.	$25/fish
Bodie bass	5 lbs. to 10 lbs.	$20/lb.
	10 lbs. to 20 lbs.	$25/lb.
	Over 20 lbs.	$30/lb.

White bass	up to 2 lbs.	$10/fish
	Over 2 lbs.	$10/lb.
Largemouth bass	Up to 2 lbs.	$10/fish
	2 lbs. to 7 lbs.	$10/lb.
	Over 7 lbs.	$20/lb.
Smallmouth bass and other black bass	Up to 2 lbs.	$10/fish
	2 lbs. to 4 lbs.	$10/lb.
	Over 4 lbs.	$20/lb.
Walleye	Up to 2 lbs.	$10/fish
	2 lbs. to 5 lbs.	$10/lb.
	Over 5 lbs.	$20/lb.
Muskellunge	Up to 1 lb.	$30/fish
	Over 1 lb.	$30/lb.
Sunfish	All Sizes	$5/fish
Crappie	All Sizes	$10/fish
Catfish (Channel, Blue and Flathead)	Up to 1 lb.	$5/fish
	1 lb. to 20 lbs.	$5/lb.
	Over 20 lbs.	$10/lb.
Trout (Wild)	Up to 7 in.	$10/fish
	7 in. to 13 in.	$15/fish
	Over 13 in.	$30/lb.
Trout (Hatchery)	7 in. to 13 in.	$5/fish
	Over 13 in.	$10/lb.
All Other Game Fish	All Sizes	$5/fish
All Other Non-Game Fish	All Sizes	$2.50/fish

(d) Cost of Investigations. The factors to be considered and the computation of costs are as specified in 15A NCAC 10B .0117.

History Note: Authority G.S. 113-134; 113-267;
Eff. December 1, 1993.

SECTION .0300 - GAME FISH

15A NCAC 10C .0301 INLAND GAME FISHES DESIGNATED

The following fishes are classified and designated as inland game fishes:

(1) mountain trout, all species including but not limited to rainbow, brown and brook trout;
(2) muskellunge, chain (jack) and redfin pickerel;
(3) yellow perch, when found in inland waters, walleye and sauger;
(4) black bass, including largemouth, smallmouth, spotted and redeye bass;
(5) black and white crappie;
(6) sunfish, including bluegill (bream), redbreast (robin), redear (shellcracker), pumpkinseed, warmouth, rock bass, (redeye), flier, Roanoke bass, and all other species of the sunfish family (Centrarchidae) not specifically listed in this Rule;

(7) spotted sea trout (speckled trout), when found in inland fishing waters;
(8) flounder, when found in inland fishing waters;
(9) red drum (channel bass, red fish, puppy drum), when found in inland fishing waters;
(10) striped bass, white bass, white perch and Morone hybrids (striped bass-white bass), when found in inland fishing waters;
(11) American and hickory shad, when found in inland fishing waters;
(12) kokanee salmon.

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.

15A NCAC 10C .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.

15A NCAC 10C .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.

15A NCAC 10C .0305 OPEN SEASONS: CREEL AND SIZE LIMITS

(a) Generally. Subject to the exceptions listed in Paragraph (b) of this Rule, the open seasons and creel and size limits are as indicated in the following table:

DAILY

CREEL MINIMUM

GAME FISHES LIMITS SIZE LIMITS OPEN SEASON

(b) Exceptions (that apply to striped bass and their hybrids)

(1) In the Dan River upstream from its confluence with Bannister River to the Brantly Steam Plant Dam and in John H. Kerr Reservoir the creel limit on striped bass and Morone hybrids is two in the aggregate and the minimum size limit is 26 inches from October 1 through May 31. From June 1 through September 30 the daily creel limit on striped bass and Morone hybrids is four in aggregate with no minimum size limit.

(2) In the Cape Fear River upstream of Buckhorn Dam and the Deep and Haw rivers to the first impoundment and in B. Everett Jordan Reservoir the creel limit on striped bass and Morone hybrids is four in the aggregate and the minimum size limit is 20 inches. In Lake Gaston and Roanoke Rapids Reservoir the creel limit on striped bass and Morone hybrids is four in aggregate with a minimum size limit of 20 inches from October 1 through May 31 and no minimum size limit from June 1 through September 30. In Lake Norman the creel limit on striped bass and Morone hybrids is four in aggregate with a minimum size limit of 16 inches from October 1 through May 31 and no minimum size limit from June 1 through September 30.

(5) In the inland fishing waters of Neuse, Pungo and Tar Pamlico rivers and their tributaries extending upstream to the first impoundment of the main course on the river or its tributaries, and in all other inland fishing waters east of Interstate 95, subject to the exceptions listed in this Paragraph, the daily creel limit for striped bass and their hybrids is two fish in aggregate. The minimum length limit is 18 inches and no striped bass or striped bass hybrids between the lengths of 22 inches and 27 inches may be possessed. In these waters, the season for taking and possessing striped bass is closed from May 1 through September 30. In the inland fishing waters of the Cape Fear River and its tributaries, the season for taking and possessing striped bass is closed year-round. In the Pee Dee River and its tributaries from the South Carolina line upstream to Blewett Falls Dam, the season for taking and possessing striped bass and their hybrids is open year-round, the daily creel limit is three fish in aggregate and the minimum length limit is 18 inches.

(6) In the inland and joint fishing waters [as identified in 15A NCAC 10C .0107(1)(e)] of the Roanoke River Striped Bass Management Area, which includes the Roanoke, Cashie, Middle and Eastmost rivers and their tributaries, the open season for taking and possessing striped bass and their hybrids is March 1 through April 30 from the joint-coastal fishing waters boundary at Albemarle Sound upstream to Roanoke Rapids Lake dam. During the open season the daily creel limit for striped bass and their hybrids is two fish in aggregate, the minimum size limit is 18 inches. No fish between 22 inches and 27 inches in length shall be retained in the daily creel limit. Only one fish larger than 27 inches may be retained in the daily creel limit.

(11) In all impounded inland waters and their tributaries, except those waters described in Exceptions (1) and (4), the daily creel limit of striped bass and their hybrids may include not more than two fish of smaller size than the minimum size limit.

(13) In designated inland fishing waters of Roanoke Sound, Croatan Sound, Albemarle Sound, Chowan River, Currituck Sound, Alligator River, Scuppernong River, and their tributaries (excluding the Roanoke River and Cashie River and their tributaries), striped bass fishing season, size limits and creel limits are the same as those established by rules or proclamations of the Marine Fisheries Commission in adjacent joint or coastal fishing waters.

(15) The Executive Director may, by proclamation, suspend or extend the hook-and-line season for striped bass in the inland and joint waters of coastal rivers and their tributaries. It is unlawful to violate the provisions of any proclamation issued under this authority.

(16)

History Note: Authority G.S. 113-134; 113-292; 113-304; 113-305;

Eff. February 1, 1976;
Temporary Amendment Eff. May 10, 1990, for a period of 180 days to expire on November 1, 1990;
Temporary Amendment Eff. May 22, 1990, for a period of 168 days to expire on November 1, 1990;
Temporary Amendment Eff. May 1, 1991, for a period of 180 days to expire on November 1, 1991;
Amended Eff. July 1, 1994; July 1, 1993; October 1, 1992;
Temporary Amendment Eff. December 1, 1994 for a period of 180 days or until the permanent rule becomes effective, whichever is sooner;
Amended Eff. July 1, 1998; July 1, 1997; July 1, 1996; July 1, 1995;
Temporary Amendment Eff. November 1, 1998;
Amended Eff. April 1, 1999;
Temporary Amendment Eff. July 1, 1999;
Amended Eff. July 1, 2000;
Temporary Amendment Eff. July 1, 2001;
Temporary Amendment Eff. March 8, 2002 [This rule replaces the rule proposed for permanent amendment effective July 1, 2002 and approved by RRC in May 2001];
Amended Eff. August 1, 2002 (approved by RRC in April 2002);
Temporary Amendment Eff. June 1, 2003;
Amended Eff. June 1, 2004 (this amendment replaces the amendment approved by RRC on July 17, 2003);
Amended Eff. August 1, 2010; May 1, 2009; July 1, 2008; May 1, 2008; May 1, 2007; May 1, 2006; June 1, 2005.

SECTION .0500 – PRIMARY NURSERY AREAS

15A NCAC 10C .0501 SCOPE AND PURPOSE

To establish and protect those fragile inland waters which support embryonic, larval or juvenile populations of marine or estuarine fish or crustacean species. These Rules will set forth permanent nursery areas in inland fishing waters. Nursery areas are necessary for the early growth and development of virtually all of North Carolina's important marine or estuarine fish or crustacean species. Nursery areas need to be maintained, as much as possible, in their natural state, and the fish and crustacean populations within them must be permitted to develop in a normal manner with as little interference from man as possible.

History Note: Authority G.S. 113-132; 113-134;
Eff. September 1, 1990;
Amended Eff. July 1, 2000.

15A NCAC 10C .0502 PRIMARY NURSERY AREAS DEFINED

Primary nursery areas are defined as those areas inhabited by the embryonic, larval or juvenile life stages of marine or estuarine fish or crustacean species due to favorable physical, chemical or biological factors.

History Note: Authority G.S. 113-132; 113-134;
Eff. August 1, 1990;
Amended Eff. July 1, 2000.

15A NCAC 10C .0503 DESCRIPTIVE BOUNDARIES

The following waters have been designated as primary nursery areas:

(1) North River:
(a) Broad Creek Camden County Entire stream;
(b) Deep Creek Currituck County Entire stream;
(c) Lutz Creek Currituck County Entire stream.

(2) Alligator River:
(a) East Lake Dare County Inland waters portion;
(b) Little Alligator River Tyrrell County Entire stream.
(3) Currituck Sound:
(a) Martin Point Creek Dare County Entire stream (Jean Guite Creek);
(b) Tull Creek and Bay Currituck County Tull Bay to mouth of Northwest River; Tull Creek from mouth upstream to SR 1222 bridge.
(4) Pamlico River:
(a) Duck Creek Beaufort County Entire stream;
(b) Bath Creek Beaufort County Entire stream;
(c) Mixons Creek Beaufort County Entire stream;
(d) Porter Creek Beaufort County Entire stream;
(e) Tooleys Creek Beaufort County Entire stream;
(f) Jacobs Creek Beaufort County Entire stream;
(g) Jacks Creek Beaufort County Entire stream;
(h) Bond Creek Beaufort County Entire stream;
(i) Muddy Creek Beaufort County Entire stream;
(j) Strawhorn Creek Beaufort County Entire stream;
(k) South Prong Wright Creek Beaufort County Entire stream;
(l) Jordan Creek Beaufort County Entire stream.
(5) Neuse River:
(a) Slocum Creek Craven County Entire stream;
(b) Hancock Creek Craven County Entire stream.
(6) New River:
(a) French Creek Onslow County Entire stream;
(b) New River Onslow County US Highway 17 bridge to NC 24/US 258 bridge.
(7) Roanoke River: Halifax and Northampton counties - US 258 bridge to Roanoke Rapids dam.
(8) Tar-Pamlico River: Nash, Edgecombe, Pitt and Beaufort counties - N&S railroad at Washington upstream to Rocky Mount Mills Dam.
(9) Neuse River: Wake, Johnston, Wayne, Lenoir, Pitt and Craven counties - Pitchkettle Creek upstream to Milburnie Dam.
(10) Cape Fear River: Chatham, Lee, Harnett, Cumberland and Bladen counties - Lock and Dam No. 1 upstream to Buckhorn Dam.
(11) Albemarle Sound: Peter Mashoes Creek – Dare County – Entire Stream.
(12) Croatan Sound: Spencer Creek – Dare County – Entire Stream.
(13) White Oak River: Onslow and Jones counties – Grants Creek upstream to Gibson Bridge Road (SR 1118).
(14) Northeast Cape Fear River: Pender County – NC 210 bridge upstream to NC 53 bridge.

History Note: Authority G.S. 113 132; 113 134;
Eff. August 1, 1990;
Amended Eff. May 1, 2008; November 1, 2007; August 1, 2004; July 1, 2000; July 1, 1993.

SECTION .0600 - ANADROMOUS FISH SPAWNING AREAS

15A NCAC 10C .0601 SCOPE AND PURPOSE

To establish and protect those inland waters which function as spawning areas for anadromous fishes. These Rules will set forth anadromous fish spawning areas in inland fishing waters. Anadromous fish spawning areas are necessary for the spawning and early development of North Carolina's important anadromous fishes. Anadromous fish spawning areas provide the physical, biological, and chemical attributes necessary for anadromous fishes to spawn successfully.

History Note: Authority G.S. 113-132; 113-134;
Eff. May 1, 2008.

15A NCAC 10C .0602 ANADROMOUS FISH SPAWNING AREAS DEFINED

Anadromous fish spawning areas are those areas where evidence of spawning of anadromous fishes has been documented by direct observation of spawning, capture of running ripe females, or capture of eggs or early larvae.

History Note: Authority G.S. 113-132; 113-134;
Eff. May 1, 2008.

15A NCAC 10C .0603 DESCRIPTIVE BOUNDARIES

The following waters have been designated as anadromous spawning areas:

(1) Currituck Sound Area:

(a) Northwest River including designated tributaries - main stem waters west of a line beginning on the north shore at a point 36° 30.8374' N – 76° 04.8770' W; running southerly to the south shore to a point 36° 30.7061' N – 76° 04.8916' W; and south of a line beginning on the west shore at a point 36° 33.0259' N – 76° 09.1609' W; running easterly to the east shore to a point 36° 33.0292' N – 76° 08.9488' W; including the following tributary from the confluence with Northwest River in the direction indicated to the specified boundary: Moyock Run (Shingle Landing Creek) - upstream (southwest) to a line beginning on the west shore at a point 36° 31.5252' N – 76° 10.7385' W; running easterly along US 168 (Caratoke Highway) to the east shore to a point 36° 31.5140' N – 76° 10.7239 W.

(b) Tull Creek - southwest of a line beginning on the north shore at a point 36° 30.0991' N – 76° 04.8587' W; running southeasterly to the south shore to a point 36° 29.9599' N – 76° 04.7126' W; including the following tributaries from their confluence with Tull Creek to the specified boundary:

(i) Roland Creek - upstream (northwest) to a line beginning on the north shore at a point 36° 29.8274' N – 76° 08.1294' W; running southerly to the south shore to a point 36° 29.8120' N – 76° 08.1308' W; and east of a line beginning on the northwest shore of Guinea Mill Run Canal at a point 36° 28.9227' N – 76° 07.9126' W; running southerly along US 168 bridge (Caratoke Highway) to the southeast shore at a point 36° 28.9045' N – 76° 07.8956' W.

(ii) New Bridge Creek - upstream (south) to a line beginning on the northwest shore at a point 36° 28.0046' N – 76° 06.3312' W; running southeasterly along US 168 bridge (Caratoke Highway) to the southeast shore to a point 36° 27.9970' N – 76° 06.3243' W.

(iii) Cowells Creek - upstream (south) to a line beginning on the west shore at a point 36° 27.1571' N – 76° 04.5391' W; running easterly along US 168 bridge (Caratoke Highway) to the east shore to a point 36° 27.1542' N – 76° 04.5128' W.

(iv) Buckskin Creek - upstream (southeast) to a line beginning on the west shore at a point 36° 27.1925' N – 76° 04.1671' W; running easterly along US 168 bridge (Caratoke Highway) to the east shore to a point 36° 27.1989' N – 76° 04.1400' W.

(c) West Landing - north of a line beginning on the west shore at a point 36° 30.9867' N – 76° 02.5868' W; running easterly to the east shore to a point 36° 31.0045' N – 76° 02.3780' W; and west of a line beginning on the north shore at a point 36° 31.5828' N – 76° 02.2977' W; running southerly to the south shore to a point 36° 31.5618' N – 76° 02.2870' W.

(2) Albemarle Sound Area:

(a) Big Flatty Creek - west of a line beginning on the north shore at a point 36° 09.3267' N – 76° 08.2562' W; running southerly to the south shore to a point 36° 08.9730' N – 76° 08.3175' W; including the following tributaries from the confluence with Big Flatty Creek in the direction indicated to the specified boundary:

(i) Chapel Creek - upstream (northwest) to a line beginning on the north shore at a point 36° 09.6689' N – 76° 09.9595' W; running southerly along SSR 1103 (Esclip Road) to the south shore to a point 36° 09.6522' N – 76° 09.9612' W.

(ii) Mill Dam Creek - upstream (southwest) to a line beginning on the north shore at a point 36° 09.0094' N – 76° 10.1667' W; running southerly along SSR 1103 (Esclip Road) to the south shore to a point 36° 08.9931' N – 76° 10.1611'W.

(b) Salmon Creek - southwest of a line beginning on the north shore at a point 36° 00.4648' N – 76° 42.3513' W; running southeasterly to the south shore to a point 36° 00.3373' N – 76° 42.1499' W; and south of a line beginning on the west shore at a point 36° 02.4783' N – 76° 45.8164' W; running easterly to the east shore to a point 36° 02.4807' N – 76° 45.7906' W.

(c) Mackeys (Kendrick) Creek - southeast of a line beginning on the north shore at a point 35° 56.3806' N – 76° 36.4356' W; running southwesterly to the south shore to a point 35° 56.3122' N – 76° 36.4613' W; and northwest of a line beginning on the southwest shore at a point 35° 52.5564' N – 76° 37.0968' W; running northeasterly along SSR 1122 bridge (Buncombe Avenue) to the northeast shore to a point 35° 52.5470' N – 76° 37.1113' W; including the following tributary from its confluence with Mackeys Creek in the direction indicated to the specified boundary: Main Canal - upstream (southeast) to a line beginning on the southwest shore at a point 35° 52.8229' N – 76° 36.6916' W; running northeasterly along SSR 1122 (Buncombe Avenue) to the northeast shore to a point 35° 52.8390' N – 76° 36.6708' W.

(d) Deep Creek (Washington County) - west of a line beginning on the north shore at a point 35° 56.1291' N – 76° 23.1179' W; running southerly to the south shore to a point 35° 56.0744' N – 76° 23.1230' W; and east of a line beginning on the north shore at a point 35° 55.4610' N – 76° 25.3996' W; running southerly along SSR 1302 bridge (Pea Ridge Road) to the south shore to a point 35° 55.4323' N – 76° 25.3974' W; and east of line beginning on the north shore at a point 35° 55.7173' N – 76° 25.3848' W; running southerly along SSR 1302 bridge (Pea Ridge Road) to the south shore to a point 35° 55.6863' N – 76° 25.3957' W.

(e) Banton (Bunton or Maybell) Creek - south of a line beginning on the west shore at a point 35° 56.0552' N – 76° 22.0664' W; running northeasterly to the east shore to a point 35° 56.1151' N – 76° 21.8760' W; and northeast of a line beginning on the west shore at a point 35° 55.6117' N – 76° 22.2463' W; running easterly to the east shore to a point 35° 55.6128' N – 76° 22.2126' W.

(f) Tom Mann Creek - south of a line beginning on the west shore at a point 35° 58.5296' N – 75° 52.8982' W; running easterly to the east shore to a point 35° 58.5175' N – 75° 53.6851' W.

(g) Peter Mashoes Creek - west of a line beginning on the north shore at a point 35° 57.2344' N – 75° 48.3087' W; running southerly to the south shore to a point 35° 56.7805' N – 75° 48.3563' W.

(3) North River, including Indiantown Creek and other designated tributaries - main stem waters west of a line beginning on the north shore at a point 36° 18.7703' N – 75° 58.7384' W; running southerly to the south shore to a point 36° 18.4130' N – 75° 58.7228' W; and south of a line beginning on the west shore at a point 36° 21.7982' N – 76° 07.0726' W; running easterly along US 158 bridge to the east shore to a point 36° 21.8030' N – 76° 07.0612' W; including the following tributary from the confluence with North River in the direction indicated to the specified boundary: Crooked Creek - upstream (west) to a line beginning on the north shore at a point 36° 18.7171' N – 76° 01.4361' W; running southerly to the south shore to a point 36° 18.7002' N – 76° 01.4296' W.

(4) North River Area: Bump Landing Creek - east of a line beginning on the north shore at a point 36° 19.3757' N – 75° 57.9057' W; running southerly to the south shore to a point 36° 19.2496' N – 75° 57.9107' W; and west of a line beginning on the north shore at a

point 36° 19.4049' N – 75° 57.4963' W; running southeasterly to the south shore to a point 36° 19.3830' N – 75° 57.5098' W.

(a) Narrow Ridges Creek - east of a line beginning on the north shore at a point 36° 18.3249' N – 75° 57.8910' W; running southerly to the south shore to a point 36° 18.1388' N – 75° 57.9029' W; and west of a line beginning on the north shore at a point 36° 18.1566' N – 75° 57.4879' W; running southeasterly to the south shore to a point 36° 18.1221' N – 75° 57.5095' W.

(b) Great Creek - west of a line beginning on the north shore at a point 36° 18.1045' N – 75° 58.4289' W; running southerly to the south shore to a point 36° 17.9882' N – 75° 58.4458' W; and northeast of a line beginning on the north shore at a point 36° 17.1310' N – 76° 00.3414'W; running southeasterly to the south shore to a point 36° 17.1163' N – 76° 00.3310' W. On the north shore of Great Creek within the fourth tributary: south of a line beginning on the west shore at a point 36° 18.1729' N – 75° 58.9137' W; running southeasterly to the south shore to a point 36° 18.1640' N – 75° 58.9022' W.

(c) Deep Creek - east of a line beginning on the north shore at a point 36° 17.1576' N – 75° 56.7594' W; running southerly to the south shore to a point 36° 16.9846' N – 75° 56.6802' W; and south of a line beginning on the west shore at a point 36° 17.9515' N – 75° 56.5174' W; running easterly to the east shore to a point 36° 17.9523' N – 75° 56.5042' W.

(d) Public Creek - west of a line beginning on the north shore at a point 36° 17.2462' N – 75° 58.2774' W; running southerly to the south shore to a point 36° 17.2121' N – 75° 58.2788' W; and northeast of a line beginning on the north shore at a point 36° 17.1661' N – 75° 58.6059' W; running southeasterly to the south shore to a point 36° 17.1574' N – 75° 58.6003' W.

(5) Pasquotank River including designated tributaries - main stem waters north of a line beginning on the west shore at a point 36° 18.0769' N – 76° 13.0979' W; running easterly along the south side of the US 158 bridge to the east shore to a point 36° 18.0594' N – 76° 12.9620' W and south of a line at South Mills beginning on the west shore at a point 36° 26.7432' N – 76° 19.6666' W; running easterly along US 17 business (Main Street) to the east shore to a point 36° 26.7642' N – 76° 19.5932' W; and southeast of a line beginning on the northeast shore at a point 36° 26.1777' N – 76° 22.1079' W; running southwesterly to the southwest shore to a point 36° 26.1693' N – 76° 22.1257' W; including the following tributaries from their confluence with the Pasquotank River in the direction indicated to the specified boundary:

(a) Joyce Creek - upstream (northeast) to a line beginning on the north shore at a point 36° 26.8329' N – 76° 17.6174' W; running southwesterly along SSR 1224 bridge (Old Swamp Road) to the south shore to a point 36° 26.8103' N – 76° 17.6193' W.

(b) Sawyers Creek - upstream (northeast) to a line beginning on the northeast shore at a point 36° 21.7237' N – 76° 10.2841' W; running southwesterly along SSR 1203 bridge (Scotland Road) to the southwestern shore to a point 36° 21.7115' N – 76° 10.3041' W.

(c) Knobbs Creek - upstream (northwest) to a line beginning on the northwest shore at a point 36° 18.5172' N – 76° 14.5920' W; running southeasterly along SSR 1309 bridge (Main Street Extended) to the southeast shore to a point 36° 18.4973' N – 76° 14.5729' W.

(6) Pasquotank River Area:

(a) Charles Creek - south of a line beginning on the west shore at a point 36° 17.8090' N – 76° 13.0732' W; running easterly to the east shore to a point 36° 17.8024' N – 76° 13.0407' W; and northeast of a line beginning on the northwest shore at a point 36° 17.4713' N – 76° 13.2227' W; running southeasterly along NC 34 (Road Street) to the southeast shore to a point 36° 17.4565' N – 76° 13.2140' W.

(b) Areneuse Creek and Mill Dam Creek - north of a line beginning on the west shore at a point 36° 17.3133' N – 76° 08.1655' W; running southeasterly along

NC 343 bridge to the east shore to a point 36° 17.1328' N – 76° 07.6269' W; and southwest of a line beginning on the west shore of Mill Dam Creek at a point 36° 18.5994' N – 76° 07.8672' W; running southeasterly to the east shore to a point 36° 18.5991' N – 76° 07.8379' W; and southwest of a line beginning on the northwest shore of Areneuse Creek at a point 36° 18.0342' N – 76° 06.9433' W, running southeasterly along NC 343 bridge to the southeast shore to a point 36° 18.0196' N – 76° 06.9245' W.

(c) Portohonk Creek - northeast of a line beginning on the west shore at a point 36° 15.0519' N – 76° 05.2793' W; running southeasterly to the east shore to a point 36° 15.0391' N – 76° 05.2532' W; and south of a line beginning on the west shore at a point 36° 16.2809' N – 76° 04.8223' W; running easterly along NC 343 bridge to the east shore to a point 36° 16.2794' N – 76° 04.8051' W.

(d) New Begun Creek - west of a line beginning on the north shore at a point 36° 13.3298' N – 76° 08.2878' W; running southerly to the south shore to a point 36° 13.0286' N – 76° 08.1820' W; and southeast of a line beginning on the northeast shore at a point 36° 12.5577' N – 76° 10.3998' W; running southwesterly along NC 34 bridge (Weeksville Road) to the southwest shore to a point 36° 12.5467' N – 76° 10.4186' W; and northeast of a line beginning on the northeast shore at a point 36° 12.3280' N – 76° 10.4934' W; running northwesterly to the northwest shore to a point 36° 12.3067' N – 76° 10.5438' W.

(7) Little River including designated tributaries - main stem wasters northwest of a line beginning on the west shore at a point 36° 12.2950' N – 76° 17.1405' W; running southeasterly to the east shore to a point 36° 12.5237' N – 76° 16.9418' W; and south of a line beginning on the west shore at a point 36° 16.9826' N – 76° 23.1763' W; running easterly along SSR 1223 (Five Bridges Road, Perquimans County) and SSR 1303 (Cherry Glade Road, Pasquotank County) bridge to the east shore to a point 36° 16.9840' N – 76° 23.1570' W; including the following tributary from the confluence with Little River in the direction indicated to the specified boundary: Halls Creek - upstream (northeast) to a line beginning on the northwest shore at a point 36°13.2067' N – 76° 16.5769' W; running southeasterly along SSR 1140 (Halls Creek Road) to the southeast shore to a point 36° 13.1944' N – 76° 16.5523' W.

(8) Little River Area:

(a) Deep Creek - southwest of a line beginning on the north shore at a point 36° 11.0945' N – 76° 16.6717' W; running southeasterly to the south shore to a point 36° 10.7510' N – 76° 16.2258' W; and south of a line beginning on the west shore at a point 36° 10.2553' N – 76° 18.7639' W; running easterly to the east shore to a point 36° 10.2633' N – 76° 18.7267' W.

(b) Symonds Creek - northeast of a line beginning on the north shore at a point 36° 10.2898' N – 76° 14.1801' W; running southeasterly to the south shore to a point 36° 10.2042' N – 76° 14.0368' W; and south of a line beginning on the west shore at a point 36° 11.4843' N – 76° 13.7218' W; running easterly along SSR 1100 bridge (Nixonton Road) to the east shore to a point 36° 11.4839' N – 76° 13.7028' W.

(9) Perquimans River including designated tributaries - main stem waters southwest of a line beginning on the west shore at a point 36° 11.6569' N – 76° 28.0055' W; running southeasterly along the US 17 business bridge (Church Street) to the east shore to a point 36° 11.6123' N – 76° 27.9382' W; and west of a line beginning on the north shore at a point 36° 18.8942' N – 76° 31.1905' W; running southeasterly to the south shore to a point 36° 18.8723' N – 76° 31.1734' W; and south of a line beginning on the west shore at a point 36° 18.9514' N – 76° 32.6510' W; running easterly along SSR 1202 bridge (Perry Bridge Road) to the east shore to a point 36° 18.9361' N – 76° 32.6584' W; including the following tributary from the confluence with the Perquimans River in the direction indicated to the specified boundary: Goodwin Creek - upstream (west) to a line beginning on the northwest shore at a point 36° 11.2807' N – 76° 33.6243' W; running southerly along SSR 1110 bridge (Center Hill Highway) to the southeast shore to a point 36° 11.2585' N – 76° 33.5755' W; and north to a line beginning on the west shore at a

point 36° 11.0494' N – 76° 32.3409' W; running easterly along SSR 1110 bridge (Center Hill Highway) to the east shore to a point 36° 11.0383' N – 76° 32.2780' W.

(10) Perquimans River Area:

(a) Mill Creek - north of a line beginning on the west shore at a point 36° 11.9757' N – 76° 27.5752' W; running easterly to the east shore to a point 36° 11.9766' N – 76° 27.2511' W; and southwest of a line beginning on the northwest shore at a point 36° 13.2910' N – 76° 26.6778' W; running southeasterly along SSR 1214 bridge (Lake Road) to the southeast shore to a point 36° 13.2762' N – 76° 26.6580' W.

(b) Walter's Creek - southwest of a line beginning on the north shore at a point 36° 11.1305' N – 76° 27.9185' W; running southeasterly to the south shore to a point 36° 11.0224' N – 76° 27.6626' W; and northeast of a line beginning on the northeast shore at a point 36° 10.0498' N – 76° 28.4208' W; running southwesterly along US 17 to the southwest shore to a point 36° 10.0408' N – 76° 28.4354' W.

(c) Suttons Creek - north of a line beginning on the west shore at a point 36° 10.0394' N – 76° 23.7945' W; running southeasterly to the east shore to a point 36° 09.9325' N – 76° 23.5263' W; and south of a line beginning on the west shore at a point 36° 11.5101' N – 76° 23.6253' W; running easterly along SSR 1300 bridge (New Hope Road) to the east shore to a point 36° 11.5081' N – 76° 23.6060' W.

(d) Jackson (Cove) Creek - northeast of a line beginning on the north shore at a point 36° 08.4642' N – 76° 20.3324' W; running southeasterly to the east shore to a point 36° 08.4159' N – 76° 20.2890' W; and southwest of a line beginning on the northwest shore at a point 36° 08.6083' N – 76° 20.1512' W; running southeasterly to the southeast shore to a point 36° 08.6007' N – 76° 20.1312' W.

(e) Muddy Creek - northwest of a line beginning on the north shore at a point 36° 07.0381' N – 76° 17.1350' W; running southeasterly to the east shore to a point 36° 07.0218' N – 76° 17.1226' W; and south of a line beginning on the west shore at a point 36° 07.5922' N – 76° 16.8153' W; running easterly to the east shore to a point 36° 07.5933' N – 76° 16.7757' W.

(11) Yeopim River including designated tributaries - main stem waters west of a line beginning on the north shore at a point 36° 05.4526' N – 76° 27.7651' W; running southerly to the south shore to Norcum Point 36° 05.1029' N – 76° 27.7120' W; and southeast of a line beginning on the north shore at a point 36° 05.1202' N – 76° 29.5050' W; running southwesterly to a point 36° 05.0644' N – 76° 29.5586' W; and running easterly to the east shore to a point 36° 05.0571' N – 76° 29.4657' W; including the following tributaries from the confluence with Yeopim River in the direction indicated to the specified boundary:

(a) Yeopim Creek - upstream (north) to a line beginning on the west shore at a point 36° 07.4416' N – 76° 26.4833' W; running easterly along SSR 1347 (Holiday Island Road) to the east shore to a point 36° 07.4409' N – 76° 26.4667' W.

(b) Bethel Creek - upstream (north) to a line beginning on the southwest shore at a point 36° 07.1208' N – 76° 29.3581' W; running northeasterly to the northeast shore to a point 36° 07.1724' N – 76° 29.2818' W.

(c) Burnt Mill Creek - upstream (northwest) to a line beginning on the northeast shore at a point 36° 05.7727' N – 76° 32.6234' W; running southwesterly along US 17 to the southwest shore to a point 36° 05.7663' N – 76° 32.6374' W.

(d) Middleton Creek - upstream (southeast) to a line beginning on the northwest shore at a point 36° 04.2913' N – 76° 30.2613' W; running southeasterly along SSR 1100 bridge (Drummond Point Road) to the southeast shore to a point 36° 04.2813' N – 76° 30.2460' W; and northeast of a line beginning on the northwest shore at a point 36° 04.0714' N – 76° 29.5779' W; running southeasterly along SSR 1100 (Drummond Point Road) to the southeast shore to a point 36° 04.0639' N – 76° 29.5583' W.

(12) Edenton Bay Area:

(a) Pembroke Creek (Pollock Swamp) - northwest of a line beginning on the west shore at a point 36° 03.2819' N – 76° 37.0138' W; running northeasterly to the east shore to a point 36° 03.4185' N – 76° 36.6783' W; and west of a line beginning on the north shore at a point 36° 08.1216' N – 76° 37.7846' W; running southerly along SSR 1316 bridge (Greenhall Road) to the south shore to a point 36° 08.1035' N – 76° 37.7818' W.

(b) Queen Anne Creek - east of a line beginning on the north shore at a point 36° 03.3757' N – 76° 36.3629' W; running southerly to the south shore to a point 36° 03.3551' N – 76° 36.3574' W; and southwest of a line beginning on the northwest shore at a point 36° 03.5719' N – 76° 35.0968' W; running southeasterly along NC 32 bridge (Yeopim Road) to the southeast shore to a point 36° 03.5659' N – 76° 35.0796' W.

(13) Chowan River Area:

(a) Buckhorn Creek (Hertford County) - north of a line beginning on the west shore at a point 36° 31.9519' N – 76° 55.2580' W; running easterly to the east shore to a point 36° 31.9628' N – 76° 55.2429' W; and east of a line beginning on the north shore at a point 36° 31.9443' N – 76° 55.8902' W; running southerly to the south shore to a point 36° 31.9099' N – 76° 55.8904' W.

(b) Somerton Creek - north of a line beginning on the west shore at a point 36° 31.7177' N – 76° 54.8327' W; running easterly to the east shore to a point 36° 31.7143' N – 76° 54.7810' W; and south of the NC/VA state line.

(c) Meherrin River Area:

(i) Vaughan's Creek (Kirby's Creek) - west of a line beginning on the north shore at a point 36° 28.3541' N – 77° 05.6259' W; running southerly to the south shore to a point 36° 28.3307' N – 77° 05.6369' W; and east of a line beginning on the north shore at a point 36° 28.7019' N – 77° 08.7566' W; running southerly along SSR 1362 bridge (Watson Mill Road) to the south shore to a point 36° 28.6834' N – 77° 08.7593' W; and northeast of a line beginning on the northwest shore at a point 36° 28.0921' N – 77° 08.5719' W; running southeasterly along SSR 1362 bridge (Watson Mill Road) to the southeast shore to a point 36° 28.0787' N – 77° 08.5557' W. Turkey Creek - from the confluence with Vaughan's Creek upstream; and northeast of a line beginning on the northwest shore at a point 36° 27.8047' N – 77° 07.7316' W; running southeasterly along SSR 1363 (Turkey Branch Road, Northampton County) and SSR 1300 bridge (Wise Store Road, Hertford County) to the southeast shore to a point 36° 27.7957' N – 77° 07.7170' W.

(ii) Potecasi Creek - southwest of a line beginning on the west shore at a point 36° 26.1234' N – 76° 57.5262' W; running southeasterly to the east shore to a point 36° 26.1005' N – 76° 57.4960' W; and east of a line beginning on the north shore at a point 36° 22.1250' N – 77° 05.3109' W; running southerly along SSR 1160 bridge (Spring Avenue) to the south shore to a point 36° 22.1035' N – 77° 05.3220' W.

(A) Old Tree Swamp - from the confluence with Potecasi Creek upstream to a line beginning on the west shore at a point 36° 22.5909' N – 77° 04.0382' W; running easterly along SSR 1167 bridge (Beaver Dam Road) to the east shore to a point 36° 22.5895' N – 77° 04.0192' W.

(B) Cutawhiskie Creek - from the confluence with Potecasi Creek upstream to a line beginning on the northwest shore at a point 36° 21.2751' N – 77° 04.3761' W; running southeasterly along SSR 1137 bridge (Liverman Mill Road) to the southeast shore to a point 36° 21.2583' N - 77° 04.3461' W.

(d) Mud Creek - north of a line beginning on the west shore at a point 36° 23.5134' N – 76° 53.9131' W; running easterly to the east shore to a point 36° 23.5132' N – 76° 53.8815' W; and east of a line beginning on the north shore at a point 36°

23.6287' N – 76° 53.8782' W; running southerly to the south shore to a point 36° 23.5943' N – 76° 53.8784' W.

(e) Catherine Creek (Hertford County) - south of a line beginning on the west shore at a point 36° 22.9579' N – 76° 53.1994' W; running southeasterly to the east shore to a point 36° 22.9456' N – 76° 53.1742' W; and north of a line beginning on the west shore at a point 36° 22.7142' N – 76° 53.1872' W; running easterly to the east shore to a point 36° 22.7209' N – 76° 53.1631' W.

(f) Buckhorn Creek (Run Off Swamp) (Gates County) - north of a line beginning on the west shore at a point 36° 22.9682' N – 76° 51.9172' W; running easterly to the east shore to a point 36° 22.9614' N – 76° 51.8870' W; and east of a line beginning on the north shore at a point 36° 23.3321' N – 76° 52.0233' W; running southerly to the south shore to a point 36° 23.3101' N – 76° 52.0244' W.

(g) Spikes Creek - northwest of a line beginning on the west shore at a point 36° 22.6515' N – 76° 50.8882' W; running northeasterly to the east shore to a point 36° 22.6684' N – 76° 50.8493' W; and east of a line beginning on the north shore at a point 36° 22.9574' N – 76°51.4953' W; running southerly to the south shore to a point 36° 22.9419' N – 76° 51.4959' W.

(h) Barnes Creek - north of a line beginning on the west shore at a point 36° 21.8820' N – 76° 48.6419' W; running easterly to the east shore to a point 36° 21.8978' N – 76° 48.5902' W; and east of a line beginning on the north shore at a point 36° 22.8208' N – 76° 50.0931' W; running southerly to the south shore to a point 36° 22.7839' N – 76° 50.0941' W.

(i) Shingle (Island) Creek - north of a line beginning on the north shore of the western most entrance into Chowan River at a point 36° 21.8449' N – 76° 48.0940' W; running southeasterly to the south shore to a point 36° 21.7831' N – 76° 48.0427' W. At the eastern most entrance to the creek: north of a line beginning of the west shore at a point 36° 21.8469' N – 76° 47.2668' W; running northeasterly to the east shore to a point 36° 21.9062' N – 76° 47.1862' W.

(j) Sarem Creek - east of a line beginning on the north shore at a point 36° 21.7259' N – 76° 46.4085' W; running southerly to the south shore to a point 36° 21.6748' N – 76° 46.4392' W; and southeast of a line beginning on the southwest shore at a point 36° 25.0514' N – 76° 49.4791' W; running northeasterly along SSR 1118 bridge (Taylors Road) to the northeast shore to a point 36° 25.0710' N – 76° 49.4657' W; including the following tributary from the confluence with Sarem Creek in the direction indicated to the specified boundary: Cole Creek - upstream (northeast) to a line beginning on the west shore at a point 36° 24.5075' N – 76° 47.0641' W; running easterly along NC 37 bridge to the east shore to a point 36° 24.5048' N – 76° 47.0397' W.

(k) Hodges Creek - west of a line beginning on the north shore at a point 36° 21.2459' N – 76° 46.3421' W; running southerly to the south shore to a point 36° 21.1823' N – 76° 46.3243' W; and east of a line beginning on the north shore at a point 36° 21.1597' N – 76° 46.6073' W; running southerly to the south shore to a point 36° 21.1309' N – 76° 46.6084' W.

(l) Wiccacon River including designated tributaries - west of a line beginning on the north shore at a point 36° 20.5439' N – 76° 45.4550' W; running southeasterly to the south shore to a point 36° 20.4684' N – 76° 45.3392' W; and east of a line beginning on the northeast shore at a point 36° 19.0196' N – 76° 53.5596' W; running southwesterly to the southwest shore to a point 36° 18.9936' N – 76° 53.5751' W; including the following tributaries from their confluence with Wiccacon River in the direction indicated to the specified boundary:

(i) Ahoskie Creek - upstream (south) to a line beginning on the west shore at a point 36° 16.4860' N – 76° 54.1172' W; running easterly along NC 561 to the east shore to a point 36° 16.4796' N – 76° 54.0933' W.

(ii) Chinkapin Creek - upstream (southwest) to a line beginning on the northwest shore at a point 36° 15.1763' N – 76° 50.9758' W; running southeasterly along SSR 1432 bridge (Big Mill Road) to the southeast shore to a point 36° 15.1671' N – 76° 50.9567' W.

(m) Beef Creek - north of a line beginning on the west shore at a point 36° 20.3235' N – 76° 44.6401' W; running easterly to the east shore to a point 36° 20.3070' N – 76° 44.5797' W; and east of a line beginning on the north shore at a point 36° 20.9720' N – 76° 44.7930' W; running southerly to the south shore to a point 36° 21.0058' N – 76° 44.7931' W.

(n) Goose Creek - west of a line beginning on the north shore at a point 36° 19.5838' N – 76° 44.5971' W; running southerly to the south shore to a point 36° 19.5375' N – 76° 44.5925' W; and northeast of a line beginning on the west shore at a point 36° 19.9806' N – 76° 45.2656' W; running easterly to the east shore to a point 36° 19.9799' N – 76° 45.2356' W.

(o) Swain Mill (Taylor Pond) Creek - west of a line beginning on the north shore at a point 36° 18.5808' N – 76° 43.4729' W; running southerly to the south shore to a point 36° 18.5616' N – 76° 43.4706' W; and northeast of a line beginning on the northwest shore at a point 36° 18.5029' N – 76° 43.5882' W; running southeasterly along SSR 1441 bridge (Swain Mill Road) to the southeast shore to a point 36° 18.4906' N – 76° 43.5694' W.

(p) Bennetts Creek - north of a line beginning on the west shore at a point 36° 18.3499' N – 76° 42.0286' W; running northeasterly to the east shore to a point 36° 18.4057' N – 76° 41.6986' W; and southwest of a line beginning on the northwest shore at a point 36° 25.9349' N – 76° 41.9859' W; running southeasterly along the Merchants Mill Pond Dam to the southeast shore to a point 36° 25.9154' N – 76° 41.9530' W.

(q) Catherine Creek including designated tributaries -main stem waters northeast of a line beginning on the west shore at a point 36° 18.1011' N – 76° 41.1286' W; running southeasterly to the east shore to a point 36° 17.9413' N – 76° 40.8627' W; including the following tributaries from the confluence with Catherine Creek in the direction indicated to the specified boundary:

  (i) Trotman Creek - upstream (northwest) to a line beginning on the north shore at a point 36° 20.8213' N – 76° 38.1714' W; running southerly along NC 32 bridge to the south shore to a point 36° 20.7989' N – 76° 38.1646' W.

  (ii) Warwick Creek - upstream (northeast) to a line beginning on the north shore at a point 36° 19.8212' N – 76° 38.0409' W; running southerly along NC 32 bridge to the south shore to a point 36° 19.7833' N – 76° 38.0235' W.

(r) Stumpy Creek - east of a line beginning on the north shore at a point 36° 16.6440' N – 76° 40.4251' W; running southerly to the south shore to a point 36° 16.6255' N – 76° 40.4196' W; and west of a line beginning on the north shore at a point 36° 16.7331' N – 76° 39.9154' W; running southerly along SSR 1232 bridge (Cannon Ferry Road) to the south shore to a point 36° 16.7220' N – 76° 39.9220' W.

(s) Dillard (Indian) Creek - east of a line beginning on the north shore at a point 36° 14.2234' N – 76° 41.5901' W; running southerly to the south shore to a point 36° 14.2023' N – 76° 41.5855' W; and west of a line beginning on the north shore at a point 36° 13.7727' N – 76° 40.3878' W; running southerly along SSR 1226 (Dillards Mill Road) to the south shore to a point 36° 13.7592' N – 76° 40.3875' W.

(t) Keel (Currituck) Creek - north of a line beginning on the west shore at a point 36° 14.1245' N – 76° 44.1961' W; running easterly to the east shore to a point 36° 14.0899' N – 76° 43.8533' W; and south of a line beginning on the west shore at a point 36° 15.2755' N – 76° 43.5077' W; running easterly to the east shore to a point 36° 15.2746' N – 76° 43.4750' W.

(u) Rocky Hock Creek - east of a line beginning on the west shore at a point 36° 06.5662' N – 76° 41.3108' W; running southeasterly to the east shore to a point

36° 06.6406' N – 76° 41.4512' W; and southwest of a line beginning on the northwest shore at a point 36° 08.3485' N – 76° 39.9790' W; running southeasterly along the face of Bennett Mill Pond Dam to the southeast shore to a point 36° 08.3353' N – 76° 39.9603' W.

(14) Cashie River including designated tributaries - main stem waters west of a line beginning on the north shore at a point 35° 54.7865' N – 76° 49.0521' W; running southerly to the south shore to a point 35° 54.6691' N – 76° 49.0553' W; and east of a line beginning on the north shore at a point 36° 05.7521' N – 77° 04.0494' W; running southerly along SSR 1260 bridge (Republican Road) to the south shore to a point 36° 05.7171' N – 77° 04.0344' W; including the following tributaries from their confluence with Cashie River in the direction indicated to the specified boundary:

(a) Connarista Swamp - upstream (north) to a line beginning on the west shore at a point 36° 06.4489' N – 77° 02.4658' W; running easterly along SSR 1221 bridge (Charles Taylor Road) to the east shore to a point 36° 06.4501' N – 77° 02.4236' W.

(b) Whiteoak Swamp - upstream (northeast) to a line beginning on the northwest shore at a point 36° 04.6654' N – 76° 58.5841' W; running southeasterly along US 13 to the southeast shore to a point 36° 04.6480' N – 76° 58.5676' W.

(c) Chiska Creek - upstream (west) to a line beginning on the north shore at a point 36° 02.5659' N – 77° 02.3636' W; running southerly along SSR 1112 bridge (Roquist Pocosin Road) to the south shore to a point 36° 02.5463' N – 77° 02.3730' W.

(d) Hoggard Mill Creek - upstream (north) to a line beginning on the northwest shore at a point 36° 01.5828' N – 76° 56.9799' W; running southeasterly along the Hoggard Mill Pond Dam to the southeast shore to a point 36° 01.5479' N – 76° 56.9556' W.

(e) Roquist Creek - upstream (west) to a line beginning on the northeast shore at a point 36° 00.6453' N – 77° 02.8441' W; running southwesterly along SSR 1112 bridge (Roquist Pocosin Road) to the southwest shore to a point 36° 00.6119' N – 77° 02.8719' W.

(f) Wading Place Creek - upstream (east) to a line beginning on the west shore at a point 35° 58.1755' N – 76° 53.0010' W; running easterly along NC 308 bridge (Cooper Hill Road) to the east shore to a point 35° 58.1631' N – 76° 52.9542' W.

(15) Cashie River Area:

(a) Broad Creek - south of a line beginning on the west shore at a point 35° 55.0568' N – 76° 45.2632' W; running easterly to the east shore to a point 35° 55.0543' N – 76° 45.1309' W.

(b) Grennel Creek - east of a line beginning on the north shore at a point 35°55.3147' N – 76° 44.5010' W; running southerly to the south shore to a point 35° 55.2262' N – 76° 44.5495' W.

(c) Cashoke Creek - west of a line beginning on the north shore at a point 35° 56.2934' N – 76° 44.1769' W; running southwesterly to the south shore to a point 35° 56.2623' N – 76° 44.1993' W; and east of a line beginning on the north shore at a point 35° 56.3383' N – 76° 44.5958' W; running southerly along NC 45 bridge to the south shore to a point 35° 56.2839' N – 76° 44.5836' W.

(16) Roanoke River including designated tributaries - main stem waters northwest of a line beginning on the west shore at a point 36° 12.5264' N – 77° 23.0223' W; running northeasterly along the south side of the US 258 bridge to the east shore to a point 36° 12.5674' N – 77° 22.9724' W; to the base of the Roanoke Rapids Dam; including the following tributary from the confluence with Roanoke River in the direction indicated to the specified boundary: Bridgers Creek - upstream (northeast) to a line beginning on the west shore at a point 36° 15.0786' N – 77° 22.3766' W; running easterly to the east shore to a point 36° 15.0846' N – 77° 22.3083' W.

(17) Roanoke River Area:

(a) Kehukee Swamp - west of a line beginning on the north shore at a point 36° 05.1942' N – 77° 18.9596' W; running southwesterly to the south shore to a point

36° 05.1670' N – 77° 18.9761' W; and south of a line beginning on the northeast shore at a point 36° 05.7019' N – 77° 19.3686' W; running southwesterly to the southwest shore to a point 36° 05.6909' N – 77° 19.3902' W.

(b) Wire Gut - north of a line beginning on the west shore at a point 36° 00.9580' N – 77° 13.0755' W; running easterly to the east shore to a point 36° 00.9542' N – 77° 13.0320' W; and east of a line beginning on the north shore at a point 36° 01.4294' N – 77° 13.6239' W; running southerly to the south shore to a point 36° 01.3873' N – 77° 13.6270' W.

(c) Apple Tree Creek - east of a line beginning on the north shore at a point 36° 00.4174' N – 77° 12.3252' W; running southeasterly to the south shore to a point 36° 00.3987' N – 77° 12.3088' W; and south of a line beginning on the west shore at a point 36° 02.3508' N – 77° 13.6900' W; running easterly to the east shore to a point 36° 02.3497' N – 77° 13.6055' W; and east of a line beginning on the north shore at a point 36° 01.9425' N – 77° 12.4225' W; running southerly to the south shore to a point 36° 01.9066' N – 77° 12.4222' W.

(d) Indian Creek - east of a line beginning on the north shore at a point 35° 59.0794' N – 77° 11.4926' W; running southerly to the south shore to a point 35° 59.0597' N – 77° 11.4967' W; and southwest of a line beginning on the northwest shore at a point 36° 03.5103' N – 77° 10.6537' W; running southeasterly along SSR 1108 bridge (Indian Woods Road) to the southeast shore to a point 36° 03.4917' N – 77° 10.6402' W; and west of a line beginning on the north shore at a point 36° 02.3940' N – 77° 09.3722' W; running southerly along SSR 1108 bridge (Indian Woods Road) to the south shore to a point 36° 02.3787' N – 77° 09.3711' W.

(e) Prices Gut - west of a line beginning on the north shore at a point 35° 57.3701' N – 77° 11.9815' W; running southerly to the south shore to a point 35° 57.3552' N – 77° 11.9796' W; and east of a line beginning on the north shore at a point 35° 57.4077' N – 77° 12.0401' W; running southerly to the south shore to a point 35° 57.3763' N – 77° 12.0135' W.

(f) Rainbow Gut - south of a line beginning on the west shore at a point 35° 55.9334' N – 77° 11.3246' W; running easterly to the east shore to a point 35° 55.9275' N – 77° 11.3136' W.

(g) Coniott Creek including designated tributaries - main stem waters west of a line beginning on the north shore at a point 35° 56.6562' N – 77° 04.2860' W; running southwesterly to the south shore to a point 35° 56.6397' N – 77° 04.3066' W; and southeast of a line beginning on the northeast shore at a point 35° 59.4139' N – 77° 08.2158' W; running southwesterly along SSR 1122 bridge (Broad Neck Road) to the southwest shore to a point 35° 59.3976' N – 77° 08.2491' W; including the following tributary from the confluence with Coniott Creek in the direction indicated to the specified boundary: Frog Level Swamp - upstream to a line beginning on the north shore at a point 35° 58.0087' N – 77° 06.3447' W; running southerly to the south shore to a point 35° 57.9223' N – 77° 06.3483' W.

(h) Conoho Creek - north of a line beginning on the west shore at a point 35° 52.5439' N – 77° 02.6673' W; running easterly to the east shore to a point 35° 52.5407' N – 77° 02.6280' W; and southeast of a line beginning on the northeast shore at a point 35° 58.3271' N – 77° 17.6825' W; running southwesterly along NC 11 bridge to the southwest shore to a point 35° 58.3096' N – 77° 17.7006' W.

(i) Sweetwater Creek including designated tributaries - main stem east of a line beginning on the west shore at a point 35° 51.6464' N – 77° 00.5090' W; running southeasterly to the east shore to a point 35° 51.6252' N – 77° 00.4879' W; and northwest of a line beginning on the northeast shore at a point 35° 48.6186' N – 77° 02.0173' W; running southwesterly along SSR 1501 bridge (Big Mill Road) to the southwest shore to a point 35° 48.5968' N – 77° 02.0311' W; including the following tributary from the confluence with Sweetwater Creek in the direction indicated to the specified boundary: Peter Swamp - upstream (southeast) to a line beginning on the west shore at a point 35° 49.0798' N – 77° 00.2510' W; running easterly to the east shore to a point 35° 49.0705' N – 77° 00.2118' W.

(j) Unnamed Tributary (upstream of Old Mill Creek) - northwest of a line beginning on the northeast shore at a point 35° 53.9775' N – 76° 56.6431' W; running southwesterly to the southwest shore to a point 35° 53.9913' N – 76° 56.6238' W; and southeast of a line beginning on the northeast shore at a point 35° 54.1143' N – 76° 56.8761' W; running southwesterly along SSR 1542 bridge (Bertie County) to the southwest shore to a point 35° 54.0927' N – 76° 56.8956' W.

(k) Old Mill Creek - north of a line beginning on the west shore at a point 35° 53.9483' N – 76° 55.3921' W; running southeasterly to the east shore to a point 35° 53.9378' N – 76° 55.3710' W; and south of a line beginning on the west shore at a point 35° 54.3010' N – 76° 55.0492' W; running easterly along SSR 1518 bridge (Bertie County) to the east shore to a point 35° 54.3085' N – 76° 55.0164' W.

(l) Gardner Creek - south of a line beginning on the west shore at a point 35°50.1599' N – 76° 56.0211' W; running easterly to the east shore to a point 35° 50.1633' N – 76° 55.9899' W; and north of a line beginning on the west shore at a point 35° 48.4791' N – 76° 55.9768' W; running easterly to the east shore to a point 35° 48.4834' N – 76° 55.9378' W.

(m) Cut Cypress Creek - northeast of a line beginning on the north shore at a point 35° 51.9465' N – 76° 53.5762' W; running southeasterly to the south shore to a point 35° 51.9229' N – 76° 53.5556' W.

(n) Roses Creek - southeast of a line beginning on the north shore at a point 35° 50.1683' N – 76° 50.9664' W; running southwesterly to the south shore to a point 35° 50.1363' N – 76° 56.9907' W; and north of a line beginning on the west shore at a point 35° 49.5501' N – 76° 50.7358' W; running easterly to the east shore to a point 35° 49.5649' N – 76° 50.6674' W.

(o) Broad Creek - west of a line beginning on the north shore at a point 35° 52.5191' N – 76° 50.4235' W; running southerly to the south shore to a point 35° 52.4262' N – 76° 50.3791' W.

(p) Welch Creek - south of a line beginning on the west shore at a point 35° 51.8458' N – 76° 45.8381' W; running easterly along the shoreline and across the mouths of the three creek entrances to the east shore to a point 35° 51.8840' N – 76° 45.6207' W; and north of a line beginning on the west shore at a point 35° 49.7473' N – 76° 47.1058' W; running easterly to the east shore to a point 35° 49.7506' N – 76° 47.0778' W.

(q) Conaby Creek - south of a line beginning on the west shore at a point 35° 55.3779' N – 76° 42.4401' W; and running easterly to the east shore to a point 35° 55.3752' N – 76° 42.3408' W; north of a line beginning on the southwest shore at a point 35° 51.6443' N – 76° 44.5188' W; running northeasterly to the northeast shore to a point 35° 51.6538' N – 76° 44.4926' W.

(18) Scuppernong River including designated tributaries - main stem waters south of a line beginning on the west shore at a point 35° 54.0158' N – 76° 15.4605' W; running easterly to the east shore to a point 35° 54.0406' N – 76° 15.3007' W; and east of a line beginning on the north shore at a point 35° 51.6231' N – 76° 26.1210' W; running southerly to the south shore to a point 35° 51.5952' N – 76° 26.1178' W; including the following tributaries from their confluence with Scuppernong River in the direction indicated to the specified boundary:

(a) First Creek (Rider's Creek) - upstream (south) to a line beginning on the north shore at a point 35° 53.5116' N – 76° 14.0222' W; running southerly along NC 94 bridge to the south shore to a point 35° 53.4948' N – 76° 14.0125' W.

(b) Second Creek - upstream (south) to a line beginning on the north shore at a point 35° 53.0541' N – 76° 15.1132' W; running southerly along SSR 1105 (Bodwell Road) to the south shore to a point 35° 53.0286' N – 76° 15.1211' W.

(c) Lake Phelps - all waters of Lake Phelps and the following main canals connecting to Scuppernong River:

(i) Moccasin Canal;

(ii) Western (Enoch) Canal;

(iii) Mountain Canal;
(iv) Thirty-foot Canal;
(v) Somerset (Old) Canal;
(vi) Batava (Minerva, Magnolia, Bonarva) Canal; and
(vii) Bee Tree Canal.

(19) Alligator River Area:

(a) Little Alligator River - west of a line beginning on the north shore at a point 35° 56.7640' N – 76° 01.0299' W; running southerly to the south shore to a point 35° 55.9362' N – 76° 01.2492' W; and north of a line beginning on the west shore at a point 35° 56.4784' N – 76° 07.5433' W; running easterly to the east shore to a point 35° 56.4771' N – 76° 07.5076' W.

(b) East Lake - east of a line beginning on the north shore at a point 35° 56.1676' N – 75° 55.2603' W; running southerly to the south shore to a point 35° 55.4727' N – 75° 55.5043' W; and south of a line beginning on the west shore at a point 35° 58.6402' N – 75° 52.1855' W; running easterly to the east shore to a point 35° 58.5887' N – 75° 51.7080' W.

(c) Second Creek - west of a line beginning on the north shore at a point 35° 51.7616' N – 76° 03.5105' W; running southerly to the south shore to a point 35° 51.1317' N – 76° 03.8003' W.

(d) Milltail Creek - east of a line beginning on the north shore at a point 35° 50.5192' N – 75° 58.6134' W; running southerly to the south shore to a point 35° 50.4956' N – 75° 58.6158' W; and northwest of a line beginning on the northeast shore at a point 35° 47.7377' N – 75° 53.1295' W; running southwesterly to the southwest shore to a point 35° 47.7180' N – 75° 53.1295' W.

(e) Whipping Creek and Lake - east of a line beginning on the north shore at a point 35° 41.3930' N – 76° 00.2481' W; running southerly to the south shore to a point 35° 41.3717' N – 76° 00.2554' W; and west of a line beginning on the north shore at a point 35° 42.1737' N – 75° 57.6728' W; running southerly to the south shore to a point 35° 42.1570' N – 75° 57.6732' W.

(f) Swan Creek and Lake - east of a line beginning on the north shore at a point 35° 40.2674' N – 76° 00.7360' W; running southerly to the south shore to a point 35° 40.2420' N – 76° 00.7548' W.

(20) Alligator River including designated tributary - main stem waters west of a line beginning on the north shore at Cherry Ridge Landing at a point 35° 42.2172' N – 76° 08.4686' W; running southerly to the south shore to a point 35° 42.1327' N – 76° 08.5002' W; and east of a line beginning on the north shore at a point 35° 36.0502' N – 76° 13.9734' W; running southerly along NC 94 to the south shore to a point 35° 36.0300' N – 76° 13.9779' W; including the following tributary from the confluence with Alligator River in the direction indicated to the specified boundary: Northwest Fork - upstream (north) to a line beginning on the north shore at a point 35° 43.6826' N – 76° 11.9538' W; running southerly to the south shore to a point 35° 43.6495' N – 76° 11.9692' W.

(21) Croatan Sound Area:

(a) Spencer Creek - west of a line beginning on the north shore at a point 35° 51.4205' N – 75° 45.0645' W; running southerly to the south shore to a point 35° 51.3876' N – 75° 45.0640' W; and west of a line beginning on the north shore 35° 51.5597' N – 75° 45.0141' W; running southerly to the south shore to a point 35° 51.4624' N – 75° 45.0498' W; and west of a line beginning on the north shore at a point 35° 51.6783' N – 75° 44.9125' W; running southerly to the south shore to a point 35° 51.5693' N – 75° 45.0109' W; and east of a line beginning on the north shore at a point 35° 52.5133' N – 75° 46.3070' W; running southerly to the south shore to a point 35° 52.4635' N – 75° 46.3110' W.

(b) Callaghan Creek - west of a line beginning on the north shore at a point 35° 51.1312' N – 75° 45.1327' W; running southwesterly to the south shore to a point 35° 51.0953' N – 75° 45.1629' W; and east of a line beginning on the north shore at a point 35° 50.0643' N – 75° 46.6041' W; running southerly to the south shore to a point 35° 50.0306' N – 75° 46.6034' W.

(22) Pamlico River Area:

(a) Chocowinity Creek - south of a line beginning on the west shore at a point 35° 30.4778' N – 77° 04.4049' W; running southerly to the east shore at a point 35° 30.4692' N – 77° 04.3862' W; and north of a line beginning on the west shore at a point 35° 28.3423' N – 77° 05.0615' W; running easterly to the east shore at a point 35° 28.3413' N – 77° 05.0334' W.

(b) Blounts Creek - south of a line beginning on the west shore at a point 35° 23.9524' N – 76° 58.0357' W; running easterly to the east shore at a point 35° 23.9565' N – 76° 57.9576' W; and north of a line beginning on the west shore at a point 35° 22.3210' N – 76° 57.7210' W; running easterly along NC 33 to the east shore at a point 35° 22.3080' N – 76° 57.6706' W; on Nancy Run, north of a line beginning on the west shore at a point 35° 22.7132' N – 76° 59.0317' W; running easterly along NC 33 to the east shore at a point 35° 22.7064' N – 76° 59.0191' W; on Herring Run, north and west of a line beginning on the north shore at a point 35° 22.5435' N – 76° 56.9969' W; running southerly along SSR 1100 (Core Point Road) to the south shore at a point 35° 22.5168' N – 76° 57.0063' W.

(c) Durham Creek - south of a line beginning on the west shore at a point 35° 21.5669' N – 76° 51.9166' W; running easterly along the SSR 1955 bridge (Durham Creek Lane) to the east shore at a point 35° 21.5721' N – 76° 51.8621' W and north of a line beginning on the west shore at a point 35° 19.1959' N – 76° 52.3278' W; running southeasterly along NC 33 to the east shore at a point 35° 19.1802' N – 76° 52.2947' W.

(d) Little Goose Creek - north and east of a line beginning on the north shore at a point 35° 28.7258' N – 76° 55.8667' W; running southeasterly to the south shore at a point 35° 28.5986' N – 76° 55.7922' W and west of a line beginning on the north shore at a point 35° 29.0329' N – 76° 54.2344' W; running southeasterly along SSR 1334 (Camp Leach Road) to the south shore at a point 35° 29.0283' N – 76° 54.2228' W; and the unnamed northwest branch, south of a line beginning on the north shore at a point 35° 29.4589' N – 76° 55.0263' W; running southwesterly to the south shore at a point 35° 29.4492' N – 76° 55.0322' W.

(e) Broad Creek - north of a line beginning on the west shore at a point 35° 30.0451' N – 76° 57.6152' W; running easterly to the east shore at a point 35° 30.0459' N – 76° 57.5318' W and south of a line beginning on the west shore at a point 35° 32.1646' N – 76° 58.5193' W; running easterly along US 264 to the east shore at a point 35° 32.1588' N – 76° 58.5048' W.

(f) Runyon Creek - north of a line beginning on the west shore at a point 35° 32.1615' N – 77° 02.3606' W; running easterly along the NC 32 bridge (Park Drive) to the east shore at a point 35° 32.1340' N – 77° 02.3438' W and south of a line beginning on the north shore at a point 35° 33.0407' N – 77° 01.1497' W; running southeasterly to the south shore at a point 35° 33.0260' N – 77° 01.1449' W.

(23) Tar River including designated tributaries - main stem waters west of a line beginning on the north shore at a point 35° 33.1993' N – 77° 05.3977' W; running southerly to the south shore at a point 35° 32.9978' N – 77° 05.1529' W and east of a line beginning on the north shore at a point 35° 57.6505' N – 77° 48.2537' W; running southeasterly along the Rocky Mount Mill Pond Dam to the south shore at a point 35° 57.5997' N – 77° 48.1412' W; including the following tributaries from their confluence with Tar River in the direction indicated to the specified boundary:

(a) Swift Creek - upstream (northwest) to a line beginning on the north shore at a point 36° 00.5829' N – 77° 39.9482' W; running southerly to the south shore at a point 36° 00.5413' N – 77° 39.9616' W.

(b) Fishing Creek - upstream (northwest) to a line beginning on the north shore at a point 36° 08.0430' N – 77° 43.2829' W; running southerly to the south shore at a point 36° 08.0173' N – 77° 43.2921' W; on Deep Creek, upstream (northeast) to a line beginning on the north shore at a point 35° 57.8688' N – 77° 27.2298' W; running southeasterly to the south shore at a point 35° 57.8403' N – 77° 27.1890' W.

(c) Town Creek - upstream (west) to a line beginning on the north shore at a point 35° 48.4135' N – 77° 36.7687' W; running southwesterly to the south shore at a point 35° 48.3728' N – 77° 36.7686' W.

(d) Otter Creek - upstream (west) to a line beginning on the west shore at a point 35° 43.2448' N – 77° 31.9013' W; running easterly to the east shore at a point 35° 43.2385' N – 77° 31.8735' W.

(e) Tyson Creek - upstream (southwest) to a line beginning on the west shore at a point 35° 40.4470' N – 77° 30.7015' W; running easterly to the east shore at a point 35° 40.4107' N – 77° 30.6075' W.

(f) Conetoe Creek - upstream (north and east) to a line beginning on the north shore at a point 35° 44.5315' N – 77° 29.1676' W; running southerly to the south shore at a point 35° 44.5071' N – 77° 29.1894' W.

(g) Hardee Creek - upstream (southwest) to a line beginning on the west shore at a point 35° 35.6842' N – 77° 19.3857' W; running easterly to the east shore at a point 35° 35.6781' N – 77° 19.3680' W.

(h) Chicod Creek - upstream (west) to a line beginning on the west shore at a point 35° 34.6186' N – 77° 14.0233' W; running southerly to the east shore at a point 35° 34.5985' N – 77° 14.0169' W.

(i) Old Grindle Creek - upstream (north) to a line beginning on the north shore at a point 35° 35.3098' N – 77° 09.9461' W; running southerly along SSR 1565 (Grimesland Bridge Road) to the south shore at a point 35° 35.2891' N – 77° 09.9511' W.

(j) Bear Creek - upstream (southwest) to a line beginning on the west shore at a point 35° 32.4699' N – 77° 07.4185' W; running easterly to the east shore at a point 35° 32.4697' N – 77° 07.3758' W.

(24) Tranters Creek including designated tributaries - main stem waters north and west of a line beginning on the west shore at a point 35° 33.1993' N – 77° 05.3978' W; running easterly to the east shore at a point 35° 33.2408' N – 77° 05.0872' W and south of a line beginning on the west shore at a point 35° 45.7848' N – 77° 15.2294' W; running easterly to the east shore at a point 35° 45.7905' N – 77° 15.1931' W; including the following tributaries from their confluence with Tranters Creek in the direction indicated to the specified boundary:

(a) Aggie Run - upstream (east) to a line beginning on the north shore at a point 35° 38.3433' N – 77° 05.5003' W; running southeasterly to the south shore at a point 35° 38.2633' N – 77° 05.4097' W.

(b) Cherry Run - upstream (northeast) to a line beginning on the north shore at a point 35° 35.1560' N – 77° 04.0436' W; running southerly along US 17 to the south shore at a point 35° 35.1404' N – 77° 04.0437' W.

(25) Lake Mattamuskeet - all waters and all inland manmade tributaries of Lake Mattamuskeet.

(26) Bay River Area: Trent Creek - south of a line beginning on the west shore at a point 35° 06.2738' N – 76° 43.1071' W; running easterly along the NC 55 bridge (Pamlico County) to the east shore to a point 35° 06.2603' N – 76° 43.0741' W; and north of a line beginning on the southwest shore at a point 35° 04.3545' N – 76° 42.8282' W; running northeasterly to the northeast shore to a point 35° 04.3686' N – 76° 42.8117' W.

(27) Neuse River including designated tributaries - main stem waters south of a line beginning on the east shore at a point 35° 47.9955' N – 78° 32.2902' W; running westerly along Milburnie Dam (Bridges Lake Dam) to the west shore to a point 35° 48.0280' N – 78° 32.3989' W; and northwest of a line near Pitch Kettle Creek beginning on the north shore at a point 35° 16.9793' N – 77° 15.5529' W; running south to the south shore to a point 35° 16.9237' N – 77° 15.5461' W; including the following tributaries from their confluence with Neuse River in the direction indicated to the specified boundary:

(a) Middle Creek - upstream (west) to a line beginning on the southwest shore at a point 35° 30.4489' N – 78° 24.1072' W; running northeasterly along the NC 210 bridge (Johnston County) to the northeast shore to a point 35° 30.4767' N – 78° 24.0676' W.

(b) Mill Creek - upstream (west) to a line beginning on the north shore at a point 35° 20.7619' N – 78° 20.0813' W; running southerly along the SSR 1185 bridge (Joyner Bridge Road) to the south shore to a point 35° 20.7262' N – 78° 20.0938' W.

(c) Little River - upstream (northwest) to a line beginning on the southwest shore at a point 35° 40.0035' N – 78° 15.5262' W; running northeasterly along the NC 42 bridge (Johnston County) to the northeast shore to a point 35° 40.0142' N – 78° 15.5060' W.

(d) Walnut Creek - upstream (north) to a line beginning on the west shore at a point 35° 15.5439' N – 77° 52.5703' W; running easterly to the east shore to a point 35° 15.5407' N – 77° 52.5574' W.

(e) Bear Creek - upstream (north) to a line beginning on the northeast shore at a point 35° 21.1265' N – 77° 49.1500' W; running southwesterly to the southwest shore to a point 35° 21.1125' N – 77° 49.1605' W.

(f) Falling Creek - upstream (northwest) to a line beginning on the west shore at a point 35° 15.6635' N – 77° 41.5862' W; running easterly along the US 70 bridge (Banks School Road) to the east shore to a point 35° 15.6687' N – 77° 41.5540' W.

(g) Contentnea Creek - upstream (northwest) to a line beginning on the west shore at a point 35° 34.1707' N – 77° 47.5396' W; running easterly to the east shore to a point 35° 34.1704' N – 77° 47.4966' W.

(h) Halfmoon Creek - upstream (southwest) to a line beginning on the north shore at a point 35° 19.1578' N – 77° 20.2050' W; running southerly to the south shore to a point 35° 19.1335' N – 77° 20.2036' W.

(i) Village Creek - upstream (southwest) to a line beginning on the northeast shore at a point 35° 18.4795' N – 77° 18.1037' W; running southwesterly to the southwest shore to a point 35° 18.4603' N – 77° 18.1121' W.

(j) Kitten Creek - upstream (northwest) to include all waters.

(k) Core Creek - upstream (west) to a line beginning on the north shore at a point 35° 10.7941' N – 77° 18.9102' W; running southerly to the south shore to a point 35° 10.7715' N – 77° 18.9012' W.

(l) Pitchkettle Creek - upstream (northwest) to include all waters.

(28) Neuse River Area:

(a) Turkey Quarter and Greens creeks - southeast of a line beginning on the west shore of Turkey Quarter Creek at a point 35° 15.6738' N – 77° 14.6823' W; running southeasterly to the southeast shore of Turkey Quarter Creek to a point 35° 15.6534' N – 77° 14.6470' W; and northwest of a line beginning on the north shore of Greens Creek at a point 35° 14.1883' N – 77° 11.8862' W; running southwesterly to the southwest shore of Greens Creek to a point 35° 14.1389' N – 77° 11.7535' W.

(b) Taylor Creek - northwest of a line beginning on the north shore at a point 35° 14.3719' N – 77° 10.8050' W; running southwesterly to the south shore to a point 35° 14.3300' N – 77° 10.8352' W.

(c) Pine Tree Creek - west of a line beginning on the north shore at a point 35° 12.6663' N – 77° 07.4285' W; running southwesterly to the south shore to a point 35° 12.7033' N – 77° 07.3594' W and north of a line beginning on the west shore at a point 35° 12.8553' N – 77° 07.8300' W; running easterly to the east shore to a point 35° 12.8372' N – 77° 07.7934' W and north of a line beginning on the west shore at a point 35° 13.2012' N – 77° 08.7753' W; running southeasterly to the east shore to a point 35° 13.1714' N – 77° 08.7071' W.

(d) Swift and Little Swift creeks - north of a line beginning on the west shore at a point 35° 11.5972' N – 77° 06.0562' W; running easterly to the east shore to a point 35° 11.5816' N – 77° 05.9861' W for both creeks and south of a line beginning on the northeast shore at a point 35° 17.8175' N – 77° 08.9421' W; running southwesterly along the SSR 1440 bridge (Streets Ferry Road) to the southwest shore to a point 35° 17.8027' N – 77° 08.9529' W for Swift Creek; and southwest of two lines, one beginning on the northwest shore of Fisher Swamp at a point 35° 14.6533' N – 77° 03.9072' W; running southeasterly to the southeast shore to a point 35° 14.6322' N – 77° 03.8983' W; and the other beginning on the northwest shore of Little Swift Creek at a point 35° 14.1315' N – 77° 03.6823' W; running southeasterly along the SR 1627 bridge (Craven County) to the southeast shore to a point 35° 14.1179' N – 77° 03.6676' W for Little Swift Creek.

(e) Bachelor Creek - west of a line beginning on the north shore at a point 35°09.0099' N – 77° 04.5858' W; running southerly to the south shore to a point 35° 08.9085' N – 77° 04.7172' W and east of a line at Rollover Creek beginning on the north shore at a point 35° 07.9194' N – 77° 11.9438' W; running southerly to the south shore to a point 35° 07.8931' N – 77° 11.9445' W.

(f) Trent River Area:

(i) Brice Creek - south of a line beginning on the west shore at a point 35° 02.1261' N – 77° 02.1243' W; running easterly to the east shore to a point 35° 02.1268' N – 77° 02.1015' W and north of a line beginning on the west shore at a point 34° 59.7828' N - 77° 00.0710' W; running easterly along the SSR 1101 bridge (County Line Road) to the east shore to a point 34° 59.7789' N - 77° 00.0534' W.

(ii) Mill Creek - south of a line beginning on the west shore at a point 35° 00.4595' N – 77° 12.8427' W; running easterly to the east shore to a point 35° 00.4593' N – 77° 12.8160' W; and north of a line beginning on the west shore at a point 34° 59.8881' N – 77° 12.8536' W; running easterly to the east shore to a point 34° 59.8878' N – 77° 12.8368' W.

(iii) Mill Run - southwest of a line beginning on the northwest shore at a point 35° 00.3766' N – 77° 16.8680' W;running southeasterly along the NC 58 bridge (Jones County) to the southeast shore to a point 35° 00.3654' N – 77° 16.8487' W; and northeast of a line beginning on the northwest shore at a point 35° 00.0929' N – 77° 17.3282' W; running southeasterly to the southeast shore to a point 35° 00.0740' N – 77° 17.3024' W.

(g) Trent River including all the waters of Jumping Creek - main stem waters southwest of a line beginning on the west shore at a point 35° 01.9478' N – 77° 15.6377' W; running easterly along the SSR 1121 bridge (Oak Grove Road) to the east shore to a point 35° 01.9506' N – 77° 15.6095' W; and northeast of a line beginning on the northeast shore at a point 35° 04.0759' N – 77° 35.3891' W; running southwesterly along the SSR 1153 bridge (Vine Swamp Road) to the southwest shore to a point 35° 04.0624' N – 77° 35.4063' W; including all the waters of Jumping Creek.

(h) Upper Broad Creek - northwest of a line beginning on the north shore at a point 35° 06.8922' N – 76° 56.3911' W, running southerly to the south shore to a point 35° 06.8623' N – 76° 56.3916' W and southeast of a line beginning on the west shore at a point 35° 08.3197' N – 76° 58.7314' W; running easterly along the NC 55 bridge at the Craven and Pamlico county line to the east shore to a point 35° 08.3209' N – 76° 58.6753' W.

(i) Beard Creek - northwest of a line beginning on the north shore at a point 35° 02.6853' N – 76° 52.3346' W; running southerly to the south shore to a point 35° 02.6663' N – 76° 52.3351' W and southeast of line beginning on the southwest shore at a point 35° 03.7198' N – 76° 52.6024' W; running northeasterly along the SSR 1115 bridge (Pamlico County) to the northeast shore to a point 35° 03.7258' N – 76° 52.5942' W.

(j) Dawson Creek - northwest of a line beginning on the southwest shore at a point 35° 01.8352' N – 76° 47.4672' W; running northeasterly to the northeast shore to a point 35° 01.8475' N – 76° 47.4283' W; and southeast of a line beginning on the southwest shore of Fork Run at a point 35° 02.1112' N – 76° 48.3083' W; running northeasterly along the SSR 1005 bridge (Pamlico County) to the northeast shore of Fork Run to a point 35° 02.1206' N – 76° 48.2922' W.

(k) Slocum Creek:

(i) Southwest Prong - southwest of a line beginning on the northwest shore at a point 34° 53.1520' N – 76° 55.8540' W; running southeasterly along the SSR 1746 bridge (Greenfield Heights Boulevard) to the southeast shore to a point 34° 53.1369' N – 76° 55.8460' W; and northeast of a line beginning on the west shore at a point 34° 51.5981' N – 76° 57.1687' W; running easterly to the east shore to a point 34° 51.5935' N – 76° 57.1229' W.

(ii) East Prong - south of a line beginning on the west shore at a point 34° 52.9687' N – 76° 54.5195' W; running easterly along the NC 101 bridge (Fontana Boulevard) to the east shore to a point 34° 52.9680' N – 76° 54.5020' W.

(l) Hancock Creek - south of a line beginning on the west shore at a point 34° 52.1403' N – 76° 50.8518' W; running easterly along the NC 101 bridge (Craven County) to the east shore to a point 34° 52.1412' N – 76° 50.8382' W.

(29) White Oak River - main stem waters north and west of a line beginning on the west shore at a point 34° 48.1466' N – 77° 11.4711' W; running easterly to a point on the west shore 34° 48.1620' N – 77° 11.4244' W; and south and east of a line beginning on the west shore at a point 34.° 53.5120' N – 77° 51.4013' W; running easterly to a point on the east shore 34° 53.5009' N – 77° 14.0194' W; including the following tributaries from their confluence with White Oak River in the direction indicated to the specified boundary:

(a) Holston Creek - east to a line beginning on the north shore at a point 34°49.6284' N – 77° 09.3783' W; running southerly to shore at a point 34° 49.6177' N – 77° 09.3670' W.

(b) Grant's Creek - west to a line beginning on the north shore at a point 34°47.9302' N – 77° 12.8060' W; running southerly along SSR 1434 bridge (Belgrade-Swansboro Road) to a point on the south shore 34° 47.9185' N – 77° 12.7954' W.

(30) New River - main stem waters north of a line beginning on the west shore at a point 34° 45.1654' N – 77° 26.1222' W; running easterly along the US Highway 17 bridge to a point on the east shore 34° 45.2007' N – 77° 25.9790' W; and south of a line beginning at a point on the west shore 34° 50.5818' N – 77° 30.1735' W running easterly along the SSR 1316 bridge (Rhodestown Road) to a point on the east shore 34° 50.5951' N – 77° 30.1534' W.

(31) Northeast and Little Northeast Creeks - north and east of a line beginning on the west shore at a point 34° 44.0778' N – 77° 21.2640' W; running southeasterly along the railroad bridge to a point on the east shore 34° 44.0446' N – 77° 21.2126' W; and west of a line beginning on the north shore 34° 44.9055' N – 77° 19.7541' W; running southerly along SSR 1406 bridge (Piney Green Road) to a point on the south shore 34° 44.8881' N – 77° 19.7649' W.

(32) Northeast Cape Fear River - main stem waters north of a line beginning at a point on the west shore 34° 26.5658' N – 77° 50.0871' W; running northeasterly along the NC 210 bridge to a point on the east shore 34° 26.6065' N – 77° 49.9955' W and south of a line beginning on the west shore 34° 38.7667' N – 77° 52.3417' W running easterly along SSR 1318 bridge (Croomsbridge Road) to a point on the east shore 34° 38.7744' N – 77° 52.3093' W; including the following tributaries from their confluence with the Northeast Cape Fear River in the direction indicated to the specified boundary:

(a) Burgaw Creek - west to a line beginning on the north shore at a point 34° 32.4670' N – 77° 51.1705' W; running southerly along SSR 1411 bridge (Stag Park Road) to a point on the south shore 34° 32.4567' N – 77° 51.1711' W.

(b) Pike Creek - west to a line beginning on the north shore at a point 34° 28.7928' N – 77° 52.5148' W; running southerly along SSR 1411 bridge (Ashton Lake Road) to a point on the south shore 34° 28.7882' N – 77° 52.5261' W.

(c) Merrick Creek - north and east to a line beginning on the north shore at a point 34° 26.8264' N – 77° 48.1948' W; running southerly along NC 210 bridge to a point on the south shore 34° 26.8028' N – 77° 48.1797' W.

(d) Island Creek - south and east to a line beginning on the west shore at a point 34° 22.0359' N – 77° 48.9107' W; running easterly along SSR 1002 bridge (Holly Shelter Road) to a point on the east shore 34° 22.0213' N – 77° 48.8854' W.

(e) Prince George Creek - south and east to a line beginning on the north shore at a point 34° 20.6773' N – 77° 54.2113' W; running southerly along NC 133 bridge to a point on the south shore 34° 20.6659' N – 77° 54.2170' W.

(f) Turkey Creek - north and east to a line beginning on the north shore at a point 34° 23.8546' N – 77° 54.7872' W; running southerly along NC 133 bridge to a point on the south shore 34° 23.8429' N – 77° 54.7772' W.

(g) Long Creek - north and west to a line beginning on the west shore at a point 34° 26.3494' N – 78° 01.5716' W; running easterly along NC 210 bridge to a point on the east shore 34° 26.3500' N – 78° 01.5396' W.

(33) Black River - north and west of a line beginning on the west shore at a point 34° 22.0783' N – 78° 04.4123' W; running easterly to a point on the east shore 34° 21.9950' N – 78 ° 04.2864' W and south and east of a line beginning at a point on the north shore 34° 42.5285' N – 78° 15.8178' W; running southerly to a point on the south shore 34° 42.5008' N – 78° 15.7972' W. South River - south and east of a line beginning at a point on the west shore 34° 38.4120' N – 78° 18.7075' W; running easterly along SSR 1007 bridge (Ennis Bridge Road) to a point on the east shore 34° 38.4080' N – 78° 18.6727' W.

(34) Cape Fear River - main stem waters north and west of a line at Lock and Dam #1 beginning on the west shore at a point 34° 24.2628' N – 78° 17.6390' W; running easterly to a point on the east shore 34° 24.2958' N – 78° 17.5634' W and south and east of a line beginning at a point on the west shore 35° 24.8404' N – 78° 49.4267' W; running easterly to a point on the east shore 35° 24.8833' N – 78° 49.3288' W; including the following tributaries from their confluence with the Cape Fear River in the direction indicated to the specified boundary:

(a) Brown's Creek - south and west to a line beginning on the north shore at a point 34° 36.8641' N – 78° 35.0917' W; running southerly along NC 87 bridge to a point on the south shore 34° 36.8477' N – 78° 35.0731' W.

(b) Hammond Creek - south and west to a line beginning on the north shore at a point 34° 34.032' N – 78° 30.3542' W; running southerly along NC 87 bridge to a point on the south shore 34° 34.0142' N – 78° 30.3397' W.

(c) Steep Run - south and west to a line beginning on the north shore at a point 34° 25.5019' N – 78° 20.9934' W; running southerly along NC 87 bridge to a point on the south shore 34° 25.4742' N – 78° 20.9549' W.

(d) Wayman's Creek - south and west to a line beginning on the north shore at a point 34° 22.4396' N – 78° 16.3904' W; running southerly along NC 87 bridge to a point on the south shore 34° 22.4287' N – 78° 16.3723' W.

(e) Livingston Creek - south to a line beginning on the north shore at a point 34° 19.5405' N – 78° 12.9889' W; running southerly along NC 87 bridge to a point on the south shore 34° 19.5128' N – 78° 12.9727' W.

(f) Hood Creek - south and west to a line beginning on the north shore at a point 34° 18.6658' N – 78° 07.1988' W; running southerly along NC 87 bridge to a point on the south shore 34° 18.6612' N – 78° 07.1741' W.

(g) Indian Creek - west to a line beginning on the north shore at a point 34° 17.7383' N – 78° 02.6706' W; running southerly along SSR 1453 bridge (Brunswick County) to a point on the south shore 34° 17.7210' N – 78° 02.6697' W.

(h) Sturgeon Creek - west to a line beginning on the north shore at a point 34° 14.6391' N – 78° 01.8154' W; running southerly to a point on the south shore 34° 14.5918' N – 78° 01.7941' W.

(i) Mill Creek - north and west of Sturgeon Creek to a line beginning on the north shore at a point 34° 15.2342' N – 78° 01.6370' W; running southerly to a point on the south shore 34° 15.2024' N – 78° 01.6525' W.

(j) Alligator Creek - north of the Brunswick River to the origin of the Creek excluding the dredged portions of the Creek.

(k) Jackeys Creek - west of the Brunswick River to a line beginning on the north shore at a point 34° 11.9672' N – 77° 58.8303' W; running southerly along the NC 133 bridge to a point on the south shore 34° 11.9544' N – 77° 58.8307' W.

(l) Mallory Creek - west of the Brunswick River to a line beginning on the north shore at a point 34° 10.0530' N – 77° 58.5927' W; running southerly along the NC Highway 133 bridge to a point on the south shore 34° 10.0351' N – 77° 58.5942' W.

(m) Town Creek - west to a line beginning on the north shore at a point 34° 09.4084' N – 78° 05.5059' W; running southerly along US 17 bridge to a point on the south shore 34° 09.3731' N – 78° 05.5147' W.

(n) Lilliput Creek - west to a line beginning on the north shore at a point 34° 04.5292' N – 77° 57.3187' W; running southerly along NC 133 bridge to a point on the south shore 34° 04.5137' N – 77° 57.3108' W.

History Note: *Authority G.S. 113-132; 113-134;*
Eff. May 1, 2008.

5.0 GENERAL LIFE HISTORY

5.1 DESCRIPTION AND DISTRIBUTION

The accepted common and scientific names for the species are striped bass, *Morone saxatilis*, (Walbaum) (Robins et al. 1991). In North Carolina it is also known as striper, rockfish, or rock. The body of a striped bass is elongate and moderately compressed with a slightly arched back. The lower jaw protrudes and extends posteriorly to the middle of the orbit. Color dorsally ranges from shades of green to steel blue or almost black. The sides are silvery with seven or eight dark, more or less continuous stripes, one of which always follows the lateral line, with three or four others above it and three below. Ventrally, the fish are white to silver with brassy iridescence. They have one soft and one spiny dorsal fin separated at the base and about equal in length. Striped bass are relatively long-lived and capable of attaining moderately large size. The current maximum observed age for a striped bass on the east coast is 31 years (Dave Secor, Chesapeake Biological Laboratory, personal communication). The current maximum observed age for a striped bass collected from the A/R spawning stock is 17 years and was collected in 2008 at Weldon, North Carolina (Godwin et al. 2009). Fish weighing 40 pounds or more are not exceptional. In general, females grow larger than males, with fish reaching lengths of 50 inches. The largest striped bass on record are two females caught in Albemarle Sound, North Carolina weighing 125 pounds each (Smith 1907). One of the largest striped bass captured in recent years weighed 92 pounds and was captured in the mid-1980s by the Maryland Department of Natural Resources (MDDNR) in an experimental drift gill net on the Patuxent River (Beth Versak, MDDNR, personal communication).

5.2 GENERAL LIFE HISTORY

Studies from 1938 through the 1990s indicated that only a small portion of striped bass spawned in the A/R system migrated out of the system to offshore waters (North Carolina Striped Bass Study Management Board 1992). However, these studies were conducted on a stock that was experiencing heavy exploitation and exhibited a truncated age structure. Since the A/R stock has recovered and the age structure has expanded however, an increasing number of tag returns indicate that a small percentage of the larger individuals (> 28 inches TL) in the A/R striped bass stock are participating in the annual migration pattern of the coastal migratory component of the Atlantic striped bass stocks. This migration pattern takes striped bass north as far as Nova Scotia Canada in the summer months then back south to overwinter in the near shore ocean off southern Virginia/northern North Carolina before returning to natal spawning grounds in the spring (Greene et al. 2009). The increase in tag returns from northern states reflects an increase in survival of individuals 28 inches TL and greater in the A/R stock, and the inability of these larger individuals to tolerate high summertime water temperatures of the internal waters of North Carolina. In order to spawn successfully, striped bass require waters having suitable flows, salinities, temperatures, and other aspects of habitat quality, which make the species particularly vulnerable to river flow alterations (Rulifson et al. 1982b).

5.2.1 Spawning

Striped bass spawn in fresh water or nearly freshwater portions of North Carolina coastal rivers from late March to June depending upon water temperatures (Hill et al. 1989). Peak spawning activity occurs when water reaches 62°-67° F (16.7°-19.4° C) on the Roanoke River (Rulifson

1990 and 1991a), 66.2° F (19° C) on the Cape Fear (Sholar 1977; Fischer 1980), and 68°-70.7° F (20°- 21.5° C) on the Neuse (Baker 1968, Hawkins 1979), and 64°- 69°F (18°- 22° C) on the Tar River (Kornegay and Humphries 1975). Spawning behavior is characterized by brief peaks of surface activity when a mature female is surrounded by up to 50 males as eggs are broadcast into the surrounding water, and males release sperm (Setzler et al. 1980). Spawning by a given female is probably completed within a few hours (Lewis and Bonner 1966).

5.2.2 Eggs

Mature eggs are 0.039 to 0.059 inch (1.0-1.5 mm) in diameter when spawned, and remain viable for about 1 hour (hr) before fertilization (Stevens 1966). Fertilized eggs are spherical, non-adhesive, semi-buoyant and nearly transparent. Water hardening occurs in a few hours, and eggs will range in diameter from 0.051 to 0.181 inch (1.3-4.6 mm) (Albrecht 1964; Murawski 1969). To keep eggs in suspension, minimum water velocities of 0.984 feet per second (ft/s) (30 cm/s) are generally required (Albrecht 1964). The incubation period at peak spawning temperatures ranges from 42 to 55 hours. At 68° F (20.0° C) (Hassler et al. 1981) found that eggs hatch in 38 hours. After hatching, larvae are carried by the current to the downstream nursery areas.

5.2.3 Larvae

The larval development of striped bass is dependent upon water temperature and is usually regarded as having three stages: 1) yolk-sac larvae are 0.20 to 0.31 inch (5-8 mm) in total length (TL) and depend on yolk material as an energy source for 7 to 14 days; 2) fin-fold larvae (0.31-0.47 inch; 8-12 mm TL) having fully developed mouth parts and persist about 10 to 13 days; and 3) post fin-fold larvae attain length up to 1.18 inches (30 mm) in 20 to 30 days (Hill et al. 1989). Researchers of North Carolina stocks of striped bass (primarily the A/R stock) divide larval development into yolk-sac and post yolk-sac larvae. Growth occurs generally within the same rates described above depending upon temperature. At temperatures ≥ 68° F (20° C), larvae reach the juvenile stage in approximately 42 days (Hassler et al. 1981). Yolk-sac larvae can feed as early as 5 days post-hatch; the survival rate is reduced as time to first feeding increases. This can become critical, because the nursery grounds where primary food sources occur are considerable distances downstream (especially the A/R stock). Larvae are totally dependent upon river flows for transport and timing of arrival to the nursery grounds where feeding is initiated.

5.2.4 Juveniles

Most striped bass enter the juvenile stage at about 1.18 inches (30 mm) TL; the fins are then fully formed, and the external morphology of the young is similar to that of the adults. Juveniles are often found in schools and apparently prefer clean sandy bottoms (Hill et al. 1989). They may spend the first two years of life maturing in and around the nursery area, which for North Carolina is the western Albemarle Sound and possibly lower Chowan River (Hassler et al. 1981).

5.2.5 Maturation and Fecundity

Information on rates of maturation and fecundity are unavailable for coastal North Carolina stocks except the A/R stock. Research conducted on the A/R stock indicated that females began reaching sexual maturity in approximately 3 years, at sizes of about 18 inches TL (Olsen and Rulifson 1992, Trent and Hassler 1968). Specifically, about 45% of the Roanoke females have reached sexual maturity by age 3; however, the viability of the eggs and resultant contribution of the progeny to the forming year class are unknown (Olsen and Rulifson 1992). Previous investigators determined the age at first maturity to be age 3 for male and age 4 for females (Trent and Hassler 1968; Harris and Burns 1983; Harris et al. 1984). In general, there is a strong positive correlation between the length, weight, and age of a female striped bass and the number of eggs it produces. All A/R females are mature by age 6, and a curvilinear relationship exists between the fish age and the number of eggs produced, with the greatest increase between age 6 and age 10. Potential fecundity estimates range from approximately 181,000 eggs for age 3 to 5,000,000 eggs for age 16 (Olsen and Rulifson 1992). Lewis (1962) noted that some females in the A/R stock, age seven and older, did not spawn annually.

One of the top research recommendations for the A/R striped bass stock has been an updated maturation and fecundity schedule. Samples collected (n = 453) from 2009-2010 were used to update the maturation schedule previously done on the A/R striped bass stock by Olsen and Rulifson 1992. Based on secondary growth characteristics fish were considered sexually mature in the developing stage and above. Mature female striped bass were found as young as age-3 (28.6%); 96.8% were mature at age 4 and were 100% mature by age 5. To determine the portion of these fish that were thought to be spawning or about to spawn, the total number of fish in the spawning capable maturity phase and above was calculated and found age-3 (16.1%), age-4 (83.2%), and age-5 (95.6%) with all fish spawning capable by age 6.

Fecundity increased about 50,000-100,000 eggs per year for fish $\leq$6 years old and 150,000-250,000 for fish >6 years old; the relationship between fecundity and age was statistically linear (r^2=0.86) but somewhat variable. Potential annual fecundity, estimated gravimetrically, ranged from 176,873 eggs for age-3 females (n=4) to 3,163,130 eggs for a single age-16 female. The average number of eggs per gram of ovarian tissue decreased with age.

Alone, all variables (age, length (TL and FL), and weight were significant predictors of fecundity and fecundity significantly increased with age, length, and weight ($P \leq 0.0001$). Age at 50% maturity was determined to be 3.2 yrs and length at 50% maturity was determined to be 427.1 mm TL using a logistic regression

Olsen and Rulifson (1992) used a 20% cutoff when determining their maturity schedule and this same criteria was used to create the maturity schedule in this study for comparison. At the 20% cutoff age-3 fish were only 29% mature while age-3 maturity was 44% based on Olsen and Rulifson (1992). Age-4 fish were 100% mature compared to 93% from Olsen and Rulifson (1992). Both studies had 100% maturity by age 6 using the 20% cutoff. When comparing the maturity methods of the 29 developing fish between studies, the current study considers them all mature while Olsen and Rulifson (1992) would have only considered 24 mature using the 20% cutoff criterion.

5.2.6 Growth Pattern

5.2.6.1 Rates

Growth rates for the A/R stock are rapid during the first three years of life, and then decrease to a relatively slow rate as the fish reach sexual maturity. Striped bass grow approximately 270 mm during their 1st year, 150 mm during their 2nd year, 70 mm during their 3rd year, and 40-20 mm yearly thereafter (Olsen and Rulifson 1992). Mean lengths at age from large samples of A/R striped bass sampled on the spawning grounds indicate female striped bass grow faster than males (Table 5.1). Growth rates for young-of-year striped bass ranged from 0.272 mm per day to 0.664 mm per day determined from a 20-year time series during 1955-1978 (Hassler et al.

1981). Statistically significant differences were found in these yearly growth rates. Additionally, analyses indicated positive correlation with young-of-year growth rates and river discharge. Hassler speculated that increased river discharge transports greater amounts of organic detritus to the estuary, which results in high productivity and faster growth rates for young-of-year striped bass.

Female striped bass collected from the Albemarle Sound ranged from 300 to 1,043 mm TL (n=215; mean=526.8 mm; SE=10.9 mm) with 97% within 300 to 600 mm TL. Fork lengths ranged from 280 to 991 mm (mean=404.5 mm; SE=10.4 mm) and weight ranged from 0.25 to 11.25 kg (mean=2.26 kg; SE=0.10 kg). Female striped bass collected from the Roanoke River ranged from 321 to 1,080 mm TL (n=205; mean=687.5 mm; SE=25.2 mm) with only 62% falling into the 30 to 600 mm TL size range. Fork lengths ranged from 300 to 1,019 mm (mean=645.5 mm; SE=32.5 mm) and weight ranged from 0.33 to 16.8 kg (mean=4.64 kg; SE=0.50 kg). Significant indicators of age ($p \leq 0.0001$) were TL, FL, and weight . FL was a significant estimator of TL ($p \leq 0.0001$) as was weight to FL ($p \leq 0.0001$).

5.2.6.2 Length-Weight Relationships

Length-weight relationships have been determined specifically for the A/R stock females from samples collected in 1989 and 1990. Regression analysis indicated a highly significant linear length-weight relationship (Olsen and Rulifson 1992);

Total fish weight = -0.6381598 + 0.016316 (FL) ($r = 0.94$, $p \leq 0.0001$, $n = 265$).

Trent (1962) established the following relation for first-summer growth of striped bass in Albemarle Sound:

$$Y = 1.84615 + 2.91977X,$$

Where Y is log weight (mg) and X is log total length (cm). After maturity, the weight of male striped bass is generally less than that of females of the same length (Merriman 1941; Mansueti 1961).

All aged samples (n=436) were used to predict the length of striped bass as a function of age using a von Bertalanffy growth model. The von Bertalanffy equation estimated for striped bass in this study was:

$$L_t=1052.10(1-e^{-0.125(t+1.0)});$$

the weight-length relationship was estimated using data from 434 fish with weights ranging from 330-16,800 g and total lengths ranging from 300-1080 mm (Figure 17).

$$W=1.55 * 10^{-11}(L)^{2.893};$$

Study Comparison

An increase in the age composition of the A/R striped bass stock has been validated as has growth in the population, since the last study was completed over 20 yrs ago using the current study and comparing the data to that collected by NCDMF. Age-at-maturity has not decreased from that reported by Olsen and Rulifson (1992), but has increased in the percentage (3.9%) of age-4 fish mature and a smaller percentage of age-3 fish (15.4%) mature. A depleted population could have been one mechanism forcing earlier maturity. Because the stock has been declared recovered for over 14 yrs, the population may not be as stressed as in previous years. Fish were considered mature if secondary growth (cortical alveoli and/or vitellogenic oocytes) was observed. Previous maturity studies used secondary growth characteristics and minimum oocyte diameter to determine maturity. Olsen and Rulifson (1992) developed a maturation schedule using the methodologies of Merriman (1941), Lewis (1962), and Specker et al. (1987) and considered the fish mature if the oocytes exhibited secondary growth and if 20% of the oocytes met the minimum diameter criterion (0.174 mm). They did not, however, distinguish between those fish sexually mature, and the percent of sexually mature fish contributing to the imminent spawning season. In this study, age-4 fish were 96.8% mature, but only 83.2% would spawn in the imminent season, with 95.6% of age-5 fish spawning at 100% maturity considered immature again.

When comparing methodologies between studies, oocytes from fish that were in the developing stage and considered sexually mature were measured for minimum oocyte diameter using the same criterion as Olsen and Rulifson (1992). Of the 29 fish in the developing stage in this study, 82.3% would have been considered mature by the criteria of Olsen and Rulifson (1992), with only five fish in disagreement between studies. All five fish in disagreement would have been considered immature by Olsen and Rulifson (1992) and were age-3. Factoring this into the age-3 maturity estimates based on current methodologies, the percent mature at age-3 would decrease from 28.6% to 17.9% increasing the difference in age-3 maturity estimates between studies from 15.6% to 26.1%. This did not affect age-4 fish that were considered mature by both studies using all methodologies and criteria.

Previous studies reported fecundity estimates similar to Olsen and Rulifson (1992), with Olsen and Rulifson (1992) having 10% overall higher values (Lewis and Bonner 1966; Holland and Yelverton 1973; Olsen and Rulifson 1992). There are multiple explanations as to why the fecundity estimated by Olsen and Rulifson (1992) was higher than any previous study including the current study. Olsen and Rulifson (1992) froze the ovaries for preservation, while this and other studies used 10% buffer formalin solution to fix the ovaries for analyses. Frozen ovarian samples can break upon thawing causing egg fragments and consequently lead to an increase in the number of eggs counted and the total fecundity estimate of the fish. Olsen and Rulifson (1992) knew this and calculated a correction factor for preservation by freezing. Another source of potential bias in the fecundity estimations calculated by Olsen and Rulifson (1992) was the incorporation of PG oocytes when estimating potential fecundity, which results in larger estimations of potential fecundity, but was the standard protocol at the time their study was conducted. When comparing fecundity estimations, counts between the studies were similar until approximately age-9, after which the values from Olsen and Rulifson (1992) increased dramatically due to only two fish representing age-10 and age-16. This study had a larger sample size of large fish age $\geq$10 (n=8); this resulted in more accurate estimations for older fish.

In order to eliminate potential bias in the estimates where eggs may have already been released by the fish, fecundity estimations were not completed on fish that showed signs of spawning (actively spawning phase), regressing, or regenerating. Excluding these fish from the fecundity sub-sample reduced the number of individual's age-7 through age-9 and led to an increase in estimates at age-8. An increase in the sample size of age classes seven through nine and incorporating more samples from earlier in the spawning season is recommended.

Technology used in the field of fisheries biology and more specifically fish reproduction has been enhanced over the last twenty years. Precise measurement techniques and use of computer software has led to more robust estimates of fecundity. Images of the samples in this study were uploaded to Image-Pro Plus 5.1 image analysis software, zoomed in for detailed viewing, and hand counted, eliminating potential bias from using a dissecting microscope, which lends itself to user error especially when used for long periods of time.

Table 5.1. Mean lengths (mm) at age for striped bass sampled from the Roanoke River spawning grounds, year classes examined since 1991. Only those year classes with four or more individuals aged are included. (NCWRC data; Thomas et al. 2010).

Sex and Year Class	Age 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Males															
1988			465	510	545	573	581								
1989		384	445	495	523	553	586	623							
1990		383	452	494	525	560	597	647							
1991		397	450	483	539	569	613	646							
1992		397	450	474	543	579	610	682	755	805	901				
1993		373	428	511	535	573	617	661	737	800					
1994		311	462	488	537	569	608	647	740	806	867				
1995		383	435	496	534	564	616	656	758	833	845				
1996		382	441	495	530	563	611	649	711	808	826	927			
1997		369	450	489	527	569	596	644	744	799	839				
1998		387	438	486	531	553	601	670	746	807					
1999	316	389	450	490	524	565	618	666	760	815					
2000		352	439	491	529	567	616	640	727						
2001	291	369	441	489	536	573	609	646							
2002	304	379	445	491	523	569	598								
2003		386	438	485	525	570									
2004		352	428	479	531										
2005	286	365	436	492											
2006	278	362	445												
2007	307	377													
2008	306														
Females															
1988			493	524	578	592	621		749						
1989		399	473	518	549	580	626	665					1033		
1990		414	472	513	545	596	626	671	773						
1991		376	478	503	553	597	631	693		856	936	975	1005		
1992		447	466	511	572	595	638	729	778	883	933	979			
1993		375	441	536	551	602	664	705	789	883	938	990	1059	1024	1112
1994			469	507	563	616	636	696	798	882	937	1012	1039	1043	1098
1995		381	462	513	573	584	629	697	798	890	950	995	1040	1051	
1996		423	476	531	541	586	644	704	780	875	945	979	1037		
1997		429	472	512	546	583	636	685	785	870	927	996			
1998		439	462	511	546	583	635	700	776	876	936				
1999			474	511	550	595	640	697	794	866					
2000		370	466	515	552	590	639	694	790						
2001			464	514	557	595	636	669							
2002			466	515	549	580	623								
2003			472	507	552	586									
2004		351	453	515	555										
2005		403	457	509											
2006		384	461												
2007	314	405													

5.3 ECOLOGICAL RELATIONSHIPS

5.3.1 Food Habits

Major food items of striped bass larvae collected in lower Roanoke River and western Albemarle Sound were *Bosmina* sp. and copepodite stage copepods (Rulifson et al. 1991). Several food habit studies have been conducted on juvenile and adult striped bass since 1955 in the Roanoke River and Albemarle Sound. Studies on juvenile striped bass in Albemarle Sound found zooplankton and mysid shrimp as primary prey items for smaller juveniles in the summer, with small fish (most likely bay anchovies) entering the diet later in the season (Rulifson and Bass 1991, Cooper et al. 1998). Adults feed extensively on blueback herring and alewives in the river during the spawning migration (Trent and Hassler 1968). Manooch (1973) conducted a seasonal food habit study in Albemarle Sound and found primarily fish in the families Clupeidae (Atlantic menhaden, blueback herring, alewife and gizzard shad) and Engraulidae (anchovies), dominated the diet in the summer and fall. Atlantic menhaden (54%) was the most frequently eaten species, which comprised a relatively large percentage of the volume (50%). In the winter and spring months, invertebrates occurred more frequently in the diet (primarily amphipods during the winter and blue crabs in the spring). Similarly, Rudershausen et al. (2005) found a diverse array of fish in the diets of age 1 striped bass whereas the diets of age-2 and age-3+ striped bass were primarily comprised of menhaden in 2002 and 2003 in the Albemarle Sound. Tuomikoski et al. (2008) investigated age 1 striped bass diets in Albemarle Sound where American shad comprised the majority of their diet in 2002, but yellow perch dominated the diet in 2003. The 2003 year class for yellow perch was one of the highest on record in NCDMF sampling programs, so the high occurrence of yellow perch in striped bass stomachs may not be typical (Loeffler 2009). However, it also supports other research that striped bass exhibit an opportunistic feeding behavior (Rulifson et al. 1982a). Patrick and Moser (2001) found similar results from the Cape Fear River, with Atlantic menhaden and threadfin shad being the predominate species. Rulifson and Price (2001) collected striped bass stomachs (n = 34) from the upper Currituck Sound during 2000 and determined that prey within the subfamily Alosinae had the highest occurrence. The American shad was the most common species observed in the fall.

From the fall of 1995 through the spring of 2001, the NCDMF Fishery Independent Gill Net Survey (IGNS), has analyzed a total of 8,296 striped bass stomachs in the Albemarle Sound area, with 1,796 of those stomachs analyzed having contents. This low percentage of stomachs with contents is indicative of gill net surveys, in which striped bass entangled in gill nets may either regurgitate their stomach contents or finish digesting contents while entangled in the gill net before retrieval by NCDMF staff. Striped bass with empty stomachs at the time of gear retrieval cannot be assumed to be food limited. During the time period of fall 1995 through spring 2001, unidentifiable fish parts was the dominant stomach content from the western sound samples (35.9%), followed by river herring (33.2%), and Atlantic menhaden (16.5%). The dominance of river herring during the spawning migration supports that reported by Trent and Hassler (1968) and Manooch (1973). Blue crab only accounted for 0.2% of the total stomach contents from the western sound. In the eastern sound samples, unidentifiable fish parts accounted for 34.0%, followed by Atlantic menhaden (31.5%), Atlantic croaker (12.1%), anchovy spp. (11.1%) and spot (6.5%). Blue crab comprised 2.1% of the stomach contents from the eastern sound.

From the fall of 2001 through the spring 2010, the NCDMF analyzed 13,665 striped bass stomachs through the IGNS, with 4,448 stomachs having contents. In the western sound samples unidentifiable fish parts accounted for 61.2% of stomach contents, followed by Atlantic menhaden (23.1%), anchovy spp. (4.0%), invertebrates (3.0%), Atlantic croaker (2.5%), and river herring (2.0%). Blue crab accounted for less than 1% of stomach contents in the western sound samples. It is interesting to note the decline in the prevalence of river herring in striped bass diet in the western sound since 2001. In the eastern sound samples, unidentifiable fish parts accounted for 41.2% of the stomach contents, followed by Atlantic menhaden (40.8%), anchovy spp. (6.4%), spot (6.4%), and Atlantic croaker (2.9%). Blue crab accounted for less than 1% of stomach contents in the eastern sound samples as well.

In Atlantic Ocean waters along the coast of Virginia and North Carolina during the winter months, Overton et al. (2009) examined diets of adult striped bass with Atlantic menhaden and bay anchovy dominating the stomach contents, followed by croaker and spot to a lesser degree and alosines comprising only a minor component of the stomach contents.

5.3.2 Feeding Behavior

Striped bass are opportunistic feeders; specific food types depend upon the size of the fish, habitat, and the season (Rulifson et al. 1982a). They undergo an ontogenetic shift in diet with larvae feeding primarily on mobile planktonic invertebrates (Doroshev 1970; Markle and Grant 1970; Bason 1971). As they grow, their diet includes larger aquatic invertebrates and small fish (Shapovalov 1936; Ware 1971).

5.3.3 Predators

The only likely predators on adult striped bass would include some marine species that might ascend rivers and sounds or, be encountered during coastal migration. These predators might include sharks, bluefish, goose fish/monkfish (*Lophius sp.)*, tuna and tarpon. Any sympatric piscivorous fish may be a predator of larvae and juvenile striped bass. Examination of stomach contents of white and yellow perch, American eel, Atlantic croaker, white catfish, channel catfish and striped bass in Albemarle Sound showed that only white and channel catfish stomach contents contained *Morone* sp. (Rulifson 1984). Stomach contents from the NCDMF Albemarle Sound IGNS have observed cannibalism among striped bass.

5.3.4 Competitors

Because striped bass share forage species with other piscivores, they are potential competitors (Setzler et al. 1980). Young striped bass may also compete with other fishes for food. Similar nursery areas and food habits show a potential for competition between young white perch and striped bass (Milhursky et al. 1976). The young may also compete with some species of clupeids (Hollis 1967).

Past research in the Cape Fear River suggested hybrid striped bass that escaped from upstream reservoirs competed for food and spawning space with native striped bass (Patrick and Moser 2001). However, since 2004 the number of hybrid striped bass observed in various NCDMF and NCWRC fishery independent surveys has declined, with zero collections of hybrid striped bass in 2010 from the NCWRC spawning ground survey (Table 7.12).

5.4 MOVEMENT AND MIGRATION

5.4.1 Albemarle/Roanoke Adult Striped Bass

Numerous tagging or migration studies have been conducted on striped bass in North Carolina and along the Atlantic Coast since the 1930s. Several of these studies suggest that the A/R stock is at least partially migratory, with primarily older adults participating in offshore migrations. Tag recapture studies from previous investigators (Merriman 1941, Vladykov and Wallace 1952, Davis and Sykes 1960, Chapotan and Sykes 1961, Nichols and Cheek 1966, Holland and Yelverton 1973, Street et al. 1975, Hassler et al. 1981. Boreman and Lewis, 1987, Benton 1992 and Laney 2010) indicate that a small amount of offshore migration occurs (Table 5.2). However, the studies occurred in the 1980s and 1991 when the stock was generally low in abundance and the age structure was truncated. In addition, the studies indicated larger, older females were more migratory than males. Fish tagged and released at various locations in the Albemarle Sound were recaptured on the spawning grounds in Roanoke River, in Albemarle, Pamlico, and Croatan sounds, and offshore from North Carolina to New England. These studies from 1937-1985 showed a 0.7-19.8% exchange rate (Table 5.2). Though the percent contribution in general has remained low, it is apparent that the Albemarle Sound and North Carolina territorial seas serve as a wintering ground for east coast stocks and to a lesser degree for the A/R stock.

In 1985, NCDMF reinstated adult striped bass tagging programs in the Albemarle and Croatan sound areas and these programs are currently ongoing. Due to the A/R population being at a low level, very few fish were tagged from 1985-1989 (n=16). Striped bass have been tagged and released from hook and line, NCDMF trawl surveys, gill nets, pound nets, NCDMF gill net surveys and NCWRC electro-fishing efforts. A total of 22,012 striped bass was tagged and released in the ASMA from 1990 through the spring 2009 (Table 5.3). The percentage of fish tagged and released 18 inches (TL) and larger has ranged from 9.1 to 69.4% annually. Of the total number tagged, 65 striped bass captured and released through the NCDMF gill net surveys were 28 inches TL and larger (Table 5.4). A total of 1,545 tags (7.0%) have been returned, with 93.7% of the returns being from the ASMA. Twenty-three of the returns were from the Atlantic Ocean off North Carolina or from areas north of the state (Table 5.3). The percentage of returns from outside the internal waters of the state has ranged from 1.4 to 33.3%. Most of these returns occurred within one year of release, while two were at large for over four years. The majority of the tag returns (n=14) from the northern areas were from April through July, from fish tagged during the fall and winter months (October – February) in the eastern Albemarle and Croatan sound areas. These returns further support the suggestion by Street et al. (1975) that the eastern Albemarle and Croatan sounds serve as a wintering ground for a portion of the Atlantic striped bass coastal migratory stock. Figure 5.1 shows the returns by length from the NCDMF Gill Net Survey, Fall-Winter segments from outside the internal waters. A total of 14 tags have been returned from outside North Carolina's internal waters. These fish have ranged in length from 14-33 inches TL. The returns from the Spring segments of the NCDMF Gill Net Survey are presented in Figure 5.2. Only 3 returns (26 in TL and 34 in TL) have been from outside the internal waters of the state.

The NCDMF, in cooperation with the NCWRC, has tagged and released 46,173 striped bass from the Roanoke River on the spawning grounds, 1991 - 2009 (Table 5.3). Fifty-eight percent of these fish were 18 inches TL or larger when tagged and released.

Table 5.2. Summary of adult striped bass tagging efforts and returns.

Tagging period	Reference	Tagging location	Number tagged	Number recaptured	Percent return	Recapture location	Percent exchange (based on total returns)
Nov 1937	Vladykov and Wallace (1952)	Currituck Sound Croatan Sound Kitty Hawk	179 298 6 483	137	28.4	136 NC 1 NJ	0.7
Mar-Apr 1937	Merriman (1941)	Kitty Hawk (ocean)/ Albemarle Sound	600	45	7.5	24- Albemarle Sound 9- Ocean off VA Beach 8- Chesapeake Bay 2- NJ 1- NY 1- RI	19.6
Apr 1938	Merriman (1941)	Western Albemarle Sound	506	47	9.3	47- Albemarle Sound area	
Oct 1955-May 1957	Davis and Sykes (1960), Nichols and Cheek (1966)	Albemarle Sound	5,242	1,651	31.5	1,565- Albemarle Sound 79- Pamlico Sound 5- Chesapeake Bay 1- New England 1- Ocean off NC	0.4
1956-1983	Hassler et al. (1981)	Roanoke River	11,662	3,264	28.0	Albemarle Sound and Roanoke River	
Dec 1956-1958	Chapotan and Sykes (1961)	Atlantic Ocean off Oregon Inlet	81	19	23.5	5- Ocean 2- Albemarle Sound 8- Chesapeake Bay 2- NJ 1- RI 1- MA	10.5
		Albemarle Sound	34	14	41.2	12- Albemarle Sound 1- Roanoke River 1- MA	7.1
		Roanoke River	63	9	14.3	1- Roanoke River 8- Albemarle Sound	

Table 5.2 (Continued)

Tagging period	Reference	Tagging location	Number tagged	Number recaptured	Percent return	Recapture location	Percent exchange (based on total returns)
1968-1971	Holland and Yelverton (1973)	Ocean- Cape Lookout to NC/VA line	1,752	197	11.2	39- Albemarle/Pamlico S. 25- Ocean off NC 78- Chesapeake Bay 55- NJ-ME	19.8
Oct- Dec 1973	Street et al. (1975)	Croatan Sound	462	128	27.7	Croatan Sound Albemarle Sound	
1964-1985	Boreman and Lewis (1987)	Chesapeake Bay to Canada	27,674	1,959	7.1	18 Albemarle and Croatan Sound	0.9
1988-2010	Benton (1992), Laney (2010)	Cape Hatteras to mouth of Chesapeake Bay	44,127	7,504	17.0	309 – Atlantic Ocean off NC 83 – Albemarle/Pamlico S.	1.1
2002	Hewitt and Hightower (2002)	Roanoke River- near Scotland Neck	729	33	4.5	1 Pungo River, 2 Blackwater R. – VA, 30 Albemarle Sound/ Roanoke River	

Table 5.3 Number of adult striped bass tagged and released throughout the ASMA and RRMA and recapture areas.

Year	Tagging location	Number Tagged	Number Returned	Percent Return	Oregon Inlet No./Percent	Outside NC Internal waters No./Percent	Internal waters outside ASMA No./Percent
Hook and line							
1990	Batchelor Bay	15	0				
1992	Albemarle Sound area	108	5	4.6			
1993	Albemarle Sound area	50	4	8.0			
1993	Pasquotank River	63	1	1.6			
1994	Pasquotank River	375	20	5.3			
1994	Albemarle Sound area	124	7	5.6			
1995	Albemarle Sound area	74	6	8.1		2 (33.3)	1 (16.6)
1996	Perquimans River	26	1	3.8	1 (100)		
1997	Albemarle Sound area	42	0				
1998	Albemarle Sound area	107	1	0.9			
1998	Perquimans River	30	2	6.7			

Table 5.3 (Continued)

Year	Tagging location	Number Tagged	Number Returned	Percent Return	Oregon Inlet No./Percent	Outside NC Internal waters No./Percent	Internal waters outside ASMA No./Percent
1999	Albemarle and Croatan sounds	244	6	2.5			
2000	Albemarle and Croatan sounds	194	19	9.8	1 (5.3)		
	Total	**1,452**	**72**				
Trawls							
1994	Albemarle Sound area	24	0				
	Total	**24**	**0**				
Virginia Game and Inland Fisheries – VA Waters							
2003	Blackwater and Nottoway R.	96	9	9.4			
2004	Northlanding and Northwest R.	26	3	11.5			
2009	Blackwater and Nottoway R.	22	1	4.5			
	Total	**144**	**13**				
Pound Nets							
1990	Batchelor Bay	275	34	12.4			
1990	Eastern Albemarle Sound	420	69	16.4			
1991	Eastern Albemarle Sound	183	30	16.4			
1992	Eastern Albemarle Sound	88	18	20.5			2 (11.1)
1993	Eastern Albemarle Sound	209	39	18.7			
1994	Eastern Albemarle Sound	77	5	6.5			
1995	Eastern Albemarle Sound	352	66	18.8	2 (3.0)	4 (6.1)	
2003	Chowan River	419	15	3.6			
2005	Eastern Albemarle Sound	19	0				
	Total	**2,055**	**278**				
Gill Net Survey	**Fall/Winter**						
1990/91	Albemarle/Croatan sounds	245	55	22.4			
1991/92	Albemarle/Croatan sounds	329	69	21.0		2 (2.9)	
1992/93	Albemarle/Croatan sounds	267	36	13.5	2 (5.6)	1 (2.8)	2 (5.6)
1993/94	Albemarle/Croatan sounds	166	29	17.5			
1994/95	Albemarle/Croatan sounds	776	73	9.4	2 (2.7)	1 (1.4)	1 (1.4)
1995/96	Albemarle/Croatan sounds	464	42	9.1	1 (2.4)	4 (9.5)	2 (4.8)
1996/97	Albemarle/Croatan sounds	782	50	6.4	1 (2.0)	3 (6.0)	1 (2.0)
1997/98	Albemarle/Croatan sounds	695	55	7.9	3 (5.5)	1 (1.8)	
1998/99	Albemarle/Croatan sounds	1,054	87	8.3	2 (2.3)		1 (1.1)

Table 5.3 (Continued)

Year	Tagging location	Number Tagged	Number Returned	Percent Return	Oregon Inlet No./Percent	Outside NC Internal waters No./Percent	Internal waters outside ASMA No./Percent
1999/00	Albemarle/Croatan sounds	586	66	11.3	5 (7.6)		3 (4.5)
2000/01	Albemarle/Croatan sounds	382	30	7.9		1 (3.3)	3 (10.0)
2001/02	Albemarle/Croatan sounds	537	36	6.7			
2002/03	Albemarle/Croatan sounds	428	29	6.8	3 (10.3)		1 (3.4)
2003/04	Albemarle/Croatan sounds	894	54	6.0		1 (1.8)	4 (7.4)
2004/05	Albemarle/Croatan sounds	546	42	7.7	1 (2.4)		1 (2.4)
2005/06	Albemarle/Croatan sounds	676	53	7.8	1 (1.9)		1 (1.9)
2006/07	Albemarle/Croatan sounds	238	3	1.3			
2007/08	Albemarle/Croatan sounds	835	69	8.3			1 (1.4)
2008/09	Albemarle/Croatan sounds	533	21	3.9			
	Total	**10,433**	**899**				
Gill Net Survey	**Spring**						
1993	Western Albemarle Sound	106	11	10.4			
1994	Western Albemarle Sound	64	4	6.3			
1995	Western Albemarle Sound	553	24	4.3			
1996	Western Albemarle Sound	406	20	4.9	2 (10.0)	1 (5.0)	
1997	Western Albemarle Sound	582	11	1.9			
1998	Western Albemarle Sound	582	8	1.4			1 (12.5)
1999	Western Albemarle Sound	785	31	3.9	2 (6.5)		4 (12.9)
2000	Western Albemarle Sound	627	14	2.2	3 (21.4)	1 (7.1)	2 (14.2)
2001	Western Albemarle Sound	648	25	3.8	1 (4.0)		3 (12.0)
2002	Western Albemarle Sound	531	31	5.8	1 (3.2)		1 (3.2)
2003	Western Albemarle Sound	299	18	6.0			1 (5.6)
2004	Western Albemarle Sound	600	10	1.7	1 (10.0)	1 (10.0)	
2005	Western Albemarle Sound	414	14	3.4	2 (14.3)		1 (7.1)
2006	Western Albemarle Sound	488	13	2.7			
2007	Western Albemarle Sound	228	5	2.2			1 (20.0)
2008	Western Albemarle Sound	732	47	6.4			
2009	Western Albemarle Sound	403	10	2.5			
	Total	**8,048**	**296**				
Electro-fishing							
1992	Albemarle Sound area	53	3	5.7			
1993	Albemarle/Roanoke	51	1	1.9			
1996	Albemarle/Roanoke	33	1	3.0			
1988	Roanoke River	37	9	24.3			
1989	Roanoke River	27	1	3.7			
1990	Roanoke River	335	33	9.8		1(3.0)	

Table 5.3 (Continued)

Year	Tagging location	Number Tagged	Number Returned	Percent Return	Oregon Inlet No./Percent	Outside NC Internal waters No./Percent	Internal waters outside ASMA No./Percent
1991	Roanoke River	1,657	179	10.8		2 (1.1)	
1992	Roanoke River	2,453	360	14.7	1 (0.3)	1 (0.3)	4 (1.1)
1993	Roanoke River	2,338	285	12.2	1 (0.4)	1 (0.3)	2 (0.7)
1994	Roanoke River	9	3	33.3			
1995	Roanoke River	1,265	133	10.5	2 (1.5)	2 (1.5)	3 (2.2)
1996	Roanoke River	1,378	128	9.3	3 (2.3)	2 (1.6)	2 (1.6)
1997	Roanoke River	2,167	288	13.3	9 (3.1)	7 (2.4)	11 (3.8)
1998	Roanoke River	2,060	243	11.8	17 (7.0)	3 (1.2)	10 (4.1)
1999	Roanoke River	2,177	217	10.0	8 (3.7)	1 (0.5)	6 (2.8)
2000	Roanoke River	1,970	194	9.8	12 (6.2)	1 (0.5)	13 (6.7)
2001	Roanoke River	2,647	323	12.2	10 (3.1)	5 (1.5)	13 (4.0)
2002	Roanoke River	2,032	180	8.9	10 (5.6)	2 (1.1)	4 (2.2)
2003	Roanoke River	3,146	336	10.7	7 (2.1)	7 (2.1)	14 (4.2)
2004	Roanoke River	1,530	150	9.8	3 (2.0)	7 (4.7)	
2005	Roanoke River	4,104	387	9.4	8 (2.1)	12 (3.1)	7 (1.8)
2006	Roanoke River	5,020	450	9.0	14 (3.1)	21 (4.7)	13 (2.9)
2007	Roanoke River	2,796	177	6.3	8 (4.5)	12 (6.8)	7 (4.0)
2008	Roanoke River	4,153	377	9.1		24 (6.4)	6 (1.6)
2009	Roanoke River	3,271	171	5.2	1 (0.6)	6 (3.5)	4 (2.3)
	Total	**46,709**	**4,629**				

Table 5.4. Total number of striped bass tagged and released, 28 inches (TL) and larger through NCDMF Independent Gill Net Survey and returns by area.

Segment/Year	Total Number Tagged	Number Tagged 28 Inches and Larger	Percent of Total – Fish 28 Inches and Larger	Number and Percent of Returns Oregon Inlet Area	Number and Percent of Returns Outside NC Internal Waters
Fall/Winter 1992-1993	267	4	1.5	1 (25%)	
Fall/Winter 1993-1994	166	2	1.2		
Fall/Winter 1994-1995	776	1	0.1		
Spring 1995	553	3	0.5		
Spring 1996	406	1	0.2		1 (100%)
Fall/Winter 1997-1998	695	1	0.1		
Fall/Winter 1999-2000	586	2	0.3		

Segment/Year	Total Number Tagged	Number Tagged 28 Inches and Larger	Percent of Total – Fish 28 Inches and Larger	Number and Percent of Returns Oregon Inlet Area	Number and Percent of Returns Outside NC Internal Waters
Spring 2000	627	1	0.1		
Fall/Winter 2000-2001	382	1	0.2		
Spring 2001	648	5	0.7		
Spring 2002	531	2	0.4	1 (50%)	
Fall/Winter 2002-2003	427	2	0.4	1 (50%)	
Spring 2003	299	6	2.0		
Fall/Winter 2003-2004	894	6	0.7		1 (16.7%)
Spring 2004	600	6	1.0		1 (16.7%)
Fall/Winter 2004-2005	546	1	0.1		
Spring 2005	414	3	0.7		
Fall/Winter 2005-2006	676	2	0.3		
Spring 2006	488	2	0.4		
Fall/Winter 2006-2007	238	0	-		
Spring 2007	228	8	3.5		
Fall/Winter 2007-2008	835	3	0.3		
Spring 2008	732	0	-		
Fall/Winter 2008-2009	533	1	0.1		
Spring 2009	403	2	0.5		

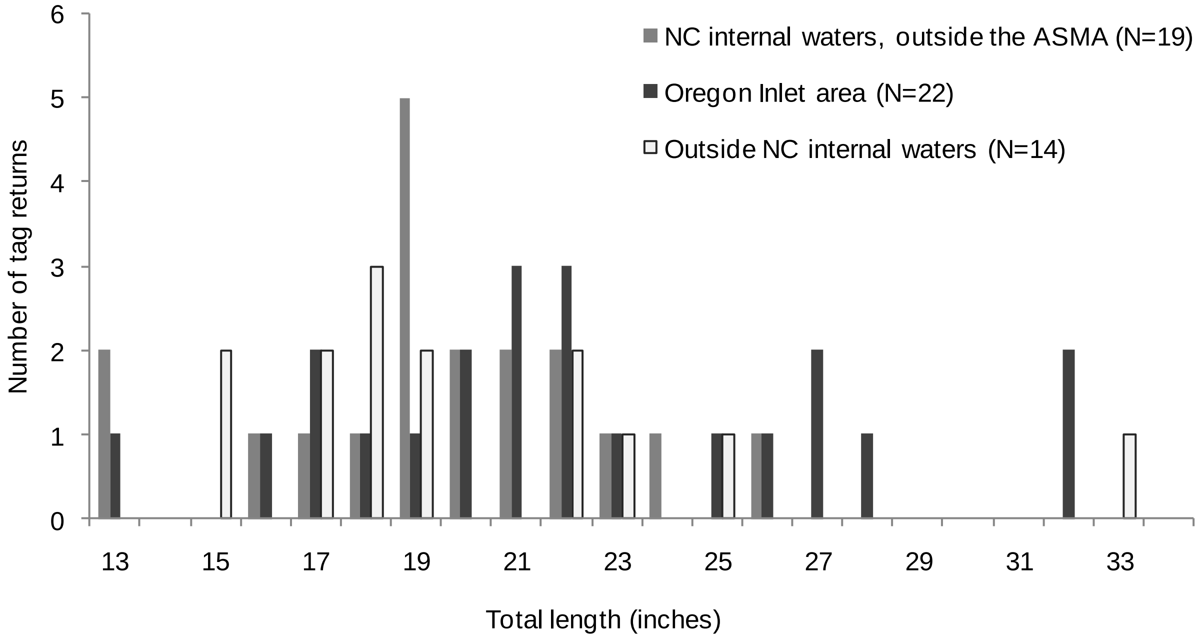


Figure 5.1. Total length (inches) of striped bass recaptured from outside the ASMA, tagged through the NCDMF Fall/Winter Independent Gill Net Survey, 1990 – 2009. Total N tagged = 10,781.

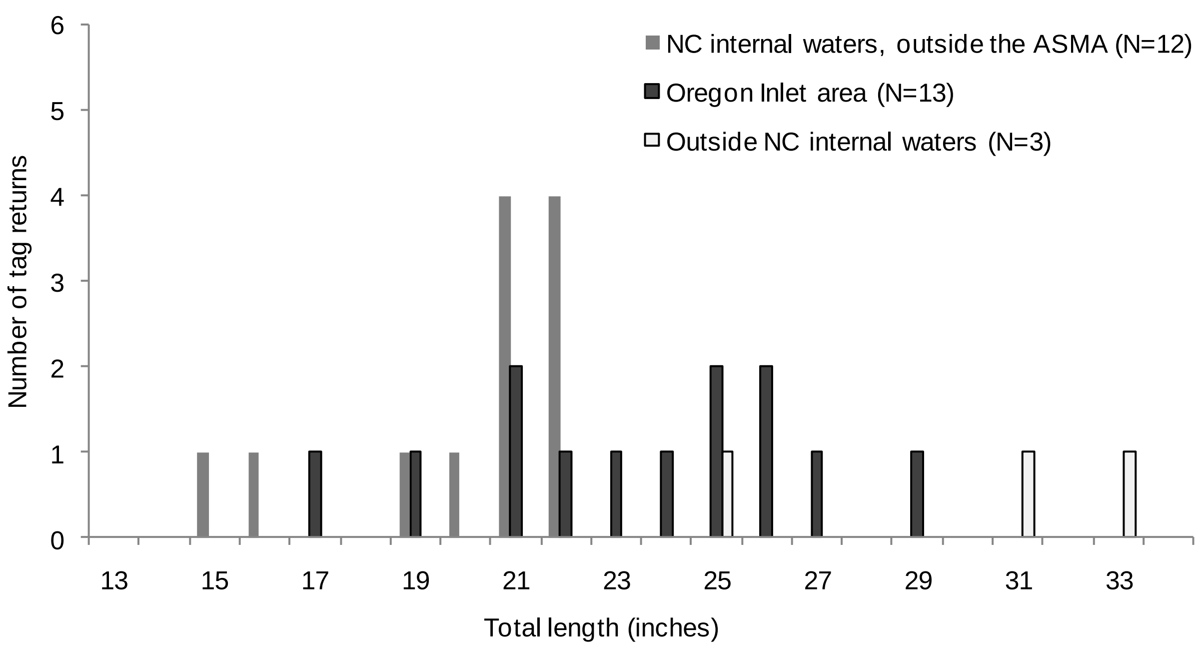


Figure 5.2. Total length (inches) of striped bass recaptured from outside the ASMA, tagged through the NCDMF Spring Independent Gill Net Survey, 1993 – 2009. Total N tagged = 8,109.

The number of striped bass 28 inches TL and larger tagged and released has increased, ranging from 0.1 – 7.0% since the stock was declared recovered in 1997 (Table 5.5). A total of 4,581 (10%) tags have been returned, with 84.8 – 98.9% of the returns being from the ASMA or RRMA. One hundred and fourteen of the returns (2.5%) have been from the Atlantic Ocean off North Carolina or from waters north of the state (Table 5.3, Figure 5.3). The percentage of returns from the ocean and areas north has ranged from 0.3 – 6.8%. Generally, these returns occurred from May through September (n=86) and the fish have been at large up to eight years prior to capture.

Hewitt and Hightower (2002) tagged and released 729 striped bass from a fishwheel, located near Scotland Neck, NC during the spring 2002. Thirty-three tags have been returned with no returns from outside the internal waters of the state (Table 5.3). These returns continue to show very little contribution of the A/R stock to the migratory population.

The returns from fish tagged on the Roanoke River, near Weldon and recaptured outside the internal waters are presented in Figure 5.4, by sex. A total of 26 males and 88 females returns have occurred. Males have ranged from 14-36 inches TL, with the 16-23 inch size groups accounting for 61.5%. Females have ranged from 15-43 inches TL, with 35 - 43 inch size groups contributing 78.4% of the returns.

Historical adult tag recovery databases (Street et al. 1975; Johnson et al. 1981; Hassler and Taylor 1986) suggested that the A/R striped bass stock was composed principally of a discrete resident population; however these conclusions were based upon tag returns from 3 through 5 year old fish that were not likely to migrate out of the system. Since the mid-1990s however, the age structure of the stock has broadened significantly and 119 (85%) of the 140 returns from outside the internal coastal waters of North Carolina have occurred during the period 1996 – 2009. Carmichael (1995) conducted telemetry studies on striped bass in the management area and the results supported the contention of Setzler et al. (1980) that there may be some mixing of the migratory and A/R populations within the Croatan Sound during the winter. Haeseker et al. (1996) through telemetry studies in the Albemarle Sound area during the summer found there was no evidence of migration to the Atlantic Ocean. Even though the number of returns from outside North Carolina has increased over the last several years the data continues to indicate that the A/R stock contributes minimally to the Atlantic migratory stock.

Tag-recapture or tag recovery studies can be used to estimate migration rates among different geographic regions, provided fish are released from several different regions simultaneously with tags that identify the region of release (Schaefer 1951; Darroch 1961; Dorazio et al. 1994).

Table 5.5. Total number of striped bass tagged and released, 28 inches total length and larger from the Roanoke River spawning grounds and returns by area. (M-male, F –female)

Year	Total Number Tagged	Number 28 In/ Larger	Percent of Total – 28 In/ Larger	Number of Females	Number of Males	No/ % Returns Inside ASMA	No/ % Returns Inside RRMA	No/% Returns Oregon Inlet Area	No/% Returns Outside NC Int. Waters	No/% Returns NC Waters out ASMA
1995	1,265	2	0.2	1	1					
1996	1,378	4	0.3	4	-			1 (F) (25%)		
1997	2,167	7	0.3	6	1		1 (M) (100%)		1 (F) (16.7%)	
1998	2,060	10	0.5	10	-			2 (F) (20%)		
1999	2,177	22	1.0	17	5			1 (F) (5.9%)		
2000	1,970	14	0.7	11	3		1 (F) (9 %)	2 (F) (18.2%)	1 (M) (33.3%)	
2001	2,647	45	1.7	32	13			1 (F) (3.1%)	3 (F) (9.4%) 1 (M) (7.7%)	
2002	2,032	72	3.5	48	24		1 (F) (2.0%) 2 (M) (8.3%)	2 (F) (4.2%) 5 (M) (20.8%)	1 (F) (2.0%) 2 (M) (8.3%)	1 (M) (4.2%)
2003	3,146	140	4.5	113	27	3 (F) (2.7%) 1 (M) (3.7%)	4 (F) (3.5%) 1 (M) (3.7%)	3 (F) (2.7%)	5 (F) (4.4%)	
2004	1,530	109	7.1	89	20		5 (F) (5.6%)	1 (M) (5.0%) 1 (F) (1.1%)	6 (F) (6.7%)	1 (M) (5.0%)
2005	4,104	75	1.8	66	9	2 (F) (3.0%) 1 (M) (11.1%)	3 (F) (4.5%)	1 (F) (1.5%)	8 (F) (12.1%)	1 (F) (1.5%)
2006	5,020	209	4.2	179	30	1 (M) (3.3%)	6 (F) (3.4%)	5 (M) (16.7%) 4 (F) (2.2%)	21 (F) (11.7%) 1 (M) (3.3%)	1 (F) (0.6%)
2007	2,796	142	5.1	114	28	1 (F) (0.9%)	3 (F) (2.6%) 3 (M) (10.7%)	2 (F) (1.8%) 1 (M) (3.6%)	10 (F) (8.8%) 1 (M) (3.6%)	1 (F) (0.9%) 1 (M) (3.6%)
2008	4,153	148	3.6	119	29				17 (F) (14.3%) 3 (M) (10.3%)	
2009	3,271	71	2.2	59	12	1 (F) (1.7%)			4 (F) (6.8%)	1 (M) (8.3%)

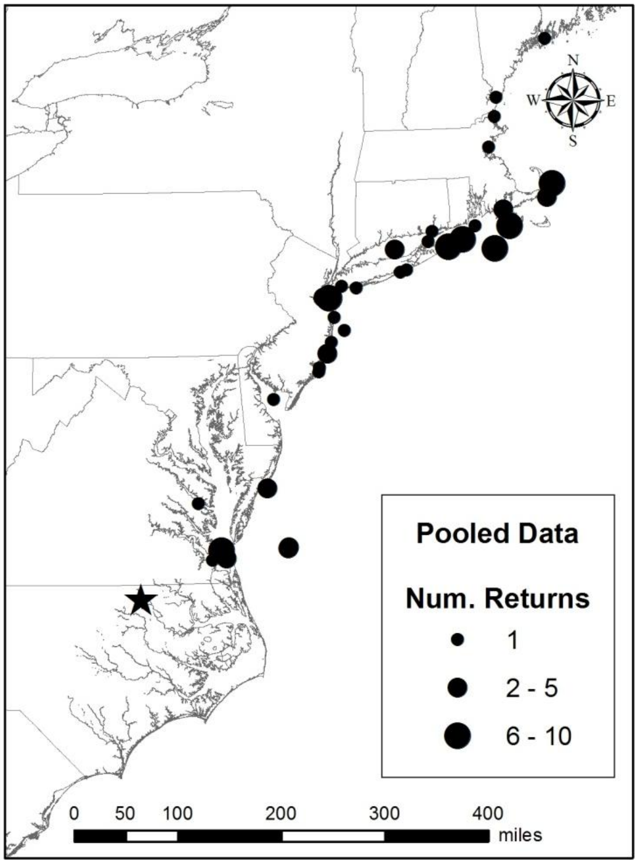


Figure 5. Locations of out-of-state returns (N=102) for striped bass tagged and released during electrofishing surveys on the Roanoke River spawning grounds (star on map) across years 1991-2010 (N=49,358). (Map Callihan et. al. 2011).

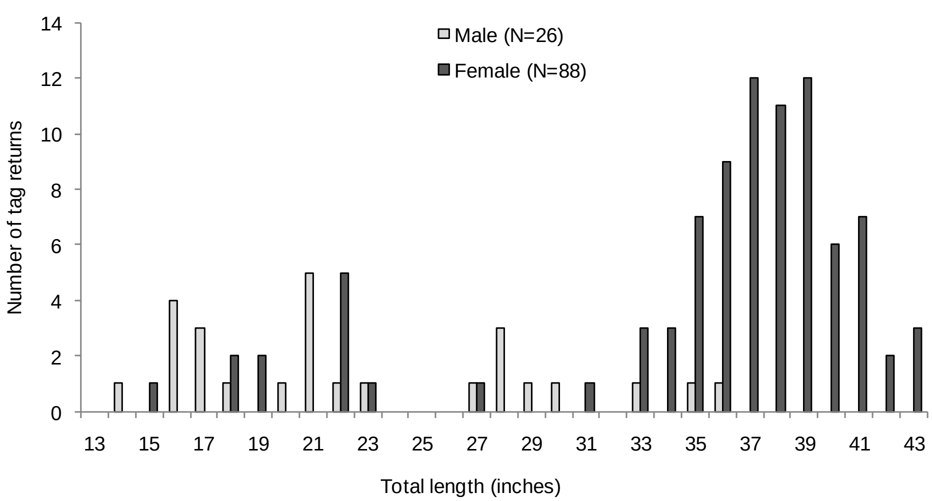


Figure 5.4 Total length (inches) of striped bass recaptured from outside North Carolina internal waters, tagged on the Roanoke River spawning grounds, 1991 – 2009. Total N tagged = 45,957.

The number of tagged fish that are recaptured in each geographic region will depend on the frequency of migration to the region from all others and on the intensity of sampling or fishing effort in the area (Dorazio et al. 1994). Low returns from other areas could indicate less fishing effort in those areas or a low rate of migration. A high return rate from internal waters may mean that few fish migrate, or that fish remaining within the sound are at a much higher risk of harvest than fish migrating to the ocean. A difference in tag return rates can also affect perceived migration rates. The size of tagged fish must be considered when examining return rates from different areas. Dorazio et al. (1994) reported relating total length to probability of migration to northern ocean waters, indicated that the probability of migration does not achieve 0.5 (50%) until fish are nearly 80 cm (31 inches TL). Considering the current size distribution for the A/R stock significant migration of the A/R stock to the coastal stock would not be expected.

The recreational fishery around Oregon Inlet grew significantly through the mid-1990s and was rather consistent into 2007. One hundred and fifty one tags have been returned from the Oregon Inlet area since 1994 (Table 5.3). Fifty-seven of these returns have occurred during October through December. The time period mid-April through August has accounted for 72 returns from this area. The majority of these returns (n=51) are from fish tagged on the spawning grounds that spring of capture, with a growing number exceeding 28 inches TL when released. The line of demarcation between the Atlantic Ocean and the ASMA is the centerline of the Bonner Bridge and the recreational fishery east of the line is open year round. Some anglers during the summer months target striped bass in this area and due to the 28 inch TL minimum size limit only large fish are retained.

Figure 5.1 shows the length frequency for the tag returns from the Fall-Winter NCDMF Gill Net Survey segments and Figure 5.2 for the Spring segments. Twenty-two returns were from the Fall-Winter surveys, with 90.1% of the returns less than 28 inches TL (Figure 5.1). Thirteen returns were from fish tagged during the Spring segment and only one fish was greater than 28 inches TL.

The Oregon Inlet area returns for striped bass tagged in the Roanoke River are shown in Figure 5.5, by sex. A total of 70 males has been recaptured ranging from 15-31 inches TL. Approximately, 84% of the males were less than 28 inches TL. Forty females have been recaptured with 47.5% of the returns being 28 inches TL or larger.

There has been an increase over time of fish tagged in the ASMA and RRMA and the number of returns from waters that flow into the Chowan River and southern systems in North Carolina. Four returns have occurred from the Blackwater and Nottoway rivers, VA from fish tagged during the Fall-Winter segments of the NCDMF Gill Net Survey in Albemarle Sound and two tags from fish tagged during the Spring segments. Nine tag returns from the Nottoway and Meherrin rivers, VA have occurred from fish that were tagged on the spawning grounds in Roanoke River one to four years previously. All of these returns have occurred in the spring. The striped bass spawning areas have not been determined in these systems by Virginia Department of Game and Inland Fisheries or Virginia Institute of Marine Science (VIMS) but based on early sampling by Street et al. (1975) spawning does occur in these systems. Five tags have been returned from Back Bay, VA from fish tagged and released on the spawning grounds on Roanoke River.

A total of 142 tags have been returned from the areas to the south (Pamlico Sound, Pamlico River, Pungo River, Tar River, Neuse River) of the ASMA and significantly increased during the period 1996-2009 (n=128).

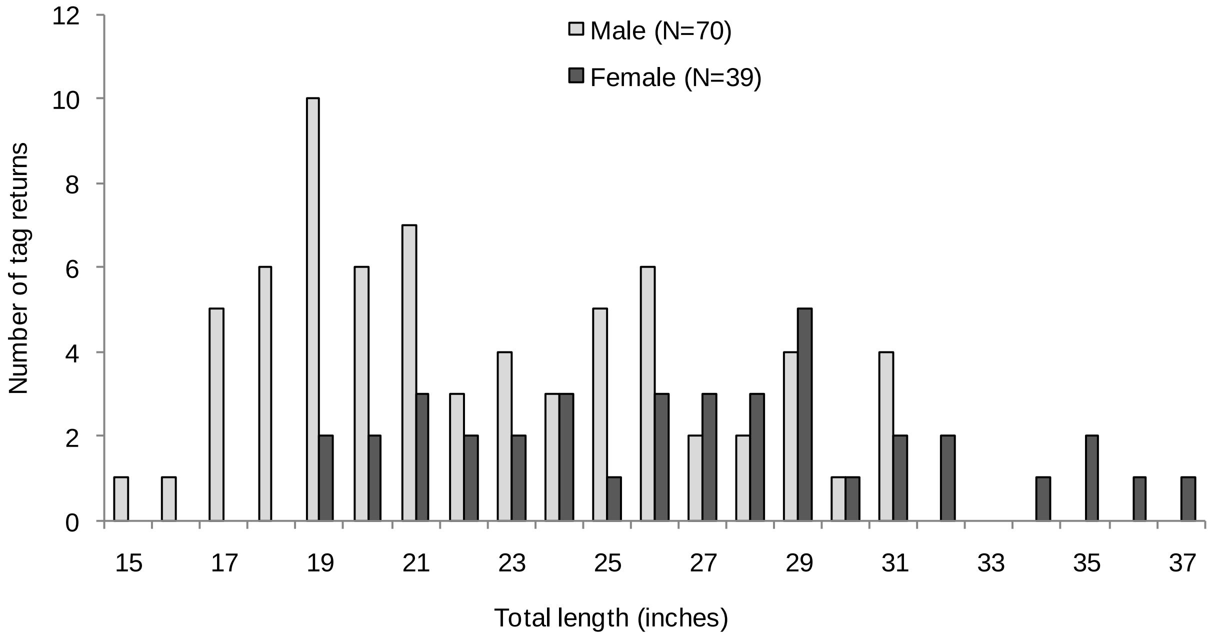


Figure 5.5. Total length (inches) of striped bass recaptured from the area around Oregon Inlet, NC, tagged on the Roanoke River spawning grounds, 1991 – 2009. Total N tagged = 45,957.

Though fish tagged in the ASMA and returned from these southern areas has increased somewhat, contributing 2.3% of the returns, the significance is the number of returns (n=112) from these areas of fish tagged on the spawning grounds in Roanoke River (Table 5.3). Hewitt and Hightower (2002) had one return from the Pungo River; the fish was tagged and released on the spawning grounds in Roanoke River. The majority of these returns (n=81) have occurred since 2000 and during June through December (n=64). Record increases in juvenile production during the 1990s through 2005 coupled with a significantly expanding age structure have resulted in an expansion in range of the A/R striped bass stock.

Thirty-one tag returns have occurred from North Carolina outside the ASMA from striped bass tagged through the NCDMF Gill Net Survey, Fall-Winter segments (N=19) and Spring segments (N=12), (Figures 5.1 and 5.2). Striped bass from the Fall-Winter segments ranged from 12-25 in TL and 15-23 in TL from the Spring segments.

A total of 80 males was returned from internal waters outside the ASMA from fish tagged and released in the Roanoke River, near Weldon (Figure 5.6). Males ranged in length from 13-33 in TL and the 17-20 in size groups accounted for 59%. Twenty-four females were returned from outside the ASMA. The 23-24 in TL size group accounted for 25% of the female returns (Figure 5.6).

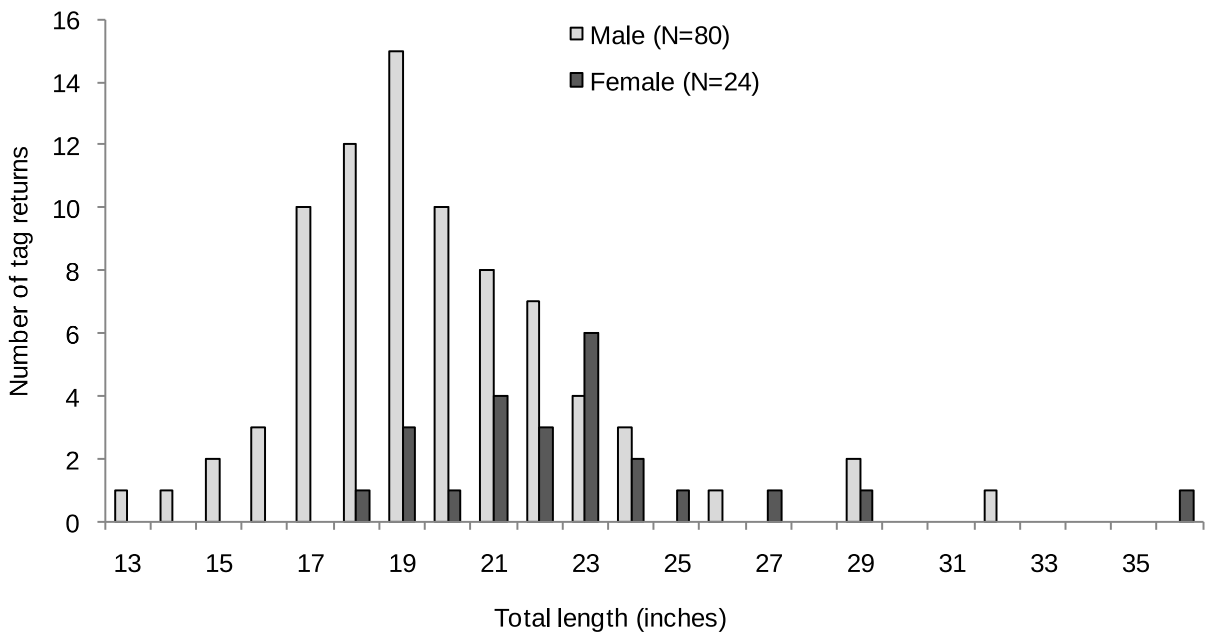


Figure 5.6. Total length (inches) of striped bass recaptured from North Carolina internal waters, outside the ASMA or RRMA, tagged on the Roanoke River spawning grounds, 1991 – 2009. Total N tagged = 45,957.

5.4.2 Phase II Striped Bass-Albemarle Area

The NCDMF in cooperation with the USFWS began a Phase II (5-8 inches TL) striped bass stocking program in the Albemarle Sound area in 1981. Annual stockings occurred through 1996 with a portion or all of the fish tagged prior to release. A total of 53,555 tagged Phase II fish was released and 4,711 tags (8.8%) were returned. Over the sixteen year period a total of 17 returns were from the Atlantic Ocean off NC or waters to the north of the State (Table 5.6). These percentages ranged from 0.3 to 3.2%. Fourteen of the 17 returns occurred within one year from release. These returns indicate very little contribution. However, these fish were considerably smaller (14 – 16 inches TL) than expected to be migratory.

Tags from Phase II fish were also returned from internal waters south of the ASMA. A total of 33 returns have occurred (Table 5.6). The percentage of returns from these areas has ranged from 0.8 to 50%. The Pungo River area has accounted for 84.8% of these returns. No tags from these stockings have been returned since 1997 from these areas.

5.4.3 Central Southern Management Area

5.4.3.1 NCDMF-Adult Striped Bass

Tagging studies conducted by Marshall (1977) and Hawkins (1980) indicated that Neuse River and Tar-Pamlico striped bass were riverine and endemic. These data also suggested that fish spent the winter in the Pamlico River between Washington and the mouth of the Pungo River and moved up the Tar River during the spring spawning run (Pate 1975; Marshall 1976; Winslow et al. 1983). It should be noted that these fish were of a young age when tagged and recaptured. Historically, both the New and White Oak rivers were shown to support runs of striped bass (Baker 1968). Sholar (1975) reported no striped bass were found in the New River and only three in the White Oak River. Fischer (1980) and Winslow et al. (1983) reported that striped bass were abundant in the Cape Fear River below Wilmington, January through May. Tagging studies as reported by Winslow et al. (1983) suggest that this stock is riverine endemic with exchange between the Cape Fear and the Northeast Cape Fear rivers.

Very limited tagging effort occurred on adult striped bass in the CSMA from 1980-1998. Since 1999, the NCDMF has incorporated various methods, including gill net surveys, minimal hook and line effort and electrofishing surveys to tag and release striped bass in the Cape Fear (n= 144), Neuse (n= 1,128), Pamlico River (n=284) systems and Pamlico Sound area (n= 111) (Table 5.7). All of the Cape Fear River tag returns have been from that system (Table 5.7). The percentage of tag returns from fish tagged in the Neuse River has ranged from 2.4 to 23.9% (Table 5.7). The majority of the returns were from the Neuse system. However, two returns were from the Pamlico River area, one from Roanoke River, near Jamesville, one from Oregon Inlet and one from the Atlantic Ocean off Avalon Pier in Kill Devil Hills, North Carolina. Eighty-eight percent of the Pamlico River tag returns have been from that system and three returns were from the Roanoke River, one from Alligator River and one from Trent River (Table 5.7). Only four tags have been returned from the Pamlico Sound tagging efforts but one of the returns was from Roanoke River at Scotland Neck and one from Moriches Inlet, NY.

5.4.3.2 NCWRC- Adult Striped Bass

During the spring 2002, the NCWRC began an electro-fishing survey and tagging/releasing adult striped bass on the spawning grounds in Neuse and Tar rivers and on the Cape Fear River in 2003. A total of 1,304 striped bass have been tagged and released in the Neuse River since 2002. One hundred and seventy-one tags have been returned, with all but one (Tar River) being from the Neuse system (Table 5.8). Efforts on the Tar River have resulted in 3,722 striped bass being tagged and released. Approximately, 12% of the tags have been returned, with 6 returns from the ASMA, one from New York and one from New Jersey (Table 5.8). The total number of striped bass ≥ 28 inches TL tagged/released in the CSMA and recaptures are shown by system in Table 5.9.

5.4.4 CSMA Phase II Striped Bass

A measure implemented as a result of the 2004 North Carolina Estuarine Striped Bass FMP was to stock two systems per year with Phase II striped bass in the CSMA.

5.4.4.1 Pamlico River

The Pamlico River has been stocked with Phase II striped bass on a rotating basis since 1983. A total of 37,629 tagged fish has been released and 1,141 tags (3%) returned (Table 5.10). The return rates have ranged from 0.7 to 20%. Only two tags have been returned from outside North Carolina waters; both were released in January 1996. One return was from Cape Cod Canal, MA in June 1998 and the other from Providencetown, MA in June 2001.

The percentage of returns from the ASMA/RRMA and the Neuse River drainage has ranged from 2 to 17.1% (Table 5.10), showing exchange between the internal waters of the state. The largest number of returns from these areas was from fish stocked in 1983 and recaptured within one year of release (Table 5.10). No returns from outside the Pamlico system have been reported since 2005 (Table 5.10).

Table 5.6. Albemarle Sound area Phase II striped bass stocking and tag return numbers, 1981 – 2009.

System	Release date	Total number stocked	Number tagged	Number recaptured	Total percent return	Recapture locations inside NC	Percent returns other NC systems	Recapture locations outside NC	Percent returns outside NC
Albemarle Sound area	Jan 26, 1981	87,181	10,000	1,817	18.2	22- Pungo R. 1- Long Shoal R. 1- Topsail Sound	1.3	9- Chesapeake Bay	0.5
	Jan 25, 1983	106,675	2,500	719	28.8	4- Pungo R. 2- Stumpy Pt. Bay.	0.8	2- Atlantic Ocean off Cape Lookout	0.3
	Dec 16, 1983	67,433	2,493	277	11.1			1- York River, VA 1- Indian River, DE	0.7
	Dec 10, 1984	236,242	6,445	575	8.9				
	Jan 10, 1986	45,200	1,110	38	3.4				
	Dec 9, 1986	118,345	4,999	453	9.1				
	Dec 9, 1987	15,435	2,500	214	8.6				
	Dec 9, 1988	5,000	5,000	94	1.9				
	Dec 7, 1989	3,289	1,400	22	1.6				
	Dec 19, 1990	2,000	2,000	62	3.1			1- Mystic River, MA 1- Newport River, RI	3.2
	Dec 11, 1991	2,994	2,994	321	10.7			1- Deep Creek, VA 1- Damariscotta River, ME	0.6
	Dec 15, 1992	2,465	2,465	84	3.4				
	Dec 9, 1993	2,180	2,180	20	0.9				
	Dec 8, 1994	2,481	2,481	2	0.08				
	Jan 10, 1996	2,498	2,498	14	0.6	2- Pungo Creek	14.3		
	Dec 12, 1996	2,490	2,490	2	0.08	1- Neuse River	50.0		
	Total	**701,908**	**53,555**	**4,714**					

Table 5.7. Number of adult striped bass tagged and released through NCDMF independent gill net and electrofishing surveys in the CSMA. The tag returns by system, year, gear and return area are presented below.

System	Release Year	# tagged	Recap. Gear*	# returned	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Return area
Cape Fear River	2003	7		0											
	2004	50	HL-8	8					6	1	1				Lock/Dam #2 to Brunswick River
	2005	19	HL-3	3						2		1			Lock/Dam #1 area
	2006	26	HL-2	2							2				Wilmington to mouth Town Creek
	2008	42	HL-8	8									3	5	NE Cape Fear River to Wilmington
Neuse River	1999	12	HL-2	2		2									Trent River
	2000	13	HL-1	1	1										Neuse R- Lenior Co.
	2003	30	HL-4	4				2		2					New Bern/Trent River to Hancock Cr.
	2004	59	HL-7 GN-3	10					6	4					Smithfield to Below New Bern, Pamlico R., Roanoke R- Jamesville
	2005	98	HL-14 GN- 2	16						4	7	4	1		Slocum Cr to Raleigh, Pamlico R- Garrison Pt.
	2006	375	HL- 58 GN-11 ES- 1	70							37	30	1	2	Hancock Cr. To above New Bern
	2007	180	HL- 34 GN- 5 ES- 4	43								33	9	1	Near Goldsboro to Hancock Creek; Oregon Inlet (1)
	2008	279	HL- 39 GN- 2	41									27	14	New Bern to Slocum Creek; Atlantic Ocean – Avalon Pier; Pamlico River – Chocowinity Bay
	2009	82	HL - 2	2										2	Slocum Creek
Pamlico River	1999	2		0											
	2000	13	GN-2	2	1		1								Chocowinity Bay to mid-Pamlico R.

Table 5.7 (Continued).

System	Release year	# tagged	Recap. Gear	# returned	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Return area
Pamlico River	2001	21	GN-2	2		1	1								Washington to Chocowinity Bay
	2003	28	HL-3 GN-2	5				1	4						Below Washington to Adams Cr, Pungo R,
	2004	16													
	2005	38	HL-8 GN-1 NCDMF GN-1	10						2	4	3	1		Upper Pamlico River, Pungo River, Roanoke River- Plymouth, Trent River, Alligator River
	2006	48	HL- 7 GN- 2	9							5	4			Washington to Rocky Mt; Roanoke Rapids
	2007	36	HL- 6 GN- 2	8								8			Upper Pamlico River
	2008	56	HL- 4 GN-1	5									2	3	Pamlico River to Pungo River; Roanoke River – Weldon
	2009	26	GN-1	1										1	Mouth of Bath Creek
Pamlico Sound	2000	6													
	2001	8	HL-1	1			1								Roanoke R – Scotland Neck
	2002	14	PN-1	1			1								Croatan Sound
	2003	29	HL-1	1					1						Moriches Inlet, NY
	2004	19	HL-1	1						1					Pamlico S- Hatteras Harbor
	2005	14		0											
	2006	12		0											
	2007	9		0											

*Recapture Gear

- GN = gill net
- HL = hook and line
- PN = pound net
- ES = electro-fishing

5.4.4.2 Neuse River

The Neuse River has also been stocked on a rotating basis since 1982. Tagged fish released in the system have totaled 39,308. Approximately, 2.5% (n=985) of these tags have been returned (Table 5.10). A tagged fish was recaptured at Conowingo Dam, MD and one in Hudson River, NY in July 1983. Both of these fish were released on February 3, 1982. A tagged fish (2002) was recaptured at Fire Island Inlet, NY in November 2007. These are the only returns from outside North Carolina for the Neuse River stockings.

The number of returns (n=18) from other internal waters of North Carolina have been north of the Neuse River and ranged from 0.8 to 14.3% (Table 5.10). The tag returns from the Phase II stocking program in the Pamlico and Neuse rivers indicate there is insignificant exchange with the Atlantic Migratory Stock. The return data show there is exchange between the ASMA/RRMA and the CSMA and in recent years the rate of exchange has increased.

5.4.4.3 Cape Fear River

Phase II stockings in the Cape Fear River have occurred seven times since 1980 (Table 5.11). No stockings occurred in the Cape Fear from 1990 through 2003, due to the lack of positive impact on the striped bass population and the high abundance of hybrids in the system. As recommended in the 2004 North Carolina Estuarine Striped Bass FMP, Phase II stocking was reinstated in 2004. A total of 17,095 tagged striped bass was released and 66 tags (0.4%) have been returned, with return rates ranging from 0.1 to 1.8%. All returns were from the Cape Fear system, except one tag was returned from the Roanoke River, at Weldon in April 2008. The moratorium implemented (2008) on striped bass harvest in the Cape Fear River has had an impact and resulted in the low number of tag returns from this system.

Table 5.8. Number of adult striped bass tagged and released by the NCWRC in the CSMA.

System	**Release year**	**No. tagged**	**Recap. Gear**	**No. returned**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**Return area**
CAPE FEAR	2003	29	HL-6	6		5	1						Buckhorn Dam/ Wilmington
	2004	44	HL-13	13			9	4					Lock/Dam 1, 2, 3 to Town Creek
	2005	81	HL-18	18				14	4				Lock/Dam 2 and 3 to Town Creek; Montauk Lighthouse, NY
	2007	67	HL-8	8						6		2	Lock/Dam 1 to 3; Northeast Cape Fear River
	2008	121	HL - 14	14							12	2	Town Creek to Lock and Dam #3
	2009	82	HL – 1	1								1	CFR - Lower Little River
NEUSE	2002	79	HL-8 GN-1 NCWRC ES-2	12	6	2	2	2					Clayton/New Bern/Goose Creek Tar River
	2003	352	HL-55 GN- 11 DMFGN- 1 NCWRC ES-10	77		43	22	5	6		1		Milburnie Dam/Clubfoot Cr, including Trent River
	2004	44	HL-1 GN-1	2				2					New Bern area
	2005	136	HL-20 NCWRC ES- 3	23				15	8				Pitch Kettle to below New Bern
	2006	55	HL-8	8					7	1			Flowers Gap to Hancock Cr.
	2007	169	HL-21 ES – 1 GN –1 DOA - 1	24						16	6	2	Above New Bern to Slocum Creek
	2008	126	HL – 9 ES – 2	11							9	2	New Bern to Wilson Mills; Tar River - Greenville
	2009	343	HL - 14	14								14	Goldsboro to Trent River
System	Release year	No. tagged	Recap. Gear	No. returned	2002	2003	2004	2005	2006	2007	2008	2009	Return area
TAR	2002	298	HL- 24 GN- 4 DOA- 1	29	10	9	6	2	2				Rocky Mt/ Broad Creek, 1 above mouth of Cashie River
	2003	177	HL- 23 GN- 4 DMFGN- 1	28		5	16	6	1				Rocky Mount/Grimesland/Broad Creek Bogue Sound- Atlantic Beach

Table 5.8 (continued).

System	Release year	No. tagged	Recap. Gear	No. returned	2002	2003	2004	2005	2006	2007	2008	2009	Return area
	2004	274	HL- 40 GN-6 Crab pot- 1	47			23	13	7	2	2		Tarboro/Bath Creek Roanoke River- Jamesville Neuse River above New Bern
	2005	1,273	HL-133 GN-24 NCDMF GN-9 PN - 1	167				53	68	39	3	4	Rocky Mount to Pungo Creek, Roanoke River (4), Albemarle Sound area (3), Shinnecock Inlet, NY
	2006	535	HL- 70 GN- 11 DMFGN- 1	82					44	36	1	1	Rocky Mount to Aurora
	2007	317	HL- 36	36						29	5	2	Rocky Mount to Goose Creek, Pitch Kettle Creek, Albemarle Sound, Spring Lake, NJ
	2008	501	HL – 34 GN - 10	44							23	21	Rocky Mount to Aurora; Neuse River – Kennels Beach
	2009	347	HL – 8 GN - 1	9								9	Tar River – Kennedy Creek to Bath Creek

*Recapture Gear

- GN = gill net
- HL = hook and line
- PN = pound net
- ES = electro-fishing

Table 5.9. Total number of striped bass tagged and released, $\geq$ 28 inches (TL) in the CSMA by the NCWRC.

System	Year	Total N Tagged	N tagged 28 inch/ Larger	Percent of Total	N Females	N Males	Release date	Location	Recapture date	Recapture Location	Size/Sex
Cape Fear River	2003	29	9 (4 unknown sex)	31	5		Apr 9, 2003	Cape Fear	Sep15, 2003	Wilmington	742/F
							May 3, 2003	Cape Fear	May 3, 2004	Cape Fear	778/F
	2004	44	7	15.9	7		Apr 14, 2004	Lock/Dam #2	Dec 22, 2005	Town Creek	716/F
							Apr 15, 2004	Lock/Dam #1	Sep 25, 2004	Lock/Dam #1	720/F
							May 13, 2004	Lock/Dam #2	Jul 3, 2004	Lock/Dam #2	722/F
	2005	81	26	32	19	7	Apr 12, 2005	Lock/Dam #1	Jan 8, 2006	Northeast Cape Fear	736/F
							Apr 12, 2005	Lock/Dam #1	Dec 11, 2005	Town Creek	718/F
							Apr 19, 2005	Lock/Dam #1	May 11, 2005	Lock/Dam #2	714/F
							May 10, 2005	Lock/Dam #3	Oct 29, 2006	Mouth Brunswick River	732/F
	2007	67	7	10.6	4	3					
	2008	121	9	7.4	7	2					
	2009	82	5	6.1	2	3					

Table 5.9 (Continued)

System	Year	Total N tagged	N tagged 28 inch/ Larger	Percent of Total	N Females	N Males	N Unknown	Release Date	Location	Recapture Date	Recapture Location	Size/Sex
Neuse River	2002	79	12	15.2	7	5		Apr 12, 2002	Below Quaker Neck	Jul 23, 2002	New Bern	742/F
								Apr 12, 2002	Below Quaker Neck	Sep 21, 2002	New Bern	772/F
	2003	352	27	7.7	22	5		Apr 23, 2003	Below Milburnie Dam	Aug 14, 2004	Above New Bern	716/F
								Apr 23, 2003	NC 42 – Johnson County	Sep 30, 2007	New Bern	720/M
								May 5, 2003	Above Quaker Neck	Sep 27, 2006	Goose Creek	731/F
	2004	44	7	15.9	4	3						
	2005	136	12	8.8	5	5	2					
	2006	55	2	3.6	2	0		Apr 12, 2006	Goldsboro	Oct 3, 2006	Hancock Creek	850/F
	2006							May 5, 2006	Near Goldsboro	Sep 27, 2006	Goose Creek	730/F
	2007	169	10	5.9	7	3						
	2008	126	3	2.4	2	1						
	2009	343	0									

Table 5.9 (Continued)

System	Year	Total N tagged	N tagged 28 inch/ Larger	Percent of Total	N Females	N Males	Release Date	Location	Recapture Date	Recapture Location	Size/Sex
Tar River	2002	298	36	12.1	23	13	Apr 17, 2002	Tar River	Jan 1, 2005	Near Bath	754/M
							Apr 24, 2002	Tar River	Jul 23, 2006	Near Aurora	777/M
							Apr 24, 2002	Below Rocky Mt.	Aug 31, 2002	Kennedy Creek	733/F
							Apr 29, 2002	Near Tarboro	Jun 19, 2002	Below Tarboro	713/F
	2003	177	27	15.2	21	6	Apr 29, 2003	Near Rocky Mt.	Oct 21, 2004	Gaylord Bay	730/M
							May 5, 2003	Near Rocky Mt.	Jun 18, 2005	Pamlico River	740/F
	2004	274	49	17.9	34	15	Apr 19, 2004	Near Rocky Mt.	Aug 8, 2004	Washington	748/F
							Apr 19, 2004	Near Rocky Mt.	Nov 19, 2004	Washington	711/F
							Apr 22, 2004	Near Tarboro	Jul 16, 2006	Near Aurora	757/F
	2004						Apr 22, 2004	Near Tarboro	Mar 25, 2007	Gaylord Bay	721/M
							Apr 27, 2004	Below Rocky Mt.	May 2, 2005	Greenville	754/F
							Apr 27, 2004	Below Rocky Mt.	Jul 19, 2004	Mouth Broad Cr.	712/F
							Apr 28, 2004	Near Tarboro	Oct 20, 2004	Washington	714/F
	2005	1,273	33	2.6	14	19	Apr 12, 2005	Near Rocky Mt.	Apr 3, 2006	Bear Creek	740/M
							Apr 14, 2005	Near Rocky Mt.	Apr 30, 2005	Dunbar Bridge	745/F
							Apr 14, 2005	Near Rocky Mt.	Apr 25, 2005	Near Tarboro	717/M
	2006	535	8	1.5	2	6					
	2007	317	6	1.9	4	2	Apr 9, 2007	Near Tarboro	Mar 24, 2008	Pitch Kettle	891/F
							Apr 30, 2007	Near Tarboro	Jul 2, 2008	Spring Lake, NJ	1,011/F
	2008	501	2	0.4	0	2					
	2009	347	3	0.9	3	0					

Table 5.10. Tar-Pamlico River Phase II striped bass stocking and tag return numbers, 1983 – 2009.

System	Release date	Total number stocked	Number tagged	Number recaptured	Total percent return	Recapture locations inside NC	Percent returns other NC systems	Recapture locations outside NC	Percent returns outside NC
Tar-Pamlico River	Jan 28, 1983	76,674	2,500	500	20.0	7- Alligator River, 12- Albemarle S. 1- Chowan River 13- Neuse River 2- Off Cedar Is. 1- Trent River	7.2		
	Dec 20, 1984	26,000	1,000	28	2.8				
	Dec 11, 1987	17,993	2,500	39	1.6				
	Dec 12, 1991	30,801	1,993	78	3.9				
	Dec 8, 1993	118,600	2,204	39	1.8	1- Currituck Sound 1- Neuse River	5.1		
	Dec 9, 1994	183,254	2,320	24	1.0	1- Roanoke River 2- Croatan Sound	11.1		
	Jan 10, 1996	140,972	2,497	49	2.0	1- Neuse River - Raleigh	2.0	1- Cape Cod Canal, MA 1- Providencetown, MA	4.0
	Dec 11, 1997	24,031	4,865	102	2.1				
	Dec 8, 1999	17,954	2,750	122	4.4	3- Neuse River 1- Trent River 1- Roanoke River	4.1		
	Dec 14, 2001	37,000	3,000	32	1.1	1- Neuse River 1-North River 1-Currituck Sound	9.4		
	Dec 11, 2003	159,996	3,000	20	0.7	1-Albemarle Sound	5.0		
	Dec 9, 2005	267,376	3,000	35	1.2	1-Chowan River 3-Neuse River 2-Roanoke River	17.1		
	Dec 5, 2007	69,871	3,000	52	1.7				
	Dec 14, 2008	91,962	3,000	21	0.7				
	Total	**1,262,484**	**37,629**	**1,141**					

Table 5.11. Neuse River Phase II striped bass stocking and tag return numbers, 1982 - 2009.

System	Release date	Total number stocked	Number tagged	Number recaptured	Total percent return	Recapture locations inside NC	Percent returns other NC systems	Recapture locations outside NC	Percent returns outside NC
Neuse River	Feb 3, 1982	47,648	2,100	230	11.0	1- Pungo River 1- Albemarle S.	1.3	1- Conowingo Dam,MD 1- Hudson River, NY	0.9
	Jan 13, 1986	39,769	2,119	60	2.8				
	Dec 8, 1988	71,092	2,500	22	0.9				
	Dec 11, 1990	61,877	2,992	84	2.8				
	Dec 14, 1992	116,820	2,527	137	5.4				
	Dec 9, 1994	79,933	2,212	7	0.3	1- Albemarle S.	14.3		
	Dec 13, 1996	100,760	4,998	119	2.4	1- Pamlico River	0.8		
	Dec 11, 1998	83,195	2,500	75	3.0	1- Tar River 2- Croatan Sound 6- Roanoke River 1-Scuppernong River	13.3		
	Dec 6, 2000	108,000	2,900	39	1.3				
	Dec 6, 2002	147,654	2,960	18	0.6	1-Pamlico River 1-Oregon Inlet	11.1	1-Fire Island Inlet, NY	
	Dec 14, 2004	168,011	2,500	7	0.2				
	Dec 6, 2006	99,595	3,000	52	1.6				
	Dec 5, 2007	69,953	3,000	135	4.5	1-Pamlico River 1-Chowan River	1.5		
	Dec 3, 2009	104,061	3,000	0					
	Total	**1,298,368**	**39,308**	**985**					

Table 5.12. Cape Fear River Phase II striped bass stocking and tag return numbers, 1980 – 2009.

System	Release date	Total number stocked	Number tagged	Number recaptured	Total percent return	Recapture locations inside NC	Percent returns other NC systems	Recapture locations outside NC	Percent returns outside NC
Cape Fear River	Jan 24, 1980	14,874	2,900	17	0.6				
	Jan 17, 1984	56,437	1,395	6	0.4				
	Dec 8, 1989	77,242	1,300	23	1.8				
	Dec 17, 2004	172,055	2,500	5	0.2				
	Dec 7, 2006	102,283	3,000	11	0.3	1-Roanoke River	9.0		
	Dec 4, 2008	92,580	3,000	4	0.1				
	Dec 3, 2009	112,674	3,000	0					
	Total	**628,145**	**17,095**	**66**					

6.0 STATUS OF THE STOCKS

6.1 ALBEMARLE/ROANOKE STOCK (ASMA AND RRMA)

6.1.1 Historical Condition 1955 to 1984

Dr. W. W. Hassler of NCSU conducted extensive research on striped bass fisheries and the A/R striped bass stock from 1955 to 1984 (Hassler et al. 1981, Hassler 1984; Hassler and Taylor, 1984). For most of those years Hassler estimated spawning population abundance through mark-recapture and regression of catch and effort, estimated egg production and egg viability, conducted juvenile abundance surveys, and estimated exploitation. Landings and effort for the primary commercial and recreational fisheries for striped bass in the Roanoke River and Albemarle Sound were also tabulated, however, that information is addressed in the description of the fisheries. Except where noted, information used to develop the following assessment of historic stock condition is all excerpted from Dr. Hassler's final reports (Hassler 1984, Hassler et al. 1984, and Hassler and Taylor, 1984).

Hassler estimated the size of the spring spawning run in the Roanoke River from 1956 to 1984. Two methods were used: 1) a Petersen mark-recapture method, based on annual estimates of exploitation from tag recoveries and total Roanoke River catch, for 1956-1984; and 2) Ricker's (Ricker 1940) regression of catch per unit effort for the commercial fishery, from 1956 to 1977. Hassler and Taylor (1984) noted a considerable decline in tag returns in 1981 following the imposition of considerable regulatory constraints. To avoid introducing a bias from the regulatory changes, they slightly modified the Petersen method and estimated spawning population abundance from annual Roanoke River harvest and average Roanoke River exploitation (tag derived), and provided updated estimates for the entire time series (1956-1984). All three estimates give similar pictures of spawner abundance over time (Figure 6.1). From 1956 to 1979 spawner abundance was variable, averaging around 300,000 fish and never falling below 100,000 fish. Estimated spawner abundance dropped nearly 70% between 1979 and 1980, and then declined even further in 1981 to only 12% of the 25 year average. Spawner abundance remained low in 1982 and 1983, although values for those years may be biased slightly low if regulatory changes imposed in 1981 reduced both harvest and exploitation.

Hassler developed a juvenile abundance index (JAI) based on trawl sampling in western Albemarle Sound. These data provide a long time series based on consistent methodology from which relative trends in abundance can be evaluated. Juvenile abundance varied considerably during the 1960s and 1970s, averaging 6.5 and ranging from 0.2 in 1958 to 23.4 in 1959. Between 1955 and 1977 only one observation fell below 2.0, while JAI values in 5 of the 6 years from 1978 to 1983 fell below 2.0 (Figure 6.2).

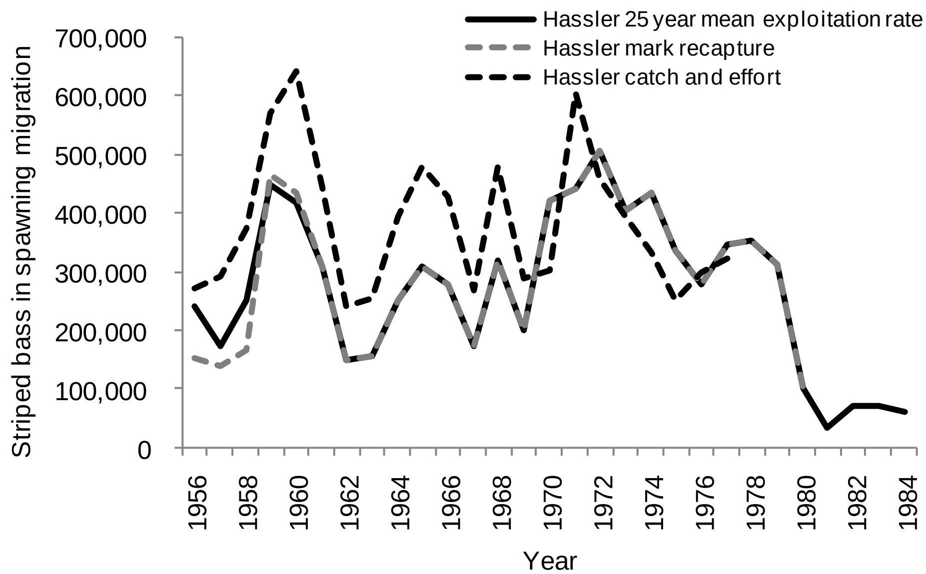


Figure 6.1 Estimated numbers of striped bass in the spawning migration ascending the Roanoke River, NC, 1956-1984.

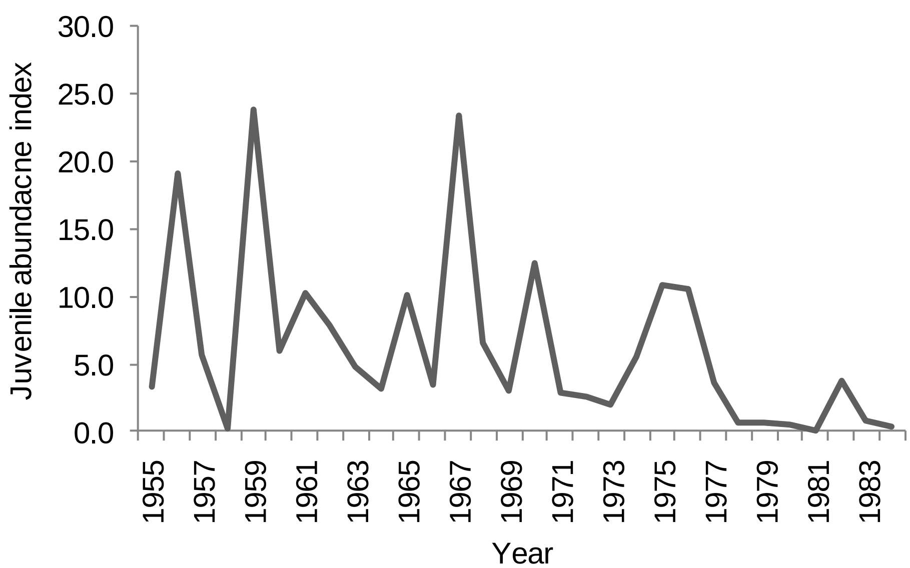


Figure 6.2 Juvenile abundance index values, 1955-1984.

Single year and multiple year exploitation rates were estimated annually from 1956-1984 (except 1975 due to lack of funds), based on the ratio of the tag returns to the total number of striped bass tagged annually. Striped bass were tagged in the lower Roanoke during April of each year. For the single year exploitation values, only the tags returned from the yearly tagging event through March 31 of the following year were used. The multiple year exploitation values utilized all tags returned, no matter how many years at large. In a few years some striped bass were tagged in the Albemarle Sound as well. The number of striped bass tagged annually ranged from 77 to 889 and averaged 451. During the 28 years of the tagging program a total of 12,619 striped bass were tagged in the Roanoke River (n=12,262) and Albemarle Sound (n=357), with a total of 3,328 tags recovered (26.4%).

As with all long-term tagging programs, several conditions can affect the validity of both the yearly values and the time series trend. First, the reporting rate (proportion of tags recovered that are actually reported) must be constant. Hassler notes that the apparent reporting rate dropped considerably following regulatory changes in 1981, and changed the estimation procedure for spawner abundance accordingly. Tagging programs are also vulnerable to a decline in reporting rate over time, as anglers become saturated with the rewards and the novelty of capturing a tagged fish wanes. Second, tags must be retained for the annual values to be valid, and the retention rate must not change over time for the time series to be valid. Fish were tagged with three separate tags over the study: 1956-1964, streamer tag; 1965-1969, spaghetti tag; and 1970-1984 Floy T-bar anchor tag. Hassler attributed the decline in the proportion of tags recovered after 1970 to tag retention problems stemming from inadequately anchoring the T-bar tags. Finally, tagged and untagged fish must be equally vulnerable to harvest. Most fish were tagged in the lower Roanoke River, and many were recaptured soon after and downstream of release. Striped bass have a tendency to ‘fall back’, or return downstream toward estuarine areas when handled during migration (Carmichael et al. 1998), and thus the vulnerability of tagged fish to capture by the significant upriver fisheries was likely reduced.

The single year rate of exploitation and multiple year rate of exploitation follow similar trends, with the multiple year exploitation slightly higher than the single year exploitation (Figure 6.3). These data show considerable fluctuations in the rate of exploitation. Moreover, the exploitation rates decline after 1970 when the program adopted the T-bar anchor tags (with known retention problems).

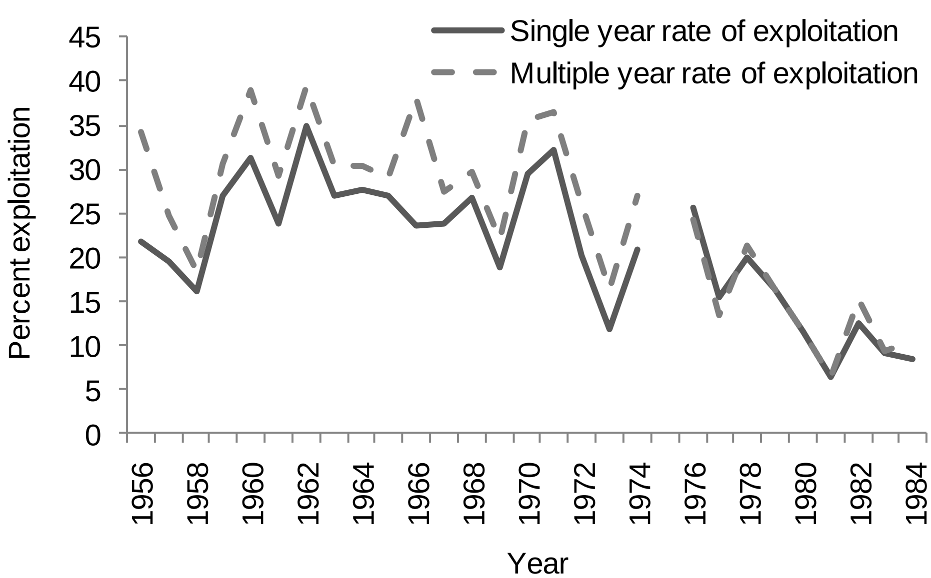


Figure 6.3 Single year and multiple year rates of exploitation for striped bass in the Roanoke River and Albemarle Sound, NC, 1956-1984.

Hassler estimated both egg production and egg viability. Egg production provides a measure of the magnitude of annual spawning, and egg viability provides a measure of egg survival. The two measures together provide an indication of overall spawning success, with the product of eggs spawned and percent viability a measure of total viable egg production. Egg production increased during the 1960s, to a high of nearly 5 billion in 1972. Production dropped to around 2 million until 1979, then dropped sharply in 1980 and 1981 (Figure 6.4). Viability averaged nearly 90% until 1975 when it dropped to below 60%. There was some recovery in 1980 and 1981, but viability did not reach the pre-1975 average and dropped again in 1983. Although egg production did not vary appreciably from the long-term average until 1980, the decline in viability led to an overall decline in viable egg production after the 1972 peak, with viable egg production falling below 1 million by 1976 and remaining low for the next 8 years (Figure 6.5).

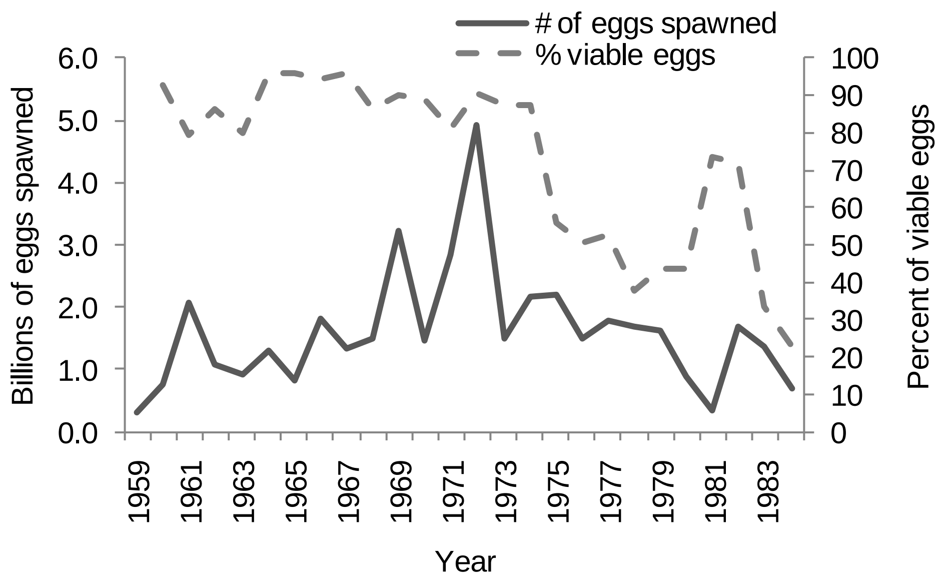


Figure 6.4 Total egg production and percentage of viable eggs, 1959-1984.

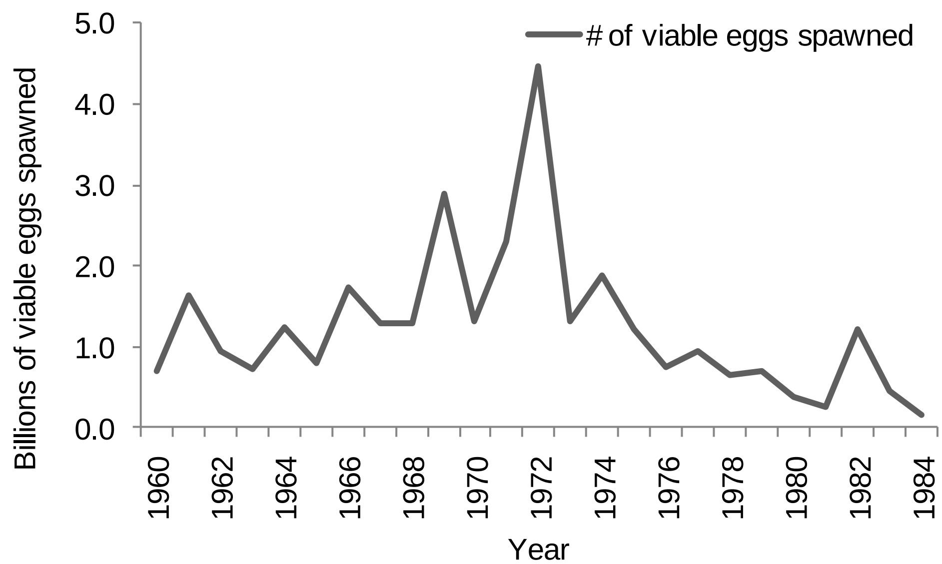


Figure 6.5 Total number of viable eggs spawned, 1960-1984.

A number of factors contributed to the decline in A/R striped bass stock in the late 1970s and early 1980s. Exploitation rates were beyond any level now believed to be sustainable throughout the series, and were at their highest levels in the late 1960s and early 1970s when declining egg production and poor juvenile survival began to drive down recruitment success. Any stock experiencing even moderate exploitation and reduced recruitment will begin to decline in abundance and biomass, and a stock that has sustained high exploitation for several generations has less reserve capacity and will typically show signs of decline within a few years. Spawning success generally declines as the average age in the population declines, and spawning magnitude declines as overall mature biomass declines.

Successful recruitment requires more than just spawning success and egg production; eggs must also hatch and juveniles must survive. Comparing juvenile abundance and total viable egg production, it is apparent that decreased juvenile survival may have been one of the earliest challenges to the stock (Figure 6.6). Egg production was highest in 1969 and 1972, yet JAI values in those years are among the lower values of the series. From the JAI, the only good year class produced from 1969 to 1973 was in 1970, even though viable egg production over these years was better than average. This suggests that poor larval survival may have been the cause of the initial recruitment failures.

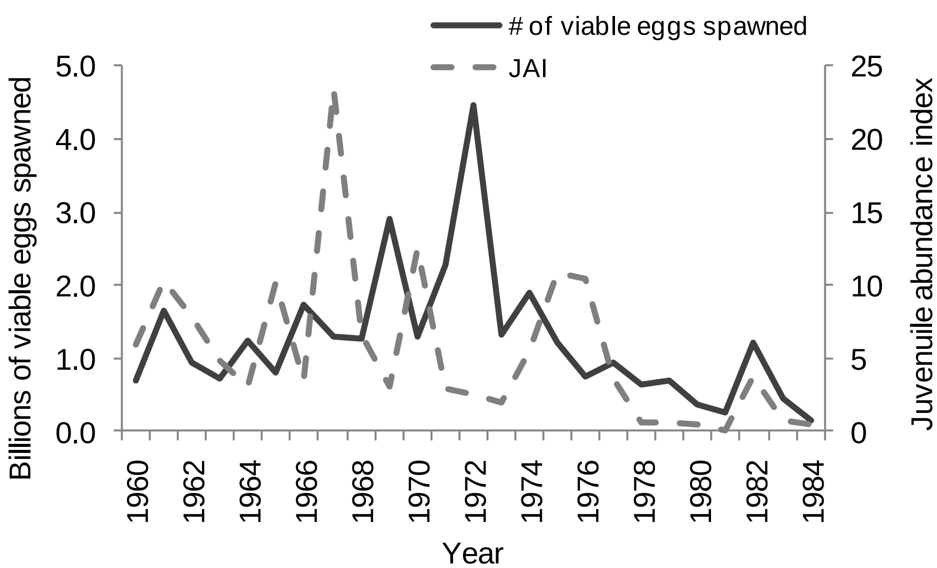


Figure 6.6 Juvenile abundance index and total viable egg production, 1960-1984.

High fishing mortality likely harvested any surplus stock generated by the strong 1970 year class within a few years, and with no other strong cohorts coming into the population, spawning stock abundance declined sharply after 1979. Reduced egg viability combined with declining egg production resulted in a steady decline in viable egg production after the 1972 peak. There is little information available from which to judge the reliability of the estimated decline in egg viability; the trend may be real or it may be an artifact of sampling. The USFWS Striped Bass Study Report to Congress (May 1992) suggests that the population age structure was truncated by the 1950s. Given that mortality estimates are high during the 1960s and 1970s, the age structure may have become severely truncated by the 1970s, with the spawning stock possibly composed of primarily first time spawners. First-time spawners produce fewer eggs and have a lower proportion of viable eggs than fish that have spawned multiple times. Some combination of truncated age structure, the possibility for a majority of the stock consisting of first-time spawners, an altered flow regime, and environmental degradation are likely to blame for the decline in viable egg production reported by Hassler et al. (1980) in the mid-1970s. The moderate 1975 and 1976 year classes indicated by the JAI apparently sustained the fishery and the spawning stock biomass through 1979, but were largely removed by fishing by 1980, therefore spawner abundance dropped markedly. Support for this scenario is provided by NCDMF sampling of the age composition of the Albemarle Sound commercial fishery, which shows that in 1980 and 1981 nearly 80% of the harvest was composed of age 1 and 2 fish from the 1978-1980 cohorts.

Although additional management measures were imposed in 1981, the damage to the stock had already occurred. The few recruits produced by the stock in the early 1980s largely supported the fisheries and provided no improvement in spawner abundance. Commercial fishery harvest shifted from 3 to 5 year old fish in the 1970s to 1 and 2 year old fish in 1980 and 1981, then 2 and 3 year old fish under the increased minimum size after 1981. It is likely that recreational fisheries exhibited a similar shift, although no data are available on the recreational fishery age composition until the 1990s. The stock remained at low abundance and fishery yields remained low for over 10 years until the late 1990s.

6.1.2 Current Condition

The following information is excerpted from the most recent A/R striped bass stock assessment (Takade-Heumacher 2010) and annual ASMFC compliance reports summarizing monitoring programs conducted on the A/R striped bass stock (Godwin et al. 2010). The entire stock assessment document can be found in appendix 14.6.

Currently the A/R stock is not experiencing overfishing and is producing a sustainable harvest. The uncertainty associated with the precise level of spawning stock biomass (SSB) as estimated from the stock assessment prevents a determination from being made on the overfished status of the stock. However, based on annual monitoring programs conducted by the NCDMF and NCWRC, the SSB appears to be healthy, with a good amount of age 6+ females in the population, and a broad age structure with the current maximum age observed on the spawning grounds of 17.

Recruitment (age-1 fish) was below the estimated time series average (312,111 fish) for the first eight years of the stock assessment. In contrast, only three of the last eight years were below the time series average for age-1 fish. Recruitment estimated for the terminal year (2008) of the assessment was 202,000 fish. Peak recruitment of 618,000 fish occurred in 2006, and the minimum recruitment (45,000 fish) during the time series occurred in 1988 (Figure 6.7).

Spawning stock biomass has been increasing steadily since 1991. In 1991, the estimated SSB was 267,377 lb, with the highest SSB occurring in the terminal year at 3,998,921 lb. Between 1991 and 2008, there have been consistent gains in SSB. The lowest SSB occurred in 1985 at 244,823 lb (Figure 6.8).

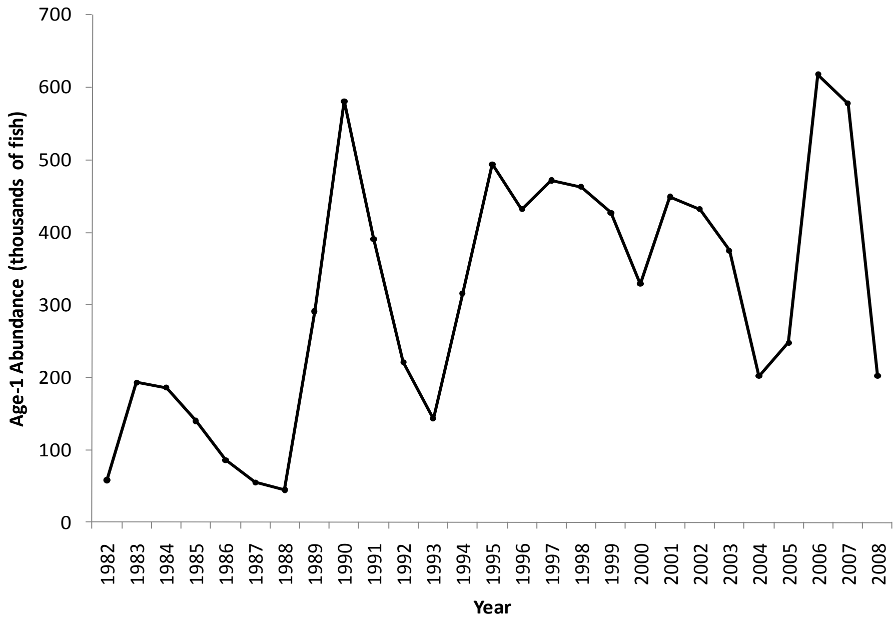


Figure 6.7 Estimated recruitment of striped bass at age-1, 1982-2008.

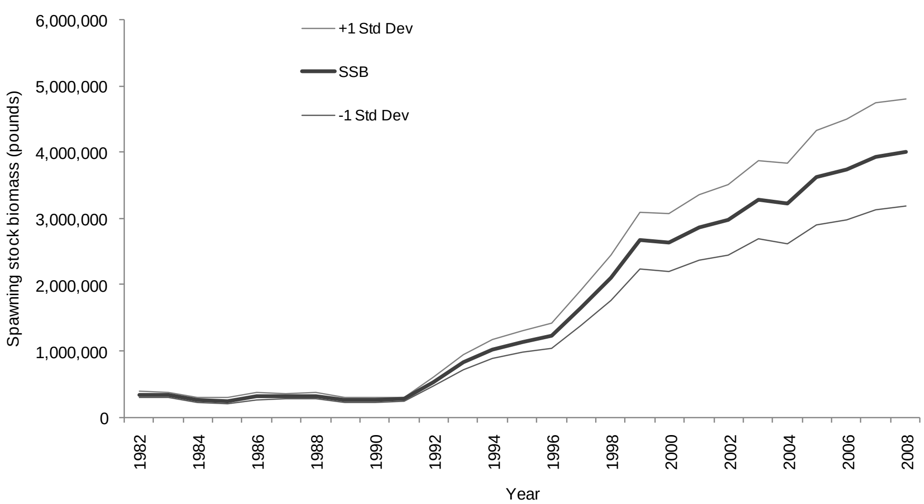


Figure 6.8 Spawning stock biomass of female striped bass, 1982-2008.

Total abundance showed an increasing trend for most of the time series. Total abundance peaked in 2007 at 2,051,000 fish. Prior to 1994, the total abundance was less than one million fish, while every year since 1994 the total abundance has been greater than one million fish (Figure 6.9). The abundance of age-9+ fish has also increased significantly, beginning in 1997. The terminal year age 9+ abundance was estimated to be 258,000 fish, which was a significant increase from the 1982 age-9+ abundance of 15,000 fish.

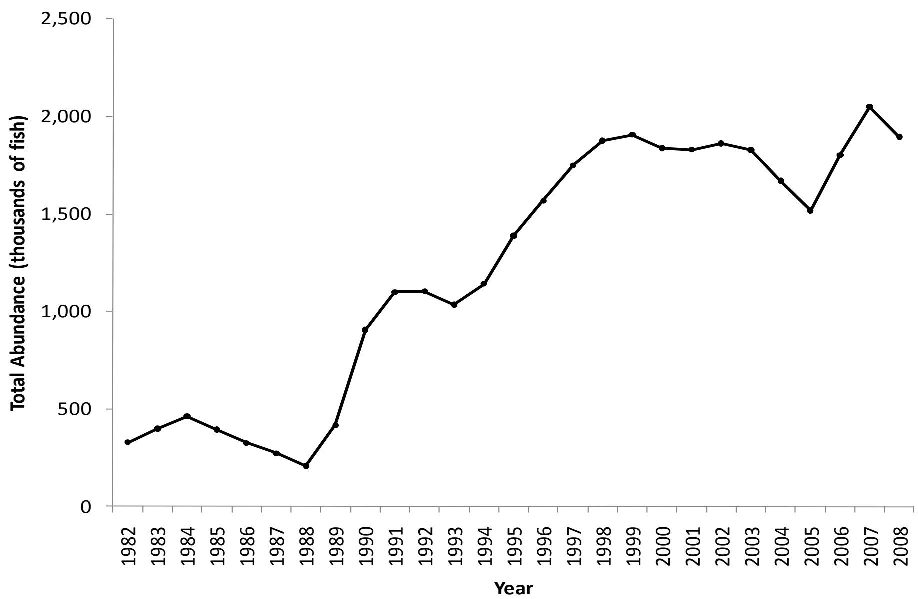


Figure 6.9 Estimated total striped bass annual abundance, 1982-2008.

The overall trend of fishing mortality (F) showed a recent decline from the earliest part of the time series. The average F on ages 4-6 peaked once in 1984 at 1.01. After 1988, there was a decline in F to one of the lowest in the time series in 1995 at 0.13. The F then began to slowly increase and hit a plateau from 2000 through 2004. Since 2004, the F has decreased from 0.34 to 0.10 in 2008, the lowest in the time series (Figure 6.10).

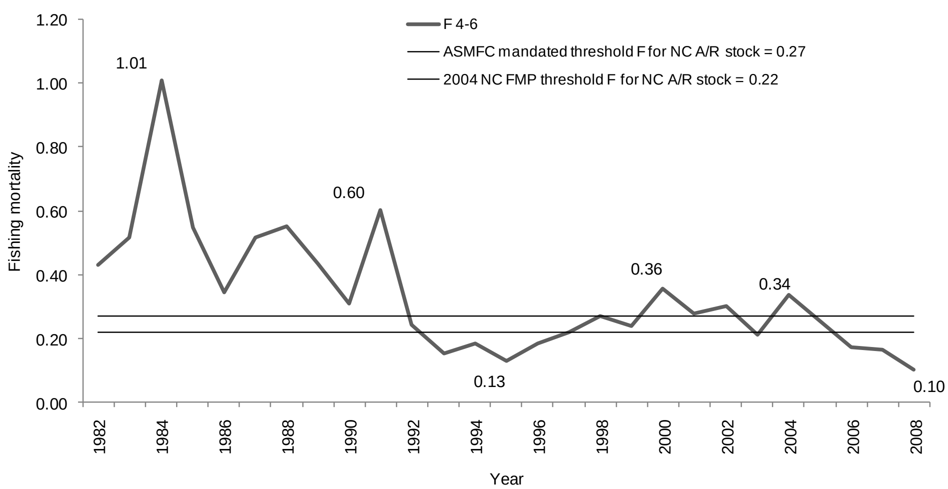


Figure 6.10 Estimated striped bass fishing mortality on ages 4-6, 1982-2008.

In comparing results from the stock assessment to independent monitoring data, both the total abundance and abundance of age 9+ fish sampled in the annual Roanoke River spawning stock electrofishing survey has increased steadily since the survey began in 1991 (Figures 6.11 and 6.12). The overall relative abundance of fish sampled on the spawning grounds is dominated by 3 and 4 year old males, which often comprise 80%-90% of the sample. In 2009, 4,761 fish were sampled by electrofishing on the spawning grounds, of which 4,132 were age 2-4 (males = 3,448 and females = 684). The number of age 9+ fish collected in 2009 totaled 127. To date, the oldest fish collected on the spawning grounds is 17 years old. By contrast, in the early years of the survey the age structure of the stock was truncated, with few fish over 6 years old collected. This expansion in the age structure of the stock supports the conclusion of the stock assessment that the A/R stock is not experiencing overfishing. A broad age structure is also vital to maintain a healthy stock as females tend to produce more viable eggs as they age. The fecundity (amount of eggs produced) of female striped bass increases about 100,000-200,000 eggs with each year of growth. Average fecundity of a 3 year old mature female is about 181,000 while a 16 year old fish may produce 5,000,000 eggs (Olsen and Rulifson 1992). A broad age structure also helps protect the stock from single year or consecutive years of spawning failures due to uncontrollable environmental conditions, such as flood or drought conditions during the spring spawning period.

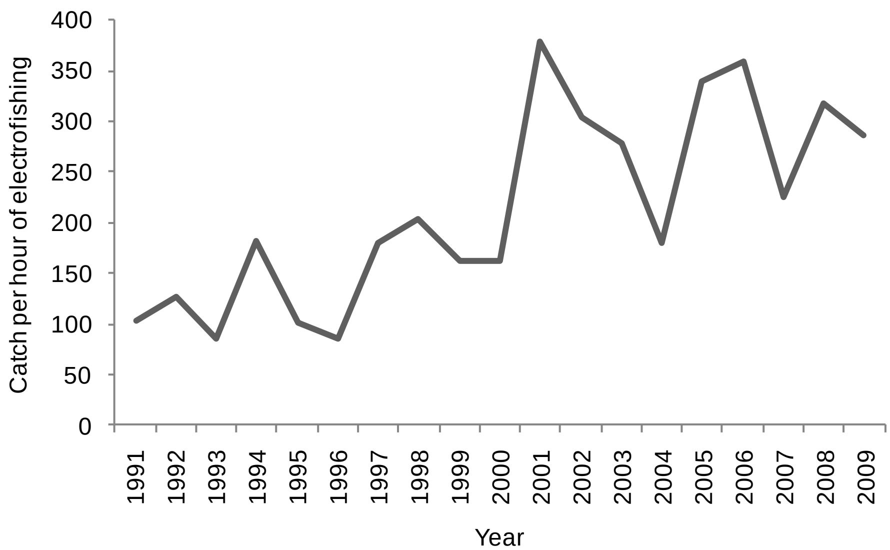


Figure 6.11 Catch per unit of effort (fish/hour) of striped bass collected on the spawning grounds during the A/R striped bass spawning stock electrofishing survey, Roanoke River, North Carolina.

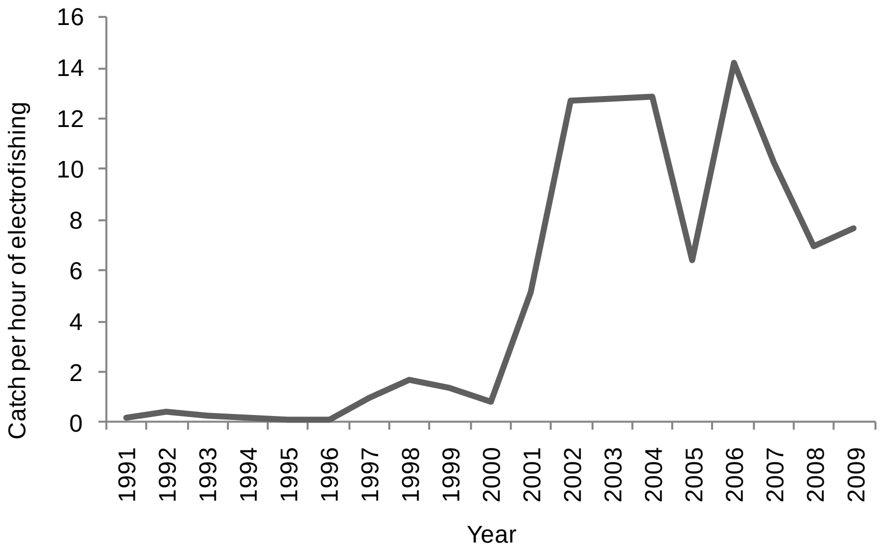


Figure 6.12 Catch per unit of effort (fish/hour) of age 9+ striped bass collected on the spawning grounds during the A/R striped bass spawning stock electrofishing survey, Roanoke River, North Carolina.

While total abundance has seen an overall increase during the time series, the stock did experience a decline in abundance of age 4-6 fish in 2007 and 2008 when compared to the abundance in 2000-2006 (Figure 6.13). As noted in Figure 6.13, juvenile production as measured by the A/R JAI was variable from 1955 through 1977, with a few really good years of spawning success, a few really poor years, and the rest could be classified as average. This is typical of anadromous fish that spawn in inland coastal rivers where environmental conditions can be highly variable from year to year. This environmental variability is most closely related to spring rains and hence river flow. River flow is one of the most critical components of striped bass spawning success.

The average JAI for 1955-1977 was 8.4. In 1978 the stock experienced the first of several years of continued spawning failures. From 1978-1987 the average JAI was 0.82, with only 1982 having what could be considered even close to an average JAI of 3.82. In 1988 and 1989 the stock experienced successful spawns in consecutive years for the first time in 11 years, since 1975 and 1976. By the early 1990s state and federal fishery managers were doing everything possible to protect what part of the stock remained as well as improve spawning success. Actions included harvest reductions of 80%, the implementation of three additional monitoring programs, numerous studies determining the optimal springtime flow regime in the Roanoke River that would provide the potential for successful spawning, and the formation of a committee to work cooperatively with the United States Army Corps of Engineers (USACE) to implement an optimal spawning flow regime.

All of these efforts set the stage for what would become a remarkable stock recovery. For six consecutive years, 1993-1998, the stock experienced successful spawns, with three of those years, 1993, 1994, and 1996, having the highest JAIs on record to date. There was an unsuccessful spawn in 1999, followed in 2000 by what remains the highest JAI on record of 58.8. The average JAI from 1993-2000 was 24.5, three times the average JAI of the entire time series prior to stock collapse in 1978. The unprecedented spawning success from 1993-2000 led to very high levels of age 4-6 abundance and thus the increased harvest rates in the commercial and recreational fisheries.

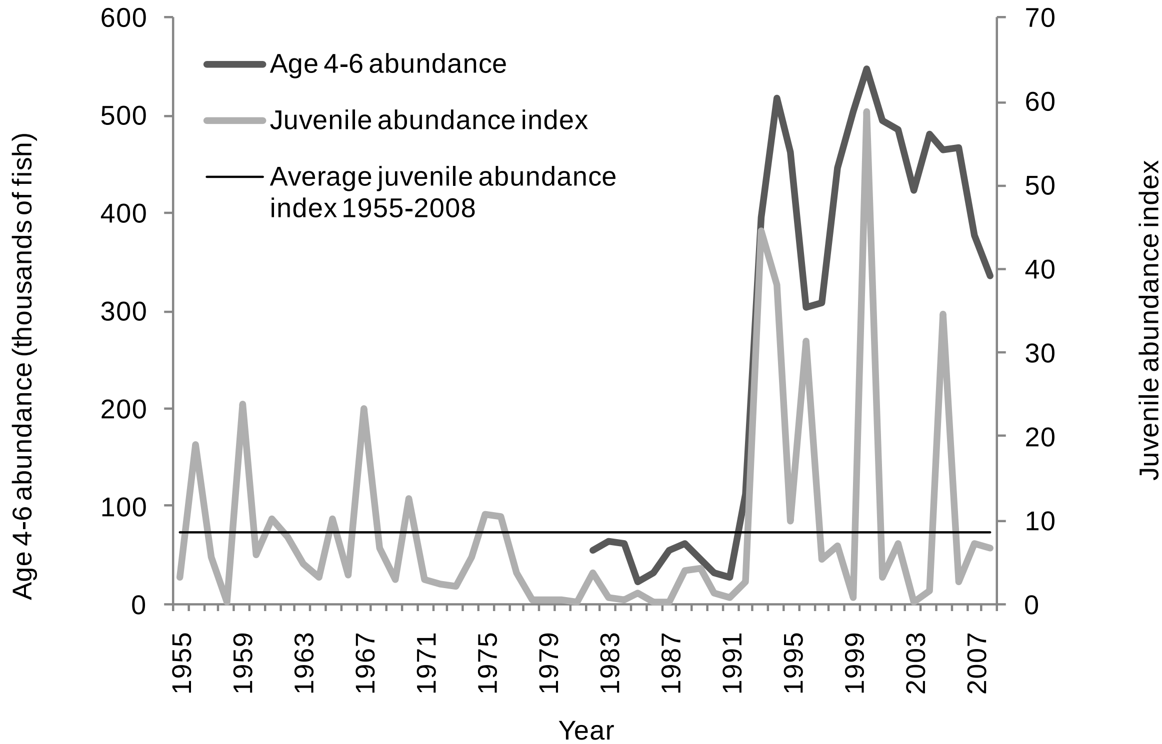


Figure 6.13 Estimated abundance of age 4-6 A/R striped bass from the latest stock assessment (1982-2008), and the annual juvenile abundance index for the A/R stock (1955-2008).

It was not reasonable to expect this level of spawning success, and therefore harvest, to continue. The period from 2001-2008 had an average JAI of 8.0, which is close to the historical average JAI prior to stock collapse of 7.9. The stock also experienced two consecutive years of very poor spawns, in 2003 and 2004. This led to the decline in age 4-6 abundance seen in the last few years of the stock assessment. Since the last exceptional spawn in 2005, the stock has averaged a JAI of 5.2 (2006-2010), slightly below the long-term series average of 8.4.

6.2 CENTRAL SOUTHERN MANAGEMENT AREA STOCKS

6.2.1. Historical Conditions

In North Carolina, estuarine striped bass of the Tar/Pamlico, Neuse and Cape Fear watersheds are managed as an internal stock in a management unit recognized formally as the CSMA. The CSMA striped bass historical conditions are not as well documented as those of the ASMA. The CSMA striped bass catch has accounted for an average of 5.9% of the North Carolina striped bass commercial landings from 1930 through 1960 (Chestnut and Davis 1975, NCDMF 2004). Since the CSMA commercial quota has been established, CSMA striped bass landings have accounted for a total of 13% of all striped bass commercial landings in internal waters. For more information refer to Section 7 Status of the Fisheries.

In the 2004 North Carolina Estuarine Striped Bass FMP (NCDMF 2004) exploitation rates for the CSMA were estimated from catch curves using data from electrofishing surveys conducted by the NCWRC on the spawning grounds of the Tar/Pamlico and Neuse rivers. Available data at the time were inadequate to estimate F and SSB targets and thresholds, so the ASMA target F of 0.22 was used as a proxy for the CSMA stocks. The CSMA F rates from the catch curves for the Tar/Pamlico and Neuse river stocks were compared to the F target to determine the stock status. The Tar/Pamlico and Neuse River striped bass F rates were significantly higher than the target F and thus, it was determined that overfishing was occurring on these stocks (NCDMF 2004). Regulatory actions were implemented in July 2008 by the NCWRC and the NCMFC with the objective of reducing overall fishing mortality in the Neuse and Tar/Pamlico rivers by ~64% and disallowing any commercial and recreational harvest in the Cape Fear River. (See Section 7.0 and Appendix 14.7).

Given the lack of historical data it is difficult to compare the current stock condition to historical stock conditions. Also, a reasonable expectation of what constitutes a "good" population in the CSMA riverine systems is needed in order to judge the current stock condition. In some instances comparisons from other systems might be used in order to determine a "good" stock level. Unfortunately there are many variables that differ between the CSMA and other systems (see Section 10.0 Environmental Status).

6.2.2. Current CSMA Stocks Conditions

The index-based method of catch curve analysis was used to assess the status of striped bass populations in the CSMA (NCDMF 2010, Appendix 14.7). Exploitation and mortality were estimated for the Tar/Pamlico and Neuse river stocks using CPUE from the NCWRC electrofishing spawning grounds survey and the NCDMF Program 915 independent gill net survey. Catch curve techniques in this case, will not detect small scale changes in population characteristics. For this reason, catch curve results (especially annual estimates of mortality) were supplemented with additional quantitative information (such as trends in mean CPUE).

As shown in the CSMA 2010 stock assessment the large confidence intervals and lack of precision in the catch curves Z estimates (total mortality rate) make them unsuitable for making a stock determination (NCDMF 2010). This view was supported by the peer reviewer comments. The lack of adequate data causes the CSMA stocks to be quantitatively assessed as unknown and to be listed as "concern" in the NCDMF annual stock status report (NCDMF 2010). The stocks may be reassessed during the next five year FMP amendment as more data become available through the completion of the numerous research recommendations (List 1). Improvements in the age structure of the CSMA striped bass stocks are expected from the regulatory restrictions implemented under the 2004 FMP and from the protective measures for endangered species implemented in May 2010 (see Section 8). The need for continued conservation management efforts at this time are supported by the constrained size and age distributions, low abundance, and the absence of older fish in the spawning ground surveys. Since the 2004 FMP there has been little change in the size and age distribution with few age 6 and older fish observed from any given cohort in any system.

In order to perform a thorough stock assessment in the future there are several research gaps that need to be fulfilled (NCDMF 2010):

List 1. Research Recommendations from the CSMA stock assessment (2010) (H- High priority, M- Medium priority, and L- Low priority).

Life History

- *Determine system of origin of fish on the spawning grounds (H).*
- *Acquire life history information: maturity, fecundity, size and weight at age, egg and larval survival (short term research projects) (H).*
- *Conduct a mark-recapture study utilizing conventional tags and telemetry approaches (expanded program) (H).*
- *Determine if suitable striped bass spawning conditions exist in the Tar/Pamlico, Neuse, and Cape Fear rivers (M).*
- *Conduct egg abundance and egg viability studies (M).*
- *Determine contribution of stocked fish to spawning stock (M).*
- *Determine extent of spawning grounds (L).*

Fishery Dependent Surveys - Recreational and Commercial

- *Improve discard estimates and discard biological characteristics from commercial fisheries (trip level observer coverage) (M).*
- *Obtain biological characteristics such as length, weight, age, and sex of recreational harvest (expanded creel surveys) (M).*
- *Obtain biological characteristics such as length, weight, age, and sex of commercial harvest (increased sampling, age structure collection) (M).*
- *Improve discard estimates and discard biological characteristics from recreational fisheries (creel survey) (L).*
- *Conduct delayed mortality studies for recreational and commercial gear (short term research projects) (L).*

Fisheries Independent Surveys

- *Conduct independent surveys that adequately capture all life stages of striped bass (H).*
- *Conduct a short term study to determine vulnerability-at-length for survey gears (L).*

6.2.3 Tar/Pamlico River Stock

The Tar River and Neuse River stocks are similar and showing no signs of improvement. Results of the 2004 FMP estimated that total mortality was excessive. The size and age distributions have not changed with few fish older than age 6 being collected. Annual CPUE were generally higher in the Tar River than the Neuse River. The NCWRC spawning grounds survey (1996- 2009) ranged from 19.5 fish/ hour in 1996 to 80.2 fish /hour in 2005 while the NCDMF Program 915 ranged from 0.7 to 1.7 fish per sample. Catch curves for the Tar River included ages 3 through 7. For the NCWRC spawning grounds survey, ages 3 through 5 varied over time with no trends until 2005 where there is a slight increasing trend. There has been increase in age 3 fish observed since 2005 while age 6 have been declining since 2000 and age 7 have been declining since 2004. NCDMF Program 915 trends are similar to those of the NCWRC survey (Appendix 14.7).

6.2.4 Neuse River Stock

Results of the 2004 catch curve analysis suggested that cohort mortality was excessive for the Neuse River stock of striped bass. Since the 2004 FMP, there has been little change to the size and age distributions and few older fish (age > 6) have been collected. Annual CPUE from the NCWRC spawning grounds survey on the Neuse River ranges from a low of 4.8 fish per hour in 2006 to a peak of 22.7 fish per hour in 2009 while the NCDMF Program 915 survey CPUE ranged from 0.6 to 1.2 per sample. Catch at age showed little to no trend for ages 3 through 5 while age 6 showed a decreasing trend in both surveys.

6.2.5. Cape Fear River Stock

A no harvest moratorium was established for striped bass in the Cape Fear River and its tributaries by the NCMFC and the NCWRC in 2008 as a result of research recommendations identified in the 2004 North Carolina Estuarine Striped Bass Fishery Management Plan (NCDMF 2007). Recreational and commercial harvest was closed due to apparent overfishing and low abundance of striped bass in the spawning ground survey conducted by the NCWRC. Efforts to quantify the current trends in the population size of striped bass in the Cape Fear River have been hindered by a limited time series as well as an incomplete cohort comprised of relatively few fish as compared to the other systems in the CSMA.

7.0 STATUS OF THE FISHERIES

7.1 INTRODUCTION

In North Carolina's coastal sounds and tributary rivers, striped bass are harvested in both commercial and recreational fisheries. Commercial fisheries occur in coastal and joint waters and recreational fisheries occur in coastal, joint, and inland waters. Striped bass harvest in the Atlantic Ocean; both commercial and recreational are managed consistent with coastwide specifications in the Amendment 6 to the ASMFC Interstate FMP for Atlantic Striped Bass (ASMFC 2003).

7.2 COMMERCIAL FISHERIES

7.2.1 A/R Stock

7.2.1.1 Historical

The Albemarle Sound area commercial striped bass fishery has been documented in numerous reports for over 100 years. In 1872, one of the most important striped bass fisheries began to develop through the haul seine fishery in Albemarle Sound. Striped bass were a bonanza to the haul seine fisheries in the Edenton area. Capehart's Avoca haul seine fishery in western Albemarle Sound was considered the best location to capture striped bass. Catches were phenomenal; on May 6, 1876 the first haul of the seine yielded 38,000 pounds and the second haul 13,000 pounds. Many of the fish weighed 80-90 pounds, with one reported at 105 pounds. Virtually all of the fish were iced and shipped to Norfolk, VA and sold to dealers in Washington, DC, Baltimore, MD, Philadelphia, PA and New York, NY (Taylor 1992).

During the early 1880s, a large fishery developed on Roanoke Island catching striped bass in the spring and fall. Gears included haul seines, drag nets, purse seines, fish traps and gill nets. The fish were small, averaging 1 – 2 pounds but the numbers were staggering. In 1886, a typical year, the 215 striped bass fishermen of Roanoke Island caught roughly 380,000 pounds. By the late 1880s, S.G. Worth reported that "The establishment and continuance of the pursuit accounts fully for the decrease or disappearance of the striped bass at the fisheries higher up on the Albemarle Sound" (Taylor 1992).

The huge haul seines, though very efficient, ultimately became victims of their own size. Harvest was high for a period of time and then dropped drastically. In 1869, two Ohio brothers, Captain John and William Hetterick, arrived in Edenton and began fishing with pound nets in Albemarle Sound (Earll 1887). The pound net, a simple device, is a long line of stakes draped with netting extended out into the channel which divert migrating fish into a small, heart-shaped funnel and then into the "pound". One or two men in a small boat used large dip nets to remove the fish from the pound. The use of the pound nets revolutionized fishing in North Carolina, especially in Albemarle Sound (Taylor 1992).

Pound nets had several advantages over the large haul seines: cost was just a few hundred dollars, were tended by only two or three men, and could be set anywhere. The number of pound nets increased from 117 in 1880 to 1,125 by 1896 in Albemarle Sound (Taylor 1992). Chestnut and Davis (1975) reported that 2,767 pound nets were set in North Carolina in 1927. Although the pound nets were set primarily for river herring and shad; striped bass were a considerable portion of the harvest. From the late 1880s through 1954 pound nets accounted for

26-62% of the total striped bass commercial harvest (Section 14, Appendix 1). The fish caught in the pound nets varied in size. Smith (1907) reported several striped bass captured in pound nets at Edenton in 1891 that weighed 125 pounds. By the late 1960's through the early 1970's, pound net contribution to the striped bass harvest had dropped to 4.8 – 7.3% of the total. Gill nets, anchor and drift, have historically been used in the striped bass fishery. Since the development of monofilament webbing, gill nets have been the dominant harvest gear. By the late 1960s to the early 1970s, gill nets were accounting for up to 77% of the striped bass harvest. Striped bass were also harvested by purse seines, fish wheels, hoop and fyke nets and trotlines.

The ASMA and Roanoke River historically supported the largest year-round commercial fishery for striped bass in North Carolina, accounting for up to 95% of the states striped bass harvest from 1930 through 1960. From 1972 to 1987, the Albemarle Sound area produced up to 87% of the striped bass landings from the state's internal waters. Chestnut and Davis (1975) presented a synopsis of striped bass landings by gear for the state (1887-1971), annual landings and value for some years, and landings by county (Section 14, Appendix 1). Annual landings by gear are shown in Table 7.1 for 1978 – 2009 and in Table 4.1 by waterbody for 1972 – 2009.

From 1915 through 1965, various regulations were promulgated for the Albemarle Sound fisheries, some specifically for striped bass, while others affected the harvest of the species though not developed directly for striped bass. The regulations included area closures, yardage restrictions, harvest limits and other restrictions (Section 14, Appendix 2). Appendix 14.3 summarizes rules and regulations enacted since 1979 for striped bass conservation and management.

The commercial fishery for striped bass has principally occurred from November through April in the Albemarle Sound, whereas, Roanoke River commercial effort was concentrated during the spring spawning run. During the summer months, all landings were much lower (Hassler et al. 1981). Anchor and drift gill nets were the most productive gear types in the spring spawning run portion of the Roanoke River fishery. In 1981, anchor gill nets were prohibited in the Roanoke River, and the mesh size of drift gill nets was restricted, resulting in sharply curtailed landings during the spawning run (Hassler 1984). Bow and dip netting was a productive method of harvesting spawning fish in Roanoke River until it was prohibited in 1981. Prior to this rule, fishermen using bow nets in the upper Roanoke River were allowed to retain 25 stripers per day when taken incidentally to shad and river herring fishing. A local law, allowing the commercial sale of striped bass in Halifax and Northampton counties was enacted by the North Carolina General Assembly and created a prominent commercial fishery for striped bass in its principal spawning area (Hassler et al. 1981). This law was repealed in 1981 and commercial fishing for striped bass was totally eliminated in the inland portions of the Roanoke River. Limited commercial fishing seasons were implemented in Albemarle Sound in 1984 (October-May) (Henry et al. 1992). State regulations enacted in 1985 prohibited the sale of hook and line caught striped bass

Table 7.1. North Carolina commercial striped bass landings from internal waters, by gear 1978-2009.

						Haul/Beach							
Year	Anchored Gillnets	Runaround Gillnet	Drift Gillnet	Pound Net	Fyke Net	Seine	Swipe Net	Trawls	Pots	Rod-n-Reel	Trolling	Unknown/other	Grand Total
1978	492,269			36,314		1,164		102		1,513	1,924		533,286
1979	274,940		131	16,844		16,542		180		9,410	56,057		374,104
1980	410,236			13,826		7,276		210		17,332	1,589	200	450,669
1981	336,035			17,645		2,310		124		9,165	504		365,783
1982	195,847			32,048		7,859		42		9,093	548		245,437
1983	286,066	210		11,793		374		189		9,016	581	250	308,479
1984	487,600			7,618		846		2		2,329			498,395
1985	259,746			19,782		16		16			197		279,757
1986	182,853			5,596		500					32		188,981
1987	232,744			29,477									262,221
1988	108,622			7,254									115,876
1989	91,387			9,253				41				57	100,738
1990	95,214			10,055									105,269
1991	113,247			3,341		12		30					116,630
1992	128,592	10		4,626		79							133,307
1993	180,233	6		1,919		4,600		18					186,776
1994	104,837	303	253	12,800	905	2,290	500		292			49	122,228
1995	91,919	120	5	4,277	790	4,592	84	42	242	80		12	102,162
1996	115,257	429	197	4,990	513	1,820	20	17	118			22	123,383
1997	106,710	1,300	120	14,007	440	773	56	206	794	7		230	124,642
1998	130,206	1,493	80	14,735	517	1,890		118	646		20	196	149,900
1999	179,491	274	15	12,820	705	2,100	54		877	252		242	196,829
2000	223,639	476	56	17,590	1,343	369		8	1,227			401	245,110
2001	226,372	1,376		12,761	2,696	538	24		1,189	17		177	245,150
2002	226,705	5,631	3,640	19,790	1,485	1,621	17		180			1,373	260,441
2003	339,056	397	251	17,586	3,480	3,040			867			44	364,721
2004	295,142	221	62	4,689	4,383	1,234		66	298			21	306,115

Table 7.1 continued

						Haul/Beach							
Year	Anchored Gillnets	Runaround Gillnet	Drift Gillnet	Pound Net	Fyke Net	Seine	Swipe Net	Trawls	Pots	Rod-n-Reel	Trolling	Unknown/other	Grand Total
2005	235,708	1,791	982	16,146	2,000	2,931			18			249	259,825
2006	184,266	875	43	17,652	2,338	1,903	6		212			253	207,547
2007	175,205	664	23	17,189	2,111	1,333		3	108			55	196,690
2008	69,879	435	44	12,440	1,639	282			186			136	85,040
2009	101,806	253		16,664	1,409	437			44			28	120,641
Grand Total	6,681,829	16,261	5,901	443,525	26,754	68,731	761	1,414	7,295	58,214	61,452	3,994	7,376,131

7.2.1.2 Current

The ASMA commercial striped bass fishery from 1990 through 1997 operated on a 98,000 pound total allowable catch (TAC). The TAC was split in order to have a spring and fall season. The commercial fishery operated with net yardage restrictions, mesh size restrictions, size limit restrictions and daily landing limits. The A/R stock was declared recovered in 1997 by the ASMFC. In 1998, the commercial TAC was increased to 125,440 pounds and additional increases in poundage occurred in 1999 and 2000. From 2000 through 2002, the commercial TAC remained at 225,000 pounds. The ASMFC Striped Bass Management Board approved a 50,000 pound TAC increase for the ASMA commercial harvest for 2003, for a commercial TAC of 275,000 pounds. Since 2003 the commercial TAC has remained at 275,000 ponds. Since the initial TAC was set in 1990, seasons, yardage, mesh size restrictions and daily landing limits have been used to control harvest and maintain the fishery as a bycatch fishery (Appendix 14.3). A summary of the ASMA commercial seasons, 1991-2009 is presented in Table 7.2.

From 1991 through 2009, the ASMA accounted for 73% – 93% of the internal striped bass landings in North Carolina (Table 4.1). The ASMA averaged approximately 407 fishermen reporting landings of striped bass for 1994 – 2002. From 2003 to 2009 the ASMA averaged 337 fishermen reporting striped bass landings annually. In 2009, 280 fishermen in the ASMA reported striped bass landings. Gill nets continue to account for the highest percentage to the harvest, followed by pound nets. For the period 2000 – 2009 gill nets contributed from 82 to 96% (average 90%) to the striped bass landings in internal state waters. For the same period pound nets contributed from 2 to 15% (average = 8%) (Table 7.1). Fyke net effort has increased in the ASMA since 1994 and is reflected in the striped bass landings (Table 7.1).

Striped bass have been managed as a bycatch of the multi-species fishery in the ASMA since 1991. During 2009, when the striped bass season was open, commercial fishermen were allowed to land from 7 to 15 fish per day, not to exceed 50% by weight of the total catch, with an 18 inch total length minimum size limit. Since 2002 the days of allowable harvest has increased 26%, from 145 to 196 in 2009 (Table 7.2). Finfish dealers who purchase striped bass are required to obtain a striped bass dealer permit from NCDMF. The dealers are required to report their landings daily to NCDMF in order for the quota to be monitored. Dealers are also required to affix striped bass sale tags, provided by NCDMF, to the fish when purchased from the fishermen.

7.2.1.3 A/R Commercial Anchored Gill Net Bycatch Mortality

The ASMA supports a substantial anchored gill net fishery for species such as flounder, striped mullet, white perch, catfish, and American shad. Less substantial catches of other commercially important species include hickory shad (*Alosa mediocris)*, weakfish (Cynoscion regalis), spotted seatrout (Cynoscion nebulosus), spot (Leiostomuus xanthurus), Atlantic croaker (*Micropogonias undulatus*), bluefish (*Pomatomus saltatrix)*, and red drum (*Sciaenops ocellatus)*. Total anchored gill net trips in the ASMA since 1994 have ranged from 13,545 trips per year (2009) to 21,198 trips per year (2001). Total landings for this same period have ranged from 1.86 million pounds (2006) to 2.87 million pounds annually (2002) (Figure 7.1). As a result of the recovery of the A/R stock, the incidental bycatch of striped bass has increased as the stock size has increased. Preventive measures have been implemented to address this issue, which have ranged from the prohibition of certain mesh sizes in gill nets, limiting the amount of yardage that can be fished, area closures, and required net attendance for small mesh gill nets during certain times of the year (Appendix 14.3). The NCMFC allows the multi-species gill net fishery to be pursued as indicated above. Since 1996, NCDMF has worked with commercial fishermen to allow observers on their vessels, on a voluntary basis, in the ASMA while gill net fishing.

Table 7.2. Summary of striped bass commercial seasons in the Albemarle Sound Management Area, North Carolina, 1991 – 2009.

Year	**TAC (lbs)**	**Spring season # Days**	**Bag limit**	**Pounds landed**	**Fall season # Days**	**Bag limit**	**Pounds landed**	**Total pounds landed # Days**
2009	275,000	Jan 1 – 31 Feb 1 – Mar 25 Mar 26 – Apr 14 Apr 15 – 30 120 days	7 fish 10 fish 15 fish 10 fish	59,832	Oct 1 – Nov 30 Dec 1 – 15 Pound net ONLY 76 days	10 fish	37,053	96,885 196 days
2008	275,000	Jan 1 – 31 Feb 1 – Apr 9 Apr 10 – 14 Apr 15 – 30 121 days	5 fish 10 fish 15 fish 10 fish	56,922	Oct 1 – Nov 30 61 days	10 fish	17,376	74,298 182 days
2007	275,000	Jan 5 – Feb 28 Mar 1 – Apr 14 Apr 15 – 30 116 days	5 fish 10 fish 5 fish	145,261	Oct 1 – Nov 30 Dec 1 - 14 75 days	10 fish	26,422	171,682 191 days
2006	275,000	Jan 1-Mar 14 Mar 15 – Apr 14 Apr 15 – 30 120 days	5 fish 10 fish 5 fish	151,682	Oct 1 – Nov 30 61 days	10 fish	34,717	186,399 181 days
2005	275,000	Jan 3- Mar 30 Apr 1 – 14 102 days	5 fish 10 fish	182,855	Oct 3 – 27 Oct 28 –Nov 30 58 days	5 fish 10 fish	49,838	232,693 160 days
2004	275,000	Jan 5 – Apr 6 91 days	5 fish	273,636	No Fall Season			273,636 91 days
2003	275,000 (269,998)	Jan 6- Mar 19 Mar 20 – Apr 14 99 days	5 fish 10 fish	190,972	Oct 27 – Dec 31 65 days	5 fish	75,583	266,555* (323,337 total – 56,782 lbs to AO) 164 days
2002	225,000 (215, 514)	Jan7 – Apr14 98 days	5 fish/18"TL	168,562	Nov 4 – Dec20 47 days	5 fish/18"TL	54,294	222,856* 145 days

Table 7.2 continued

Year	TAC (lbs)	Spring season # Days	Bag limit	Pounds landed	Fall season # Days	Bag limit	Pounds landed	Total pounds landed # Days
2001	225,000 (211,348)	Jan5 – Mar25 Mar26 – Apr14 100 days	5 fish/18”TL 10 fish/ 18” TL	185,585	Nov19 – Dec21 33 days	5 fish/18”TL	34,648	220,233* 133 days
2000	225,000 (200,109)	Jan7 – Mar26 Mar27 – Apr14 99 days	5 fish/ 18”TL 10 fish/ 18” TL	162,467	Nov13 – Dec31 49 days	5 fish/ 18”TL	51,562	214,029* 148 days
1999	137,984	Feb9 – Mar28 Mar29 – Apr14 65 days	5 fish/ 18”TL 10 fish/ 18” TL	124,527	Dec1 – Dec12 Dec13 – Dec31 31 days	10 fish/ 18”TL 5 fish/ 18”TL	38,343	162,870 96 days
1998	125,440	Feb16 – Mar6 Mar7 – Apr14 58 days	5 fish/ 18”TL 10 fish/ 18” TL	101,093	Dec1 – Dec31 31 days	10 fish/ 18”TL	22,834	123,927 89 days
1997	98,000	Feb15 – Mar23 Mar24 – Apr14 59 days	3 fish/ 18”TL 7 fish/ 18”TL	73,534	Nov.3 – Dec5 33 days	5 fish/ 18”TL	22,588	96,122 92 days
1996	98,000	Feb16 – Apr7 Apr8 – Apr14 59 days	5 fish/18”TL 3 fish/18”TL	79,678	Nov30 – Dec22 Dec23 – Dec31 32 days	5 fish/18”TL 10 fish/18”TL	10,455	90,133 91 days
1995	98,000	Mar1– Apr4 Apr5– Apr14 45 days	5 fish/18”TL 2 fish/ 18” TL	83,636	Nov22 – Dec31 40 days	2 fish/18”TL	4,200	87,836 85 days
1994	98,000	Feb21 – Mar13 21 days	10 fish/ 18”TL	53,698	Nov21 – Dec23 33 days	5 fish/ 18”TL	48,672	102,370 54 days
1993	98,000	Feb1 – Feb28 Mar1 – Apr5 64 days	5 fish/ 18”TL 3 fish/ 18” TL	109,475	No Season			109,475 64 days

Table 7.2 continued.

Year	TAC (lbs)	Spring season # Days	Bag limit	Pounds landed	Fall season # Days	Bag limit	Pounds landed	Total pounds landed # Days
1992	98,000	Jan11 – Feb2 Feb3 – Mar18 Mar19 – Apr16 97 days	10 fish/ 18"TL 5 fish/ 18" TL 3 fish/18"TL	96,435	Nov9 – Nov20 12 days	3 fish/ 18"TL	4,114	100,549 109 days
1991	98,000	Jan7 – Jan9 Jan18 – Feb12 Feb13 – Feb28 Mar1 – Mar24 Mar25 – Apr5 Apr6 – Apr13 86 days	Monthly quota/14"TL Coastal/16"TL Joint 3 fish/20"TL 5 fish/18"TL 10 fish/18"TL 20 fish/14"TL Coastal/16"TL Joint 5 fish/18"TL	101,219	Nov.1 – Dec20 50 days	3 fish/ 18"TL	7,241	108,460 136 days

*Total allowable catch adjusted to compensate for overages in previous year.

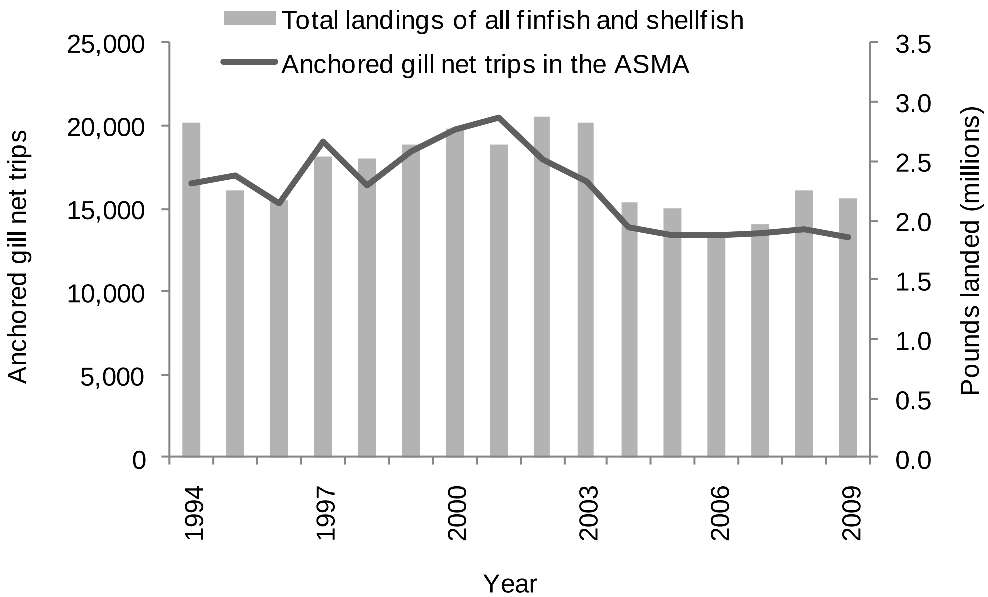


Figure 7.1 Annual gill net trips and total pounds (millions) landed from the Albemarle Sound Management Area 1994-2009.

These observer trips have mainly focused on the flounder gill net fishery, during the summer and early fall, when personnel have been available. Some observer trips have been made in the shad and small mesh gill net fisheries as well, but insufficient data have been gathered to make estimates of striped bass discard mortality in all fisheries based on observer coverage alone.

In 2003 the NCDMF initiated an observer program in the Pamlico Sound directed at more accurately estimating interactions with sea turtles in the fall/winter large mesh flounder gill net fishery. However, at sea observer trips were also made in the ASMA small mesh fisheries and large mesh flounder fisheries. From 2003 to 2008 over 250 trips observing ~225,000 yards of gill net were made in the ASMA. These observer trips have allowed the NCDMF to more accurately estimate variables such as: average yards per trip for various fisheries, at net striped bass gill net mortality rates for various fisheries, and striped bass catch rates in various fisheries.

The estimation of striped bass bycatch in the ASMA gill net fisheries has been a point of compliance with the ASMFC Striped Bass Interstate Fishery Management Plan since 1994. An annual estimate of striped bass discards in the ASMA anchored gill net fisheries has occurred since 1994. The methods used and the estimates derived are discussed in the following sections.

7.2.1.3.1 Bycatch Estimation Methods

In order to calculate an annual anchored gill net discard mortality estimate for the ASMA, total annual gill net trips and the average yards set per trip was estimated. Also needed was an estimate of rates of striped bass catch and mortality. Because observer coverage was limited, assumptions concerning average yards set per trip and striped bass catch rates had to be substituted where observations could not be made. Also, when adequate observer coverage was available all necessary estimates were calculated monthly. When inadequate observer coverage is available certain estimates may be pooled across several months. The total number of annual fishing trips also needed to be further broken down into major fishery categories. The total number of trips was obtained from the NCDMF Trip Ticket Program (TTP). Each time fish are sold to a licensed seafood dealer in North Carolina a trip ticket must be completed. Information included on each ticket includes the weight in pounds for each species sold, the gear type used (i.e., trawl, gill net, pound net, etc.), and the primary area fished. Total yards of gill net fished is not recorded on trip tickets. While the total number of gill net fishing trips was easily obtainable, assumptions were required to determine the mesh size used in each trip. First, three trip categories were established: 1) flounder, 2) shad, and 3) small mesh (also termed “other”).

Next, predominant allowable mesh sizes were estimated for each category. Based on at sea observer data and fishery research, the predominant mesh size used in the perch, mullet, and catfish fisheries is 3 ¼ inch stretched mesh, while 5 ½ inch stretched mesh (ISM) is used in the flounder and shad fisheries. Third, assuming that size selectivity of small mesh nets would not result in substantial catches of flounder or shad, and that flounder and shad trips could be categorized based on catch characteristics, each trip was examined for species composition and assigned to one of the three categories based on the primary species landed. A catch that consisted of 10% or greater of flounder, and flounder landings greater than shad, was considered a flounder trip. This procedure worked well when determining the number of flounder trips, largely because regulations require flounder nets to be tied down and set so as to fish on the bottom not to exceed a vertical height of 48 inches. The 5 ½ ISM or larger flounder net is more effective in the capture of flounder than any other species, and usually other gill net types are not fished simultaneously with the flounder net, so the trip would not be incorrectly assigned to another type of fishery. The minimum mesh size allowed for flounder nets is 5 ½ ISM, and from January through April no meshes greater than 6 ISM are allowed. This is not the case when estimates of trips were made for the shad and the small mesh category in the spring. These fisheries occur simultaneously and fishermen typically employ both shad nets and small mesh nets in a single trip. Although several mesh sizes were likely used in any given trip, trips were either counted as shad or small mesh trips depending on the catch composition. Shad trips were defined as shad landings greater than flounder or greater than 30 pounds of shad. Trips that did not meet the criteria for the flounder or shad trips were considered small mesh trips (Table 7.3).

Table 7.3 The number of anchored gill net trips broken down into trip category, 1994-2009, ASMA.

Year	Small mesh trips (attended and unattended)	Flounder trips	Shad trips	Totals
1994	5,559	10,059	832	16,450
1995	5,461	10,356	1,430	17,247
1996	5,014	8,338	1,836	15,188
1997	4,681	12,866	1,527	19,074
1998	5,137	10,311	2,252	17,700
1999	8,291	8,425	2,288	19,004
2000	8,077	9,326	2,546	19,949
2001	8,526	10,099	2,573	21,198
2002	8,299	7,630	2,029	17,958
2003	8,964	5,655	2,651	17,270
2004	6,394	5,903	2,096	14,393

Table 7.3. (Continued).

Year	Small mesh trips (attended and unattended)	Flounder trips	Shad trips	Totals
2005	6,467	5,189	1,989	13,645
2006	5,087	6,653	1,896	13,636
2007	4,633	7,110	1,922	13,665
2008	4,974	8,586	1,178	14,738
2009	4,171	8,031	1,343	13,545
Totals	99,735	134,537	30,388	264,660

Once the total number of trips for each category for a given year was estimated, trips were further broken down by month. Mortality estimates were calculated monthly because of the significant impact water temperature has on mortality. Mortality increases as water temperature increases. For some years the amount of gear used per trip was estimated for the flounder nets and small mesh nets by using the average yardage from observer data compiled by NCDMF staff. Currently the average yards per flounder trip used in discard calculations varies from 1,317 to 1,688 depending on the month. The average yards per trip used for small mesh trips for the 2009 estimate was 650. There is currently insufficient observer data available in the shad fisheries, so the maximum allowed yardage per trip (1,000 yards) must be used in discard calculations.

Catch per unit of effort was defined as the catch of striped bass per yard of gill net set for 24 hours. Catch per unit effort is one variable in the equation that must be developed annually for each trip category because CPUE is directly related to individual year class strength. Also, due to the way they are constructed, flounder nets capture far less striped bass than shad nets. So even though both nets may employ the same mesh size it is not reasonable to expect them to have the same striped bass CPUE. So over the years CPUE has come from NCDMF observer data, Fishery Resource Grants (FRG), or the IGNS (Table 7.4).

Table 7.4 Origination of variables used in annual mortality estimates for the ASMA anchored gill net fisheries. IGNS=Independent Gill Net Survey; FRG=Fisheries Resource Grant.

Year	Fishery Category	Yards Per Trip	Striped bass catch rates (# striped bass per yard)	Percent At Net Mortality
2009				
	Flounder	Observer Trips	IGNS	Observer Trips
	Shad	Maximum Assumed	IGNS	Observer Trips
	Attended small mesh	Observer Trips	IGNS	FRG 1997
	Unattended small mesh	Observer Trips	IGNS	Observer Trips
2008				
	Flounder	Observer Data	IGNS	Observer Data
	Shad	Maximum Assumed	IGNS	Observer Data
	Attended small mesh	Observer Data	IGNS	FRG 1997
	Unattended small mesh	Observer Data	IGNS	Observer Data
2007				
	Flounder	Observer Data	Observer Data	Observer Data
	Shad	Maximum Assumed	IGNS	Observer Data
	Attended small mesh	Observer Data	IGNS	FRG 1997
	Unattended small mesh	Observer Data	IGNS	Observer Data

Table 7.4 (Continued).

Year	Fishery Category	Yards Per Trip	Striped bass catch rates (# striped bass per yard)	Percent At Net Mortality
2006				
	Flounder	Observer Data	Observer Data	Observer Data
	Shad	Maximum Assumed	IGNS	Observer Data
	Attended small mesh	Observer Data	IGNS	FRG 1997
	Unattended small mesh	Observer Data	IGNS	Observer Data
2005				
	Flounder	Observer Data	Observer Data	Observer Data
	Shad	Maximum Assumed	IGNS	Observer Data
	Attended small mesh	Observer Data	Observer Data	FRG 1997
	Unattended small mesh	Observer Data	Observer Data	Observer Data
2004				
	Flounder	Observer Data	Observer Data	Observer Data
	Shad	Maximum Assumed	Observer Data	Observer Data
	Attended small mesh	Observer Data	Observer Data	FRG 1997
	Unattended small mesh	Observer Data	Observer Data	Observer Data
2003				
	Flounder	Observer Data	Observer Data	IGNS & Observer Data
	Shad	Maximum Assumed	Observer Data	IGNS
	Attended small mesh	Maximum Assumed	FRG 1997, 1998	FRG 1997
	Unattended small mesh	Maximum Assumed	Observer Data	IGNS
2002				
	Flounder	Observer Data	Observer Data	IGNS & Observer Data
	Shad	Maximum Assumed	Observer Data	
	Attended small mesh	Maximum Assumed	FRG 1997, 1998	FRG 1997
	Unattended small mesh	Maximum Assumed	Observer Data	IGNS
2001				
	Flounder	Observer Data	Observer Data	IGNS & Observer Data
	Shad	Maximum Assumed	Observer Data	Observer Data
	Attended small mesh	Maximum Assumed	FRG 1997, 1998	FRG 1997
	Unattended small mesh	Maximum Assumed	Observer Data	IGNS
2000				
	Flounder	Observer Data	Observer Data	IGNS & Observer Data
	Shad	Maximum Assumed	Observer Data	Observer Data
	Attended small mesh	Maximum Assumed	FRG 1997, 1998	FRG 1997
	Unattended small mesh	Maximum Assumed	Observer Data	IGNS
1999				
	Flounder	Observer Data	Observer Data	IGNS & Observer Data
	Shad	Maximum Assumed	IGNS	IGNS
	Attended small mesh	Maximum Assumed	FRG 1997, 1998	FRG 1997
	Unattended small mesh	Maximum Assumed	Observer Data	IGNS
1998				
	Flounder	Observer Data	Observer Data	IGNS & Observer Data
	Shad	Maximum Assumed	IGNS	IGNS
	Attended small mesh	Maximum Assumed	FRG 1997, 1998	FRG 1997
	Unattended small mesh	Maximum Assumed	Observer Data/FRG (1995)	IGNS/Observer data/FRG (1997)

Table 7.4 (Continued).

Year	Fishery Category	Yards Per Trip	Striped bass catch rates (# striped bass per yard)	Percent At Net Mortality
1997				
	Flounder	Observer Data	Observer Data	IGNS & Observer Data
	Shad	Maximum Assumed	IGNS	IGNS
	Attended small mesh	Maximum Assumed	FRG 1997, 1998	FRG 1997
	Unattended small mesh	Maximum Assumed	Observer Data/FRG (1995)	IGNS
1996				
	Flounder	Observer Data	Observer Data	IGNS & Observer Data
	Shad	Maximum Assumed	IGNS/observer data	IGNS/observer data
	Attended small mesh	Maximum Assumed	IGNS/observer data	IGNS/observer data
	Unattended small mesh	Maximum Assumed	IGNS/observer data/FRG (1995)	IGNS/observer data
1995				
	Flounder	Observer Data	Observer Data	IGNS & Observer Data
	Shad	Maximum Assumed	IGNS	IGNS
	Attended small mesh	Maximum Assumed	IGNS	IGNS
	Unattended small mesh	Maximum Assumed	IGNS/FRG (1995)	IGNS
1994				
	Flounder	Observer Data	Observer Data	IGNS & Observer Data
	Shad	Maximum Assumed	IGNS	IGNS
	Attended small mesh	Maximum Assumed	IGNS	IGNS
	Unattended small mesh	Maximum Assumed	IGNS	IGNS

Mortality rates were calculated by dividing the number of dead striped bass observed at the time the net was fished by the total number of striped bass captured. At net mortality rates would not be expected to change from year to year, only monthly with changing water temperature. There is enough observer coverage over several years so that an at net mortality rate can be used from the observer data source in the small mesh and flounder fisheries. Furthermore, small mesh nets in the ASMA must be attended from late spring through early fall. There have been several FRGs conducted using small mesh nets during this period of required attendance, so at net mortality rates for attended small mesh nets was calculated using data from these FRGs. At net mortality rates for shad fisheries were obtained from the IGNS during those same months in which the shad fishery operated. Additionally, it is known that some percentage of striped bass released alive from gill nets will suffer delayed mortality. Without adequate studies on delayed mortality in the various fishery categories in the ASMA, a range of delayed mortality estimates of 25%, 50%, and 75% were also made.

Once all necessary variables were obtained, the total numbers of striped bass captured in each fishery category was determined monthly by multiplying the average yards per trip, trips per month, and striped bass CPUE. Examining the estimate from the flounder fishery for 2009, the number of striped bass overall discard mortalities was obtained by applying the at net mortality rate to the striped bass encountered (N=3,037; Table 7.5a). The number of dead striped bass then needs to be converted into pounds of striped bass by age (Table 7.5b). Numbers of discards were proportioned into age groups based on the composition of striped bass age classes in the 5 ½ ISM from the IGNS. The numbers were then converted into pounds based on mean weight at age (11,576 lbs; Table 7.5 b). Once we have the estimate of dead discards encountered in the fishery category for the year we subtract actual commercial harvest from that fishery category. The difference is reported as dead discard mortality. In this particular example the estimated striped bass discard mortality in the flounder fishery (11,576 lbs) was less than the actual commercial harvest in the flounder fishery (17,659 lbs), so no striped bass discard mortality was attributed to the flounder fishery in 2009.

Table 7.5 An example of bycatch calculation procedures used in the 2009 flounder net category striped bass discard mortality estimate.

a.

Year	Month	Average yards per trip	Trips	Total yards	Striped bass CPUE	Striped Bass Encountered	Percent At Net Mortality	Number of dead striped bass
2009	1	1,317	16	21,072	0.00536	113	0.37143	42
2009	2	1,317	17	22,389	0.00000	0	0.37143	0
2009	3	1,317	40	52,680	0.00156	82	0.37143	31
2009	4	1,317	390	513,630	0.00000	0	0.37143	0
2009	5	1,688	609	1,027,992	0.00000	0	0.61538	0
2009	6	1,688	771	1,301,448	0.00023	295	0.61538	181
2009	7	1,688	821	1,385,848	0.00023	314	0.61538	193
2009	8	1,688	796	1,343,648	0.00023	304	0.61538	187
2009	9	1,688	1,507	2,543,816	0.00023	576	0.61538	355
2009	10	1,600	2,074	3,318,400	0.00023	752	0.69565	523
2009	11	1,600	987	1,579,200	0.00139	2,193	0.69565	1,526
			8,028	13,110,123		4,629		3,038

b.

From 5.5 ISM 2009 IGNS					flounder						
YC	N	% comp	avg kg per fish	avg lb per fish	YC	% comp	N	lbs/fish	ttl lbs	dis #	dis lbs
2005	2	0.13	1.26	2.78	2005	0.13	380	2.78	1,055	-274	-760
2004	8	0.50	1.64	3.62	2004	0.50	1,519	3.62	5,491	-841	-3,041
2003	5	0.31	1.72	3.79	2003	0.31	949	3.79	3,599	-501	-1,901
2002	0	0.00	0.00	0.00	2002	0.00	0	0.00	0	0	0
2001	1	0.06	3.42	7.54	2001	0.06	190	7.54	1,431	-50	-380
	Number of dead striped bass						3,038				
						estimated bycatch lbs			11,576		-6,083
						commercial lbs landed			17,659		
						discard estimate lbs			-6,083		

7.2.1.3.1 Bycatch Estimation Results and Discussion

Total striped bass discard mortality estimates for the ASMA anchored gill net fisheries have ranged from 32,495 lbs in 2009 to 227,900 lbs in 1997 (Table 7.6). The small mesh category has routinely accounted for the majority of the estimated striped bass discard mortality in the ASMA anchored gill net fisheries. At net mortality estimates have ranged from 32,495 pounds in 2009 to 145,826 pounds in 1995. The catch composition in small mesh nets is characterized by striped bass that are less than the 18 inch minimum TL size limit, the majority of which are two to three years old. Years with very high discard estimates can be traced back to years with very high JAIs. Years with high discard estimates in the small mesh category included: 1995, 1997, 2002, 2003, and 2008. Each of these high discard estimates is lagged two and three years behind strong year classes, which included the 1993, 1994, 2000, and 2005 year classes. With the exception of 2008, estimated discards in this category have steadily declined since 2003 (Figure 7.2). This is due in part to lower than average striped bass recruitment for the years 2003-2009 when compared to 1993-2002. Also, the reduction in striped bass discard estimates in the small mesh category was helped through adoption and implementation of the management measures in the North Carolina River Herring FMP, Amendment 1 (2007). Since 1994, the small mesh category has comprised approximately 66% of the total estimated discards by pounds.

The shad and flounder gill net categories have ranged from highs of 74,775 pounds and 51,585 pounds in 1998 and 1997 respectively, to lows of zero estimated discard mortalities in 2009 (Figure 7.2). This low estimate for 2009 seems reasonable intuitively, considering the low striped bass catch rates in flounder and shad nets as reflected in the overall low commercial harvest in 2009 (96,154 lbs). During sampling trips to fish houses in 2009 NCDMF personnel also noted that very few commercial fishermen had captured their maximum possession of striped bass per day, which was either 10 or 15 fish. This is the first time since 1994 that zero discard mortality has been attributed to a fishery category in an annual discard estimate. Both the flounder and shad gill net fishery categories have seen a steady overall decline in estimated discard mortality since 2003. Probably the largest contributing factor in this decline was the last increase in the TAC for the commercial fishery which occurred in 2003. Until 1998, the TAC for the commercial fishery of striped bass was held at 98,000 lb. With the growth of the population and the static TAC, discards of striped bass increased. In October 1997, the A/R stock was declared recovered by the ASMFC after showing substantial growth in the population. Since 1997, the TAC has increased four times to the current harvest level of 275,000 pounds for the commercial fishery. This increase in harvest has had the effect of lowering the number of discards in the flounder and shad fisheries. More of these fish that would have been discarded in previous years are now making it to market. Still, from 1994 through 2004 the number of estimated discards combined with commercial harvest exceeded the TAC during each year (Figure 7.4). In years prior to the poundage increases, the poundage of discards have been equivalent to or as much as two times the allowed harvest for that year. Since 2005 the discard mortalities combined with the harvest has been below the TAC.

Table 7.6 Estimates of initial and delayed striped bass discard mortality for the anchored gill net fisheries in the Albemarle Sound Management Area 1994-2009.

2009

			Combined Initial and Delayed Mortality					
	Initial Mortality		25%		50%		75%	
NET TYPE	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB
Flounder	0	0	0	0	0	0	0	0
Shad	0	0	0	0	0	0	0	0
Un. Sm Mesh	15,667	16,946	19,584	21,183	23,501	25,419	27,417	29,656
Att. Sm Mesh	14,376	15,549	17,970	19,436	21,564	23,324	25,158	27,211
TOTAL	**30,043**	**32,495**	**37,554**	**40,619**	**45,065**	**48,743**	**52,575**	**56,866**

2008

			Combined Initial and Delayed Mortality					
	At Net Mortality		25%		50%		75%	
NET TYPE	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB
Flounder	2,457	10,728	3,071	13,410	3,686	16,092	4,300	18,774
Shad	679	2,962	849	3,703	1,019	4,443	1,188	5,184
Un. Sm Mesh	60,523	81,979	75,654	102,474	90,785	122,969	105,915	143,463
Att. Sm Mesh	9,234	12,508	11,543	15,635	13,851	18,762	16,160	21,889
TOTAL	**72,893**	**108,177**	**91,116**	**135,221**	**109,340**	**162,266**	**127,563**	**189,310**

2007

			Combined Initial and Delayed Mortality					
	At Net Mortality		25%		50%		75%	
NET TYPE	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB
Flounder	1,158	3,994	1,448	4,993	1,737	5,991	2,027	6,990
Shad	1,563	5,054	1,954	6,318	2,345	7,581	2,735	8,845
Un. Sm Mesh	26,503	24,983	33,129	31,229	39,755	37,475	46,380	43,720
Att. Sm Mesh	10,019	9,445	12,524	11,806	15,029	14,168	17,533	16,529
TOTAL	**39,243**	**43,476**	**49,054**	**54,345**	**58,865**	**65,214**	**68,675**	**76,083**

2006

			Combined Initial and Delayed Mortality					
	At Net Mortality		25%		50%		75%	
NET TYPE	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB
Flounder	1,176	4,129	1,470	5,161	1,764	6,194	2,058	7,226
Shad	3,566	14,059	4,458	17,574	5,349	21,089	6,241	24,603
Un. Sm Mesh	11,052	23,097	13,815	28,871	16,578	34,646	19,341	40,420
Att. Sm Mesh	7,985	16,689	9,981	20,861	11,978	25,034	13,974	29,206
TOTAL	**23,779**	**57,974**	**29,724**	**72,468**	**35,669**	**86,961**	**41,613**	**101,455**

Table 7.6 (continued).

2005								
	Combined Initial and Delayed Mortality							
	At Net Mortality		25%		50%		75%	
NET TYPE	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB
Flounder	486	1,704	608	2,130	729	2,556	851	2,982
Shad	2,615	10,304	3,269	12,880	3,923	15,456	4,576	18,032
Un. Sm Mesh	5,307	11,092	6,634	13,865	7,961	16,638	9,287	19,411
Att. Sm Mesh	10,692	22,345	13,365	27,931	16,038	33,518	18,711	39,104
TOTAL	**19,100**	**45,445**	**23,875**	**56,806**	**28,650**	**68,168**	**33,425**	**79,529**

2004								
	Combined Initial and Delayed Mortality							
	At Net Mortality		25%		50%		75%	
NET TYPE	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB
Flounder	2,621	8,725	3,276	10,906	3,932	13,088	4,587	15,269
Shad	476	1,584	595	1,980	714	2,376	833	2,772
Un. Sm Mesh	25,214	38,884	31,518	48,605	37,821	58,326	44,125	68,047
Att. Sm Mesh	26,405	40,679	33,006	50,849	39,608	61,019	46,209	71,188
TOTAL	**54,716**	**89,872**	**68,395**	**112,340**	**82,074**	**134,808**	**95,753**	**157,276**

2003								
	Combined Initial and Delayed Mortality							
	At Net Mortality		25%		50%		75%	
NET TYPE	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB
Flounder	6,005	24,576	7,506	30,720	9,008	36,864	10,509	43,008
Shad	1,180	4,826	1,475	6,033	1,770	7,239	2,065	8,446
Un. Sm Mesh	51,280	86,890	64,100	108,613	76,920	130,335	89,740	152,058
Att. Sm Mesh	27,043	45,822	33,804	57,278	40,565	68,733	47,325	80,189
TOTAL	**85,508**	**162,114**	**106,885**	**202,643**	**128,262**	**243,171**	**149,639**	**283,700**

2002								
	Combined Initial and Delayed Mortality							
	At Net Mortality		25%		50%		75%	
NET TYPE	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB
Flounder	4,994	21,992	14,722	64,831	20,331	89,531	25,941	114,236
Shad	4,702	20,873	8,912	39,562	13,123	58,255	17,333	76,944
Un. Sm Mesh	46,928	85,790	62,913	115,013	78,899	144,237	94,884	173,459
Att. Sm Mesh	7,818	14,292	12,168	22,245	16,518	30,197	20,868	38,149
TOTAL	**64,442**	**142,947**	**98,715**	**241,651**	**128,871**	**322,220**	**159,026**	**402,788**

Table 7.6 (continued).

2001								
	Combined Initial and Delayed Mortality							
	At Net Mortality		25%		50%		75%	
NET TYPE	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB
Flounder	3,416	15,046	5,070	22,331	6,723	29,612	8,377	36,897
Shad	4,295	18,918	7,141	31,454	9,987	43,989	12,833	56,525
Un. Sm Mesh	27,426	58,083	35,570	75,330	43,714	92,578	51,857	109,823
Att. Sm Mesh	5,502	11,652	8,564	18,137	11,625	24,620	14,687	31,104
TOTAL	**40,639**	**103,699**	**56,345**	**147,252**	**72,049**	**190,799**	**87,754**	**234,349**

2000								
	Combined Initial and Delayed Mortality							
	At Net Mortality		25%		50%		75%	
NET TYPE	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB
Flounder	4,665	18,328	5,941	23,341	7,216	28,350	8,492	33,364
Shad	7,263	28,535	9,855	38,719	12,446	48,898	15,038	59,082
Un. Sm Mesh	42,545	91,134	52,321	112,075	62,098	133,018	71,874	153,959
Att. Sm Mesh	6,207	13,296	9,661	20,695	13,114	28,091	16,568	35,490
TOTAL	**60,680**	**151,293**	**77,778**	**194,830**	**94,874**	**238,357**	**111,972**	**281,895**

1999								
	Combined Initial and Delayed Mortality							
	At Net Mortality		25%		50%		75%	
NET TYPE	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB
Flounder	5,156	20,111	6,806	26,547	8,457	32,987	10,107	39,422
Shad	9,659	37,675	18,980	74,032	28,302	110,392	37,623	146,749
Un. Sm Mesh	41,118	81,257	54,322	107,350	67,526	133,444	80,730	159,538
Att. Sm Mesh	7,099	14,029	11,049	21,835	14,999	29,641	18,949	37,447
TOTAL	**63,032**	**153,072**	**91,157**	**229,764**	**119,284**	**306,464**	**147,409**	**383,156**

1998								
	Combined Initial and Delayed Mortality							
	At Net Mortality		25%		50%		75%	
NET TYPE	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB
Flounder	3,875	15,646	8,003	32,314	12,190	49,219	16,348	66,008
Shad	18,519	74,775	31,874	128,699	45,230	182,627	58,585	236,551
Un. Sm Mesh	29,176	45,436	43,062	67,061	56,947	88,684	70,833	110,309
Att. Sm Mesh	7,350	11,446	11,440	17,816	15,530	24,185	19,620	30,554
TOTAL	**58,920**	**147,303**	**94,379**	**245,890**	**129,897**	**344,715**	**165,386**	**443,422**

Table 7.6 (continued).

1997								
	Combined Initial and Delayed Mortality							
	At Net Mortality		25%		50%		75%	
NET TYPE	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB
Flounder	10,438	51,585	13,748	67,943	17,058	84,301	20,369	100,664
Shad	11,529	56,976	16,097	79,551	20,664	102,121	25,232	124,696
Un. Sm Mesh	51,908	110,668	85,610	182,521	119,311	254,371	153,013	326,224
Att. Sm Mesh	4,067	8,671	6,330	13,496	8,593	18,320	10,856	23,145
TOTAL	**77,942**	**227,900**	**121,785**	**343,511**	**165,626**	**459,113**	**209,470**	**574,729**

1996								
	Combined Initial and Delayed Mortality							
	At Net Mortality		25%		50%		75%	
NET TYPE	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB
Flounder	6,575	28,023	9,421	40,153	12,268	52,287	15,114	64,417
Shad	15,199	64,778	17,533	74,726	19,866	84,669	22,200	94,616
Un. Sm Mesh	18,491	23,502	23,858	30,323	29,226	37,146	34,593	43,968
Att. Sm Mesh	3,636	4,621	5,659	7,193	7,682	9,764	9,705	12,335
TOTAL	**43,901**	**120,924**	**56,471**	**152,395**	**69,042**	**183,866**	**81,612**	**215,336**

1995								
	Combined Initial and Delayed Mortality							
	At Net Mortality		25%		50%		75%	
NET TYPE	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB
Flounder	8,581	31,791	12,055	44,662	15,529	57,532	19,002	70,399
Shad	12,026	44,554	14,445	53,516	16,865	62,482	19,284	71,444
Un. Sm Mesh	124,694	143,273	170,233	195,597	215,772	247,921	261,311	300,246
Att. Sm Mesh	2,222	2,553	3,459	3,974	4,695	5,395	5,932	6,816
TOTAL	**147,523**	**222,171**	**200,192**	**297,749**	**252,861**	**373,330**	**305,529**	**448,905**

1994								
	Combined Initial and Delayed Mortality							
	At Net Mortality		25%		50%		75%	
NET TYPE	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB	# OF STB	LB OF STB
Flounder	4,133	14,666	5,620	19,943	7,107	25,219	8,593	30,492
Shad	1,861	6,604	2,267	8,045	2,674	9,489	3,080	10,940
Un. Sm Mesh	33,142	82,457	43,255	107,618	53,368	132,779	63,481	157,940
Att. Sm Mesh	6,963	17,324	10,837	26,962	14,712	36,603	18,586	46,242
TOTAL	**46,099**	**121,051**	**61,979**	**162,568**	**77,861**	**204,090**	**93,740**	**245,614**

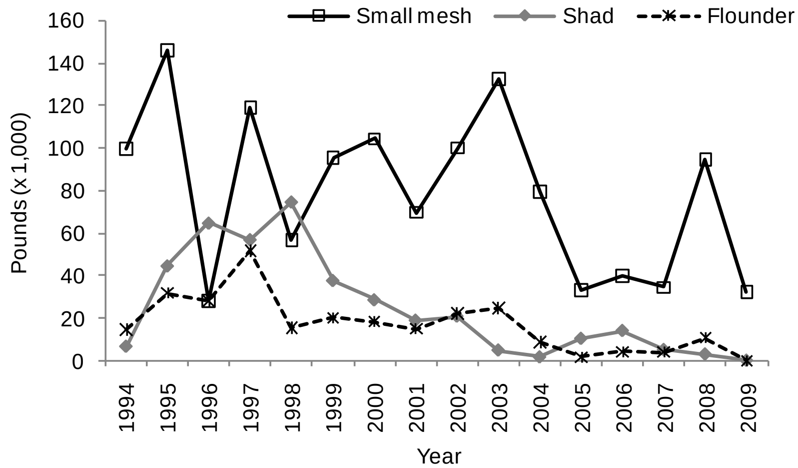


Figure 7.2 Estimated striped bass discards by trip category, 1994-2009, ASMA, NC.

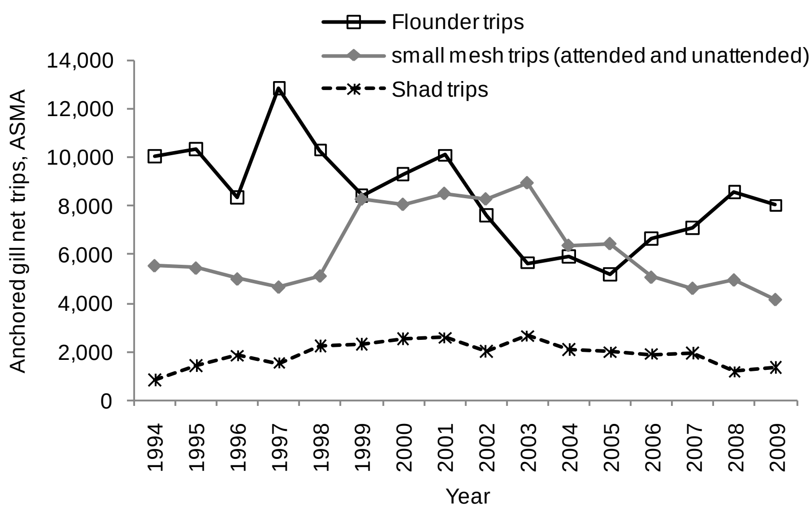


Figure 7.3 Estimated gill net trips by trip category, 1994-2009, ASMA, NC.

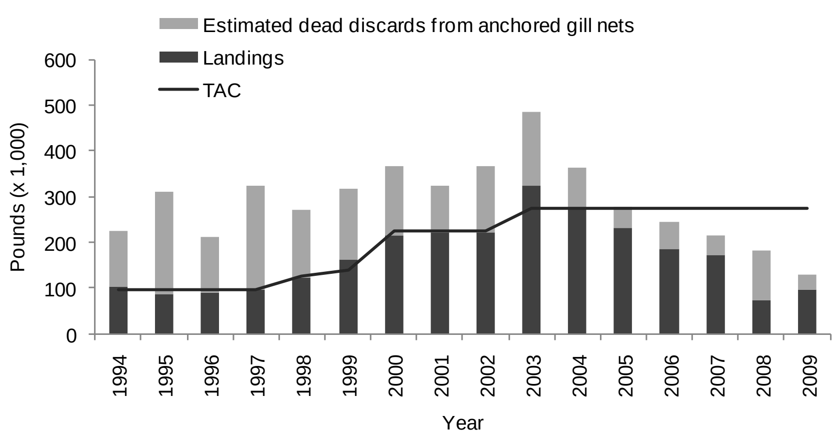


Figure 7.4 Estimated striped bass dead discards, landings, and Total Allowable Catch (TAC) 1994-2009, ASMA, NC.

In examining the discard mortality estimates more closely, it becomes evident how important at sea observer coverage is in accurately estimating striped bass discards. For the time period 2004 – 2009 there is sufficient observer coverage to make improved estimates of the average yards fished per trip for the flounder and small mesh fisheries in each year. In comparing the estimates generated from these years using the maximum allowed yard per trip versus the average yards per trip obtained from observer data, estimates made assuming maximum yardage per trip are nearly twice the estimates made using known values of yard per trip (Figure 7.5). For these six years, the discard mortality estimates totaled 680,256 pounds for assumed maximum yards per trip and 377,439 pounds when at sea observer data was used. If adequate observer information were available for the shad fisheries that indicated the average yards set per trip was less than the currently assumed maximum 1,000 yards, the estimates would be lower still.

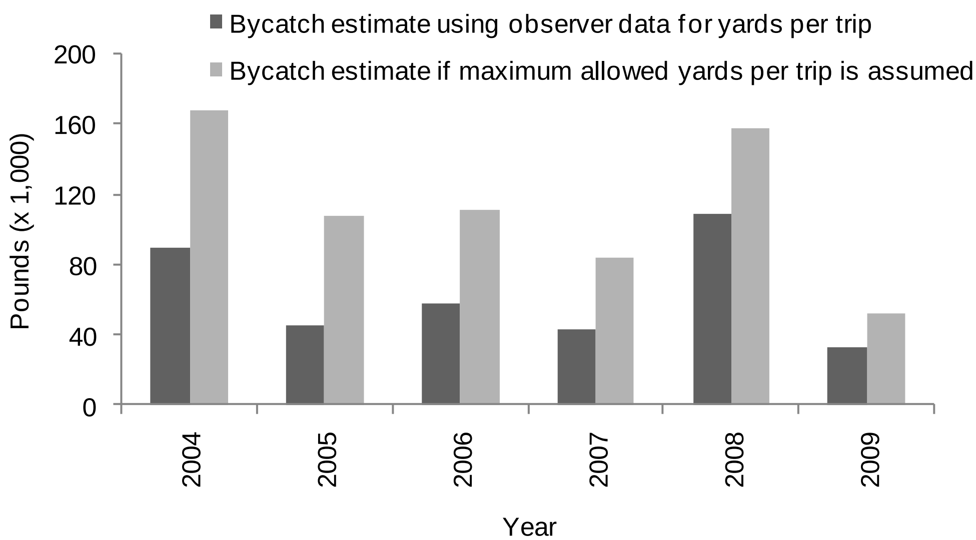


Figure 7.5 Comparison of ASMA anchored gill net striped bass discard mortality estimates using observer information versus assumed maximum values for average yards per trip.

Additional caveats with using IGNS data for the discard estimates are better understood by examining the 2008 discard estimate, the highest estimate since 2003. Two things in particular probably led to a much inflated dead discard estimate in 2008: 1) The strong 2005 year class of striped bass resulted in some of the highest catch rates observed in the IGNS in the entire time series of the survey. However, these high catch rates were observed in the western ASMA only. Zones II and III (western ASMA) accounted for 70% of the total striped bass catch in the 3.0 and 3.5 ISM nets (N=446, CPUE=0.08711), while Zones VI and VII (eastern ASMA) accounted for only 4% of the catch (N=27, CPUE=0.00527). Without an accurate way to distinguish gill net trips made in the western ASMA versus eastern ASMA, these high striped bass catch rates from the IGNS were applied to the total number of commercial gill net trips made in the entire ASMA. The TTP reported 4,974 commercial small mesh gill net trips were made in the ASMA during 2008. Looking at the catch composition from trip tickets it is evident many of these trips were made in the eastern portion of the ASMA. With the low striped bass catch rates observed in the IGNS from this area it is likely very little if any striped bass bycatch was observed in many of these eastern sound trips; 2) The IGNS was designed as a random-stratified-multiple mesh gill net survey to estimate the relative abundance and composition of striped bass residing and overwintering in the ASMA and the relative abundance and composition of the A/R spawning stock. It was not designed to estimate catch rates of any species observed in commercial fishing operations. This is an important caveat to consider when IGNS striped bass catch rates must be used in estimating bycatch losses attributed to the commercial gill net fisheries. Price (2004) showed that commercial fishermen in the Currituck Sound could use Traditional Ecological Knowledge (TEK) to reduce striped bass bycatch in small mesh white perch fisheries. Striped bass catch rates were significantly lower in nets set by fishermen using TEK compared to nets randomly set. Commercial fishermen will try and set nets so as to encounter as little unwanted bycatch as possible, thus reducing time on the water and fuel consumption. The majority of striped bass captured in the small mesh fisheries are undersized discards, so fishermen use TEK to avoid setting in areas that are likely to produce significant striped bass undersized discards.

There are also many additional regulations since 1990 that would have reduced striped bass discard mortality in the ASMA that may not be reflected when IGNS data have to be used in the annual estimates (Table 7.7). Total harvest and discards by commercial and recreational sectors is shown in Figure 7.6. Table 7.8 is a summary of striped bass commercial seasons in the ASMA.

Acquiring the funding for a state-wide at-sea observer program in all fisheries should be a top priority.

7.2.2 CSMA Stocks: Tar/Pamlico River and Pamlico Sound

7.2.2.1 Historical

Commercial striped bass fisheries have historically occurred throughout Pamlico Sound and its tributaries. However, these fisheries were not of the magnitude of the Albemarle Sound and ran second in total landings for the state. As with the Albemarle Sound, the progression of various gears was the same over time from haul seines, pound nets to gill nets. From the 1930s through the 1960s the Pamlico Sound and Tar/Pamlico River accounted for 3.4 – 5.5% of the total internal striped bass landings in North Carolina. During the 1970s and 1980s this area contributed 7 – 10% of the state's internal striped bass landings. Chestnut and Davis (1975) presented a synopsis of striped bass landings by gear for the state (1887 – 1971), annual landings and value for some years, and landings by county (Section 14, Appendix 1). Annual landings by gear are shown in Table 7.1 from 1978 to 2009 and in Table 4.1 by waterbody for 1972 – 2009.

From 1915 to 1965, various regulations were enacted on the fisheries of the Pamlico system. The regulations included net restrictions and area restrictions (Section 14, Appendix 2). Appendix 14.3 summarizes rules and regulations enacted since 1979 relative to striped bass management.

7.2.2.2 Current

Since 1994, when the initial North Carolina Striped Bass Management Plan was approved, the CSMA (all areas south of the ASMA line) has operated on a 25,000 pound TAC (Table 7.9). The fishery has operated as a low harvest level fishery, using set seasons with size limit restrictions and daily landing limits. The various rules and regulations are shown in Appendix 3.

The Pamlico Sound and Pamlico/Pungo River complex has accounted for 9% of the state's internal striped bass landings since 1994. During 1999 and 2000, these areas exceeded the total 25,000 pound TAC for the entire Central/Southern area of the state (Table 4.1). In the CSMA between 1994 and 2000, there was an average of 211 fishermen reporting landings in a given year. Since 2001, the number of fishermen reporting landings annually has dropped to approximately 168.

Table 7.7 Regulations promulgated since 1990 that would have decreased striped bass discard mortality attributed to anchored gill net fisheries in the ASMA.

Year/Area	Large mesh 5 inch and larger	Shad (Feb 1 – Apr 14)	Flounder	Small Mesh (Unattended/Attended)
1990	No restrictions			3 to 4 in – up to 1,600 yards
1991 - 1993	5 ¼ in and greater no restrictions			3 to 3 ½ in – 400 – 1,200 yards
1991 - 1993 Roanoke/Croatan areas	No restrictions			2 ½ in and larger unlimited
1991 – present Batchelor Bay area	Closed to all gill nets Feb 1 – Late Nov			
1994	All gill nets – only set from sunrise Mon – Fri at 4:00 pm	500 yards		3 – 3 ¼ in up to 1,000 yards
1994 - present			Flounder net definition – max 3,000 yards – 5 ¼ and larger	
Roanoke/Croatan areas 1994 – early 1999				2 ½ inch and larger unlimited
1995		500 - 800 yards		3 – 3 ¼ in – 300 -1,000 yards (unattended/attended)
1996 - 2006		1,000 yards		3 – 3 ¼ inch – 400 -800 yards; 3 – 4 inch – 800 yard attended (summer)
Roanoke/Croatan areas Early 1999 - 2001				3 – 3 ¼ inch – 400 – 1,000 yards, seasonal 3 – 4 inch – not exceed 1,200yards
Roanoke/Croatan areas 2002- 2006				3 – 3 ¼ inch – max 800 yards, seasonal 3 – 4 inch not exceed 800 yards total
2007 – present		1,000 yards	Flounder net definition – 5 ½ inch and larger, max 3,000 yards,	Only 3 ¼ inch – max 800 yards – Jan – mid- May, 3 – 4 inch – Max 800 yards – attended – Mid-May – Mid – Nov, 3 and 3 ¼ inch – max 800 yards – unattended - mid-Nov - Dec

Figure 7.6 Total harvest and discards by commercial and recreational sectors 1994-2009, ASMA.

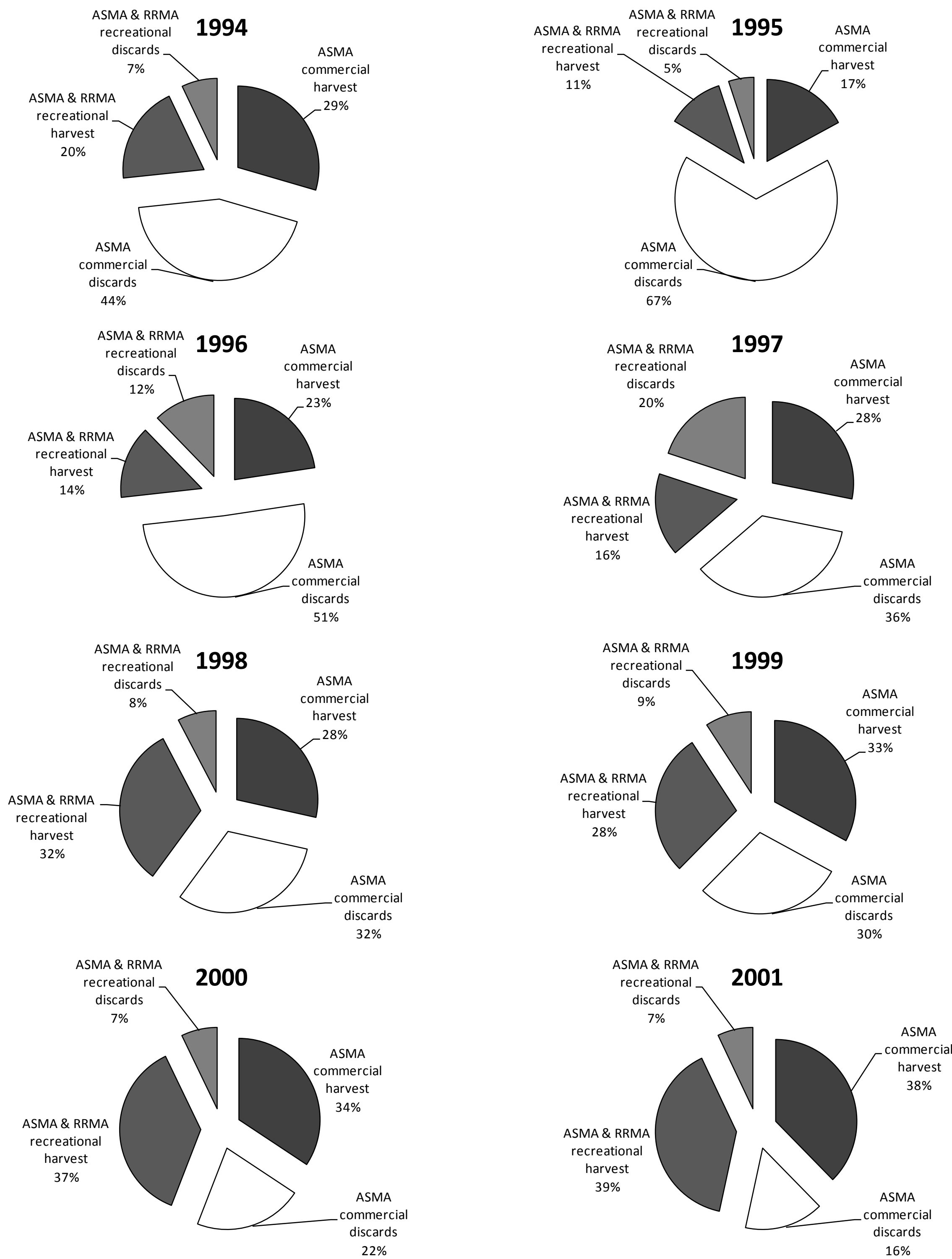
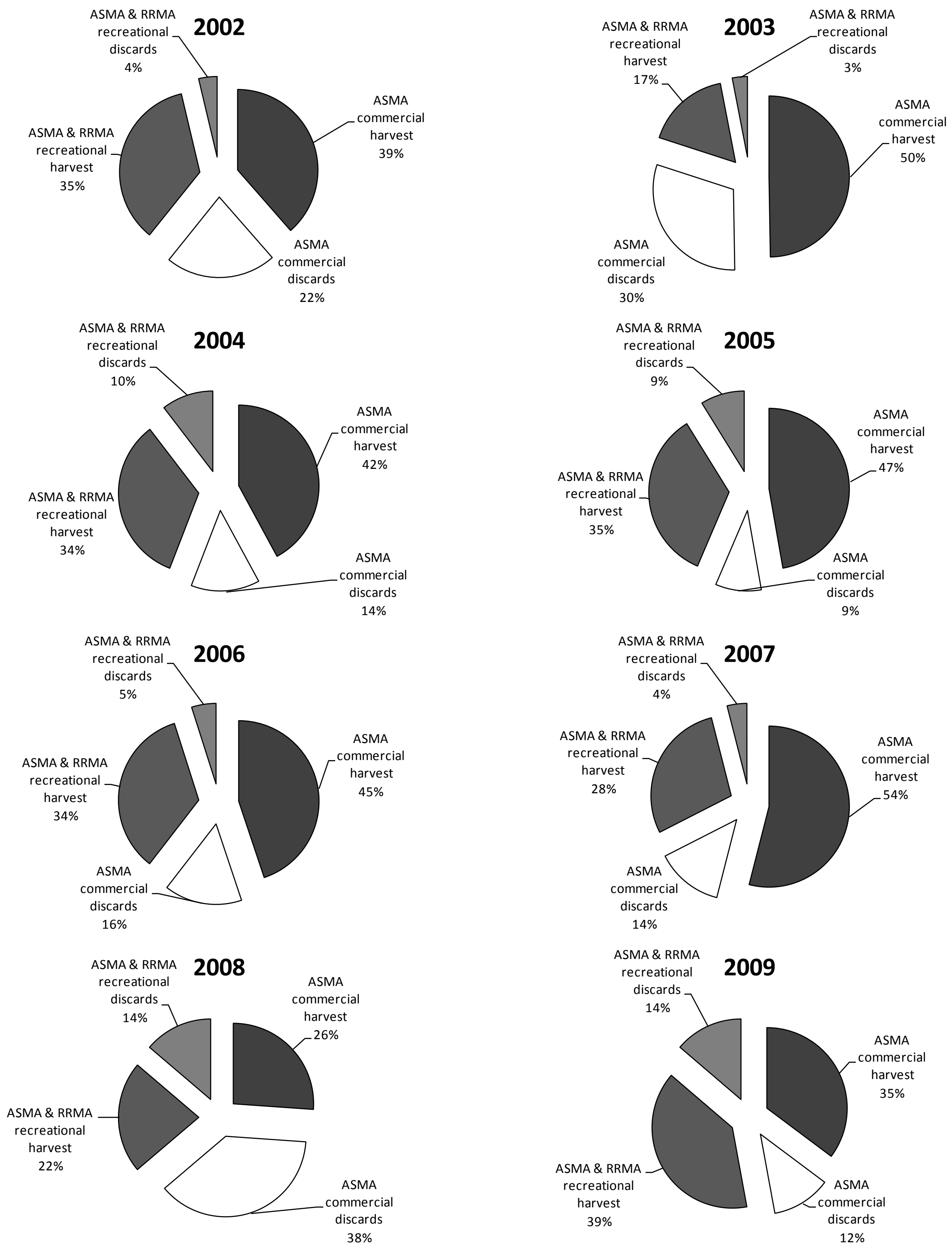


Figure 7.6 (continued).



The majority of these fishermen were from the Pamlico Sound and Pamlico/Pungo river areas. Gill nets account for the highest percentage of the striped bass landings from this area.

For the Neuse and Tar/Pamlico rivers, striped bass discards from large mesh gill nets were identified as the primary source of mortality within the CSMA. To identify ways to reduce discard mortality, NCDMF examined the effectiveness of tie-downs for gill nets to reduce striped bass catch during seasons closed to harvest, and evaluated the effect of prohibiting large mesh gill netting within various distances from shore. To address discards from the commercial large mesh gill net fishery, large mesh gill nets were required to be tied down such that the vertical height did not exceed three feet, with the nets required to be set a minimum distance of 50 yards from shore. This requirement went into effect July 2008.

The striped bass low harvest level fishery occurs only in the spring season. During the open season fishermen are restricted to daily landing limits and minimum size limits. From 2005 to present in Pamlico Sound only, striped bass cannot exceed 50% by weight of the daily commercial catch. Finfish dealers are required to obtain a striped bass permit, with a CSMA validation, report landings daily to NCDMF and affix a sale tag to the striped bass when purchased from the fishermen.

Table 7.8. Summary of striped bass commercial seasons in the Albemarle Sound Management Area, North Carolina, 1991 – 2009.

Year	TAC (lbs)	Spring season # Days	Bag limit	Pounds landed	Fall season # Days	Bag limit	Pounds landed	Total pounds landed # Days
2009	275,000	Jan 1 – 31 Feb 1 – Mar 25 Mar 26 – Apr 14 Apr 15 – 30 120 days	7 fish 10 fish 15 fish 10 fish	59,832	Oct 1 – Nov 30 Dec 1 – 15 Pound net ONLY 76 days	10 fish	37,053	96,885 196 days
2008	275,000	Jan 1 – 31 Feb 1 – Apr 9 Apr 10 – 14 Apr 15 – 30 121 days	5 fish 10 fish 15 fish 10 fish	56,922	Oct 1 – Nov 30 61 days	10 fish	17,376	74,298 182 days
2007	275,000	Jan 5 – Feb 28 Mar 1 – Apr 14 Apr 15 – 30 116 days	5 fish 10 fish 5 fish	145,261	Oct 1 – Nov 30 Dec 1 - 14 75 days	10 fish	26,422	171,682 191 days
2006	275,000	Jan 1-Mar 14 Mar 15 – Apr 14 Apr 15 – 30 120 days	5 fish 10 fish 5 fish	151,682	Oct 1 – Nov 30 61 days	10 fish	34,717	186,399 181 days
2005	275,000	Jan 3- Mar 30 Apr 1 – 14 102 days	5 fish 10 fish	182,855	Oct 3 – 27 Oct 28 –Nov 30 58 days	5 fish 10 fish	49,838	232,693 160 days
2004	275,000	Jan 5 – Apr 6 91 days	5 fish	273,636	No Fall Season			273,636 91 days
2003	275,000 (269,998)	Jan 6- Mar 19 Mar 20 – Apr 14 99 days	5 fish 10 fish	190,972	Oct 27 – Dec 31 65 days	5 fish	75,583	266,555* (323,337 total – 56,782 lbs to AO) 164 days
2002	225,000 (215, 514)	Jan7 – Apr14 98 days	5 fish/18”TL	168,562	Nov 4 – Dec20 47 days	5 fish/18”TL	54,294	222,856* 145 days

Table 7.8 (continued).

Year	TAC (lbs)	Spring season # Days	Bag limit	Pounds landed	Fall season # Days	Bag limit	Pounds landed	Total pounds landed # Days
2001	225,000 (211,348)	Jan5 – Mar25 Mar26 – Apr14 100 days	5 fish/18"TL 10 fish/ 18" TL	185,585	Nov19 – Dec21 33 days	5 fish/18"TL	34,648	220,233* 133 days
2000	225,000 (200,109)	Jan7 – Mar26 Mar27 – Apr14 99 days	5 fish/ 18"TL 10 fish/ 18" TL	162,467	Nov13 – Dec31 49 days	5 fish/ 18"TL	51,562	214,029* 148 days
1999	137,984	Feb9 – Mar28 Mar29 – Apr14 65 days	5 fish/ 18"TL 10 fish/ 18" TL	124,527	Dec1 – Dec12 Dec13 – Dec31 31 days	10 fish/ 18"TL 5 fish/ 18"TL	38,343	162,870 96 days
1998	125,440	Feb16 – Mar6 Mar7 – Apr14 58 days	5 fish/ 18"TL 10 fish/ 18" TL	101,093	Dec1 – Dec31 31 days	10 fish/ 18"TL	22,834	123,927 89 days
1997	98,000	Feb15 – Mar23 Mar24 – Apr14 59 days	3 fish/ 18"TL 7 fish/ 18"TL	73,534	Nov.3 – Dec5 33 days	5 fish/ 18"TL	22,588	96,122 92 days
1996	98,000	Feb16 – Apr7 Apr8 – Apr14 59 days	5 fish/18"TL 3 fish/18"TL	79,678	Nov30 – Dec22 Dec23 – Dec31 32 days	5 fish/18"TL 10 fish/18"TL	10,455	90,133 91 days
1995	98,000	Mar1– Apr4 Apr5– Apr14 45 days	5 fish/18"TL 2 fish/ 18" TL	83,636	Nov22 – Dec31 40 days	2 fish/18"TL	4,200	87,836 85 days
1994	98,000	Feb21 – Mar13 21 days	10 fish/ 18"TL	53,698	Nov21 – Dec23 33 days	5 fish/ 18"TL	48,672	102,370 54 days
1993	98,000	Feb1 – Feb28 Mar1 – Apr5 64 days	5 fish/ 18"TL 3 fish/ 18" TL	109,475	No Season			109,475 64 days

Table 7.8 (continued).

Year	TAC (lbs)	Spring season # Days	Bag limit	Pounds landed	Fall season # Days	Bag limit	Pounds landed	Total pounds landed # Days
1992	98,000	Jan11 – Feb2 Feb3 – Mar18 Mar19 – Apr16 97 days	10 fish/ 18"TL 5 fish/ 18" TL 3 fish/18"TL	96,435	Nov9 – Nov20 12 days	3 fish/ 18"TL	4,114	100,549 109 days
1991	98,000	Jan7 – Jan9 Jan18 – Feb12 Feb13 – Feb28 Mar1 – Mar24 Mar25 – Apr5 Apr6 – Apr13 86 days	Monthly quota/14"TL Coastal/16"TL Joint 3 fish/20"TL 5 fish/18"TL 10 fish/18"TL 20 fish/14"TL Coastal/16"TL Joint 5 fish/18"TL	101,219	Nov.1 – Dec20 50 days	3 fish/ 18"TL	7,241	108,460 136 days

*Total allowable catch adjusted to compensate for overages in previous year.

Table 7.9. Summary of striped bass commercial seasons in the Central Southern Management Area, North Carolina, 1991 – 2009.

Year	TAC (lbs)	Spring season # Days	Bag limit	Pounds landed	Fall season # Days	Bag limit	Pounds landed	Total pounds landed # Days
2009	25,000	Mar 16 – Apr 10 26 days (Cape Fear Closed)	7 fish	24,407	No Fall Season	-	-	24,407 26 days
2008	25,000	Jan 10 – Apr 30 (CF) Mar 3– Apr 30 79 days	5 fish	10,230	No Fall Season	-	-	10,230 79 days
2007	25,000	Jan 10 – Apr 3 (CF) Mar 1 – Apr 3 63 days	5 fish	24,040	No Fall Season	-	-	24,040 63 days
2006	25,000	Jan 1- Apr 3 (CF) Mar 2 Apr 3 60 days	5 fish	20,955	No Fall Season	-	-	20,955 60 days
2005	25,000 (26,932)	Jan 1 – Apr 30 (CF) Feb 28 – Mar 24 58 days	5 fish	26,932	No Fall Season	-	-	26,932 58 days
2004	25,000 (32,480)	Jan 6 –Apr 30 (CF) Mar 8 – Apr 5 116 days	10 fish 5 fish	32,480	No Fall Season	-	-	32,480 99 days
2003	25,000	Jan 9 – Apr 30 (CF) Mar 3 –Apr 1 114 days	10 fish 5 fish	20,327	Dec 1 – Dec 21 21 days	5 fish	4,226	24,472 135 days

Table 7.9 continued.

Year	TAC (lbs)	Spring season # Days	Bag limit	Pounds landed	Fall season # Days	Bag limit	Pounds landed	Total pounds landed # Days
2002	25,000	Jan 7 – Apr 30 (CF) Feb 25 – Mar 16 114 days	10 fish 5 fish	17,752	Dec 2 – Dec 13 12 days	5 fish	1,998	19,810 126 days
2001	25,000	Jan 8 – Apr 30 (CF) Feb 12 – Mar 2 113 days	10 fish 5 fish	20,739	Dec 4 – Dec 14 11 days	5 fish	3,994	24,843 124 days
2000	25,000 (30,832)	Jan 8 – Apr 30 (CF) Feb 11 – Mar 9 113 days	10 fish 5 fish	22,429	Nov 13 – Nov 28 16 days	5 fish	8,383	30,828 129 days
1999	25,000 (31,156)	Jan 7 – Apr 30 (CF) Feb 9 – Apr 30 113 days	10 fish 5 fish	25,214	Dec 1 – Dec 31 31 days	5 fish	5,942	31,156 144 days
1998	25,000	Jan 8 – Apr 30 (CF) Feb 16 – Apr 8 113 days	10 fish 5 fish	21,650	Dec 1 – Dec 31 31 days	5 fish	1,905	23,555 144 days
1997	25,000 (28,859)	Jan 13 – Apr 30 (CF) Feb 15 – Mar 22 102 days	10 fish 3 fish	19,006	Nov 3 – Nov 19 17 days	5 fish	9,853	28,859 119 days
1996	25,000 (32,706)	Jan 29 – Apr 30 (CF) Feb 29 – Apr 15 90 days	10 fish 5 fish	28,568	Dec 12 – Dec 31 19 days	5 fish	4,138	32,706 109 days
1995	25,000	Jan 23 – Apr 30 (CF) Mar 6 – Apr 30 97 days	10 fish 5 fish	7,557	Nov 22 – Dec 31 39 days	10 fish	6,674	14,230 136 days
1994	25,000	Neuse & Cape Fear) Jan 31 – Mar 13 Pam. S. & Pam. R) Feb 21 – Apr 30 41 days	10 fish	12,260	Neuse Nov 24 – Dec 31 38 days	20 fish	7,348	19,808 79 days

7.2.3 Central/Southern Stocks: Neuse River

7.2.3.1 Historical

Striped bass commercial fisheries have occurred in the Neuse River since colonial times. Worth (1903) reported that striped bass were numerous at New Bern and at other points along the Neuse River.

The progression of commercial gears was similar to the other areas of the state. Commercial fisheries on the Neuse River employed drift gill nets with a full range of mesh sizes upstream to Pitch Kettle Creek and stake gill nets and haul seines principally from New Bern downstream (Marshall 1977).

From the 1930s through the 1980s commercial landings of striped bass in the Neuse River were insignificant compared to the statewide landings. The commercial striped bass fishery may have been important at the turn of the century but has remained at very low levels for the last 50 years. Chestnut and Davis (1975) presented striped bass landings by county for the period 1930 – 1968 (Appendix 1), which shows the small amount of landings for the counties along the Neuse River. Table 4.1 shows the Neuse River landings from 1972 to 2002.

The fisheries of the Neuse were affected by various regulations enacted from 1915 to1965 (Appendix 2). The rules and regulations enacted since 1979 relative to striped bass management are shown in Appendix 3.

7.2.3.2 Current

The harvest of striped bass is from bycatch of other fisheries and the landings are part of the 25,000 pound CSMA commercial TAC. Since 1994, the Neuse River striped bass commercial landings increased from that of the 1970s and 1980s, but still only made up 3% of the states internal striped bass landings. The landings since 2000 have been fairly consistent and averaged 6,158 lbs (Table 4.1). Gill nets account for the majority of the harvest.

7.2.4 CSMA Stocks: Cape Fear River

7.2.4.1 Historical

The striped bass fishery in the Cape Fear River system has typically been small compared to the other systems of the state. In 1923, a law was passed that made it unlawful to catch or take with nets or seines any striped bass in any waters of New Hanover County (North Carolina Fishing Laws- 1923) (Section 14, Appendix 2). This law remained in effect through 1987. The majority of the striped bass landed were taken as incidental bycatch in the American shad fishery. Striped bass landings by county from 1930 to 1968 are presented in Appendix 1. Since 1979, various rules and regulations have been enacted by the state that have affected striped bass harvest (Appendix 3).

7.2.4.2 Current

The Cape Fear River system striped bass fishery has operated under the CSMA TAC since 1994. The fishery has been prosecuted as the other parts of the state with seasons, minimum size limits, daily landings limits and dealer permit requirements. A no harvest regulation (15A

NCAC 03M .0202a) was established for striped bass in the Cape Fear River and its tributaries July 1, 2008. Prior to the closure, the Cape Fear River season was only open to striped bass commercially harvested during the spring (January – April). The striped bass landings primarily occur as bycatch of the American shad fishery. Anchored gill nets accounted for 97% of the landings from 1994 to 2008, while driftnets composed about 3% of the landings. The average annual landings (1994-2008) were approximately 1,300 lbs, which is about 44% less than the average annual landings reported in the 1970s and about 62% less than the early 1980s (Table 4.1).

7.2.5 CSMA Commercial Discard/Bycatch Mortality

The CSMA estuarine gill net fishery is a year round multi-species fishery where netting used and species targeted varies by area and season. Species commonly caught by the gill net fishery include American shad, Atlantic croaker, southern flounder, red drum, spot, spotted seatrout, striped bass, striped mullet and weakfish. Even though a 25,000 lbs TAC, daily landing limits and seasons exist in the CSMA, striped bass is a targeted catch in the bays and mouths of the rivers. Even with the five to ten fish per operation daily landing limit, 7% of the trips in Pamlico Sound and 29% of the river area gill net trips during the open season were dominated by striped bass (striped bass being the highest poundage on the trip ticket).

An estimate of the discarded catch for a gear may be computed by estimating the “total catch” (quantity taken that reaches the deck of vessel) and subtracting from it the “landed catch” (that which is brought ashore). The discarded catch may then be multiplied by a mortality estimate (percent that are dead at the time of harvest) to give an estimate of the quantity of dead discard. The NCDMF data and methods used to calculate a discard (dead) estimate for the set gill net fishery in Pamlico Sound and Pamlico, Pungo, Bay and Neuse rivers can be found in Section 11.7, Discard Mortality of Striped Bass From Commercial Set Gill Nets in the CSMA. Similar data for other areas in the CSMA are not available. Dead discard estimates were based on either observer (fishery dependent data) or the Independent Gillnet Survey (fishery independent data) catch and mortality rates combined with numbers of trips from the Trip Ticket program. For 2004 – 2009 the yearly average dead discard striped bass commercial estimate for these areas was ~5,500 lbs using the observer data and ~16,000 lbs using IGNS data. These estimates for a number of reasons are not precise and are meant to provide a relative basis on which to judge the relative extent of the commercial discards. At-net mortality rate during the cooler water temperatures of the open season averaged 16% whereas the closed season rate was higher at 24%. These are pooled values across the years 2004-2009.

7.3 RECREATIONAL FISHERIES

7.3.1 Introduction

The origins of recreational angling in North Carolina are poorly documented in existing literature, although Worth (1912) provides an interesting anecdotal account of the Neuse and Roanoke Rivers. When Ralph Lane and the first English explorers visited the Croatan, Roanoke, and Albemarle Sound area, they observed the various Native American tribes harvesting fish with weirs. The early colonists may have also taken striped bass with hook and line purely as a matter of subsistence. After the industrial revolution and with the advent of outboard motors, anglers began to seek striped bass with hook and line for both subsistence and recreation. Early in the 20th century, in the Croatan and Roanoke Sound areas of Dare County, charter boat fishing fleets developed, signaling a move towards angling for striped bass, purely as a recreational activity. An increase in disposable income and leisure time during the mid-1900s gave rise to a great interest in fishing for striped bass in North Carolina's sounds and rivers. As recovery of the A/R stock continued into the late 1990s, a tremendous increase in recreational effort for striped bass occurred.

Keeping striped bass for food has always been an important element of the recreational experience, but because striped bass caught recreationally were allowed to be sold in some areas the distinction between recreational and commercial fisheries has been unclear at times. For example, until the early 1980s, striped bass were caught with recreationally licensed bow nets in the upper reaches of Roanoke River and local legislation allowed these fish to be bought and sold. Striped bass caught on hook and line in the eastern Albemarle Sound charter boat fisheries were also bought and sold. After the near collapse of the A/R striped bass stock in the late 1970s, regulatory agencies recognized the need to remove economic incentives to sell striped bass taken with traditional recreational gear so that commercial harvest could be limited and quantified. Statutes allowing the sale of recreationally caught striped bass were repealed and rules of the NCMFC were changed to implement distinctions between the manner in which commercially saleable striped bass could be taken.

Taking and possession of striped bass using hook and line in coastal North Carolina is regulated by the NCWRC in designated Inland waters, jointly by the NCWRC and NCMFC in designated Joint waters and by the NCMFC in designated Coastal waters. In designated Joint waters, rules governing harvest seasons, creel limits and size limits are jointly enacted by the NCWRC and the NCMFC and are jointly enforced by officers of both agencies.

Techniques for catching striped bass on hook and line include trolling, casting, and jigging with artificial lures and the use of live bait (eels, shiners) and cut bait. Traditionally most preferred live bait or cut bait for striped bass has been river herring. In 2007 the NCDMF instituted a no harvest provision on river herring for commercial and recreational fishermen. Similarly, NCWRC enacted a moratorium (no harvest) on river herring greater than 6 inches. These actions to protect river herring essentially eliminated the use of fresh, live or cut bait river herring for recreational anglers targeting striped bass, especially during the spring harvest season in the RRMA.

The total TAC for the A/R stock is 550,000 lbs annually. This is split evenly between commercial and recreational sectors, with the recreational portion of the TAC (275,000 lbs) further divided between the ASMA and RRMA (137,500 lbs each). The total commercial TAC for the CSMA is 25,000 pounds and there is no CSMA recreational poundage limit or quota.

7.3.2 Roanoke River Management Area

Using a combination of observer tallies and angler post card surveys, Hassler et al. (1981) estimated numbers of striped bass caught on hook and line in the Weldon area of Roanoke River from 1959 through 1980 and in the entire length of the river from 1970 through 1980. Catch (and presumably harvest) in the Weldon area survey ranged from 3,174 striped bass in 1963 to 37,446 in 1971. In the survey of the entire Roanoke River, estimates of striped bass catch were lowest in 1980 (15,239) and highest in 1971 (65,399). Based upon angler reports, Hassler et al. (1981) also estimated numbers of striped bass caught by drift bow nets and fight bow nets for the period 1961 through 1980. Striped bass catches by drift bow net fishermen ranged from 69 fish in 1968 to 8,655 in 1964. Fight bow net catches ranged from 1,051 striped bass in 1978 to 10,393 in 1969.

In 1988, NCWRC began monitoring striped bass harvest in the Roanoke River with creel surveys during spring months. The area surveyed included Roanoke River from Roanoke Rapids Lake dam, downstream to Albemarle Sound, and the Middle, Eastmost, and Cashie rivers. As the agencies recognized that significant harvest restrictions would be necessary to rebuild the A/R stock, NCWRC first closed recreational springtime striped bass harvest in Roanoke River with emergency rules on May 10, 1990. Management of striped bass harvest by TAC began in both the RRMA and ASMA in 1991 and NCWRC closed the RRMA by emergency rules on May 1, 1991. From 1991 until 2001, NCWRC opened and closed the spring striped bass harvest season in the RRMA by proclamation authority of the Executive Director. Season closures were based upon weekly estimates of striped bass harvest as compared to the TAC of striped bass allocated to the RRMA. Because of high angling pressure, NCWRC limited striped bass harvest to three days per week during the spring season with an 18 inch minimum TL size limit with a slot limit (no possession 22-27 inches TL) in inland waters of the RRMA in 1994.

After recovery of the stock in 1997, substantial increases in the TAC were implemented and NCWRC increased the number of days from 3 days to 4 days per week in which striped bass could be possessed. In 2002, after another increase in the TAC to 112,500 lbs, NCWRC decreased the daily creel limit for striped bass from three to two, but set a 46 day season in the lower river (March 1 through April 15) and a 46 day season in the upper river (March 15 through April 30), and allowed striped bass to be possessed seven days per week. From 2000 to 2002, the quota remained at 112,500 lbs yet was exceeded in each of those years. During the spring 2003 season (harvest season ended April 30), NCWRC managed the RRMA with a 112,500 pound allowable harvest although the quota was increased to 137,500 lbs. Despite this difference in TAC management, neither quota would be reached in 2003 when higher flows and cooler water temperatures likely contributed to a decline in angling effort and subsequent harvest.

Since 2004, the TAC for the RRMA has remained at the current level of 137,500 lbs of striped bass and only 1 striped bass of the two fish creel limit could be 27 inches or greater. In 2005 and 2006, season extensions were allowed in the RRMA (both zones in 2005 and the lower zone in 2006). In 2007, a proclamation was set to establish a set season of March 1 to April 30 in the entire river with a subsequent extension for 6 days in the entire river. In 2008, a set season from March 1 through April 30 for the entire river was established by NCWRC rule and continuing through 2009 (Table 7.10). Since 2004, annual harvest estimates have been below the quota , especially in 2008 when mostly sub-legal male striped bass from the strong 2006 cohort were caught but not harvested (Thomas et al. 2009). From the period of 1991 through 2009, estimates of striped bass harvest in the RRMA ranged from 7,471 fish (28,883 lbs) in 1995 to 38,206 fish (120,113 lbs) in 2000 (Table 7.11).

7.3.3 Albemarle Sound Management Area

Recreational striped bass harvest (numbers of fish) in Albemarle Sound and its tributaries as well as Croatan and Roanoke sounds was monitored by Hassler et al. (1981) from 1967 through 1973. Estimates of striped bass harvest were based upon records of marina or landing owners, angler interviews, and angler post card surveys. Striped bass catch was estimated to be 67,172 in 1967 with a peak catch of 96,170 in 1970, and a low catch of 30,783 fish in 1973. Mullis and Guier (1982) used a non-uniform probability, roving/access creel survey to estimate recreational striped bass harvest and effort in Albemarle, Roanoke, and Croatan sounds as well as tributary rivers (excluding Roanoke River) from 1977 through 1980. An average of 118,340 angler hours (54,914 party hours) was exerted each year of the study specifically for striped bass. Estimated striped bass harvest was 33,202 fish (71,871 lb.) in 1977, 16,599 fish (30,915 lb.) in 1978, and 5,235 fish (12,553 lb.) in 1979.

Table 7.10 Summary of striped bass recreational seasons in the Roanoke River Management Area, North Carolina, 1991 – 2009. Note: For the 2003 spring season, allowable harvest was managed with 112, 500 lbs TAC, although the TAC was subsequently increased to 137,500 lbs.

Year	Allowable Harvest (lbs)	Estimated Harvest (lbs)	Regulations (Bold indicates first year of updated rule)
2009	137,500	69,581	2 fish/18"+ slot + only 1 over 27"; 7 fishing days a week (set season 3/1-4/30 in entire river **by rule**); single barbless hook;
2008	137,500	32,725	2 fish/18"+ slot + only 1 over 27"; 7 fishing days a week (set season 3/1-4/30 in entire river **by rule**); single barbless hook;
2007	137,500	62,492	2 fish/18"+ slot + only 1 over 27"; 7 fishing days a week; **proclamation to set unified season of 3/1-4/30 for entire river**, then proclamation to **extend to 5/6 in entire river**; single barbless hook;
2006	137,500	84,521	2 fish/18"+ slot + only 1 over 27"; 7 fishing days a week (set season 3/1-4/22 in Zone 2, 3/15-4/30 in Zone 1); **7 day extension in lower by proclamation**; single barbless hook;
2005	137,500	107,530	2 fish/18"+ RRMA slot + only 1 over 27"; 7 fishing days a week (set season 3/1-4/27 in Zone 2, 3/15-5/4 in Zone 1); **12 day extension in lower & 4 day extension in upper by proclamation**; single barbless hook;
2004	137,500	90,191	2 fish/18"+ RRMA slot + **only 1 fish over 27"**; 7 fishing days a week (set season 3/1-4/15 in Zone 2, 3/15-4/30 in Zone 1); inland single barbless hook;
2003	112,500	39,170	2 fish/18"+ RRMA slot; 7 fishing days a week (set season 3/1-4/15 in Zone 2, 3/15-4/30 in Zone 1); inland single barbless hook;
2002	112,500	112,698	**2 fish/18"+ RRMA slot; 7 fishing days a week (set season 3/1-4/15 in Zone 2, 3/15-4/30 in Zone 1); first year that slot was in effect for entire season throughout the river;** inland single barbless hook
2001	112,500	112,805	3 fish/18"+ inland slot; 4 fishing days a week (**Tue,Wed,Sat,Sun**); 24 fishing days Zone 2 (3/13-4/22), 28 fishing days Zone 1 (3/13-4/29); slot in lower after 4/1; single barbless hook in upper 4/1-6/30;
2000	112,500	120,091	3 fish/18"+ inland slot; **4 fishing days a week** (**Tue,Wed,Sat,Sun**); 17 fishing days Zone 2 (3/15-4/12), 27 fishing days Zone 1 (3/15-4/30); slot in lower after 4/1; single barbless hook in upper 4/1-6/30;

.

Table 7.10 continued.

Year	Allowable Harvest (lbs)	Estimated Harvest (lbs)	Regulations (Bold indicates first year of updated rule)
1999	68,970	72,967	3 fish/18"+ inland slot; 3 fishing days a week (Wed,Sat,Sun); 12 fishing days Zone 2 (3/13-4/7), 21 fishing days Zone 1 (3/13-4/28); slot in lower after 4/1; single barbless hook in upper 4/1-6/30;
1998	62,700	73,541	3 fish/18"+ inland slot; 3/14-4/12 (lower) & 3/14-4/29 (upper); 21 day season; 3 fishing days a week (Wed,Sat,Sun); slot in lower after 4/1; single barbless hook in inland waters 4/1-6/30;
1997	29,400	29,997	3 fish/18"+ inland slot; 3/15-3/23 (5 days lower) & 3/15-4/2 (9 d upper); 3 fishing days a week (Wed,Sat,Sun); upper river re-opened on 4/19 for 6 hours; 9 day upper season; **single barbless hook in inland waters 4/1-6/30;**
1996	29,400	28,178	3 fish/18" + inland slot; 3/16-4/10 (12 d lower) & 3/16-4/17 (15 d upper); 3 fishing days a week (Wed,Sat,Sun); slot in lower after 4/1;
1995	29,400	28,883	3 fish/18"+ inland slot upstream of HWY 258; 3/1-4/9 (18 lower) & 3/1-4/19 (22 upper); 3 fishing days a week (Wed, Sat, Sun); **slot includes lower river (joint waters) from 4/1-5/31;**
1994	29,400	28,089	3 fish/18" + inland slot upstream of HWY 258; 2/19-4/2 (lower) & 2/19-4/21 (upper) 23 day season; **3 fishing days a week** (**Wed,Sat,Sun**);
1993	29,400	45,145	1 fish/18" inland waters from 1/1-3/31 & 3 fish/18" joint waters from 1/1-3/31; 4/1-4/20 3 fish/18"+ inland slot upstream of HWY 258; 2/1-4/25 = 84 day season;
1992	29,400	36,016	**1 fish/18" inland** waters from 1/1-3/31 & **3 fish/18" joint** waters from 1/1-3/31; **4/1-4/20 3 fish/18"+ inland 22"-27" slot upstream of HWY 258;** 1/1-4/20 = 109 day season;
1991	29,400	72,529	3 fish per day; 16" minimum; harvest season **January 1 - May 1** (120 day season); **Roanoke River Management Area established via joint rule with NCDMF on January 1**

Table 7.11. Estimates of striped bass angling effort, harvest, and numbers caught and released from the Roanoke River Striped Bass Management Area, 1988-2009.

	Open Season (Harvest estimates)				Post Harvest Period (Catch and Release Only)			
Year	Number of striped bass	Weight (lbs)	Effort (angler-hours)	Number of trips**	Number of striped bass	Weight (lbs)	Effort (angler-hours)	Number of trips**
1989	8,753	32,107	46,566	9,803	*	*	*	*
1990	15,694	42,204	56,169	11,825	*	*	*	*
1991	26,934	72,529	74,596	15,704	*	*	*	*
1992	13,372	36,016	49,277	10,374	*	*	*	*
1993	14,325	45,145	52,932	11,144	*	*	*	*
1994	8,284	28,089	44,693	9,409	*	*	*	*
1995	7,471	28,883	56,456	11,885	52,698	*	20,639	4,345
1996	8,367	28,178	46,164	9,719	148,222	*	32,743	6,893
1997	9,364	29,997	23,139	4,871	271,328	*	47,001	9,895
1998	23,109	73,541	72,410	15,244	102,299	*	26,367	5,551
1999	22,479	72,967	72,717	15,309	113,394	*	30,633	6,449
2000	38,206	120,091	95,622	20,131	*	*	*	*
2001	35,231	112,805	100,119	21,078	*	*	*	*
2002	36,422	112,698	122,584	25,807	*	*	*	*
2003	11,157	39,170	77,863	16,392	*	*	*	*
2004	26,506	90,191	145,782	30,691	*	*	*	*
2005	34,122	107,530	130,755	27,527	68,147	*	24,146	5,083
2006	25,355	84,521	120,621	25,394	24,719	*	15,235	3,207
2007‡	19,305	62,492	141,874	29,868	11,622	*	9,254	1,948
2008‡	10,541	32,725	110,608	23,286	47,992	*	17,764	3,740
2009	23,248	69,581	120,675	25,405	*	*	*	*

* - No data

** - Number of trips calculated as the dividend of angler effort and an angler trip estimate of 4.75 h

‡ - Post harvest estimates from upper zone of Roanoke River

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In 1991, NCDMF began monitoring the recreational harvest of striped bass in the Albemarle Sound and its tributaries, excluding the Roanoke, Middle, Eastmost, and Cashie rivers. In 1994, the survey was expanded to cover the Currituck, Croatan, and Roanoke sounds to fully encompass the ASMA. Beginning on November 26, 1989, NCDMF opened and closed the spring and fall striped bass harvest seasons in the ASMA by proclamation authority of the Fisheries Director. Management of striped bass harvest through a TAC began in the ASMA on January 1, 1991. Season closures were based upon weekly estimates of striped bass harvest as compared to the TAC of striped bass allocated to the management area. Because of high angling pressure, NCDMF, in 1994, began limiting striped bass harvest to three days per week. In an effort to extend the number of fishing days, from 1995 through 1997, the daily creel limit for the fall season was reduced from three to two fish per person and the minimum size limit was increased to 21 inches TL. In the spring of 1988 the daily creel limit was reduced to two fish per person for both the spring and fall season, with a minimum size limit of 18 inches. TL

Since the A/R stock was declared recovered by the ASMFC in 1997 the overall recreational TAC has increased several times, from 29,400 lbs in 1997 to 137,500 lbs for the ASMA in 2003. The current recreational TAC of 275,000 lbs is split evenly between the ASMA and RRMA. Since the last TAC increase in 2003 harvest peaked in 2004 at 97,097 lbs and dropped to a low of 26,633 lbs in 2007. Since 2007 harvest has risen slowly to 37,313 lbs in 2009. Since 2006, the daily bag limit has been 3 fish at 18 inches TL and seven days per week during the open season. The recreational season in the ASMA has been open the maximum days (October – April) allowed by rule since 2006. A detailed listing of number of days open, daily creel limits, and annual harvest by season is contained in Tables 7.12 and 7.13.

For the fall 2005 season the creel survey design was changed from a non-uniform probability roving-access design to a non-uniform probability stratified access-point design (Pollock 1994). This survey design is the same as is used in the RRMA and CSMA surveys allowing for more statistically valid comparisons of results.

Estimated total effort for striped bass on the Chowan River in 2002 was 24,787 (SE = 3,669) angler hours and peaked during the spring of April 2002 open season in the lower section of the Chowan River (Dockendorf et al. 2004). Total estimated catch of striped bass was 14,024 (SE = 5,183) and an estimated 6,655 (SE = 1,583) striped bass were harvested during the recreational harvest season in spring 2002. Mean trip length for striped bass anglers was 3.7 hours and mean number of striped bass anglers per party was 2.1.

7.3.4 Central Southern Management Area

The 2004 FMP research recommendation for landing statistics for recreational fisheries was met by implementing in 2004 creel surveys in the CSMA. These creel surveys conducted by the NCDMF and NCWRC provided a reliable estimate of the recreational harvest for the CSMA for the first time. The survey area included the Pungo, Tar/Pamlico, and Neuse rivers. A non-uniform probability stratified access-point survey was utilized for site selections as well as effort and catch estimation (Pollock 1994). Returning fishing parties were interviewed to obtain information regarding the trip, catch, and socioeconomic attributes of striped bass anglers. Survey results were expanded to estimate total striped bass catch and effort in the CSMA (NCDMF 2009).

For the NCDMF creel survey, from January 2004 to December 2009, 3,951 survey assignments were conducted resulting in 25,168 intercepts, including 13,711 with fishing activity. A total of 3,260 interviews were anglers targeting striped bass with angling effort estimated over 12,793 fishing hours, resulting in a reported catch of 10,195 striped bass. Total length of observed striped bass ranged from 16.5 inches to 32.3 inches with a mean weight of 3.8 lbs. Expanded data provided an estimated 41,708 striped bass trips over 218,071 angling hours in the CSMA throughout the report period. Estimated striped bass catch was 110,733 fish, comprised of 92,861 discards and 17,873 harvested fish weighing 62,463 lbs. Discarded striped bass were mostly sub-legal sized fish (83%)(Table 7.14). Estimated striped bass catch was 110,733 fish, comprised of 92,861 discards and 17,872 harvested fish weighing 62,463 lbs. Discarded striped bass were mostly sub-legal sized fish (83%) and the total discard to harvest ratio was 5.2:1 (Table 7.14). Estimated catch per unit effort throughout the CSMA from 2004 to 2009 was approximately 0.5 fish per trip.

NCWRC conducted three creel surveys on the three primary rivers of the CSMA between 2002 and 2005 in separate fiscal years. Each creel survey was conducted from July to June and rotated on an annual basis beginning on the Neuse, then Cape Fear and finally, the Tar. Expanded data provided an estimated 66,520 angling hours in these systems during the combined survey period. Estimated striped bass catch was 34,273 striped bass with an estimated 10,017 striped bass harvested. The discard to harvest ratio was 2.4:1.

Following these creel surveys the recreational management regime in the CSMA changed. Prior to July 2008, the recreational fishery in coastal and joint waters the season was open year round with a 3 fish limit per person per day and an 18 inch TL minimum size. Inland waters required the same measures with the addition of a slot limit (22-27 inch TL not allowed) during May and April in upstream inland waters. Significant changes in recreational regulations occurred in 2008, including the establishment of a closed season from 1 May to 30 September. Reduction in the daily creel limit from 3 fish to 2 fish, and a protective slot limit of 22-27 inches TL was enacted throughout the Tar/Pamlico and Neuse river basins in joint and inland waters. The 18 inch TL minimum size limit for the recreational fisheries was maintained in coastal waters. A no harvest provision was implemented in the Cape Fear River and its tributaries. Recreational limits and season apply not only to the hook-and-line fishery but also to any harvest from recreational commercial gear (See Section 7.6).

7.3.5 Tar/Pamlico River

For the Tar/Pamlico River from the NCDMF creel survey, an estimated 12,804 striped bass trips over 64,321 angling hours occurred throughout the report period. Estimated striped bass catch was 38,772 fish, comprised of 36,109 discards and 2,663 harvested fish weighing 9,939 lbs. Discarded striped bass were mostly sub-legal sized fish (95%) (Table 7.14). Estimated catch per unit effort in the Tar/Pamlico River was approximately 0.6 fish per trip.

From the NCWRC creel survey on the Tar/Pamlico River from July 2004 to June 2005, striped bass was the second most popular species sought by anglers and the estimated striped bass angling effort was 14,100 angler-hours (SE = 3,153) (Homan et al. 2006). Effort for striped bass was highest in the lower river during winter (December through February), whereas peak effort in the upper river suggested increased importance of this species during spring (February and June). An estimated 17,177 striped bass (SE = 6,191) were caught with an estimated 188 striped bass (SE = 70) harvested during the creel survey (discard = 16,989; SE =). The estimated discard to harvest ratio was 90:1.

7.3.7 Pungo River

For the Pungo River from the NCDMF creel survey, expanded data provided an estimated 5,565 striped bass trips over 34,045 angling hours occurred throughout the report period. Estimated striped bass catch was 20,159 fish, comprised of 15,170 discards and 4,989 harvested fish weighing 17,230 lbs. Discarded striped bass were mostly sub-legal sized fish (88%) and the total discard to harvest ratio was 3:1 (Table 7.14). Estimated catch per unit effort in the Pungo River was approximately 0.6 fish per trip.

7.3.6 Neuse River

For the Neuse River from the NCDMF creel survey, expanded data provided an estimated 23,338 striped bass trips over 119,705 angling hours occurred throughout the report period. Estimated striped bass catch was 51,802 fish, comprised of 41,581 discards and 10,221 harvested fish weighing 35,292 lbs. Discarded striped bass were mostly sub-legal sized fish (72%) and the discard ratio was 4.1:1 (Table 7.14). Estimated catch per unit effort in the Neuse River was approximately 0.4 fish per trip.

From the NCWRC creel survey on the Neuse River from July 2002 to June 2003, striped bass anglers exerted an estimated total effort of 46,407 angler-hours (SE = 20,249) (Rundle et al. 2004). Striped bass effort peaked during April and June in the upper section of the river and during December and May in the lower section of the river around New Bern. An estimated 15,062 striped bass (SE = 5,438) were caught with an estimated 9,674 striped bass (SE = 5,144) harvested during the creel survey. The estimated harvest to discard ration was 0.5:1. Mean trip length for striped bass anglers was 4.0 hours, with an average of 1.7 anglers per party.

Table 7.12. Estimates of striped bass angling effort, harvest, and numbers caught and released from the Albemarle Sound Striped Bass Management Area, 1991-2009.

Season		Length in days	Angler hours	Number of fish harvested	Average number of fish harvested per day	Average weight of each fish harvested	Total pounds harvested	Average number of pounds harvested per day	Number of fish released	Average number of fish released per day	Number of fish measured by creel clerks
1991	Spring	113		9,978	88	2.5	24,561	217	11,701	104	
	Fall	30		4,417	147	2.4	10,783	359	11,839	395	
1992	Spring	120		8,034	67	2.9	23,582	197	13,167	110	
	Fall	30		2,508	84	2.9	7,176	239	6,814	227	
1993	Spring	77		11,404	148	3.2	36,049	468	13,241	172	
	Fall	No fall season		--	--	--	--	--	--	--	--
1994	Spring	12		4,005	334	3.5	14,087	1,174	no data	no data	495
	Fall	7		4,586	655	3.5	16,130	2,304	no data	no data	684
1995	Spring	9		4,240	471	4.1	17,355	1,928	no data	no data	452
	Fall	15		3,103	207	4.3	13,209	881	no data	no data	502
1996	Spring	8		4,374	547	3.4	14,851	1,856	no data	no data	469
	Fall	14	6,349	3,059	219	4.7	14,335	1,024	no data	no data	487
1997	Spring	5	4,332	4,941	988	3.5	17,315	3,463	6,111	1,222	620
	Fall	21	9,324	1,960	93	4.8	9,409	448	24,660	1,174	468
1998	Spring	18	38,760	9,310	517	3.3	30,709	1,706	25,060	1,392	1,276
	Fall	28	52,060	10,256	366	3.3	34,052	1,216	66,828	2,387	1,963
1999	Spring	37	36,477	10,137	274	3.6	36,970	999	32,742	885	1,722
	Fall	24	27,965	6,830	285	3.6	24,477	1,020	7,579	316	695
2000	Spring	67	53,957	13,993	209	3.7	51,428	768	23,205	346	1,410
	Fall	32	46,468	24,092	753	2.7	64,986	2,031	55,736	1,742	1,746
2001	Spring	53	49,307	17,582	332	2.7	47,448	895	16,737	316	1,783
	Fall	24	60,380	22,545	939	3.2	71,197	2,967	44,681	1,862	2,581
2002	Spring	52	57,549	17,989	346	3.3	59,297	1,140	20,502	394	2,274
	Fall	32	39,931	9,907	310	3.4	33,352	1,042	31,053	970	899
2003	Spring	61	44,588	8,937	147	3.4	30,141	494	14,283	234	724
	Fall	64	42,704	6,187	1,086	3.5	21,653	338	10,998	172	682
2004	Spring	62	53,794	13,728	221	3.5	48,577	784	22,346	360	1,028
	Fall	58	48,711	14,276	246	3.4	48,520	837	18,695	322	1,826
2005	Spring	79	25,397	6,133	78	3.4	21,117	267	4,396	56	826
	Fall *	92	61,546	11,821	128	3.6	42,360	460	16,824	183	809
2006	Spring	120	27,380	3,967	33	3.6	14,354	120	2,482	21	180
	Fall	92	38,377	6,744	73	3.2	21,631	235	6,973	76	558
2007	Spring	126	29,715	4,569	36	3.6	16,410	130	5,537	44	204
	Fall	92	31,964	2,574	28	4.0	10,223	111	8,062	88	226
2008	Spring	121	30,538	3,227	27	3.8	12,140	100	19,375	160	254
	Fall	92	42,135	6,821	74	2.9	19,488	212	17,084	186	379
2009	Spring	120	39,631	8,164	68	2.8	22,904	191	30,896	257	296
	Fall	92	32,390	3,905	42	3.7	14,409	157	9,647	105	253

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Table 7.13 Summary of striped bass recreational seasons in the Albemarle Sound Management Area, North Carolina, 1991 – 2009.

Year	TAC (lbs)	Spring Season # Days	Bag Limit/ Fishing Days Per Week	Pounds Landed	Fall Season # Days	Bag Limit/ Fishing Days Per Week	Pounds Landed	Total Pounds Landed # Days
2009	137,500	Jan 1 – Apr 30 120 days	3 fish/7 days	22,904	Oct 1 – Dec 31 92 days	3 fish/7 days	14,409	37,313 212 days
2008	137,500	Jan 1 – Apr 30 121 days	3 fish/7 days	12,140	Oct 1 – Dec 31 92 days	3 fish/7 days	19,488	31,628 213 days
2007	137,500	Jan 1 – May 6 126 days	3 fish/7 days	16,410	Oct 1 – Dec 31 92 days	3 fish/7days	10,223	26,633 218 days
2006	137,500	Jan 1-Apr 30 120 days	2 fish/7 days	14,355	Oct 1 – Dec 31 92 days	3 fish/7 days	21,642	35,997 (+ ~5,000 lbs RCGL) 212 days
2005	137,500	Jan 5-Apr30 79 days	2 fish/4 days 7 days (Apr 4-30)	21,117	Oct 1-Dec 31 92 days	2 fish/7 days	42,360	63,477 (+ ~3,000 lbs RCGL) 171 days
2004	137,500	Jan 14-Apr 30 62 days	2 fish/4 days	48,577	Oct 11-Dec 31 58 days	2 fish/4 days 7 days (Dec 2-31)	48,520	97,097 (1,306 lbs. RCGL) 120 days
2003	137,500	Jan 15-Apr 30 61 days	2 fish/4 days	30,141	Oct 11-Dec 31 64 days	2 fish/4 days 7 days (Nov 24-Dec 31)	21,653	51,794 (4,986 lbs. RCGL) 125 days
2002	112,500	Jan16 – Apr14 52 days	2 fish/ 4 days	59,297	Nov 6-Dec 29 32 days	2 fish/4 days	33,352	92,649 84 days

Table 7.13 continued

Year	TAC (lbs)	Spring Season # Days	Bag Limit/ Fishing Days Per Week	Pounds Landed	Fall Season # Days	Bag Limit/ Fishing Days Per Week	Pounds Landed	Total Pounds Landed # Days
2001	112,500	Jan17 – Apr18 53 days	2 fish/4 days	47,448	Oct17 – Nov25 24 days	2 fish/4 days.	71,058	118,506 (-9,664 lb overage) 77 days
2000	112,500	Jan1 – Apr26 67 days	2 fish/ 4 days	51,315	Oct. 11 – Nov. 12 Nov. 15 – Dec. 3 32 days	2 fish/ 18”TL Sat.,Sun.,Wed.,Fri. 1 fish/ 18”TL Sat.,Sun.,Wed.,Fri.	64,843	116,158 (-3,658 lb overage) 99 days
1999	68,992	Jan1 – Mar16 Apr 2 – Apr5 37 days	2 fish/ 18”TL Sat.,Sun.,Wed. Fri.,Sat.,Sun.,Mon	36,870	Nov 6 – Dec29 24 days	2 fish/ 18”TL Sat.,Sun.,Wed.	24,468	61,338 61 days
1998	62,720	Mar14 – Apr22 18 days	3 fish/ 18”TL Sat.,Sun.,Wed.	30,671	Oct28 – Dec30 28 days	2 fish/ 18”TL Sat.,Sun.,Wed.	33,909	64,580 46 days
1997	29,400	Mar15 – Mar23 5 days	3 fish/ 18”TL Sat.,Sun.,Wed.	17,257	Nov.15 – Dec31 21 days	2 fish/ 21”TL Sat.,Sun.,Wed.	9,324	26,581 26 days
1996	29,400	Mar16 – Mar31 8 days	3 fish/ 18”TL Sat.,Sun.,Wed.	14,851	Nov22 – Dec23 14 days	2 fish/ 21”TL Sat.,Sun.,Wed.	14,335	29,186 22 days
1995	29,400	Mar1 – Mar19 9 days	3 fish/18”TL Sat.,Sun.,Wed.	17,355	Nov22 – Dec24 15 days	2 fish/21”TL Sat.,Sun.,Wed.	13,209	30,564 24 days
1994	29,400	Feb19 – Mar 16 12 days	3 fish/18”TL Sat.,Sun.,Wed.	14,087	Nov23 – Dec7 7 days	3 fish/18”TL Sat.,Sun.,Wed.	16,130	30,217 19 days

Table 7.13 continued

Year	TAC (lbs)	Spring Season # Days	Bag Limit/ Fishing Days Per Week	Pounds Landed	Fall Season # Days	Bag Limit/ Fishing Days Per Week	Pounds Landed	Total Pounds Landed # Days
1993	29,400	Feb1 – Apr18 77 days	3 fish/18"TL Everyday	36,049	No Season			36,049 77 days
1992	29,400	Jan1 – May1 120 days	3 fish/18"TL Everyday	23,582	Nov1 – Nov30 30 days	1 fish/21"TL Everyday	7,176	30,758 150 days
1991	29,400	Jan1 – Jan31 Feb7 – May1 113 days	3 fish/16"TL Everyday	24,561	Nov 1 – Nov30 30 days	3 fish/18" TL Everyday	10,783	35,344 143 days

Table 7.14 Estimates of striped bass angling effort, harvest, and numbers caught and released from the Central Southern Management Area, 2004-2009.

River	Year	Total Fishing Trips	Striped Bass Fishing Trips	Striped Bass Effort (angler hours)	Number of Allowable Harvest	Pounds of Allowable Harvest	Striped Bass Discard (number over creel)	Striped Bass Discard (number under-sized)	Striped Bass Discard (number legal sized)	Striped Bass Discard (total number)	Discard / Harvest Ratio
Neuse River	2004	26,663	7,445	39,941	3,985	14,845	29	5,720	1,221	6,970	1.7:1
	2005	36,667	5,902	25,425	1,718	6,873	13	6,473	630	7,116	4.1:1
	2006	21,063	3,703	18,901	1,246	4,081	0	7,797	1,980	9,777	7.8:1
	2007	17,908	3,018	16,223	2,618	7,115	140	4,859	1,485	6,484	2.5:1
	2008*	15,770	1,995	10,131	405	1,510	2,838	4,801	2,449	10,088	24.9:1
	2009*	9,440	1,275	9,084	249	868	0	442	704	1,146	4.6:1
	sub-total	127,511	23,338	119,705	10,221	35,292	3,020	30,092	8,469	41,581	4.1:1
Tar/Pamlico River	2004	13,880	3,425	13,666	663	2,887	0	3,463	263	3,726	5.6:1
	2005	10,305	2,554	12,940	572	2,511	0	8,425	294	8,719	15.2:1
	2006	8,064	1,593	8,034	675	1,443	0	2,588	278	2,866	4.2:1
	2007	11,791	2,312	12,995	345	1,656	0	12,392	114	12,506	36.2:1
	2008*	6,408	1,632	8,616	174	648	0	5,137	296	5,433	31.2:1
	2009*	8,463	1,288	8,070	234	794	0	2,348	511	2,859	12.1:1
	sub-total	58,911	12,804	64,321	2,663	9,939	0	34,353	1,756	36,109	13.6:1
Pungo River	2004	5,532	1,909	10,183	1,494	5,227	56	2,543	259	2,858	1.9:1
	2005	3,877	1,152	5,948	1,620	5,915	139	713	76	928	0.6:1
	2006	5,167	758	3,954	562	1,832	33	2,164	56	2,253	4:01
	2007	6,826	991	7,870	637	2,024	7	4,422	108	4,537	7.1:1
	2008*	6,956	304	2,549	263	832	0	1,781	571	2,352	8.9:1
	2009*	6,724	451	3,541	413	1,400	7	1,682	553	2,242	5.4:1
	sub-total	35,082	5,565	34,045	4,989	17,230	242	13,305	1,623	15,170	3:01
All	2004	46,074	12,780	63,791	6,142	22,959	85	11,727	1,743	13,555	2.2:1
	2005	50,849	9,608	44,313	3,909	15,299	152	15,611	1,000	16,763	4.3:1
	2006	34,294	6,055	30,889	2,483	7,355	33	12,550	2,315	14,898	6:01
	2007	36,525	6,321	37,088	3,599	10,796	147	21,673	1,708	23,528	6.5:1
	2008*	29,134	3,931	21,296	842	2,991	2,838	11,719	3,316	17,873	21.2:1
	2009*	24,628	3,013	20,696	896	3,062	7	4,471	1,768	6,246	7:01
Total		221,504	41,708	218,071	17,873	62,463	3,261	77,751	11,849	92,861	5.2:1

*2 fish daily creel limit, Oct 1 - Apr 30 season, harvest moratorium on Cape Fear River and its tributaries-effective July 1, 2008

7.3.8 Pamlico Sound

Although estimates of striped bass harvest specifically from Pamlico Sound are not available, NCWRC and NCDMF personnel believe it to be substantial, especially in northern Pamlico Sound. NCDMF, in cooperation with NMFS, estimates recreational harvest of fish in ocean and estuarine areas of North Carolina through the Marine Recreational Information Program (MRIP). The MRIP estimates categorize catch estimates as having come from offshore, nearshore, or from inside waters. In North Carolina, inside estuarine waters include all southern and central sounds and extreme lower portions of coastal rivers, extending up to and including Croatan and Roanoke sounds. Striped bass harvest in Croatan and Roanoke sounds is therefore included in both the ASMA creel survey and the MRIP estimates, so there is no valid method to attribute harvest in this area to Pamlico Sound.

7.3.9 Cape Fear River

From the NCWRC creel survey on the Cape Fear River from July 2003 to June 2004, striped bass anglers exerted an estimated 6,013 angler-hours (SE = 784) of total effort (Ashley and Rachels 2005). Striped bass effort peaked during April and June in the upper section of the river and between September and March in the lower section of the river. An estimated 2,034 striped bass (SE = 232) were caught with an estimated 155 striped bass (SE = 33) harvested during the creel survey (discard = 1,879). The discard to harvest ratio was 12.1:1. Mean trip length for striped bass anglers was 4.1 hours, with an average of 1.6 anglers per party.

Despite the recent no harvest regulation for striped bass in the Cape Fear River (15A NCAC 03M .0202a), a recreational catch and release fishery still occurs with many local guide services offering trips targeting striped bass. The release mortality rate that can be attributed to the catch and release fishery in the Cape Fear River is presently unknown. Thus, it is important that the NCDMF and NCWRC educate anglers on proper fishing and handling techniques.

A tag and release striped bass tournament started on the Cape Fear River in 2008 by the Cape Fear River Watch. The tournament raises money for removing the three lock and dams on the river and increases public awareness about anthropogenic factors affecting anadromous fish populations. The tournament selects local charter boat captains trained to tag fish by the NCDMF to guide the tournament fishermen. In December 2008, 21 fishermen participated in the tournament and released 42 striped bass. The next tournament was held in January 2010 with 27 fishermen releasing 25 striped bass. The Cape Fear River Watch continues to organize the Cape Fear Striped Bass Tournament with assistance of the NCDMF and NCWRC.

7.5 GUIDED FISHING FOR STRIPED BASS

In 1984, a North Carolina license requirement for charter boats, headboats or guide boats ("for-hire" vessels) was initiated when North Carolina General Statute 113-152 (Licensing of vessels) was amended to include *"Commercial fishing operations also includes taking people fishing for hire".* After much public debate and with the passage of the Fisheries Reform Act in 1997, "fishing for-hire" was eliminated from the definition of commercial fishing operations, and the license requirement for charter boats and headboats was eliminated, effective July 1, 1999 (NCDMF 2003). In designated joint and inland waters, fishing guides (persons receiving monetary compensation for taking others fishing) are required to purchase an annual guide's license from NCWRC. Since 2008, NCDMF requires for-hire vessels to possess either a For

Hire Blanket Coastal Recreational Fishing License (CRFL) or a Division of Marine Fisheries For Hire Fishing Permit (each customer must have a CRFL).

Since the recovery of the A/R stock and the Atlantic Migratory Stock, striped bass has become one of the major species in the guided recreational fishery. During early 2002, nearly 315 for-hire vessels were identified as operating in North Carolina's coastal waters, representing a 37% increase from the three prior years. Though many of these vessels pursue a variety of species, a growing number target striped bass. In 2002, 96 new vessels entered the for-hire fishery with 48% of these occurring in the northern coastal area of North Carolina. In 2009, 843 vessels entered the for-hire fishery with 35% occurring in the northern region, while 33% and 31% in the central and southern regions. Among the vessels registered in the northern region, 26% were less than 25 feet, 17% were between 26 and 35 feet, and the remaining 57% were greater than 35 feet in length. Among the vessels registered in the central region, 51% were less than 25 feet, 20% were between 26 and 35 feet, and the remaining 29% were greater than 35 feet in length. Among the vessels registered in the southern region, 59% were less than 25 feet, 24% were between 26 and 35 feet, and the remaining 17% were greater than 35 feet in length.

Annual sales of NCWRC guide licenses have increased steadily from 292 in 1987 to 1,213 in 2009 (Figure 7.9). Because the NCWRC guide license is a combination hunting/fishing guide license, the exact proportion of license sales that can be attributed to fishing guides is not possible without separation of the license data or surveys conducted with specific inquiries related to guided striped bass angling trips. Linehan (2008) conducted an angler opinion survey of those who fished the Roanoke River for striped bass in spring 2007. Of the 277 survey respondents, the majority of respondents (90%, N = 252) did not go striped bass fishing with a guide on the Roanoke River in spring 2007. Although fishing guides are a component of the angling parties on the Roanoke River, the actual number of guides or the number of guided trips conducted for striped bass on the Roanoke River are unknown.

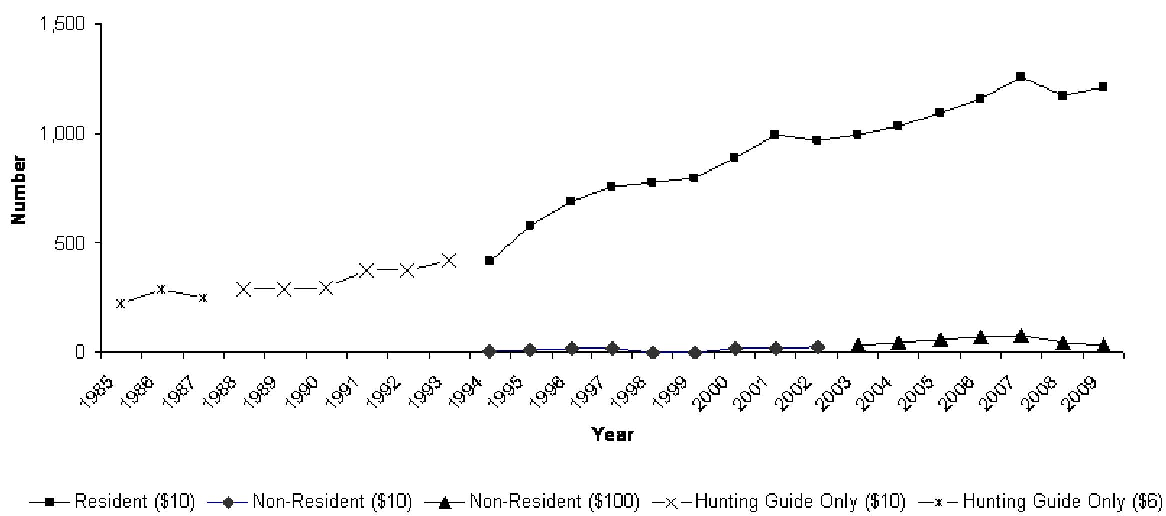


Figure 7.7 NCWRC hunting and fishing guide license sales, 1985-2009

7.6 CATCH AND RELEASE FISHING

Since the early 1990s, conservative striped bass creel limits have been in effect during open harvest seasons in the ASMA and RRMA. As this striped bass population has grown, an extensive catch and release fishery has developed both within and outside of the harvest seasons. During open harvest seasons, many anglers catch and retain their daily creel limit, then continue catching and releasing striped bass with individual catch rates sometimes exceeding 100 fish per day. Anglers often express the opinion that catching and releasing large numbers of striped bass after taking the daily creel limit offsets their desire to harvest more fish. Still, other anglers enjoy catching and releasing striped bass regardless of whether the harvest season is open, expressing no desire to keep any striped bass. The magnitude of the releases was shown for each area previously in Section 7.3.

A proportion of striped bass caught and released in the hook and line fisheries die as a result of injuries or physiological stress. Hooking injuries that cause damage to the gills or puncture the esophagus are often fatal. Striped bass that are bleeding heavily upon capture generally die immediately (referred to as "initial mortality") but many striped bass that are apparently in good condition upon release die at a later time (referred to as "delayed mortality"). The physical exertion associated with being hooked, fought, dehooked, handled, and released causes the fish's metabolic rate to increase greatly above normal limits and as a result, large amounts of lactic acid are produced with the muscle tissues. Although this severe condition known as "lactic acidosis" is often fatal, death occurs slowly over a period of several days. Many anglers are under the false impression that if a caught and released striped bass swims away, then it will survive the encounter.

Extensive research has been conducted upon catch and release mortality of striped bass and indicates that hooking location, bait type, and water temperature are the main factors influencing whether a caught and released striped bass will live or die. In an analysis of hooking mortality of 1,275 striped bass in fresh water based on published and unpublished data, Wilde et al. (2000) found that bait type and water temperature were both significant predictors of hooking mortality. Mortality was greater in fish captured on natural baits than artificial lures and increased rapidly for both bait types as water temperatures exceeded 77°F. The predictive model developed in this analysis, suggested that 50% of striped bass captured on natural bait die when water temperatures reach 80.6°F. In controlled tank studies of Roanoke River striped bass caught and released into large holding tanks, mean mortality rates were estimated to be 6.4%, however at water temperatures exceeding 70°F, mortality rates ranged up to 26.7% (Nelson 1998). In Albemarle Sound studies, survival of striped bass caught and released was lowest when water temperatures were high and dissolved oxygen low (Gearhart, 2002). Similar results (less than 10% mortality in cooler waters and up to 40% mortality in warm waters) have been documented in studies in estuarine striped bass populations in Massachusetts, Maryland, and in reservoir striped bass in Texas. In the Hudson River, Millard et al. (2005) found that mortality rates increased when water temperatures were at or above 60.8°F.

Hooking location and its relation to bait type also play a role in catch and release mortality. In studies on Roanoke River, hooking in the esophagus (throat) and gut was much more likely using natural bait than with artificial lures. Striped bass hooked in the esophagus, gut or gills had significantly greater mortality rates than fish hooked in the jaw or mouth. Bartholomew and Bohnsack (2005) also noted that natural bait appeared to increase the risk of deep hooking and that cutting the line on deeply hooked fish significantly increased survivorship. In Albemarle Sound studies (Gearhart, 2002*)*, predictors of mortality included bleeding, fish length, water temperature, hook removal, and dissolved oxygen. Overall, 57.1% of deep hooked striped bass died compared to 16.7% that were hooked in the mouth or gill and 2.7% for jaw hooked fish. Fish hooks that penetrate the esophagus may penetrate the heart or liver, which lie under the esophagus, causing internal injury and bleeding. Gills damaged by hooks bleed profusely and may result in mortality because they contain major arteries directly from the heart supplying blood flow to the gills for re-oxygenation. Millard et al. (2005) indicated that hook location and occurrence of bleeding were the most important variables in determining the probability of death among striped bass caught and released in Hudson River; noting that the odds of death for a fish that bled around the hooking site was about 15 times greater than a fish with no observable bleeding. In the Neuse River, the short term release mortality was observed for striped bass caught on hook and line using different hook types throughout the year (Brown 2007). Striped bass experiencing no bleeding were 3.4 times more likely to survive than those experiencing minimal bleeding, and striped bass experiencing handling times less than 30 seconds were 3.8 times more likely to survive compared to individuals handled between 30 and 60 seconds. Striped bass caught on treble hooks were 7.4 times more likely to survive then fish caught on circle hooks and 7.8 times more likely to survive when caught on treble hooks compared to individuals caught on J-hooks. Both circle (40.9%) and J-hooks (43.8%) had significantly higher release mortality rates than treble hooks (12.2%). Artificial lures used in the study, typically made up of treble hooks, were thought to be more difficult to swallow, minimizing the adverse hooking location associated with single hooks. Observed mortalities at low salinity trials average 39.2%, and ranged from 0-65.5%, while mortality at high salinity trials averaged 4.3%, ranging from 0-20.0%. Mortality associated with hook type is described in more detail in barbless hook issue paper in section 11.3.

As the popularity of catch and release fishing for striped bass continues to grow, the rate of discards is predicted to rise following the implementation of stricter fishing regulations. The number of discards in the CSMA has fluctuated as a result of the creel limits and seasonal closures set in place as of July 1, 2008 (Table 7.14). In the Neuse River the discard to harvest ratio ranged from 1.7:1 (2004) to 7.8:1 (2006). However in 2008, the discard to harvest ratio increased to 24.9:1, marking the largest increase in discards observed in the CSMA following the restrictions. In the Tar/Pamlico the harvest to discard ratio ranged from 4.2:1 (2006) to 36.2:1 (2007). Nevertheless, in 2008 the discard to harvest ratio (31.2:1) indicated a slight decrease in the number of discards and substantial decrease in the number of directed striped bass fishing trips and effort. In the Pungo River the discard to harvest ratio ranged from a 0.6:1 (2005) to 8.9:1 (2008). Prior to the current CMSA restrictions a slight increase in the number of discards was reported. As a whole, the CSMA discard to harvest ratio ranged from 6.5:1 (2007) to 21.2:1 (2008) following the current restrictions, marking a substantial increase in the number discards. However, the 2009 discard to harvest ratio did not reflect what was observed in 2008 directly following the current CSMA restrictions. Using the post regulation years of 2008 and 2009 and assuming a mortality rate of ten percent, the average dead discard in the hook and line fishery on an annual basis would be 1,206 fish (4,600 lbs if assume average weight=3.8 lbs) in the CSMA, with a dead discard to harvest ratio dropping to 0.4:1.

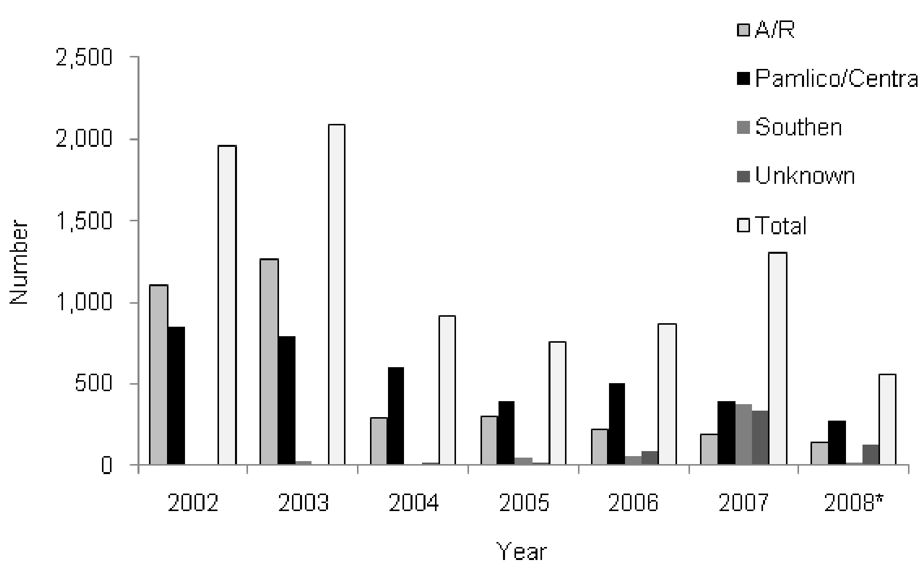
7.4 RECREATIONAL COMMERCIAL GEAR LICENSE

The North Carolina Fisheries Reform Act approved by the North Carolina General Assembly in 1997 established the Recreational Commercial Gear License (RCGL). An individual holding a RCGL is allowed to use limited amounts of specified commercial gear to catch seafood for personal consumption or recreational purposes. The holder of this license cannot sell the catch and the catch must stay within the recreational size and creel limits. This license is not transferable and expires one year from the date of purchase. 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 NCDMF. Types of information collected through the survey include gears and quantity used, number of trips, estimates of the number and poundage of each species harvested, and estimated numbers of each species discarded. Total effort and catch were computed for the subsample and extrapolated to the entire RCGL population. To more easily describe the spatial distribution of RCGL striped bass harvest, the coast was divided into three regions, ASMA, CSMA and unknown if the survey respondent did not provide location information. This survey does not capture individual lengths or weights of fish reported. Due to funding cuts the survey ended in 2008.

7.6.1 RCGL Harvest and Effort Estimates

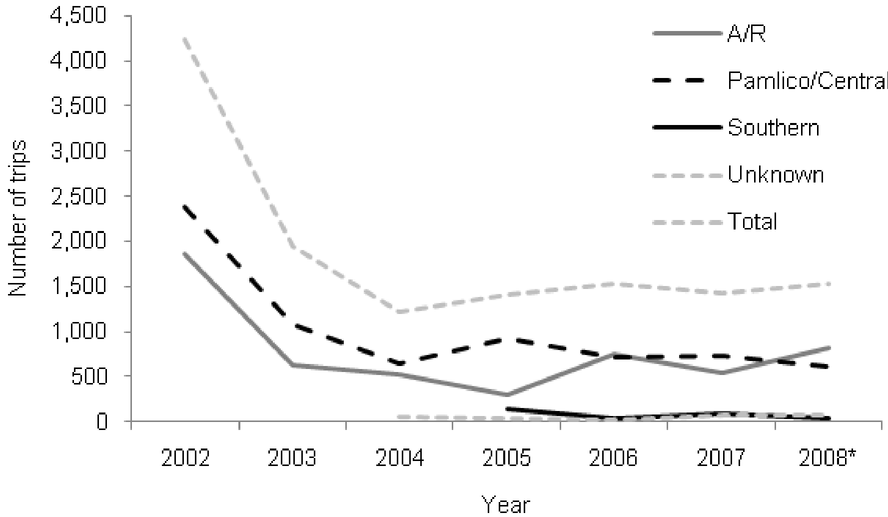
The total contribution of striped bass harvested by RCGL gears was insignificant compared to the harvest by recreational anglers, contributing only 3% by number and weight to the total recreational harvest during the year 2002 through 2008 for inside waters. The RCGL harvest of striped bass exhibited a pattern similar to that observed from the CSMA creel survey with a sharp decline in harvest occurring after 2003 when the largest number of striped bass (2,082) were harvested (Table 7.15). The decline in harvest continued until 2008 when 5,554 striped bass were harvested, with the biggest declines occurring in the A/R and Pamlico/Central management areas (Figure 7.8 and Table 7.15 &.16). Low harvest numbers were observed in the southern region of the CSMA from 2002 to 2006, reaching an all-time high in 2007 when 376 striped bass were harvested. The sharp decline in 2008 was a result of the harvest moratorium enacted in 2008 on the Cape Fear River and its tributaries.

The decline in the RCGL harvest of striped bass can be attributed to the sharp decline in trips occurring after 2003 (Figure 7.9). A total 1,857 trips were reported in the A/R region in 2002; however, an average of 593 trips was reported from 2003 through 2008. In the Pamlico/Central region 2,375 trips were reported in 2002, followed by a yearly average of 784 trips from 2003 through 2008. In the southern region, 2003 marked the highest number of trips reported (233). However, an average of 78 trips was reported from 2005 through 2008.



*2 fish daily creel limit, Oct 1 - Apr 30 season, harvest moratorium on Cape Fear River and its tributaries-effective July 1, 2008

Figure 7.8 North Carolina harvest (number) of striped bass by RCGL holders, 2002-2008.



*2 fish daily creel limit, Oct 1 - Apr 30 season, harvest moratorium on Cape Fear River and its tributaries-effective July 1, 2008

Figure 7.9 Trips targeting striped bass by RCGL holders, 2002-2008.

7.6.2 RCGL Seasonality of Harvest and Discard

During the period 2002 through 2008 in the A/R, 72.4% of the total harvest of striped bass by number occurred during the months of March (24.2%), April (16.0%), and October (32.2%). In the A/R, striped bass discards by RCGL holders was highest in October (24.1%) followed by March (14.6%), April (13.9%) and November (10.9%). In the CSMA, 69.2% of the total harvest of striped bass by number occurred during the months of November (21.6%), December (13.0%), May (12.7%), June (11.2%), and March (10.7%) in the CSMA. Striped bass discards by RCGL holders in the CSMA was highest in October (17.0%), followed by December (14.6%), November (13.7%), March (13.0%), and June (11.2%) (Figure 7.10).

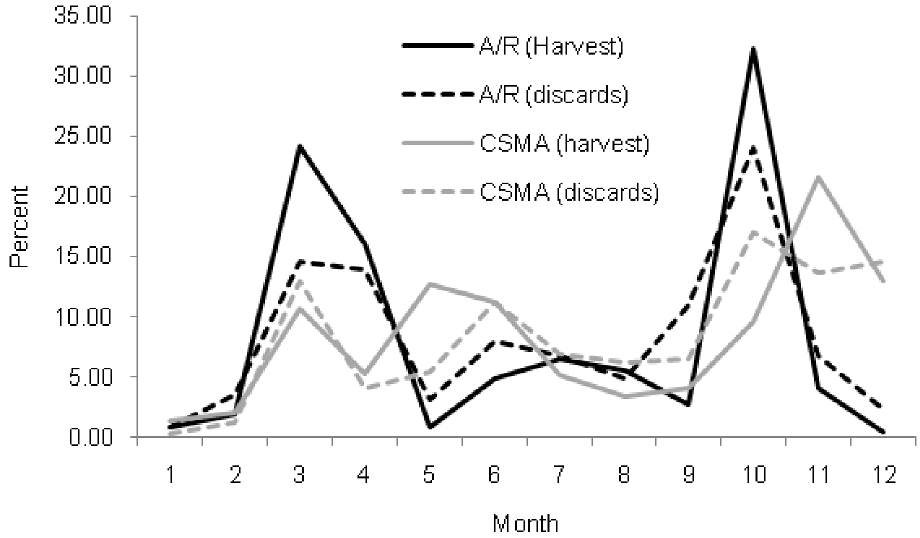


Figure 7.10 Monthly striped bass harvest and discard by RCGL holders during the period 2002 through 2008.

Table 7.15. Striped bass harvested (number, lbs, discard:harvest ratio) by RCGL holders during the period 2002 through 2008.

		Trips (number)				Harvest (number)				Harvest (lbs)				Discard (number)				Discard Harvest Ratio	Discard Harvest Ratio	Discard Harvest Ratio
Year	Gear	A/R	CSMA	Unknown	Total	A/R	CSMA	Unknown	Total	A/R	CSMA	Unknown	Total	A/R	CSMA	Unknown	Total	A/R	CSMA	Total
2002	Large	659	1,607		2,267	428	674		1,101	2,557	3,250		5,807	859	829		1,689	2.0:1	1.2:1	1.5:1
	Small	1,198	767		1,965	675	181		856	2,761	510		3,271	1,124	378		1,502	1.7:1	2.1:1	1.8:1
	All	1,857	2,375		4,232	1,103	855		1,957	5,318	3,760		9,078	1,983	1,208		3,191	1.8:1	1.4:1	1.6:1
2003	Large	59	910		969	109	391		500	496	2,249		2,745	9	244		253	0.1:1	0.6:1	0.5:1
	Small	565	409		973	1,152	430		1,582	5,449	2,005		7,454	1,705	327		2,032	1.5:1	0.8:1	1.3:1
	All	623	1,319	0	1,942	1,261	821	0	2,082	5,945	4,253	0	10,199	1,714	571	0	2,285	1.4:1	0.7:1	1.1:1
2004	Large	103	460	38	602	38	338	0	376	181	1,591	0	1,772	94	180	28	303	2.5:1	0.5:1	0.8:1
	Small	320	181	14	516	255	267	14	537	1,125	711	43	1,879	402	420	0	822	1.6:1	1.6:1	1.5:1
	Other	107			107				0				0	54			54			
	All	531	642	52	1,225	293	606	14	913	1,306	2,302	43	3,651	549	600	28	1,179	1.9:1	1.0:1	1.3:1
2005	Large	30	650	43	723	29	317	14	360	116	1,553	43	1,712	8	238	0	246	0.3:1	0.8:1	0.7:1
	Small	262	416		678	273	125		397	937	408		1,346	464	170		634	1.7:1	1.4:1	1.6:1
	All	292	1,066	43	1,401	302	442	14	757	1,054	1,962	43	3,058	472	408	0	880	1.6:1	0.9:1	1.2:1
2006	Large	554	351		906	112	356		469	564	1,468		2,032	486	775		1,261	4.3:1	2.2:1	2.7:1
	Small	194	410	27	631	107	209	85	402	486	521	342	1,349	295	736	79	1,110	2.8:1	3.5:1	2.8:1
	All	748	762	27	1,537	220	565	85	871	1,050	1,989	342	3,381	781	1,511	79	2,371	3.6:1	2.7:1	2.7:1
2007	Large	332	402	13	747	73	233	0	307	487	1,016	0	1,503	164	209	7	379	2.2:1	0.9:1	1.2:1
	Small	211	420	54	686	118	538	339	995	485	1,013	471	1,969	335	437	13	784	2.8:1	0.8:1	0.8:1
	All	543	822	68	1,433	191	771	339	1,302	972	2,029	471	3,472	498	646	19	1,163	2.6:1	0.8:1	0.9:1
2008*	Large	406	278	43	727	68	124	0	192	706	1,088	0	1,794	172	43	21	237	2.5:1	0.3:1	1.2:1
	Small	395	359	21	774	76	163	124	363	872	958	110	1,940	786	349	14	1,148	10.3:1	2.1:1	3.2:1
	Other	21			21				0		0		0	7			7			
	All	821	637	64	1,522	144	286	124	555	1,578	2,046	110	3,734	965	391	35	1,392	6.7:1	1.4:1	2.5:1
All	Large	2,143	4,659	137	6,941	858	2,433	14	3,305	5,107	12,216	43	17,365	1,792	2,518	57	4,368	2.1:1	1.0:1	1.3:1
	Small	3,144	2,964	116	6,223	2,656	1,913	562	5,132	12,116	6,127	965	19,208	5,110	2,816	106	8,032	1.9:1	1.5:1	1.6:1
	Other	128	0	0	128	0	0	0	0	0	0	0	0	60	0	0	61			
Total		5,415	7,623	253	13,292	3,514	4,346	576	8,437	17,223	18,343	1,008	36,573	6,963	5,334	162	12,459	2.0:1	1.2:1	1.5:1

*2 fish daily creel limit, CSMA restricted to Oct 1 - Apr 30 season, harvest moratorium on Cape Fear River and its tributaries-effective July 1, 2008

7.6.3 RCGL Catch and Discard by Area and Gear

The contributions from each region (North, Central, Pamlico, South, and unknown) to the total poundage of striped bass harvested by weight were 42%, 1%, 44%, 6%, and 7% respectively (Table 7.15). An annual average of 502 striped bass was harvested in the ASMA (North) with an annual average discard of 995 fish during the period of 2002 through 2008. Within the CSMA (Pamlico, Central, and South), an average of 621 striped bass were harvested with an annual average discard of 762 striped bass. The overall discard to harvest ratio was 2.0:1 for the ASMA (North), 1.4:1 for the Pamlico, 0.2:1 in the Central, 0.1:1 in the Cape Fear River (South), and 0.3:1 for unknown locations during 2002 through 2008 (Table 7.15).

Approximately 13,291 trips using small mesh and large mesh gill nets were responsible for landing 36,574 lbs of striped bass during the period from 2002 through 2008. Small mesh gill nets accounted for 53% by lbs of all striped bass harvested by RCGL holders followed by large mesh gill nets (47%) (Table 7.16). Sixty-four percent of all discarded striped bass by RCGL holders were initially captured in small mesh gill nets. The total discard to harvest ratio for small mesh gill nets (1.6:1) was slightly higher than the large mesh gill nets (1.3:1) and slightly higher in the A/R (2.0:1) than the CSMA (1.2:1). The largest discard to harvest ratio (10.3:1) was observed in the small mesh gill nets in the A/R in 2008. In the CSMA there was only a slight increase in the discard to harvest ratio in 2008, during the time when restrictions were set in place limiting creel limit and season as well as harvest moratorium on the Cape Fear River and its tributaries.

Table 7.16 Number of RCGL trips taken, harvested (number or lbs), discarded striped bass by area and discard:harvest ratio, 2002-2008.

		Trips		Harvest				Discard		Discard Harvest
Year	Region	Number	Percent	Number	Percent	Pounds	Percent	Number	Percent	Ratio
2002	North	1,857	44	1,103	56	5,318	59	1,983	62	1.8:1
	Pamlico	2,375	56	855	44	3,760	41	1,208	38	1.4:1
	Central	0	0	0	0	0	0	0	0	
	South	0	0	0	0	0	0	0	0	
	All	4,232	100	1,958	100	9,078	100	3,191	100	1.6:1
2003	North	623	32	1,261	61	5,945	58	1,714	75	1.4:1
	Pamlico	1,077	56	775	37	3,983	39	563	25	0.7:1
	Central	8	0	17	1	117	1	0	0	0.0:1
	South	233	12	29	1	153	2	8	0	0.3:1
	All	1,942	100	2,083	100	10,199	100	2,285	100	1.1:1
2004	North	531	43	293	32	1,306	36	549	47	1.9:1
	Pamlico	642	52	606	66	2,302	63	600	51	1.0:1
	Central	0	0	0	0	0	0	0	0	
	South	0	0	0	0	0	0	0	0	
	Unknown	52	4	14	2	43	1	28	2	2.0:1
	All	1,225	100	913	100	3,651	100	1,178	100	1.3:1

Table 7.16 continued

Year	Region	Trips Number	Trips Percent	Harvest Number	Harvest Percent	Harvest Pounds	Harvest Percent	Discard Number	Discard Percent	Discard Harvest Ratio
2005	North	292	21	302	40	1,054	35	472	54	1.6:1
	Pamlico	916	65	396	52	1,828	60	408	46	1.0:1
	Central	0	0	0	0	0	0	0	0	
	South	150	11	46	6	133	4	0	0	0.0:1
	Unknown	43	3	14	2	43	1	0	0	0.0:1
	All	1,401	100	758	100	3,058	100	880	100	1.2:1
2006	North	748	49	220	25	1,050	31	781	33	3.6:1
	Pamlico	612	40	446	51	1,377	41	1,474	62	3.3:1
	Central	111	7	62	7	373	11	14	1	0.2:1
	South	39	3	58	7	239	7	24	1	0.4:1
	Unknown	27	2	85	10	342	10	79	3	0.9:1
	All	1,536	100	870	100	3,381	100	2,371	100	2.7;1
2007	North	543	38	191	15	972	28	498	43	2.6:1
	Pamlico	735	51	395	30	1,721	50	646	56	1.6:1
	Central	0	0	0	0	0	0	0	0	
	South	87	6	376	29	308	9	0	0	0.0:1
	Unknown	68	5	339	26	471	14	19	2	0.1:1
	All	1,433	100	1,301	100	3,472	100	1,163	100	0.9:1
2008*	North	821	54	144	26	1,578	42	965	69	6.7:1
	Pamlico	602	40	272	49	1,973	53	378	27	1.4:1
	Central	0	0	0	0	0	0	0	0	
	South	35	2	15	3	73	2	13	1	0.9:1
	Unknown	64	4	124	22	110	3	35	3	0.3:1
	All	1,522	100	554	100	3,735	100	1,391	100	2.5:1
All	North	5,415	41	3,514	42	17,223	47	6,962	56	2.0:1
	Pamlico	6,959	52	3,745	44	16,944	46	5,277	42	1.4:1
	Central	119	1	79	1	490	1	14	0	0.2:1
	South	544	4	524	6	906	2	45	0	0.1:1
	Unknown	254	2	576	7	1,009	3	161	1	0.3:1
	All	13,291	100	8,437	100	36,574	100	12,459	100	1.5:1

*2 fish daily creel limit, CSMA restricted to Oct 1 - Apr 30 season, harvest moratorium on Cape Fear River and its tributaries-effective July 1, 2008

7.7 HYBRIDS

The NCWRC has documented hybrid striped bass (striped bass X white bass *Morone chrysops*) in the Tar River system, the Neuse River spawning grounds, and the Cape Fear River spawning grounds. These hybrids are the likely result of stockings into upstream impoundments or escapement from aquaculture facilities.

Hybrid striped bass were introduced inadvertently into the Cape Fear River by stocking practices performed in Jordan Lake by the NCWRC, which subsequently escaped into the river (Patrick and Moser, 2001). Stocking of hybrids in Jordan Lake occurred from 1983 to 2001,and during this period hybrid striped bass abundance in the Cape Fear River increased from approximately a 25:75 (hybrid:native) ratio in 1990 to a 50:50 ratio in 2001 (Mallin et at. 2001, Patrick and Moser 2001). Since 2002, however, the number and percentage of hybrid striped bass collected during annual striped bass electrofishing spawning stock survey has steadily declined and is likely related to the discontinuation of stocking hybrid striped bass in Jordan Lake by the NCWRC.

Hybrid striped bass have been collected by the NCWRC from the Neuse River spawning grounds, but are uncommon. Since 2004, only two hybrid striped bass have been collected from the Neuse spawning grounds. Additionally, six hybrid striped bass have been collected from the Tar River spawning grounds since 2004. The number of hybrid striped bass encountered on the Cape Fear spawning grounds has also steadily declined. Hybrid striped bass are infrequently encountered during spawning stock surveys on the Roanoke River. In 2009 the number of hybrid striped bass collected in all the spawning area surveys conducted by the NCWRC totaled less than 2%, and zero hybrid striped bass were collected on CSMA spawning grounds in 2010 (Table 7.17)

During routine field sampling the NCDMF has verified hybrid striped bass in the CSMA. Since 2000, the NCDMF has collected a total of 512 hybrid striped bass compared to 6,132 striped bass. In all years, the Pamlico and Pungo rivers had the highest collected number of hybrid striped bass, but the number of hybrids never exceeded the number of striped bass collected. The highest number of hybrids was collected in 2002 when there were 45 hybrid bass collected compared to 122 striped bass. The Cape Fear River has consistently had the highest percentage of hybrid striped bass, with hybrid striped bass outnumbering striped bass 25 to 23 in 2002. Since 2002, the numbers of hybrid striped bass observed in all systems has steadily dropped. In 2009 there were less than 11 hybrid striped bass captured in all of the NCDMF sampling programs, and zero collected in Pamlico Sound and Cape Fear River (Table 7.18).

Table 7.17 Number and percentage of striped bass and hybrid striped bass collected during annual NCWRC electrofishing spawning stock surveys in the Tar, Neuse, and Caper Fear rivers, NC.

Sample Year	River System	Number of Striped Bass	Number of Hybrid Striped Bass	%Hybrid Striped Bass
2004	Tar	318	1	0.3%
	Neuse	90	0	0.0%
	Cape Fear	104	12	11.5%
2005	Tar	1,419	0	0.0%
	Neuse	127	1	0.8%
	Cape Fear	111	7	6.3%
2006	Tar	530	2	0.4%
	Neuse	62	0	0.0%
	Cape Fear	12	4	33.3%
2007	Tar	317	2	0.6%
	Neuse	173	0	0.0%
	Cape Fear	125	3	2.4%
2008	Tar	505	1	0.2%
	Neuse	142	1	0.7%
	Cape Fear	110	2	1.8%
2009	Tar	347	0	0.0%
	Neuse	374	0	0.0%
	Cape Fear	103	2	1.9%
2010	Tar	392	0	0.0%
	Neuse	158	0	0.0%
	Cape Fear	191	0	0.0%
	Total	5,710	38	0.7%

Table 7.18 Number and percentage of striped bass and hybrid striped bass collected through NCDMF programs 127, 416, and 915, Pamlico Sound area, NC.

Sample Year	River System	Number of Striped Bass	Number of Hybrid Striped Bass	%Hybrid Striped Bass
2000	Pamlico/Pungo	265	2	0.7%
	Neuse/Bay rivers	128	1	0.8%
	Pamlico Sound	11	0	0.0%
2001	Pamlico/Pungo	144	20	12.2%
	Neuse/Bay rivers	13	0	0.0%
	Pamlico Sound	27	3	10.0%
2002	Pamlico/Pungo	112	45	28.7%
	Neuse/Bay rivers	31	0	0.0%
	Pamlico Sound	92	11	10.7%
	Southern Cape Fear	23	25	52.1%
2003	Pamlico/Pungo	321	118	26.9%
	Neuse/Bay rivers	223	1	0.4%
	Pamlico Sound	182	10	5.2%
	Southern Cape Fear	65	40	38.1%
2004	Pamlico/Pungo	318	77	19.5%
	Neuse/Bay rivers	219	1	0.5%
	Pamlico Sound	103	0	0.0%
	Southern Cape Fear	110	40	26.7%
2005	Pamlico/Pungo	527	23	4.2%
	Neuse/Bay rivers	270	2	0.7%
	Pamlico Sound	74	0	0.0%
	Southern Cape Fear	65	3	4.4%
2006	Pamlico/Pungo	499	31	5.8%
	Neuse/Bay rivers	374	6	1.6%
	Pamlico Sound	87	0	0.0%
	Southern Cape Fear	43	2	4.4%

Table 7.18 continued.

Sample Year	River System	Number of Striped Bass	Number of Hybrid Striped Bass	%Hybrid Striped Bass
2007	Pamlico/Pungo	353	20	5.4%
	Neuse/Bay rivers	233	3	1.3%
	Pamlico Sound	49	2	3.9%
	Southern Cape Fear	44	3	6.4%
2008	Pamlico/Pungo	296	11	3.6%
	Neuse/Bay rivers	233	0	0.0%
	Pamlico Sound	27	1	3.6%
	Southern Cape Fear	13	0	0.0%
2009	Pamlico/Pungo	282	8	2.8%
	Neuse/Bay rivers	216	3	1.4%
	Pamlico Sound	57	0	0.0%
	Southern Cape Fear	3	0	0.0%
	Total	6,132	512	8.3%

Hybrid striped bass are also recorded during interviews in NCDMF creel surveys in the CSMA. Since the creel surveys started in 2004 agents have measured 1,238 striped bass and 55 hybrids. The majority are observed in the Tar/Pamlico and Pungo rivers (Table 7.20).

Hybrid striped bass are known to reproduce under hatchery conditions (Forshage et al. 1986; Harrell and Webster, 1997) and in the wild (Ware 1975; Avise and Van Den Avyle 1984; Harrell et al. 1993). However, Smith and Jenkins (1984) reported only a 10% hatching rate in the wild for hybrids.

Sources of these hybrids may be a result of escapement from aquaculture facilities during the floods that resulted from the hurricanes in the late 1990's, especially Hurricane Floyd in 1999. According to the North Carolina Department of Agriculture and Consumer Services website (http://www.ncagr.gov/) , there are 14 active hybrid striped bass facilities in North Carolina. The NCMFC regulations that apply to striped bass also apply to hybrids in coastal and joint waters of the state.

Table 7.19 Number and percentage of striped bass and hybrid striped bass encountered through the NCDMF CSMA striped bass creel survey.

Sample Year	River System	Number of Striped Bass	Number of Hybrid Striped Bass	% Hybrid Striped Bass
2004	Tar/Pamlico/Pungo	280	16	5.4
	Neuse River	152	0	0.0
2005	Tar/Pamlico/Pungo	259	11	4.1
	Neuse River	86	0	0.0
2006	Tar/Pamlico/Pungo	107	6	5.3
	Neuse River	43	1	2.3
2007	Tar/Pamlico/Pungo	87	10	10.3
	Neuse River	67	1	1.5
2008	Tar/Pamlico/Pungo	44	1	2.2
	Neuse River	11	2	15.4
2009	Tar/Pamlico/Pungo	96	5	5.0
	Neuse River	6	2	25.0
	Total	1,238	55	4.3

8.0 PROTECTED SPECIES

8.1 BACKGROUND

Protected species in FMPs are generally discussed in relation to their implication to fisheries being prosecuted for the FMP species and that these fisheries may have an incidental take of protected species. The protected species topic herein intends to identify the principal fisheries, describe the various federal and state laws that deal with protected species, and discuss the ongoing management programs and implications of protected species interactions in the inshore striped bass fisheries.

The dominant gears for the harvest of striped bass in the inshore waters of North Carolina are recreational hook and line, commercial gill net (large mesh), and commercial pound net (Table 8.1).

Table 8.1. Percent of North Carolina estuarine striped bass commercial harvest by gear and management area.

Gear	ASMA	CSMA
Gill net, anchor	89.6	94.3
Pound net	7.9	1.1
Fyke net	1.0	0.2
Seine	0.9	0.7
Gill net, run around	0.3	2.0
Pot	0.2	0.4
Cast net	0.1	<0.1
Gill net, drift	<0.1	1.2
Lines	<0.1	<0.1
Trawl, Crab	<0.1	0.1
Trawl, Shrimp	0.0	<0.1

An in-depth description of these fisheries may be found in Section 7.0, Status of the Fisheries. The final report from the NCMFC Sea Turtle Advisory Committee (STAC) is a reference document that describes North Carolina estuarine fisheries that interact with threatened and endangered sea turtles (STAC 2006). The STAC was formed by the NCMFC in response to continuing problems with sea turtle interactions in fisheries throughout North Carolina. The committee in late 2003 began the process of gathering relevant information pertaining to the many issues surrounding federal and state protected sea turtles and information for North Carolina commercial and recreational, inshore fisheries. Their final report was accepted by the NCMFC in 2007 and the report identified primary fisheries of concern: hook and line, gill net, pound net, and shrimp trawl. Other gears were identified as gears of other concern, and many gears were identified as no concern (STAC 2006).

The likelihood of fisheries interactions with protected species will vary depending on where the fishing activity is taking place and the abundance of protected species in the same locale. The STAC fisheries of concern were identified based on this fact and studies that documented interactions and mortality. Sea turtles observations and interactions are mapped based on available data from three sources; NCWRC sea turtle database, a National Oceanic and

Atmospheric Administration (NOAA) sea turtle tagging database, and a NOAA aerial sea turtle sighting database. Data for the NCWRC and NOAA tagging database were used from 2000-2010 and the NOAA aerial survey database is available from 2000-2004 (Figures 8.1-8.4). Interactions with Atlantic sturgeon are mapped based on available data from four NCDMF IGNSs: the Albemarle Sound IGNS 1990-2009, Pamlico Sound IGNS 2003-2009, Pamlico, Pungo, and Neuse rivers IGNS 2000, 2003-2009, Cape Fear River Fishery Independent Assessment Program (FIAP) 2002-2007, Cape Fear River IGNS 2008-2009, and the NCDMF Observer Program 2001-2009. Figures 8.5-8.9 show Atlantic sturgeon distribution for four areas; the RRMA/ASMA, the Pamlico Sound, Pamlico, Pungo, and Neuse rivers, and the Cape Fear River area.

Recreational hook and line fisheries for striped bass occur throughout North Carolina in the RRMA, ASMA, and CSMA. The main techniques for striped bass fishing are trolling, jigging, live bait, and cut bait. It is unlikely interactions with protected species would occur while fishing with artificial baits. However, Atlantic sturgeon has been captured with hook and line gear in both the CSMA and RRMA. The use of cut bait on long line rigs has resulted in interactions with sea turtles in other areas and could occur during striped bass fishing (Gardner et al. 2008, and Watson et al., 2005).

The majority of hook and line fishing for striped bass in the ASMA is in the central and western Albemarle Sound, areas not known for sea turtles, but areas where sturgeon are often found. Sea turtles do not use the Roanoke River as habitat but the river may be one of few spawning areas for Atlantic sturgeon in North Carolina. The striped bass fishery on the Roanoke River would coincide with a possible spring spawning run of sturgeon making them susceptible to hook and line gear. In the CSMA sea turtles are common during certain seasons and areas, thus raising concern for interactions, but the numbers of Atlantic sturgeon are less than found in the ASMA.

Shortnose sturgeon are more abundant in the southern area of the CSMA than the ASMA, although there has been one record of a shortnose sturgeon collected in the Albemarle Sound by the NCDMF Albemarle Sound IGNS.

The main commercial large mesh gill net fisheries which harvest striped bass are the spring shad fishery and the flounder gill net fishery. The gear used in the shad fishery are monofilament gill nets, generally 5¼ to 6 ISM, and normally 25 to 40 meshes deep. The manner in which the nets are set and fished varies between the northern and southern portions of the state due to the size of the water bodies and the amount of tide and current. Some nets are anchored or staked out with small-diameter poles and others are drift nets that float along in the water column because shad use the entire water column. There have been no documented turtle interactions with shad nets.

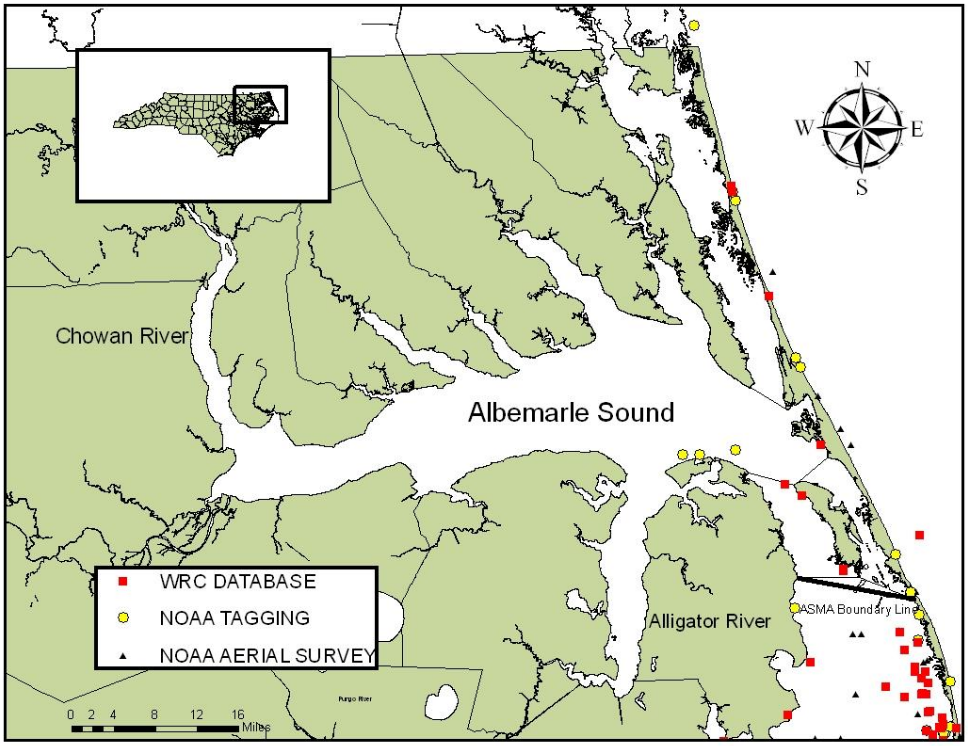


Figure 8.1. Sea turtles in the Albemarle Sound Management Area, NC, 2000-2010.

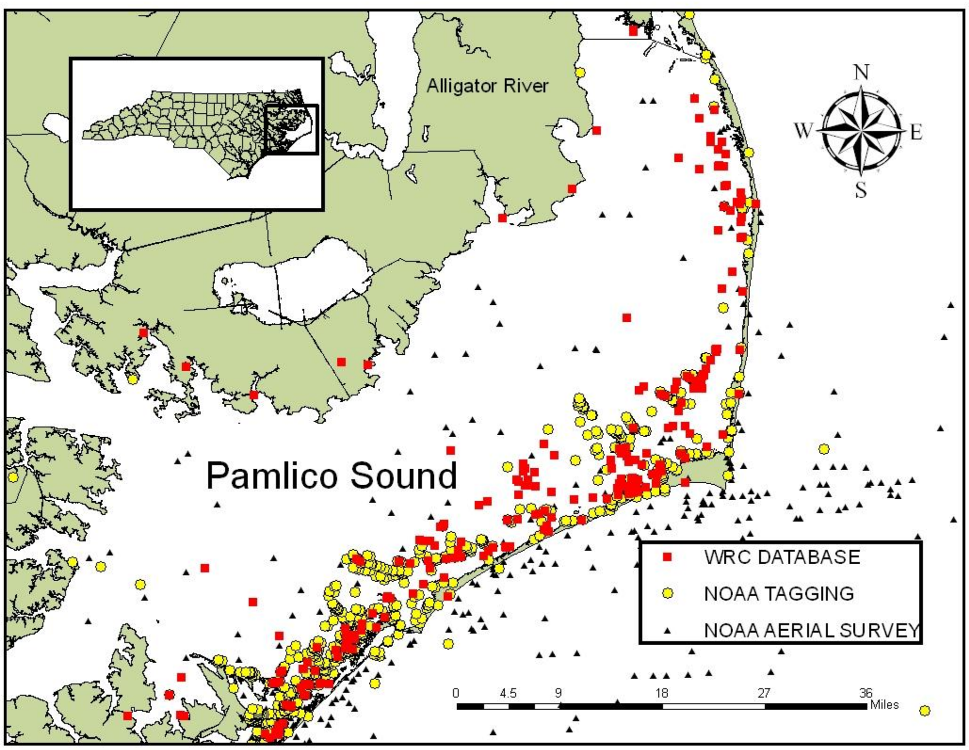


Figure 8.2. Sea turtles in the Pamlico Sound, NC 2000-2010.

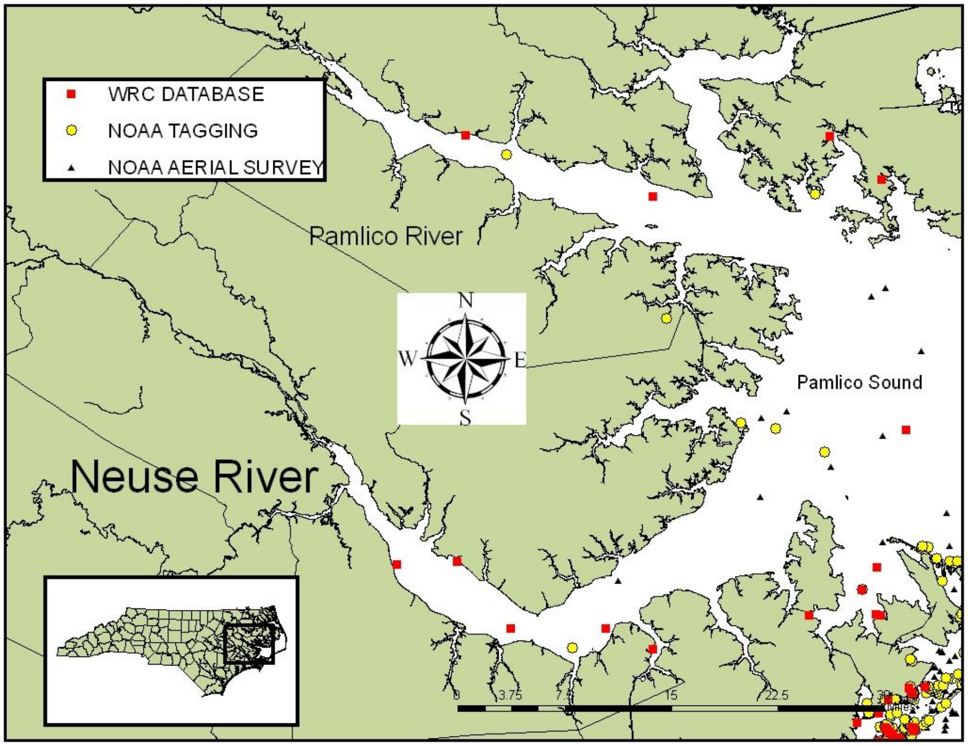


Figure 8.3. Sea turtles in the Pamlico, Pungo, and Neuse rivers, NC, 2000-2010.

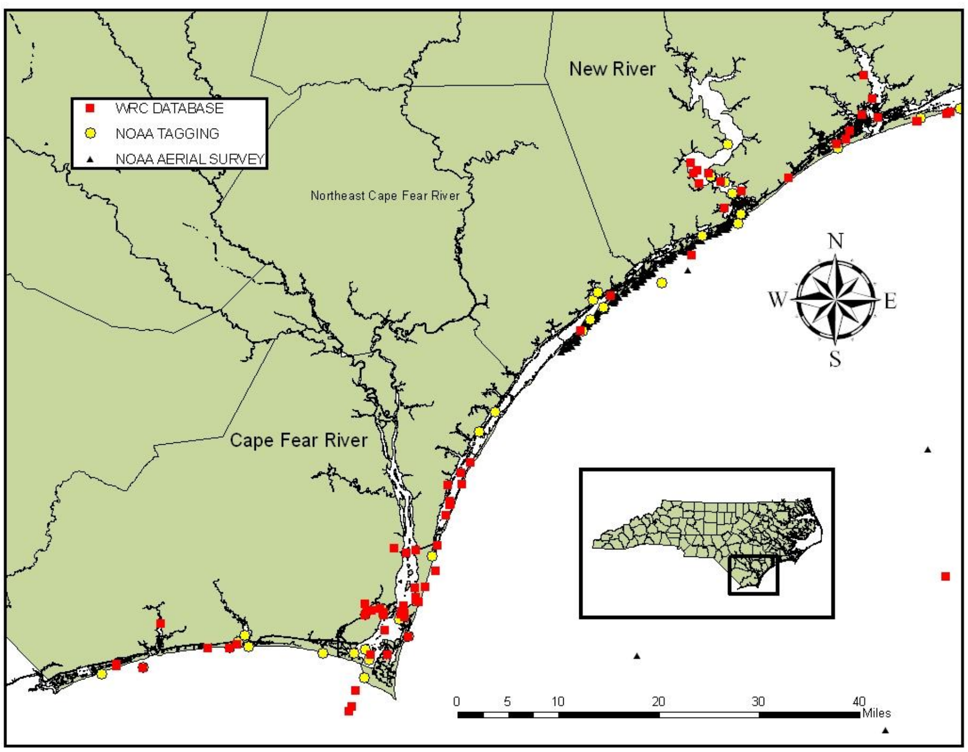


Figure 8.4. Sea turtles in the Cape Fear River area, NC, 2000-2010.

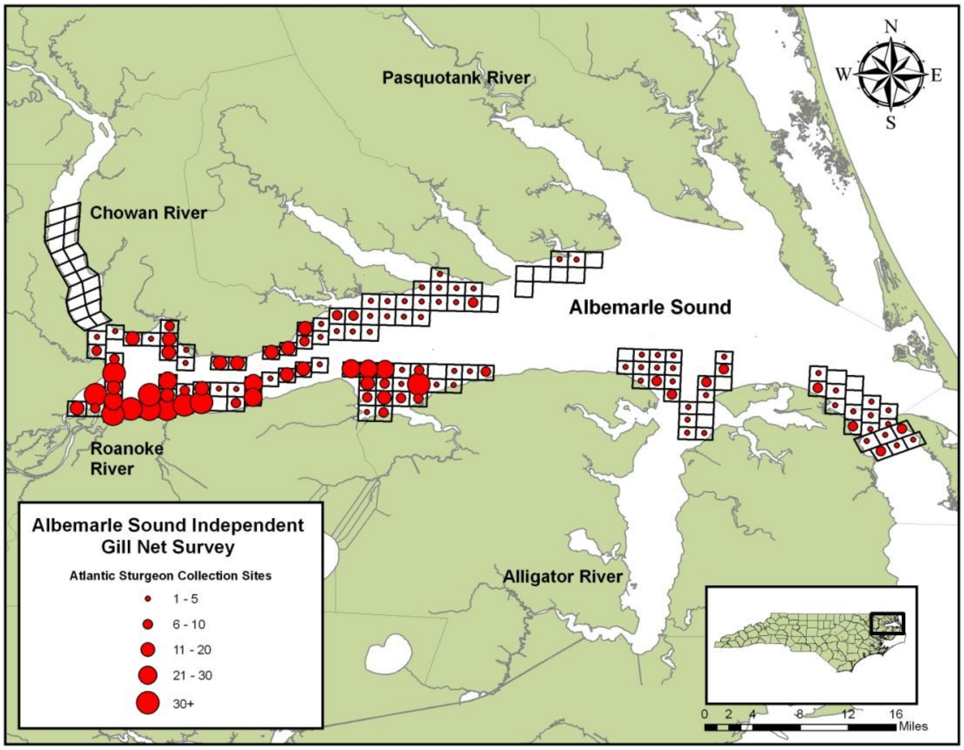


Figure 8.5. Atlantic sturgeon collected from the NCDMF Independent Gill Net Survey, Albemarle Sound, NC 1990-2009.

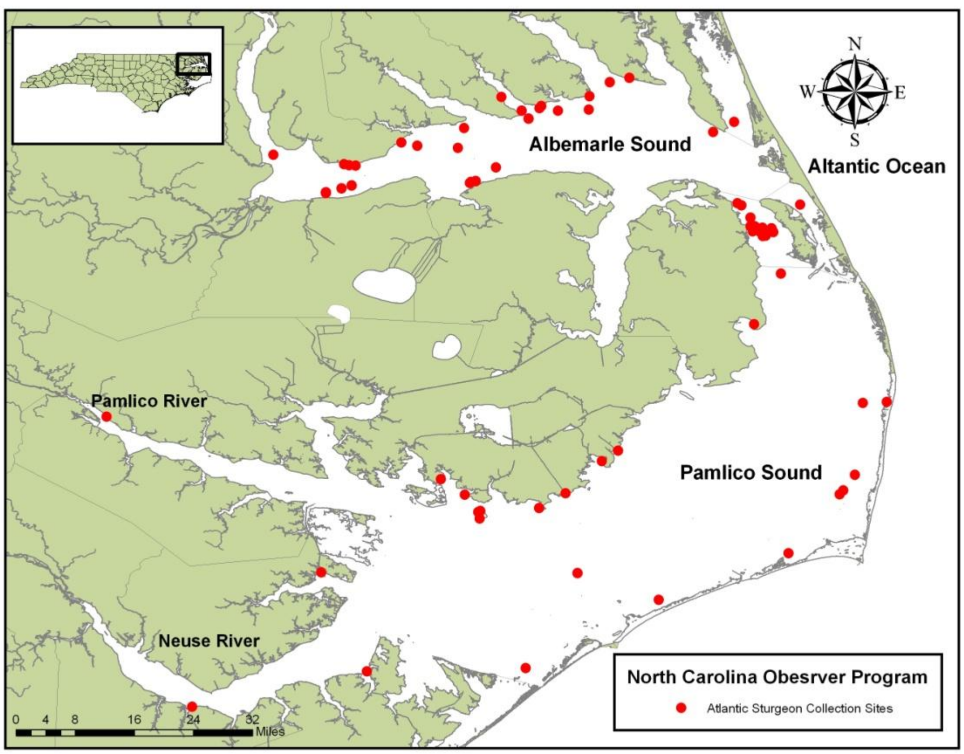


Figure 8.6. Atlantic sturgeon collected from the NCDMF observer program, Albemarle and Pamlico Sounds, NC, 2001-2009.

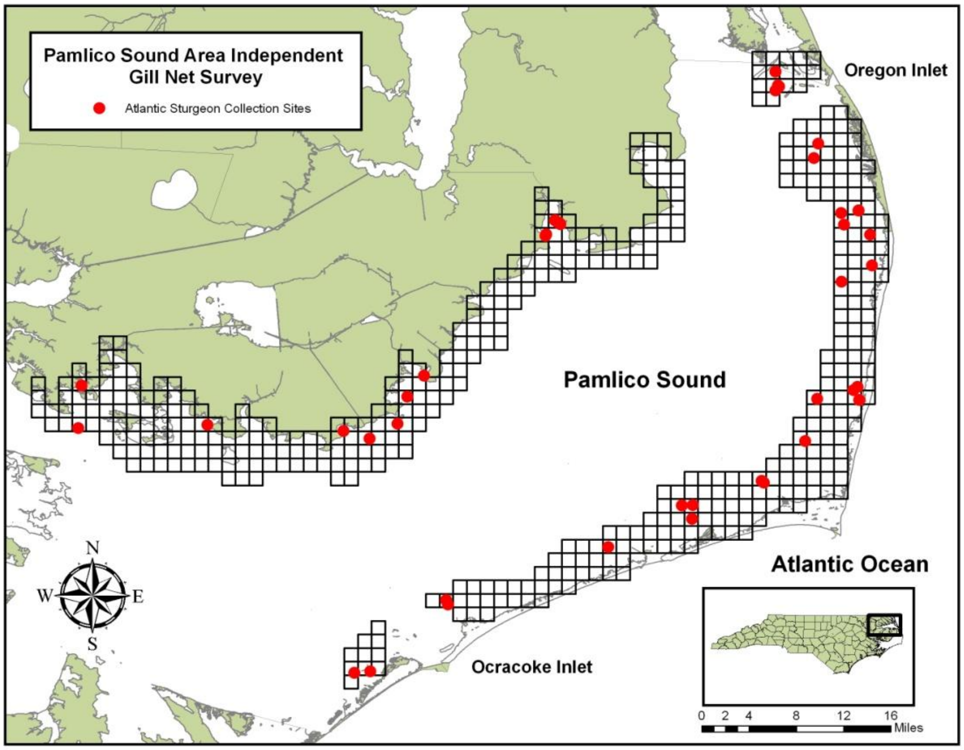


Figure 8.7. Atlantic sturgeon collected from the NCDMF Independent Gill Net Survey, Pamlico Sound, 2003-2009.

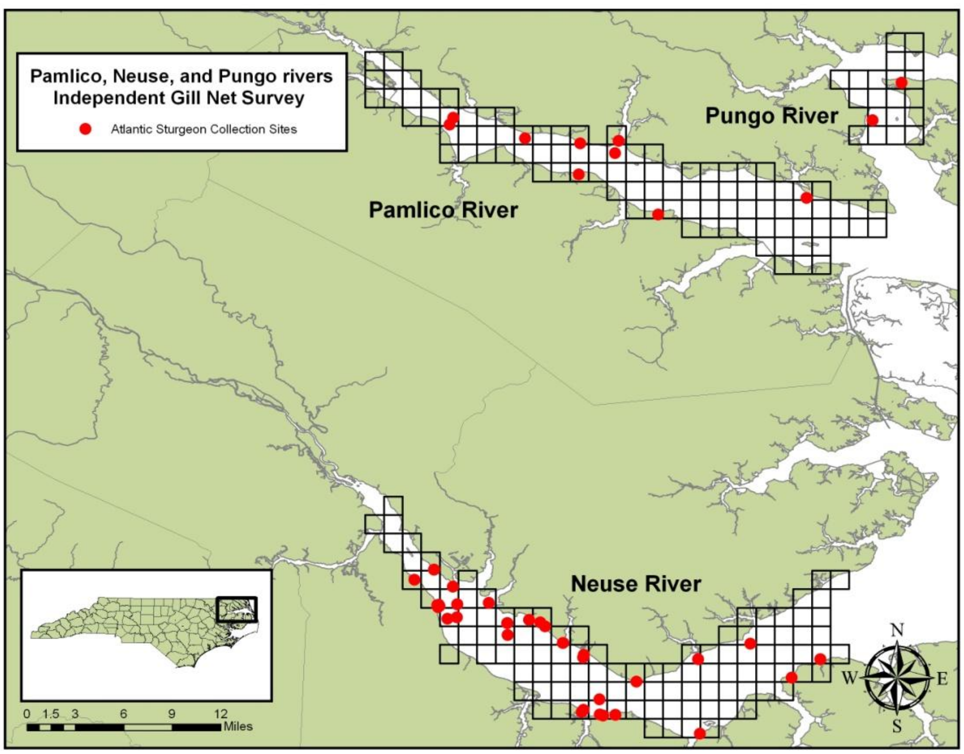


Figure 8.8. Atlantic sturgeon collected from the NCDMF Independent Gill Net Survey, Pamlico, Pungo, and Neuse rivers, NC, 2000 and 2003-2009.

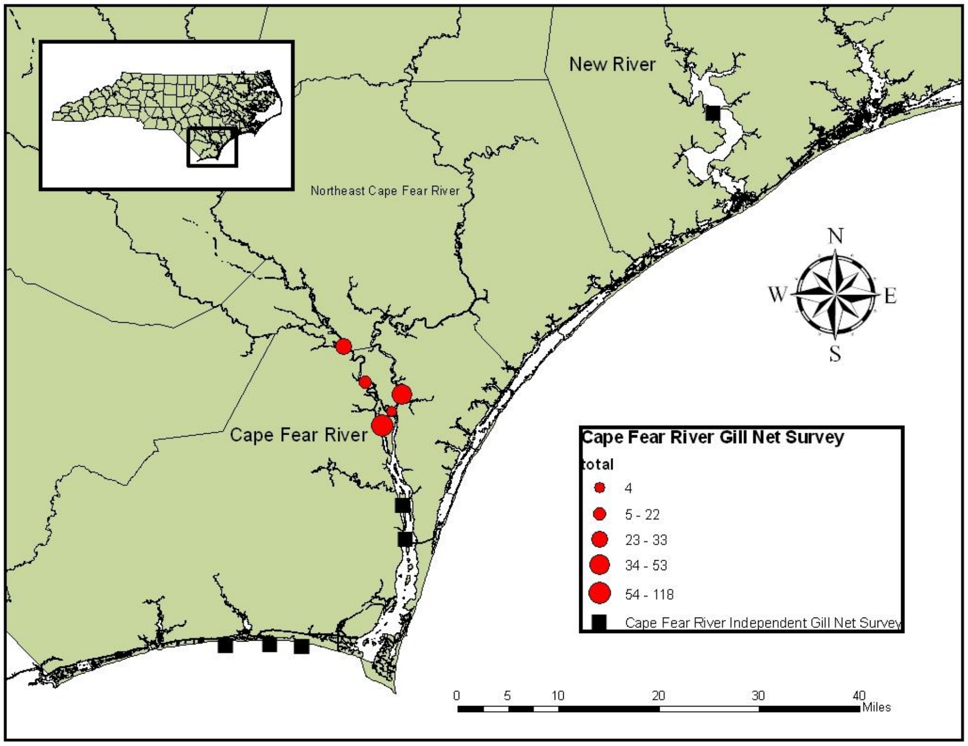


Figure 8.9. Atlantic sturgeon collected from the NCDMF Independent Gill Net Survey and Cape Fear River Gill Net Survey, Cape Fear and New rivers and Atlantic Ocean, NC.

There are at least two types of flounder gill net operations, which can be broken down by vessel size: smaller boats (8-25 feet) that fish nearshore in shallow (<10 feet) water pulling the nets by hand or mechanical net reels, and larger vessels (> 25 feet) that fish in deep water ($\geq$ 10 feet) and use mechanical net reels to haul in the net. These gill nets are set nets of large mesh (5-inch and larger stretched mesh) that are deployed and left from only a few hours to several days depending on water temperature and depth. Flounder gill nets are known to interact with sea turtles. Establishment of the Pamlico Sound Gill Net Restricted Area (PSGNRA) was the result of some of these interactions and was in place from 2000-2010. Area, season, mesh size, yardage, attendance of gear, and combinations of these restrictions are available for resource management and are currently used at various times of the year to prevent the waste of fish, to protect particular fish stocks, and minimize capture of protected species (NCDMF 2005).

Pound nets also harvest striped bass. A pound net is a stationary gear that directs fish into enclosures or lbs by means of a lead. Most pound nets are fished seasonally in the fall and spring, and operate in Pamlico, Core, and Albemarle sounds. Permits are required to set pound nets and pound nets are required to have escape panels to cull undersized finfish. This gear is also known to have interactions with sea turtles. The National Marine Fisheries Service (NMFS) prior to 2005 conducted an annual mark-recapture study of loggerhead, green, and Kemp's ridley sea turtles incidentally captured in pound nets set in Core and Pamlico sounds. From this study, NMFS researchers were able to document seasonal distribution, species composition, and abundance of sea turtles in the area (STAC 2006).

8.2 PROTECTED SPECIES LEGISLATION

Protected species is a broad term that encompasses a host of species that are identified by federal or state protective statutes. The federal protective authorities are paramount and the dominant ones are the Endangered Species Act (ESA), Marine Mammal Protection Act (MMPA), and Migratory Bird Treaty Act (MBTA).

8.2.1Federal Endangered Species Act (ESA)

The Endangered Species Act (ESA) was enacted in 1973, "to provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved, (and) to provide a program for the conservation of such endangered species and threatened species." The ESA is a comprehensive act with eighteen sections that cover many aspects of endangered species protection and management (STAC 2006).

The ESA defines a species as threatened when it is likely to become an endangered species within the foreseeable future. An endangered species is defined as any species which is in danger of extinction throughout all or a significant part of its range. A take is to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct (STAC 2006). Candidate species are species that appear to warrant consideration for addition to the federal ESA list. They are sometimes referred to as "species of special concern. These species receive no substantive or procedural protection under the ESA.

Section 10 of the ESA provides for exceptions to the take prohibitions in the form of permits. These permits can be for either an intentional take or for an incidental take. Intentional take permits are intended for scientific purposes or to enhance the propagation or survival of the affected species. Incidental take permits (ITP) are for activities that are otherwise lawful but are expected to incidentally take a listed species. Permit holders must develop and implement conservation plans that reduce and minimize the impacts of the take. When a Section 10 permit application is reviewed and deemed appropriate, a permit is granted to authorize a specified level of takes. Along with the specified take that is authorized, the permit includes reporting requirements, and often includes other conditions that must be met (tagging, handling guidelines, data analyses, conservation plans, etc.). The PSGNRA for example was set up under a Section 10 permit. The Section 10 permit provision is very important to the regulated community, including the states, because it can allow a fishery to continue (under constraints) that would otherwise have to be shut down under the ESA mandates. Likewise, it allows the applicant the opportunity to try management measures to see if they would be successful in allowing the fishery to continue to operate (STAC 2006).

Section 7 of the ESA relates to interagency cooperation amongst federal agencies. There are two primary provisions to this section: 1) all federal agencies shall utilize their authorities towards the furtherance of the goals of the ESA; 2) and each federal agency must consult with the Secretary (in practice the NMFS or USFWS) to insure that any action funded, authorized, or carried out by the agency is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of its critical habitat. Although this section relates to federal agency cooperation, it can impact state projects through a federal nexus. If a project has federal authorization, funding, or other participation, it is subject to Section 7 consultation between the federal agency and NMFS. The NCDMF has received biological opinions and incidental take statements in regards to Section 7 consultations on several federally funded division research projects.

Most of the species listed as endangered or threatened fall under federal jurisdiction either with the NMFS or the USFWS. The following is a list of endangered (E) or threatened (T) species that may occur in estuarine and ocean waters of North Carolina (NCDMF 2005):

Fish

Smalltooth sawfish (*Pristis pectinata*) E
Shortnose sturgeon (*Acipenser brevirostrum*) E

Reptiles

Green sea turtle (*Chelonia mydas*) T
Kemp's Ridley sea turtle (*Lepidochelys kempii*) E
Hawksbill sea turtle (*Eretmochelys imbricate*) E
Leatherback sea turtle (*Dermochelys coriacea*) E
Loggerhead sea turtle (*Caretta caretta*) T (under review)

Mammals

West Indian manatee (*Trichechus manatus)* E
Fin whale (*Balaenoptera physalus*) E
Humpback whale (*Megaptera novaeangliae*) E
Northern right whale (*Balaena glacialis*) E
Sperm whale (*Physeter catodon*) E
Sei whale (*Balaenoptera borealis*) E

Of this list, only the sea turtles and the shortnose sturgeon interact with estuarine large mesh gill nets and pound nets.

8.2.2 Marine Mammal Protection Act (MMPA)

The Marine Mammal Protection Act (MMPA) of 1972 was enacted in response to increasing concerns by scientists and the public that significant declines in some species of marine mammals were caused by human activities. It established a national policy to prevent marine mammal species and population stocks from declining to a point where they ceased to be significant functioning elements of the ecosystem.

The Department of Commerce through the NMFS is charged with protecting whales, dolphins, porpoises, seals, and sea lions. Walruses, manatees, otters, and polar bears are protected by the Department of the Interior through the USFWS. The MMPA established a moratorium on the taking of marine mammals in U.S. waters. It defines "take" to mean "to hunt, harass, capture, or kill" any marine mammal or attempt to do so. Exceptions to the moratorium can be made through permitting actions for take incidental to commercial fishing and other nonfishing activities, for scientific research, and for public display at licensed institutions such as aquaria and science centers.

The MMPA requires NMFS to categorize each commercial fishery into one of three categories based upon the level of serious injury and mortality to marine mammals that occurs incidental to each fishery. Category I fisheries pose the greatest threat and Category III fisheries the least threat. The category in which a fishery is placed determines whether fishermen are subject to certain provisions of the MMPA, such as registration, observer coverage and take reduction plan (TRP) requirements.

To date, there have been no observations of dolphin interactions by NCDMF gill net observers throughout North Carolina's estuarine waters including the extensively observed Pamlico Sound flounder gill net fishery (K. Brown, NCDMF, personal communication). However, a lethal take of a bottlenose dolphin in a Fisheries Resource Grant net was reported in 2010, as well as two interactions in NCDMF field studies (beach seine gear work and independent gill net). According to the 2009 U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessment (Waring 2009) there are now nine new bottlenose dolphin Atlantic bay, sound and estuarine stocks. Two of these stocks are in North Carolina estuaries and are called the Northern North Carolina Estuarine System Stock and the Southern North Carolina Estuarine System Stock. As new information on the bottlenose dolphin stocks become available, medium mesh gill nets ($\geq$ 5.0 ISM, < 7.0 ISM) may come under additional regulatory and nonregulatory management measures. There are no new management measures proposed for North Carolina waters at this time, but changes can occur if there are reported or observed interactions in the flounder gill net fishery (R. Munden, NCDMF, personal communication).

Manatees are under the jurisdiction of USFWS and since 2005 there have been 23 sightings of manatees in North Carolina, two of which were dead and were necropsied. There have been no stranded manatees with evidence of interaction (V. Thayer, NCDMF personnel communication).

8.2.3 Migratory Bird Treaty Act

The original 1918 statute implemented the 1916 Convention between the U.S. and Great Britain (for Canada) for the protection of migratory birds. Later amendments implemented treaties between the U.S. and Mexico, the U.S. and Japan, and the U.S. and the Soviet Union (now Russia). The statute makes it unlawful, unless permitted by regulations, to pursue, hunt, take, capture, kill or sell any migratory bird. The statute does not discriminate between live or dead birds and also grants full protection to any bird parts including feathers, eggs and nests. Over 800 species are currently on the list.

Migratory birds are managed federally by the USFWS. There are several species of diving ducks and seabirds that are unintentionally caught and drowned in gill nets. The USFWS completed a study to assess bird mortality in nearshore anchored gill nets in the ocean from New Jersey to Virginia and found that an estimated 2,387 birds were killed in the mid-Atlantic gill net fishery from February through April 1998 (Forsell 1999).

8.2.4 North Carolina Endangered Species Act (Chapter 113 Article 25)

Listing of protected species from a state perspective lies with the NCWRC (North Carolina General Statutes - Chapter 113 Article 25). The NCWRC compiled state lists of animals deserving protection over 20 years ago based on guidance from Scientific Councils (the group of scientists identified and assembled by the NCWRC North Carolina Nongame Wildlife Advisory Committee to review the scientific evidence and to evaluate the status of wildlife species that are candidates for inclusion on a protected animal list) on mammals, birds, reptiles, amphibians, freshwater fishes, mollusks, and crustaceans. Endangered, Threatened, and Special Concern species of mammals, birds, reptiles, amphibians, freshwater fishes, freshwater and terrestrial mollusks, and crustaceans are protected by state law. Protection for crustaceans and certain venomous snakes was enacted in 2002. However, state law does not allow for protection of invertebrate groups other than mollusks and crustaceans.

Under the state Endangered Species Act the NCWRC has the following powers and duties:

(1) To adopt and publish an endangered species list, a threatened species list, and a list of species of special concern, as provided for in G.S. 113-334, identifying each entry by its scientific and common name.
(2) To reconsider and revise the lists from time to time in response to public proposals or as the Commission deems necessary.
(3) To coordinate development and implementation of conservation programs and plans for endangered and threatened species of wild animals and for species of special concern.
(4) To adopt and implement conservation programs for endangered, threatened, and special concern species and to limit, regulate, or prevent the taking, collection, or sale of protected animals.
(5) To conduct investigations to determine whether a wild animal should be on a protected animal list and to determine the requirements for conservation of protected wild animal species.
(6) To adopt and implement rules to limit, regulate, or prohibit the taking, possession, collection, transportation, purchase or sale of those species of wild animals in the classes Amphibia and Reptilia that do not meet the criteria for listing pursuant to G.S. 113-334 if the Commission determines that the species requires conservation measures in order to prevent the addition of the species to the protected animal lists pursuant to G.S. 113-334. This subdivision does not authorize the Commission to prohibit the taking of any species of the classes Amphibia and Reptilia solely to protect persons, property, or habitat; to prohibit possession by any person of four or fewer individual reptiles; or to prohibit possession by any person of 24 or fewer individual amphibians.

The NCWRC develops conservation plans for the recovery of protected wild animal species, using the procedures set out in Article 2A of Chapter 150B of the General Statutes.

State listed species whose range may at times overlap with striped bass are shortnose sturgeon (E), Atlantic sturgeon (Special Concern or SC), loggerhead sea turtle (T), leatherback sea turtle (E), hawksbill sea turtle (E), Kemp's Ridley sea turtle (E), Green sea turtle (T), and diamondback terrapin (SC).

These species also appear on the 2010 Natural Heritage Program List of the Rare Animal Species of North Carolina. The Natural Heritage Program inventories, catalogues, and supports conservation of the rarest and the most outstanding elements of the natural diversity of our state. These elements of natural diversity include those plants and animals which are so rare or the natural communities which are so significant that they merit special consideration as land-use decisions are made.

8.3 ONGOING PROTECTED SPECIES EVENTS

On March 15, 2010 the NMFS and the USFWS announced their joint determination that the loggerhead sea turtle is globally compromised and issued a Federal Register notice (Federal Register: 75(50), 12598-12656) the following day. The notice distinguishes nine separate loggerhead Distinct Population Segments (DPS) worldwide and list two as threatened and seven as endangered. The Northwest Atlantic loggerhead sea turtle population is proposed to be reclassified with endangered status (Conant et al. 2009).

On February 23, 2010 a lawsuit was filed against the NCDMF and its Director and the NCMFC in federal court by the Duke Environmental Law and Policy Clinic on behalf of the Karen Beasley Sea Turtle Rescue and Rehabilitation Center. The lawsuit claimed violations of the

Endangered Species Act regarding unauthorized sea turtle interactions with gill nets. Addressing this lawsuit became a priority for the division. A settlement agreement was reached May 13, 2010. The agreement resulted in modified gill net regulations, expanded at-sea observer coverage through current observer staff, added observer duties to Marine Patrol, a federal Incidental Take Permit application was drafted and submitted (revised) in December 2010 to NMFS, and the STAC was reactivated. The following are the new gill net measures enacted due to the settlement:

It is unlawful to use large mesh gill nets (defined as 4.0 - 6.5 ISM, inclusive) unless they comply with the following provisions (proclamation M-8-2010):

A. It is unlawful to set and retrieve large mesh gill nets except during the following times:

1. No sooner than one hour before sunset on Monday and no later than one hour after sunrise on Tuesday.
2. No sooner than one hour before sunset on Tuesday and no later than one hour after sunrise on Wednesday.
3. No sooner than one hour before sunset on Wednesday and no later than one hour after sunrise on Thursday.
4. No sooner than one hour before sunset on Thursday and no later than one hour after sunrise on Friday.

B. It is unlawful to use large mesh gill nets of more than 15 meshes in height and without a lead core or leaded bottom line. It is unlawful to use cork, floats, or other buoys except those required for identification except that south of the Highway 58 Bridge, beginning at a point on the north shore at 34° 40.7848'N - 77° 04.0273'W; running southerly to a point on the south shore at 34° 39.8620'N – 77° 03.7438'W, floats are allowed.

C. It is unlawful to use or possess more than 2,000 yards of large mesh gill net per vessel north of the Highway 58 Bridge (coordinates above) and it is unlawful to use or possess more than 1,000 yards of large mesh gill net per vessel south of the Highway 58 Bridge.

D. It is unlawful to set more than 100 yards of large mesh gill net without leaving a space of at least 25 yards between separate lengths of net.

The settlement agreement may be modified when all parties agree. On August 18, 2010 the agreement was modified to exclude North River, a tributary of Albemarle Sound, from the above restrictions (proclamation M-12-2010) and addressed the appointment process for the STAC. In January 2011 the agreement was modified to allow the traditional American shad and hickory shad fishery to occur with customary gear (proclamation M-2-2011). When water temperatures warm, gill net restrictions would revert to those listed under the initial agreement.

The NCDMF has submitted to NMFS an application for inshore gill net fisheries (revised December 2010) for a statewide Section 10 ITP and outlined its conservation plan. The proposed conservation plan will specify the impact likely to result from takes, a description of measures to minimize and mitigate the level of take anticipated, and a description of alternatives considered that might that and minimize takes . The specifics of the conservation plan and permit application are subject to agency and public review. While NMFS noted they would work with the State to complete the process as soon as possible, they noted it was unlikely to happen quickly. The Section 10 Permit for the PSGNRA took 9 months to obtain and generated over 1,800 public comments. The application is under review for adequacy by NMFS and will be listed in the federal register for public comment at some point. The ITP application noted 228 documented turtle takes in North Carolina over ten years. It also acknowledges the magnitude of the requested yearly 2,961 sea turtle takes in the application. The extrapolated take numbers were used as a tool to address a worst-case scenario. The division believes that the gear restrictions, adaptive management, extensive monitoring, delineation of management units and estimate of takes 60 times per year (in each of the five management units each month) will ensure continued protection for endangered or threatened sea turtle populations (NCDMF 2010).

On October 6, 2009 the Natural Resources Defense Council submitted a petition to NMFS, National Oceanic and Atmospheric Administration (NOAA), Department of Commerce to list Atlantic sturgeon as endangered under the Endangered Species Act, 1973. On January 6, 2010 NMFS published a notice of a 90-day finding on the proposed petition and a request for information. This notice allowed interested parties to submit comments on the proposed petition as well as submit additional information on Atlantic sturgeon not included in the petition. After review of the 2007 Status Review of Atlantic Sturgeon and all other best available data, NMFS, NOAA, Department of Commerce determined listing of Atlantic sturgeon as threatened for the Gulf of Maine Distinct Population Segment (DPS) and as endangered for the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs was warranted. The NMFS published two separate listing determinations, one for the three northern DPSs, and another one for the Carolina and South Atlantic DPSs. A three month comment period was initiated October 6, 2010 and originally scheduled to close January 4, 2011. The NMFS issued a federal register notice extending the comment deadline to February 3, 2011. The NMFS now has until October 2011 to make a final determination on the listing. The ASMFC, the NCWRC, and the NCDMF have all submitted comments opposing this listing, and are in support of continuing the goals and objectives contained in the ASMFC Amendment I to the Interstate FMP for Atlantic Sturgeon.

8.4 DISCUSSION OF STATE PROGRAMS AND MANAGEMENT IMPLICATIONS

The NCDMF and NCWRC have addressed protected species issues throughout the coastal waters since the 1970s. This has been accomplished by cooperative agreements with the NCWRC, establishment of a sea turtle sanctuary, and proclamation authority given to the director of NCDMF for protected species.

8.4.1 NCWRC Programs

The NCWRC Wildlife Diversity Program, formerly the Nongame and Endangered Wildlife Program, strives to prevent species from becoming endangered by working towards maintaining viable, self-sustaining populations of all native wildlife, with an emphasis on priority species and habitats identified in North Carolina's Wildlife Action Plan. In 1983, the NCWRC created the North Carolina Sea Turtle Protection Program to monitor sea turtle nesting activity in the state, document reproductive success and mortality, and protect beach habitat along the North Carolina coast for sea turtle nesting. Commission biologists coordinate hundreds of volunteers who participate in the year-round monitoring of sea turtle activities. During the nesting season (May through September), biologists and volunteers mark and observe nests during incubation and also document all cases of sea turtle mortality. The Commission also heads up a "Stranding and Salvage" network that responds to all cases of injured or sick turtles. The collaborative effort among the Commission, the North Carolina Aquariums, and the Karen Beasley Sea Turtle Rescue and Rehabilitation Center on Topsail Island allows for dozens of turtles to be rehabilitated and released back to the wild each year (B. Wynne, NCWRC personal communication).

8.4.2 NCDMF Programs

An agreement was established in 1979 with the NCWRC to exercise regulatory jurisdiction over any species of sea turtle, and their eggs and nests, consistent with designation of such species as endangered or threatened by the USFWS. In 1980, the NCMFC established a Sea Turtle Sanctuary off the coast of North Carolina to protect nesting beaches (North Carolina Fisheries Rule – 15A NCAC 03R.0101). In 1983, proclamation authority was given to the director of NCDMF by NCMFC to close areas to protect endangered/threatened species (North Carolina Fisheries Rule-15A NCAC 03I.0107). In 1989, an addition was made to the Marine Recreational Fisheries Statistics Survey (MRFSS) program to include a sea turtle sightings query on the survey form.

In the latter part of 2010, NCDMF received funds to establish the Protected Resources Section within the division and to support a statewide at-sea observer program for the gill net fishery. The program was needed to maintain the gill net fishery in North Carolina as outlined in the federal settlement agreement filed by the Duke Environmental Law and Policy Clinic on behalf of the Karen Beasley Sea Turtle Rescue and Rehabilitation Center. The new Protected Resources Section will be the lead for NCDMF actions involving protected species such as at-sea observer programs, marine mammal stranding responses and marine mammal take reduction teams and other protected species issues that may arise (D. Lupton, NCDMF personal communication).

Marine mammal stranding response along the central North Carolina coast, sounds and rivers transitioned from North Carolina State University Center for Marine and Science Technology to the NCDMF in October of 2010. This project is funded year to year from the John H. Prescott Marine Mammal Rescue Assistance Foundation, pending successful proposal review and acceptance. A full- time stranding director was hired and stranding personnel responded to 52 marine mammal strandings in 2010, including one sperm whale, one fin whale, one minke whale, one beaked whale, three dwarf sperm whales, two pygmy sperm whales, one spotted dolphin, one Risso's dolphin, 36 bottlenose dolphins and five harbor seals. North Carolina stranding response is divided into four areas: University of North Carolina Wilmington personnel respond to all strandings in the southern part of the state up to and including Camp Jejeune; NCDMF stranding personnel respond to strandings from Hammocks Beach State Park to Cape Lookout National Seashore and strandings in Albemarle and Pamlico sounds; Cape Hatteras National Seashore (CAHA) stranding personnel respond to strandings in CAHA National Seashore, and DENR personnel respond to strandings from CAHA north to the Virginai border. Stranding personnel conduct outreach by giving public seminars at marine mammal meetings, local museums, and Universities, and classrooms. Stranding personnel disseminate results and tissue samples from stranded animals to collaborating researchers and agencies.

The NCDMF observer program began in 1999 when the sea turtle stranding network noted significant increases in sea turtle strandings in the southeastern portion of Pamlico Sound. The purpose of these observations was to begin the process of characterizing effort, catch, and bycatch by area and season in various fisheries. In addition, this program was established to monitor fisheries for the potential for protected species bycatch. Observer data are used for fisheries management decisions, stock assessments, and conservation efforts for protected species. Data collections from observer trips includes: date, location, unit, time, season, gill net description (net length, number of net shots, mesh size, presence/absence of tie downs, vertical mesh height, hang ratio), soak time and water depth. Additionally, environmental parameters (wind, tide stage and water quality data) are collected when feasible. Total catches of target species are estimated and final disposition (kept or discarded) is recorded. Sea turtle interaction information includes species, condition, tag numbers, and final disposition. Sea turtle interactions may also be photo documented when possible. Gill net interactions involving other protected species are documented. All observers are required to adhere to these data collection parameters.

The reactivation of the STAC with its representation of stakeholders will provide recommendations and guidance to the NCDMF in addressing protection of sea turtles in North Carolina. As noted in the turtle settlement agreement the duties of the STAC include but are not limited to: reviewing observer reports, devising means for fishermen to report turtle interactions, assisting with fishermen education, determining measures to reduce the incidental take of sea turtles, monitor observer program issues, and reviewing all future ITP provisions and take calculations prior to formal application to NMFS.

Since the 1970s, the NCDMF has been proactive in developing ways to minimize impacts to threatened and endangered marine species. The NCDMF works closely with NMFS and other state and federal agencies to develop regulations that minimize impacts to protected species while trying to allow the prosecution of many economically important fisheries. In addition to the ITPs issued for the PSGNRA, the NCDMF has been issued ITPs for the shrimp trawl fishery off the North Carolina coast between Browns Inlet and Rich’s Inlet allowing limited tow times in lieu of the use of Turtle Excluder Devices (TEDs) because of high concentrations of algae which clog both shrimp trawl nets and TEDs.

The NCDMF has tested modified gill net designs for the purpose of reducing sea turtle interactions and still maintain acceptable levels of target species (Gearhart and Price 2003; Brown and Price 2005; Price and Van Salisbury 2007). These studies have identified low-profile gill net gear that can be used in the deep water portion of Pamlico Sound to mitigate the bycatch of sea turtles. In addition, the 2007 study indicated the potential transference of this technology to other gill net fisheries where similar conditions and sea turtle bycatch issues exist (Price and Van Salisbury 2007; Gilman et al. 2010). In July 2010, the NCDMF began research on the effectiveness of various designs of hard and soft fish pots in targeting flounder. Basic testing of pot characteristics (i.e. entrance size, shape, orientation, and color) were conducted. The development of a fish pot fishery for flounder in the inshore waters of North Carolina could potentially have numerous advantages over other gears used to target flounder. However, initial results are not promising (K. Brown, NCDMF, personal communication).

8.4.3 Management Implications

New measures enacted after the settlement with the Karen Beasley Sea Turtle Rescue and Rehabilitation Center have reduced overall large mesh effort in the Pamlico Sound and southern North Carolina sounds and rivers. Although the data are preliminary, the number of trips during the period May 15 through August 30 in 2010 was 3,971, which indicates a 58% reduction in effort over the previous year’s same time period (NCDMF 2010). Measures were designed to reduce interactions with sea turtles but should also reduce interactions with Atlantic and shortnose sturgeon. The striped bass fisheries are also impacted by the required observer coverage and potential reporting burdens under the pending ITP application for the inshore gill net fishery. Individuals fishing in North Carolina’s coastal waters may be monitored by state and/or federal observers and are required to carry observers on their vessels if requested. Fishermen holding any division-issued fishing license are required to cooperate with state observers (under the authority granted in rule to obtain biological data, harvest information, or statistical data). Federal observers with the NMFS are also working in North Carolina coastal waters. Vessels selected to be monitored by federal observers must successfully complete the

U.S. Coast Guard Commercial Fishing Vessel Safety Examination and display a current safety decal issued within the last two years. Vessels that do not have a current safety decal are deemed unsafe for purposes of carrying a federal observer and are prohibited from fishing. Federal enforcement action may result when a vessel required to take a federal observer does not meet the safety requirements and embarks on a fishing trip without that observer. The inshore gill net fishery, a Category II fishery, is subject to these federal provisions.

Implications to the striped bass fisheries as a result of the proposed Atlantic sturgeon listing are unknown at this time. Changes in regulations if Atlantic sturgeon is listed, either as endangered or threatened, could be wide ranging. There is the potential for changes to current commercial gears with the possibility of a complete closure of gill net fisheries in the estuarine waters of North Carolina where sturgeon are encountered as bycatch. Regulation changes are more likely to be addressed through mesh size restrictions, soak times (based on water temperatures), yardage limits, seasonal closures, and area closures. However, as Atlantic sturgeon interactions have been recorded in pound net and hook and line fisheries, these gears could be impacted as well. If Atlantic sturgeon is listed then NCDMF has no option but to follow measures described in the ESA. The most severe is no "take" of a threatened or endangered animal. The ESA defines take as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." The Division would have to follow section 9 of the 1973 ESA which states; "Except as provided in sections 6(g)(2) and 10 of this Act, with respect to any endangered species of fish and wildlife listed pursuant to section 4 of this Act is unlawful for any person subject to the jurisdiction of the United States to - (B) take any such species within the United States or the territorial sea of the United States; (C) take any such species upon the high seas; (D) possess, sell, deliver, carry, transport, or ship, by any means whatsoever, any such species taken in violation of subparagraphs (B) and (C)." Incidental capture with live or dead release of an endangered species is considered an interaction and "take" by the ESA, and is therefore unauthorized, unless a Section 10 ITP is obtained that would allow limited commercial takes for the fisheries covered by the ITP.

The uncertainty surrounding impacts of ESA listing to fisheries is not a unique situation for the striped bass FMP. The southern flounder FMP amendment and spotted seatrout FMP both dealt with similar situations. All aspects of some management issues may not be totally revealed during the development and approval timeframe of each FMP initial plan or amendment; other factors (new data, federal compliance, etc.) that come to light may be valid to consider changing a management approach. In order to address these situations and hold true to the tenets of the FRA (insure purposeful, deliberate action that has been well examined and fully debated), the legislature passed House Bill 1710 (session law 2010-15) in June 2010 that provides for a FMP supplement. The supplement considers adding temporary management measures to an existing FMP when the DENR Secretary deems it is in the interest of the long-term viability of the fishery. The supplement process is recommended when a single discrete issue requires resolution before a FMP amendment could be enacted, it is a time sensitive situation. Temporary supplement measures must be incorporated in the next amendment of the FMP or they expire on the date the amendment is adopted. An alternative approach to addressing uncertainty within a FMP is to specify adaptive management: the amount of flexibility allowed for a management strategy in the FMP is determined and clearly stated. The FMP adaptive management statement sets the stage and bounds for subsequent action after the FMP has been approved, conditioned on new data or legislative action, or other limitations existing at the time the FMP is adopted. The CSMA recreational changes and gill net restrictions implemented in 2008 are examples of products that came from adaptive management statements in the 2004 FMP. With either technique, the division would be able to respond to protected species issues in an effective manner for the striped bass fisheries.

Federal protected species listings as noted previously in the ITP requirement discussion places an additional administrative burden on the division. But even more so it has the potential to significantly impact ongoing research surveys. The division would have to immediately consider discontinuing fishery sampling programs that have a high likelihood of interactions or risk liability under federal rules. NCDMF is responsible for data collection to remain compliant with the ASMFC FMPs and in the case of ASMA striped bass that includes a 20 year gill net survey. Sampling would resume when a Section 10 ITP is obtained. Obtaining an ITP would take time (estimated at 12 months) and would be expected to contain limitations that may well inhibit the division from sampling under current protocols. This potential loss of data series has ramification in stock assessments and thus, effective management of the striped bass stocks. The very surveys in jeopardy are the sources for the majority of the Atlantic sturgeon data in the estuarine environment.

In summary the issues surrounding protected species in the striped bass fisheries are dynamic and all parties are striving to balance the needs of the fisheries with the conservation of protected species. The fishing public needs to be aware that this is a complex issue.

8.5 RESEARCH AND COMPLIANCE NEEDS

- **Request funding for state observer program:**

  Provides data on interactions, fisheries characterizations, and discard information
  Allows for continued proactive management
  Expensive
  Could be difficult to achieve adequate observer coverage coast wide

- **Apply for ITP for impacted fisheries:**

  Provides a legal means of having interactions
  Provides data on protected species and fisheries characterization
  Allows for continued proactive management
  Expensive
  Could be difficult to achieve adequate observer coverage coast wide

- **Continue gear development research to minimize species interactions:**

  Allows fisheries to continue
  Potentially increased survival of protected species
  Potentially reduces interactions
  Potential for fisheries to close due to protected species interactions while gear is being developed

- **Implementation of outreach programs to inform state agencies, the public, and the commercial and recreational fishing industries about issues relating to protected species and fishery management:**

  Well informed public may be able to reduce interactions
  Proactive way to address the issues
  Additional staff time to develop outreach materials

9.0 DESCRIPTION OF THE SOCIOECONOMIC CHARACTERISTICS OF THE FISHERY

9.1 DEFINITIONS

Commercial Fishing – Fishing in which fish harvested, either in whole or in part, are intended to enter commerce or enter commerce through sale, barter or trade. In North Carolina, a commercial fisherman is required to have a commercial license issued by the NCDMF and is allowed only to sell to a licensed dealer.

Confidential data – Direct or indirect identity of a fisherman and/or dealer (i.e., licensee) is considered confidential according to G.S. 113-170.3. Long-standing NCDMF policy (standard supported by all Atlantic coast fisheries agencies) identifies confidential data as data derived from fewer than three fishermen or dealers (termed the 'Rule of Three'). Confidential data can only be released in a summarized format that does not allow the user to track landings or purchases to any individual unless by direct court order.
Ex-vessel price and value – The total landed dollar amount of a given species (or species landing condition and market category). Example: 100 lbs of striped bass at a PRICE of $1.50 per pound will have a VALUE of $150.

Fishing Trip – A period of time over which fishing occurs. The time spent fishing includes configuring, deploying, and retrieving gear, clearing animals from the gear, and storing, releasing or discarding catch. When watercraft are used, a fishing trip also includes the time spent traveling to and from fishing areas or locales and ends when the vessel offloads product at sea or returns to the shore. When fishing from shore or man-made structures, a fishing trip may include travel between different fishing sites within a 24-hour period.

Inflation-adjusted values – Inflation is overall 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 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.

Recreational Fishing – Any trip for the purpose of recreation from which none of the catch is sold or bartered. This includes trips with effort but no catch. An inland recreational fishing license is required for those who fish in inland waters under the jurisdiction of the NCWRC. A coastal recreational license is also required for anglers fishing in coastal and joint waters under jurisdiction of the NCDMF. Anglers who wish to use limited amounts of commercial fishing gear in coastal waters under the jurisdiction of the NCDMF are also required to have a RCGL license.

Management Units – The Fisheries Reform act calls for this Section of an FMP to describe the social and economic impact of the fishery to the State. The fishery covered in this plan is the North Carolina estuarine striped bass fishery consisting of the A/R and CSMA stocks, exclusive of the Atlantic Ocean migratory stock. However, information regarding the Atlantic Ocean migratory stock is provided herein for comparative purposes, and in some cases socioeconomic data sources do not allow for reporting at the finer individual stock level.

9.2 COMMERCIAL FISHING

9.2.1 Ex-vessel value and price

Value records are available beginning in 1972 and were provided voluntarily by cooperating dealers. The trip ticket program began in 1994 and it was mandated that all commercial landings be reported to NCDMF. Reporting the value of the landing continues to remain optional; however, the values of landings are reliable estimates. Considering that there is nearly thirty-five years of data to compare, it is useful not only to report the actual dollars paid for the seafood, but also to tie the value of annual landings back to an established baseline to control for the effects of inflation. In this way changes in landings values since 1972 can be more clearly understood.

ASMA. From 1972 through 1978 there was a general trend for increased landings value from the ASMA that is associated with increases in landings. From 1978 through 1997 the overall trend is towards decreasing value. As is typical, the inflation adjusted figures show less volatility, nonetheless, the 1978 high of $272,335 (inflation adjusted) is eight to nine times greater than the lows of approximately $30,000 - $40,000 from 1988 through 1998. From 1999 through 2007 the value of the landings increased, but were still lower than the pre-1988 values (inflation adjusted). Much of the reduction in value observed from the late 1980s through the late 1990s is due to the lower total allowable catch (TAC) during these years. The most recent inflation-adjusted values in 2008 and 2009 were similar to those of the mid 1990s when landings were at their lowest. The value (inflation adjusted) over the last 10 years has averaged around $70,000 (Figure 9.1).

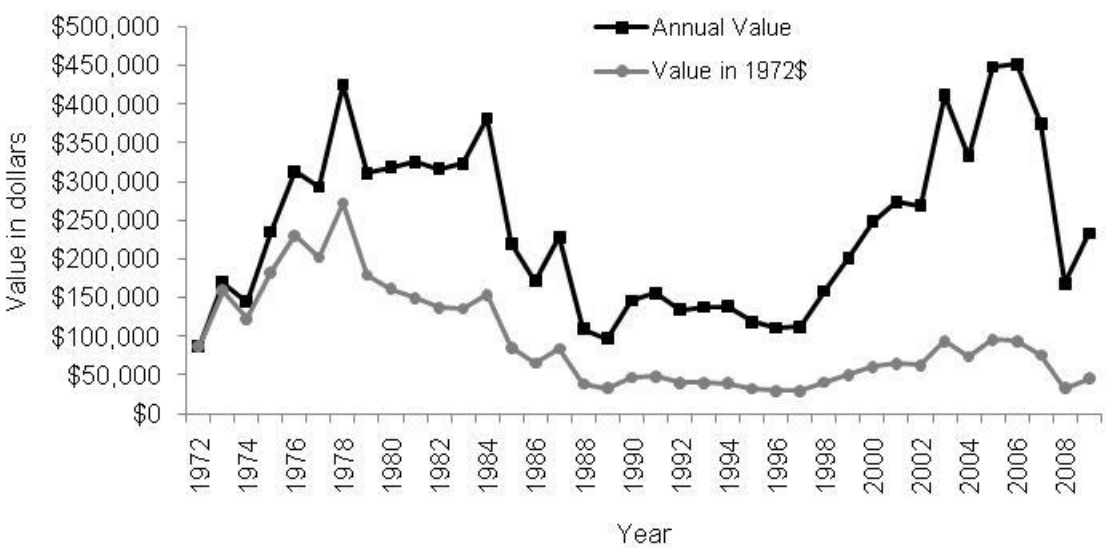


Figure 9.1 Value of ASMA striped bass landings, 1972 – 2009 (NCDMF Trip Ticket Program).

CSMA. Striped bass TAC in the CSMA was set to 25,000 lbs in 1994. Consequently, the value of landings is also lower. Controlling for inflation, 1980 saw landings with the highest value ($38,358). The value (inflation adjusted) over the last 10 years has averaged around $9,000 (Figure 9.2).

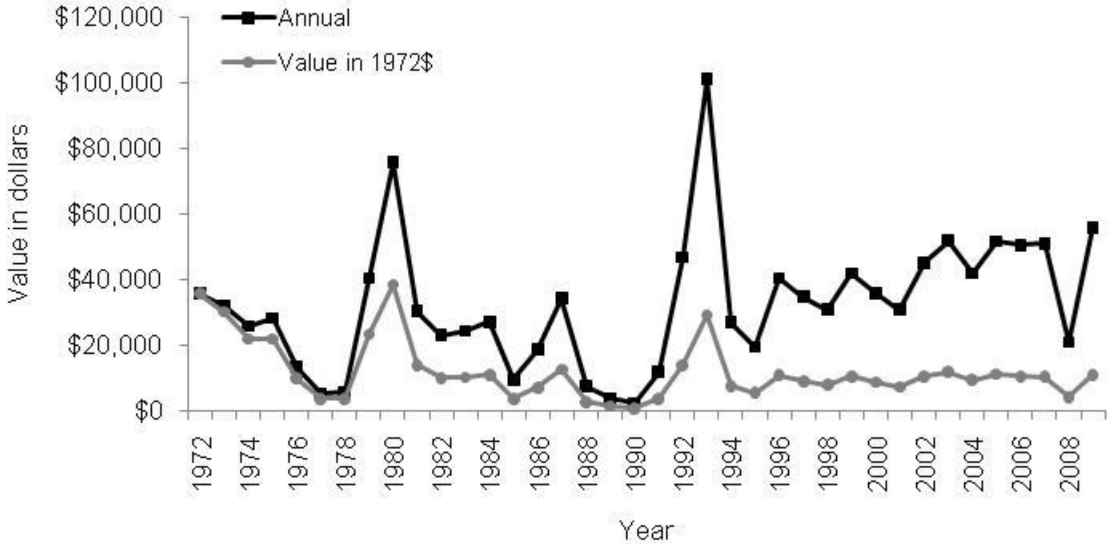


Figure 9.2 Value of CSMA striped bass landings, 1972 – 2009 (NCDMF Trip Ticket Program).

Atlantic Ocean. Presenting socioeconomic data from the Atlantic Ocean fishery within the N.C. Estuarine Striped Bass FMP was the best way to store this information for long term utility. The early trend in striped bass landings from the ocean decreased from a high of $367,655 (adjusted for inflation) in 1973 to a low of $17,529 in 1984 (Figure 9.3). From 1985 through 1989 the ocean was closed to harvesting of striped bass as mandated by the ASMFC Interstate FMP. Landings of striped bass from the ocean began to increase significantly in the mid 1990s with the recovery of the Atlantic striped bass stock. Landings values have increased somewhat in recent years, but they have not recovered to a level much higher than the 1976 inflation-adjusted values. The value (inflation adjusted) over the last 10 years has averaged around $118,000.

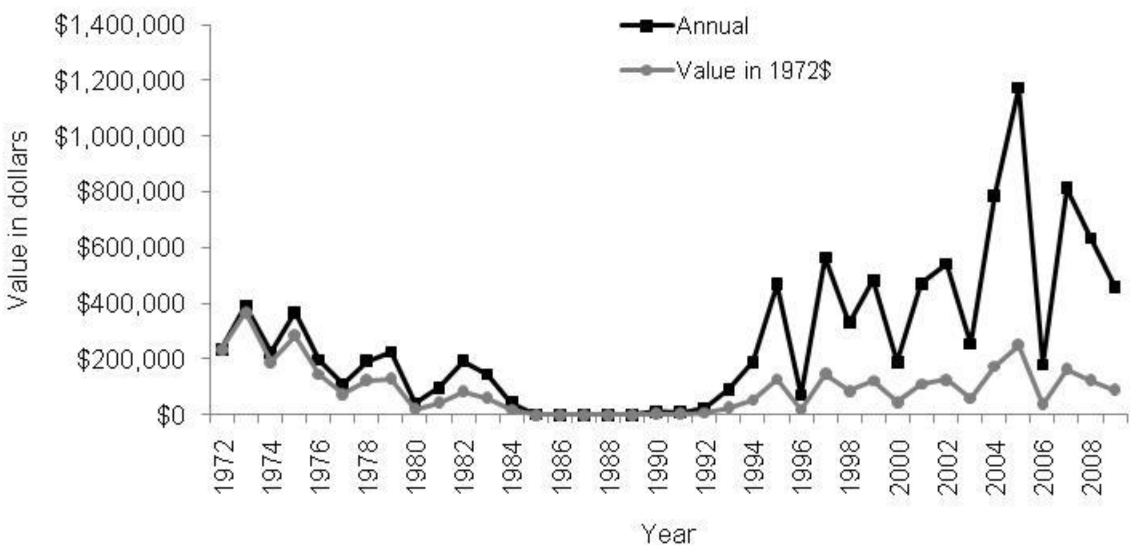


Figure 9.3 Value of Atlantic Ocean striped bass landings, 1972 – 2009 (NCDMF Trip Ticket Program).

All combined. Figure 9.4 shows the 1972 inflation-adjusted values of the landings for all water bodies combined for each year from 1972 through 2009. As can be seen, the majority of the value for any given year can be accounted for in the landings from the ASMA and the ocean, except for the years 1984 through 1992 when ocean harvesting was closed or extremely limited.

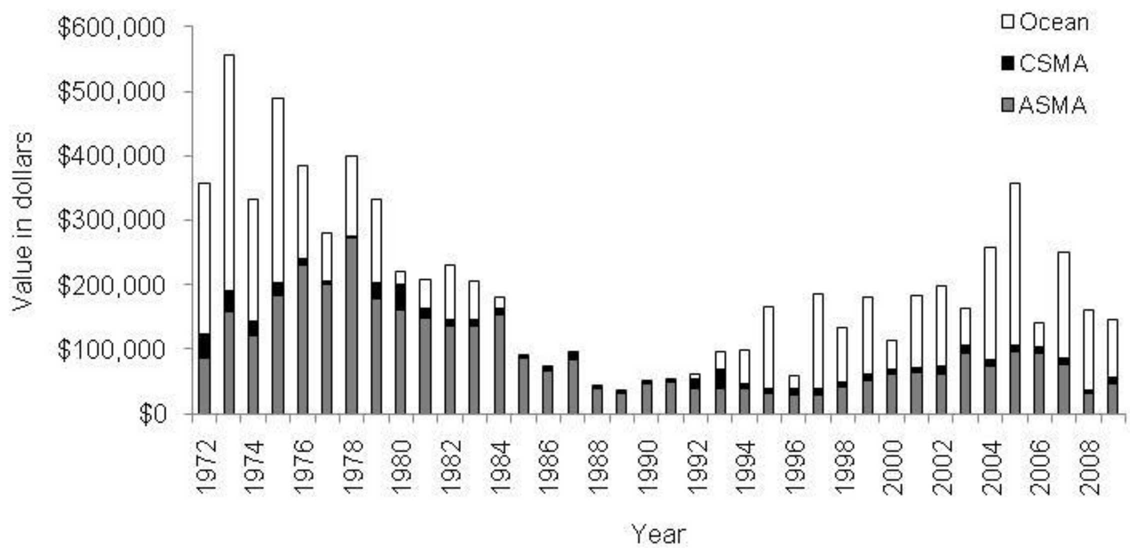


Figure 9.4 Total value of striped bass landed by management unit (adjusted for inflation), 1972 – 2009 (NCDMF Trip Ticket Program).

As shown in Figure 9.5, the total number of pounds landed diminished steadily from a high of 1.75 million pounds in 1973 to a low of just over 100,000 lbs in 1989. Much of the decrease in harvest can be attributed to the moratorium and changes in the TAC in the different water bodies during this period. The average number of pounds has been increasing since the early 1990s with 2004 showing the largest annual landings of approximately 900,000 lbs.

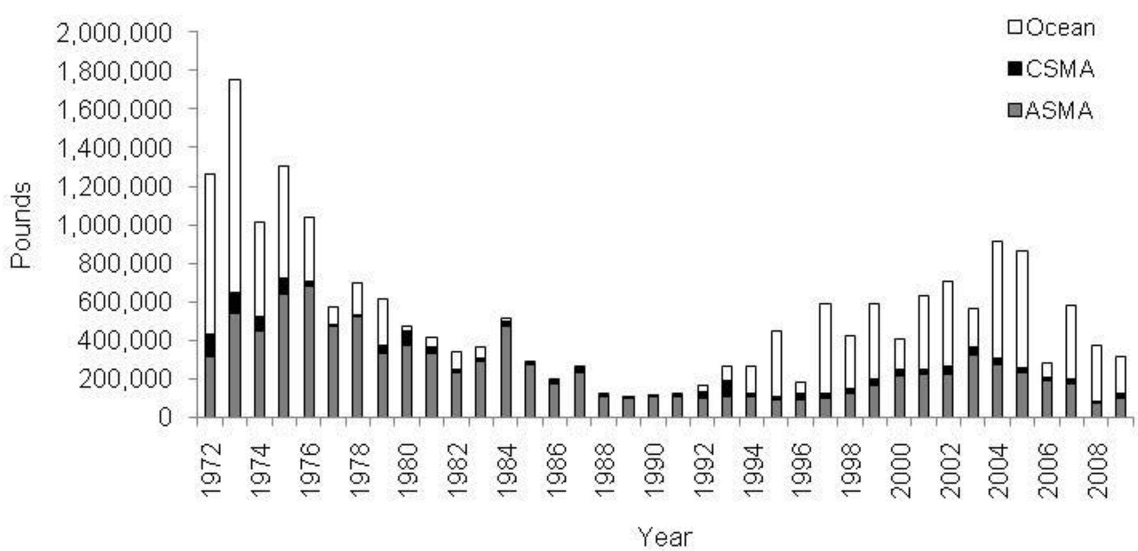


Figure 9.5 Number of pounds of striped bass landed by management unit, 1972 – 2009 (NCDMF Trip Ticket Program).

In the early 1970s the largest portion of striped bass were caught in the ocean. By the mid-1970s the majority of landings were coming from the ASMA. From the mid-1980s to the early 1990s landings from the ocean were extremely limited or nonexistent due to closures or limited fishing opportunities. From the mid-1990s on, with the exception of 1996, 2000, 2003, and 2006, ocean landings accounted for at least 50% of the total annual landings.

The trend in average price per pound (unadjusted value) paid to the fisherman tends to be very similar for fish caught in the ASMA or in CSMA (Figures 9.6 and 9.7). Price per pound in both these management units increased steadily from $0.28 in 1972 to an early period high of around $1.45 in 1982. There was a slight decline from 1982 through 1989. In 1990 the price per pound rose back to approximately $1.40, and for the next 15 years averaged $1.28 in both the ASMA and CSMA. In 2005 the price per pound increased significantly, and from 2006 through 2009 the average price per pound for both management units has been $2.25. When controlling for inflation, the price per pound reached a high of about $0.60 in 1982 and declined until 2004, with some recovery since. The price per pound of striped bass landed from the ocean was more volatile from 1972 through 1987 (Figure 9.8), from a low of $0.28 per pound in 1972 to a high of $3.00 per pound in 1984. Like estuarine striped bass, there was a decline in price until recent years.

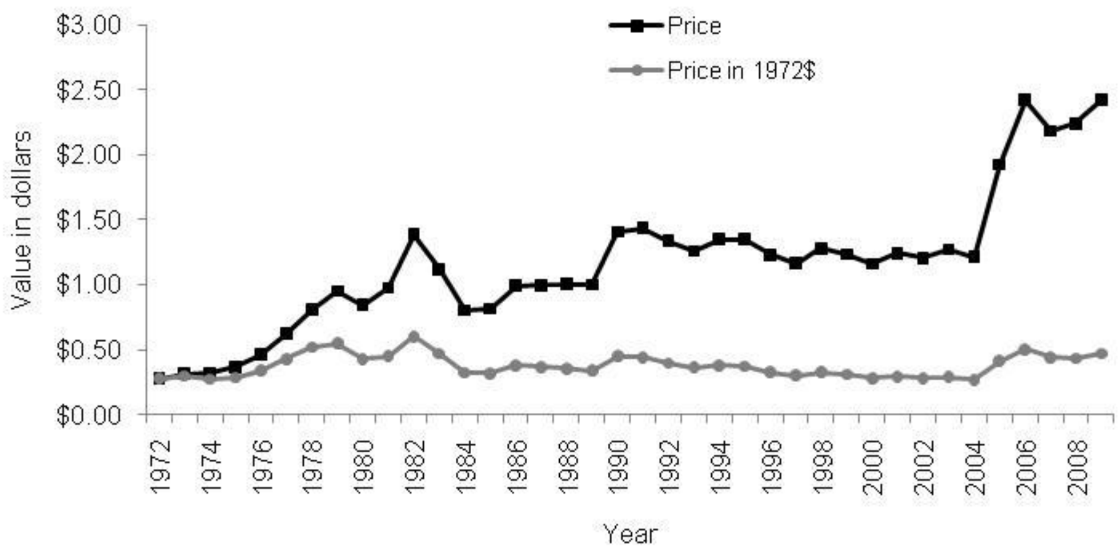


Figure 9.6 Price per pound by year for striped bass caught in ASMA, 1972 – 2009 (NCDMF Trip Ticket Program).

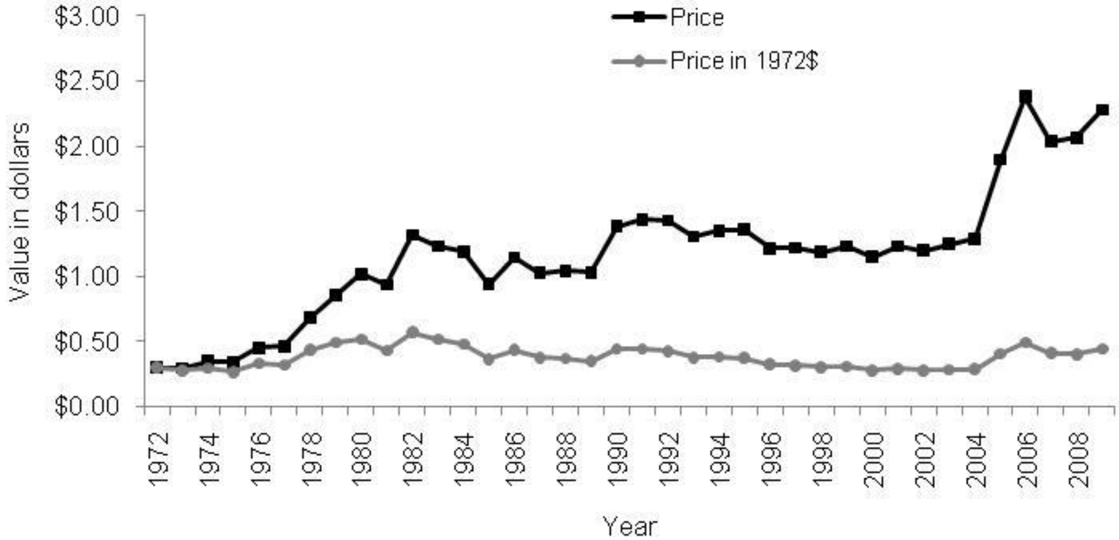


Figure 9.7 Price per pound by year for striped bass caught in CSMA, 1972 – 2009 (NCDMF Trip Ticket Program).

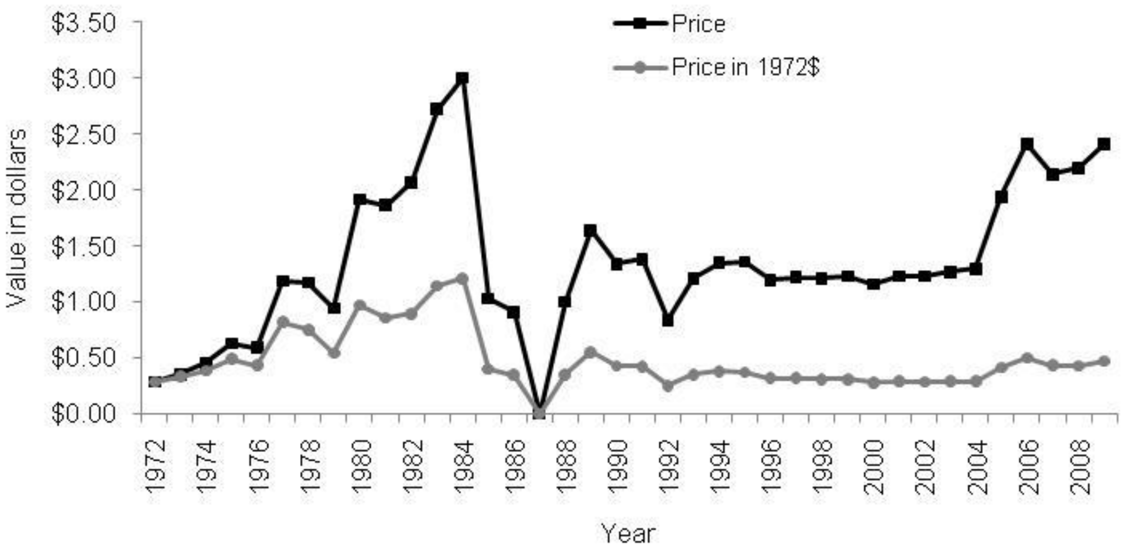


Figure 9.8 Price per pound by year for striped bass caught in the Atlantic Ocean, 1972 – 2009 (courtesy of the NCDMF Trip Ticket Program).

Table 9.1 shows the number of participants in the fishery by year, management unit, and the value of their annual landings from 2001 through 2009. In those years, the ASMA averaged 356 fishermen reporting landings of striped bass. Of those, 57% had annual landings with values less than $500. In the CSMA, there is an average of 160 fishermen reporting landings in a given year. Eighty-three percent reported annual landings valued less than $500.

Table 9.1 Number of participants in the striped bass fishery by year, management unit, and value of annual landings, 2001 - 2009 (NCDMF Trip Ticket Program).

Management Unit	Income Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average
ASMA	<= $100.00	124	122	86	53	82	82	80	98	93	91
	$100.01 - $500.00	137	139	126	99	133	96	92	92	84	111
	$500.01 - $1,000.00	75	57	74	66	51	43	53	32	31	54
	> $1,000	93	90	117	107	128	130	108	56	72	100
	Total	429	408	403	325	394	351	333	278	280	356
CSMA	<= $100.00	108	93	113	61	86	68	49	66	32	75
	$100.01 - $500.00	78	72	80	58	70	43	52	31	37	58
	$500.01 - $1,000.00	10	23	23	17	18	20	13	10	18	17
	> $1,000	1	7	10	9	12	13	21	3	16	10
	Total	197	195	226	145	186	144	135	110	103	160
Ocean	<= $100.00	20	11	18	17	6	8	11	8	9	12
	$100.01 - $500.00	88	116	154	178	182	54	122	60	37	110
	$500.01 - $1,000.00	52	55	79	128	178	80	143	96	40	95
	> $1,000	115	213	46	231	364	59	261	206	78	175
	Total	275	395	297	554	730	201	537	370	164	391

9.2.2 Gear and Price

From 1972 through 2009, 59% of all striped bass were caught using gill nets. An additional 21% were caught using beach seines, 9% in flounder trawls and 4% in pound nets. The remaining 7% were caught as bycatch using other gears such as haul seines, other kinds of nets, pots, or trolling (Figure 9.9).

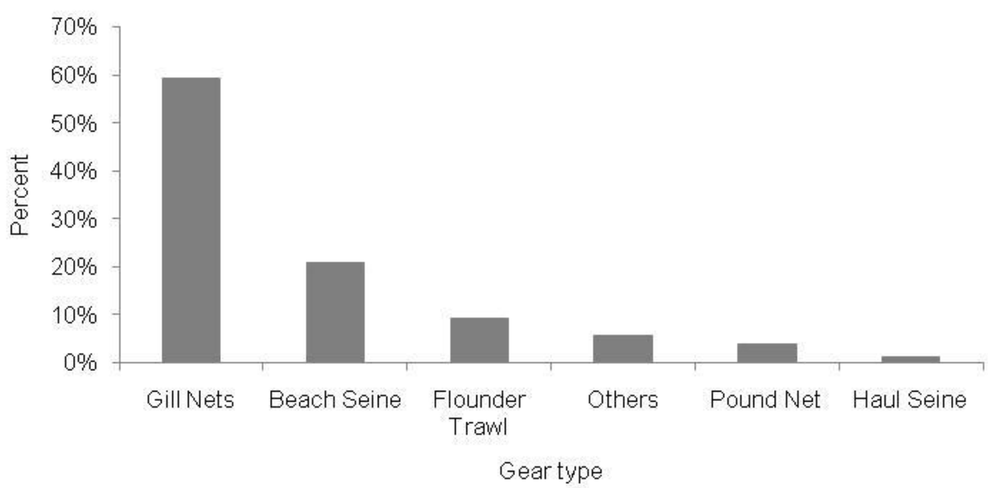


Figure 9.9 Percent of landings by gear used to harvest striped bass in all North Carolina waters, 1972 – 2009 (NCDMF Trip Ticket Program).

Table 9.2 shows by year from 1994 through 2009 the number of trips made by each of the gears listed in Figure 9.9. The table also shows the number of pounds landed, the total value and the price per pound. In each case it can be seen that flounder trawls and beach seines have a much greater CPUE than do gill nets. Overall, there is very little difference in terms of the gear used on the average price per pound. Table 9.2 does not show inflation-adjusted amounts, but as can be seen in a comparison with Figures 9.6 – 9.8, the average price per pound has followed a general downward trend.

Table 9.2 The average price per pound for striped bass (unadjusted for inflation) using different gears for the years 1994 – 2009 (NCDMF Trip Ticket Program).

Year	Category	Beach Seine	Flounder trawl	Gill Net	Haul Seine	Pound Net	All Other Gears	Total
1994	Trips	74	9	2,836	68	297	62	3,346
	Pounds	60,693	16,485	139,800	2,290	12,800	29,832	261,900
	Ave. pounds/trip	820	1,832	49	34	43	481	543
	Value	$ 81,936	$ 22,255	$188,730	$ 3,092	$ 17,279	$ 40,273	$ 353,565
	Price/pound	1.35	1.36	1.35	1.35	1.35	1.35	1.35
1995	Trips	244	34	5,648	152	321	141	6,540
	Pounds	169,201	16,184	232,768	3,195	4,277	20,534	446,159
	Ave. pounds/trip	693	495	41	21	13	146	235
	Value	$229,943	$ 22,867	$315,741	$ 4,372	$ 5,706	$ 27,899	$ 606,528
	Price/pound	1.36	1.41	1.36	1.37	1.33	1.36	1.37
1996	Trips	87	*	6,030	91	344	86	6,638
	Pounds	39,607	*	130,086	1,820	4,990	5,096	181,599
	Ave. pounds/trip	455	*	22	20	15	59	114
	Value	$ 47,127	*	$159,323	$ 2,200	$ 6,097	$ 6,196	$ 220,943
	Price/pound	1.19	*	1.22	1.21	1.22	1.22	1.21
1997	Trips	349	15	7,295	46	671	339	8,715
	Pounds	185,890	5,145	201,330	773	14,007	180,640	587,785
	Ave. pounds/trip	533	343	28	17	21	533	246
	Value	$244,619	$ 6,377	$242,605	$ 921	$ 15,654	$220,914	$ 731,090
	Price/pound	1.21	1.24	1.21	1.19	1.12	1.22	1.20
1998	Trips	147	34	5,783	98	421	219	6,702
	Pounds	75,004	22,607	237,427	1,890	14,735	71,205	422,868
	Ave. pounds/trip	510	665	41	19	35	325	266
	Value	$ 93,980	$ 26,725	$293,087	$ 2,309	$ 18,829	$ 85,110	$ 520,040
	Price/pound	1.25	1.18	1.23	1.22	1.28	1.20	1.23
1999	Trips	98	0	8,276	114	462	148	9,098
	Pounds	61,774	0	509,465	2,100	12,820	2,153	588,312
	Ave. pounds/trip	630	0	62	18	28	15	126
	Value	$ 76,394	$ -	$627,337	$ 2,590	$ 15,866	$ 2,657	$ 724,844
	Price/pound	1.24	0.00	1.23	1.23	1.24	1.23	1.03

Table 9.2 (continued)

Year	Category	Beach Seine	Flounder trawl	Gill Net	Haul Seine	Pound Net	All Other Gears	Total
2000	Trips	102	62	10,599	21	677	274	11,735
	Pounds	58,147	46,169	226,243	369	17,590	58,987	407,505
	Ave. pounds/trip	570	745	21	18	26	215	266
	Value	$ 67,218	$ 52,867	$261,766	$ 418	$ 20,667	$ 68,979	$ 471,915
	Price/pound	1.16	1.15	1.16	1.13	1.17	1.17	1.16
2001	Trips	184	41	10,986	*	504	359	12,074
	Pounds	93,580	37,301	348,415	*	12,761	134,001	626,058
	Ave. pounds/trip	509	910	32	*	25	373	370
	Value	$120,402	$ 43,788	$430,210	*	$ 15,749	$162,930	$ 773,079
	Price/pound	1.29	1.17	1.23	*	1.23	1.22	1.23
2002	Trips	332	22	9,795	67	846	218	11,280
	Pounds	237,983	36,090	347,046	8,267	19,790	52,284	701,460
	Ave. pounds/trip	717	1,031	35	123	23	240	362
	Value	$295,006	$ 43,374	$419,145	$ 9,912	$ 23,781	$ 64,240	$ 855,458
	Price/pound	1.24	1.20	1.21	1.20	1.20	1.23	1.21
2003	Trips	0	22	10,455	85	584	341	11,487
	Pounds	0	25,929	432,621	3,040	17,586	86,744	565,919
	Ave. pounds/trip	0	1,179	41	36	30	254	257
	Value	$ -	$ 32,099	$548,004	$ 3,886	$ 22,362	$111,629	$ 717,981
	Price/pound	0.00	1.24	1.27	1.28	1.27	1.29	1.06
2004	Trips	230	60	8,398	39	260	385	9,372
	Pounds	180,640	90,765	499,473	1,234	4,689	134,672	911,473
	Ave. pounds/trip	785	1,513	59	32	18	350	460
	Value	$234,154	$119,808	$624,719	$ 1,574	$ 5,993	$174,382	$1,160,631
	Price/pound	1.30	1.32	1.25	1.28	1.28	1.29	1.29
2005	Trips	456	4	9,477	114	634	211	10,896
	Pounds	331,341	2,906	469,658	2,931	16,146	41,307	864,289
	Ave. pounds/trip	727	727	50	26	25	196	292
	Value	$650,713	$ 5,447	$900,976	$ 5,651	$ 31,255	$ 79,027	$1,673,068
	Price/pound	1.96	1.87	1.92	1.93	1.94	1.91	1.92
2006	Trips	0	16	7,098	74	621	158	7,967
	Pounds	0	6,217	241,525	1,903	17,652	14,440	281,736
	Ave. pounds/trip	0	389	34	26	28	91	95
	Value	$ -	$ 14,520	$584,390	$ 4,453	$ 41,365	$ 36,174	$ 680,902
	Price/pound	0.00	2.34	2.42	2.34	2.34	2.51	1.99

Table 9.2 (continued).

Year	Category	Beach Seine	Flounder trawl	Gill Net	Haul Seine	Pound Net	All Other Gears	Total
2007	Trips	46	74	7,386	37	571	135	8,249
	Pounds	10,471	76,644	446,742	1,333	17,189	24,006	576,384
	Ave. pounds/trip	228	1,036	60	36	30	178	261
	Value	$ 21,400	$157,573	$971,915	$ 2,863	$ 34,480	$ 50,724	$1,238,956
	Price/pound	2.04	2.06	2.18	2.15	2.01	2.11	2.09
2008	Trips	186	25	3,628	9	422	130	4,400
	Pounds	75,711	17,637	208,938	282	12,440	58,442	373,450
	Ave. pounds/trip	407	705	58	31	29	450	280
	Value	$171,613	$ 38,403	$467,214	$ 600	$ 25,678	$119,058	$ 822,566
	Price/pound	2.27	2.18	2.24	2.13	2.06	2.04	2.15
2009	Trips	6	28	4,044	19	513	180	4,790
	Pounds	4,856	39,083	153,736	437	16,664	95,828	310,604
	Ave. pounds/trip	809	1,396	38	23	32	532	472
	Value	$ 12,484	$ 94,334	$372,235	$ 1,061	$ 37,385	$229,810	$ 747,308
	Price/pound	2.57	2.41	2.42	2.43	2.24	2.40	2.41

*** *denotes confidential information*

Tables 9.3 to 9.5 show the gears that were used to land striped bass in the ASMA, CSMA, and Atlantic Ocean from 1996 through 2009. Gill nets accounted for the majority of landings in all water bodies for these years. The only other gear with significant landings was the use of beach seines in the Atlantic Ocean.

Table 9.3 Striped bass landings and value by gears for the ASMA, 1997 – 2009 (NCDMF Trip Ticket Program).

1997

Gear	Value ($)	Pounds	Price/lb. $	Value in 1972 ($)	Price/lb. in 1972 ($)
Crab pot	660	549	1.20	172	0.31
Fyke net	495	440	1.12	129	0.29
Gill net (runaround)	249	201	1.24	65	0.32
Gill net (anchored)	94,513	80,645	1.17	24,611	0.31
Haul seine	609	522	1.17	158	0.30
Pound net	14,851	13,359	1.11	3,867	0.29
Other & Conf.	471	406	1.16	123	0.30
Total or Average*	111,847	96,122	1.16	29,125	0.26

1998

Gear	Value ($)	Pounds	Price/lb. $	Value in 1972 ($)	Price/lb. in 1972 ($)
Crab pot	255	216	1.18	65	0.30
Fyke net	628	517	1.22	161	0.31
Gill net (runaround)	1,610	1,363	1.18	413	0.30
Gill net (anchored)	134,980	105,430	1.28	34,609	0.33
Haul seine	2,309	1,890	1.22	592	0.31
Pound net	18,139	14,151	1.28	4,651	0.33
Other & Conf.	454	360	1.26	116	0.32
Total or Average*	158,376	123,927	1.28	40,608	0.33

1999

Gear	Value ($)	Pounds	Price/lb. $	Value in 1972 ($)	Price/lb. in 1972 ($)
Crab pot	181	147	1.23	45	0.31
Fyke net	873	705	1.24	219	0.31
Gill net (anchored)	181,158	146,781	1.23	45,452	0.31
Haul seine	2,556	2,072	1.23	641	0.31
Pound net	15,858	12,813	1.24	3,979	0.31
Other & Conf.	436	352	1.23	109	0.31
Total or Average*	201,061	162,870	1.23	50,446	0.31

2000

Gear	Value ($)	Pounds	Price/lb. $	Value in 1972 ($)	Price/lb. in 1972 ($)
Crab pot	401	352	1.14	97	0.28
Fyke net	1,589	1,343	1.18	386	0.29
Gill net (runaround)	373	328	1.14	91	0.28
Gill net (anchored)	224,348	193,687	1.16	54,449	0.28
Pound net	20,588	17,520	1.18	4,997	0.29
Other & Conf.	910	799	1.14	221	0.28
Total or Average*	248,209	214,029	1.15	60,241	0.28

2001

Gear	Value ($)	Pounds	Price/lb. $	Value in 1972 ($)	Price/lb. in 1972 ($)
Crab Pot	673	530	1.27	159	0.30
Fyke Net	3,260	2,648	1.23	769	0.29
Gill net (runaround)	1,293	1,107	1.17	305	0.28
Gill net (anchored)	251,504	202,598	1.24	59,355	0.29
Pound Net	15,265	12,341	1.24	3,602	0.29
Other & Conf.	1,294	1,009	1.28	305	0.30
Total or Average	272,289	220,233	1.24	64,425	0.29

2002

Gear	Value ($)	Pounds	Price/lb. $	Value in 1972 ($)	Price/lb. in 1972 ($)
Crab Pot	139	127	1.09	32	0.25
Fyke Net	1,661	1,459	1.14	386	0.26
Gill net (runaround)	870	728	1.20	202	0.28
Gill net (anchored)	239,339	198,312	1.21	55,622	0.28
Pound Net	23,025	19,161	1.20	5,351	0.28
Other & Conf.	3,767	3,070	1.23	875	0.29
Total or Average	268,801	222,857	1.21	62,469	0.28

Table 9.3 (continued).

Gear	2003 Value ($)	Pounds	Price/lb. $	Value in 1972 ($)	Price/lb. in 1972 ($)
Crab Pot	882	824	1.07	200	0.24
Fyke Net	4,384	3,455	1.27	996	0.29
Gill net (runaround)	287	259	1.11	65	0.25
Gill net (anchored)	381,121	299,279	1.27	86,591	0.29
Pound Net	20,902	16,396	1.27	4,749	0.29
Other & Conf.	3,994	3,125	1.28	907	0.29
Total or Average	411,570	323,337	1.27	93,509	0.29

Gear	2004 Value ($)	Pounds	Price/lb. $	Value in 1972 ($)	Price/lb. in 1972 ($)
Crab Pot	128	108	1.19	28	0.26
Fyke Net	5,472	4,383	1.25	1,211	0.28
Haul seine	1,574	1,234	1.28	348	0.28
Gill net (anchored)	319,373	263,150	1.21	70,677	0.27
Pound Net	5,993	4,689	1.28	1,326	0.28
Other & Conf.	94	72	1.31	21	0.29
Total or Average	332,634	273,636	1.22	73,612	0.27

Gear	2005 Value ($)	Pounds	Price/lb. $	Value in 1972 ($)	Price/lb. in 1972 ($)
Crab Pot	35	18	1.92	7	0.41
Fyke Net	4,037	2,000	2.02	864	0.43
Gill net (runaround)	3,355	1,762	1.90	718	0.41
Gill net (anchored)	401,831	208,779	1.92	85,992	0.41
Haul Seine	5,651	2,931	1.93	1,209	0.41
Pound Net	31,255	16,146	1.94	6,688	0.41
Other & Conf.	2,024	1,057	1.91	433	0.41
Total or Average	448,186	232,693	1.93	95,912	0.41

Gear	2006 Value ($)	Pounds	Price/lb. $	Value in 1972 ($)	Price/lb. in 1972 ($)
Crab Pot	167	73	2.29	35	0.47
Fyke Net	5,962	2,331	2.56	1,252	0.53
Gill net (runaround)	1,450	768	1.89	301	0.39
Gill net (anchored)	397,780	163,543	2.43	82,460	0.50
Pound Net	41,061	17,522	2.34	8,512	0.49
Other & Conf.	5,176	2,162	2.39	1,073	0.50
Total or Average	451,596	186,399	2.42	93,633	0.50

Table 9.3 (continued).

Gear	2007 Value ($)	Pounds	Price/lb. $	Value in 1972 ($)	Price/lb. in 1972 ($)
Crab Pot	183	92	1.99	37	0.40
Fyke Net	4,334	2,111	2.05	874	0.41
Gill net (runaround)	862	411	2.10	174	0.42
Gill net (anchored)	332,227	150,644	2.21	66,977	0.44
Haul Seine	2,609	1,214	2.15	526	0.43
Pound Net	34,414	17,156	2.01	6,938	0.40
Other & Conf.	132	55	2.39	27	0.48
Total or Average	374,761	171,682	2.18	75,552	0.44

Gear	2008 Value ($)	Pounds	Price/lb. $	Value in 1972 ($)	Price/lb. in 1972 ($)
Crab Pot	44	21	2.12	9	0.41
Fyke Net	3,471	1,639	2.12	674	0.41
Gill net (runaround)	792	410	1.93	154	0.37
Gill net (anchored)	137,101	60,125	2.28	26,611	0.44
Pound Net	25,467	12,328	2.07	4,943	0.40
Other & Conf.	885	403	2.20	172	0.43
Total or Average	167,760	74,926	2.24	32,562	0.43

Gear	2009 Value ($)	Pounds	Price/lb. $	Value in 1972 ($)	Price/lb. in 1972 ($)
Crab Pot	88	39	2.25	17	0.44
Fyke Net	3,128	1,396	2.24	609	0.44
Gill net (runaround)	251	123	2.04	49	0.40
Gill net (anchored)	190,786	77,475	2.46	37,184	0.48
Pound Net	37,385	16,664	2.24	7,286	0.44
Other & Conf.	1,061	437	2.43	207	0.47
Total or Average	232,699	96,134	2.42	45,330	0.47

Table 9.4 Striped bass landings and value by gears for CSMA, 1977 – 2009 (NCDMF Trip Ticket Program).

1997						1998					
Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)	Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Crab pot	303	245	1.24	79	0.32	Crab pot	405	343	1.18	104	0.30
Crab Trawl	58	47	1.24	15	0.32	Crab Trawl	72	61	1.18	18	0.30
Gill net (drift)	127	103	1.23	33	0.32	Gill net (drift)	94	80	1.18	24	0.30
Gill net (runaround)	1,362	1,099	1.24	355	0.32	Gill net (runaround)	153	130	1.18	39	0.30
Gill net (anchored)	31,679	26,065	1.22	8,249	0.32	Gill net (anchored)	29,410	24,777	1.19	7,541	0.30
Haul seine	380	307	1.24	99	0.32	Pound net	690	584	1.18	177	0.30
Pound net	803	648	1.24	209	0.32	Total or Average*	30,823	25,973	1.19	7,904	0.30
Other & Conf.	9	7	1.24	2	0.32						
Total or Average*	34,721	28,521	1.22	9,042	0.32						

1999						2000					
Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)	Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Crab pot	832	677	1.23	209	0.31	Crab pot	974	854	1.14	236	0.28
Gill net (runaround)	267	217	1.23	67	0.31	Gill net (runaround)	176	148	1.20	43	0.29
Gill net (anchored)	40,257	32,710	1.23	10,101	0.31	Gill net (anchored)	34,439	29,953	1.15	8,358	0.28
Other & Conf.	438	356	1.23	110	0.31	Other & Conf.	144	126	1.14	35	0.28
Total or Average*	41,794	33,960	1.23	10,486	0.31	Total or Average*	35,733	31,081	1.15	8,673	0.28

Table 9.4 (continued).

2001					
Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Crab Pot	484	389	1.25	115	0.29
Gill net (runaround)	309	269	1.15	73	0.27
Gill net (anchored)	29,320	23,774	1.23	6,919	0.29
Pound net	485	420	1.15	114	0.27
Other & Conf.	89	65	1.38	22	0.32
Total or Average*	30,687	24,917	1.23	7,243	0.29

2002					
Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Gill net (runaround)	5,893	4,904	1.20	1,370	0.28
Gill net (anchored)	34,066	28,393	1.20	7,917	0.28
Pound net	755	629	1.20	176	0.28
Other & Conf.	4,395	3,660	1.20	1,021	0.28
Total or Average*	45,109	37,586	1.20	10,484	0.28

2003					
Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Gill net (runaround)	169	138	1.23	38	0.28
Gill net (anchored)	49,676	39,778	1.25	11,286	0.28
Other & Conf.	1,802	1,468	1.23	409	0.28
Total or Average	51,647	41,384	1.25	11,734	0.28

2004					
Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Crab Pot	235	190	1.23	52	0.27
Gill net (runaround)	254	194	1.31	56	0.29
Gill net (anchored)	41,183	31,992	1.29	9,114	0.28
Other & Conf.	137	104	1.32	30	0.29
Total or Average	41,808	32,480	1.29	9,252	0.28

2005					
Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Gill net (runaround)	54	29	1.87	12	0.40
Gill net (anchored)	51,114	26,929	1.90	10,938	0.41
Other & Conf.	327	174	1.88	70	0.40
Total or Average	51,495	27,132	1.90	11,020	0.41

2006					
Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Crab Pot	323	139	2.34	67	0.48
Gill net (runaround)	236	107	2.21	49	0.46
Gill net (anchored)	49,394	20,724	2.38	10,239	0.49
Other & Conf.	420	180	2.33	88	0.49
Total or Average	50,374	21,149	2.38	10,444	0.49

Table 9.4 (continued).

	2007				
Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Crab Pot	32	16	2.00	6	0.40
Gill net (runaround)	505	252.5	2.00	102	0.40
Gill net (anchored)	50,023	24,561	2.04	10,085	0.41
Other & Conf.	372	178	2.09	75	0.42
Total or Average	50,933	25,008	2.04	10,268	0.41

	2008				
Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Gill net (runaround)	50	24.5	2.03	10	0.39
Gill net (anchored)	20,171	9,754	2.07	3,915	0.40
Other & Conf.	685	336	2.04	133	0.40
Total or Average	20,906	10,115	2.07	4,058	0.40

	2009				
Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Gill net (runaround)	298	130	2.30	58	0.45
Gill net (anchored)	55,425	24,331	2.28	10,802	0.44
Other & Conf.	107	46	2.33	21	0.45
Total or Average	55,830	24,507	2.28	10,881	0.44

Table 9.5 Striped bass landings and value by gears for the Atlantic Ocean, 1997 – 2009 (NCDMF Trip Ticket Program).

1997

Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Beach seine	224,619	185,890	1.21	58,491	0.31
Fish Trawl	224,150	183,169	1.22	58,369	0.32
Gill net (anchored)	114,658	93,201	1.23	29,857	0.32
Other & Conf.	1,096	884	1.24	285	0.32
Total or Average*	564,523	463,144	$1.22	147,002	$0.32

1998

Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Beach seine	93,980	75,004	1.25	24,096	0.32
Fish Trawl	109,935	92,244	1.19	28,187	0.31
Gill net (anchored)	126,840	105,649	1.20	32,522	0.31
Other & Conf.	86	72	1.19	22	0.31
Total or Average*	330,841	272,969	1.21	84,827	0.31

1999

Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Beach seine	76,394	61,774	1.24	19,167	0.31
Gill net (anchored)	405,566	329,685	1.23	101,757	0.31
Other & Conf.	28	23	1.23	7	0.31
Total or Average*	481,988	391,482	1.23	120,931	0.31

2000

Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Beach seine	67,218	58,147	1.16	16,314	0.28
Fish Trawl	118,379	102,167	1.16	28,730	0.28
Gill net (anchored)	2,366	2,072	1.14	574	0.28
Other & Conf.	11	10	1.14	3	0.28
Total or Average*	187,974	162,396	1.16	45,622	0.28

2001

Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Beach Seine	120,037	93,580	1.28	28,415	0.30
Fish Trawl	201,591	167,199	1.21	47,575	0.28
Gill net (anchored)	146,266	119,353	1.23	34,519	0.29
Other & Conf.	1,516	1,314	1.15	358	0.27
Total or Average*	468,293	381,446	1.23	110,517	0.29

2002

Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Beach Seine	295,006	237,983	1.24	68,559	0.29
Fish Trawl	103,302	84,795	1.22	24,007	0.28
Gill net (anchored)	132,486	109,308	1.21	30,790	0.28
Other & Conf.	10,754	8,932	1.20	2,499	0.28
Total or Average*	541,547	441,018	1.23	125,855	0.29

Table 9.5 (continued).

2003					
Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Fish Trawl	138,148	108,141	1.28	31,387	0.29
Gill net (anchored)	116,443	92,917	1.25	26,456	0.28
Other & Conf.	173	142	1.22	39	0.28
Total or Average	254,764	201,199	1.27	57,882	0.29

2004					
Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Beach Seine	234,154	180,640	1.30	51,818	0.29
Fish Trawl	287,577	220,166	1.31	63,641	0.29
Gill net (anchored)	260,474	201,534	1.29	57,643	0.29
Other & Conf.	3,984	3,018	1.32	882	0.29
Total or Average	786,189	605,358	1.30	173,984	0.29

2005					
Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Beach Seine	650,713	331,341	1.96	139,253	0.42
Fish Trawl	70,658	37,598	1.88	15,121	0.40
Gill net (anchored)	441,259	230,360	1.92	94,429	0.41
Other & Conf.	10,758	5,166	2.08	2,302	0.45
Total or Average	1,173,387	604,464	1.94	251,105	0.42

2006					
Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Fish Trawl	43,384	17,797	2.44	8,994	0.51
Gill net (anchored)	126,755	52,627	2.41	26,276	0.50
Other & Conf.	8,794	3,765	2.34	1,823	0.48
Total or Average	178,933	74,189	2.41	37,093	0.50

2007					
Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Beach Seine	21,400	10,471	2.04	4,314	0.41
Fish Trawl	203,558	98,344	2.07	41,037	0.42
Gill net (anchored)	585,327	269,389	2.17	118,002	0.44
Other & Conf.	2,978	1,491	2.00	600	0.40
Total or Average	813,262	379,694	2.14	163,954	0.43

2008					
Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Beach Seine	171,613	75,711	2.27	33,310	0.44
Fish Trawl	153,276	74,118	2.07	29,751	0.40
Gill net (anchored)	308,269	138,216	2.23	59,835	0.43
Other & Conf.	742	365	2.03	144	0.39
Total or Average	633,900	288,410	2.20	123,040	0.43

Table 9.5 (continued).

	2009				
Gear	Value ($)	Pounds	Price/lb. ($)	Value in 1972 ($)	Price/lb. in 1972 ($)
Beach Seine	12,484	4,856	2.57	2,432	0.50
Fish Trawl	320,820	133,430	2.40	62,528	0.47
Gill net (anchored)	125,474	51,677	2.43	24,455	0.47
Total or Average	458,779	189,963	2.42	89,370	0.47

9.2.3 Marketing, Distribution, and Processing

Striped bass purchased by licensed dealers generally is sold fresh. By the time it gets to the consumer the vast majority of the fish have been processed into fillets. A few fish are sold whole, but as many of the individual fish are quite large, processing the fish into fillets is a matter of practicality as much as preference. A large percentage of the striped bass landed in North Carolina are destined for markets in the Northeast or Midwest US. In the past striped bass were frequently sold to consumers labeled as other kinds of fish. In recent years there has been a change towards selling striped bass under its own name, or simply as “rock fish”.

9.2.4 Economic Impact of Commercial Fishing

The NCDMF collects commercial fishing landings and effort data through its trip ticket program. Among many other functions, this data is used to estimate the economic impact of the commercial fishing industry on a statewide as well as species specific basis. The trip ticket program provides data that allows several methods to be employed when estimating the economic impacts of commercial fishing.

The best information available to estimate recreational economic impacts is the number of trips taken and average trip expenditures. While this data is available for commercial fishing as well, it is somewhat rudimentary to use when examining economic impacts on a species specific level. When utilizing this methodology, all trip expenditures are assigned to one species, even when several species may be landed in a single trip. This often leads to overly inflated economic impacts. Due to the more detailed data available for commercial fishing, it is possible to have a more sophisticated approach to estimate the economic impact of a single species by using the ex-vessel value of the catch. Data of this specificity is not available for recreational fishing, therefore it is important to also calculate commercial economic impacts in a similar manner to recreational economic impacts. This is accomplished by using the number of trips landing a given species to provide a more equitable comparison. For this reason commercial economic impacts are included based on all commercial trips landing striped bass (Table 9.6) as well as the ex-vessel value of all striped bass landed commercially (Table 9.7).

The economic impact to the North Carolina economy of commercial trips landing striped bass in 2009 is shown in Table 9.6. These impacts are based on the estimated expenditures and income from all commercial trips where striped bass was landed. The calculations were made using IMPLAN, an economic modeling software. IMPLAN estimates economic impacts by modeling how money is spent and re-spent in an economy. For example, the purchase of insurance for a fisherman’s boat helps employ an insurance agency, which then must purchase business supplies from another store and pays 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. Using recent expenditure data gathered from commercial fishermen in the inshore fisheries, total expenditures for striped bass-landing commercial trips for 2009 are as follows:

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

where t = number of striped bass-landing trips, Ẽ=median per-trip expenditures, n = number of striped bass-landing fishermen, tall = total trips taken by striped bass-landing fishermen throughout the year, Ỹ=median yearly fixed expenditures, and Ĩ=median proprietary income.

Analysis using the IMPLAN model for North Carolina estimated the total economic impact of commercial striped bass landing trips to be $3.97 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 fishermen's businesses. The sum of these two factors is equal to the trip ticket value for those trips:

Table 9.6 Economic impact of commercial trips landing striped bass in North Carolina, 2009. IMPLAN 2.0.

Category	Dollar amount or N
Economic inputs (costs)	$2,284,578
Proprietary income (profits)	$189,089
Additional economic activity generated	$1,493,027
Additional jobs supported	49
Total economic Impact	**$3,966,694**

The economic impact of commercial striped bass landings to the North Carolina economy in 2009 is shown in Table 9.7. These impacts are based on the ex-vessel value ($747,308) for all reported commercial landings of striped bass in 2009. The calculations were also made using IMPLAN economic modeling software. To obtain these calculations, the commercial fishing model native to IMPLAN was modified to more accurately reflect the expenditures and participation of the North Carolina commercial fishery. Using 2009 data, the economic impacts of commercial striped bass landings in North Carolina were $1.3 million. With this method, it is assumed that the ex-vessel value (economic inputs) is equal to the expenditures (costs) as well as the proprietary income (profits) resulting from a given species. If this were not the case, the fishermen would not be making a profit and like any business would cease to operation.

Table 9.7 Economic impact of commercial striped bass landings in North Carolina, 2009. IMPLAN Pro 3.0.

Category	Dollar Amount or N
Economic inputs (costs+profits)	$747,308
Additional economic activity generated	$557,449
Additional jobs supported	59
Total economic impact	**$1,304,757**

The 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. It is very important to note that both models for estimating the commercial economic impacts do not include the post-landings economic effects of striped bass, only the business inputs from the commercial fishermen. The economic effects of striped bass landings on dealers, seafood markets, restaurants, and shipping interests requires data that is not currently available. The economic impacts from these additional sectors is substantial. The NCDMF is currently working to estimate expenditures of licensed seafood dealers in North Carolina to add to the IMPLAN model, further improving the estimates for the economic impact of the striped bass commercial sector.

9.3 RECREATIONAL FISHING

Annually, there are four survey programs in North Carolina that collect data from recreational striped bass anglers. Figure 9.10 shows the areas covered by these surveys. The Marine Recreational Information Program (MRIP) collects data from the ocean and portions of inside waters in the ASMA and CSMA. Data are also collected up into the major river systems, but not far enough to cover the entire range where striped bass are caught. The NCDMF conducts the ASMA striped bass creel survey to estimate angler effort, catch, and harvest during the spring and fall harvest seasons. In the CSMA the survey is conducted year-round. The MRIP survey overlaps coverage in parts of the ASMA and CSMA with regard to internal waters. The NCWRC conducts the RRMA striped bass creel survey to estimate angler effort, catch, and harvest during the spring harvest season. In some years estimates of angler effort and catch and release of striped bass after the harvest season closes are also made (depending upon available funding). Unlike the MRIP survey which is designed to make estimates on all fishing trips and species landed, the ASMA and RRMA striped bass creel surveys are designed specifically to generate the various estimates associated with striped bass trips only.

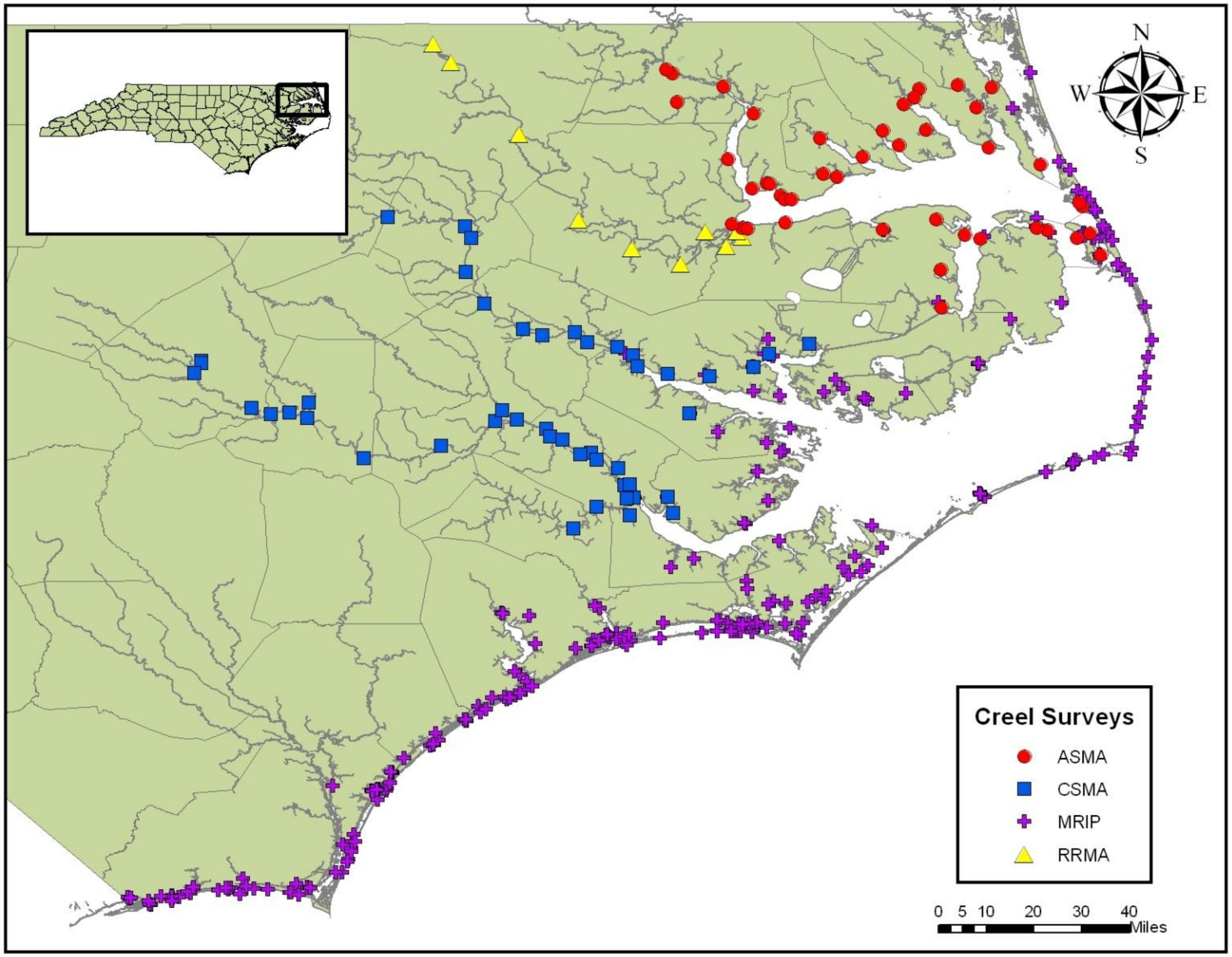


Figure 9.10 Map of annual recreational fishing surveys conducted in North Carolina.

9.3.1 Historical Trends in Landings

ASMA Creel Survey. Since 1991 the NCDMF has conducted a recreational creel survey in the ASMA. The survey samples fishermen throughout the ASMA each season and then estimates angler hours, the number of fish harvested, pounds harvested, and the number of fish released. In the fall of 2005 the Northern District of the NCDMF changed the design of its striped bass creel survey to more accurately reflect fishing pressure estimates and harvest estimates. This new design was the same design as used by NCDMF personnel for striped bass creel surveys in the CSMA, and NCWRC personnel for striped bass creel surveys in the RRMA, allowing for a more statistically valid comparison of effort and harvest data between the various management areas.

Catch and effort data were collected through on-site interviews at boat ramps during allowed harvest days for each of four ASMA sampling zones. Statistics were calculated through a non-uniform probability access-point creel survey (Pollock et al. 1994). Site probabilities were set in proportion to the likely use of a site according to time of day, day of week, and season. Probabilities for this survey were assigned based on seasonal striped bass fishing pressure observed during past surveys, in addition to anecdotal information (personal communication NCDMF Sara Winslow and Kathy Rawls). Probabilities can be adjusted during the survey period according to angler counts to provide more accurate estimates. Morning and afternoon periods were assigned unequal probabilities of conducting interviews, with each period representing half a fishing day. A fishing day was defined as 1.5 hours after sunrise until 1.0 hour after sunset. These values varied among sites within zones due to differing fishing pressure.

In the early years of the survey length of harvest days varied considerably. During the late 1980s and early 1990s overall striped bass abundance was very low. Due to very successful spawning in 1988 and 1989, stock abundance began to increase. Record high juvenile production in the early 1990s meant that by 1994 the A/R striped bass stock had increased significantly in abundance, and recreational interest in striped bass fishing was increasing as well. Even with strict regulations allowing harvest on only three days during the week, between 1994 and 1998 the seasons were open an average of only 14 days before the TAC was reached (Table 9.6).

In recent years angler hours have decreased slightly. During the period 2000 – 2004 angler hours averaged 49,739 per year. From 2005 – 2009 yearly angler hours averaged 35,907 (Table 9.7).

Table 9.8 NCDMF ASMA striped bass creel survey, 1991 – 2009 (NCDMF).

Season		Length in days	Angler hours	Number of fish harvested	Average number of fish harvested per day	Average weight of each fish harvested	Total pounds harvested	Average number of pounds harvested per day	Number of fish released	Average number of fish released per day	Number of fish measured by creel clerks
1991	Spring	113		9,978	88	2.5	24,561	217	11,701	104	
	Fall	30		4,417	147	2.4	10,783	359	11,839	395	
1992	Spring	120		8,034	67	2.9	23,582	197	13,167	110	
	Fall	30		2,508	84	2.9	7,176	239	6,814	227	
1993	Spring	77		11,404	148	3.2	36,049	468	13,241	172	
	Fall	No fall season		--	--	--	--	--	--	--	--
1994	Spring	12		4,005	334	3.5	14,087	1,174	no data	no data	495
	Fall	7		4,586	655	3.5	16,130	2,304	no data	no data	684
1995	Spring	9		4,240	471	4.1	17,355	1,928	no data	no data	452
	Fall	15		3,103	207	4.3	13,209	881	no data	no data	502
1996	Spring	8		4,374	547	3.4	14,851	1,856	no data	no data	469
	Fall	14	6,349	3,059	219	4.7	14,335	1,024	no data	no data	487
1997	Spring	5	4,332	4,941	988	3.5	17,315	3,463	6,111	1,222	620
	Fall	21	9,324	1,960	93	4.8	9,409	448	24,660	1,174	468
1998	Spring	18	38,760	9,310	517	3.3	30,709	1,706	25,060	1,392	1,276
	Fall	28	52,060	10,256	366	3.3	34,052	1,216	66,828	2,387	1,963
1999	Spring	37	36,477	10,137	274	3.6	36,970	999	32,742	885	1,722
	Fall	24	27,965	6,830	285	3.6	24,477	1,020	7,579	316	695
2000	Spring	67	53,957	13,993	209	3.7	51,428	768	23,205	346	1,410
	Fall	32	46,468	24,092	753	2.7	64,986	2,031	55,736	1,742	1,746
2001	Spring	53	49,307	17,582	332	2.7	47,448	895	16,737	316	1,783
	Fall	24	60,380	22,545	939	3.2	71,197	2,967	44,681	1,862	2,581
2002	Spring	52	57,549	17,989	346	3.3	59,297	1,140	20,502	394	2,274
	Fall	32	39,931	9,907	310	3.4	33,352	1,042	31,053	970	899
2003	Spring	61	44,588	8,937	147	3.4	30,141	494	14,283	234	724
	Fall	64	42,704	6,187	1,086	0.3	21,653	338	10,998	172	682
2004	Spring	62	53,794	13,728	221	3.5	48,577	784	22,346	360	1,028
	Fall	58	48,711	14,276	246	3.4	48,520	837	18,695	322	1,826
2005	Spring	79	25,397	6,133	78	3.4	21,117	267	4,396	56	826
	Fall *	92	61,546	11,821	128	3.6	42,360	460	16,824	183	809
2006	Spring	120	27,380	3,967	33	3.6	14,354	120	2,482	21	180
	Fall	92	38,377	6,744	73	3.2	21,631	235	6,973	76	558
2007	Spring	126	29,715	4,569	36	3.6	16,410	130	5,537	44	204
	Fall	92	31,964	2,574	28	4.0	10,223	111	8,062	88	226
2008	Spring	121	30,538	3,227	27	3.8	12,140	100	19,375	160	254
	Fall	92	42,135	6,821	74	2.9	19,488	212	17,084	186	379
2009	Spring	120	39,631	8,164	68	2.8	22,904	191	30,896	257	296
	Fall	92	32,390	3,905	42	3.7	14,409	157	9,647	105	253

CSMA Creel Survey. The 2004 North Carolina Estuarine Striped Bass Fishery Management Plan addressed having no creel survey to represent the CSMA as an issue for evaluating striped bass stocks of North Carolina. A comprehensive creel survey was initiated in January 2004 to identify the recreational component of striped bass harvests in the CSMA.

The CSMA survey area includes the Neuse, Tar/Pamlico, and Pungo rivers. A non-uniform probability stratified access-point survey (Pollock et al. 1994) was utilized for site selections as well as effort and catch estimation. Returning fishing parties were interviewed to obtain information regarding the trip, catch (harvest and discard), and socioeconomic attributes of striped bass anglers.

Recreational catch and effort of striped bass within the CSMA were highest in the first year of the survey with 22,959 lbs landed from 12,780 striped bass fishing trips. Catch and effort declined throughout the reported time period with a low of 3,062 lbs harvested during 3,013 trips in 2009 (Table 9.8). Management strategies to reduce recreational harvest and effort became effective in 2008 and appear to have had the desired result.

Table 9.9 CSMA recreational striped bass catch and effort estimates, 2004 through 2009.

Year	Striped Bass Trips	Striped Bass Hours Fished	Number Landed	Pounds Landed	Number Released
2004	12,780	63,791	6,142	22,959	13,555
2005	9,608	44,313	3,909	15,299	16,763
2006	6,055	30,889	2,483	7,355	14,898
2007	6,321	37,088	3,599	10,796	23,528
2008*	3,931	21,296	842	2,991	17,873
2009*	3,013	20,696	896	3,062	6,246

*
Restriction went in place 1 July 2008 (closing CSMA seasonally and total closure on Cape Fear). Striped bass season is October 1 through April 30th.

MRIP. In response to the reauthorization of the Magnuson Stevens Fisheries Conservation and Management Act (MSA), the National Marine Fisheries Service (NMFS) initiated steps to improve data collection from recreational fishing through the development of the Marine Recreational Information Program (MRIP).

MRIP has replaced the Marine Recreational Fisheries Statistics Survey (MRFSS) as the primary source of catch and effort data from the recreational fishery. MRIP consists of several surveys to provide coverage of saltwater sport fishing (including estuarine and brackish water) from private/rental boats, charter and headboats, manmade structures, and the shore throughout North Carolina.

Within MRIP, there are several complimentary surveys used to produce estimates of catch and effort for the striped bass recreational fishery. These surveys include the Access-Point Angler Intercept Survey (APAIS), Coastal Household Telephone Survey (CHTS), and the For-Hire Survey (FHS). The CHTS utilizes a random digit dialing telephone survey approach to collect marine recreational fishing effort information from residential households located in coastal counties to determine fishing effort (trips) from the man-made, beach/bank, and private boat modes. Estimates of charterboat, guideboat, and headboat fishing effort are produced through the FHS.   Individual catch and discard data for calculation of catch rate at the species level are collected through APAIS, an onsite intercept survey conducted at fishing access-sites. Creel clerks collect intercept data year-round (in two-month waves) by interviewing anglers completing fishing trips in one of four fishing modes (man-made structures, beaches, private boats, and for-hire vessels). Results from the complimentary 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 MRIP 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 (less that 20%) indicate precise estimates while high PSEs (greater than 20%) are less reliable.

In North Carolina, access sites surveyed through the APAIS are recognized as any site where the likelihood of encountering marine species may exist. These sites do not extend much farther inland than the boundaries established for the coastal zone. Therefore, portions of the state coastal area sampled through MRIP overlap with the more specialized ASMA and CSMA striped bass surveys.

Only sites located in the eastern portion of the ASMA are covered through MRIP sampling. These sites are located at Mann's Harbor, Manteo, Wanchese, Oregon Inlet, Kill Devil Hills, Kitty Hawk, and Southern Shores. Anglers intercepted at these sites fish primarily in Croatan, Roanoke, and Pamlico Sounds. Occasionally, anglers fishing in the most eastern section of Albemarle Sound near Mashoes Light are also intercepted. Additionally, MRIP does not collect landings for striped bass in the Tar, upper Pamlico, upper Neuse, Trent, or Cape Fear rivers where there are known landings.

Table 9.9 shows landings estimates from MRIP for the Atlantic Ocean by mode of fishing, and year.

Table 9.10 Landings of striped bass from the Atlantic Ocean, by mode, 1988 through 2009. (NC MRIP).

Year	Mode of fishing	Number landed	Pounds landed	Average fish weight (lbs)	Year	Mode of fishing	Number landed	Pounds landed	Average fish weight (lbs)
1988	Private/Rental	367	972	2.6	2001	Manmade	4,404	10,276	2.3
	Total	367	972	2.6		Beach/Bank	7,317	130,437	17.8
1991	Beach/Bank	391	3,882	9.9		Charter	2,671	47,077	17.6
	Total	391	3,882	9.9		Private/Rental	25,623	420,827	16.4
1992	Beach/Bank	967	16,197	16.7		Total	40,015	608,617	15.2
	Total	967	16,197	16.7	2002	Manmade	1,493	24,447	16.4
1993	Beach/Bank	264	3,029	11.5		Beach/Bank	3,820	62,697	16.4
	Total	264	3,029	11.5		Charter	2,900	54,363	18.7
1994	Beach/Bank	3,758	53,739	14.3		Private/Rental	25,397	461,079	18.2
	Private/Rental	3,667	17,456	4.8		Total	33,610	602,586	18.0
	Total	7,425	71,195	9.6	2003	Beach/Bank	5,823	105,404	18.1
1995	Manmade	507	6,665	13.1		Charter	4,649	77,661	16.8
	Beach/Bank	3,590	49,024	13.7		Private/Rental	38,042	665,353	17.4
	Charter	654	9,183	14.0		Total	48,514	848,418	17.4
	Private/Rental	6,699	93,226	13.9	2004	Manmade	3,343	64,328	19.2
	Total	11,450	158,098	13.8		Beach/Bank	4,096	75,093	18.3
1996	Manmade	1,908	17,630	9.2		Charter	21,727	449,663	20.7
	Beach/Bank	6,970	84,258	12.1		Private/Rental	249,103	4,985,703	20.1
	Charter	3,061	39,936	13.0		Total	278,269	5,574,787	20.1
	Private/Rental	5,196	57,853	11.1	2005	Beach/Bank	239	5,276	22.0
	Total	17,135	199,677	11.6		Charter	8,474	170,083	20.1
1997	Manmade	3,034	41,149	13.6		Private/Rental	96,284	2,019,685	20.9
	Beach/Bank	11,451	133,261	11.6		Total	104,997	2,195,044	20.9
	Charter	5,385	84,412	15.7	2006	Beach/Bank	2,792	57,670	20.7
	Private/Rental	27,282	349,156	12.8		Charter	2,524	48,296	19.2
	Total	47,152	607,978	12.9		Private/Rental	85,438	2,047,262	24.0
1998	Manmade	1,105	16,076	14.5		Total	90,754	2,153,228	23.8
	Beach/Bank	7,113	108,440	15.2	2007	Beach/Bank	2,325	60,549	26.0
	Charter	5,364	90,678	16.9		Charter	4,718	96,440	20.5
	Private/Rental	17,098	200,392	11.7		Private/Rental	38,460	891,591	23.1
	Total	30,680	415,586	13.5		Total	45,503	1,048,580	23.0
1999	Manmade	302	3,272	10.8	2008	Manmade	3,180	64,579	20.3
	Beach/Bank	4,623	54,996	11.9		Charter	3,914	87,626	22.5
	Charter	5,201	60,968	11.7		Private/Rental	37,795	786,498	20.7
	Private/Rental	36,672	437,686	11.9		Total	44,889	938,703	20.8
	Total	46,798	556,922	11.9	2009	Charter	3,623	104,401	28.9
2000	Manmade	1,004	6,863	6.8		Private/Rental	3,752	105,455	28.2
	Beach/Bank	1,865	23,886	13.4		Total	7,375	209,856	28.5
	Charter	4,675	94,879	20.3		**Grand Total**	**869,462**	**16,400,627**	**18.9**
	Private/Rental	5,363	60,649	13.7					
	Total	12,907	186,277	15.5					

MRIP collection of striped bass landings began in 1988 when overall landings were low. Landings in these early years varied greatly from estimates of 264 fish in 1993 to 48,513 in 2003. The availability of striped bass in the Atlantic Ocean off of North Carolina increased substantially in the early 2000's. Prior to 2004, MRIP did not survey during wave 1 (January/February), however the increased abundance of striped bass prompted NCDMF to initiate wave 1 sampling in 2004. As a result, landing dramatically increased from 848,416 lbs in 2003 to a record high of 5,574,787 lbs in 2004. Landings remained relatively high until 2007 before falling below a million pounds. Environmental conditions influencing the southern migration of striped bass during winter likely resulted in both reduced effort and catch.

Table 9.11 shows landings estimated by MRIP for Atlantic Ocean waters. Fish harvested from the ocean averaged 18.9 lbs

Table 9.11 Striped bass landings from the Atlantic Ocean, 1988 through 2009. (MRIP)

Year	Number landed	Pounds landed	Year	Number landed	Pounds landed
1988	367	972	2000	12,908	187,276
1989			2001	40,016	608,617
1990			2002	33,610	602,586
1991	391	3,882	2003	48,513	848,416
1992	967	16,197	2004	278,270	5,574,787
1993	264	3,029	2005	104,997	2,195,043
1994	7,426	71,195	2006	90,753	2,153,231
1995	11,450	158,096	2007	45,502	1,048,581
1996	17,136	199,675	2008	44,890	938,703
1997	47,152	607,978	2009	7,375	209,856
1998	30,680	415,585	**Total**	**869,462**	**16,400,627**
1999	46,798	556,922			

RRMA Creel Survey. The NCWRC estimates striped bass harvest from the RRMA using an intensive creel survey when the spring harvest season is open (2009 harvest season: March 1 through April 30 for the entire river). The NCWRC allocates the entire allowable harvest (137,500 lbs. in 2009) for the RRMA during the spring season whereas NCDMF allots half their allowable harvest (137,500 lbs. in 2009) in the ASMA during the spring and half during the fall. Besides harvest estimates, the NCWRC estimates the total number of striped bass caught and released during the harvest season (Table 9.11). In some years, the NCWRC also monitored catch & release of striped bass after the harvest season closed, termed the post-harvest period.

Table 9.12 Recreational fishing trips landing striped bass from the RRMA. The number of striped bass harvested excludes numbers of striped bass caught and released during the harvest season. (NCWRC).

	Open Season (Harvest estimates)				Post-Harvest Period (Catch and Release Only)			
Year	Number of striped bass	Weight (lbs)	Effort (angler-hours)	Number of trips**	Number of striped bass	Weight (lbs)	Effort (angler-hours)	Number of trips**
1989	153,185	32,107	46,566	9,803	*	*	*	*
1990	106,073	42,204	56,169	11,825	*	*	*	*
1991	26,934	72,529	74,596	15,704	*	*	*	*
1992	13,372	36,016	49,277	10,374	*	*	*	*
1993	14,325	45,145	52,932	11,144	*	*	*	*
1994	8,284	28,089	44,693	9,409	*	*	*	*
1995	7,471	28,883	56,456	11,885	52,698	*	20,639	4,345
1996	8,367	28,178	46,164	9,719	148,222	*	32,743	6,893
1997	9,364	29,997	23,139	4,871	271,328	*	47,001	9,895
1998	23,109	73,541	72,410	15,244	102,299	*	26,367	5,551
1999	22,479	72,967	72,717	15,309	113,394	*	30,633	6,449
2000	38,206	120,091	95,622	20,131	*	*	*	*
2001	35,231	112,805	100,119	21,078	*	*	*	*
2002	36,422	112,698	122,584	25,807	*	*	*	*
2003	11,157	39,170	77,863	16,392	*	*	*	*
2004	26,506	90,191	145,782	30,691	*	*	*	*
2005	34,122	107,530	130,755	27,527	68,147	*	24,146	5,083
2006	25,355	84,521	120,621	25,394	24,719	*	15,235	3,207
2007‡	19,305	62,492	141,874	29,868	11,622	*	9,254	1,948
2008‡	10,541	32,725	110,608	23,286	47,992	*	17,764	3,740
2009	23,248	69,581	120,675	25,405	*	*	*	*

9.3.2 Recreational Fishing Activity

The NCDMF creel survey estimates anglers targeted striped bass for approximately 72,021 hours during the spring and fall seasons of 2009. This is down from the high in the series in which anglers targeted striped bass for 108,687 hours in the spring and fall of 2001 (Table 9.7). The majority of fishermen interviewed lived in the county where they were fishing. Nearly all the other fishermen were from surrounding counties. Counties closer to the Virginia border were more likely to have fishermen who traveled from there to fish.

The number of Atlantic Ocean directed striped bass trips fluctuated while exhibiting an increase as fish became more abundant. The number of directed trips (those targeting or catching striped bass) was greatest in 2004 with 398,151 trips but has since declined to 100,034 trips in 2009. Directed trips are calculated by applying the ratio of samples where anglers target striped bass or had striped bass in their catch to the overall estimate of angler trips (Table 9.12).

Table 9.13 Directed Atlantic Ocean striped bass recreational fishing trips, 1988 through 2009. (NC MRIP).

Year	Fishing Mode	Directed Trips	Year	Mode	Directed Trips
1988	Private/Rental boat	1,333	2001	Beach/bank	48,549
	Total	**1,333**		Charter boat	2,945
1989	Private/Rental boat	0		Man-made shore	9,051
	Total	**0**		Private/Rental boat	39,491
1991	Beach/bank	18,396		**Total**	**100,036**
	Man-made shore	230	2002	Beach/bank	45,934
	Private/Rental boat	256		Charter boat	2,241
	Total	**18,882**		Man-made shore	9,242
1992	Beach/bank	3,604		Private/Rental boat	74,335
	Private/Rental boat	1,541		**Total**	**131,752**
	Total	**5,145**	2003	Beach/bank	38,999
1993	Beach/bank	11,717		Charter boat	3,776
	Man-made shore	1,163		Man-made shore	6,028
	Private/Rental boat	341		Private/Rental boat	71,453
	Total	**13,221**		**Total**	**120,256**
1994	Beach/bank	52,509	2004	Beach/bank	53,158
	Man-made shore	2,501		Charter boat	13,587
	Private/Rental boat	6,144		Man-made shore	25,418
	Total	**61,154**		Private/Rental boat	305,988
				Total	**398,151**

Table 9.13 (continued).

Year	Fishing Mode	Directed Trips	Year	Mode	Directed Trips
1995	Beach/bank	41,679			
	Charter boat	1,049	2005	Beach/bank	52,071
	Man-made shore	3,818		Charter boat	5,466
	Private/Rental boat	15,923		Man-made shore	4,969
	Total	**62,469**		Private/Rental boat	145,665
1996	Beach/bank	89,915		**Total**	**208,171**
	Charter boat	3,260	2006	Beach/bank	103,037
	Man-made shore	29,802		Charter boat	4,172
	Private/Rental boat	21,292		Man-made shore	1,170
	Total	**144,269**		Private/Rental boat	119,588
1997	Beach/bank	122,897		**Total**	**227,967**
	Charter boat	6,200	2007	Beach/bank	71,621
	Man-made shore	22,087		Charter boat	4,063
	Private/Rental boat	42,065		Man-made shore	5,530
	Total	**193,249**		Private/Rental boat	96,192
1998	Beach/bank	96,229		**Total**	**177,406**
	Charter boat	5,679	2008	Beach/bank	72,867
	Man-made shore	24,364		Charter boat	2,527
	Private/Rental boat	44,942		Man-made shore	13,941
	Total	**171,214**		Private/Rental boat	136,119
1999	Beach/bank	41,714		**Total**	**225,454**
	Charter boat	9,084	2009	Beach/bank	29,054
	Man-made shore	6,148		Charter boat	2,858
	Private/Rental boat	66,492		Man-made shore	5,187
	Total	**123,438**		Private/Rental boat	62,935
2000	Beach/bank	90,883		**Total**	**100,034**
	Charter boat	2,451			
	Man-made shore	14,444		**Grand Total**	**2,616,116**
	Private/Rental boat	24,737			
	Total	**132,515**			

The NCWRC collects angler effort data on the number of hours anglers fish for striped bass in the RRMA. Angler effort is divided by an estimated average of 4.75 hours per fishing trip to determine the number of trips taken to harvest striped bass during the open season and in some years, post-harvest season (Table 9.11). "Number of striped bass," is the number of striped bass harvested during the harvest season each year and does not include the total number of striped bass caught and released during the harvest season. Harvest and trip estimates are available in 1989 and 1990, although striped bass were not managed with a TAC in the RRMA until 1991. From 1991 through 1996, the number of trips taken by anglers to reach the quota of striped bass (TAC = 29,400 lbs between 1991 and 1996) ranged between 9,400 and 15,700 trips. In 1997, striped bass anglers reached the quota of 29,400 lbs in 4,900 trips, the fewest estimated trips; likely related to a relatively short harvest season (15 days). In 1998 and 1999, the TAC in the RRMA was increased to 62,700 and 68,970, respectively; the quota was exceeded in an estimated 15,000 fishing trips each year. From 2000 to 2003, the quota was increased to 112,500 lbs and exceeded in each year, except for 2003 when higher flows and cooler water temperatures likely contributed to a decline in angling effort and subsequent harvest. Following a TAC increase to 137,500 lbs of striped bass in 2004 and continuing through 2009, the number of striped bass fishing trips ranged from 23,286 to 30,691 trips with annual harvest estimates well below the quota during those years, especially in 2008. Although harvest estimates were relatively low in 2008, nearly 23,286 angler trips were expended for an estimated catch of 141,646 striped bass, comprised mostly of sub-legal male striped bass from the strong 2006 cohort (age-2) (Thomas et al. 2009).

9.3.3 Economic Value of the Recreational Fishery

NCWRC. During the 2006 striped bass creel survey on the RRMA, NCWRC staff estimated expenditures by striped bass angler trips. Following questions related to angler effort and striped bass catch and harvest, creel clerks inquired the associated expenditures (bait, lodging, fuel, food, guide fees and other expenses) to participating angling parties. An estimate of the economic value of the 2006 Roanoke River recreational striped bass fishery was determined as the product of the total estimated angler-hours and the overall mean expense per angler-hour (Malvestuto 1983). Standard error for the economic value was approximated using the Taylor Expansion Series (Sheps and Menken 1973). Mean total expenditures for striped bass anglers during the 2006 season in the RRMA was $1,546,332 (SE = $80,659; McCargo et al. 2007). Mean expenditures per trip were calculated for striped bass anglers during the allowed harvest periods (1 March to 22 April below Hwy 258 in Zone 2, 15 March to 30 April in Zone 1) and post-harvest period (May 1 to May 31 in Zone 1) on the Roanoke River (Table 9.13). Anglers fishing during the harvest season spent an estimated $87.60 per fishing trip whereas anglers fishing during the catch and release season spent $200.76 per fishing trip, more than twice as much per fishing trip.

Table 9.14 Mean expenditures (US$) by recreational striped bass angler trip by season (harvest or catch and release only) in the RRMA, 2006 (McCargo et al., 2007). Sample size is the number of angler parties interviewed for expenditure information of total number of striped bass parties interviewed during the creel survey.

	Catch and release ($) (N=96 of 120)	**Catch and Keep ($) (N=456 of 630)**
Lodging	40.63	7.65
Bait	25.95	9.25
Fuel	71.07	38.11
Food	37.18	16.23
Other‡	25.94	16.35
Total	**200.76**	**87.60**

‡ Includes guide fees

Table 9.15 Expenditures by recreational striped bass anglers in the RRMA, 1998 (Schuman, 1999).

	Catch and release ($) (N=146)	**Catch and keep ($) (N=213)**
Lodging	8.83	1.08
Bait	7.37	5.65
Fuel	5.03	4.08
Guide	38.77	3.02
Other	9.55	7.00
Total	**69.55**	**20.83**

Prior to the 2006 study, Schuhmann (1999) measured the economic value of the recreational fishery in the Roanoke River areas covered by the 1998 NCWRC creel survey. Economic value was determined using a willingness to pay analysis and a measurement of actual expenditures. Anglers were separated into two groups: catch and release vs. catch and keep. The economic value of the fishery was determined as “the benefits realized by the recreational anglers over and above the actual expenditures” (Schuhmann, 1999). Overall willingness to pay to catch a fish ranged from $796,500 to $814,000 (in 1998 dollars), with 95% of that amount coming from the striped bass catch and release fishery. Anglers who participated in catch and release incurred approximately $70 in expenses per trip while the average catch and keep angler incurred $22 in additional expenses. Average additional expenses are shown in Table 9.14. When the data are aggregated across all anglers, these expenditures amounted to approximately $918,000 in revenues that may have been realized by local businesses (Schuhmann 1999).

Comparing these two studies, expenditures between the season appear similar with anglers fishing during the catch and release season spending more money than those fishing during the harvest season. Although reasons for differences in expenditures are difficult to relate directly to each fishery, a mail survey of striped bass anglers on the Roanoke River in 2007 indicated that catching fish is more important than keeping fish (Linehan 2008). Adjusting the Schuhmann (1999) estimate for inflation may allow for a closer comparison for the two estimates. Calculated in 2006 dollars with an inflation calculator (U.S. Bureau of Labor Statistics 2010), the 1998 estimate is $1,135,391 and about $400,000 less than the estimate by McCargo et al. (2007). The economic growth potentially realized is likely related to the continued expansion of the A/R striped bass stock on the spawning grounds near Weldon each year.

NCDMF. The NCDMF collects data about saltwater recreational fishing in conjunction with MRIP. Combining the most recent trip estimates with the average estimated expenditures per inshore saltwater recreational trips in 2009, the total expenditures are as follows:

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

where t = number of striped bass-targeting and -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. The estimated combined impact of striped bass-related saltwater trips in North Carolina was $38,255,800 in 2009 across all modes (beach, charter, private boat, and piers) (Table 9.15).

Table 9.16 Economic impact of the striped bass related saltwater angling trips in North Carolina, 2009. IMPLAN 2.0.

Category	Dollar amount or N
Direct expenditures	$26,695,260
Additional economic activity generated	$14,560,540
Additional jobs generated	477
Total economic Impact	**$41,255,800**

Dumas (2009) studied the commercial charter fleet and estimated the impact of striped bass-related charter trips at $7,735,246.

9.4 DEMOGRAPHIC CHARACTERISTICS

9.4.1 Commercial Fishermen

The socioeconomic program at the NCDMF has been conducting a series of in-depth interview-style surveys with commercial fishermen along the coast since 2001. Data from these interviews is added to a growing database and used for fishery management plans, among other uses. A total of 58 of the fishermen in the database reported commercial landings of striped bass. This is about 6% of the total commercial fleet. That group is used to provide a snapshot of North Carolina fishermen who catch striped bass.

The demographic characteristics of the striped bass-reporting fishermen surveyed by the Socioeconomic Program over the past five years are shown in Table 9.7. Nearly all were white males, with an average age of 51 and over 28 years of commercial fishing experience. Three quarters of them had a high school diploma and 31% had at least some college education. Over half exceeded $30,000 in household income when surveyed, with 29% bringing in $50,000 or more. Only 10% had less than $15,000 in annual household income (Table 9.16).

Fishing accounted for almost two-thirds (65%) of the household income from these fishermen. They are least likely to fish from December through February, which is the slowest time of the year for most fishermen.

Table 9.17 Demographic characteristics of striped bass commercial fishermen.

	N = 58	Average or %
Years Fishing		28
Age		51
Gender		
	Male	97%
	Female	3%
Race		
	White	98%
	Black	2%
	other	1%
Education Level		
	Less than High School	28%
	High School Graduate	41%
	Some College	21%
	College Graduate	10%
Marital Status		
	Married	83%
	Divorced	10%
	Widowed	
	Never Married	
	Separated	7%
Total Household Income		
	Less than $15,000	10%
	$15,001 - $30,000	28%
	$30,001 - $50,000	22%
	$50,001 - $75,000	24%
	More than $75,000	5%

9.4.2 Recreational Fishermen

Beginning in 2007, North Carolina required coastal recreational anglers to purchase a Coastal Recreational Fishing License (CRFL). One of the stated reasons for the creation of the CRFL was to enable more complete surveying of recreational anglers than are allowed by the MRFSS. Accordingly, the NCDMF began gathering socioeconomic information on hook-and-line recreational fishermen in 2009. In a study of 610 CRFL holders, 265 (43%) reported that they fish for striped bass. Like commercial fishermen, CRFL holders are primarily white males with an average age close to 50, but the recreational anglers have generally higher education and household incomes (Table 9.17).

Table 9.18. Demographic characteristics of recreational striped bass anglers.

Variable	N = 265	Average or %
Years Fishing		28
Age		48
Gender		
	Male	93%
	Female	7%
Race		
	White	93%
	Black	3%
	Other	4%
Education Level		
	High School Grad or less	26%
	Some College	34%
	College Graduate	26%
	Graduate School	13%
Marital Status		
	Married	80%
	Divorced	6%
	Widowed	1%
	Never Married	9%
	Separated	2%
Total Household Income		
	Less than $15,000	1%
	$15,001 - $30,000	8%
	$30,001 - $50,000	17%
	$50,001 - $75,000	19%
	More than $75,000	35%
	Prefer not to answer	19%

10.0 ENVIRONMENTAL STATUS

10.1 HABITAT

Striped bass utilize a variety of habitats as described in the life history section with variations in habitat preference due to location, season, and ontogenetic stage. Although primarily estuarine, striped bass use habitats throughout estuaries and the coastal ocean. Striped bass 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, hard 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. Although striped bass are found in all of these habitats the usage varies by habitat. Additionally, these habitats provide the appropriate physicochemical and biological conditions necessary to maintain and enhance the striped bass population. Therefore the protection of each habitat type is critical to the sustainability of the striped bass stock. Limburg and Waldman (2009) have shown that the loss of habitat contributes to the decline in anadromous fish stocks throughout the world. Information on the ecological value of each of these habitats to striped bass and their current condition is provided below.

Successful restoration, recovery and maintenance of striped bass populations in all coastal river systems cannot occur unless the extent and quality of all the required habitats are maintained or restored. Parameters which are important for defining the quality of habitats used by striped bass and their prey include dissolved oxygen (D.O.), temperature, salinity, current velocity, flow delivery pattern and timing (for spawning reaches), and prey abundance. In-stream D.O. concentrations greater than 5 milligrams per liter (mg/l) are recommended for all life stages of striped bass (Setzler-Hamilton and Hall 1991, Funderburk et al. 1991).

Striped bass are recorded from all of North Carolina's coastal river ecosystems (Menhinick 1991). Coastal basins with historical or potential striped bass spawning, nursery and adult/subadult habitats which are situated wholly or primarily in North Carolina are: Albemarle Sound and its tributaries, the major ones being the Chowan and Roanoke Rivers; Pamlico Sound and its tributaries, with the Neuse and Tar/Pamlico Rivers the largest; the Newport River; the White Oak River; the New River; the Cape Fear and Northeast Cape Fear Rivers and estuary; and the Shallotte River. Additional rivers which enter the Atlantic Ocean in South Carolina also host striped bass and some spawning and nursery habitats for these populations are present in North Carolina. These include the Pee Dee River system and its Waccamaw and Lumber River tributaries.

10.1.1 Essential Fish Habitat

10.1.2 Water Column

Striped bass use the water column habitat, for spawning, transport of progeny, foraging and movement throughout the estuary and nearshore coastal areas. Spawning conditions (salinity, temperature, D.O., and flow) for striped bass must be within in a suitable range for successful spawning activity to occur. These conditions are described in the life history section of this plan. Striped bass spawning in North Carolina occurs in fresh or nearly fresh portions of the rivers, with specific locations in individual rivers ranging as far inland as the Fall Zone (historically well above the Fall Zone, for example see Jenkins and Burkhead 1993) to portions much closer to the river mouth.

Striped bass larvae have three development stages all of which inhabit the water column of riverine systems downstream of the spawning reaches. Early juveniles tolerate a broader range of environmental conditions than eggs and larvae (Bain and Bain 1982). Movements, distribution and habitat use of early juveniles, especially in the water column of southeastern U.S. rivers, are little known (Hill et al. 1989). Setzler et al. (1980) indicated that the migration of early juveniles varies with locality. In Virginia, Markle and Grant (1970) reported a downstream migration to higher salinities during the first summer of life. Other authors (Sasaki 1966, Carlson and McCann 1968) reported that shoals were used as nursery areas. Rathjen and Miller (1957) reported the largest catches of juvenile striped bass were near clean sandy bottoms.

An additional habitat consideration for larval and early juvenile striped bass is food availability (Bain and Bain 1982). Some authors believe that striped bass year class strength is established, at least in part, by the availability of abundant zooplankton in the habitats required by the larval and early juvenile stages (i.e., in the downstream water column, soft bottoms, submerged aquatic vegetation and wetlands of rivers, river deltas and the landward portions of estuaries) (see Heinle et al. 1975, Eldridge et al. 1981 as cited in Bain and Bain 1982). Zooplankton abundance is in turn related to riverine and estuarine productivity, which are further linked to freshwater inflows and associated detrital inputs. Zooplankton abundance for river herring in the Chowan River and tributaries is being studied as part of a Fisheries Resource Grant (S. Ensign, UNC-IMS, pers. com. 2010). Monitoring results from April 2008 through May 2009 showed individuals per liter ranging from 21-42, which is approximate ten-fold higher than densities reported from the early 1980s (Winslow et al. 1985). The preliminary data indicate a suitable abundance of zooplankton forage for river herring in the Chowan River and tributaries. However, the spatial and temporal coincidence of larval fish and zooplankton abundances remains an issue (B.J. Copeland, NCMFC, pers. com., 2010). Samantha Binion, an ECU graduate student is expanding on this work as her Master's Thesis (A. Overton, ECU, per. com. 2010).

Migratory striped bass (presumed to be only some of the A/R stock in North Carolina) use the water column of inland and coastal rivers for spawning, and migrate to and from the spawning grounds through the water column of rivers and adjacent estuaries and inlets to the Atlantic Ocean. Migrating fish move north in the spring and summer and south in the fall and winter (Merriman 1941, Clark 1968, Boreman and Lewis 1987). Most adults from estuaries south of the Albemarle Sound remain in rivers or adjacent estuaries for their entire life cycle, as do a majority of the A/R stock. The water column of sandy beaches along the Atlantic coast, rocky shores and shallow bays are inhabited in both marine and estuarine environments (Bigelow and Schroeder 1953). Striped bass adults are reported to remain relatively close (6-8 km; 4-5 mi) to shore when in the ocean (Bain and Bain 1982), but the North Carolina Cooperative Winter Tagging Cruise has tagged striped bass up to 20 miles offshore (S. Winslow, NCDMF, pers. com. 2010).

10.1.3 Soft Bottom

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 striped bass 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 habitat is used by striped bass as foraging grounds and is necessary as a corridor to striped bass spawning grounds (Street et al. 2005).

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 striped bass within this habitat.

10.1.4 Submerged Aquatic Vegetation

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. Striped bass use SAV as nursery, forage, and refuge habitats (Thayer et al. 1984; Hurley 1990; SAFMC 1998).

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 of 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). The NCMFC and the Coastal Resources Commission (CRC) redefined the definition of SAV to encompass both the seasonal and spatial complexity of this habitat. This rule defines SAV habitat as areas that have had one or more species of high or low salinity present over the past 10 growing seasons (15A NCAC 03I .0101). Under current NCMFC rule, SAV habitat is designated as a Fish Habitat Area [NCMFC 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, Hurley 1990; Laney 1997; SAFMC 1998).

In addition to their importance to ecosystem function, SAV also provides crucial structural habitat for fishes and invertebrates. 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). 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).

10.1.5 Shell Bottom

Shell bottom is defined in the CHPP as "estuarine intertidal or subtidal bottom composed of surface shell concentrations of living or dead oysters (*Crassostrea virginica*), hard clams (*Merceneria merceneria*), and other shellfish" (Street et al. 2005). Common terms 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). Striped bass have been known to use shell bottom as nursery areas and as forage habitat (Street et al. 2005). In the Chesapeake Bay, VA Harding and Mann (2003) correlated estuarine striped bass habitat to oyster reefs. Estuarine striped bass habitat has been positively correlated to the complex trophic community found on these oyster reefs, providing an important foraging habitat (Harding and Mann 2003).

10.1.6 Hard Bottom

Hard bottom habitat is defined in the CHPP as "exposed areas of rock or consolidated sediments, usually colonized by a thin veneer of live or dead biota, and generally located in the ocean rather than in the estuarine system" (Street et al. 2005). Migratory subadult striped bass (age 1 through sexual maturity at ages 2-5) likely use the ocean hard bottom of the nearshore Atlantic Ocean as well. It is generally believed that the majority of striped bass less than 2 years of age do not migrate (Boreman and Lewis 1987); therefore these fish would use only habitats in rivers and adjacent estuaries. Some subadult fish which appeared less than age 2 (based on TL), however, have been captured in Atlantic Ocean waters off Virginia and North Carolina (USFWS, South Atlantic Fisheries Coordination Office, unpublished data), so to the extent subadults may travel offshore, there is limited use at least of hard bottom habitats.

10.1.7 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" (federal regulations [40 CFR 230.3(t)]; EMC rules [15A NCAC 2B .0202(71)], and 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 striped bass, 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. Striped bass will utilize wetlands for nursery, foraging and refuge (Mitsch and Gosselink 1993; Street et al. 2005). On the Roanoke River, striped bass are known to forage within bottomland hardwood wetlands during spring high river flows which provide them access to the floodplain (R. Wilson Laney, USFWS, pers. com. 2010).

Habitat requirements for all life stages of migratory and coastal resident striped bass are generally summarized in Hill et al. (1989) and Bain and Bain (1982). A general discussion of the habitat requirements of each striped bass life stage, which borrows liberally from those reports, is provided in the following sections. Localities and attributes of particular striped bass habitats in individual North Carolina river/estuary systems or portion thereof are documented in specific references for each system as indicated in the text following the general habitat descriptions.

10.1.8 Spawning Habitat

Striped bass have successful spawns in inland reaches of the North Carolina rivers where water temperatures, dissolved oxygen and flows are adequate for maintaining the semi-buoyant eggs in suspension and providing for proper development and hatching. Historically, in the absence of dams, striped bass migrated well into the Piedmont physiographic province. At present, dams on most of the major rivers (Figures 10.1 and 10.2) confine spawning to those reaches located at the lower end of the Fall Zone. Several of these dams have been removed, and fish passage is planned for other dams. Dam removal or provision of passage will reestablish access to historic striped bass spawning areas. These blockages are further discussed in the Blockages of Historical Habitat section.

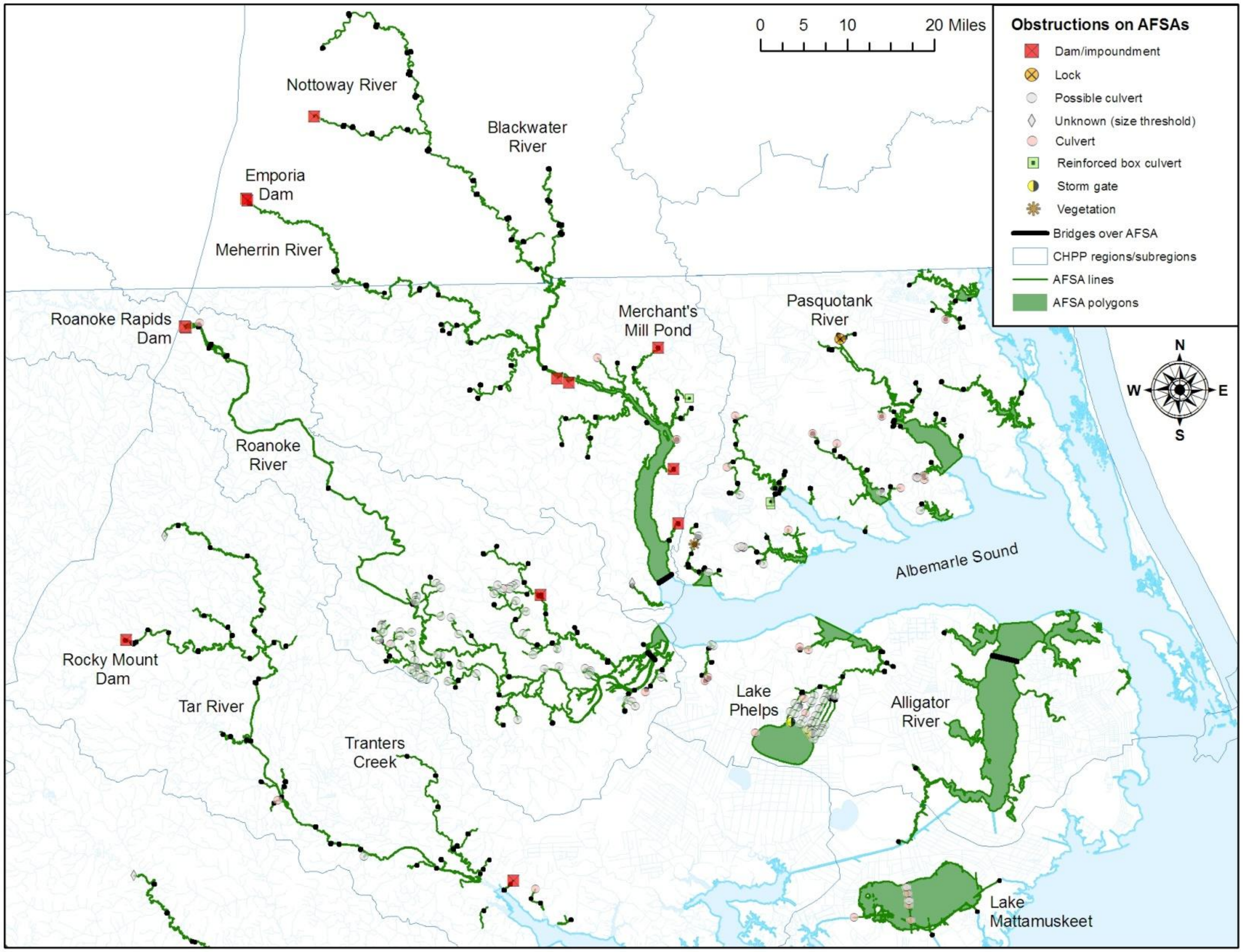


Figure 10.1 Map of North Carolina Marine Fisheries Commission designated ASMA and part of CSMA Anadromous Fish Spawning Areas and potential blockages to striped bass spawning migrations. (continued in Figure 10.2).

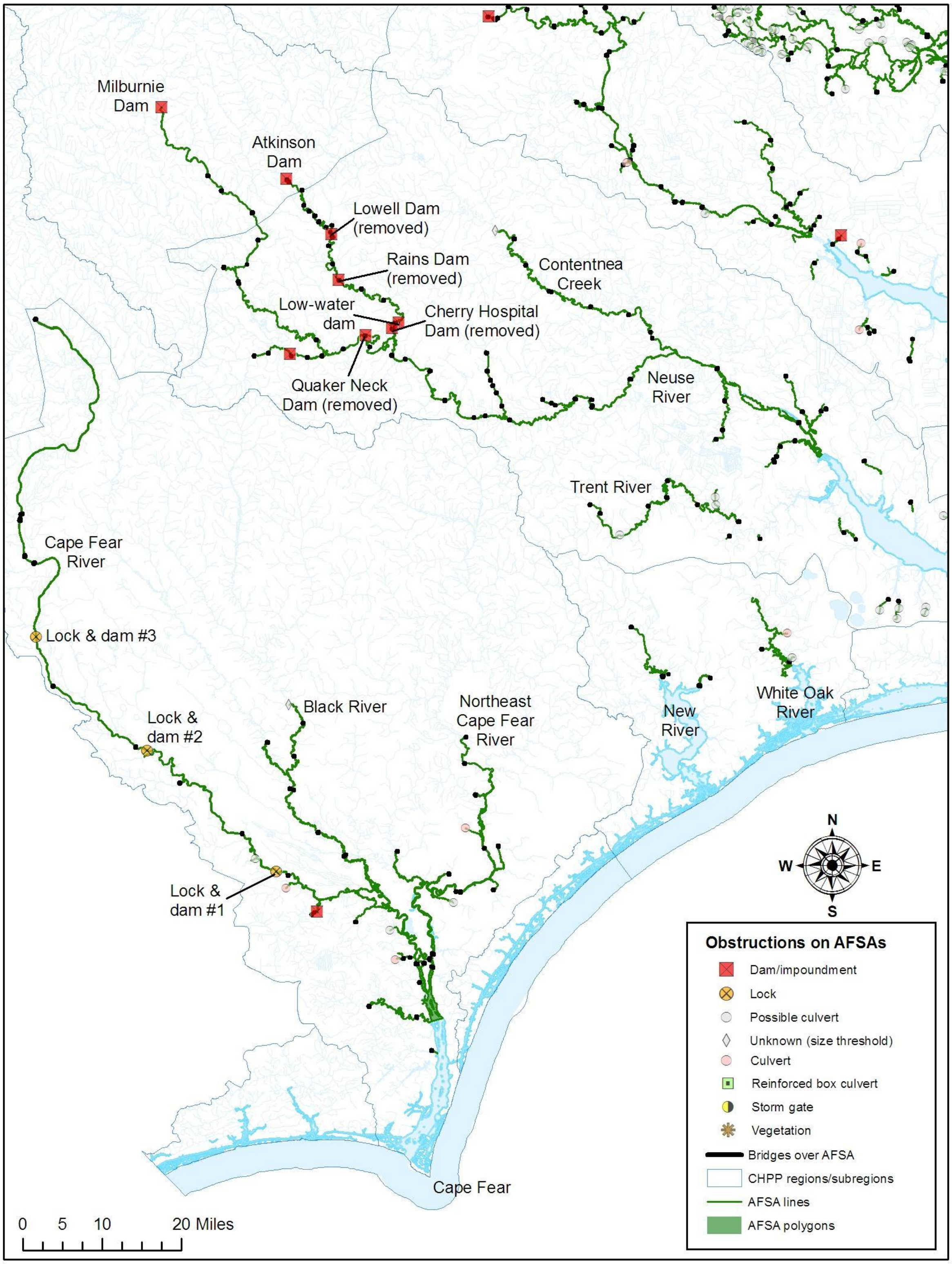


Figure 10.2. Partial map of North Carolina Marine Fisheries Commission designated CSMA Anadromous Fish Spawning Areas and potential blockages to striped bass spawning migrations.

Striped bass stocks which spawn in the inland portions of rivers requires water column habitat with appropriate patterns and volumes of freshwater discharge before and during spawning season (Bain and Bain 1982). The Habitat Suitability Index (HSI) model developed for coastal stocks of striped bass assumes that 100 percent of the natural river discharge will provide optimal spawning conditions (Bain and Bain 1982). River discharge above the average is believed to reduce habitat suitability; however it has been speculated that on the Roanoke and other North Carolina rivers with broad floodplains located downstream of spawning grounds, eggs, larvae and early juveniles may be transported into adjacent wetlands where higher mortality may occur during above average flows. Specific current velocities are required to suspend eggs in the water column during incubation. Minimum velocities of about 30 cm/sec are generally required (Albrecht 1964). Velocity required by different stocks may vary due to differences in egg buoyancy. Eggs which settle to the bottom may still hatch, provided substrates are relatively coarse (Bayless 1968).

10.1.9 Nursery Habitats (eggs, larvae, early juveniles)

Nursery habitat for striped bass eggs, larvae and early juveniles (age less than a year) in North Carolina rivers consists of the water column habitat in river channels downstream from the spawning areas, and water column, soft bottom, submerged aquatic vegetation and wetlands of river deltas at the river mouths, and in adjacent estuaries. Rulifson et al. 2009 was able to determine that striped bass otoliths had the chemical signature of the specific nursery habitats in Albemarle Sound. These results indicate that it is possible to show recruitment success of striped bass from a specific nursery habitat. It is expected that this work will expand to other North Carolina estuaries (R. Rulifson, ECU, pers. com, 2010).

10.1.10 Striped Bass Habitats in NC River/Estuary Systems

The following sections contain information regarding the use of specific habitats in North Carolina by coastal striped bass life stages (Figures 10.1 and 10.2). For the sake of completeness, all habitats used by a stock are included, even though in some cases, fish which use habitats in North Carolina may spawn offspring which use habitats up- or downstream in other states. North Carolina fishery management agencies and institutions, both state and federal, anglers, and other groups need to be aware of the need to protect these habitats and enact compatible management measures for these stocks throughout their ranges.

10.2 ALBEMARLE SOUND MANAGEMENT AREA

10.2.1 Chowan River and Tributaries (Blackwater, Meherrin and Nottoway Rivers)

10.2.1.1Spawning Areas

Striped bass are known to have spawned in the Chowan River basin both historically (Mike Street, NCDMF, pers. com. 2004) and (1998) in the Meherrin River, based on the collection of eggs. Dr. Gilbert Tripp and students of Chowan College collected eggs in April, 1998, at Boone's Bridge (SR 1311) in Northampton County (J.W. Kornegay, NCWRC, Division of Inland Fisheries, personnel communication and unpublished data). No recent surveys of spawning activity or habitats used for spawning have been conducted by the NCWRC or NCDMF.

10.2.1.2 Nursery Areas

As described above striped bass eggs and larvae have been observed in the Chowan River system. The NCDMF has also observed striped bass larvae in Spike's Creek and Hodge's Creek during 2005 larval sampling (NCDMF unpublished data). These striped bass larvae most likely originated in the Meherrin River (C. Godwin, NCDMF, pers. com. 2010). Since 1972, NCDMF has also collected juvenile striped bass in the Chowan River as part of the juvenile trawl survey.

10.2.1.3 Adult Movements, Summer Habitats, Migration

No information was located on habitats used by adult striped bass which occupy the Chowan River or its tributaries. Although Jenkins and Burkhead (1993) depict one capture site for striped bass in the Virginia portion of the Chowan River, they do not discuss the species in the text. Rulifson et al. (1982a) conducted an extensive review of striped bass literature, but also do not mention the Chowan River or its tributaries as hosting striped bass. Haeseker et al. (1996) did find "large" numbers of striped bass to tag at the US HWY 17 Chowan River Bridge in the summer, but did not provide numbers observed. Based on recreational and commercial harvest and tag returns, NCDMF has documented adult striped bass utilizing the Chowan River from mouth up into VA.

10.2.2 Roanoke River

10.2.2.1Spawning Areas

Results of previous investigations (Fish 1959; McCoy 1959; Smith 1907; Hassler et al. 1981) were compared with Rulifson (1991a) to determine the extent and location of spawning habitat. Construction of the Roanoke Rapids Dam in 1955 at River Mile (RM) 137 blocked access to any spawning grounds farther upstream; however, historical accounts indicate major spawning activity centered around Weldon (RM 130). Spawning grounds now range from RM 78 to RM 137 with most of the activity between RM 120 and RM 137, still centered around Weldon.

10.2.2.2 Nursery Areas

The primary nursery area for Roanoke River spawned fish is the low amplitude tidal, wind-influenced primarily fresh waters of western Albemarle Sound (Figure 10.1). Striped bass may spend the first two years of life maturing in and around this nursery area (Hassler et al. 1981). Dr. W. W. Hassler and the North Carolina State University staff conducted juvenile abundance surveys from 1955 to 1987. The NCDMF began sampling the seven stations established by Hassler in 1982 and has continued these surveys to present establishing a long-term relative index of abundance. In 1984 the NCDMF began sampling twelve stations in central Albemarle Sound to determine if a shift in the nursery area had occurred. Juveniles have also been collected in the central sound indicating dispersal throughout the Albemarle Sound and its tributaries (Henry et al. 1991, Godwin and Winslow, 2006).

10.2.2.3 Adult Movements, Summer Habitats, Migration

Tagging studies suggest that some portion of this stock is migratory with primarily older adults migrating offshore, and that the percent migration may be increasing as the age structure and population size rebuild. Tag-recapture studies from previous investigators (Fish 1959, Merriman 1941, Hassler and Taylor 1986, Davis and Sykes 1960, Chapoton and Sykes 1961, Street et al. 1975, Henry et al. 1992, Holland and Yelverton 1973, Benton 1992, Boreman and Lewis 1987, ASMFC 1990, Winslow 2010), were examined to determine the amount and extent of migration from the spawning grounds to other seasonal habitats. It has been speculated that Croatan Sound and offshore waters serve as a wintering ground (Street et al.1975), and movement offshore and north occurs during the summer. Fish tagged and released at various locations in Albemarle Sound have been recaptured on the spawning grounds, in Albemarle, Pamlico and Croatan sounds, and offshore from North Carolina to New England. Studies from 1938 to present indicate a small amount of migration occurs. It was noted by several of these investigators that larger, older females were more migratory than males. However, it is apparent that the Albemarle Sound and North Carolina territorial seas serve as a wintering ground for not only the A/R stock, but for the Atlantic migratory stock as well. Tag returns suggest that some fish from the Atlantic migratory stock move into eastern Albemarle Sound during winter.

10.3 CENTRAL SOUTHERN MANAGEMENT AREA

10.3.1 Tar-Pamlico River

10.3.1.1 Spawning Areas

The area of peak spawning activity was documented to occur upstream of Tarboro between RM 50 and RM 85 (Figure 10.1) (Humphries 1966). Eggs have been collected from Rocky Mount to Grimesland (just upstream of Washington) (Marshall 1976). Upstream migration of anadromous fish is blocked by a dam at North Carolina 43 (Collier and Odom 1989).

10.3.1.2 Nursery Areas

Larval striped bass, juveniles, and yearlings were collected in 1978 above Washington in the Tar River, and downstream in the Pamlico River to the Pungo River that were considered to originate from natural stock (Hawkins 1980).

10.3.1.3 Adult Movements, Summer Habitats, Migration

Tagging studies indicate that Tar-Pamlico River striped bass are riverine and endemic (Marshall 1977; Hawkins 1980; and Winslow 2010). These data also suggest that fish spend the winter in the Pamlico River between Washington and the mouth of the Pungo River and move up the Tar River during the spring spawning run (Marshall 1976; Pate 1975; Winslow et al. 1983; Winslow 2010).

10.3.2 Neuse River

10.3.2.1 Spawning Areas

Spawning in the Neuse River was documented in 1978 and 1979 to occur between RM 80 and RM 145 approximately between Kinston and Goldsboro, respectively (Figure 10.2). Spawning activity is concentrated between RM 80 and RM 120 in an area of high turbulence (Hawkins 1980). The Quaker Neck Dam at Goldsboro had been reported to block the upstream migration of striped bass (Baker 1968) with few eggs collected above the low-head dam. These results indicated that some striped bass were able to migrate beyond the dam and spawn successfully. Distribution was greatly hindered by the dam (Hawkins 1980), until removal in 1998, opening up historical spawning reaches with adults occurring up to Milburnie Dam since that time during high flow years. Since removal of the Quaker Neck Dam striped bass eggs and larvae have been collected upstream of the former dam site (Burdick and Hightower 2006).

10.3.2.2 Nursery Areas

A few striped bass larvae and juveniles have been collected in the New Bern area in 1978 on the Neuse River that were thought to originate from natural stock (Hawkins 1980). The nursery area is considered to be downstream of New Bern (Figure 10.2). In 2004 and 2005 Burdick and Hightower (2006) collected striped bass eggs and larvae in the Neuse River upstream of the former Quaker Neck Dam site. Juvenile sampling in the Neuse River during 2006 and 2007 revealed low numbers of naturally-produced age-0 striped bass (Barwick et al. 2010) suggesting a recruitment-limited population.

10.3.2.3 Adult Movements, Summer Habitats, Migration

Tagging studies indicate that Neuse River striped bass are riverine and endemic (Marshall 1977; Hawkins 1980; and Winslow 2010). After removal of the Quaker Neck Dam, Beasley and Hightower (2001) acoustically tracked adult striped bass moving upstream of the former dam site.

10.3.3 Newport, White Oak and New Rivers

Little information is available on these medium-sized streams in southern North Carolina. Historically, both the New and White Oak Rivers are shown as supporting runs of striped bass in Baker's (1968) Reconnaissance of Inland Fishing Waters. In 1973-1975, NCDMF conducted a fishery-independent anadromous fish survey for eggs, larvae, and adults.

No striped bass eggs, larvae, or adults were found in the New River. Spawning habitat previously found above Jacksonville no longer exists because of channelization. Three adult striped bass were collected in the White Oak River. Two were three year old females and one was a seven year old female (Sholar 1975). NCWRC spring electrofishing survey has documented few striped bass in these rivers (B. Barwick. NCWRC, pers. com. 2010).

10.3.4 Cape Fear River

10.3.4.1 Spawning Areas

Spawning activity has been documented on the Cape Fear River from RM 10 to RM 30 (upstream of Wilmington) where relatively high tidal currents keep eggs in suspension (Figure 9.2) (Fischer 1980; Winslow et al. 1983). Spawning activity has been documented on the Northeast Cape Fear from Ness Creek to Crooms Bridge. The South and Black Rivers apparently do not support spawning habitat for striped bass (Sholar 1977; Winslow et al. 1983). Smith (2009) documented the highest density of eggs between lock and dam 2 and 3.

10.3.4.2 Nursery Areas

Juveniles have been collected on the Cape Fear and Northeast Cape Fear rivers, though infrequently. The nursery area on the Cape Fear is located around Wilmington (Figure 10.2) (Fischer 1980; Winslow et al. 1983). The nursery area on the Northeast Cape Fear ranges from Wilmington to Lanes Ferry (Sholar 1977; Winslow et al. 1983). NCWRC sampling in the Northeast Cape Fear has documented the presence of juvenile striped bass near Wrightsboro from 2005-2007 ranging in length from 91 mm TL – 354 mm TL) (B. Barwick, NCWRC, pers. com. 2010).

10.3.4.3 Adult Movements, Summer Habitats, Migration

Adults have been collected from Pikes Creek to the lower portion of the river in the Northeast Cape Fear. Some large striped bass (45 lbs) have been reported by recreational fishermen (Sholar 1977; Winslow et al. 1983). The distribution is more compressed in the Cape Fear River because of a series of locks and dams. NCDMF has had tag returns from fish from Buck Horn Dam and below. With the proposed construction of the Lock and Dam 1 rock passage it is expected that more striped bass will go be able to move up and downstream. In the early 1980s, striped bass were abundant during January-May below Wilmington (Fischer 1980; Winslow et al. 1983). Although one individual tagged in the Cape Fear River was recaptured in Buzzards Bay, Massachusetts, tagging studies suggest that this stock is riverine endemic with exchange between the Cape Fear and Northeast Cape Fear Rivers (Winslow et al. 1983, Winslow 2010). Major tributaries including the South and Black rivers do not seem to support spawning populations (Winslow et al. 1983). However, this may reflect a lack of sampling effort, since interviews with local recreational anglers in 1984 indicated that striped bass were caught in the spring in the upper segments of tributaries of the Black River (Laney 1984).

10.3.5 Waccamaw River

10.3.5.1 Spawning Areas

No spawning is documented to occur in the Waccamaw River drainage; however, striped bass weighing 20 lbs have been caught in the river above Conway, and smaller fish have been caught only 15-20 miles below the North Carolina state line (C. Sasser, USFWS,, Waccamaw National Wildlife Refuge, personal communication, 2010).

10.3.5.2 Nursery Areas

No information on nursery areas used by striped bass eggs, larvae or early juveniles in the Waccamaw River drainage was located.

10.3.5.3 Adult Movements, Summer Habitats, Migration

No information has been located on habitats used by adult striped bass in the Waccamaw River system.

10.3.6 Lumber River

No information has been located on any habitats used by any striped bass life stages in the Lumber River system.

10.3.7 Pee Dee River

10.3.7.1 Spawning Areas

The only portion of the Pee Dee River presently available for spawning striped bass in North Carolina waters is the approximately 14-mile reach from Blewett Falls Dam, near Rockingham, North Carolina, to the South Carolina state boundary. Areas reported as constituting striped bass spawning habitat include the Pee Dee River or Intercoastal Waterway in South Carolina (Crochet et al. 1976) and the Pee Dee River upstream from the US 301 bridge (White and Curtis 1969).

10.3.7.2 Nursery Areas

No information has been located on areas used as nursery habitats by striped bass life stages in the Pee Dee River system.

10.3.7.3 Adult Movements, Summer Habitats, Migration

No information has been located on areas used by striped bass adults in the Pee Dee River ecosystem except for the population as defined by Burns (1887). The Pee Dee River was listed by Burns (1887) as having a striped bass population. The population was still extant in 1980 (McIlwain 1980).

10.4 HABITAT PROTECTION STATUS

Protection of the quantity and quality of striped bass habitat, particularly areas designated as critical (i.e. spawning and nursery areas) is essential to the goal of this plan. Increasing human activity across North Carolina continues to have a significant influence on habitat quantity and quality as well as associated wildlife and fisheries resources.

NCDMF has the authority to designate Anadromous Fish Spawning Areas (AFSAs), and Nursery Areas. Anadromous spawning and nursery area surveys have been conducted by the Division in the watersheds of Currituck Sound, Albemarle Sound, Tar-Pamlico River, Neuse River, White Oak River, New River, and Cape Fear River, but no directed surveys have occurred since the early 1980s outside of the Albemarle Sound area. Areas in each system that have been documented to function as spawning areas for striped bass have been adopted into rule by the NCMFC (15A NCAC 03R .0115). Furthermore, NCMFC has no additional regulatory authority in these areas and can only regulate fish size, creel, and method of fishing.

The NCWRC has the authority to designate waters as Inland Primary Nursery Areas. Currently portions of the Roanoke, Tar, Neuse, and Cape Fear rivers are so designated. However, the NCWRC has no additional regulatory authority and can only regulate fishing activities in these areas. Permitting agencies give these areas additional consideration relative to impacts prior to issuing development permits.

In order to protect anadromous fish, both the NCWRC and NCDMF request that all in water work in anadromous fish spawning and nursery areas follow a seasonal work moratorium. These moratoriums vary depending on the area, but generally range from February through September, but may extend into October. NCWRC and NCDMF request these moratoriums in order to eliminate or minimize impacts due to elevated turbidity and noise levels during peak anadromous fish spawning periods. Other projects that may degrade water quality in AFSA undergo a permitting process by NCDWQ.

The 1997 FRA mandates that the NCDENR shall coordinate the preparation of CHPP for critical fisheries habitats (CHPP -- G. S. 143B-279.8). The legislative goal of the CHPP shall be the long-term enhancement of coastal fisheries associated with coastal habitat. The NCDMF, North Carolina Division of Water Quality (DWQ) and North Carolina Division of Coastal Management (DCM) shall prepare the CHPP, with assistance from other federal and state agencies. The plans shall: (1) describe and classify biological systems in the habitats, (2) evaluate the function, value to coastal fisheries, status, and trends of the habitats, (3) identify existing and potential threats to the habitats and the impact on coastal fishing and (4) recommend actions to protect and restore the habitats. In 2005, the NCMFC, the North Carolina Environmental Management

Commission (EMC), and the North Carolina Coastal Resources Commission (CRC) jointly approved these plans and develop CHPP implementation plans. The CHPP is updated every 5 years, with the most current update (2010) expected to be approved late 2010. In 2010 the NCWRC joined the CHPP Steering Committee, the cooperative interagency effort to update and implement the CHPP. Actions taken by all four 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 four commissions as well as their supporting NCDENR agencies.

The CHPP recommends that some areas of fish habitat be designated as “Strategic Habitat Areas” (SHAs), 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). In 2009, the NCMFC nominated and approved SHAs for the sounds and tributaries of Albemarle, Currituck, Roanoke, and Croatan sounds and the nearshore Atlantic Ocean (Figure 10.3). Approximately 75 % of the Anadromous Fish Spawning Areas in Region 1 were approved as SHAs. The SHAs for the Pamlico Sound, Tar and Neuse River and the associated tributaries are expected to be nominated and approved in 2010-2011.

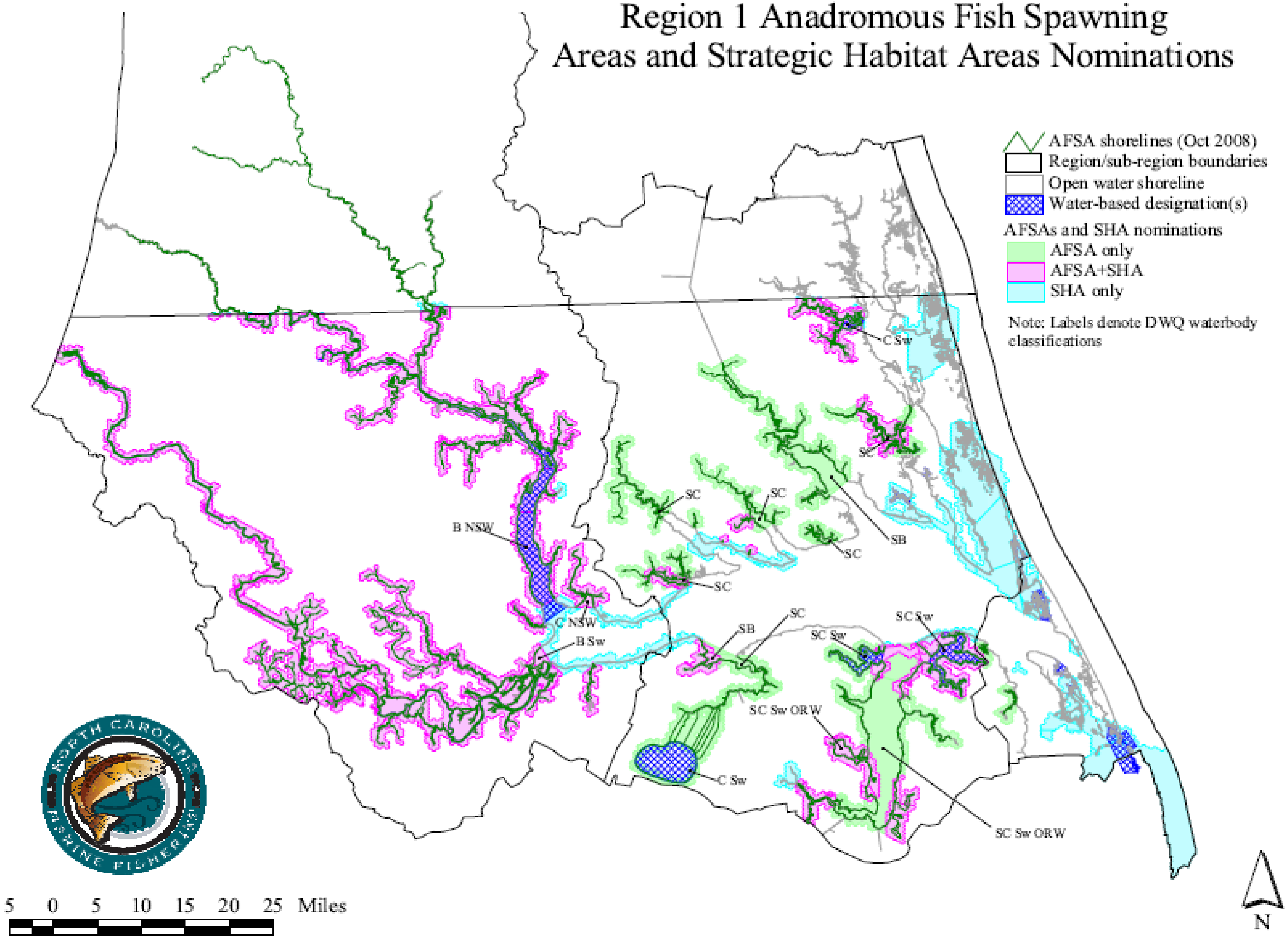


Figure 10.3 Region 1 Strategic Habitat Areas as nominated and approved by the NCMFC.

The CHPP focuses on the fish habitat and threats to the habitat, while this FMP describes habitat conditions or needs for the various life stages of estuarine striped bass. The FRA gives precedent to the CHPP and stipulates habitat and water quality considerations in the FMP be consistent with CHPP. Any recommendations will be considered and acted upon through the CHPP implementation process. The CHPP is currently being reviewed and will be updated in 2010.

10.5 HABITAT CONCERNS

10.5.1 Blockage of Historical Spawning Habitat

A blockage is defined as any man made or natural obstruction that impedes striped bass trying to reach historical spawning areas. Dams are the primary obstruction to striped bass migrations, but obstructions can include culverts or log jams. Mainstem dams occur in all coastal rivers in North Carolina (Figures 10.1 and 10.2). The lowermost dams are often located near the fall line as in the Meherrin, Roanoke, Nottoway, Tar and Neuse rivers (Hightower 2001). This is evident by the fact that striped bass were trapped in Kerr Reservoir when the dams were closed. Kerr Reservoir lies several miles above the fall line on the Roanoke River.

In the coastal plains of North Carolina, there are 512 documented dams. Of these dams 125 are in the RRMA and ASMA and the remaining 387 are in the CSMA (Deaton et al. *in press*).   It is probable that these blockages have had detrimental impacts to striped bass populations in the Roanoke, Tar, Neuse, and Cape Fear rivers and contributed to the decline of striped bass populations. In the following sections the dams that impede striped bass migration on the main portions are described, while there are many other dams on the tributaries. Striped bass populations declined in the 1980’s in these systems. Striped bass populations have made a dramatic come back in the Roanoke system where water releases from Kerr Dam were altered to provide flows more conducive to striped bass spawning. It is thought the flow releases negotiated with the U.S. Army Corps of Engineers (USACE) and Dominion Power are one of the primary factors in restoring the A/R stock.

Although there has been some progress in working with dam operators and the removal of dams in North Carolina, there are still numerous blockages that do not allow striped bass to reach historical spawning grounds. Neither NCDMF nor NCWRC has authority covering existing dams unless a hydro-electric facility comes up for relicensing. At this point both agencies would have certain rights and privileges to comment on settlement agreements submitted to the Federal Energy Relicensing Commission (FERC). The Clean Water Trust Fund has monies available to buy existing dams or have them opened for fish passage, and receive input from both agencies on where fisheries priorities exist in the state. In 2010, American Rivers, has initiated a dam removal program in North Carolina. This organization has been working with state and federal agencies to prioritize which dams should and can be removed. While creating this list, American Rivers has been actively trying to obtain funding to remove dams.

10.5.1.1 Chowan River

The Blackwater and Nottoway rivers form the Chowan River just after entering North Carolina. There are three dams located on the Nottoway River. The lowermost dam (Baskerville Mill Dam) currently blocks migrating anadromous fish (Odom et al. 1986). The next dam upstream (Camp Pickett Dam) may be within the historical range of anadromous fish but the third dam in the series is above an impassable waterfall (Odom et al. 1986). It is believed that all of the dams on the Nottoway River are too far upstream to block historical spawning grounds of striped bass

(Eric Brittle, VGIF, pers. com. 2010). One low head dam is present on the Blackwater River, approximately 8 miles above Franklin, VA. During normal spring flows this dam does not act as an impediment to anadromous fish (Mitchell Norman, VGIF, personal communication, 2010). This dam has slots to allow fish and water to move freely through the dam (Eric Brittle, VGIF, personal communication 2010).

Emporia Dam is the first blockage in the Meherrin River, a major tributary to the Chowan. A fish lift was installed in 1990 to allow American shad past, but passage has been minimal to date, due in part to design problems (J. W. Kornegay, NCWRC, pers. com. 2010). A second dam further upriver (Whittles Mill Dam) is considered to be beyond the limit of migration for anadromous fish (Odom et al. 1986).

Little is known of striped bass movement, abundance, or spawning in the Chowan, Blackwater or Nottoway rivers, but anecdotal information from anglers suggests that striped bass are utilizing the Blackwater and Nottoway rivers. Spring electrofishing sampling has found few striped bass present in the Meherrin River below Emporia, Virginia (Chad Thomas, NCWRC, pers. com. 2010).

10.5.1.2 Roanoke River

Currently, numerous large and small dams are present in the upper reaches of the Roanoke River Basin. Roanoke Rapids Dam at river mile 137 is the lowermost dam on the main stem of the river. Roanoke Rapids Dam impounds the reach to Gaston Dam at river mile 145. Gaston Dam impounds the reach to river mile 170, below Kerr Dam at river mile 179. Kerr Dam impounds the river up the Dan River to river mile 206, and up the Staunton River to river mile 212 (Laney et al. 2001).

The impacts of fish passage above Roanoke Rapids dam are difficult to predict, but historical documents indicate that the historical spawning grounds are at Weldon (Worth 1902). The only landlocked population of striped bass that can successfully spawn is found in Kerr Reservoir, while other landlocked populations of striped bass have been developed through stocking in many of the upstream impoundments. These populations are currently the focus of many anglers and do not make spawning migrations (W. Laney, USFWS, pers. com. 2010). Managers are currently trying to understand potential beneficial and/or negative impacts to reservoir fisheries associated with providing passage for fish downstream of the dams.

10.5.1.3 Tar River

The Rocky Mount Mills Dam is the lowermost dam on the Tar River that obstructs migration of striped bass, American shad, Atlantic sturgeon, hickory shad, and blueback herring (Collier and Odom 1989). The Rocky Mount Mills Dam is a small hydro-dam that conducts peaking operations to produce electricity. Removal of the dam is unlikely due to the fact that the City of Rocky Mount has a water supply intake just above the dam and the dam is listed as a state historical site. However, discussions with the current owner, Capitol Broadcasting, Inc., are ongoing regarding the possibility of improving water flows downstream, and providing upstream passage (R.W. Laney and J.E. Ellis, USFWS, pers. com. 2010). Two other Tar River dams further upstream are considered to be within the range of anadromous fish migration, but are not currently accessible (Collier and Odom 1989). Fish ladders would allow striped bass access to approximately 15 miles of additional riverine habitat before reaching the next dam. Utilization of this habitat would only be during periods of high flow, if then.

10.5.1.4 Neuse River

The first blockage in the Neuse River is currently Milburnie Dam at river mile 183. The next obstruction is Falls of Neuse Dam at river mile 195. A substantial amount of mainstem habitat was restored in 1998 with the removal of the Quaker Neck Dam near Goldsboro (Bowman and Hightower 2001).

Removal of Milburnie dam would allow the USACE some latitude to provide a stable flow regime for the Neuse and provide access to another 10-20 miles of riverine habitat for spawning. The owner of the dam has expressed an interest in selling the dam. The DWQ has expressed concern over removal of Milburnie Dam, due to possible loss of wetlands associated with the dam. In March 2010, the USACE received a prospectus to utilize the 29,000 LF of the Neuse River near the Milburnie Dam as a mitigation bank for state and federal permits.

Little River, a Neuse River tributary has had 3 low-head dams removed since 1998. Cherry Hospital Dam, Rain Mills Dam, and Lowell Mill Dam have been removed and have reconnected 51 RM of Little River to the Neuse River and 147 RM including Little River tributaries. Near Goldsboro there is the water withdrawal and treatment structure that has been breached. This structure may still impede striped bass migrations during low flow years (W. Laney, USFWS, pers. com. 2010). In 2010, the American Rivers has proposed removal of the remaining part of the structure.

10.5.1.5 Cape Fear River

In the Cape Fear River, the lowermost obstructions to migration are the three locks and dams located within the coastal plain. Passage was attempted through a creek on the north side of the river during the 1960's but failed ostensibly from attractant flows being sufficient to draw fish into the creek channel. The first complete obstruction to migration is Buckhorn Dam, which is located near the fall line. Buckhorn Dam is considered to be an obstruction to migration for striped bass in the Cape Fear River.

The Cape Fear River may provide the best opportunity for remediation of obstructions. The USACE operates the three locks and dams in the coastal plain of North Carolina, and is willing to relinquish control of the upper two locks and dams if a suitable entity can be found to maintain the associated land surrounding the area. The Corps is also working on fish passage for the lower most lock and dam, and is studying the necessity for operating the structure in a manner that would not block spawning migration. The City of Wilmington does have a water intake structure above this facility, which would present some problems in opening the structure permanently, or removing it from the river. Due to financial and land ownership issues in 2009, the USACE decided to forgo construction of a fish passageway that would bypass Lock and Dam No. 1. In 2010, the USACE has designed a rock passage that will allow fish to get past the lower dam.

10.5.1.6 Yadkin-Pee Dee

Although not entirely a North Carolina river basin, the Pee Dee does have an anadromous run of striped bass into North Carolina. The first dam blocking this run above South Carolina is Blewett Falls, followed by Tillery, Falls, Badin, Tuckertown and High Rock. Historically, striped bass were found above all these dams.

The Yadkin chain of dams is currently undergoing FERC relicensing. Blewett Falls and Tillery are owned by Progress Energy. As a part of the relicensing a settlement agreement which will provide improved spawning flows from Blewett, and passage above it for selected species, has been finalized. Litigation is still ongoing regarding the provision of appropriate instream flows from Tillery. The next four dams, Falls, Badin, Tuckertown and High Rock, are owned and operated by ALCOA, Inc., and are the subject of current litigation by the State of North Carolina over whether the generation of hydropower, if it is no longer used for aluminum smelting, should be a public or private enterprise. Fish passage was prescribed fishways at the Blewett and Tillery dams (Yadkin-PeeDee Hydroelectric Project), and the prescriptive authority was reserved for the future at both the Yadkin-PeeDee Hydroelectric Project and the Yadkin Hydroelectric Projectas part of the re-licensing process for all these structures. State and federal fishery management agencies have focused on providing passage for American eels, and American shad working closely with the licensee, under the Yadkin-Pee Dee Diadromous Fish Passage Agreement. Agencies will continue to investigate the feasibility of passage for striped bass above the Yadkin chain of dams in North Carolina. The most efficient alternatives will be identified for fish restoration and passage of striped bass and other anadromous species to their historical range in the Yadkin-Pee Dee system

10.6 RIVER FLOWS

The flow pattern of a coastal river (the timing, rate, and delivery pattern of water in the channel of the waterway) is critical to maintaining proper oxygen, salinity, and temperature regimes and dissipating wastes throughout the watershed, including the receiving estuary. This pattern is important to striped bass and other anadromous species. North Carolina rivers typically have exhibited higher flows during the spring of the year, providing an attractant flow for adult fish migrating toward the spawning grounds. Because striped bass have buoyant eggs, river discharge (the rate of flow per unit time) must be high enough to keep the eggs in suspension until they hatch and to transport the larval and postlarval stages to the appropriate nursery areas in the river. River flows must also be sufficient to maintain appropriate salinities in the estuarine nursery areas used by juvenile striped bass.

Disruptions to the historical patterns of flow, in volume and/or timing can render habitat unsuitable for use by fish and other aquatic organisms, or can significantly alter the extent of nursery or spawning habitats. Flow regimes can be altered by a number of human activities including dam operations, diversions, and water withdrawals (Rozengurt and Haydock 1993). Some rivers in North Carolina have been dammed for hydropower generation, water supply, and flood control. Hydropower operations can vary discharge patterns in a highly unnatural manner, over a short time period causing rapid changes in depth and temperatures, and accumulation of water in adjacent back swamps (i.e flows on the Roanoke River increasing from 2,000 cfs to as much as 18,500 cfs within a matter of hours). Reservoirs constructed for water supply and/or recreational purposes can alter downstream flow patterns when water is retained for those purposes and not released downstream. Flood control operations by the USACE result in reduced maximum flows, but prolonged higher discharge levels, often for weeks at a time. Water diversions alter flows in river channel segments. Withdrawals of water from the river alter the flow temporarily below the intake, or permanently if the withdrawal is consumptive (not returned to the river) or is discharged into another distant basin (an interbasin transfer). Three examples of interbasin transfers that affect North Carolina estuarine striped bass are the City of Virginia Beach's removal of up to 93 cfs (60 mgd) from the Roanoke River at Gaston Reservoir, the transfer of 8.3MGD from the Tar River Basin to the Contentnea and Neuse River Basins, and the transfer of 30.5 mgd from the Deep River basin to the Haw River and Yadkin River basins, with conditions. These conditions include making sure that D.O. levels of the water released are the same or better than the ambient water levels (NCDWR 1992). Another potential source of impact to river flow patterns is groundwater withdrawal, which can affect subsurface flow to river ecosystems. Withdrawals from shallow wells which intersect groundwater supplies maintaining river base flows could be detrimental, especially during low-flow periods. All of these alterations may impact the cues which striped bass and other species require to successfully complete their life cycles.

Flow patterns in some North Carolina river systems exhibit significant deviations from historical patterns due to the regulation of flows within them or their major tributaries (Chowan, Roanoke, Tar-Pamlico, Neuse, Cape Fear, Yadkin-Pee Dee). Other rivers remain largely in an unregulated condition (White Oak, Northeast Cape Fear, Waccamaw).

Preliminary evaluations of the flow patterns, as well as present and future predicted water demand, suggest that measures should be taken to provide for appropriate future flows to maintain striped bass populations and all other ecological functions. Such authority rests with the NCDWQ, the North Carolina Division of Water Resources (NCDWR), USACE, and individual hydropower operators, subject to license under the FERC. None of the federal or state fishery management agencies have the authority to regulate or specify flows. While there are weekly meetings between the USACE and resource agencies that discuss the predicted water release from the dams on the Roanoke, Neuse, and Cape Fear rivers, the Roanoke River is the only river that has a flow agreement in effect. This cooperative group takes predicted and past weather events, water temperature as well as current striped bass abundance on the spawning grounds into account to determine volume and duration of water releases.

A number of studies have been undertaken to quantify the relationship between river flows and striped bass recruitment (Stevens 1977, Klauda et al. 1980, Mihursky et al. 1981, Uphoff 1989, Rulifson and Manooch 1990, Zincone and Rulifson 1991, Richter et al. 1996, Richter et al. 1997, Poff et al. 1997 and Silk et al. 2000). Stevens (1977) reported that in the Sacramento-San Joaquin Estuary, high survival of striped bass coincides with moderately high river flows. He reported also that an unpublished study by the Maryland Department of Natural Resources determined that haul seine catch (for 1961-1971) of juvenile striped bass in the Potomac River was highly correlated with mean April-May river flow. However, similar relationships were not found for other parts of Chesapeake Bay. Klauda et al. (1980; reported in Versar 1990) concluded that striped bass year-class success in the Hudson River was directly or indirectly influenced by some combination of freshwater flow and water temperature just prior to and during spawning. Mihursky et al. (1981) determined that strong striped bass year classes in the Potomac River estuary were correlated with colder than average winters (December) which were followed by above average spring (April) freshwater runoff to the estuary. They concluded that “any significant diminution of springtime freshwater discharge to the estuary would tend to decrease the probability of substantial recruitment success.” Uphoff (1989) found that year-class success during 1980-1985 was significantly related to rainfall and river flow during the early larval stage; however, the correlations were between those variables and striped bass postlarval daily mortality. There was no significant correlation between those variables and abundance.

Over the period 1955 –1987, Rulifson and Manooch (1990) found striped bass recruitment to be best (juvenile abundance index, hereafter JAI, > 5.0) for years in which Roanoke River flows were low to moderate (5,000 to 11,000 cfs) and poor (JAI<5.0) when flows were very low (3,900-8,100 cfs) or very high (10,000 cfs or greater) during the spawning season (1 April-15 June). They found further that the average flow pattern for good recruitment years (JAI > 5.0) most closely resembled pre-impoundment flow conditions. When Roanoke River flow patterns were analyzed to assess the days within which a recommended flow regime (maintaining river discharge between the historical 25% low-flow and 75% high-flow values for the period March 1-June 30) had occurred, it was determined that the years of lowest JAI values were also those with the fewest days in which river flows were within the recommended bounds. Striped bass egg viability also was higher when discharges were within the bounds over 50% of spawning period days, but less when days within bounds averaged 27%. The authors noted also that river flow directly influenced 1) seasonal timing and location of spawning; 2) daily or hourly patterns in spawning activity; 3) egg transport downstream; 4) larval transport and feeding; 5) location of primary nursery grounds in Albemarle Sound; and 6) concentration and distribution of zooplankton (used as food by striped bass postlarvae and juveniles). Further analysis by Zincone and Rulifson (1991) confirmed the relationship of striped bass JAI from Albemarle Sound correlating with Roanoke River flows and contended that good JAI years corresponded with years in which flows were closest to pre-impoundment flows. Leahy (1992) maintained there were problems with the analysis which rendered the conclusions invalid; however, Zincone and Rulifson (1992) satisfactorily addressed his concerns.

Poff et al. (1997) reviewed the natural flow regime of unaltered rivers; human alteration of flow regimes; ecological functions of the natural flow regime; ecological responses to altered flow regimes; and recent approaches to streamflow management. They conclude that “it is necessary to preserve the natural hydrologic cycle by safeguarding against upstream river development and damaging land uses that modify runoff and sediment supply in the watershed”(Poff et al. 1997, p. 780). New methods for assessing the degree to which river ecosystems have undergone hydrologic alteration attributable to human influence (Richter et al. 1996) and for setting streamflow-based river ecosystem management targets (Richter et al. 1997) also have been developed, and in fact are applied to the Roanoke River in both of these publications. Finally, Silk et al. (2000) considers the utility of reversing the traditional approach to instream flow water rights. Conventional instream flow approaches protect up to a specified level of flow to be left in a stream and indirectly allocate the remaining flows for water development. Silk et al. (2000) suggest that the reverse approach, directly specifying a level of water development and protecting the remaining flow in the stream, may be beneficial as an alternative approach or in combination with the traditional approach.

There are many factors that have or may alter river flows, in each North Carolina coastal river system which hosts striped bass. These factors include obstructions, river flows, and water withdrawals in both North Carolina and Virginia. Every community water system serving at least 1,000 people must submit a local water use plan at least one time every five years describing the current and estimated population and water use (G.S. 130A-313(10)). As of 2010, the 2001 NCDWR statewide water supply plan had not been updated. NCDWR has moved from a statewide plan to river basin plans and now back to modeling each basin and creating a statewide water supply plan (D. Rayno, NCDWR, pers. com. 2010).

10.6.1 Chowan River Basin

The Chowan River Basin lies in the northeastern coastal plain of North Carolina and southeastern Virginia. It is formed at the North Carolina-Virginia border by the confluence of the Blackwater and Nottoway Rivers, and joined by the Meherrin River in North Carolina. Approximately 75 percent of the watershed lies in Virginia (NCDWQ 2001a). The Chowan River empties into western Albemarle Sound. See Table 10.1 for characteristics of the basin.

Table 10.1. Characteristics of river basins supporting anadromous striped bass populations in North Carolina (and Virginia and South Carolina)(Burgess undated; NC Division of Water Quality 1999a-b, 2000, 2001a-c, 2002).

River Basin (north to south)	Area (sq. mi.)	Stream Miles	Mean Annual Flow (cfs)	September Median Flow (cfs)
Pasquotank	3,697 NC VA	478 NC		
Chowan	1,378 NC 4,061 VA 5,439 Tot.	788 NC		
Roanoke	3,503 NC 6,273 VA 9,776 Tot.	2,389 NC	8,500?	
Tar-Pamlico	5,440 NC	2,335		
Neuse	6,192 NC	3,440		
White Oak	1,233 NC	446		
Cape Fear (Northeast Cape Fear)	9,322 NC	6,049		
Lumber	3,336 NC SC	2,283 NC		
Yadkin-Pee Dee	7,213 NC 7,956 SC 15,169 Tot	5,989 NC 13,555 SC 19,544 Tot		

Table 10.2. Current (2008) surface water withdrawals and relevant capacities derived from data reported to DENR-Division of Water Resources and Department of Agriculture and Consumer Services Agricultural Statistics for CHPP subregions. (Source: D. Rayno/DWR, unpublished data, 2009).

	Community Water Systems*		**Thermoelectric Generation**		**Other Uses****		
CHPP subregion	**No. of systems**	**treatment capacity (MGD)**	**No. of facilities**	**withdrawal capacity (MGD)**	**No. of systems**	**withdrawal capacity (MGD)**	**Total withdrawal capacity (MGD)**
Cape Fear	2	337.6	4	2334.4	21	122.8	2794.8
Roanoke (NC portion)	8	68.7	3	1763.1	7	32.3	1864.1
Neuse	11	219.1	1	31.7	11	91.7	342.5
Tar-Pamlico	7	84.5	0	0	6	13.8	98.3
TOTALS	*48*	*709.776*	*8*	*4129.23*	*45*	*260.613*	5099.619

*Data submitted to DWR in Local Water Supply Plans for water systems supplying residential, commercial, institutional and industrial users

** Other Uses includes agricultural operations, golf courses, quarries, and non-electric generating industrial operations

There are a number of dams in the Chowan River basin, including the Baskerville and Camp Pickett Dams on the Nottoway and a hydropower dam on the Meherrin River at Emporia, Virginia. The latter facility began operation around 1908 and does practice peak power generation. At present, the degree to which flows in the Chowan River and its major tributaries are regulated is unknown.

Local Water Supply Plans were submitted to the State of North Carolina by 21 water systems in the basin. All North Carolina water supply systems (three countywide and one regional) in the basin currently rely exclusively on groundwater (NCDWQ 2001a,b). Surface water withdrawals from the Chowan River are primarily for agricultural purposes. There is one municipal surface water withdrawal, for the City of Norfolk water supply, which is withdrawn from the Blackwater River in the Virginia portion of the watershed.

10.6.2 Roanoke River Basin

The Roanoke River Basin in Virginia and North Carolina occupies an area of approximately 9,776 square miles. The Roanoke River historically transported more water than any other river in North Carolina, with an average annual flow of about 8,500 cfs (Manooch and Rulifson 1989; Figure 10.4).

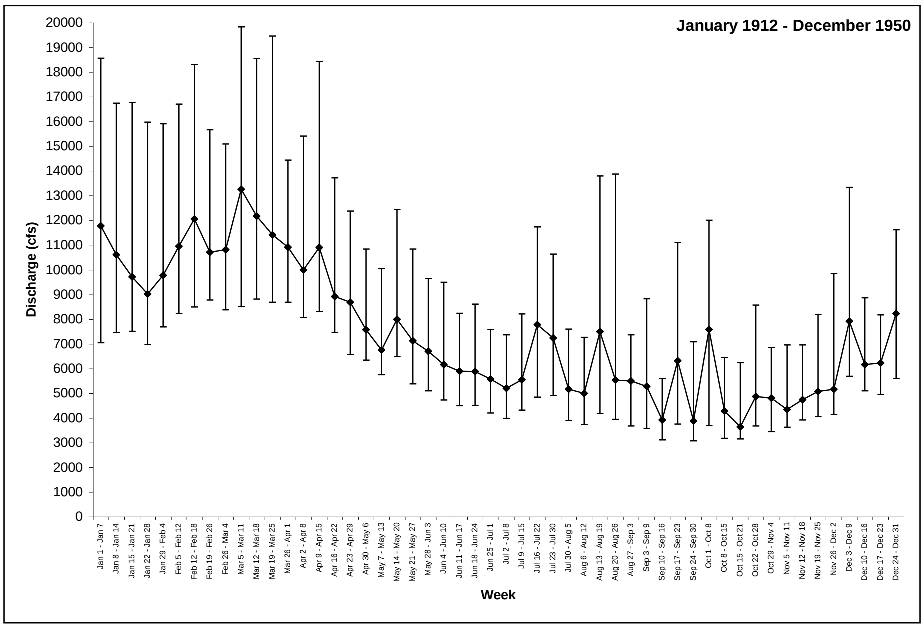


Figure 10.4 Weekly median discharges with corresponding 25th and 75th percentiles measured at the U.S. Geological Survey gaging station on the Roanoke River at Roanoke Rapids before and after construction of John H. Kerr Dam.

Flow modifications which have altered discharge patterns on the Roanoke River have been discussed in detail in the reports of the Roanoke River Water Flow Committee (see Manooch and Rulifson 1989; Rulifson and Manooch 1990, 1991 and 1993). Flows in the river were altered by the construction and operation of six dams located upstream of Roanoke Rapids (RM 137) beginning in 1950 with John H. Kerr Dam. Water flow regulation by the USACE, operator of Kerr Dam, prevents the magnitude of pre-impoundment floods; however, the unnatural, extended flooding during post-impoundment years adversely affected certain wildlife species, especially wild turkey, and likely reduced the survival of young striped bass and perhaps other anadromous species (Manooch and Rulifson 1989). Extremely low water releases are also thought to have negatively impacted the survival of young striped bass and other anadromous species.

Because of the dramatic declines in egg viability, juvenile abundance, estimated population size and adult striped bass landings which occurred during the late 1970s and early 1980s, fishery management agencies and Congress became concerned for the future of this nationally significant resource. While there were undoubtedly multiple contributing factors to the observed decline of striped bass on the Roanoke River, including deteriorating water quality and heavy fishing pressure it was clear that "...one of the major forces influencing the aquatic environment and, therefore, striped bass stocks [was] water flow," (Manooch and Rulifson 1989).

The Roanoke River Water Flow Committee (RRWFC) was established in 1988 specifically to address the issue of flows on the lower Roanoke River. The Committee examined pre- and post-impoundment water flows, and concluded that there had been significant changes in the river's flow regime since impoundment, and especially since 1977, as a consequence of hydropower peaking activities. Other investigations by the Committee indicated that there were significant relationships between striped bass egg viability and the percentage of days in which flows on the river were within the historic limits of flow variability. Flows for years in which the striped bass JAI was relatively high were also more similar to pre-impoundment flows (Manooch and Rulifson 1989). The work of the Committee ultimately resulted in the negotiation of a new flow regime for implementation during the striped bass spawning period (presently April 1-June 15). The new flow regime, coupled with harvest controls, has coincided with improved juvenile striped bass recruitment, with the JAI reaching record high levels.

Richter et al. (1996, 1997) used new approaches, the Indicators of Hydrologic Alteration (IHA) and Range of Variability Approach (RVA) respectively, to assess the degree to which flows on the Roanoke River have been altered, and for determining instream flow targets. The approaches rely on analysis of changes which occur in the five fundamental characteristics of hydrologic regimes (see Poff et al. 1997 for definitions) 1) magnitude, the amount of water moving past a fixed location per unit time; 2) frequency, how often a flow above a given magnitude recurs over some specified time interval; 3) duration, the period of time associated with a specific flow condition; 4) timing or predictability, the regularity with which flows of defined magnitude occur; and 5) rate of change or flashiness, how quickly flow changes from one magnitude to another.

The results of the IHA analysis for the Roanoke reflect the effects of Kerr Reservoir and Roanoke Rapids Dam on downstream flows, showing severe effects on pulsing behavior, elimination of high-magnitude flooding and prolonged multi-day maxima (Richter et al. 1996). The average duration of pulses was much shorter in the post-dam than pre-dam periods, which the authors attributed to hydropower operations. The effect on the hydrologic regime is to create a greater frequency of high and low pulses of lesser duration and also to increase the number of hydrograph rises and falls. The magnitude and timing of the annual minima have changed, with the post-dam period showing a shift to lower mid-winter annual lows. The authors attribute this change to the capturing of winter flows for later spring and summer use. The average rate of flow increase was reduced in comparison to the pre-dam period. This change is attributed to the fact that flow releases seldom exceed 20,000 cfs, which corresponds to the turbine capacity at Roanoke Rapids. In the pre-dam period, flows commonly rose more than 40,000 cfs in a single day, during rainstorms. Overall, variability of flows on the Roanoke has been reduced in summer and winter monthly means, in extremely low water conditions, in timing of the annual highs and lows, in high and low pulse durations, and in frequency and rate of hydrograph rises and falls. However, coefficients of variation increased for springtime monthly means and long duration (30 and 90-day), high flow magnitudes. The authors concluded that their IHA analysis should direct attention to assessing the effects of dam operations on fish populations, littoral-zone benthic fauna, and floodplain forest communities (Richter et al. 1996). They recommend that programs to monitor response to hydrologic restoration could follow two strategies 1) continue to characterize the hydrologic regime using the IHA method, in order to look for expected decreases in the before and after deviations in IHA groups; and 2) directly monitor the status of the targeted biota.

The results of the RVA are reported in detail in Richter et al. (1997). Based upon the RVA analysis conducted for the Roanoke River, they recommended that operations rules for Kerr Reservoir, including the “guide” curve, be modified to accomplish five primary objectives 1) restore high-magnitude flooding; 2) shift the timing of the largest annual floods back into the spring (February-April) and shift the timing of annual low flow extremes to early autumn (September-October); 3) decrease the frequencies of high and low pulses and increase their durations; 4) decrease the frequency of hydrograph reversals (shifts between rising and falling flow levels) attributable to hydropower operations; and 5) moderate the rate at which flow release rates rise or fall within or between days. They noted that some of the recommendations would entail more than merely changing the way Kerr Reservoir is operated. Downstream measures would be necessary to accomplish flood restoration on the Roanoke. The authors note that a monitoring regime should be established for both flows and resources which are dependent upon them, including striped bass.

Currently, a new group of agency, municipal and industry representatives are working to develop a new flow regime for the lower river which will in part be based on the results of instream flow incremental analysis (IFIM). The Fisheries Technical Work Group was formed as a part of the relicensing process for Dominion (formerly Virginia Electric and Power Company) Gaston and Roanoke Rapids Dams hydropower operations, and is currently negotiating a new regime which includes striped bass as an evaluation species.

Outside of the striped bass spawning period, flows on the river remain altered by USACE controlled floods and hydropower peaking operations. Hydropower operations dewater the portion of the river bypassed by the tailrace and cause extreme hourly and daily fluctuations downstream of Roanoke Rapids Dam as a consequence of peaking operations. Flood control operations conducted by the USACE eliminate historic high discharges, and cause prolonged flooding of adjacent floodplain areas, frequently during periods of the year which such flood events did not historically occur. All of these flow effects also impact the quality of habitat within the downstream nursery areas.

Water supply in the basin is addressed in NCDWQ (2001b). Surface water is currently used to meet most water needs in the North Carolina portion of the basin (approximately 56 percent of estimated total water use). Water demand from public systems in the North Carolina portion of the basin is expected to increase 55 percent by 2020. Seven of the 43 systems reported that available water supply was not adequate to meet the projected 2020 demand, and seventeen other systems indicated that 2020 demand levels will exceed 80 percent of available supply.

Water supply systems in other basins are also viewing the Roanoke as a potential source for future water supply. The City of Virginia Beach successfully planned and implemented a withdrawal from the Roanoke at Lake Gaston in 1998 (CVB 2010). Since 2007, the City of Virginia Beach has withdrawn over 10 billion gallons per year (CVB 2010). There has also been discussion on the part of municipalities located in the Piedmont portion of North Carolina regarding additional interbasin transfers from the Roanoke. Currently, there are 18 registered surface water withdrawals in the North Carolina portion of the Roanoke River basin. The cumulative permitted withdrawal capacity in 2008 was 1,864.1MGD (D. Rayno. NCDWR. pers. com. 2010) (Table 10.2).

10.6.3 Tar-Pamlico River Basin

In the Tar River, striped bass generally spawn from the City of Rocky Mount (RM 122) downstream to Bells Bridge (RM 94); however, their upstream migration is flow-dependent. Median weekly discharge for the Tar River at Rocky Mount ranges from 399 to 950 cfs during the months of April and May and generally declines over this time period (Figure 10.5).

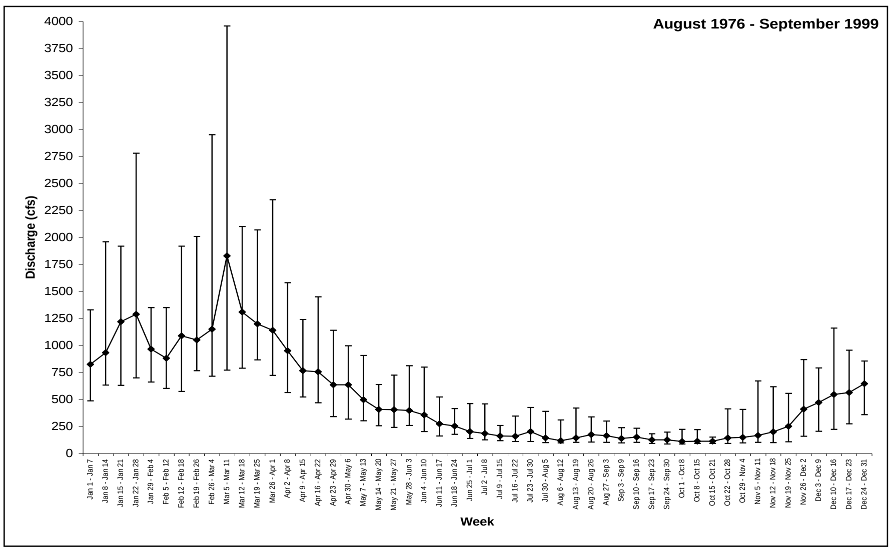


Figure 10.5 Weekly median discharges with corresponding 25th and 75th percentiles measured at the U.S. Geological Survey gaging station on the Tar River at Rocky Mount.

Instream flow in the Tar River below Rocky Mount is determined in part by releases from the Tar River Reservoir (RM 130). It is a 1,860-acre water supply reservoir for the City of Rocky Mount constructed in 1970. The minimum flow requirement for water quality augmentation is 80 cfs, except during drought conditions when it is reduced to 65 cfs. Although Tar River Reservoir impacts downstream flow, there is little opportunity for augmentation during the spring for anadromous fishes given the reservoir's limited storage capacity.

Flow downstream of Rocky Mount is further altered by Rocky Mount Mills Dam (RM 122). This is a small privately-owned hydropower facility, which is currently operated as a peaking operation, resulting in frequent changes in downstream flow. As a result, river depth downstream can fluctuate as much as 1 ft over a short period of time. The dam is required to maintain a minimum release of 85 cfs; however, this requirement is not enforced. Significantly higher flows are needed during the months of March, April, and May for striped bass spawning; however, it is unrealistic in most years due to the dam's limited storage capacity. Nevertheless, striped bass would benefit from the elimination of peaking operations during the spring, which would result in more natural flows downstream of the dam. In 2008 Capitol Broadcasting purchased the Rocky Mount Mills Dam. The new owners have actively been communicating with NCWRC, USFWS, and NMFS regarding fish passage and or restoring flows around the dam (W. Laney. USFWS. pers. com. 2010).

Other factors impacting instream flow within the basin are the withdrawals of surface water for the purposes of municipal drinking water and agricultural use. The NCWRC personnel have observed numerous agricultural water intake pipes located in the river during the growing season. Unlike municipal withdrawals, such agricultural withdrawals are largely unregulated by the NCDWR. Permits for agricultural water intakes are only required for withdrawals of greater than 1 million gallons per day. As part of the 2010 water basin models NCDWR is trying to quantify how many unpermitted intakes there are. Municipalities currently withdrawing water include Enfield, Franklinton, Greenville, Louisburg, Rocky Mount and Tarboro. Each of these municipalities must submit a local water supply plan every five years to the NCDWR. Based upon 1997 local water supply plans, mean daily water demand from municipal water systems with existing surface water withdrawals in the Tar-Pamlico River basin is projected to increase 25 percent by 2010 and 37 percent by 2020 (Table 10.3)**.** Although a portion of the municipal water withdrawn is returned to the river in the form of wastewater, there is an overall net loss. In addition, as the demand for water increases, not only are these systems expanding, new systems are being proposed. Furthermore, a portion of the basin (Beaufort, Edgecombe, Martin, Pitt, Washington and Wilson Counties) is within the Central Coastal Plain Capacity Use Area. The Central Coastal Plain Capacity Use Area rules, which became effective August 1, 2002, required entities that withdraw water from aquifers within the use area to reduce groundwater withdrawals over a 16-year period. As a result, more municipalities will consider surface water as a supply source. Although each system withdrawing surface water must individually comply with the guidelines of the NCDWR, the cumulative impact of these withdrawals on the spawning habitat available to striped bass, and other species, must be considered. As of 2008, there were 13 permitted water intake structures that had a total of 98.3 MGD withdrawal capacity (Table 10.2).

Table 10.3. Current and projected water supply and demand data (mgd) for municipal water systems with surface water intakes within the Tar River Basin based upon 1997 Local Water Supply Plans submitted to the N.C. Division of Water Resources (http://dwr32.ehnr.state.nc.us:81/cgi-bin/foxweb.exe/c:/foxweb/lwsp971).

Municipal Water System	Surface Water Source	Surface Water Supply 1997	Total Water Supply 1997	Projected Total Water Supply 2010	Projected Total Water Supply 2020	Mean Daily Demand[a] 1997	Projected Mean Daily Demand[a] 2010	Projected Mean Daily Demand[a] 2020
Franklinton	New City Pond/Old City Pond	0.4[b]	0.4	0.4	0.4	0.6	0.7	0.7
Louisburg	Tar River	2.0	2.0	2.0	2.0	1.5	0.8	0.9
Rocky Mount	Tar River/Tar River Reservoir	29.1[c]	29.1	29.1	29.1	15.5	19.2	21.1
Tarboro	Tar River	12.0	12.0	12.0	12.0	3.2	3.7	3.9
Greenville	Tar River	22.5	22.9[d]	31.4	31.4	11.9	16.6	18.6
Enfield	Fishing Creek	7.3	7.3	7.3	7.3	0.5	0.6	0.6

[a] Includes service area demands and contract sales to other water systems.
[b] Includes 0.3 mgd from New City Pond and 0.1 mgd from Old City Pond.
[c] Includes 16.0 mgd from Tar River and 13.1 mgd from Tar River Reservoir.
[d] Includes 0.4 mgd of groundwater.

10.6.4 Neuse River Basin

With the removal of the Quaker Neck Dam near Goldsboro (RM 140) in 1998, an additional 74 miles of historic spawning habitat upstream to Milburnie Dam near Raleigh (RM 214) became accessible to striped bass as well as other anadromous and resident species. However, this habitat is only accessible during years of moderate to high flows. During years with low flow, striped bass only migrate upstream as far as Smithfield (RM 188) (Herndon et al. 2000; Bowman and Hightower 2001). Bowman and Hightower (2001) concluded that adequate flow is most critical for striped bass when they migrate above the fall line (RM 184). Increases in streamflow correspond to higher electrofishing catches at sample sites established near Raleigh (NCWRC unpublished data)

Milburnie Dam, a small hydropower facility, is a run-of-the-river operation, and instream flow downstream of Milburnie Dam is determined mainly by releases from Falls Dam (RM 230). Operated by the USACE, Wilmington District, the dam impounds Falls of the Neuse Reservoir, which is managed for downstream flood control, municipal water supply, water quality enhancement downstream of the dam (under low-flow conditions), and recreation. Riverine fish habitat downstream of the dam is not a current consideration. Minimum flow guidelines for downstream water quality augmentation from April through October are 100 cfs measured at the base of the dam and 254 cfs measured at the U.S. Geological Survey gauging station near Clayton. These minimum releases are not sufficient to allow migration of striped bass upstream of Smithfield. It is estimated that a flow greater than 800 cfs at Clayton is needed to provide striped bass access to spawning habitat upstream of Smithfield (NCWRC, unpublished data). Prior to the construction of Falls Dam, weekly median discharge during May was greater than 570 cfs measured at Clayton (Figure 10.6). Since its construction, weekly median discharge in May has been generally less than 492 cfs at Clayton. Furthermore, discharge typically declines throughout the spring, but in late spring discharge can decrease by an order of magnitude over a few days. Some of this change may be due to natural variability; however, much of it is due to USACE management practices. The current USACE step-down guidelines range from approximately 500 to 1,000 cfs each hour for the transition from high flow releases to lower flow releases, resulting in large, abrupt changes in flow. This problem is exacerbated during low water years and can disrupt striped bass spawning activity, especially during the late spring. The impact of these fluctuations on striped bass spawning success and the subsequent survival of eggs and larvae is unknown.

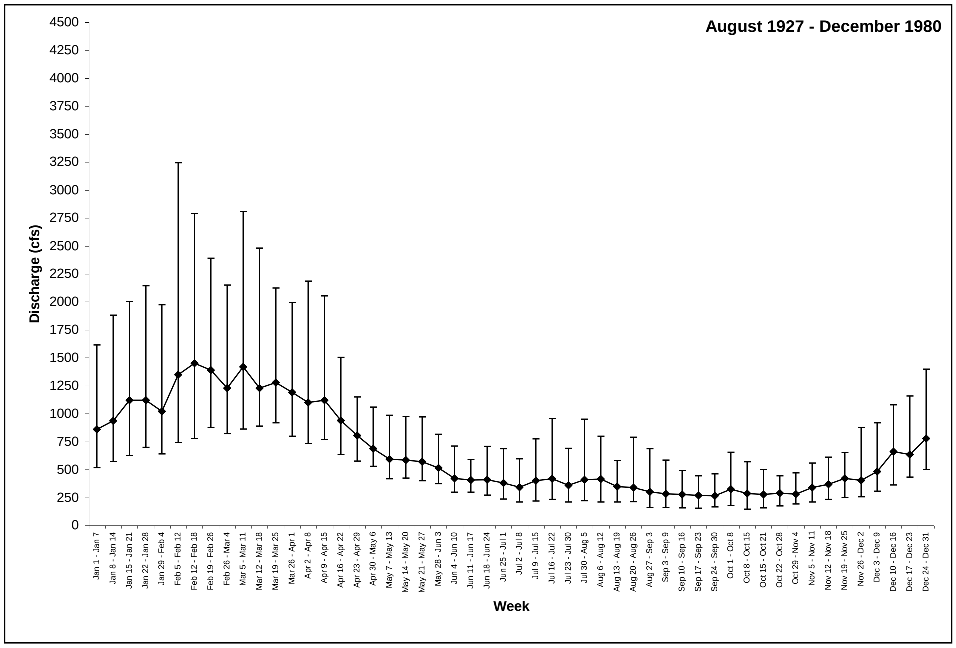


Figure 10.6 Weekly median discharges with corresponding 25th and 75th percentiles measured at the U.S. Geological Survey gaging station on the Neuse River near Clayton before and after the construction of Falls Lake Dam.

The flexibility of the USACE in releasing flows from Falls Dam is constrained by the backwater effect of Milburnie Dam. This backwater effect causes flows in excess of 4,000 cfs to flood a subdivision located between Falls Dam and Milburnie. If MilburnieDam was not present, backwater effects would not occur and the USACE would be able to release sustained higher flows for fishery management purposes.

Water intake structures also affect the Neuse River flow. In 2008, there were 23 permitted surface water withdrawals that had a total capacity of 342.5 MGD (D. Rayno. NCDWR. pers com. 2010) (Table 10.2). All of the municipalities that have surface water intakes in the Neuse River Basin are expected to increase the mean daily demand by 2020 (Table 10.4).

Table 10.4. Current and projected water supply and demand data (mgd) for municipal water systems with surface water intakes within the Neuse River Basin based upon 1997 Local Water Supply Plans submitted to the N.C. Division of Water Resources (http://dwr32.ehnr.state.nc.us:81/cgi-bin/foxweb.exe/c:/foxweb/lwsp971).

Municipal Water System	Surface Water Source	Surface Water Supply 1997	Total Water Supply 1997	Projected Total Water Supply 2010	Projected Total Water Supply 2020	Mean Daily Demand[a] 1997	Projected Mean Daily Demand[a] 2010	Projected Mean Daily Demand[a] 2020
Orange-Alamance	Corporation Lake	0.4	0.5[b]	0.5	0.5	1.1	1.6	2.2
Hillsborough	Lake Ben Johnson	0.7	0.7	3.7	3.7	1.8	2.2	2.6
Durham	Flat River/Little River	37.0[c]	37.0	45.5	64.5	28.3	35.0	41.1
Creedmoor	Lake Rogers	0.8	0.8	0.8	0.8	0.3	0.3	0.3
Butner	J.D. Holt Reservoir	13.8	13.8	13.8	13.8	2.4	2.8	3.0
Raleigh	Falls Lake	72.0	72.0	89.0	89.0	55.2	69.6	80.1
Johnston Co.	Neuse River	12.0	12.0[d]	14.5	14.5	3.0	7.7	10.5
Smithfield	Neuse River	6.0	6.1[e]	6.0	6.0	2.1	4.6	4.8
Goldsboro	Neuse River	32.0	32.0	32.0	32.0	6.2	8.7	9.3
Zebulon	Little River	2.0	3.0[f]	4.0	4.0	0.7	0.9	1.2
Wilson	Toisnot Reservoir/Wiggins Mill Reservoir	7.0[g]	7.0	30.0	30.0	8.0	14.7	17.3

[a] Includes service area demands and contract sales to other water systems.
[b] Includes 0.1 mgd of groundwater.
[c] Includes 19.0 mgd from Flat River and 18.0 mgd from Little River.
[d] Includes <0.1 mgd purchased from Wendell.
[e] Includes 0.1 mgd purchased from Johnston Co.
[f] Includes 1.0 mgd purchased from Zebulon/Knightdale/Wendell/Raleigh.
[g] Includes 1.0 mgd from Toisnot Reservoir and 6.0 mgd from Lake Wiggins, but does not include regular withdrawals from Buckhorn Reservoir or Lake Wilson.

10.6.5 Cape Fear River Basin

Instream flow in the upper Cape Fear River is in part determined by releases from B. Everett Jordan Reservoir. Located on the Haw River (RM 4), it is 202 miles from the mouth of the Cape Fear River. This reservoir is operated by the USACE for the purposes of water supply, downstream flood control, water quality augmentation downstream of the dam, recreation and fish and wildlife conservation. Minimum flow required for downstream water quality augmentation is 600 cfs measured at Lillington. Prior to the construction of B. Everett Jordan Dam, weekly median discharge during May ranged from 1,210 to 1,750 cfs, and since its construction, weekly median discharge in May has been comparable ranging from 1,090 to 1,950 cfs (Figure 10.7).

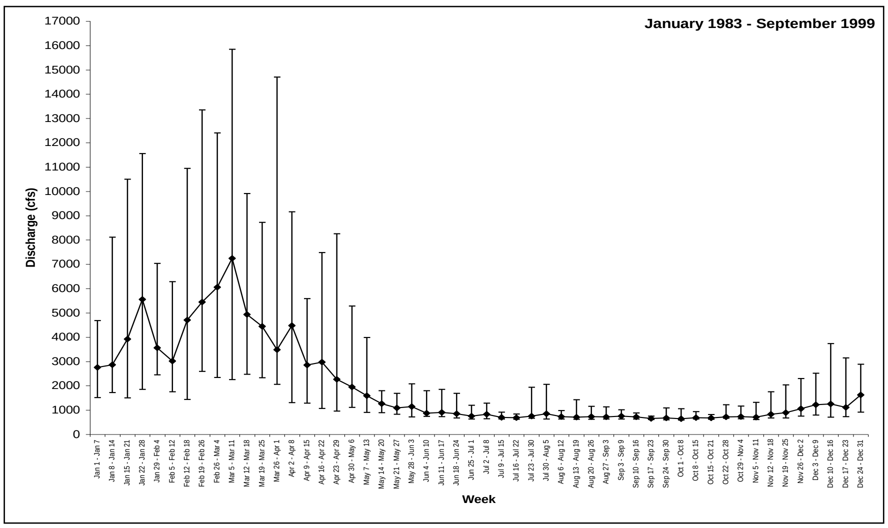


Figure 10.7. Weekly median discharges with corresponding 25th and 75th percentiles measured at the U.S. Geological Survey gaging station on the Cape Fear River near Lillington before and after the construction of B. Everett Jordan Dam.

Downstream of Jordan Reservoir, there are four additional dams located on the Cape Fear River. Buckhorn Dam (RM 188) is a hydropower facility, owned by Progress Energy, which was originally constructed to provide supplement storage for a downstream hydro facility. However, it is now used to ensure adequate water elevation ("head") for the cooling water intake of the Progress Energy Cape Fear Steam Plant upstream of the dam. Lock and Dam No. 1 (RM 67), Lock and Dam No. 2 (RM 100) and Lock and Dam No. 3 (RM 123) are operated by the USACE for the purpose of navigation upstream to Fayetteville, with a navigable depth of 8 ft at low water. Although these dams are impediments to fish migration, they function as run-of-the-river dams and have little impact on instream flow.

Within the Cape Fear River Basin, instream flow is not currently considered a major limiting factor to either striped bass migration or spawning success (K.W. Ashley, NCWRC, pers. com. 2010). Weekly median discharge measured near Lillington ranges from 1,090 to 4,480 cfs during April and May (Figure 10.7).

Municipal water withdrawals are the largest threat to instream flow in the Cape Fear River. Based upon 1997 local water supply plans, mean daily water demand from municipal water systems with existing surface water withdrawals in the Cape Fear River Basin is project to increase 39 percent by 2010 and 56 percent by 2020 **(**Table 10.5**).** This does not account for any new surface water withdrawals that may be permitted. Current water allocations from Jordan Reservoir include Cary-Apex, Chatham County, Holly Springs, Morrisville, Orange County and Wake County-Research Triangle Park.

Table 10.5. Current and projected water supply and demand data (mgd) for municipal water systems with surface water intakes within the Cape Fear River Basin based upon 1997 Local Water Supply Plans submitted to the N.C. Division of Water Resources (http://dwr32.ehnr.state.nc.us:81/cgi-bin/foxweb.exe/c:/foxweb/lwsp971).

Municipal Water System	Surface Water Source	Surface Water Supply 1997	Total Water Supply 1997	Projected Total Water Supply 2010	Projected Total Water Supply 2020	Mean Daily Demand[a] 1997	Projected Mean Daily Demand[a] 2010	Projected Mean Daily Demand[a] 2020
Reidsville	Lake Reidsville	19.0	19.0	19.0	19.0	3.4	8.1	8.4
Burlington	Lake Mackintosh/Stoney Creek	48.0[b]	48.0	48.0	48.0	14.5	18.2	19.6
Graham	Graham-Mebane Lake	12.0	12.0	12.0	12.0	7.2	8.2	9.3
Pittsboro	Haw River	7.6	7.6	7.6	7.6	0.7	1.0	1.2
Orange Co. WSA	Cane Creek/University Lake	10.4[c]	10.4	20.4	20.4	9.0	11.7	13.8
Apex	B. Everett Jordan Reservoir	3.7	3.7	9.2	11.0	1.8	5.6	8.9
Cary	B. Everett Jordan Reservoir	12.3	15.8[d]	18.6	21.3	12.0	11.8	14.5
Chatham Co.	B. Everett Jordan Reservoir	6.0	6.0	12.0	12.0	0.8	3.2	4.2
High Point	City Lake/Oak Hollow Lake	21.4[e]	21.4	31.4	31.4	15.5	22.3	26.0
Greensboro	Lake Brandt	36.0[f]	36.0	71.0	71.0	40.3	50.5	58.0
Randleman	Polecat Creek	1.5	2.5[g]	3.5	3.5	1.2	1.5	1.6
Ramseur	Sandy Creek	6.6	6.6	6.6	6.6	0.6	0.9	1.0
Robbins	Bear Creek	1.5	1.5	1.5	1.5	0.8	0.8	0.9
Goldston-Gulf SD	Deep River	0.5	0.5	0.5	0.5	0.3	0.4	0.4
Siler City	Rocky River Lower Reservoir	3.8	3.8	5.8	5.8	2.8	3.4	3.7
Lee Co.	Deep River	1.5	1.5	1.5	1.5	0.8	0.9	0.9
Sanford	Cape Fear River	12.6	12.6	12.6	12.6	8.2	10.3	12.5
Erwin	Swift Textiles Reservoir	1.5	1.5	1.5	1.5	0.6	0.8	0.9
Dunn	Cape Fear River	8.0	8.0	8.0	8.0	4.6	5.6	5.7
Harnett Co.	Cape Fear River	12.0	13.3[h]	13.3	13.3	10.0	18.2	22.9
Carthage	Nick's Creek	0.5	0.5	0.5	0.5	0.3	0.5	0.5
Moore Co.	Little River	1.5	1.5	1.5	1.5	0.1	0.1	0.2
Fort Bragg	Little River Reservoirs	20.0	20.0	20.0	20.0	7.6	7.6	7.6
Fayetteville	Big Cross Creek/Cape Fear	92.0[i]	92.0	92.0	92.0	27.1	47.9	52.3
Riegelwood SD	Cape Fear River	1.0	1.0	1.0	1.0	0.6	0.6	0.6
Lower Cape Fear WSA	Cape Fear River	50.0	50.0	50.0	50.0	40.7	50.7	50.7
Wilmington	Cape Fear River	15.0	30.0[j]	35.4	35.4	12.3	19.9	22.1

[a] Includes service area demands and contract sales to other water systems.
[b] Includes 26.0 mgd from Lake Mackinstosh and 12.0 mgd from Stoney Creek.
[c] Includes 8.0 mgd from Cane Creek and 2.4 mgd from University Lake.
[d] Includes 3.5 mgd purchased from City of Raleigh.
[e] Includes 8.6 mgd from City Lake and 12.8 mgd from Oak Hollow Lake.
[f] Does not include regular withdrawals from Lake Townsend
[g] Includes 1.0 mgd purchased from City of Asheboro.
[h] Includes 1.0 mgd purchased from City of Dunn and 0.3 mgd purchased from Johnston County.
[i] Includes 2.- mgd from Big Cross Creek, 85.0 mgd from Cape Fear River, and 5.0 mgd from Glenville Lake.
[j] Includes 15.0 mgd purchased from Lower Cape Fear WSA.

Other municipalities including Fayetteville, Durham, and Greensboro have expressed an interest in future allocations from the reservoir. Downstream of Jordan Reservoir, major surface water withdrawals include Sanford, Harnett County, Fort Bragg, Fayetteville, the Lower Cape Fear Water and Sewer Authority, and Wilmington. The practice of interbasin transfer further complicates this issue. For example, the Town of Cary receives water from the Jordan Reservoir (Cape Fear Basin), yet its wastewater is currently discharged into Crabtree and Middle creeks (Neuse River Basin). In addition to municipal water withdrawals, industries including textile manufacturing, electrical power generation, paper production, and mining also use surface water. Within the Cape Fear River Basin these include Progress Energy (multiple facilities), International Paper, DuPont, and DAK Monomers, LLC. All surface water withdrawals, both municipal and industrial, have to individually comply with the guidelines of the DWR. In 2008 there were 27 permitted water intake structures with a capacity intaking 2794.8 MGD (D. Rayno, DWR. pers. com. 2010.) (Table 10.2). However, the accumulative impact of these water withdrawals on instream fish habitat must be considered as local water supply plans are developed and revised within this regime**.**

10.6.6 Pee Dee River Basin

Currently, flows on the Pee Dee are highly regulated by a chain of reservoirs constructed primarily for hydropower operations by Progress Energy (Blewett Falls, Tillery) and Alcoa Corporation (four dams upstream of Tillery). All six projects are licensed by the Federal Energy Regulatory Commission (FERC) and their licenses expired in 2008. Both licensees recently convened Issue Advisory Groups (IAGs) to begin the scoping and study identification process. Representatives of the USFWS and the NCWRC, in cooperation with South Carolina agencies, will be participating on the IAGs and will be identifying flow issues which need to be addressed by the licensees. At this time, the agencies have requested the two licensees to collaborate on the development of a flow model which will cover the river from the uppermost dam downstream to the Winyah Bay estuary. Flow issues have not specifically been identified at this time; however based on personal observations, present patterns and quantities of water released from the system are likely unsuitable for optimal use of the striped bass habitats located downstream of the dams (Figure 10.8.).

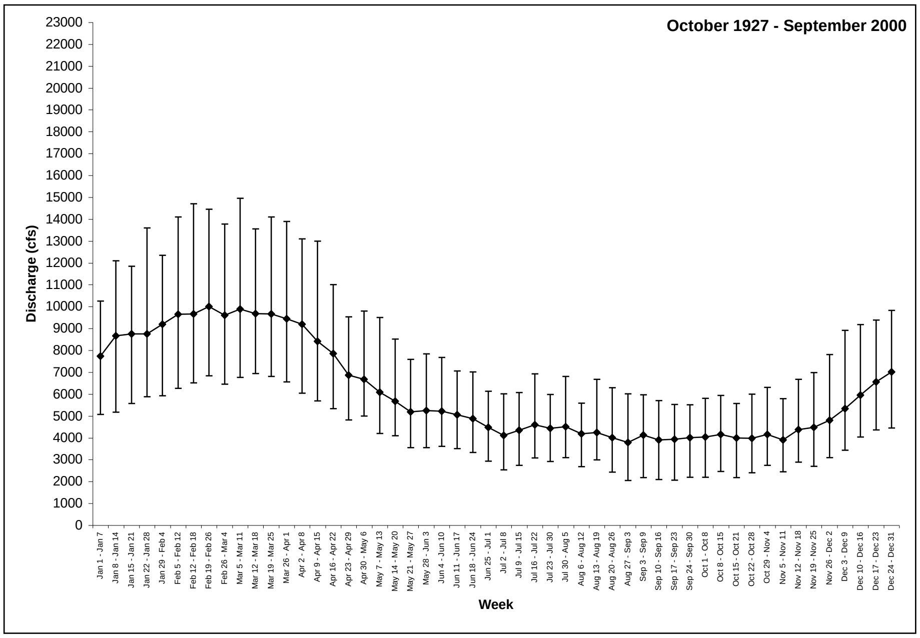


Figure 10.8. Weekly median discharges with corresponding 25th and 75th percentiles measured at the U.S. Geological Survey gaging station on the Pee Dee River near Rockingham before and after the dam construction.

10.7 LOSSES OF STRIPED BASS EGGS AND FRY TO WATER INTAKES

Striped bass eggs are approximately 3.5 mm (about 1/8th of an inch) in diameter and drift downstream with river currents. Once hatched, striped bass fry are approximately 5 mm (about ¼ inch) in length and 2 mm in cross section width. Striped bass fry also drift downstream with river currents and until several days after hatching can swim only sporadically in an upward motion. Not until 10 days or so after hatching, at a length of 10 mm (about ½ inch), can the fry swim horizontally and then only in short distances. Once grown past the fry stage, juvenile striped bass do not develop strong swimming abilities for several weeks. In summary, striped bass eggs, fry, and juveniles are unable to avoid being entrained into most water withdrawal systems.

Millions of gallons of water are pumped daily from coastal rivers by industrial, municipal, and agricultural water users. During the striped bass spawning season, striped bass eggs and larvae drifting downstream with river currents are subject to entrainment (drawing organisms into a system through water suction) or impingement (pinning organisms against a screen by water intake pressure) by these various water intakes. Juvenile striped bass that have not fully developed their swimming abilities are also susceptible to be removed. Once entrained, eggs, larvae, and juveniles can be considered completely lost from the river. Even if the withdrawn water is returned to the river (such as is the case with industrial cooling water), striped bass are killed by high water pressure, turbulence, abrasion, and exposure to excessive temperatures. Some intake structures are equipped with fine-mesh screens to exclude fish eggs and larvae; however, in many instances, fish eggs and larvae are impinged on these screens by water pressure. Furthermore, these screens require constant cleaning with air and water jets to remove debris. Little is known about the survival rates of eggs and larvae that are impinged and then released by cleaning operations. However, damage or even death from pressure and abrasion seems likely. Removal of these eggs, larvae, and juveniles through water intakes represents a direct loss in striped bass reproductive success. Devices including electrical screens, air bubble curtains, lights, high-frequency sound, chemicals, and lights have been developed as a “warning” system to deter fish from intake systems (Martin et al. 1994, Greene et al. 2009). In the lower Cape Fear River, a study at the Brunswick Steam Electric Plant found that the combined use of fish diversion structures, fine mesh screens, a fish return system, and flow minimization reduced the number of impinged or entrained larvae and fish by 40–70% (Thompson 2000).Although the overall impact is currently unknown, these losses could theoretically be significant for those striped bass populations in which spawners are few. In order to reduce the number of striped bass eggs and fry that are affected by intake structures the NCWRC has adopted the standard of water flow less than 0.5 ft/s with 1 mm slotted screens. The primary concern with cooling water intake structures is the cumulative impact of multiple facilities on fish populations (ASMFC 2002). For example, in the Delaware Bay estuary, which has four power plant facilities, it was estimated that an average of 14.3 million fish/year were impinged and more than 616 million fish/year were entrained (EPA 2002). Although DWR requires registration of major water withdrawals, compliance with registration requirements is not monitored therefore the full extent of withdrawals is unknown.

The magnitude and seasonal timing of agricultural water withdrawals from coastal rivers is unknown. Documentation of these withdrawals should be required by Division of Water Resources and Division of Water Quality, so that the extent of entrainment of striped bass eggs, fry, and juveniles can be estimated.

10.8 LOSS OF WETLANDS

Wetlands form a unique interface between terrestrial and aquatic ecosystems, providing valuable water related functions and important habitat for a broad range of fish and wildlife species. Major conversions of coastal and freshwater wetlands have occurred due to agricultural and silvicultural expansion, industrial development, and urban encroachment. It is estimated that North Carolina has already lost 34% of its coastal wetlands (NCDCM 1999), which are critical fisheries habitat. Bulkheads also degrade spawning and nursery habitat for many species, including river herring and striped bass, which utilize the vegetated march edge (O’Rear 1983; SAFMC 1998; Waters and Thomas 2001; and NCDMF 2004).

Permit issuance to individuals and/or entities requesting permission to impact surface waters and wetlands is granted by state and federal regulatory agencies (NCDWQ, NCDCM, and USACE). Resource agencies (NCWRC, NCDMF, USFWS, and NMFS) are given the authority to request modification or denial of projects when the design is perceived as having adverse impacts to fisheries and aquatic resources. Basinwide water quality management plans prepared by the NCDWQ also identify specific water quality concerns within an individual watershed.

The NCEMC can classify areas with special water quality such as Outstanding Resource Waters (ORW), and these areas are given additional consideration of impacts prior to issuing development permits. In addition, the EMC can classify areas as Nutrient Sensitive Waters (NSW), and the Chowan River, Neuse River and Tar-Pamlico River basins have been designated as such. In conjunction with this designation, Nutrient Sensitive Waters Strategy (NSWS) is developed and includes a 30% reduction in nitrogen loading from agriculture, no net increase in phosphorous, protection for riparian areas, stormwater runoff control, and wastewater discharge standards.

The CRC regulations do not allow authorization of projects that can violate water quality standards or adversely affect the life cycle of estuarine resources. The CRC regulates development activities in Areas of Environmental Concern, which include coastal wetlands. Generally, no development is allowed in coastal wetlands except water dependent activities such as docks. The EMC manages wetlands through the 401/404 Certification Program, under the federal Clean Water Act. This program focuses on avoiding and minimizing filling of wetlands and streams through review of all Environmental Assessments (EAs), Coastal Area Management Act (CAMA) major permit applications, and USACE permit applications to determine if the project will violate water quality standards.

Regulations enacted for water quality protection by the EMC and the CRC must be consistent with the authority of the CHPP.

10.9 WATER QUALITY

10.9.1 Water Quality Requirements

Striped bass have very specific water quality requirements for survival, spawning, and development. These requirements are thoroughly described in the life history section. (Scruggs 1957, May and Fuller 1965, Smith 1973 and Barkuloo 1967). Spawning may terminate if temperatures decline as a function of weather (passage of cold fronts) or reservoir releases (see Calhoun et al. 1950, Mansueti and Hollis 1963, Boynton et al. 1977, as cited in Hill et al. 1989; Rulifson 1990 and 1991b). Although salinity and total dissolved solids (TDS) concentrations have been reported as important factors in some systems (Bain and Bain 1982), they have not been reported to influence spawning behavior in North Carolina rivers.

10.9.2 Water Quality Concerns

There are a wide range of water quality concerns that may affect striped bass. These concerns include point and non-point source discharges, hypoxia, blue green algae blooms, summer conditions, and contaminants. All of these potential issues may negatively affect striped bass in all life stages.

10.9.2.1 Point Source Discharges

The DWQ has the responsibility of ensuring that the waste limits in the National Pollutant Discharge Elimination System (NPDES) permits are established to protect water quality standards in receiving waters. NPDES permits contain effluent limitations that establish the theoretical safe level of various pollutants that may be discharged into surface waters. Maintaining adequate levels of dissolved oxygen (DO) on a year-round basis is a major issue for all of coastal North Carolina. For most of the State's waters the dissolved oxygen standard is 5.0 mg/L. Streams classified, as "swamp waters" by DWQ do not retain this level of protection, and are instead assigned acceptable DO levels on a case-by-case basis. Because many of the rivers and tributaries in coastal river basins receive drainage from swampland, low DO and low pH characteristics can be naturally occurring. This further reduces the ability of these waters to buffer negative impacts arising from seemingly low levels of point and non-point source pollution. The cumulative effects of multiple discharges in coastal North Carolina are of concern and DWQ has concluded that the past approach of assigning acceptable DO levels may have resulted in the over allocation of waste assimilative capacity of receiving waters. The DWQ has identified the need to develop a better method of assessing the ability of swamp waters to assimilate oxygen-consuming waste.

The largest permitted outfall (approximately 80 MGD) in the A/R management area is from the Domtar/Weyerhaeuser Paper Company, which operates a paper mill near Plymouth. The outfall originally discharged into Welch Creek until 1988 when it was relocated to the mainstem Roanoke River. In the 1980s, dioxin, a carcinogen byproduct of the chlorine paper bleaching process and discharged in Weyerhaeuser's effluent was found to be accumulating in the tissues of fish living in the lower Roanoke River. It was not until 1994 that a complete modernization of the paper mill was instituted, rendering the use of chlorine in the bleaching process obsolete. Although dioxin levels in fish tissues are gradually decreasing, fish consumption advisories remain in effect in the A/R management area as a result, and Welch Creek and the lower Roanoke River will retain an impaired-waters listing until the advisory is removed. Union Camp, a large paper mill that discharged effluent into the upper reaches of Roanoke River near Roanoke Rapids and to the Blackwater River in Virginia, a major tributary to the Chowan River closed in the Spring of 2010.

Point discharges are also a special concern in the CSMA systems, as the management area receives effluent from numerous municipal wastewater treatment plants. Some of the largest of these are permitted to the cities of Raleigh, Smithfield and Kinston on the Neuse River, Rocky Mount, Tarboro and Greenville on the Tar River and Fayetteville and Wilmington on the Cape Fear River. Major industrial discharges are also present near the mouths of the Neuse and Cape Fear rivers.

In an attempt to enhance their abilities to provide potable water to their constituents, several coastal municipalities use or are considering the use of membrane technologies (reverse osmosis (RO)). Membrane processes produce two streams, the permeate stream (product water) and the by-product stream (concentrated brine effluent). One of the more practiced forms of concentrate disposal is via discharge to surface waters. Problem constituents in this effluent include hydrogen sulfide, chloride, fluoride, pH, nutrients (TP and TN), ammonia, dissolved oxygen, metals (copper, iron), radionuclides (Radium 226/228), conductivity and total dissolved solids. Research conducted near reverse osmosis plant outfalls in Florida indicates concentrate discharges typically fail toxicity tests performed on invertebrate and vertebrate organisms indigenous to the receiving waters (Andrews 2001). There are no existing reverse osmosis plants in operation within the United States that function in aquatic systems similar to those found in the coastal ecoregion of North Carolina. Currently, reverse osmosis plants are proposed or have been constructed in the counties of Currituck, Camden, Pasquotank, Hyde, Tyrrell, Dare and Beaufort. Although most of these reverse osmosis plants were originally designed where the discharge would go into areas that had salinity values that were greater or equal to the discharge, newer facilities are being designed in less saline areas. There has been some work in North Carolina investigating the impacts of RO discharge on the benthic invertebrates and fishes. Researchers at ECU have found no significant reductions in the abundance of benthic organisms around the discharge location. The researchers concluded there would be only minor impacts at the proposed discharge sites along the more saline and higher energy shoreline of Albemarle Sound (Deaton et al. *in press*). Although this work was set to continue on to determine if effects occurred over a longer period this work was not continued. Generally these less saline areas are classified as anadromous fish spawning areas.

10.9.2.2 Non-point discharges

Sedimentation resulting from erodible agricultural fields, construction and development sites, unstable shorelines, woody debris removal and road construction adjacent to waters in coastal North Carolina degrades water quality and threatens fisheries resources. In addition, increasing urbanization has intensified stormwater run-off pollution within each river basin. This is especially the case in Dare and Currituck counties in the A/R system which have experienced population growth in excess of 100% between 1970-1980, and again from 1980-1990. Similar increases have been observed in Brunswick (43%), Pender (42%) and New Hanover (33%) counties in the CSMA systems between 1990-2000. The losses of wetlands and riparian buffer zones, which help to filter pollutants and settle out sediments, have an adverse impact on water quality and fisheries resources in adjacent water bodies.

Maintenance of good water quality in spawning and nursery habitats is essential to the well-being of striped bass stocks. High concentrations of suspended solids (500-1000 mg/L^{-1}) significantly reduce hatching of striped bass eggs and survival of striped bass larvae (Auld and Schubel, 1978). An increase in water turbidity can also adversely affect the ability of striped bass larvae to capture zooplankton prey, resulting in larval starvation or poor condition. When impacts on reproductive processes are severe, year-class strength, and ultimately recruitment of individuals to the fishery, is significantly reduced. Management strategies focused on the protection and maintenance of the water quality functions of wetlands, specifically for nonpoint source pollutant abatement, need to be strengthened and enforced in coastal North Carolina. DWQ has identified the need for more widespread monitoring data to better assess the impacts of nonpoint sources of pollution on water quality.

10.9.2.3 Hypoxia Events

Dissolved oxygen (DO) concentrations >5 mg/L are recommended for all life history stages of striped bass. As oxygen levels drop below this standard, potential population impacts include deformities and reduced hatch of striped bass eggs (Turner and Farley 1971), yolk-sac larvae mortality (Rogers et al., 1980), mortality of juvenile striped bass at or below 3.0-3.6 mg/L (Chittenden, 1971; Coutant, 1985), and avoidance of waters by all ages of striped bass when dissolved oxygen falls below 3-4 mg/L (Cheek et al., 1985; Coutant, 1985).

Numerous episodes of hypoxia (low dissolved oxygen) confirm that certain waterbodies in coastal North Carolina can become stressed to the point that striped bass growth and survival may be impacted. For instance, during the summer of 1998, and under currently permitted biochemical oxygen demand (BOD) loads, continuous water quality monitoring stations in Roanoke River indicated that the dissolved oxygen standard of 5 mg/L was contravened for 21 consecutive days. Proposals to bring further industrial development to the Roanoke River are of great concern because of the existing tenuous DO conditions. DWQ has stated that "The Roanoke River model has consistently predicted that the BOD capacity of the system is exhausted."(Mulligan, et. al 1993, in Roanoke River Water Flow Committee Report). Given the absence of additional assimilative capacity, it is critical to the continued management of the A/R striped bass stock that no new BOD loads be permitted in the Roanoke River. Flood control and hydropower operations contribute to hypoxic conditions in Roanoke River. Prolonged and seasonal flooding of the extensive wetlands adjacent Roanoke River causes DO levels in the river to plummet when high BOD swamp waters suddenly enter the river at the end of a water control action. Recurrent hypoxic events are also well documented in Pamlico and Neuse rivers as well as Pamlico Sound and are linked to algae blooms resulting from nutrient over-enrichment.

10.9.2.4 Blue-green algae blooms

Nutrient loading in coastal North Carolina from both point and nonpoint sources has been problematic for decades as evidenced by the recurrence of blue-green algae blooms in the lower Chowan River and western Albemarle Sound and the Pamlico and Neuse rivers as well as Pamlico Sound. Sources of nutrients include animal operations, cropland, urban stormwater, fertilizer plants and wastewater treatment plants. Some waters, such as the Chowan and Neuse rivers, have been classified as NSW by the EMC and receive special nutrient loading protection. In previous analyses of nutrient over-enrichment problems in Albemarle Sound, DWQ identified Roanoke River as a significant contributing source for nitrogen and phosphorus. An overabundance of nutrients, primarily nitrogen and phosphorus, under certain conditions can stimulate the occurrence of nuisance algae blooms. Algae blooms, through the processes of respiration and decomposition, deplete dissolved oxygen in the water column often causing fish kills. Blue-green algae blooms are more severe (covering a wider area and of longer duration) during years with heavy winter and spring rains followed by a dry summer. One important concern associated with blue-green algae blooms appears to be disruption of the food chain for young striped bass. Evidence suggests that blue-green algae, which are not a suitable food source for small aquatic animals, can disrupt the food chain by displacing normal algae populations.

10.9.2.5 Summertime Conditions

The optimum temperature range for striped bass shifts to lower temperatures as the fish grow; for first year juveniles it approaches 26°C (78.8°F), whereas it is near 20-24°C (68-75°F) for age-2 fish (Coutant and Carroll, 1980; Coutant et al., 1984). As adults, optimum water temperatures drop to 20-22°C (68-71.6°F), with avoidance of temperatures above 25°C (77°F) when cooler water is available (Schaich and Coutant, 1980).

Periods of excessively high water temperatures have been observed in the coastal waters of North Carolina during the summer months. Although this condition is a function of natural environmental processes and is not considered a type of degradation, the impacts of hot water on striped bass can be significant. In August 1999, DWQ reported that approximately 21,000 adult striped bass died in Albemarle Sound and portions of Croatan Sound as a result of high water temperatures. An extended period (August 5-August 28) of hot weather resulted in water temperatures exceeding 29.4°C (85°F). There have been several fish kills during summertime conditions including approximately 150 striped bass deaths in August 2002 (S. Winslow, NCDMF, pers. com. 2010). In Albemarle and Pamlico sounds, persistent periods of hot weather, little wind, and low precipitation result in stratification of the estuarine water column. Saline water, which is denser than fresh water, layers the bottom and does not readily mix with upper freshwater layers. This results in a depletion of oxygen within the bottom layers of the water column and with little wind aeration, an eventual oxygen depletion of the entire column. Excessive nutrient inputs into all of North Carolina’s estuaries with the accompanying overgrowth of microorganisms are known to exacerbate this summertime phenomenon. In periods of drought, reservoirs tend to release less water, and can reduce flows during critical periods for striped bass.

In years when there is low precipitation, drought conditions may occur causing a change in public water demand. Changes may include reducing water releases at dams and increased water withdrawals from surface waters. For example on the Tar River in Greenville, North Carolina water companies are trying to find alternative methods to prevent salt wedges from reaching water intake structures. Some of the proposed designs include a semi-permeable inflatable dam and moving water intakes further upstream. In 1995, the USACE did not release water from the Kerr dam. As a consequence anoxic water from the black swamps reached the Roanoke River causing a fish kill.

10.9.2.6 Aquaculture

There have been some concerns regarding the effects of striped bass farms on water quality. After a series of public complaints regarding algal blooms in surface waters that have aquaculture facility discharges, the NCDWQ started working with 5 of the 20 eastern North Carolina listed aquaculture facilities in 2006. The NCDWQ and the facility operators were working together to determine best management practices on how to minimize the impacts of these facilities on surface waters. As a general practice the aquaculture facilities will drain their ponds several times a year and discharge into adjacent waters. As part of NCDWQ's initial survey the water quality (TSS, TN, TP, chlorophyll a, and BOD) of the facilities' ponds and adjacent surface waters was monitored. While working with these facilities a high level of variability was observed when measuring TSS, TN, TP, chlorophyll a, and BOD, but concluded that more samples would be needed to discuss trends (J. Paxson, NCDWQ, pers. comm. 2010). As a result the NCDWQ suggested a 5 day period to drain the facilities' ponds. As of 2010, 5 of the aquaculture facilities that have direct discharges in surface waters have been operating under a Special Order of Consent (SOC) (J. Johnson, NCDENR, pers. comm. 2010), while the other facilities will be looked at in the future once the process has been completed on the original facilities (A. Hodge, NCDWQ, pers. comm. 2010). This SOC has allowed these 5 facilities to continue to operate using BMPs. The facilities must also: 1) create a facility management plan, 2) evaluate how to reduce, reuse and minimize the amount of discharge, and 3) explain how to meet effluent standards. In 2010, the 5 facilities operating under the SOC have completed phase 1 and are working on phase 2. As a condition these facilities have had to monitor water quality and report to NCDWQ every six months. In 2014, these facilities will have to apply for a NPDES permit stating the minimum amount of discharge. During this process they will have to undergo a full permit review.

10.9.2.7 Contaminants

The persistence of dioxins, mercury and other contaminants in our river basins can have significant and adverse impacts on aquatic and terrestrial organisms, and when absorbed or ingested by humans, pose serious and life threatening consequences. Dioxins are unintentionally produced in many manufacturing and incineration processes and are some of the most carcinogenic substances known to man. Burton et al. (1983) analyzed the impacts of treated bleached Kraft mill effluent on striped bass post-larvae, and concluded that at volumes approaching 8-20%, mortality after 72 hours of exposure was significant. In addition, because dioxins are chemically stable and bioaccumulate in animal tissues, organisms higher up in the food chain tend to have greater concentrations of the chemical. Dioxins do not mix with water, instead binding tightly with sediment, food particles and organic matter, leaving extremely low concentrations dissolved in the water. Due to the slow breakdown rate of dioxins, organisms (like large fish such as bass and bowfin) exposed to continuous sources of dioxins tend to have higher levels in their tissues than fish that are lower in the food chain.

Bioaccumulation of these substances in certain sections of the A/R management area has resulted in fish consumption advisories being posted to warn the public of the health risks posed by eating fish. Research needs in the CSMA systems include an assessment of the sediments in the lower Neuse and Pamlico rivers for the presence of contaminants resulting from Hurricane Floyd. The DWQ has monitored dioxin levels in fish tissues from the Roanoke River, Chowan River and Albemarle Sound since 1989. Fish consumption advisories for the Roanoke River and Welch Creek have been in place since 1990 and for Albemarle Sound since 1991. The current advisory, as of March 2001, covers Welch Creek; the Roanoke River from the U.S. Highway 17 bridge near Williamston to the mouth of the Albemarle Sound; and Albemarle Sound from Bull Bay to Harvey Point and west to the mouth of the Roanoke River and the mouth of the Chowan River at the US Highway 17 Bridge. The advisory reads, "Catfish and carp from these waters may contain low levels of dioxins. Women of childbearing age and children should not eat any catfish or carp from this area until further notice. All other persons should eat no more than one meal per person per month of catfish and carp from this area." Welch Creek, a Roanoke River tributary has been a wastewater disposal site for dioxin and furan. In February 2010, project plans have been designed to remediate Welch Creek by capping the creek bottom using approximately 5cm of sand.

Methylmercury has been identified as the most toxic and widespread contaminant affecting aquatic ecosystems in the United States (Wiener and Krabbenhoft, 1999). Atmospheric deposition of inorganic mercury (Hg) is the primary source of contamination. Certain water bodies can be classified as mercury sensitive, in that relatively small inputs of total mercury can seriously contaminate fish. Known mercury sensitive systems include wetlands, low-alkalinity lakes, and surface waters that border areas that are prone to flooding (Wiener and Krabbenhoft, 1999). In North Carolina, mercury contamination is problematic, leading to consumption advisories for largemouth bass, bowfin, and chain pickerel south and east of Interstate 85. The DuPont factory on the Neuse River is an example of a mercury source. In 2010, DuPont was fined $59,000 for releasing 8 ½ times the EPA allowed amount of mercury into the river. Additionally, a statewide consumption advisory exists for bowfin due to elevated mercury levels.

An oil spill can be detrimental to the entire ecosystem affecting all 6 habitat types outlined in the CHPP. In the areas where there is low flow, oil can persist for decades (Peterson 2001 and Peterson et al. 2003). Although most of North Carolina's coastal beaches are high energy areas, oil spills can cause closures of beaches and fishing activities. The presence of oil in soft bottom sediments can prevent fish eggs from hatching, limit the growth rate of small fish, and prevent fish from returning to previously utilized spawning habitat (Peterson 2001 and Peterson et al. 2003). It is important to note that these impacts can be caused by other sources such as shipping vessels running aground and natural leaking of oil or gas from subsurface deposits.

Endocrine disrupting chemicals (EDCs) are hormonally active chemicals that alter growth, development, reproductive or metabolic processes, adversely affecting the organism, its progeny, and/or stock viability (Weis and Weis 1989; Wilbur and Pentony 1999, DeFur and Foersom 2000, and Deaton et al. *in press*). EDCs may include some, but not necessarily all industrial chemicals, pesticides, metals, flame retardants, plasticizers, disinfectants, prescription medications such as antibiotics and hormones, and some pharmaceuticals and personal care products. While the public may realize that pesticides and heavy metals from industrial and car emissions may be dangerous, it is less known that seemingly benign products such as caffeine, ibuprofen, antibacterial soap, and byproducts from plastic bottles and upholstery materials are entering coastal waters and may be adversely affecting the growth and reproduction of aquatic organisms. Some examples of the effects that have been documented as a result of exposure to these contaminants include: decreases in reproduction, altered sexual development or "gender bending", environmental antibiotic resistance to one or more antibiotics, and changes in population structure or localized extinction of some species. In 2008, the NCMFC established an Endocrine Disrupting Chemical workgroup to discuss what was known regarding the effects of EDCs on coastal fishery species, and status of these chemicals in estuarine waters. *The workgroup recommended that to assess potential impact of endocrine disruptors in North*

Carolina's estuaries, a site-specific, compound specific monitoring program is needed. The program should include:

- *estuarine monitoring of the concentration and prevalence of priority chemicals of concern with possible focus on the Neuse River system,*
- *specific research on the effects of chemicals on fishery species, particularly blue crab, oysters, and fish,*
- *education and outreach regarding proper disposal of pharmaceuticals, pesticides and antibiotics, including what existing waste management and recycling programs are available,*
- *expand the NC Pesticide Disposal Assistance Program to include unused and outdated pharmaceuticals, and*
- *a plan for removal of chemicals from wastewater and runoff.*

10.10 RESEARCH RECOMMENDATIONS

Suitable and adequate habitat and water quality are critical elements in the ecology and productivity of estuarine systems. Degradation or improvement in one aspect of habitat may have a corresponding impact on water quality. Maintenance and improvement of suitable estuarine habitat and water quality is critical to successfully managing estuarine striped bass stocks. The NCMFC, CRC, and EMC should adopt rules to protect critical habitats as outlined in the Coastal Habitat Protection Plans (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 NCMFC and NCDMF should continue to comment on activities that may impact aquatic habitats and work with permitting agencies to minimize impacts and promote restoration and research.

As a result of the 2004 striped bass FMP and 2005 CHPP (Deaton et al. *in press*) several management and research recommendations have been completed or have had some progress. While adoption of NCDMF identified Anadromous Fish Spawning Areas was the only FMP recommendation completed, several are ongoing or have had some progress. This includes permit reviewers commenting on water intake structures and wetland impacts, the expected construction of the rock passage at Lock and Dam #1, and the identification of SHAs in the Albemarle Sound area (including tributaries). Although there has also been progress on research recommendations none have been completed. Research recommendations with progress include re-evaluating spawning and nursery areas in the CSMA and identifying contaminants in striped bass habitats, For a full list of the progress of the striped bass recommendations from the 2004 FMP, see Appendix 14.6.

Research Recommendations

- *There should be an effort to identify and designate Anadromous fish nursery areas and how early juveniles move and are distributed in NC estuarine waters.*
- *Investigation of the North Carolina portions of the Waccamaw River should be undertaken during the appropriate season.*
- *There should be continued support and development of SHAs in NC.*
- *Nottoway, Blackwater and Meherrin rivers are tributaries to the Albemarle Sound Management Area. Investigations would determine if dams in this system were having an impact on striped bass spawning. Investigate abundance and spawning contribution of striped bass in the Blackwater, Nottoway and Meherrin rivers. Manpower and monies*

need to complete surveys are lacking at this time and work will require adding additional Virginia agencies to the management process.

- *Continue to investigate the potential for passage of striped bass above Roanoke Rapids Dam.*
- *Data on the density and distribution of striped bass eggs, fry, and juveniles in coastal rivers are needed so that potential losses to entrainment and impingement can be estimated.*
- *Determine if contaminants are present and identify those that are potentially detrimental to various life history stages of striped bass.*
- *Evaluate the effects of existing and future water withdrawals on water quality and quantity and fisheries habitat in coastal watersheds.*
- *Evaluate the impacts/effects of reverse osmosis plants on receiving waters and aquatic resources*.

Recommendations

- *Once the SHAs have been designated there should be continued protection of these areas by the cooperating agencies.*
- *Verify condition of identified SHAs used by striped bass.*
- *Work with NCWRC, DWQ, and others to implement management measures that will enhance water quality in SHAs used by striped bass*.
- *NCDMF and NCWRC should work with DWQ and other agencies to initiate efforts to determine and establish more stringent water quality standards in waters designated as Anadromous Fish Spawning Areas.*
- *Recommendations pertaining to striped bass from the 2010 CHPP should be supported and implemented (i.e. dam removal and SHA development).*
- *Support the removal of Buckhorn Dam and Lock and Dam No.2 and No.3 and construction of expected rock ladder at Lock and Dam No. 1. Striped bass would be able to return to historical spawning grounds. A fishery for striped bass and other anadromous species would develop upstream.*
- *Investigate the feasibility of fish passage at and improved water flows from Rocky Mount Mill Dam and Tar River Reservoir Dam.*
- *Support the removal of Milburnie Dam in Raleigh.*
- *Investigate the feasibility of fish passage above the Yadkin chain of dams in North Carolina. Passage would be costly but striped bass and other anadromous species could be restored to their historical range.*
- *Work with American Rivers and other partners to accelerate dam removal in priority areas.*
- *Identify effective engineering solutions to prevent entrainment and impingement of striped bass eggs, fry, and juveniles.*
- *Agencies should continue to protect North Carolina coastal wetlands through the permit review process.*

11.0 PRINCIPAL ISSUES AND MANAGEMENT OPTIONS

11.1 RECREATIONAL STRIPED BASS HARVEST CLOSURE- OREGON INLET AREA/ATLANTIC OCEAN

I. ISSUE

Increased and unaccounted harvest of A/R striped bass 28 inches total length (TL) and larger during the late spring through the summer/early fall from the Atlantic Ocean.

II. ORIGINATION

Striped Bass Plan Development Team

III. BACKGROUND

The recreational striped bass fishery around Oregon Inlet has grown significantly since the mid-1990s. This fishery not only targets the Atlantic Migratory Stock during the fall and winter but also the Albemarle/Roanoke (A/R) stock during the late spring through the summer/early fall. The line of demarcation between the Atlantic Ocean and the Albemarle Sound Management Area (ASMA) is the centerline of the Bonner Bridge and east of this line is open to harvest year round. The daily allowed harvest limit east of this line is 2 fish per person and a 28 inch TL minimum size limit. This Oregon Inlet area fishery has resulted in essentially year round fishing directed on a portion of the A/R stock. This was an issue debated in the 2004 North Carolina Estuarine Striped Bass Fishery Management Plan (FMP) and the approved option at that time was status quo, to allow the fishery to continue.

Since the early 1990s, 161 tags have been returned from the Oregon Inlet area and near ocean Waters (Corolla to south of Oregon Inlet). These fish were either tagged on the spawning grounds in the Roanoke River or in the ASMA. The recapture time period May through October has accounted for 107 (66.5%) of the returns (Table 11.1.1 and 11.1.2). The majority of these returns (n=83) are from fish tagged on the spawning grounds, with a growing number exceeding 28 inches TL when tagged and released (Table 11.1.1). Approximately 67% of the returns from the NCDMF gill net survey tagged fish were from this time period (Table 11.1.2). The number of 28 inch and larger fish tagged and released annually on the spawning grounds since 2001 has ranged from 1.7 through 7.0% and the overall percentage is still ~ 3.5% of the total number tagged since 2001. Twenty-eight (33.7%) of the 83 returns from the ocean for the May-October period were 28 inches or larger and tagged on the spawning grounds, Roanoke River. The NCDMF is not only concerned with the increased harvest of these large fish but also the unknown levels of catch and release mortality of sub-legal fish as a result of higher water temperatures during the summer months. Seventy-two percent of the returns for the May – October period were sub-legal fish (Table 11.1.1 and 11.1.2).

Data collected from the Marine Recreational Information Program (MRIP) (formerly the Marne Recreational Fishery Statistics Survey) survey in 2002 for the time period May-October for the ocean showed ~59,000 lbs (PSEs>50) of striped bass harvested. The MRIP data (number of fish and annual pounds) for 2005 – 2009 are shown in Table 11.1.3, with landings only reported for 2007. The number of fish landed in 2007 for May – October

(Wave 3 – 5), accounted for 9.3% of the total number of fish harvested that year (PSE=98.2 for Wave 5).

Since 2005, the NCDMF implemented an Atlantic Ocean striped bass catch card program from May 1 through October 31 annually by proclamation (see FF-48-2010). A copy of the current proclamation is attached. The catch card requirement applies to recreational harvest of striped bass from Ocracoke Inlet to the North Carolina/Virginia state line. Striped bass landed during the period are required to have a DMF landing tag affixed through the mouth and gill cover before the fish is removed from the vessel. Catch cards must be completed to obtain a landing tag. The intent of this requirement is to produce an estimate of recreational striped bass harvest from the Atlantic Ocean during the ASMA closed season (Table 11.1.4). The estimates of this catch provided by MRIP during this period lack precision needed for the current management strategies.

IV. CURRENT AUTHORITY

North Carolina Marine Fisheries Commission Rules
<u>North Carolina Fisheries Rules for Coastal Waters (15A NCAC)</u>
3M.0204 Season, Size and Harvest Limit: Atlantic Ocean

V. DISCUSSION

As the A/R striped bass year classes have continued to increase, so has the availability of fish 28 inches TL and larger in the population. Since 2001, the percentage of striped bass 28 inches and larger tagged on the spawning grounds has increased annually, ranging from 1.7 % through 7%. However, the percentage is still just over 3.5% of the total number tagged since 2001. Even though the number of fish 28 inches and larger have increased, they still only represent a small percentage of the total population. Striped bass of this size are considered prime spawners and should be provided protection. The impact of the harvest of these 28 inch and larger fish during the May – October period on the A/R stock cannot be quantified but the percentage of the returns has ranged from 0 to 14.3% (Table 11.1.1).

The number of tag returns from striped bass less than the legal size (28 in TL) during the period May - October is shown in Table 11.1.1 and Table 11.1.2. The number of tag returns from sub-legal fish account for 72% of the total returns for the period May – October. Mortality of catch and release striped bass increases as water temperatures increase. Various studies indicate that mortality rates are highly dependent on water temperatures and increase with each degree when water temperatures increase above 70° F. The adjusted mortality rates range from 6.4% to 9% as reported in Diodati 1989, Diodati and Richards 1996, Nelson 1998, and Gearhart 2002. Other factors that play a role in mortality include salinity levels, artificial verses live bait, hook type, hook location/bleeding and hook removal (handling). One of the management measures implemented as a result of the 2004 Estuarine Striped Bass FMP to address such mortality – “recreational harvest seasons should be limited to months (October – April) in which cool water temperatures (<70° F) occur, thus minimizing mortality from catch and release fishing”.

Based on information from numerous fishing reports and web pages of the striped bass catches during the period May – October, catch card compliance among anglers is low. Thus, an estimate of the harvest during the period is unknown. The Division feels there is not a survey mechanism to provide a reliable estimate of harvest without a great cost. The status quo action (allow harvest year round) taken through the 2004 Estuarine Striped Bass

FMP, with the catch card survey provided the opportunity for fishing to continue. However, compliance has not been achieved. The closure of the Atlantic Ocean to the harvest of striped bass during the period May – September would be consistent with the recreational closure for internal waters of North Carolina and provide protection of these larger "broodstock". Also, since the tag returns show that harvest of ASMA striped bass are occurring, these fish are not accounted for as part of the annual recreational total allowable catch (TAC) (137,500 lbs).

Initial review of this issue by the A/R AC during their September 23, 2010 meeting, resulted in a request to NCDMF to conduct a sensitivity analysis on change in fishing mortality (F) on the A/R stock due to possible increased harvest of age 9+ fish. The Division presented the requested sensitivity analysis December 2, 2010 to the AC for their consideration. The presentation described the methods used, presented F rates of age 4-6 and age 9+ from the ASAP2 2009 stock assessment, and for comparison, the F rates of the age 9+ group with various levels of additional harvest.

The analysis was based on the recreational catch-at-age matrix that was used as input into the ASAP2 2009 stock assessment model. Five various harvest level scenarios were presented: the harvest of age 9+ fish was increased for the years 1998-2008 in the amounts of 500; 1,000; 1,500; 2,000; 5,000; and 10,000 age 9+ fish annually. The new F rates on age 9+ fish were then compared to the F rates from the stock assessment. Figure 11.1.1 shows the overall stock abundance as well as the abundance of age 9+ fish from the ASAP2 2009 stock assessment model.

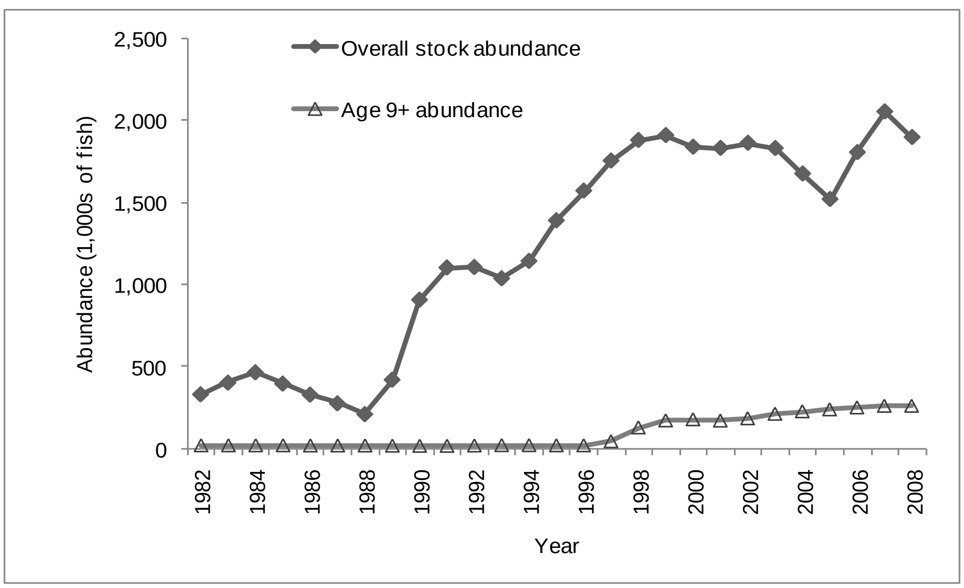


Figure 11.1.1. Overall A/R stock abundance as well as the abundance of age 9+ fish from the ASAP2 stock assessment model.

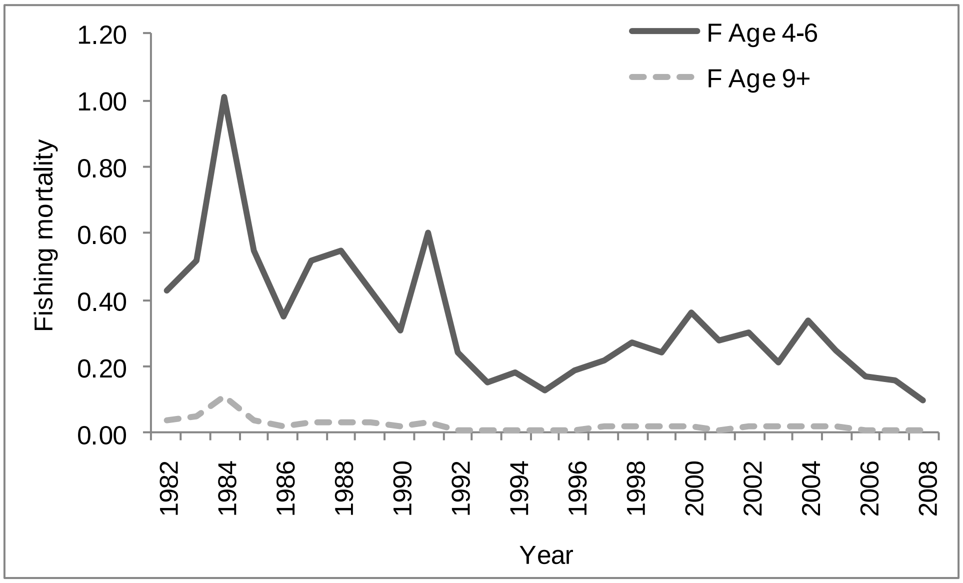


Figure 11.1.2. Fishing mortality (F) values for the A/R stock for age 4-6 and age 9+ from the ASAP2 stock assessment model.

As seen in Figure 11.1.2 the F on age 9+ is small, contributing very little in terms of the model. To better see the trends in F age 9+ the scale is magnified in Figure 11.1.3. From 2000-2008, total numbers of age 4-6 fish removed (harvest + discards) ranged from 33,000-157,000 fish. This range was used to provide reasonable bounds for the age 9+ harvest scenarios. Total numbers removed for the same period ranged from 290,000-654,000 fish. In looking at the five various harvest level scenarios (additional removals from 500 to 10,000 fish) (Figure 11.1.4) the modeled increases in F are probably not statistically measureable. Even at the largest scenario the F only increases by 0.04. At each assumed level of harvest the F rate increased as follows:

- Additional 500 fish removed annually: + 0.0079
- Additional 1,000 fish removed annually: + 0.0103
- Additional 1,500 fish removed annually: + 0.0123
- Additional 2,000 fish removed annually: + 0.0143
- Additional 5,000 fish removed annually: + 0.0260
- Additional 10,000 fish removed annually: + 0.0448
-

The increase in F wouldn't even affect the stock until the fish have reached 9+ and had presumably spawned a couple times anyway. That's exactly why the coastwide stock in the ocean has the 28 inch minimum size limit which allows females at that size to spawn a couple times before harvest. Figure 11.1.5 shows these F rates on the same scale as the F age 4-6.

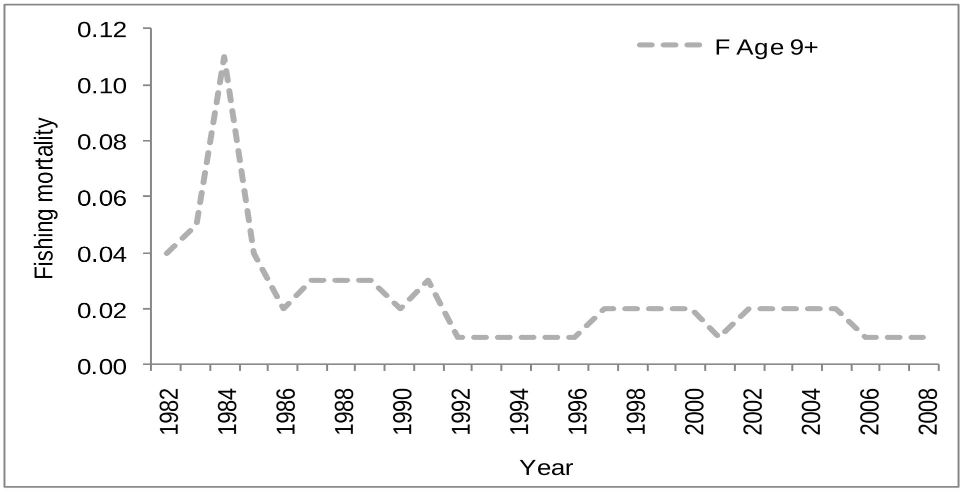


Figure 11.1.3. F rate on age 9+ striped bass from the ASAP2 stock assessment

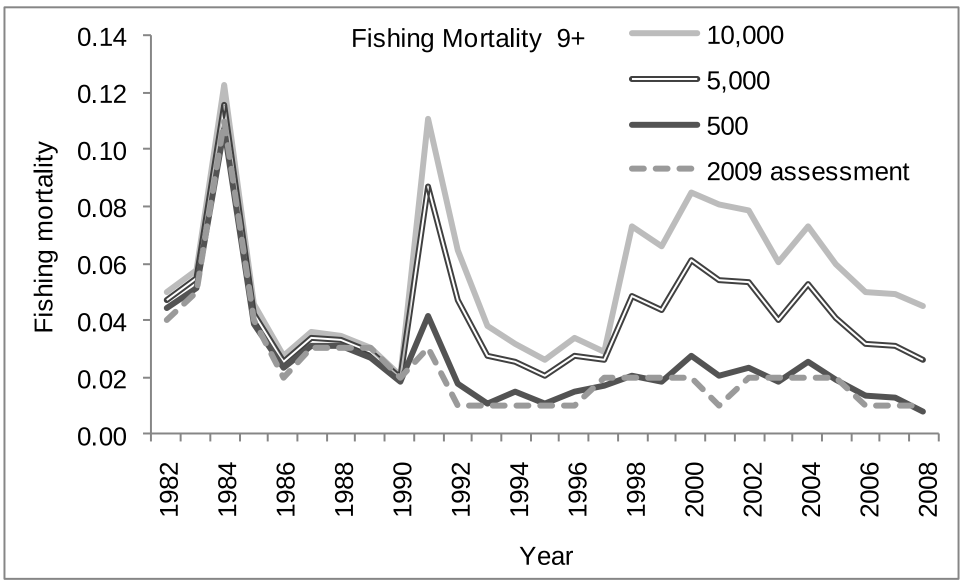


Figure 11.1.4. F rate on age 9+ striped bass from the ASAP2 stock assessment, and sensitivity of F at various assumed levels of harvest.

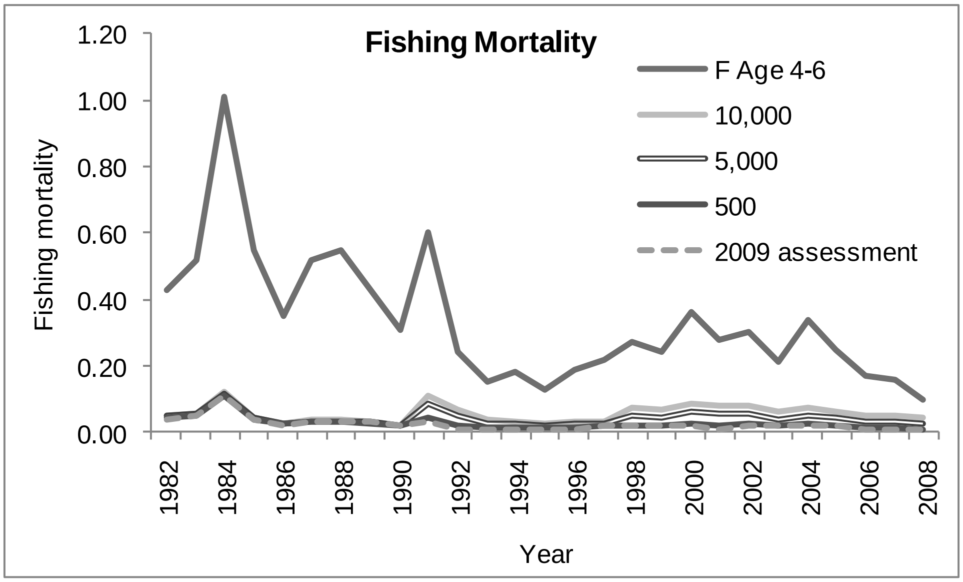


Figure 11.1.5. F rates on age 4-6 striped bass from the ASAP2 stock assessment for comparison to F at age 9+ at various assumed levels of harvest.

A motion to overturn the previous AC recommendation failed to pass by a 2/3 majority at the December 2, 2010 AC meeting., The original A/R AC motion from the September 23 2010 was to maintain status quo – allow the fishery to continue with catch card survey May – Oct.

VI. MANAGEMENT OPTIONS

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

1) Status Quo – allow the fishery to continue with catch card survey (May – Oct)
- will provide no protection for 28 inch TL and larger striped bass
- directed fishery will continue with hook and release mortality of sub-legal fish
- unquantified harvest will continue and portion to ASMA recreational Total Allowable Catch (TAC) will be unknown

\+ allow for economic gain to charter and guide services

2) Close the Atlantic Ocean to the harvest of striped bass from the time the ASMA recreational season closes in the spring until October 1 of each year.

\+ will provide protection of 28 inch TL and larger striped bass

\+ no harvest of the recreational ASMA TAC when fishery closed (~ May - September)

\+ could reduce the hook and release mortality of sub-legal fish due to no directed fishery

\+ closure will coincide with adjacent North Carolina internal waters (ASMA)

\+ cost saving to Division – tags and distribution

\- potential for economic impact to charter and guide services

VII. RESEARCH NEEDS

- Methodology tested to accurately capture Atlantic Ocean harvest.

VIII. MANAGEMENT RECOMMENDATIONS

NCDMF Management Recommendation:
Close the Atlantic Ocean to the harvest of striped bass from the time the ASMA recreational season closes in the spring until October 1 of each year.

NCWRC Management Recommendation:
Concurs with the NC Marine Fisheries Commission's decision to maintain the status quo (allow the fishery to continue with the catch card survey May 1 – October 30) and encourages NCDMF to remain vigilant in collecting catch and harvest data necessary to evaluate the effects of the Oregon Inlet Area fishery on the Albemarle Sound-Roanoke River striped bass stock.

A/R Advisory Committee Management Recommendation:[3]
Close the Atlantic Ocean to the harvest of striped bass from the time the ASMA recreational season closes in the spring until October 1 of each year.

CSMA Advisory Committee Management Recommendation:
Status quo; allow the fishery to continue with the catch card survey May 1 through Oct 30.

NCMFC Preferred Management Option:
Status quo; allow the fishery to continue with the catch card survey May 1 through Oct 30.

Draft August 17, 2010
Revised September 24, 2010
Revised December 3, 2010
Revised November 30, 2011

[3] When the A/R AC was first presented this Issue Paper on September 23, 2010, they voted for status quo-continue the fishery with the catch card survey from May 1 – September 30, and requested a sensitivity analysis be performed to estimate the F on age 9+ fish at various hypothetical harvest levels. At the next A/R AC meeting the sensitivity analysis was provided, at which time a motion was made to close the Atlantic Ocean to harvest of striped bass from the time the ASMA recreational season closes in the spring until October 1 of each year; the motion failed due to a tie vote. At the October 6, 2011 A/R AC meeting at which time the AC was presented public comment on the draft FMP and the management recommendations from the various NCMFC standing and regional ACs, a motion was once gain made to close the Atlantic Ocean to harvest of striped bass from the time the ASMA recreational season closes in the spring until October 1 of each year; this time the motion passed. It should also be noted all members of the AC were not present at the October 6, 2011 meeting.

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Gearhart, J. 2002. Hooking mortality of striped bass (*Morone saxatilis)* in Albemarle Sound, North Carolina, Study II, Documentation and reduction of bycatch, Interstate Fisheries Management Program Implementation for North Carolina, 23p.

Nelson, K.L. 1998. Catch-and-release mortality of striped bass in the Roanoke River, North Carolina. N. Amer. J. Fish. Management 18:25-30.

Table 11.1.1. Striped bass tag returns from Oregon Inlet and Atlantic Ocean waters off NC, May – October. These fish were tagged and released on the spawning grounds, Roanoke River, North Carolina.

Year	<28" TL returns M	F	>/= 28" TL returns M	F	Total number tagged >/= 28" TL	Total returns May - Oct	Total annual returns
1991							1
1992							1
1993							1
1994							0
1995					2		2
1996	2				4	2	3
1997	2	1			7	3	9
1998	5			1	10	6	17
1999	6	1		1	22	8	10
2000	6	2		2	14	10	12
2001	5	1		2	45	8	10
2002	2		6	2	72	10	10
2003	3	2		2	140	7	8
2004	2		1	2	109	5	5
2005	4	6			75	10	12
2006	3		5	2	209	10	14
2007	1			2	142	3	9
2008	0				148	0	0
2009	1				71	1	1
Total	**42**	**13**	**12**	**16**	**1,070**	**83**	**125**

Table 11.1.2. Striped bass tag returns from Oregon Inlet and Atlantic Ocean waters off NC, May – October. These fish were tagged and released throughout the Albemarle Sound area.

Season/Year	Number <28" TL tag returns	Number >/= 28" TL tag returns	Total number tagged >/= 28" TL	Total returns May - Oct	Annual total returns
Fall/Winter 92-93			4		2
Fall/Winter 93-94			2		
Fall/Winter 94-95	1		1	1	2
Spring 1995			3		
Fall/Winter 95-96	1			1	2
Spring 96	2	1	1	3	3
Fall/Winter 96-97	1		0	1	2
Fall/Winter 97-98	2		1	2	3

Season/Year	Number <28" TL tag returns	Number >/= 28" TL tag returns	Total number tagged >/= 28" TL	Total returns May - Oct	Annual total returns
Fall/Winter 98-99	2		0	2	2
Spring 99	1		0	1	2
Fall/Winter 99-00	5		2	5	5
Spring 00	3		1	3	3
Fall/Winter 2000-2001			1		
Spring 01	1		5	1	1
Spring 02		1	2	1	1
Fall/Winter 02-03	1		2	1	3
Spring 03			6		
Fall/Winter 03-04			6		
Spring 04			6		1
Fall/Winter 04-05			1		1
Spring 05	2		3	2	2
Fall/Winter 05-06			2		1
Spring 06			2		
Spring 07			8		
Fall/Winter 07 - 08			3		
Fall/Winter 08 - 09			1		
Spring 09			2		
Total	22	2	65	24	36

Table 11.1.3. Striped bass landings (number of fish and annual pounds) from the Atlantic Ocean, 2005 – 2009 (Marine Recreational Fisheries Statistics Survey).

Year	Wave 3 * number of fish	Wave 4** number of fish	Wave 5*** number of fish	Total number of fish annually	Total annual pounds
2005	0	0	0	104,997	2,195,040
2006	0	0	0	90,753	2,153,229
2007	0	186	4,056	45,502	1,048,580
2008	0	0	0	44,890	938,704
2009	0	0	0	7,375	209,856

* Wave 3 – May – June, ** Wave 4 – July – August, *** Wave 5 – September – October

Table 11.1.4. Striped bass harvested from the Atlantic Ocean based on catch card survey (May 1 – October 31), 2005 – 2009.

Year	No. of Striped bass	Mean length (in)	Min. length	Max. length	Mean weight	Min. weight	Max. weight
2005	114	30.6	28	39	10.7	7	20
2006	139	32	28	41	13.1	8	25
2007	0						
2008	3	34.4	28.25	38	17.5	17	18
2009	28	31.5	28	39	12.6	7	20

FF 48 2010

PROCLAMATION

**RE: STRIPED BASS RECREATIONAL ATLANTIC OCEAN:
OCRACOKE INLET TO NORTH CAROLINA/VIRGINIA STATE LINE**

Dr. Louis B. Daniel III, Director, Division of Marine Fisheries, hereby announces that effective at 12:01 A.M., Saturday, May 1, 2010 the following restrictions will apply to the recreational harvest of striped bass in the Atlantic Ocean waters of North Carolina from Ocracoke Inlet (35° 04.4333N latitude) to the North Carolina/Virginia state line:

I. SIZE AND CREEL LIMITS

No person shall take or possess more than two (2) striped bass taken with hook and line or for recreational purposes from the Atlantic Ocean. The minimum size limit is 28 inches total length. Size and creel limits remain in effect, irrespective of changes in tagging requirements.

II. TAGGING REQUIREMENTS

All striped bass landed from May 1, 2010 through midnight October 31, 2010 are required to have a landing tag affixed through the mouth and gill cover before removal from the vessel. Captains or operators from trailered vessels shall have the landing tag affixed before the vessel is removed from the water. Catch cards must be completed to obtain a landing tag.

III. TAGGING REQUIREMENT EXPIRATION

The requirement for landing tags will end at 12:01 A.M., Monday, November 1, 2010.

IV. 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. Marine Fisheries Rules 15A NCAC 03H .0103; 03M .0201 and 03M .0204.

B.It is unlawful to violate the provisions of any proclamation issued by the Director under his delegated authority pursuant to N.C. Marine Fisheries Rule 15A NCAC 03H .0103.

C.The intent of this proclamation is to enable an estimate of recreational striped bass harvest from the Atlantic Ocean during the Albemarle Sound Management Area closed season. The estimates of this catch provided by Marine Recreational Fishery Statistics Survey (MRFSS) during this time period lack the precision needed for the current management strategies.

D.The waters of the Atlantic Ocean pertaining to this proclamation are defined as waters seaward of the COLREGS Demarcation Lines as indicated on National Ocean Service navigation charts. The landing restrictions apply from the 35°04.4333'N latitude line at Ocracoke Inlet to the North Carolina/Virginia state line out to a distance of three miles.

E. Catch cards and landing tags may be obtained at North Carolina Striped Bass reporting Stations. Landing tags and catch cards will also be available at all Atlantic Ocean Fishing Piers and most tackle shops in the Northern District (Outer Banks). North Carolina Division of Marine Fisheries Recreational Port Agents will also serve as Mobile Reporting Stations. Landing tags may be obtained in exchange for a completed catch card. The following information must be included on each catch card submitted: (1) Date, (2) Reporting station, (3) For Hire Permit number (if applicable), (4) Vessel name, (5) Trip type (charter boat, private boat, or head boat), (6) Tournament (Yes or No), (7) Length total length (inches), Weight (pounds), and (8) Tag number.

F.North Carolina For Hire Permit (FHP) holders may apply for on board catch card and landing tag materials to allow self reporting. FHP holders will be contacted by Marine Fisheries Recreational Port Agents each month to reconcile landings tags used and catch cards completed. To obtain an on board tagging kit, contact Doug Mumford

(Doug.Mumford@ncdenr.gov). Telephone: 1 800 338 7804 or 252 946 6481.

G.Anglers arriving at dock after office hours may contact the DMF 24 hour toll free number (800 682 2632) or (252 726 7021) to report their catch. A verification number will be provided to the vessel operator or Captain to keep for reporting compliance purposes. This method of reporting is restricted to after office hours landings only.

H.All undersized or over limit striped bass shall be immediately returned to the waters where taken regardless of the condition of the fish.

I.Holders of Recreational Commercial Gear License shall adhere to the size and creel limits restrictions of the recreational fishery for striped bass.

J.This proclamation adds a reporting requirement for recreational striped bass harvest through October 31, 2010. It does not supersede any existing size and creel limits or season requirements.

April 26, 2010
10:15 A.M.
FF-48-2010

11.2 STRIPED BASS STOCKING IN COASTAL RIVERS

I. ISSUE

Stocking striped bass in North Carolina coastal rivers.

II. ORIGINATION

Striped Bass Plan Development Team

III. BACKGROUND

Historical

Enhancing striped bass resources in North Carolina through stocking programs was initiated more than 120 years ago. North Carolina established the Department of Agriculture by an Act of the General Assembly (March 12, 1877) and the Act required the Board of Agriculture, Immigration and Statistics “at once to provide for stocking all available waters of the State with the most approved breeds of fishes”. During the late 1870s, hatcheries were established in the vicinity of New Bern, primarily for American shad production and Avoca (confluence of Roanoke and Chowan rivers) for striped bass production (Rulifson and Laney 1999).

Because the striped bass was an important food source, the US Fish Commission was committed to “arresting its alarming decrease” (Worth 1884). In 1884, a striped bass hatchery was established on the Roanoke River (spawning grounds) at Weldon and was the only one in the nation until the 1960s and operated almost continuously, first by the Federal fisheries agencies and then by the North Carolina Wildlife Resources Commission (WRC) (Harrell et al. 1990). The US Fish and Wildlife Service (USFWS) Edenton National Fish Hatchery was also involved in striped bass production using Roanoke River broodstock and served as a major source to other federal and state hatcheries, as well as fulfilling overseas requests. The Roanoke River striped bass population served as the original strain for culture beginning in 1884, and for many years eggs, fry and fingerlings of Roanoke River origin were stocked in watersheds throughout the eastern seaboard, along the Gulf of Mexico and in Russia. These fish were used for stock enhancement and stock restoration programs. As a result of this 100+ year-old practice of cross-stocking (stocking of non-natal fish), introgression of non-endemic genetic strains to many striped bass populations has occurred. The effects of this long-standing practice remain largely undocumented and unquantified (Rulifson and Laney 1999).

Division of Marine Fisheries

The Division of Marine Fisheries (DMF) Phase II (5-8 inches total length (TL)) striped bass stocking and tagging program began in 1980, as a result of a co-operative agreement with the USFWS. Striped bass were hatched and reared to Phase II sizes and stocked in the Albemarle Sound area, Pamlico River, Neuse River and Cape Fear River. This program was developed in an effort to augment striped bass populations during low population levels. The major objectives of the program were (1) to determine the effects of stocking on the striped bass fisheries in coastal North Carolina, and (2) to determine if stocked fish would contribute to the spawning populations. A portion of the Phase II fish stocked in each coastal system were tagged to estimate distribution, migration, use by the different fisheries, mortality and the contribution to the spawning stocks. DMF decided early in the program not to use Phase I (1+ inches TL) fish because of the possibility of obscuring the results of the annual juvenile abundance index (JAI) surveys. Phase II fish were grown in the hatcheries, tagged and stocked in December and January, well after the JAI surveys were completed.

Phase II fish were supplied by the USFWS Edenton and McKinney Lake National Fish Hatcheries in North Carolina, with supplemental fish produced in South Carolina, Georgia, Alabama and Texas. However, the Edenton Hatchery has been the primary producer. Broodstock from Roanoke River (Weldon and Dan River), Monks Corner, SC and Weldon/Monks Corner crosses were artificially spawned and larvae reared at the hatcheries. The Phase II fish (~6 months old) are harvested from the hatchery ponds in the late fall to early winter. Fish are then inventoried in the holding house at the hatchery, a portion tagged by DMF staff and all released within approximately five days of harvest in the system to be stocked.

Phase II fish have been released in the Cape Fear, Neuse and Tar-Pamlico rivers on a rotating basis (1980–2003). Since 2004, Phase II stockings have occurred in two systems annually, with a goal of 100,000 fish per stocking; this was a management measure within the 2004 North Carolina Estuarine Striped Bass Fishery Management Plan (FMP). The Albemarle Sound area was first stocked in 1981, then annually from 1983 through 1996. All of these stockings have occurred in suspected natural striped bass nursery areas (Street et al. 1975, Marshall 1976, Sholar 1977, Hawkins 1980, Dilday and Winslow 2002).

From 1981 through 1996, over 700,000 Phase II fish were stocked in the Albemarle Sound area with nearly 54,000 of these fish tagged (Table 11.2.1). From 1990 through 1996, all striped bass released in the Albemarle Sound area were tagged, so that they would not be confused with naturally spawned fish captured in later surveys. During the early to mid 1990s, greater harvest restrictions and management of river flows on Roanoke River resulted in recovery of the Albemarle/Roanoke stock; consequently, stocking in this system was discontinued in 1996. The Cape Fear River was stocked with Phase II fish during 1980, 1984, and 1989. Infrequent stockings in the Cape Fear River were a function of low number of prior tag returns coupled with complications posed by large numbers of hybrid striped bass present in the system as emigrants from Jordan Reservoir. Hybrid striped bass stockings were discontinued in Jordan Reservoir in 2002; consequently, striped bass stockings were reinitiated in the Cape Fear River in 2004, 2006, 2008 and 2009. Phase II stocking continued on a rotating basis in the Tar-Pamlico and Neuse river systems through 2008. Sub-samples of the hatchery fish continue to be externally tagged, since 1998 all fish have been marked with oxytetracycline (OTC) prior to release.

Wildlife Resources Commission

In 1993, the North Carolina Wildlife Resources Commission (WRC) began stocking Phase I striped bass (approximately 1.25 inches TL, ~ 3 months old) in coastal river systems with a target of 100,000 per system annually (Table 11.2.1). During 1998–2000, the WRC also stocked Phase II fish in the Cape Fear River and the Northeast Cape Fear River (Table 11.2.1). Phase I fish were reared at the WRC's Watha State Fish Hatchery and the USFWS Edenton National Fish Hatchery and usually stocked in June or July. Prior to 1998, Phase I fish did not receive any type of tag or mark. Since 1998, all fish stocked by the WRC have been OTC marked.

During most years, striped bass fingerlings stocked by WRC originated from Roanoke River population parentage were stocked. Patrick and Stellwag (2001) identified six distinct lineages or genotypes among striped bass from the Roanoke, Tar and Neuse rivers. Lineages I-III were abundant among all three populations, and represented 96% of the sample. Genotypic frequencies were similar between the Tar and Roanoke rivers populations, but were significantly different ($P < 0.05$) from the Neuse population. The researchers concluded that stocking practices could potentially affect the natural genotypic distribution in these populations, and suggested that broodstock should be taken from each specific population for aquaculture production, rather than entirely from the Roanoke River, especially when stocking the Neuse River population.

Formal studies were conducted by WRC in the early 2000s to estimate the percent contribution of stocked fish to the striped bass spawning stocks in the Tar and Neuse rivers. Sagittal otoliths were removed from adult striped bass from 2000 to 2004 in the Neuse River (N=124) and from 2002 to 2004 in the Tar River (N=115) and analyzed for the presence of an oxytetracycline mark (Barwick et al. 2008). Results suggested striped bass stocked in the Neuse and Tar rivers appeared to contribute little to the spawning stocks in these systems. In the Neuse River from 2000 to 2002 and Tar River in 2004 no stocked juveniles were recaptured as spawning adults. Low numbers of stocked juveniles (fewer than two fish annually) were recaptured as adults in other years; in the Neuse River, one returning adult was collected during 2003 while two returning adults were collected during 2004. Similar results were documented in the Tar River as only one returning adult was captured in 2002 and two were captured in 2003. Researchers cautioned that low mark efficiency (27% of all fish treated with oxytetracycline did not retain the mark) may have confounded project results (Barwick et al. 2008).

With low abundance of Phase I striped bass documented on the spawning grounds, WRC research efforts shifted to an evaluation of the contribution of stocked fish to seine and electrofishing samples conducted in the Neuse River. During the summers of 2006 and 2007, a combination of beach seining and electrofishing was conducted at numerous estuarine and inland sampling locations (Barwick and Homan 2008). In 2006, no striped bass stocked as Phase I fingerlings were collected at any sample site. During 2007, five juvenile striped bass were collected from two sites in the Neuse River. Of this total, three were collected from a single estuarine site in relative proximity to New Bern and were all of hatchery origin, whereas the two other juveniles did not have marks and were collected from a sample site much further (85 km) inland. Results from this project suggested limited utility of Phase I fingerlings as a management option to supplement striped bass populations in the Neuse River. In addition, the low numbers of native juveniles indicated poor reproductive success, poor survival to the juvenile stage, or a combination of these two factors (Barwick and Homan 2008).

IV. DISCUSSION

Specific objectives for stocking striped bass into coastal river systems include attempts to increase spawning stock abundance while promoting self-sustaining population levels appropriate for various habitats and ecosystems. The DMF Phase II stocking program is part of the North Carolina Striped Bass Monitoring Project funded under a Federal Aid in Sportfish Restoration grant from the USFWS. This Federal Aid grant provides 75% federal support along with a 25% state match requirement; currently, the federal share is $10,100 with a $3,400 state match for this portion of the project. The grant funds do not totally cover the cost of the tags ($0.98 each) or the rewards annually. A production goal of 200,000 Phase II fish has been set annually for stocking. These fish are grown out at the Edenton National Fish Hatchery after an early transfer of striped bass fry from the WRC’s Watha State Fish Hatchery. The grant funds received by DMF do not include the production costs that the hatcheries expend to produce and raise these fish to Phase II size. Stock enhancement programs for striped bass currently cost approximately thirty-five cents for each Phase I fish currently, compared to twenty cents each in the early 1990s. The estimated cost for Phase II fish is $2.10 each, compared to a dollar each in the early 1990s (Stephen Jackson, Edenton National Fish Hatchery, USFWS, personal communication).

Based on tag returns of Phase II fish, these stocking programs have contributed to the recreational and commercial fisheries in the various systems. Continued stocking may help sustain the striped bass populations in the Tar-Pamlico and Neuse rivers, especially in estuarine areas. In addition, stocked fish have also been captured on the spawning grounds by anglers in the Roanoke, Tar, and Neuse rivers. However, contribution of Phase II fish to actual spawning populations in the Tar and Neuse rivers is believed to be low based on the frequency of returns from inland areas. The current Phase II stocking program has likely helped sustain striped bass populations in the Tar-Pamlico and Neuse rivers during periods of low abundance, but is limited in its ability to restore populations to self-sustaining levels if excessive mortality continues. Similarly, although Phase I hatchery fish have been recaptured occasionally as adults, there is little evidence to suggest that stocking juvenile striped bass in the Tar and Neuse rivers has improved the spawning stocks.

Poor contribution of Phase I striped bass to coastal riverine populations despite more than a decade of annual stockings prompted elimination of this management strategy. A Cooperative Agreement between the USFWS, DMF and WRC in the fall of 2009 outlined new stocking strategies for striped bass in the Tar, Neuse and Cape Fear rivers beginning with the 2010 production year. Annual WRC hatchery space and resources necessary to produce Phase I fingerlings (N=300,000) for all three river systems was shifted instead toward the production of an additional 100,000 Phase II striped bass. This change will allow the stocking of Phase II striped bass (target 100,000) in all three major CSMA systems annually, effectively replacing the approach of rotating Phase II stockings among systems every two years. Genetics-based research is also being planned in 2010 to determine if contribution of Phase II fish to populations in the Cape Fear River can be increased by stocking fish of Cape Fear parentage. Broodstock from the Cape Fear River were collected and transported to the Watha State Fish Hatchery during spring 2010. Offspring from these fish were isolated from fry produced for transfer to Edenton National Fish Hatchery, and will only be stocked in the Cape Fear River. Through recent advances in genetic sequencing, collection of fin clips from striped bass on the spawning grounds and among various habitats throughout the Cape Fear River system will reveal if these recaptured fish were originally hatchery produced. If results suggest that use of river-specific broodstock (as opposed to Roanoke River parentage) is responsible for an increase in spawning stock abundance, then expansion of this practice to the Neuse and Tar rivers should be considered. Although Roanoke River broodstock were collected to produce Phase II striped bass for the Neuse and Tar rivers in 2010, genetic material was also archived from these fish providing the opportunity to determine year-specific stocking contributions within these systems as well.

V. MANAGEMENT OPTIONS

1) Status Quo
    + Continue the striped bass stocking program with an increase beginning in 2010, all three major CSMA systems stocked with Phase II fish annually (all fish OTC marked, portion with external tags), with a production goal of 100,000 fish per year, per system
    + Stocked fish may contribute to the spawning stock
    + Public visibility for improving the striped bass population
    + The strategy of increase the number of fish stocked and released was listed as a management option in the 2004 Striped Bass FMP
    - Numbers of fish may not be adequate to increase population size

2) Further increase the number of fish produced/released - three systems per year, goal of 150,000 Phase II per system

+ Would potentially increase the number of individuals in the striped bass population
+ Stocked fish may contribute to the spawning population
+ Public visibility for improving the striped bass population
+ Increase number of tagged (external) fish- provides more data on migration, movement, growth, known age fish, time at large, etc.
- Cost of production/program would increase significantly
- Increase cost of reward program
- Effectiveness cannot be determined based on lack of focused research

3) Decrease the number of fish produced/released
   + Reduce the overall cost of the program
   - Would provide no increase to the existing population size or spawning stock
   - Reduce/eliminate externally marked fish- lose data on migration, movement, growth, known age fish, time at large, etc.

4) Eliminate the stocking programs
   +/- Maintain self-sustaining population through controlled harvest
   - Loss of data from tagged fish

VI. REASEARCH NEEDS

- Survey stocked systems to determine percent contribution of wild versus stocked fish.
- Determine if fish produced from system-specific parentage will increase stocking contribution to spawning populations.
- Determine factors impacting survivability of stocked fish in each system.

VII. MANAGEMENT RECOMMENDATIONS

NCDMF Management Recommendation:
Status quo – Goal of 100,000 Phase II striped bass stocked annually per CSMA system (Tar-Pamlico, Neuse and Cape Fear) with 3,000 stocked fish tagged annually in each system and research needs.

A/R Advisory Committee Management Recommendation:
Status quo – Goal of 100,000 Phase II striped bass stocked annually per CSMA system (Tar-Pamlico, Neuse and Cape Fear) with 3,000 stocked fish tagged annually in each system and research needs.

CSMA Advisory Committee Management Recommendation:
Status quo – Goal of 100,000 Phase II striped bass stocked annually per CSMA system (Tar-Pamlico, Neuse and Cape Fear) with 3,000 stocked fish tagged annually in each system and research needs.

NCMFC AND NCWRC Preferred Management Option:
Selects the NCDMF Management Recommendation.

Updated: August 17, 2010
Revised September 24, 2010
Revised November 30, 2011

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Table 11.2.1. Phase I (1-2 inches total length) and Phase II (5-8 inches total length) striped bass stockings in coastal North Carolina. Phase I fish were released by the North Carolina Wildlife Resources Commission and Phase II by the North Carolina Division of Marine Fisheries. A portion of the Phase II fish was tagged with external tags prior to release. All fish stocked from 1998 to present were also OTC marked.

			Phase II			Phase I
System stocked	Year stocked	Total number stocked	Number tagged	Number of tag returns	Percent tag returns	Number stocked
Albemarle Sound area	1981	87,181	10,000	1,817	18.2	
	1983	106,675	2,500	719	28.8	
	1983	67,433	2,493	276	11.0	
	1984	236,242	6,445	575	8.9	
	1986	45,200	1,110	38	3.4	
	1986	118,345	4,999	453	9.1	
	1987	15,435	2,500	214	8.6	
	1988	5,000	5,000	94	1.9	
	1989	3,289	1,400	22	1.6	
	1990	2,000	2,000	62	3.1	
	1991	2,994	2,994	320	10.6	
	1992	2,465	2,465	84	3.3	
	1993	2,180	2,180	23	1.0	
	1994	2,481	2,481	2	0.1	
	1996	2,498	2,498	12	0.5	
	1996	2,490	2,490	2	0.08	
Total		**701,908**	**53,554**	**4,714**	**8.8**	
Pamlico-Tar River	1983	76,674	2,500	500	20.0	
	1984	26,000	1,000	28	2.8	
	1987	17,993	2,500	39	1.6	
	1991	30,801	1,993	78	3.9	
	1993	118,600	2,204	39	1.8	
	1994	183,254	2,320	24	0.9	127,635
	1995					100,000
	1996	140,972	2,497	49	2.0	39,450
	1997	24,031	4,865	102	2.1	28,022

			Phase II			Phase I
System stocked	Year stocked	Total number stocked	Number tagged	Number of tag returns	Percent tag returns	Number stocked
	1998					230,606
	1999	17,954	2,750	122	4.4	100,000
	2000					188,839
Pamlico-Tar River	2001	37,000	3,000	32	1.1	171,000
	2002					39,110
	2003	159,996	3,000	20	0.7	100,000
	2004					100,000
	2005	267,376	3,000	35	1.2	114,000
	2006					134,100
	2007	69,871	3,000	52	1.7	160,995
	2008	91,962	3,000	21	0.7	91,440
	2009	61,054	0	0		
Total		**1,323,538**	**37,629**	**1,141**	**3.0**	**1,725,197**
Neuse River	1982	47,648	2,100	230	11.0	
	1986	39,769	2,199	60	2.8	
	1988	71,092	2,500	22	0.9	
	1990	61,877	2,992	84	2.8	
	1992	116,820	2,527	137	5.4	
	1993					48,000
	1994	79,933	2,212	7	0.3	103,057
	1995					99,176
	1996	100,760	4,998	119	2.4	100,000
	1997					100,000
	1998	83,195	2,500	75	3.0	207,730
	1999					100,000
	2000	108,000	2,900	39	1.0	121,993
	2001					103,000
	2002	147,654	2,960	18	0.6	
	2003					100,000
	2004	168,011	2,500	7	0.2	100,000
	2005					114,000
	2006	99,595	3,000	135	4.5	146,340

			Phase II			Phase I
System stocked	Year stocked	Total number stocked	Number tagged	Number of tag returns	Percent tag returns	Number stocked
	2007	69,953	3,000	135	4.5	172,882
	2008					205,500
	2009	104,061	3,000	0		100,228
Total		**1,298,368**	**39,308**	**985**	**2.5**	**1,921,906**
Cape Fear River	1980	14,874	2,900	17	0.6	
	1984	56,437	1,395	6	0.4	
	1989	77,242	1,300	23	1.8	
	1994					100,733
	1995					100,000
	1998	30,479 (<14,098 OTC marked-WRC				
	1999					
	2000	8,915 (OTC marked- WRC)				
	2001					90,149
	2002					50,000
	2003					104,775
	2004	172,055	2,500	5	0.2	50,000
	2005					54,500
	2006	102,283	3,000	4	0.1	80,450
	2007					80,376
	2008	92,580	3,000	4	0.1	395,220
	2009	112,674	3,000	0		58,379
Total		**628,145**	**17,095**	**66**	**0.3**	**1,164,582**
Northeast Cape Fear River	1999	10,327 (OTC marked- WRC)				
	2000	15,635 (OTC marked- WRC)				
	2001					94,083
	2002					50,000
	2003					151,873

			Phase II			Phase I
System stocked	Year stocked	Total number stocked	Number tagged	Number of tag returns	Percent tag returns	Number stocked
	2004					50,000
	2005					54,500
	2006					84,125
	2007					79,690
	2008					190,460
	2009					51,750
Total		**25,962**				**806,481**

11.3 USE OF SINGLE BARBLESS HOOKS DURING THE STRIPED BASS CLOSED SEASON

I. ISSUE

The use of single barbless hooks when harvest of striped bass is not allowed. This proposal could be considered in certain regions (e.g. ASMA May 1 – September 30) or expanded statewide.

II. ORIGINATION

Member of the Albemarle/ Roanoke Striped Bass Advisory Committee (A/R AC) under the Marine Fisheries Commission (NCMFC).

III. BACKGROUND

Recreational catch and release fishing for striped bass is a popular activity in eastern North Carolina during the summer months when harvest is not permitted. When striped bass congregate during this time, the possibility exists for them to be easily caught and released in high numbers by anglers. Therefore, depending on the type of hooks used during elevated water temperatures, catch and release mortality can be high.

An A/R AC member raised concerns regarding the targeting of striped bass in these "hot spots" by shore anglers using lures with triple barbed hooks to catch and release large numbers of striped bass during the closed season. The committee member believes the mortality is high in these areas at these times and recommends allowing only single barbless hooks for specific seasons and dates, or possibly state wide, following a similar rule enacted by the North Carolina Wildlife Resources Commission (NCWRC) in the upper Roanoke River.

IV. AUTHORITY

<u>15A NCAC 03H .0103</u>
<u>15A NCAC 03M .0201</u>
<u>15A NCAC 03M .0202</u>
<u>15A NCAC 03R .0201</u>
<u>15A NCAC 10C .0302</u>

V. DISCUSSION

Recreational fishing gear regulations such as allowing only the use of single barbless hooks could reduce hooking mortality of striped bass when caught and released during summer months. However, the extent of the reduction is unknown due to other factors that influence catch and release mortality of striped bass including stress to the fish due to excessive handling, fighting time, hooking depth, and duration of hook removal. Yet, striped bass caught during seasons with elevated water temperatures reduces the chance of survival following release.

Mortality of catch and release striped bass increases as water temperatures increase. Nelson (1998) determined mortality was highly dependent on water temperature and mortality increased with each 1.0°C (1.8° F) increase above 21°C (69.8°F). Wilde et al. (2000) reported mortality increased rapidly at temperatures beyond 16°C (60.8° F), reaching 67% and 57% for natural and artificial baits respectively, at 31°C (87.8° F). Gearhart (2002) observed higher mortality during catch of release on striped bass when water temperatures were greater than 25°C (26% mortality) compared to water temperatures less than 25°C (4% mortality) in the Albemarle Sound, North Carolina.

Differences in catch and release mortality often occur between bait types. Natural baits have a greater mortality than artificial baits typically because of the increased depth of hooking due to swallowing the natural bait (Diodati and Richards 1996, Nelson 1998, Millard et al. 1999 and 2005, Wilde et al. 2000, and Bettinger et al. 2005). Deeper depths of hooking is often associated with an increased amount of bleeding in the hooked area. Millard et. al. (2005) reported that striped bass were 15 times more likely to die when bleeding than when no bleeding was observed. Gearhart (2002) documented higher mortality for striped bass exhibiting excessive bleeding (36% mortality) whereas striped bass mortality with minimal or no bleeding was less (13% combined, 8% minimal and 5% no bleeding). Nelson (1998) reported 9% mortality for fish with slight bleeding, 33% for light bleeding, and 75% for heavy bleeders. Nelson (1998) also noted that most fish caught on live bait (87%) and artificial bait (92%) were not or only slightly bleeding.

Mortality caused by hook design often differs among the available literature. Diodati and Richards (1996) found a 13% mortality rate on striped bass using single hooks (artificial and natural baits combined) and a 3% mortality rate for anglers using one to three sets of treble hooks. Several studies compared the catch and release mortality of fish caught with single hooks versus treble hooks. DuBois and Dubielzig (2004) showed that single barbless hooks were quicker to remove but there was little difference in mortality between hook types on wild trout captured in Wisconsin streams. Whereas, Taylor and White (1992) reviewed the results of 18 hooking mortality studies on nonanadromous trout and found no differences in the mortality rates for number of hooks, whether single or treble, but did see a decrease for barbless hooks versus barbed hooks. Nuhfer and Alexander (1992) estimated a significant decrease in hooking mortality on wild brook trout caused by spinners and spoons rigged with single hooks or treble hooks. However, they also noted no mortality caused by artificial lures rigged with double treble hooks. The reduction in mortality was attributed to the limited depth at which the lures were ingested and the reduced damage to the gill arches and esophageal area. Mortality was positively and significantly correlated to fish size for the spinners and spoons combined ($p<0.003$). In addition, Millard et al. (2005) determined 16% mortality for traditional J hooks and 5% mortality when circle hooks were used for striped bass by anglers on the Hudson River in spring 2001.

Implementation of a proposed barbless hook rule would affect recreational anglers targeting all fish species available to hook and line angling during the proposed timeframe and locals. Fisheries managers, in cooperation with enforcement officers, must weigh these effects on anglers and associated fisheries occurring in the same areas. Use of a single barbless hook in North Carolina, whether statewide, regional or local, will impact recreational fisheries of a multitude of species including, but not limited to: white perch, yellow perch, catfish, largemouth bass, spot, croaker, speckled trout, red drum, weakfish, flounder, and sunfish. It may also impact commercial and recreational commercial gear license (RCGL) holders utilizing trot lines rigged with barbed hooks.

To minimize hooking mortality on striped bass in the Roanoke River, NCWRC enacted a rule during the 1997 spring season that requires anglers to use single, barbless hooks from April 1 to

June 30 in the river section between the Roanoke Rapids Dam and the US 258 bridge. Nelson (1998) advised the objective of this regulation was to reduce the handling time and facilitate quick release of fish thereby reducing stress-related mortality following catch and release angling. This regulation is enforceable in the Roanoke River because it occurs during a certain time period, includes all waters between two physical boundaries and limited access is available in this river section (C. Hatcher, NCWRC Wildlife Enforcement Officer, pers. comm.).

Modifications in angling practices are often encouraged to reduce mortality associated with catch and release angling. Angler education and outreach may assist in reducing catch and release mortality of striped bass. Removing or crimping the barbs may also play a role in reducing mortality (Taylor and White 1992). In cooperation with Eagle Claw™, NCWRC distributed 5,000 barbless circle hooks and informational cards with striped bass catch and release practices to striped bass anglers at Roanoke River boating access areas during spring 2009 and 2010.

VI. MANAGEMENT OPTIONS/IMPACTS

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

1) Status quo (continue to educate anglers on conservative angling practices for striped bass)
- \+ Inform anglers on best practices to minimize release mortality of striped bass
- \+ Could improve stock by reducing catch and release mortality through anglers adopting conservative angling practices
- \+ No additional enforcement responsibilities
- \+ No additional regulations or rule changes
- +/- No reduction in closed season effort
- \- Use of hooks and gear that may cause high release mortality
- \- Fishing still allowed during times of higher release mortality

2) Require the use of single barbless hooks state wide during specified timeframe
- \+ May reduce catch and release mortality of striped bass
- \+ May reduce catch and release mortality of other species
- \+ Could improve stock by reducing catch and release mortality
- +/- No reduction in closed season effort
- \- Fishing still allowed during times of high release mortality
- \- Would require additional regulations or rule changes
- \- Would alter standard fishing practices for other species
- \- Lack of enforceability
- \- Added responsibility to enforcement staff

3) Require the use of single barbless hooks in specific areas and times where striped bass are known to congregate and when anglers direct effort for striped bass in these locations.
- \+ May reduce catch and release mortality
- \+ Could improve stock by reducing catch and release mortality
- \+ Specific locations and seasons are less restrictive
- +/- No reduction in closed season effort
- \- Would require additional regulations or rule changes
- \- Lack of enforceability
- \- Added responsibility to enforcement staff

- Would alter standard fishing practices for other species
- Fishing still allowed during times of higher release mortality

VI. PROPOSED RULE(S)

Not applicable

VII. MANAGEMENT RECOMMENDATIONS

NCDMF Management Recommendation:
Status Quo - continue to educate anglers on conservative angling practices for striped bass.

A/R Advisory Committee Management Recommendation:
Status Quo - continue to educate anglers on conservative angling practices for striped bass.

CSMA Advisory Committee Management Recommendation:
Status Quo - continue to educate anglers on conservative angling practices for striped bass.

NCMFC AND NCWRC Preferred Management Option:
Selects the NCDMF Management Recommendation with additional recommendation to include mortality statistics associated with various handling techniques when possible.

Draft: **August 17, 2010**
Revised **September 29, 2010**
Revised November 30, 2011

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11.4 STRIPED BASS MANAGEMENT AREA - ALBEMARLE SOUND MANAGEMENT AREA SOUTHERN BOUNDARY LINE ADJUSTMENT

I ISSUE

As a result of significant erosion a new coordinate point (lat/long) must be established for Roanoke Marshes Point the western point of the southern boundary of the Albemarle Sound Management Area.

II ORIGINATION

NC Division of Marine Fisheries (DMF)

III BACKGROUND

The North Carolina Striped Bass Cooperative (NCSBC) comprised of the DMF, NC Wildlife Resources Commission (WRC) and the United States Fish and Wildlife Service (USFWS) was formed in 1990 to begin developing the NC Striped Bass Management Plan. Through the NCSBC agreement, the formation of two distinct management zones was created: the Roanoke River Management Area (RRMA) and the Albemarle Sound Management Area (ASMA). The formation of the line from Eagle Nest Bay across to Roanoke Marshes Point, the southern boundary of the ASMA, came about as a mutual agreement among the NCSBC members (Map 1). Under much scrutiny and backed by scientific evidence, the cooperative deemed it necessary to protect the one point of ingress and egress to the Atlantic Ocean that would allow a migration corridor for the Albemarle/Roanoke stock. The management area was and is also necessary to effectively manage the ASMA Total Allowable Catch (TAC) established and approved by the Atlantic States Marine Fisheries Commission. The ASMA was established at that time and currently exists.

Significant erosion along the shoreline of Roanoke Marshes Point has occurred and the point indicated in the rule is no longer on shore. Establishing a new point is necessary to complete the management area line and facilitate fishing operations and enforcement.

IV AUTHORITY

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

North Carolina Marine Fisheries Commission Rules for Coastal Fishing Waters (15A NCAC)

03M .0200	Striped Bass – General
03Q .0108	Management Responsibility for Estuarine Striped Bass in Joint Waters
03Q .0109	Implementation of Estuarine Striped Bass Management Plans
03R .0201	Striped Bass Management Areas

V DISCUSSION

The ASMA boundary line must be maintained in order for NC to operate under the ASMFC Amendment 6 - conservation equivalency (18 in TL size limit and reduced F target = 0.27) and associated approved TAC. Through the development of the amendment to the NC Estuarine

Striped Bass Fishery Management Plan (FMP), Marine Patrol indicated the coordinate point on the western shore of the ASMA boundary was no longer located above normal water level (NWL) as a result of erosion. Thus, the selection of a point on land located inland is needed for compliance with the approved fishing plan and for enforceability. The point location needs to be located far enough inland so that shoreline erosion will not be a problem for years to come. The proposed location is shown on the attached map. Considering the length of time this boundary has been in place and the need relative to striped bass management, the line "orientation" should remain as is.

In addition to the striped bass management areas, the southern boundary line of the ASMA is utilized in two additional rules: 15A NCAC 03J .0209 Albemarle Sound/Chowan River Herring Management Areas, and 15A NCAC 03R .0112 Attended Gill Net Areas (Map 1). The NC River Herring FMP, Amendment 1, approved in 2007, implemented a no harvest provision for the state. Even though a moratorium is currently in place the Albemarle Sound/Chowan River Herring Management Areas are defined in rule (03J .0209). The NC River Herring FMP review is scheduled to begin in 2012. However, the earliest effective date of any rule changes that could result would not be until April 1, 2014. If a change is made to re-establish the coordinate in the striped bass rule it should be made in this rule at the same time. Also, this boundary line is utilized in Attended Gill Net Areas [03R .0112 (b)]. For the same reasons of efficiency and consistency the "new point" for the Roanoke Marshes Point will need to be incorporated in all three of these rules simultaneously.

VI PROPOSED RULES

15A NCAC 03J .0209 ALBEMARLE SOUND/CHOWAN RIVER HERRING MANAGEMENT AREAS
(a) The Albemarle Sound Herring Management Area is defined as Albemarle Sound and all its joint water tributaries; Currituck Sound; Roanoke and Croatan sounds and all their joint water tributaries, including Oregon Inlet, north of a line beginning on the west shore at a point ~~35° 48.3693' N – 75° 43.7232' W~~ 35° 48.5015' N – 75° 44.1228' W on Roanoke Marshes Point; running southeasterly to the east shore to a point 35° 44.1710' N – 75° 31.0520' W on the north point of Eagles Nest Bay.
(b) The Chowan River Herring Management Area is defined as that area northwest of a line beginning on the west shore at a point 35° 59.9267' N – 76° 41.0313' W on Black Walnut Point; running northeasterly to the east shore to a point 36° 02.2140' N – 76° 39.3240' W on Reedy Point, to the North Carolina/Virginia state line; including the Meherrin River.
(c) Effective January 1, 2001, it is unlawful to use drift gill nets in the Albemarle Sound and Chowan River river herring management areas with a mesh length less than three inches from January 1 through May 15.

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;
Temporary Adoption Eff. May 1, 2000;
Eff. April 1, 2001;
Amended Eff. April 1, 2013; December 1, 2007.

[NOTE: 15A NCAC 03R .0112 is currently under construction, with an earliest effective date of April 1, 2011. Those proposed changes are indicated with underlining and strike-through marks. Additional proposed changes are indicated by block shading.]

15A NCAC 03R .0112 ATTENDED GILL NET AREAS
(a) The attended gill net areas referenced in ~~15A NCAC 03J .0103 (g)~~ 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~~ 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; 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; and

(7) Within 200 yards of any shoreline in Neuse River and its tributaries east of the Highway 17 highrise bridge and south and west of a line beginning on Maw Point at a point 35° 09.0407' N - 76° 32.2348' W; running southeasterly near the Maw Point Shoal Marker "2" to a point 35° 08.1250' N - 76° 30.8532' W; running southeasterly near the Neuse River Entrance Marker "NR" to a point 35° 06.6212' N - 76° 28.5383' W; running southerly to a point 35° 04.4833' N - 76° 28.0000' W near Point of Marsh in Neuse River. In Core and Clubfoot creeks, the Highway 101 Bridge constitutes the attendance boundary.

(b) The attended gill net areas referenced in ~~15A NCAC 03J .0103 (h)~~ 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;~~ 35° 48.5015’ N - 75° 44.1228’ 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~~ no-trawl areas described in 15A NCAC 03R .0106 (2), (4), (5), ~~and (6);~~ (7), (8), (10), (11), and (12);

(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° 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 southeasterly to a point 35° 14.9386' N - 75° 42.9968' W near Beacon "35" in Rollinson Channel; running southwesterly to a point 35° 14.0377' N - 75° 45.9644' W near a "Danger" Beacon northwest of Austin Reef; 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~~ 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;~~ 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 in the area upstream of the 76° 28.0000' W longitude line beginning at a point 35° 22.3752' N - 76° 28.0000' W near Roos Point in Pamlico River; running southeasterly to a point 35° 04.4833' N - 76° 28.0000' W near Point of Marsh in Neuse River; and

(5) Within 50 yards of any shoreline east of the 76° 28.0000' W longitude line beginning at a point 35° 22.3752' N - 76° 28.0000' W near Roos Point in Pamlico River; running southeasterly to a point 35° 04.4833' N - 76° 28.0000' W near Point of Marsh in Neuse River, except from October 1 through November 30, 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;~~ 113-221.1; 143B-289.52;
Eff. August 1, 2004;
Amended Eff. April 1, 2013; April 1, 2009.

15A NCAC 03R .0201 STRIPED BASS MANAGEMENT AREAS

(a) The Albemarle Sound Management Area is designated as Albemarle Sound and all its joint and inland water tributaries, (except for the Roanoke, Middle, Eastmost and Cashie rivers), Currituck, Roanoke and Croatan sounds and all their joint and inland water tributaries, including Oregon Inlet, north of a line beginning at a point ~~35° 48.3693'N - 75° 43 .7232'W~~ 35° 48.5015' N - 75° 44.1228' W on Roanoke Marshes Point, running southeasterly to a point 35° 44 .1710'N - 75°31 .0520'W on the north point of Eagle Nest Bay.

(b) The Roanoke River Management Area is designated as Roanoke River and its joint and inland tributaries, including Middle, Eastmost and Cashie rivers, up to the Roanoke Rapids dam.

(c) The Central/Southern Management Area is designated as all internal coastal, and joint and contiguous inland waters south of a line beginning at a point ~~35° 48 .3693'N - 75° 43 .7232'W~~ 35° 48.5015' N - 75° 44.1228' W on Roanoke Marshes Point, running southeasterly to a point 35°44 .1710'N - 75°31 .0520'W on the north point of Eagle Nest Bay, to the South Carolina line.

History Note: Authority G.S. 113-132; 113-134; 113-182; 143B-289.52;
Eff. ~~October 1, 2004.~~ October 1, 2004;
Amended Eff. April 1, 2013.

VII MANAGEMENT RECOMMENDATIONS

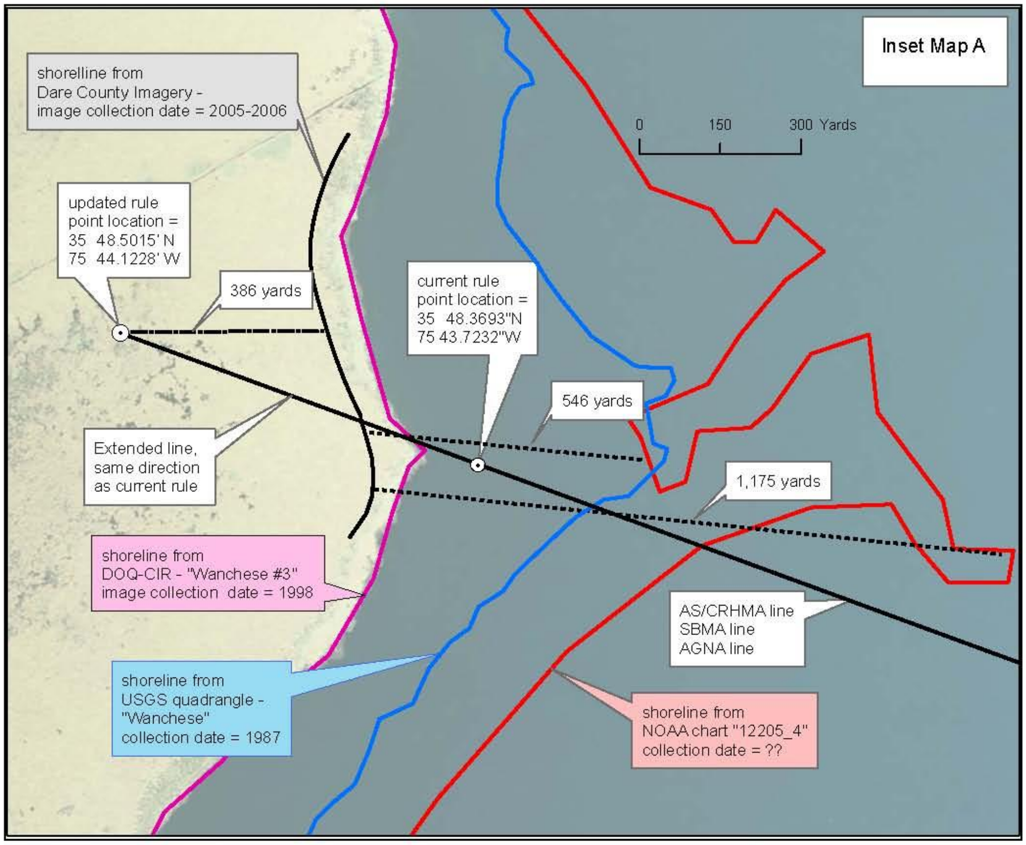
NCDMF Management Recommendation:
Supports the recommended rule changes to create a new boundary point.

A/R AC Management Recommendation:
Supports the recommended rule changes to create a new boundary point.

CSMA AC Management Recommendation:
Supports the recommended rule changes to create a new boundary point.

NCMFC AND NCWRC Preferred Management Option:
Selects the NCDMF Management Recommendation.

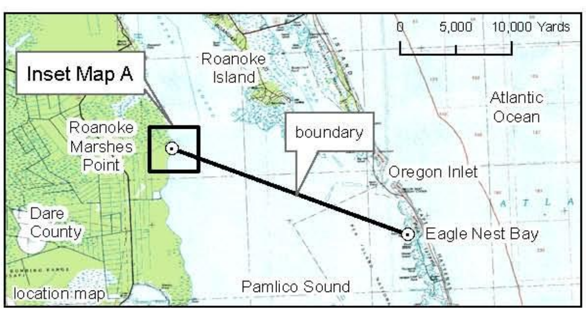
Prepared by: Sara E. Winslow
Phone – (252) 264-3911
Date: September 28, 2010
Revised: November 1, 2010
December 3, 2010
November 30, 2011



Information delineating a latitude/longitude point and boundary line at Roanoke Marshes Point, in Dare County.

Current Marine Fisheries' rules which use this boundary:

1. Albemarle Sound/Chowan River Herring Management Areas (03J .0209) (AS/CRHMA)
2. Striped Bass Management Area (03R .0201) (SBMA)
3. Attended Gill Net Areas (03R .0112) (AGNA)



Source information and imagery:
NOAA Nautical chart 12205_4
USGS quadrangle - Wanchese
1998 DOQ-CIR imagery for NC
2005-2006 Dare County Imagery

Marine Fisheries' Rules:
AS/CRHMA; SBMA; AGNA

Map Date: November 01, 2010

Map 1

11.5 CASHIE RIVER – CHANGE IN JOINT AND COASTAL WATERS BOUNDARY LINE

I. ISSUE

The NC Wildlife Resources Commission, Division of Inland Fisheries staff has been contacted by members of the public requesting a shift in the Cashie River boundary line between Joint and Coastal Waters. This boundary line shift will slightly increase the size of the Albemarle Sound Management Area (ASMA) and reduce the size of the Roanoke River Management Area (RRMA).

II. ORIGINATION

Public request to NC Wildlife Resources Commission (WRC) and in turn to NC Division of Marine Fisheries (DMF)

III. BACKGROUND

The Descriptive Boundaries for Coastal-Joint- Inland Waters (03Q .0202) rules in the format of coordinates has been in place since 2004; jurisdictional boundaries have been in existence since the 1960s. A request from a member of the public, on behalf of a group of local anglers, was made to the WRC in December 2009 to shift the boundary line between Joint and Coastal Waters of Cashie River (Map 1). The current coordinates create a line at an angle to a line of reference. The WRC and public felt that shifting the line would effectively eliminate the triangle created by the current coordinates. This would reduce confusion about the coordinates and make it easier for the public and enforcement to determine the applicable regulations for the corresponding fishing area. The WRC forwarded the request to DMF staff for consideration.

IV. AUTHORITY

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

North Carolina Marine Fisheries Commission Rules for Coastal Fishing Waters (15A NCAC)

03Q .0100 General Regulations: Joint
03Q .0108 Management Responsibility for Estuarine Striped Bass in Joint Waters
03Q .0109 Implementation of Estuarine Striped Bass Management Plans: Recreational Fishing
03Q .0201 Specific Classification of Waters
03Q .0202 Descriptive Boundaries for Coastal-Joint-Inland Waters

V. DISCUSSION

A request to shift the Joint/Coastal boundary line in the Cashie River has been made through WRC. The Cashie River boundary line issue can be easily addressed by utilizing an existing point for the Cashoke Creek boundary (Map 1). The new line would be a straight line instead of one at an angle. This would make it easier for the public to identify and adhere to the different striped bass regulations between the ASMA and the RRMA. The shift in this line will slightly increase the size of the ASMA and reduce the size of the RRMA. However, WRC and DMF staff agrees there will be no noticeable negative impacts from the boundary line shift.

VI. PROPOSED RULE

15A NCAC 03Q .0202 DESCRIPTIVE BOUNDARIES FOR COASTAL-JOINT-INLAND WATERS

Descriptive boundaries for Coastal-Joint-Inland Waters referenced in 15A NCAC 03Q .0201 are as follows:

. . .

(2) Bertie County

(a) Albemarle Sound - All waters in this waterbody are designated as Coastal.

(iii) Cashie River - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 35° 54.7865' N - 76° 49.0521' W; running southerly to a point on the south shore 35° 54.6691' N - 76° 49.0553' W. Joint Waters south and west and Coastal Waters north and east of a line beginning at a point on the ~~north~~ west shore ~~35° 56.4598' N -76° 43.8093' W;~~ 35° 56.2934' N - 76° 44.1769' W; running ~~southerly~~ easterly to a point on the north shore of an island in the mouth of the river ~~35° 56.2250' N - -76° 43.9265' W;~~ 35° 56.2250' N - 76° 43.9265' W; Joint Waters west and Coastal Waters east of a line beginning at a point on the south shore of an island in the mouth of the river 35° 56.1254' N - 76° 43.9846' W; running southerly to a point on the south shore ~~35° 56.0650' N - -76° 43.9599' W.~~ 35° 56.0650' N - 76° 43.9599' W.

. . .

History Note: Authority G.S. 113-132; 113-134; 143B-289.52;
Eff. February 1, 1991;
Amended Eff. April 1, 2013; April 1, 2009; August 1, 2004; July 1, 1993; September 1, 1991.

VII. MANAGEMENT RECOMMENDATIONS

NCDMF Management Recommendation:
Supports the recommended rule change to create a new boundary point.

A/R AC Management Recommendation:
Supports the recommended rule change to create a new boundary point.

NCMFC AND NCWRC Preferred Management Option:
Selects the NCDMF management recommendation.

Prepared by: Sara E. Winslow
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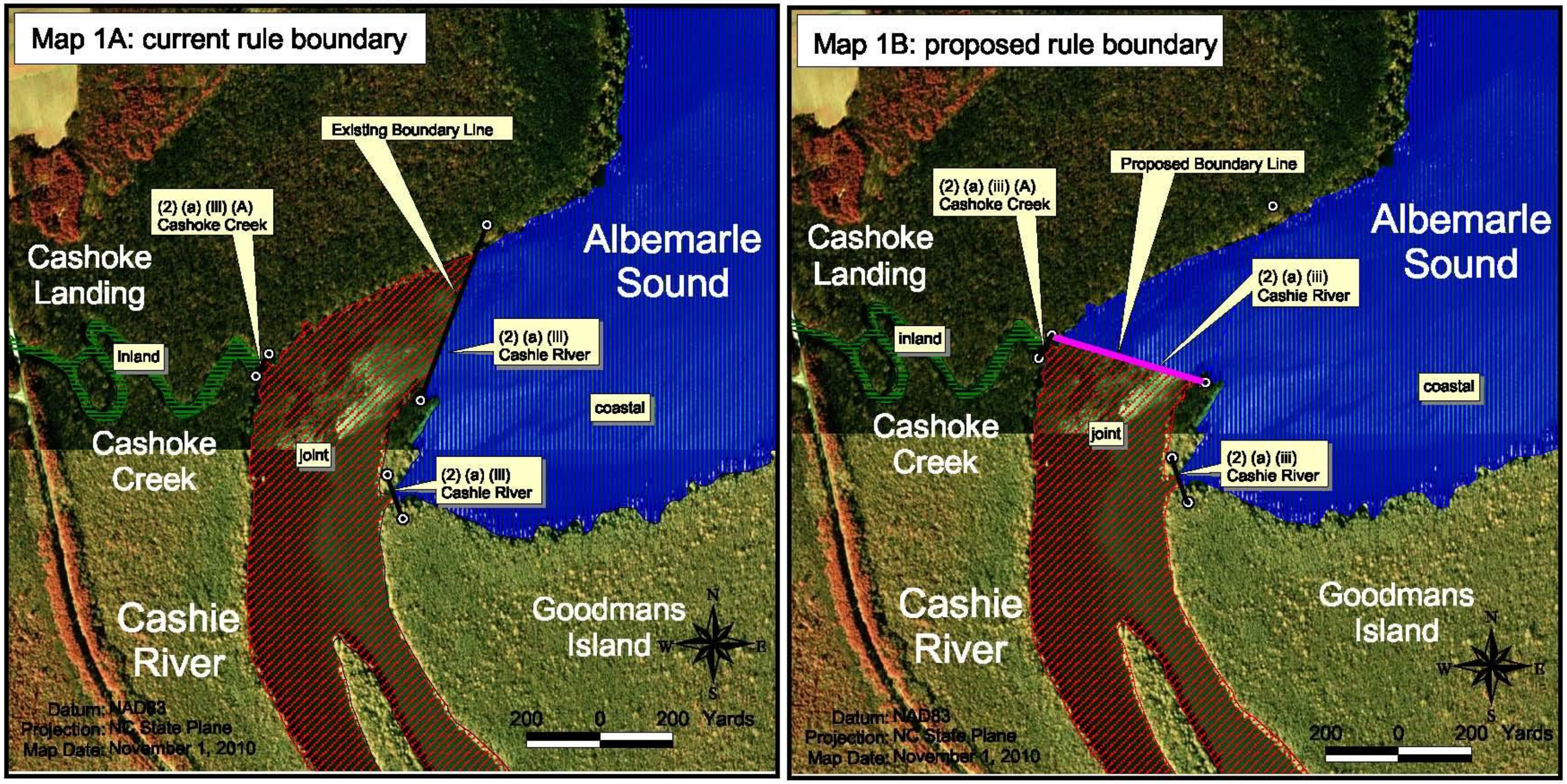
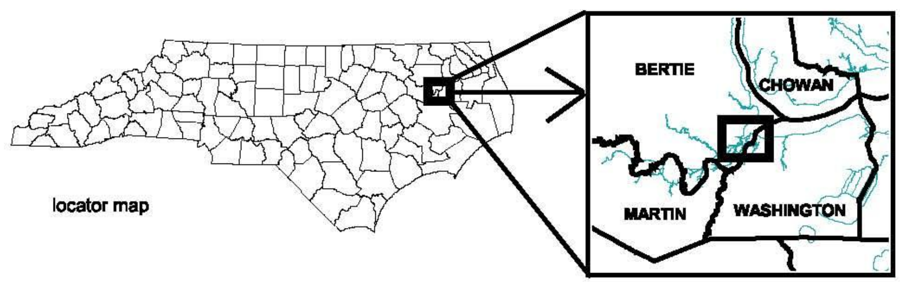
November 30, 2011



Proposed rule boundary change for Cashie River.

Rule: Descriptive Boundaries for
Coastal-Joint-Inland Waters (03Q .0202)



Map 1

11.6 DISCARD MORTALITY OF STRIPED BASS FROM COMMERCIAL SET GILL NETS CENTRAL SOUTHERN MANAGEMENT AREA (CSMA)

(Addendum A has been added since the CSMA AC meeting on 6/2/2011)

I. ISSUE

Investigate discards of striped bass in the commercial set gill net fishery in the Central Southern Management Area (CSMA).

II. ORIGINATION

Division of Marine Fisheries Director based on numerous public inquiries, and the Striped Bass Plan Development Team

III. BACKGROUND

Gill Net Fisheries

The commercial inshore estuarine gill net fishery of North Carolina is a year round multi-species fishery where netting techniques used and species targeted varies by area and season. Species commonly caught by the set gill net fishery include American shad, Atlantic croaker, red drum, southern flounder, spot, spotted seatrout, striped bass, striped mullet and weakfish. Within the CSMA there are two primary ways to deploy gill nets: set and runaround. Runaround nets are also referred to as drop nets or strike nets. This gear is actively set to encircle a school of fish. The runaround gillnet fishery typically targets striped mullet and operates year round with most of the effort occurring during the fall from September through November. Vessels are usually open skiffs ranging from 15 to 25 feet in length with one or two-man crews (NCDMF 2004). Since the fishermen are with the net at all times and able to monitor the catch, this type of fishery has fewer management restrictions than the second type of gill nets. Set gill nets are passively deployed, anchored or staked, and left from a few hours up to a few days depending on severity of the weather and water temperature. Most sets are overnight. Set nets can be further divided into float and sink net categories. Float nets fish the entire height of the water column, while sink nets fish a fixed distance off the bottom and do not extend to the upper portion of the water column. Large mesh nets (5.0 inch and greater) are set primarily for flounder, shad or striped bass, while small mesh (less than 5 inch) are directed toward bluefish, sciaenids, striped mullet, and a variety of other species.

While three watersheds contribute to the striped bass stocks in the CSMA (Tar/Pamlico, Neuse and Cape Fear), the three CSMA area designations (referred to herein) consist of the Pamlico Sound, the Rivers area (Neuse, Pamlico, Pungo, and Bay rivers combined), and the Southern area of the CSMA (Core Sound south including Cape Fear River) (Table 11.6.1). These groups were based on the availability of various dependent and independent data. From the NCDMF Trip Ticket program (TTP),using 2004 - 2009 as a basis, average annual pounds and dollar value of landed target species in the commercial set gill net fishery are listed in Tables 11.6.2, categorized by large (>5 inch stretch mesh) and small mesh for each area. For all species combined, the Pamlico Sound set gill net fishery averaged 1.4 million pounds landed with a dockside value of $1.2 million. The Rivers set gill net fishery averaged 0.5 million pounds and

$0.6 million and the remainder of the CSMA waters had landings of 0.8 million pounds with a dockside value of $0.9 million. Total anchored gill net trips in the CSMA since 1994 have ranged from 18,462 trips per year (2007) to 29,048 trips per year (2001). Total landings for this same period have ranged from 2.5 million pounds (2007) to 4.3 million pounds annually (1998) (Figure 11.6.1). Table 11.6.3 gives the average annual number of participants (defined as an individual who had at least 10 gill net trips annually, 2004-2009) for the three areas. Approximately 150 gill netters fish regularly in Pamlico Sound, with a little over 100 fishermen active in the Rivers area, and less than 20 fishermen active in the Cape Fear River. Since a single fisherman may be active in more than a single area, the numbers of fishermen from each area are not additive. As noted in Section.7.2.2.2 the non-duplicative number of gill netters in the CSMA varies from year to year but is in the 175- 200 range.

CSMA Management

Since 1994, when the North Carolina Estuarine Striped Bass Fishery Management Plan (FMP) was approved, the CSMA has operated on a 25,000 pound Total Allowable Catch (TAC) of striped bass. The fishery has operated as a low harvest level fishery with a proclamated spring season and an 18 inch minimum size limit, and daily landing limits. Striped bass may be a targeted catch in the CSMA (Pamlico Sound has a bycatch only provision). Even with the five to ten fish per operation daily limit, many gill net trips during the open striped bass season are composed primarily of striped bass (defined as striped bass being the top species by weight on the trip ticket, 2004-2009). Of the nearly 17,000 trips taken in Pamlico Sound or Rivers area during the open commercial season (~March and April, 2004-2009), 7% of the trips in Pamlico Sound and 29% of Rivers trips were dominated by striped bass. Regardless of area, striped bass averaged nearly 75% of the catch on trip tickets where striped bass was the top species. Finfish dealers are required to obtain a striped bass permit with a CSMA validation, report landings daily to NCDMF, and affix a sale tag to striped bass purchased from fishermen. These permit measures (See Section 7, Table 7.4) have been in place since 1997. The various rules and regulations for the CSMA are shown in Appendix 3 of the FMP.

Several management measures have restricted the commercial take of striped bass in the CSMA. The North Carolina Wildlife Resources Commission (NCWRC) initially (1996) allowed the use of a special device license for attended set gill nets in a number of inland waters. In 2000 the use of set gill nets was no longer permitted within inland waters of the northern and central coastal districts (Districts 1 & 2), and this regulation was expanded to disallow the use of set gill nets in all designated inland waters east of Interstate 95 in 2001.

The NCDMF gill net attendance requirements for small mesh (<5 inch) gill nets were first instituted in Pamlico and Neuse rivers by proclamation in 1995. Expanded attendance requirements were placed in rule statewide from the red drum FMP (September 2008; 15A NCAC 03J.0103). Year round attendance is required in the upper portions of the rivers and within 200 yards of shore in lower portions of the rivers. From May 1 through November 30 small mesh nets must be attended in all primary and permanent secondary nursery areas, no trawl areas, and in a large area along Outer and Core Banks. This measure has reduced the amount of small mesh effort in these areas. Evidence of the rules impact on the reduction in small mesh effort is seen in the trip ticket data. There was a 32 % reduction in the overall small mesh trips when comparing the average number to trips taken from 1994 to 1999 versus 2000-2005, with the mean number of trips declining from 8,352 to 5,680 (NCDMF 2007a). Both dependent and independent NCDMF gill net data from Pamlico Sound indicates minimal catch rates of striped bass in small mesh. Earlier division analysis (2004-2006) compared small mesh striped bass catch per unit effort (CPUE) of Pamlico Sound to the rivers and reported a 93%

decrease in CPUE for Pamlico Sound. Observer data was also analyzed and showed minimal catch rates of striped bass in small mesh nets in either area. (NCDMF 2007a)

Federal rule (50 CFR Part 223.206) states "No person may fish with gillnet fishing gear which has a stretched mesh size larger than 4 1/4 inches, annually from September 1 through December 15, in the inshore waters of Pamlico Sound, North Carolina, and all contiguous tidal waters bounded on the north by 35°46.3' N. lat., on the south by 35°00' N. lat., and on the west by 76°30'W. long." This permanent federal rule closed a major deep water area to flounder gill net fishing in 2001 in order to reduce large mesh gill net interactions with sea turtles. As a result of this rule a Pamlico Sound Gillnet Restricted Area permit (PSGNRA) was established and is issued to fishermen by NCDMF, under a federal Section 10 endangered species permit that allows flounder fisheries in the shallow water Outer Banks area and mainland Hyde County bays to continue with gear limits, weekly reporting and observer coverage. The current Section 10 permit expires after December 2010 and NCDMF has submitted a new Section 10 application for gill nets in all internal coastal waters. The specifics of the new Section 10 application have not been approved by National Marine Fisheries Service (NMFS) but as of December 2010 the major features (subject to change) for large mesh gillnets (defined as: $\geq$ 4 in through 6 ½ in. stretch mesh) are:

- Restrict the number of days during the week that fishermen could operate (Mon – Fri) and limit soak times to night time.
- Establish a maximum yardage limit of 2,000 yards.
- Nets must be deployed as low profile with a net height of no more than 15 meshes, all cork and other buoys removed except as required for identification, and set in individual 100-yard shots with at least a 25-yard break between individual shots.
- Provide observer coverage of gill net trips throughout the state.
- Run-around or strike nets and drop nets are exempt

The above measures were implemented by NCDMF Proclamation M-8-2010 in May 2010 and apply to all set gill nets in the CSMA. These are also minimum gill net requirements negotiated in the sea turtle settlement agreement (May 2010) with the Karen Beasley Sea Turtle Rescue and Rehabilitation Center.

The 2004 FMP management options for the CSMA focused on reducing striped bass discards in the rivers. The River area large mesh gill net fisheries were the principle target because fishery independent data showed Pamlico Sound striped bass catch rates were minimal and there were effective attendance restrictions that curtailed interactions in the small mesh fisheries. One measure approved during 2004 FMP adoption was to set the commercial possession limit during the open commercial season at 10 fish in the rivers, and set striped bass to 50% by weight of the total catch, and not to exceed a limit of 5 fish in Pamlico Sound. This action was intended to shorten the "targeted" striped bass harvest season.

In 2004, NCDMF tested the effectiveness of various tie-down and gill net setting configurations in reducing striped bass bycatch in the spring and fall. The results of these studies indicated:

- Distance from shore is a significant factor in striped bass catch rates, with up to a ~60% reduction in striped bass when nets are set greater than 50 yards from shore. The smallest distance from shore increment tested was 50 yards. (No other studies have been undertaken to evaluate other distances from shore.)

- Tie-downs decrease the amount of striped bass captured, with ~85-99% reduction depending on season and in water depths greater than 3 feet.
- Reduction estimates given are the maximum possible, assuming pre-regulated nets were not rigged or fished in the prescribed (restricted) manner.

Based on the study results (following a full review through the normal advisory committees and review process) of the proposed 2007 management measures to reduce striped bass discards in the CSMA, the Marine Fisheries Commission (MFC) approved and the NCDMF implemented by proclamation (May 2008) the following measures:

- Require the use of a 3 foot tie down in large mesh (>=5 inch stretch mesh) gill nets in internal coastal fishing waters upstream of the 76 °28.0000' W longitude line.
- Maintain a minimum distance from shore of 50 yards for these nets upstream of the lines shown in Figure 11.6.2.
- Restrictions are effective after the commercial 25,000 lb. total allowable catch (TAC) is met (spring ~April) through December 31 of each year.
- In the Cape Fear River and its tributaries a striped bass moratorium (no harvest) was also initiated.

Discard

Updated striped bass bycatch estimates in the commercial set gill net fisheries from 2004 - 2009 are presented here for Pamlico Sound and the Rivers areas. Data needed to produce discard estimates of other areas in the CSMA are not available at this time.

Discard Estimates for the CSMA Methods

In 2003, the NCDMF initiated an observer program (Program 466) in Pamlico Sound directed at improving estimated interactions in the PSGNRA with sea turtles in the fall/winter large mesh gill net flounder fishery (Price 2009). However, limited at-sea observer trips were also made in other areas of the CSMA. From 2004 – 2009 over 1,750 trips observing ~2,078,000 yards of gill net were made in the CSMA with nearly 1,200 of these trips occurring in Pamlico Sound. Participation in this expanded observer 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. Data collected from observer trips have allowed the NCDMF to more accurately estimate variables such as: average yards per trip, striped bass catch rates, and at net striped bass gill net mortality rates for various fisheries. Information from the observer program was not available when the initial CSMA striped bass dead discard was estimated in the 2004 FMP (NCDMF 2004). Prior to 2003, the Independent Gill Net Survey (IGNS, Program915) was used as the surrogate source of information for striped bass catch and mortality rates. Because the observer program concentrates on commercial trips taken within the PSGNRA observer data is insufficient for reliable estimates of discard quantities in many other areas throughout the CSMA. In those instances IGNS is again used as a substitute source of data. When both sources are limited, certain discard estimates may be pooled across time or areas.

An estimate of the discarded catch for a gear may be computed by estimating the "total catch" (quantity taken that reaches the deck of the fishing vessel) and subtracting from it the "landed catch" (that which is brought ashore). The discarded catch may then be multiplied by a mortality estimate (percent that are dead at the time of capture) to give an estimate of the quantity of dead discard. The following diagram shows the matrix of NCDMF data that were used to calculate a discard (dead) estimate for the commercial set gill net fishery for the years 2004-2009.

Total number of trips was obtained from the TTP. Each time fish are sold to a licensed seafood dealer in North Carolina a trip ticket must be completed. Information provided on each ticket includes: the weight in pounds for each species sold, the gear type used (i.e., trawl, gill net, pound net, etc.), and the primary area fished. Total yards of gill net fished are not recorded on trip tickets. While the total number of gill net fishing trips was easily obtainable, assumptions were required to determine the mesh size used on each trip. The method selected mirrored those used for the analysis of red drum discard in gill nets (NCDMF 2008).

Data sources used for the discard estimate of striped bass in set gill nets in the CSMA.

Variable	Trips	Harvest of striped bass	Yards fished average	Soak Time	Catch of striped bass (per yard/1 day set) in number	Catch of striped bass (per yard/1 day set) in weight	Mortality estimate (percent dead at time net fished)
Source	Trip Ticket	Trip Ticket	Fish House Samples	Fish House Samples	NCDMF Independent gill net (IGNS) samples and observer data	NCDMF Independent gill net (IGNS) samples and observer data	NCDMF Survey Same as <<←== s
Area	Pamlico Sound (code 34), Rivers (29,3,33,52)'		0500 to 052799=Sound, 0528 to 053530=Rivers		0500 to 052799=Sound, 0528 to 053530=Rivers		
Mesh	Mesh based on the top species on the trip ticket, following the technique used in the red drum FMP		From interview with fishermen, large >=5 inch and small <5 inch		Large CPUE based on net mesh sets >= 5 in. in the deep strata (> 6 feet) set parallel to shore,. Small CPUE based on net mesh sets 3.0 to 4.5 in. in the shallow strata		Same as <<←==
Caveat			If a computational cell was missing any of these values then an estimate was used, based on other applicable cells, to complete the calculations				

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. This results in gill netters using 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. 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 be inferred from the catch composition. Using trip ticket data, the species of highest abundance in landings was considered the target species and was used to define the trip. Once trips were defined, each fishery was then further characterized for mesh size, net length, and soak times from available fish house sampling and observer data from 2004 - 2009. Species with similar gear parameters for mesh size are grouped together into large ($\geq$ 5 inch) or small (<5 inch) stretch mesh gill net fisheries. Available information is also separated by area and also partitioned into two seasons. Seasons were selected based on whether the striped bass commercial fishery was closed or open (months of March and April).

An estimate of rates of striped bass catch and associated mortality comes preferably from the observer data or if that is lacking the catch rate from the IGNS is substituted. Also in order to mirror the source of the catch rates used in the 2004 FMP discard estimates were also calculated based solely on the IGNS data. Catch per unit of effort (CPUE) was defined as the catch of striped bass per yard of gill net set for 1 day. Catch per unit effort is one variable in the equation that must be developed annually for each trip category because CPUE is directly related to individual year class strength. Mortality rates for each data source (observer coverage or IGNS) were calculated by dividing the number of dead striped bass observed at the time the net was fished by the total number of striped bass captured. At net mortality rates would not be expected to change from year to year, but are know to change seasonally with fluctuations in water temperature.

Once all the necessary parameters were obtained, the total number of striped bass captured in each category (area by mesh by year by season) was determined by multiplying the average yards per trip, total number of trips, and striped bass CPUE. The landed harvest (number of fish) is subtracted from this total capture estimate, resulting in a discarded catch number estimate. The discarded catch may then be multiplied by a mortality estimate (percent that are dead at the time of harvest) to give an estimate of the quantity of dead discard in numbers. The numbers of dead striped bass were then converted into pounds based on mean weight from the NCDMF surveys (observer coverage and IGNS). It is known that some percentage of striped bass released alive from gill nets will suffer delayed mortality; however, adequate data was not available to estimate a rate so this factor is not accounted for in the dead discard estimates. In summary, the discard (dead) estimate = [(number of trips * yards fished *soak hours *IGNS or observer cpue) minus the commercial landings] * mortality estimate.

Discard Estimates for the CSMA Results

Dead discard estimates based on observer coverage (fishery dependent data) or the IGNS (fishery independent data) catch and mortality rates are presented in Table 11.6.4 by mesh size (small and large) and area (Pamlico Sound and the Rivers). Corresponding effort data (trips and yardage) are also shown. The observer data produces a lower estimate of dead discard, ranging from an annual low of 3,000 lbs to a high of 12,000 lbs, when compared to the IGNS based estimate that ranged from 7,000 to 33,000 pounds annually. The thighest observer based estimate of 12,000 lbs in 2007 is an artifact of the methodology where IGNS data is substituted when no observer data is available. In 2007 no observer trips were made in the river area and in that year the IGNS small mesh catch rate was higher than usual. For 2004 – 2009 the yearly average dead discard estimate was 5,500 lbs using the observer data and 16,000 lbs using IGNS. Viewing the estimates by mesh size (Figure 11.6.3 for small mesh and Figure 11.6.4 for large mesh) shows annual estimates to be highly variable and the level of dead discards generally lower in small mesh. The number of estimated discards combined with commercial harvest exceeded the TAC during each year (Figure 11.6.5) when based on the IGNS catch rates, but using the fishery based observer data there were several years where the combined quantity was just above or below the TAC. Note: in order to accurately portray the level of combined catch with IGNS in Figure 5, the amount hatched on the graph for the IGNS is the additional amount beyond the observer quantity (the absolute amount of the IGNS estimate is the portion of the bar above the commercial harvest).

The dead discard estimates should be viewed cautiously with a full understanding of the assumptions made in the analysis. For example, catch and mortality rates should be reflective of the commercial fishery and account for variable catch rates by time and area. As noted previously, the observer data is at times limited in coverage. The substitute IGNS data, while the only other source for catch rates, has a number of short comings. The IGNS was designed as a random-stratified multiple-mesh gill net survey to estimate the relative abundance of a suite of species; it was not designed solely for striped bass. As a fishery-independent random survey, it was not designed to be fully representative of catch rates observed in commercial fishing operations. This is an important caveat to consider when making management decisions based on IGNS data. For example, Price (2004) showed that commercial fishermen in Currituck Sound could use their local fishing knowledge to reduce striped bass bycatch in small mesh white perch fisheries. Commercial fishermen will often try and set nets in a manner so as to encounter as little unwanted bycatch as possible, thus reducing time on the water and fuel consumption. In a similar fashion, their experience and expertise allows them to be more successful in catching striped bass than nets set randomly. This analysis uses the catch rate to produce the presumed overall catch from which the known TTP landings are subtracted to produce the discard quantity. In many instances, the total estimate was less than the landed catch, indicating the catch rates used were likely lower than those actually occurring in the fishery. These discrepancies become more apparent when viewing the estimates at finer breakdowns (e.g. mesh/season/area) but are assumed to average out when combined for an entire year. The estimations do, however, provide some information upon which to judge the relative extent of the discard issue.

IV. AUTHORITY

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)

3H .0103 Proclamation Authority of Fisheries Director
3J .0103 Gill Nets, Seines, Identification, Restrictions
3M .0202 Striped Bass Season, Size and Harvest Limit Internal Coastal Waters
3Q .0107 Special Rules, Joint Waters
3Q .0108 Management Plans for Striped Bass in Joint Waters
3Q .0109 Implementation of Striped Bass Management Plans

V. DISCUSSION

Obtaining reliable estimates of commercial gill net bycatch has proven difficult. The MFC adopted a policy in November 1991 directing the NCDMF to establish the goal of reducing bycatch to the absolute minimum and incorporate that goal into actions. Bycatch is defined as “the portion of a catch taken incidentally to the targeted catch because of non-selectivity of the fishing gear to either species or size differences” [Atlantic States Marine Fisheries Commission (ASMFC) 1994]. Bycatch can be divided into two components: incidental catch and discarded catch. Incidental catch refers to retained catch of non-targeted species. Discarded catch is that portion of the catch returned to the sea as a result of economic, legal, or personal considerations. In looking at ways to reduce discard there are just three basic ways to accomplish it (Alverson et al. 1994):

- Catch fewer numbers of the individuals/species.
- Reduce the mortality of the individuals/species being discarded.

- Use a greater spectrum of the species or sizes of species normally caught and discarded.

Gear restrictions (mesh sizes, yardage limits, and attendance) and area (including distance set from shore) and season closures have been used to limit discard losses in a number of North Carolina fisheries. Other regulation based solutions such as effort reduction and incentive or disincentive programs have not been initiated.

As reported in the 2004 FMP, the commercial discard for the CSMA, prior to implementing the 2008 gill net restrictions or having observer based catch rates, accounted for ~67% (~94,000 lbs for years 2000 & 2001) of the total striped bass removals in the CSMA. The management measures enacted in 2008 were meant to decrease gill net discards up to 85%, based on limited field studies conducted in by the NCDMF (NCDMF 2007). The dead discard estimate presented herein is substantially less than the 2004 FMP estimate. This is due to lower catch rates in the source data coupled with the downward trend in the number of commercial gill net trips taken (Figure 11.6.1). The average yardage per trip used in either the large or small mesh fisheries has been relatively stable (Figures 11.6.3 & 11.6.4). The at-net mortality rate during the cooler water temperatures of the open season averaged 16% whereas the closed season rate was higher at 24%. These are pooled values across the years 2004 -2009.

As noted previously under CSMA Management overview heading, the initiation of gill net restrictions from the sea turtle settlement in the large mesh gill net fishery may further impact the effort portion of the discard equation. These restrictions are defined in detail in MFC Proclamation M-8-2010 which reduced the number of fishing days and reduced the maximum yardage limit for large mesh gill nets to 2,000 yards from Albemarle Sound east of Alligator River and Currituck Sound south of the US Highway 158 Bridge to western Bogue Sound at the NC Highway 58 Bridge at Emerald Isle; the yardage limit was reduced to 1,000 yards from south of the NC Highway 58 Bridge at Emerald Isle to the South Carolina state line. Dependent data was examined statewide and for particular areas of the CSMA (area designations are found in Table 11.6.1). In draft Amendment 1 to the Southern Flounder FMP (NCDMF 2010), analytical techniques were used to evaluate the impact on southern flounder harvest of reducing the number of fishing days and the reduction in the maximum yardage of nets that could be fished. A similar analysis was applied to the CSMA large mesh gill net fishery in regards to striped bass. Proclamation M-8-2010 results in an annual total of 156 closed days to large mesh gill nets (based on 2011 calendar year). Monthly and total striped bass harvest reduction estimates for large mesh gill nets were calculated using 2004-2009 reference years. Restrictions enacted under Proclamation M-8-2010 impact the entire CSMA but the open harvest season for striped bass is only occurring in March and April. These reduced day restrictions would result in a negligible estimated harvest reduction of 0.4% in the CSMA large mesh gill net striped bass fishery (Table 11.6.5).

This same analytical technique was applied to the discard estimate (as opposed to harvest), where the closed season accounts for 89.63% of annual dead discards for large mesh gill nets. Under Proclamation M-8-2010, the greatest reduction in dead discards from reduced fishing days would occur during the closed season. Closed season dead discards would decrease by 38.63% with a total dead discard reduction of 42.88% for the CSMA (Table 11.6.6).

Under the reduced yardage restrictions imposed by Proclamation M-8-2010, the greatest estimated reduction in striped bass effort would occur in the Southern area of the CSMA due to the smaller yardage limit in areas south of the NC Highway 58 Bridge at Emerald Isle, since these areas had the highest proportion of large mesh gill net effort from trips greater than 2,000 yards (Table 11.6.7). The gill net area that encompasses Pamlico Sound would also be effected for an overall estimated harvest reduction of 0.28% in the CSMA occurring due to decreased yardage.

This analysis is primarily based on trip ticket data and provides for general comparisons of quantities landed after any new restrictions have been implemented. It is important to note that differences seen may not be entirely attributable to just newly imposed management restrictions. Other factors such as changing environmental conditions, level of recruitment, natural mortality, changes in fishing effort, etc. may impart just as much influence on the landings. So while from one year to the next landings or discard may be reduced by a certain percentage, it is not possible to distinguish or isolate the impact associated with each factor from trip ticket data alone.

The sea turtle conservation measures were implemented in May 2010 by Proclamation M-8-2010 and TTP data is now becoming available to compare the number of trips taken by week between the pre (2009) and post (2010) gill net restrictions. While a longer time series will prove more reliable the initial preliminary information indicates a significant reduction in effort, beyond just the days and gear reductions noted previously. Table 11.6.8 shows from May through November the number of weekly trips taken in 2009, the number of trips projected to be taken in 2010 (based on the 43% reduction anticipated from the reduction in fishing days) and then the actual number of trips reported in 2010. The majority of the ASMA is exempt from the turtle related gill net restrictions (2010 estimated trips=2009 trips in Table 11.6.8) but the ASMA still had a 59% drop in effort so far for 2010. The Pamlico Sound gill net effort declined 20%, and the trips spiked upward during the initial opening of the PSGNRA. The river area and the southern area both declined 67%. In order to see if these declines were typical, the average annual differences (based on mean of each month differences) in number of trips for the same timeframe of May through November 2004-2009 were computed. The May-November comparisons between each set of years were all positive and ranged from+2% to +23%. The preliminary 2010 data indicate that fishing behavior likely changed in response to the turtle related gill net restrictions, and other factors (market, environmental, etc.) as well. If the reduced level of effort is maintained, then with all else being equal in the discard equation, the magnitude of forthcoming CSMA dead discard will likely be less than that calculated based on the 2004-2009 fishing effort pattern. A more thorough examination of the ESA ramifications for striped bass management will be covered in the Protected Species Issue paper.

The 2010 CSMA stock assessment was not able to provide accurate estimates of stock abundance or exploitation rates for the CSMA stocks. However, continued conservation management efforts are supported by the constrained size and age distributions, low abundance, and the absence of older fish (NCDMF 2010b). All fishing sectors, along with water quality and environmental conditions, contribute to the condition of the stocks. Using the recreational CSMA harvest and discard data presented in Section 7.3 along with the commercial harvest and discard data the relative contribution of the various components are shown by year (2004 -2009) in Figures 11.6.6 & 11.6.7, depending on whether the commercial discard is based on the observer or IGNS data. The pie charts indicate that the commercial sectors are the predominant factors. The impact of reducing the recreational bag limit to 2 fish is clearly seen in 2009 where the recreational sectors (harvest and discard) declined to 20%, when the previous 5 year average had been ~40% (based on observer data). Likewise the commercial sector rose to 81% in 2009 and the previous 5 year average was ~60%.

Since the implementation of the distance from shore (DFS) and tie-down measures in the rivers the NCDMF has received numerous complaints from commercial gill netters. The NCMFC Central Regional Advisory Committee passed a motion in 2010 to eliminate these requirements. The complaints are based on the following views:

- Striped bass do not comprise a significant bycatch in the flounder fishery
- The management lines for the DFS are too restrictive; they should be moved upstream to allow more area to be unrestricted.
- The DFS measure pushes the gillnets out into areas with more cownose rays that damage nets and/or conflicts with crab potters and thus reduce flounder catches
- In water depths less than 3 feet, the tie downs are ineffective

Using available IGNS survey data and TTP data the NCDMF staff investigated these concerns. As noted in the previous Background CSMA management discussion the measures in place are based on the objective to maximize the reduction in striped bass discard and minimize the effects, as much as practical, to the flounder and shad fisheries in the rivers. It was acknowledged that there would be collateral impacts to other fisheries when these measures were discussed and voted on by the NCMFC but the potential gain to striped bass balanced the loss to the other fisheries. The initially proposed DFS lines in 2007 were the same as the original 76° 30 ‘ longitude tie down line (PSGNRA). The DFS lines were adjusted upstream to Gum Point/Fork Point in the Pamlico River and Fisher Landing Point/Cooper Point in the Neuse River based on a review of the seasonal distribution of striped bass from the IGNS and observer data. The tie-down line was moved slightly east to 76° 28 ‘ longitude to provide for consistent restrictions and to address enforcement concerns for the Pamlico County western bays (not divide a bay).

Responding to continued public comment, the distribution of cownose rays and striped bass in the IGNS was mapped. The IGNS data for cownose rays indicates that cownose rays prefer habitat greater than 50 yards from shore (Tables 11.6.9 & 11.6.10, Figures 11.6.8-11.6.15). This data substantiates the views of the commercial gill netters that they are in fact being moved into areas with cownose rays. The IGNS data shows that cownose rays are also found at times close to shore, in the areas <50 yards. Similarly, IGNS data for striped bass indicates that striped bass typically utilize near shoreline habitat (<50 yards from shore) and are present during the summer months, albeit at reduced levels, in areas upstream of the DFS lines (Tables 11.6.9 & 11.6.10, Figures 11.6.16-11.6.24).

Flounder landings, grouped by July-June, for the pre-regulation period (2007) and the post-regulation period (2008 & 2009) are compared in Table 11.6.11. Number of overall commercial flounder trips decreased by 11% in 2008 and 19% in 2009 when compared to 2007. Flounder harvest rose by 86% in 2008 but declined slightly (4%) in 2009. There was an increase in summer time flounder landings for all areas. It should be noted that Bay River is an area not included in the DFS and tie-down gill net restrictions.

VI. MANAGEMENT OPTIONS/IMPACTS

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

1) Status Quo

+No further restrictions on gill net fishery due to interactions of target species striped bass
+Would allow time to assess the impact of Proclamation M-8-2010 in reducing discards and bycatch
+No new gear changes for fishermen
-Current rate of discards would remain the same, unless harvest was increased

2) Modify DFS or tie-down area

+Address the concerns of the fishermen
+ -Likely increase commercial landings and lower discards reductions if area is expanded
- +Likely decrease commercial landings and raise discards reductions if area is further constricted

3) Additional restrictions (attendance, yardage limit)

+Reduce the amount of gear in the water that could catch striped bass and reduce the bycatch mortality
+ Reduce discards and bycatch
-Would result in the loss of more marketable fish
-Burden to fishermen
-Marine patrol increased work load

4) Remove all gear restrictions

+Would allow for increased harvest
-Would increase the harvest on a stock whose status is uncertain
-Inequity in conservation measures between commercial and recreational sectors
-Increase in bycatch of striped bass and other non-target species

VI. PROPOSED RULE(S)

Not applicable.

VII. RESEARCH NEEDS

To determine fully the effectiveness of the 2008 management strategy it is necessary to evaluate the actual outcomes in the commercial fishery. The level of discard reduction is best obtained by comparing actual commercial gill net catch rates pre and post July 2008. The NCDMF onboard observer program is the best source for this type of data.

1) More at-sea observations made for the gill net fishery to more accurately assess the discards from the fishery.

+Allows for a more accurate account of the unmarketable bycatch and a fuller assessment of what is being caught
-Increases burden on fishermen to have extra people on board their vessels
-Cost of running a survey

2) Explore improvements to NCDMF programs (Trip Ticket, Fish House sampling, fishermen surveys or logbooks) in order to acquire spatially and temporally accurate gill net gear parameters (yardage, mesh size, etc.).

+Allow gathering of information that could be used for calculations of total yards fished in a fishery and CPUE for species
-Increases burden to fishing community (completeness of responses)
-Increases work load for DMF staff
-Less accuracy in trip ticket reporting if gear parameters mandated for that program
-Trip ticket software program would need to be modified to accommodate any new variables

3) Further investigate the impacts of delayed mortality on striped bass captured in gill nets.

+Gives a more complete picture of the total losses to the striped bass population
-Number of delayed mortalities may impact the number of striped bass that could be harvested

VIII. MANAGEMENT RECOMMENDATIONS

NCDMF Management Recommendation:
Status quo for this issue, after the closure of commercial season through December 31:

- Require the use of a 3 foot tie down in large mesh (>=5 inch stretch mesh) gill nets in internal coastal fishing waters upstream of the 76 °28.0000’ W longitude line.
- Maintain a minimum distance from shore of 50 yards for these nets upstream of the existing DFS line

CSMA AC Management Recommendation[4]:
Status quo for this issue, after the closure of commercial season through December 31:

- Require the use of a 3 foot tie down in large mesh (>=5 inch stretch mesh) gill nets in internal coastal fishing waters upstream of the 76 °28.0000' W longitude line.
- Maintain a minimum distance from shore of 50 yards for these nets upstream of the existing DFS line.

NCMFC AND NCWRC Preferred Management Option:
Selects the NCDMF Management Recommendation.

Draft: K. West. December 7, 2010
Revised December 17, 2010
Revised July 15, 2011
Revised November 30, 2011

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North Carolina Division of Marine Fisheries (NCDMF). 2007b. Issue paper prepared for the Central Southern Striped Bass Advisory committee entitled "Central/Southern Management Area (CSMA) Striped Bass Management Measures, September 2007". North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries. 58p.

[4] When the CSMA AC was first presented this Issue Paper on January 19, 2011, they voted to move the 50 yard DFS lines upriver to the points specified in the Sheltdon Cuthrell map (see Addendum A) by proclamation from June 15 to August 31, at which point the DFS lines are to be restored to the original position. At the October 5, 2011 CSMA AC meeting the AC was presented public comment on the draft FMP and the management recommendations from the various NCMFC standing and regional ACs. A motion was made to support the status quo NCDMF/NCWRC management recommendation as written above: the motion passed. It should also be noted all members of the AC were not present at the October 5, 20110 meeting.

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Table 11.6.1. Area designations and their associated waterbodies for the Central Southern Management Area for striped bass of North Carolina.

Area	Waterbodies
Pamlico Sound	Pamlico Sound and its bays
Rivers	Bay, Neuse, Pamlico, Pungo rivers
Southern	Core Sound to the South Carolina state line

Table 11.6.2. Commercial set gill net landings (pounds) and value by mesh size for the Central Southern Management Area, 2004-2009.

		Large mesh								Small mesh									
		Cape Fear River		Pamlico Sound		Rivers		Total		Cape Fear River		Pamlico Sound		Rivers		Total		Overall total	
Species	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Bluefish	Total	2,882	729	19,804	5,209	1,709	422	24,394	6,360	25,615	5,891	217,181	56,374	9,411	2,311	252,207	64,576	276,601	70,935
	% of total	0.71%	0.11%	3.78%	0.67%	0.52%	0.09%	1.94%	0.34%	6.05%	2.32%	23.45%	12.00%	3.80%	1.59%	15.79%	7.43%	9.68%	2.57%
Croaker	Total	574	150	2,382	830	1,903	624	4,859	1,605	4,306	1,314	19,382	7,588	2,516	950	26,204	9,852	31,063	11,457
	% of total	0.14%	0.02%	0.45%	0.11%	0.58%	0.14%	0.39%	0.09%	1.02%	0.52%	2.09%	1.62%	1.02%	0.65%	1.64%	1.13%	1.09%	0.42%
Flounders	Total	290,054	557,775	319,148	635,875	179,512	340,208	788,713	1,533,858	7,376	13,443	10,106	20,219	7,854	15,317	25,336	48,979	814,049	1,582,838
	% of total	71.49%	85.55%	60.90%	82.09%	54.28%	74.13%	62.57%	81.35%	1.74%	5.28%	1.09%	4.30%	3.17%	10.55%	1.59%	5.63%	28.49%	57.45%
Gray trout	Total	1,585	1,306	4,100	3,677	947	802	6,633	5,785	8,110	6,818	36,169	32,095	1,377	1,230	45,656	40,142	52,289	45,927
	% of total	0.39%	0.20%	0.78%	0.47%	0.29%	0.17%	0.53%	0.31%	1.91%	2.68%	3.91%	6.83%	0.56%	0.85%	2.86%	4.62%	1.83%	1.67%
Hickory shad	Total	6,206	1,264	32,162	7,054	24,208	4,864	62,576	13,182	254	50	5,009	1,033	2,881	595	8,144	1,679	70,720	14,861
	% of total	1.53%	0.19%	6.14%	0.91%	7.32%	1.06%	4.96%	0.70%	0.06%	0.02%	0.54%	0.22%	1.16%	0.41%	0.51%	0.19%	2.47%	0.54%
Menhaden	Total	323	32	1,981	164	3,417	365	5,721	562	19,783	1,964	246,500	25,603	78,075	8,709	344,357	36,276	350,078	36,838
	% of total	0.08%	0.00%	0.38%	0.02%	1.03%	0.08%	0.45%	0.03%	4.67%	0.77%	26.62%	5.45%	31.53%	6.00%	21.56%	4.17%	12.25%	1.34%
Mixed fish	Total	52,282	26,688	79,118	34,390	41,340	11,862	172,741	72,940	30,474	24,639	63,640	45,730	5,626	1,900	99,740	72,269	272,480	145,209
	% of total	12.89%	4.09%	15.10%	4.44%	12.50%	2.58%	13.70%	3.87%	7.19%	9.68%	6.87%	9.74%	2.27%	1.31%	6.24%	8.31%	9.53%	5.27%
Mullets	Total	2,835	1,226	3,371	1,515	3,067	1,350	9,273	4,091	84,651	38,667	98,280	44,122	56,526	24,219	239,457	107,008	248,730	111,099
	% of total	0.70%	0.19%	0.64%	0.20%	0.93%	0.29%	0.74%	0.22%	19.98%	15.20%	10.61%	9.39%	22.83%	16.68%	14.99%	12.31%	8.70%	4.03%
Red drum	Total	26,677	38,643	40,581	58,847	17,083	24,761	84,342	122,252	3,117	4,413	7,025	10,042	2,881	4,144	13,023	18,600	97,364	140,852
	% of total	6.58%	5.93%	7.74%	7.60%	5.17%	5.40%	6.69%	6.48%	0.74%	1.73%	0.76%	2.14%	1.16%	2.85%	0.82%	2.14%	3.41%	5.11%
Shad	Total	13,010	13,073	4,501	4,839	32,032	32,893	49,543	50,805	23	22	669	638	5,208	5,476	5,900	6,135	55,443	56,940
	% of total	3.21%	2.01%	0.86%	0.62%	9.69%	7.17%	3.93%	2.69%	0.01%	0.01%	0.07%	0.14%	2.10%	3.77%	0.37%	0.71%	1.94%	2.07%
Spanish mackerel	Total	175	177	712	865	98	109	984	1,152	2,073	2,291	108,178	131,120	4,545	5,260	114,796	138,672	115,781	139,824
	% of total	0.04%	0.03%	0.14%	0.11%	0.03%	0.02%	0.08%	0.06%	0.49%	0.90%	11.68%	27.92%	1.84%	3.62%	7.19%	15.95%	4.05%	5.08%
Speckled trout	Total	4,683	6,619	6,823	9,994	8,041	11,683	19,547	28,296	22,713	31,975	32,628	48,566	33,462	48,972	88,804	129,513	108,351	157,808
	% of total	1.15%	1.02%	1.30%	1.29%	2.43%	2.55%	1.55%	1.50%	5.36%	12.57%	3.52%	10.34%	13.51%	33.72%	5.56%	14.90%	3.79%	5.73%
Spot	Total	3,058	1,791	4,112	2,305	2,244	1,334	9,414	5,430	215,084	122,898	69,917	38,149	22,136	13,390	307,137	174,437	316,551	179,867
	% of total	0.75%	0.27%	0.78%	0.30%	0.68%	0.29%	0.75%	0.29%	50.77%	48.30%	7.55%	8.12%	8.94%	9.22%	19.23%	20.06%	11.08%	6.53%
Striped bass	Total	1,386	2,524	4,041	8,287	13,963	26,891	19,390	37,702	35	67	1,325	2,262	2,295	4,516	3,655	6,845	23,045	44,547
	% of total	0.34%	0.39%	0.77%	1.07%	4.22%	5.86%	1.54%	2.00%	0.01%	0.03%	0.14%	0.48%	0.93%	3.11%	0.23%	0.79%	0.81%	1.62%
White perch	Total	0	0	1,212	768	1,102	719	2,314	1,487	10	7	10,041	6,147	12,788	8,213	22,840	14,367	25,154	15,854
	% of total	0.00%	0.00%	0.23%	0.10%	0.33%	0.16%	0.18%	0.08%	0.00%	0.00%	1.08%	1.31%	5.16%	5.66%	1.43%	1.65%	0.88%	0.58%
Yellow perch	Total	0	0	2	2	32	38	34	39	1	1	6	6	22	23	29	31	63	70
	% of total	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.02%	0.00%	0.00%	0.00%	0.00%
Total		405,729	651,998	524,051	774,621	330,697	458,927	1,260,477	1,885,546	423,625	254,461	926,057	469,693	247,603	145,226	1,597,286	869,380	2,857,764	2,754,926

Table 11.6.3. Number of gill net fishermen with at least 10 trips per year in the Central Southern Management Area. A given fisherman may be active in more than a single area; the numbers of fishermen from each area are not additive.

Year	Cape Fear River	Pamlico Sound	Rivers
2004	12	149	106
2005	14	169	110
2006	12	165	104
2007	15	137	108
2008	14	138	89
2009	13	150	99

Table 11.6.4. Striped bass dead discard estimates for the Pamlico Sound and the Rivers and mesh size, 2004-2009, fishery dependent (observer) and independent (IGNS) gill net data.

			Trip Ticket data			DMF data	
		Mesh	Total	Yards		Dead discards (lbs.)	
Area	Year	size	trips	trip	Landings	Dependent	Independent
Pamlico	2004		7,928	4,198	7,895	360	2,417
Sound		Large	4,752	3,143	3,441	302	550
		Small	3,176	1,054	4,454	58	1,867
	2005		8,101	3,806	7,970	443	4,196
		Large	4,368	2,781	6,567	0	1,598
		Small	3,733	1,025	1,403	443	2,598
	2006		8,222	4,441	7,255	131	6,685
		Large	4,979	3,283	6,242	131	5,735
		Small	3,243	1,158	1,013	0	950
	2007		7,750	4,056	7,222	92	733
		Large	4,348	3,047	6,624	0	0
		Small	3,402	1,008	598	92	733
	2008		7,926	4,141	583	0	1,294
		Large	5,127	3,134	466	0	393
		Small	2,799	1,007	117	0	901
	2009		7,305	3,924	1,271	2,490	2,841
		Large	4,316	2,878	907	0	0
		Small	2,989	1,046	364	2,490	2,841
Pamlico Sound total			47,232	24,566	32,196	3,516	18,167
		Large	27,890	18,267	24,247	433	8,276
		Small	19,342	6,299	7,949	3,082	9,891
Rivers	2004		5,055	3,970	21,726	2,453	4,839
		Large	4,142	2,884	19,823	2,296	2,732
			913	1,086	1,904	157	2,107
	2005		5,124	3,968	16,313	4,394	14,232
		Large	4,036	2,752	13,134	4,394	5,100
		Small	1,088	1,216	3,180	0	9,133
	2006		5,269	4,441	12,340	6,151	26,519
		Large	3,835	3,081	9,256	5,582	3,838
		Small	1,434	1,360	3,083	569	22,681
	2007		5,440	4,221	15,749	11,943*	11,943
		Large	3,852	3,084	13,415	710*	710
		Small	1,588	1,137	2,334	11,233	11,233
	2008		4,262	4,354	8,362	3,323	14,967
		Large	2,819	3,176	6,044	3,323	5,991
		Small	1,443	1,178	2,319	0	8,976
	2009		5,036	4,161	23,060	645	5,128
		Large	3,711	2,918	22,108	0	618
		Small	1,325	1,243	953	645	4,510
Rivers total			30,186	25,115	97,550	28,910	77,628
		Large	22,395	17,894	83,779	16,305	18,989
		Small	7,791	7,221	13,771	12,604	58,640
Overall			77,418	49,681	129,746	32,425	95,795
		Large	50,285	36,161	108,026	16,738	27,265
		Small	27,133	13,520	21,720	15,687	68,531

Table 11.6.5. Monthly and total commercial gill net landings reduction from weekly three day closures implemented by Proclamation M-8-2010 (based on 2011 calendar year).

Month	Number of days closed	Monthly landings	Per diem percent harvest	Monthly harvest reduction	Percent landings affected	Total reduction
January	15	5.13%	0.002%	0.025%	100%	0.025%
February	12	3.59%	0.001%	0.015%	100%	0.015%
March	12	75.62%	0.024%	0.293%	100%	0.293%
April	13	13.64%	0.005%	0.059%	100%	0.059%
May	14	0.00%	0.000%	0.000%	100%	0.000%
June	12	0.00%	0.000%	0.000%	100%	0.000%
July	14	0.00%	0.000%	0.000%	100%	0.000%
August	13	0.00%	0.000%	0.000%	100%	0.000%
September	12	0.00%	0.000%	0.000%	100%	0.000%
October	15	0.68%	0.000%	0.003%	100%	0.003%
November	12	0.07%	0.000%	0.000%	100%	0.000%
December	12	1.28%	0.000%	0.005%	100%	0.005%
Total	156					0.400%

Table 11.6.6. Seasonal discard reduction estimates from weekly three day closures implemented by Proclamation M-8-2010 (based on 2011 calendar year).

Season	Number of days closed	Days/Season	Estimated Discards per Year (lbs)	Percent of Discards	Per day Percent Discards	Percent Seasonal Reduction	Percent Landings Affected	Percent Total Discard Reduction
Close	131	304	2,500.54	89.63%	0.29%	38.63%	100%	38.63%
Open	25	61	289.17	10.37%	0.17%	4.25%	100%	4.25%
Total Discard Reduction:								42.88%

Table 11.6.7. Effort reduction and harvest reduction estimates from decreasing the coast wide maximum large mesh gill net yardage limit to 2,000 yards per operation from Croatan/Roanoke area to Bogue Sound, and 1,000 yards per operation in the Southern area (NCDMF Estuarine Gill Net Fish House Sampling Program and NCDMF Trip Ticket Program).

Area	% Effort reduction	Percent trips	% Harvest reduction
Pamlico Sound*	0.11%	13.03%	0.01%
Rivers*	0.00%	75.88%	0.00%
Southern#	2.74%	11.08%	0.27%
Total			0.28%

Table 11.6.8. Estimated and actual weekly trip reductions by area implemented by Proclamation M-8-2010.

Area	Week	2009 Trips	2010 Estimated Trips	2010 Trips	2010 Estimated Reduction	2010 Actual Reduction
Albemarle#						
	May 14-20	111	111	26	0%	77%
	May 21-27	187	187	58	0%	69%
	May 28-June 3	190	190	35	0%	82%
	June 4-10	178	178	71	0%	60%
	June 11-17	166	166	80	0%	52%
	June 18-24	175	175	56	0%	68%
	June 25-July 1	173	173	63	0%	64%
	July 2-8	157	157	83	0%	47%
	July 9-15	206	206	77	0%	63%
	July 16-22	203	203	63	0%	69%
	July 23-29	195	195	101	0%	48%
	July 30- Aug 5	145	145	130	0%	10%
	Aug 6-12	167	167	78	0%	53%
	Aug 13-19	197	197	80	0%	59%
	Aug 20-26	177	177	162	0%	8%
	Aug 27- Sept 2	169	169	199	0%	18%
	Sept 3-9	281	281	144	0%	49%
	Sept 10-16	377	377	260	0%	31%
	Sept 17-23	418	418	243	0%	42%
	Sept 24-30	295	295	191	0%	35%
	Oct 1-7	411	411	71	0%	83%
	Oct 8-14	409	409	146	0%	64%
	Oct 15-21	482	482	99	0%	79%
	Oct 22-28	527	527	82	0%	84%
	Oct 29-Nov 4	385	385	17	0%	96%
Total		6,381	6,381	2,615	0%	59%
Pamlico						
	*May 14-20	60	34	43	43%	28%
	May 21-27	78	45	43	43%	45%
	May 28-June 3	67	38	64	43%	4%
	June 4-10	73	42	49	43%	33%
	June 11-17	82	47	63	43%	23%
	June 18-24	83	48	60	43%	28%
	June 25-July 1	125	72	70	43%	44%
	July 2-8	103	59	116	43%	13%
	July 9-15	175	100	77	43%	56%
	July 16-22	191	109	50	43%	74%
	July 23-29	165	94	102	43%	38%

Table 11.6.8. Continued

Area	Week	2009 Trips	2010 Estimated Trips	2010 Trips	2010 Estimated Reduction	2010 Actual Reduction
Pamlico	July 30- Aug 5	127	73	116	43%	9%
	Aug 6-12	156	89	123	43%	21%
	Aug 13-19	204	117	136	43%	33%
	Aug 20-26	208	119	146	43%	30%
	Aug 27-Sept 2	147	84	133	43%	10%
	Sept 3-9	204	117	87	43%	57%
	Sept 10-16	301	172	182	43%	40%
	**Sept 17-23	227	130	228	43%	0%
	**Sept 24-30	188	108	250	43%	33%
	**Oct 1-7	265	152	201	43%	24%
	**Oct 8-14	239	137	236	43%	1%
	**Oct 15-21	255	146	243	43%	5%
	**Oct 22-28	43	25	159	43%	270%
	**Oct 29-Nov4	21	12	62	43%	195%
Total		3,787	2,168	3,039	43%	20%
Rivers						
	*May 14-20	60	34	38	43%	37%
	May 21-27	108	62	12	43%	89%
	May 28-June 3	119	68	12	43%	90%
	June 4-10	101	58	19	43%	81%
	June 11-17	100	57	29	43%	71%
	June 18-24	104	60	30	43%	71%
	June 25-July 1	114	65	30	43%	74%
	July 2-8	117	67	35	43%	70%
	July 9-15	104	60	23	43%	78%
	July 16-22	108	62	25	43%	77%
	July 23-29	90	52	40	43%	56%
	July 30- Aug 5	73	42	41	43%	44%
	Aug 6-12	91	52	44	43%	52%
	Aug 13-19	93	53	45	43%	52%
	Aug 20-26	114	65	56	43%	51%
	Aug 27- Sept 2	103	59	61	43%	41%
	Sept 3-9	111	64	54	43%	51%
	Sept 10-16	147	84	65	43%	56%
	Sept 17-23	109	62	84	43%	23%
	Sept 24-30	111	64	46	43%	59%
	Oct 1-7	147	84	8	43%	95%
	Oct 8-14	107	61	21	43%	80%
	Oct 15-21	134	77	16	43%	88%
	Oct 22-28	102	58	14	43%	86%

Table 11.6.8. Continued

Area	Week	2009 Trips	2010 Estimated Trips	2010 Trips	2010 Estimated Reduction	2010 Actual Reduction
	Oct 29-Nov 4	54	31	2	43%	96%
Total		2,621	1,500	850	43%	67%
Southern						
	*May 14-20	174	100	78	43%	55%
	May 21-27	283	162	82	43%	71%
	May 28-June 3	270	155	95	43%	65%
	June 4-10	246	141	139	43%	43%
	June 11-17	277	159	132	43%	52%
	June 18-24	245	140	134	43%	45%
	June 25-July 1	212	121	49	43%	77%
	July 2-8	156	89	51	43%	67%
	July 9-15	189	108	44	43%	77%
	July 16-22	140	80	18	43%	87%
	July 23-29	122	70	37	43%	70%
	July 30- Aug 5	130	74	38	43%	71%
	Aug 6-12	169	97	45	43%	73%
	Aug 13-19	196	112	60	43%	69%
	Aug 20-26	180	103	59	43%	67%
	Aug 27- Sept 2	207	119	79	43%	62%
	Sept 3-9	226	129	94	43%	58%
	Sept 10-16	248	142	104	43%	58%
	Sept 17-23	217	124	86	43%	60%
	Sept 24-30	194	111	69	43%	64%
	Oct 1-7	201	115	11	43%	95%
	Oct 8-14	165	94	31	43%	81%
	Oct 15-21	158	90	19	43%	88%
	Oct 22-28	138	79	19	43%	86%
	Oct 29-Nov 4	133	76	8	43%	94%
Total		4,876	2,792	1,581	43%	67%

Gill net restriction under proclamation M-8-2010 did not apply to the Albemarle area.
* Gill Net restriction went into place on May 15, 2010 under proclamation M-8-2010.
** PSGNRA Pamlico Sound Area opened for large mesh gill nets September 20, 2010.

Table 11.6.9. Striped bass and cownose ray seasonal catch totals from samples less than or equal to 50 yards from shore compared to samples greater than 50 yards from shore in the NCDMF Program 915 Fisheries Independent Assessment, Pamlico/Pungo and Neuse rivers combined for 2003-2009 average. Seasons are winter (Feb.-Mar.), spring (Apr.-Jun.), summer (Jul.-Sep.) and fall (Oct.-Dec.).

		Distance From Shore (DFS)						
		Less than or equal to 50 yards			Greater than 50 yards			
Species	Season	N	%season (column)	%(DFS) (row)	N	%season (column)	%(DFS) (row)	Total
Striped Bass	Winter	68	16%	76%	21	16%	23%	89
	Spring	123	29%	84%	24	18%	16%	147
	Summer	91	22%	81%	21	16%	19%	112
	Fall	138	33%	67%	67	51%	33%	205
	Total	419		76%	132		24%	551
Cownose Ray	Winter	0	0%	0%	0	0%	0%	0
	Spring	84	41%	17%	425	52%	83%	509
	Summer	117	57%	25%	351	43%	75%	468
	Fall	5	2%	10%	40	5%	90%	45
	Total	206		20%	816		80%	1,022

Table 11.6.10. Striped bass and cownose ray seasonal catch totals from samples less than or equal to 50 yards from shore compared to samples greater than 50 yards from shore in the NCDMF Program 915 Fisheries Independent Assessment, Pamlico/Pungo and Neuse rivers combined for 2008. Seasons are winter (Feb.-Mar.), spring (Apr.-Jun.), summer (Jul.-Sep.) and fall (Oct.-Dec.).

		Distance From Shore (DFS)						
		Less than or equal to 50 yards			Greater than 50 yards			
Species	Season	N	%season (column)	%(DFS) (row)	N	%season (column)	%(DFS) (row)	Total
Striped Bass	Winter	29	9%	69%	13	11%	31%	42
	Spring	80	24%	98%	2	2%	2%	82
	Summer	79	24%	94%	5	4%	6%	84
	Fall	144	43%	61%	94	82%	39%	238
	Total	332		74%	114		26%	446
Cownose Ray	Winter	0	0%	0%	0	0%	0%	0
	Spring	53	22%	17%	264	27%	83%	317
	Summer	192	78%	22%	698	72%	78%	890
	Fall	1	0%	7%	13	1%	93%	14
	Total	246		20%	975		80%	1,221

Table 11.6.11. Gill net commercial flounder trips, number of participants (P) and landings (lbs) for the Neuse, Pamlico/Pungo and Bay rivers before and after tie-down and 50 yard from shore regulation, effective July 2008. Pre-regulation period from July 2007 – June 2008 and post-regulation periods from July 2008 – June 2009 and July 2009 – June 2010.

		Pre-Regulation (July 2007)			Post-Regulation (July 2008)			Post-Regulation (July 2009)		
Waterbody	Season	Trips	P	Landings (lbs.)	Trips	P	Landings (lbs.)	Trips	P	Landings (lbs.)
Neuse	Winter	259	26	5,367	160	23	2,389	182	27	1,241
	Spring	432	40	18,664	573	49	25,851	215	32	7,670
	Summer	475	48	17,089	456	48	21,633	668	59	38,833
	Fall	480	45	22,374	174	34	5,827	214	35	9,353
	Sub-total	1,646		63,494	1,363		55,700	1,279		57,097
Pamlico / Pungo	Winter	269	39	4,105	290	47	5,587	213	40	2,215
	Spring	645	73	22,888	716	84	21,913	254	43	6,313
	Summer	557	70	21,814	596	64	37,992	774	78	41,135
	Fall	673	80	39,249	381	60	28,244	423	63	33,187
	Sub-total	2,144		88,056	1,983		93,736	1,664		82,850
Bay River	Winter	22	5	259	14	3	58	20	7	82
	Spring	113	11	3,928	80	10	3,028	79	11	1,799
	Summer	77	9	3,656	170	8	13,301	172	16	10,782
	Fall	92	14	3,209	32	8	1,040	75	16	2,706
	Sub-total	304		11,052	296		17,427	346		15,369
Total		4,094		162,602	3,642		302,855	3,289		155,316

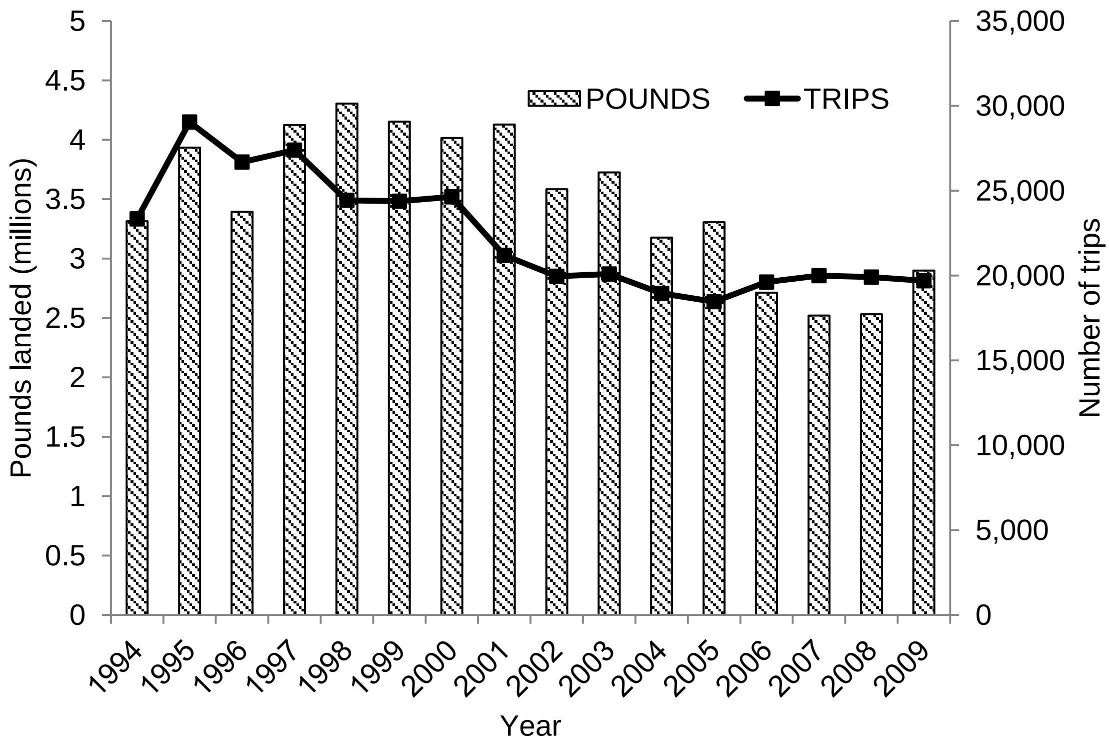

Figure 11.6.1. Anchored gill net sets and landings (pounds) for the Central Southern Management Area (CSMA); 1994 – 2009.

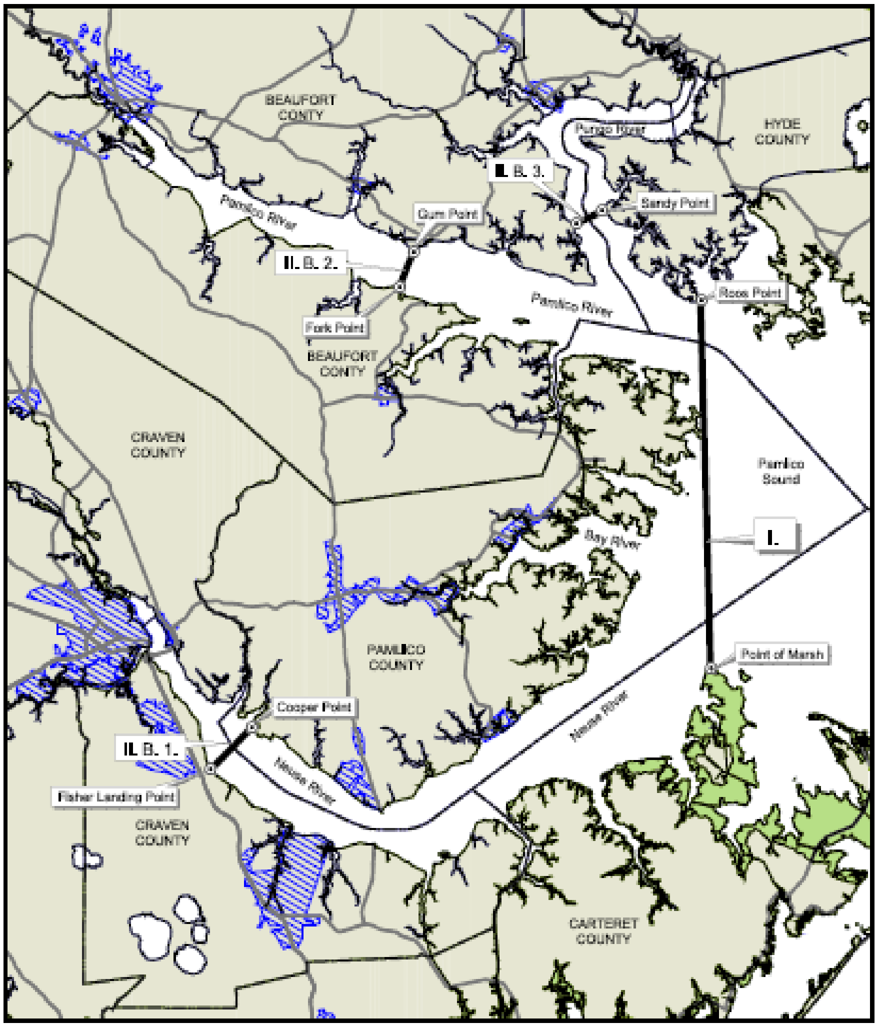

Figure 11.6.2. Restricted areas (3 foot tie down and minimum 50 yard distance from shore) implemented in May 2008 by proclamation, and each subsequent year upon closing of the Central Southern Management area commercial striped bass season.

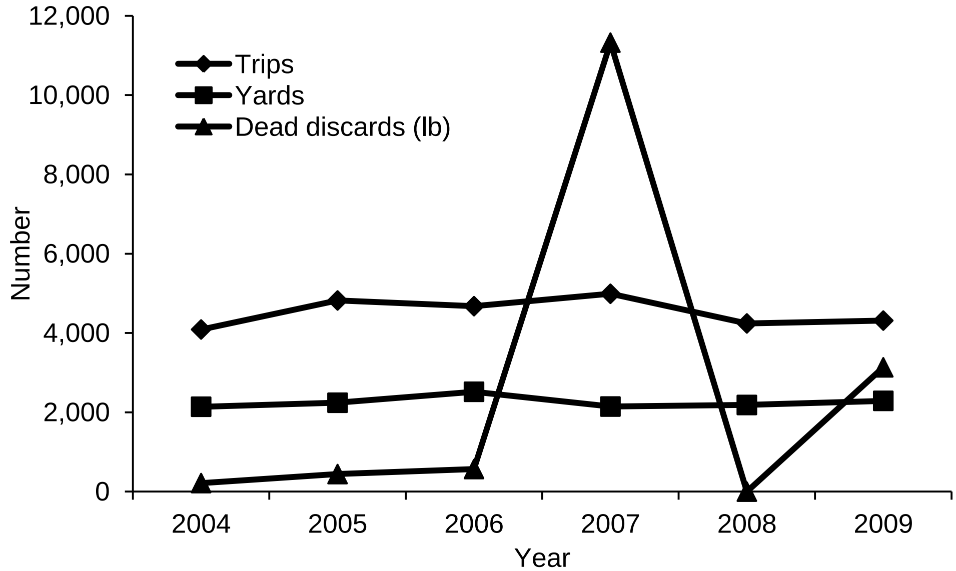

Figure 11.6.3. Number of trips, average yards of **small mesh** gill net fished per trip, and observed dead striped bass for commercial gill nets in the Central Southern Management Area. See text page 7 for note on why year 2007 atypical.

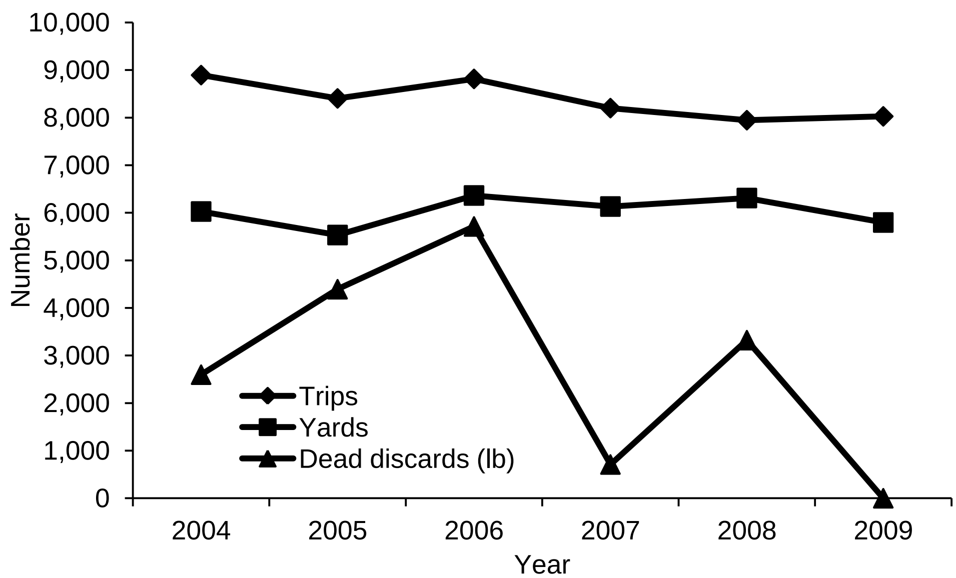

Figure 11.6.4. Number of trips, average yards of **large mesh** gill net fished per trip, and observed dead striped bass for commercial gill nets in the Central Southern Management Area.

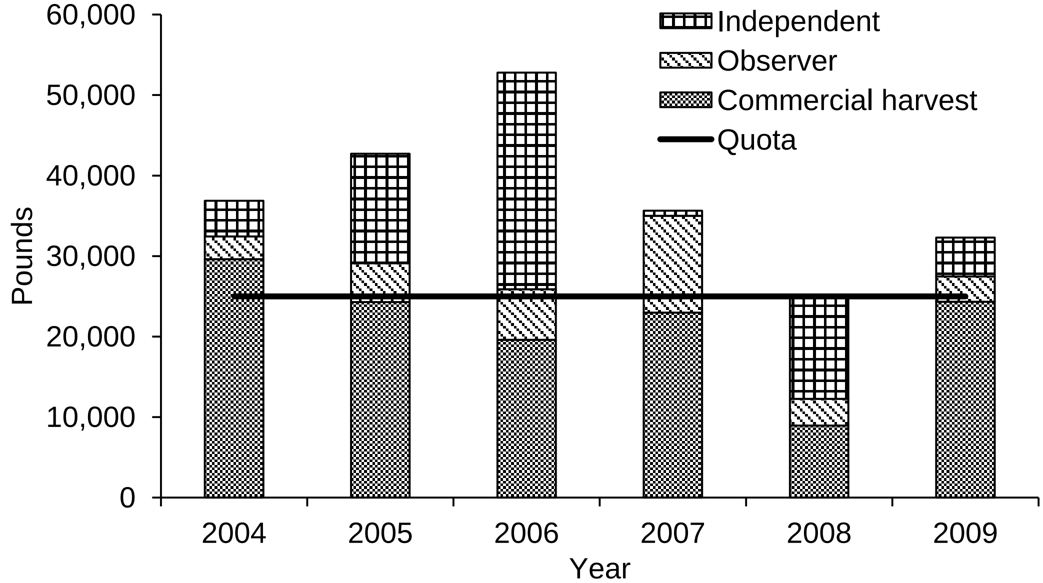

Figure 11.6.5. Total striped bass take (harvest + dead discards) for the Central Southern Management area.

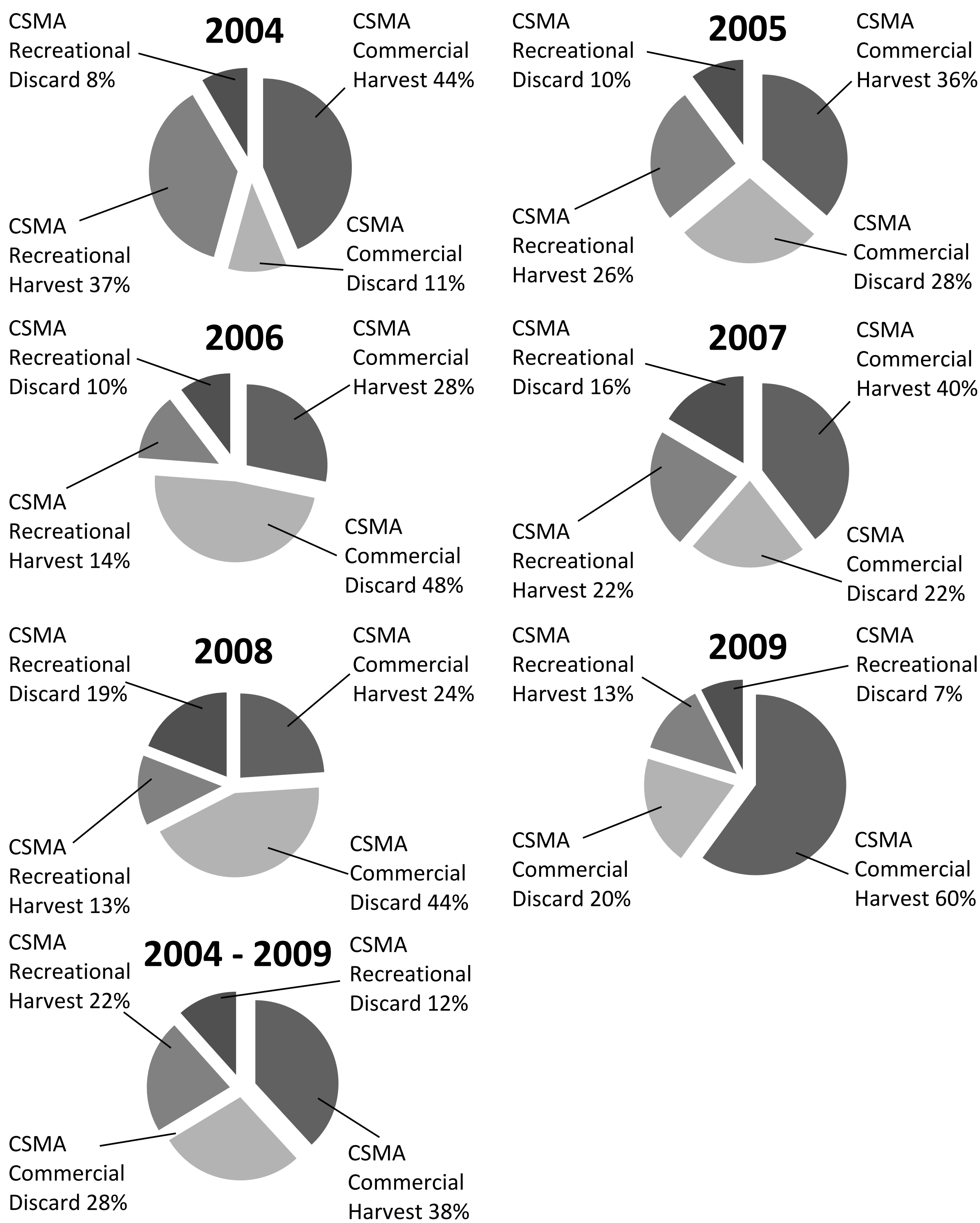

Figure 11.6.6. Total harvest and discards by commercial and recreational sectors 2004-2009, CSMA. Commercial discard estimates taken from the NCDMF **Independent Gillnet Survey.** *2009 recreational harvest and discard numbers used an average of RCGL numbers for 2004-2008.

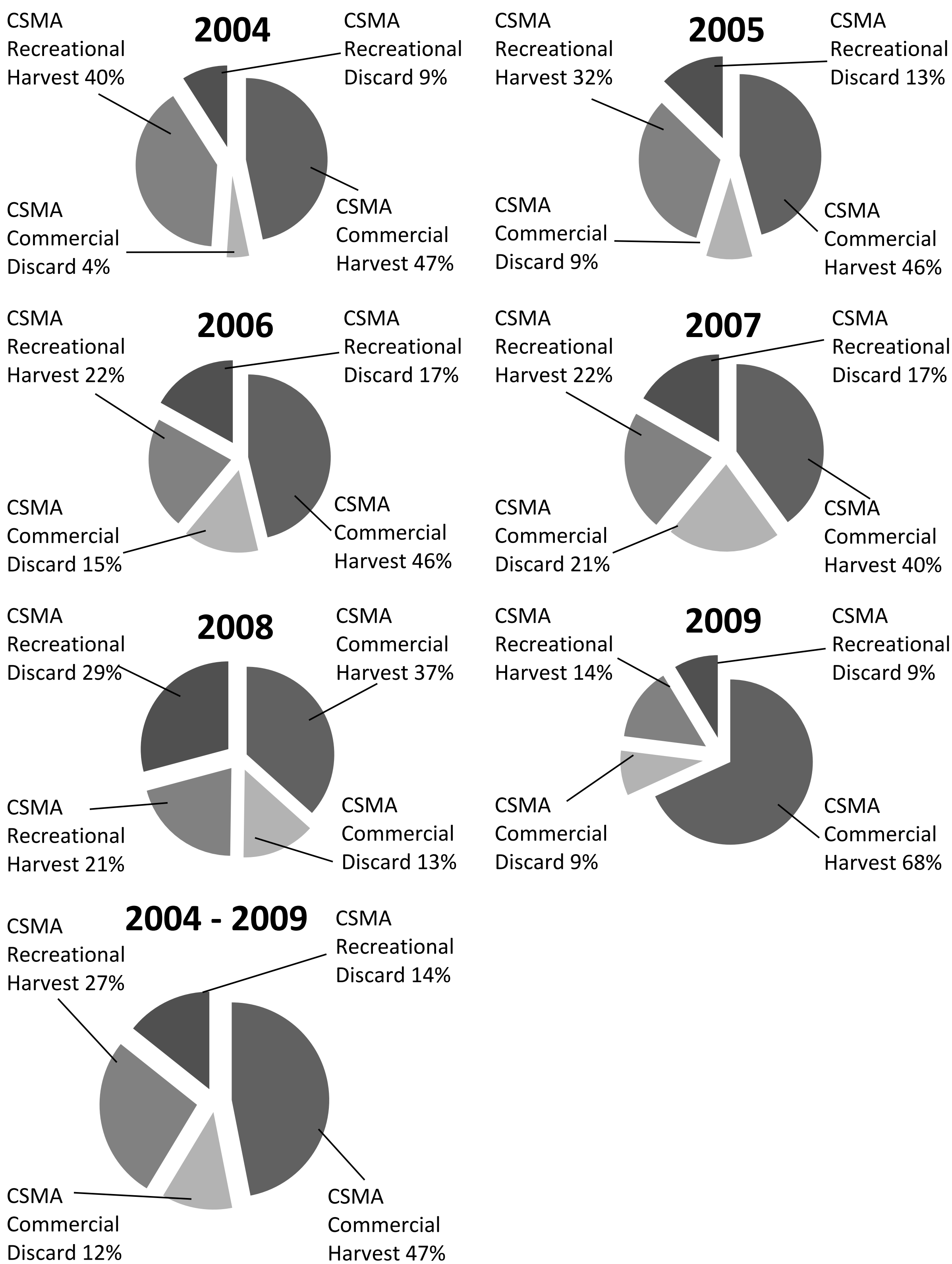

Figure 11.6.7. Total harvest and discards by commercial and recreational sectors 2004-2009, CSMA. Commercial discard estimates taken from **fishery dependent observer data** *2009 recreational harvest and discard numbers used an average of RCGL numbers for 2004-2008.

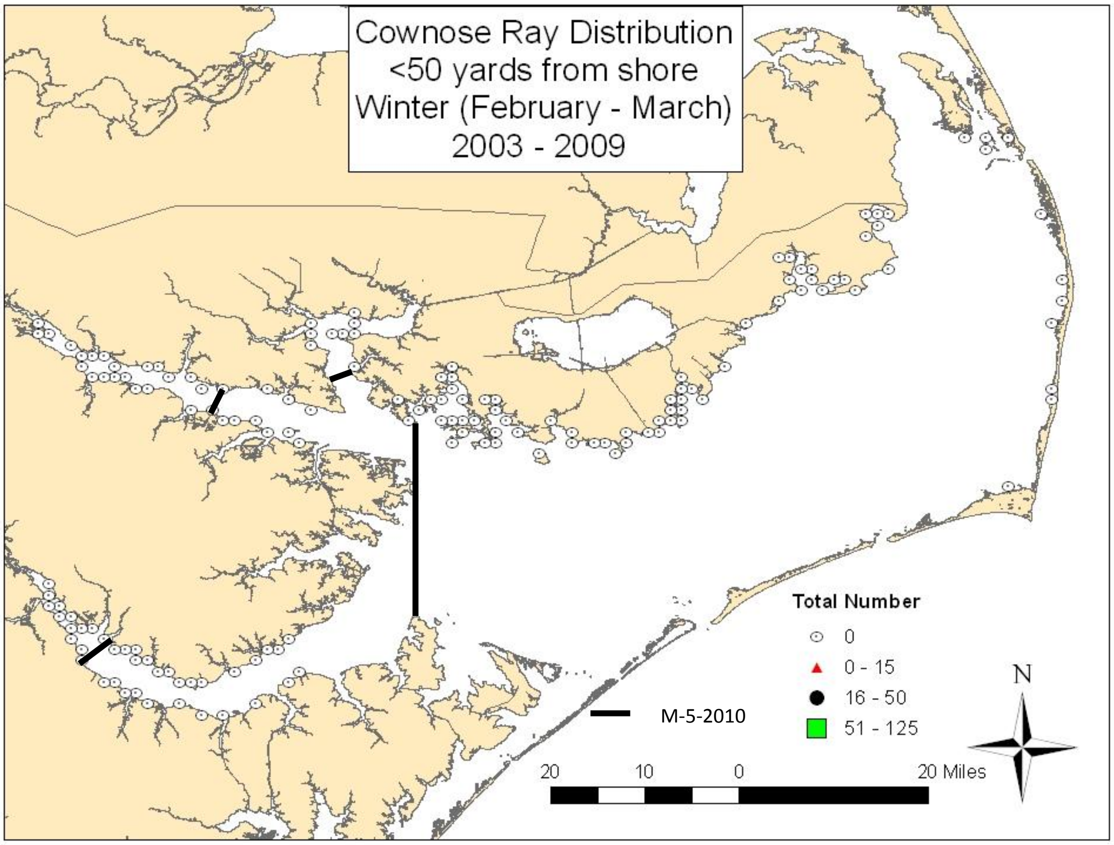

Figure 11.6.8. Winter (February – March) cownose ray distribution in samples within 50 yards from shore in NCDMF Program 915 Fisheries Independent Assessment.

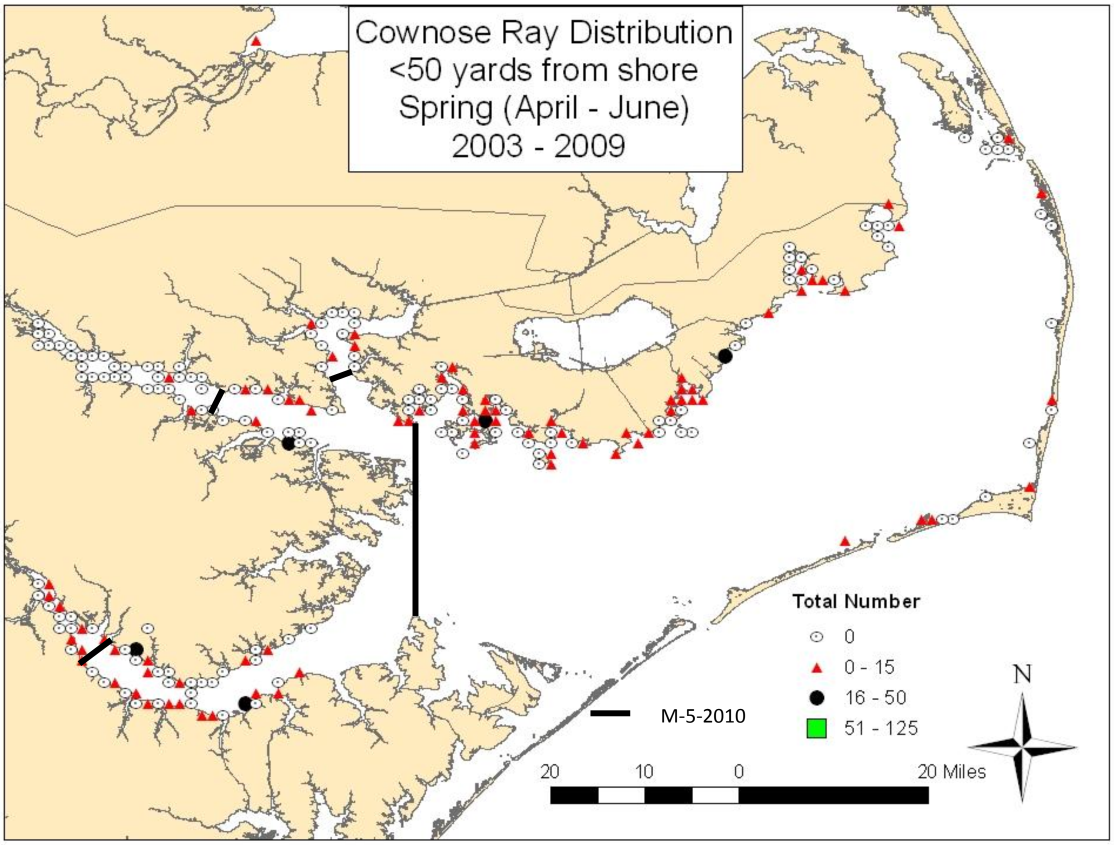

Figure 11.6.9. Spring (April – June) cownose ray distribution in samples within 50 yards from shore in NCDMF Program 915 Fisheries Independent Assessment.

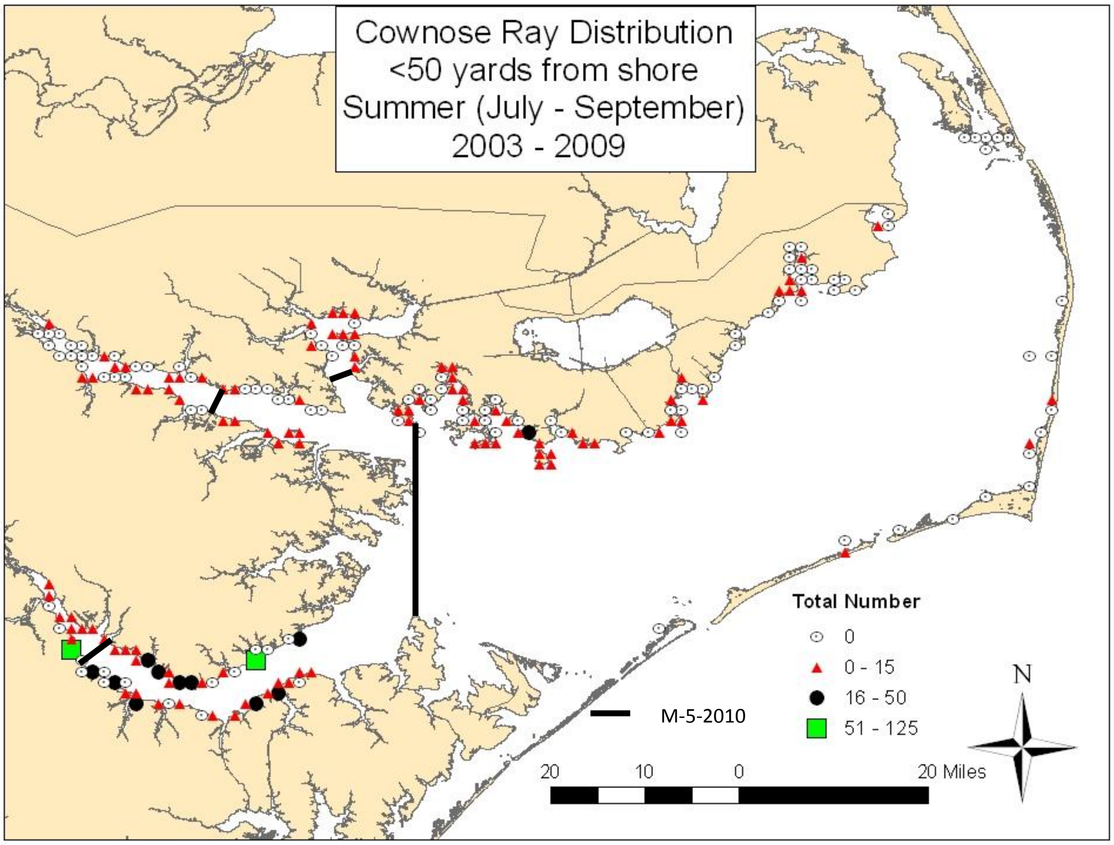

Figure 11.6.10. Summer (July – September) cownose ray distribution in samples within 50 yards from shore in NCDMF Program 915 Fisheries Independent Assessment.

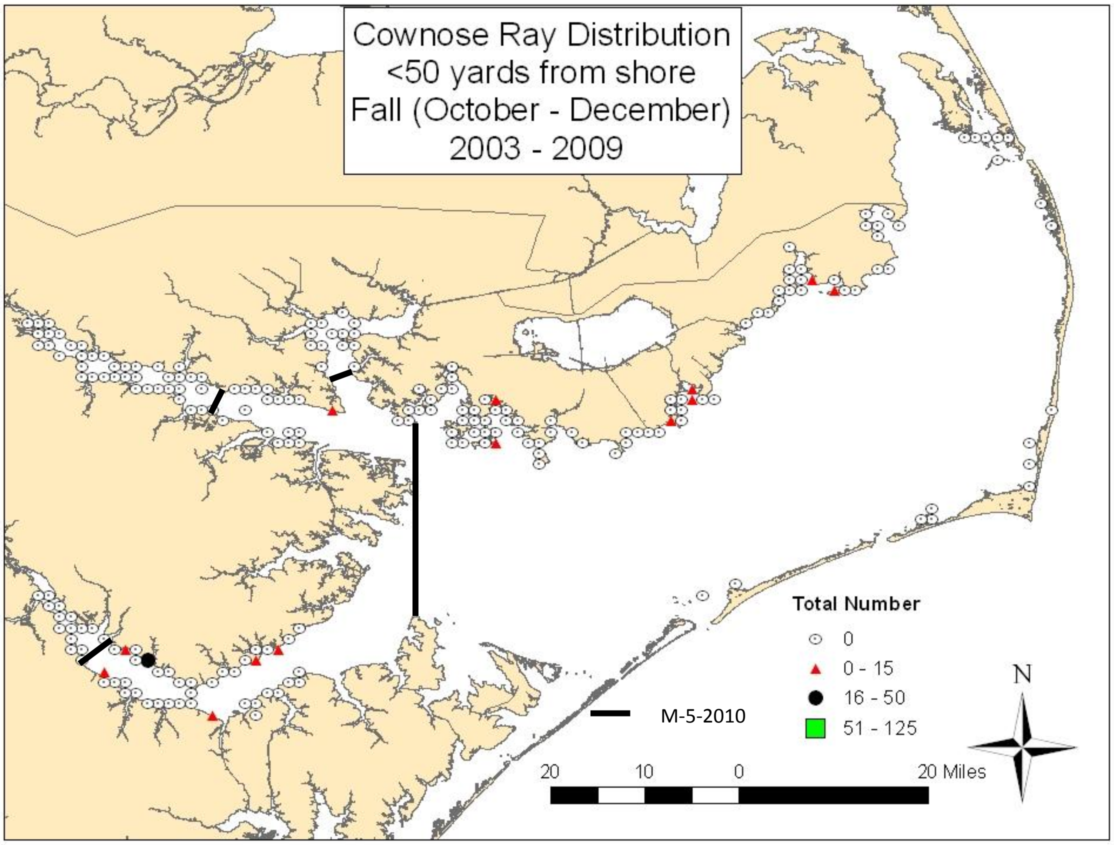

Figure 11.6.11. Fall (October. – December) cownose ray distribution in samples within 50 yards from shore in NCDMF Program 915 Fisheries Independent Assessment.

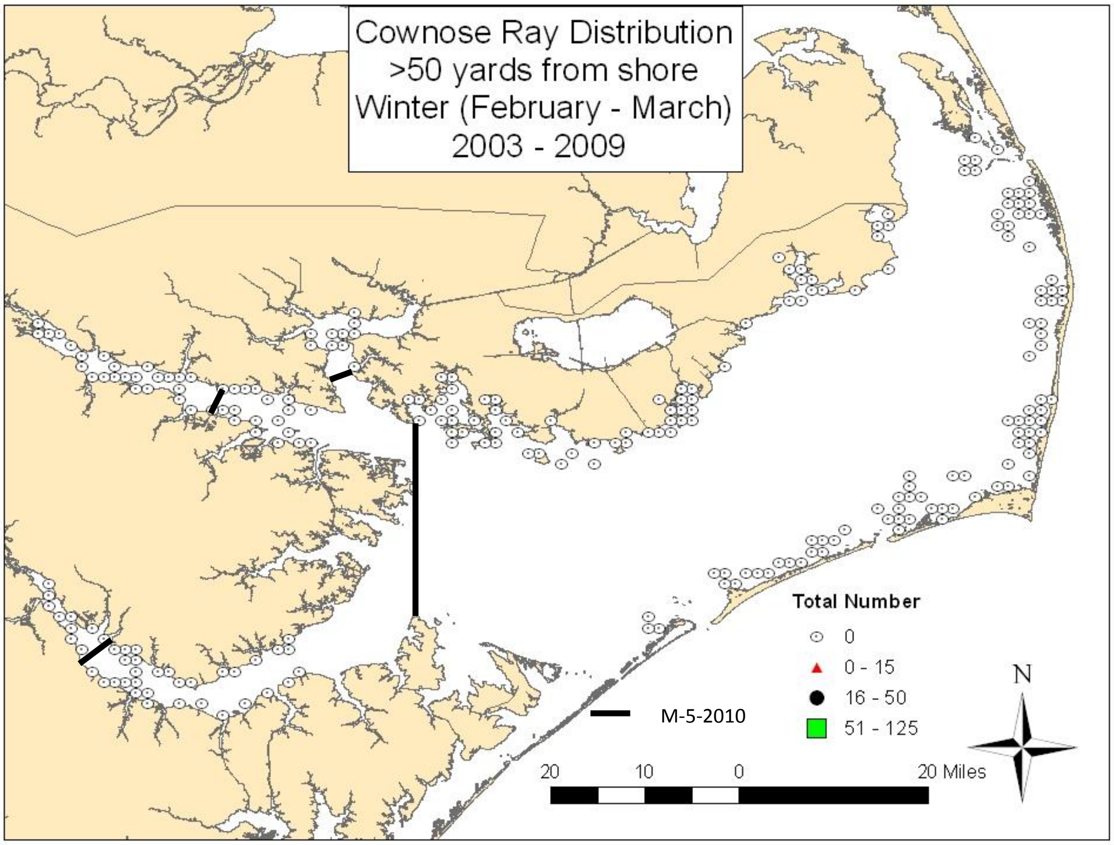

Figure 11.6.12. Winter (February – March) cownose ray distribution in samples greater than 50 yards from shore in NCDMF Program 915 Fisheries Independent Assessment.

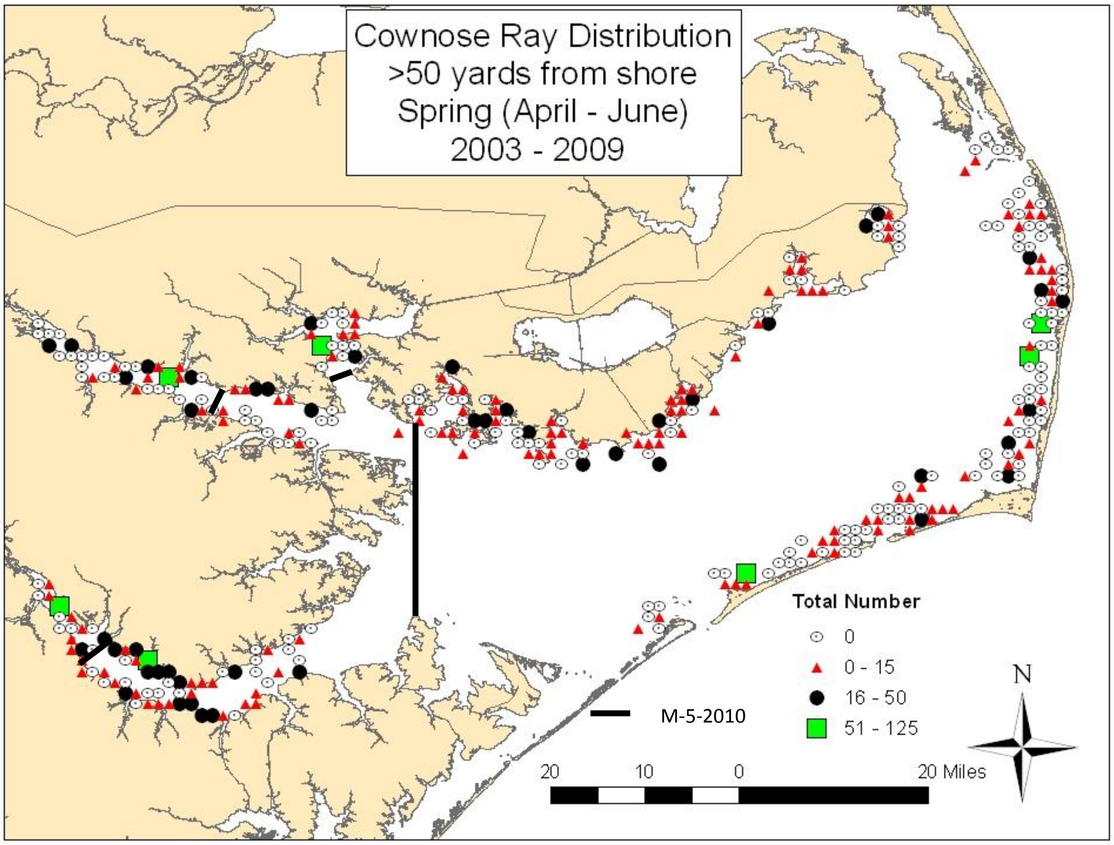

Figure 11.6.13. Spring (April – June) cownose ray distribution in samples greater than 50 yards from shore in NCDMF Program 915 Fisheries Independent Assessment.

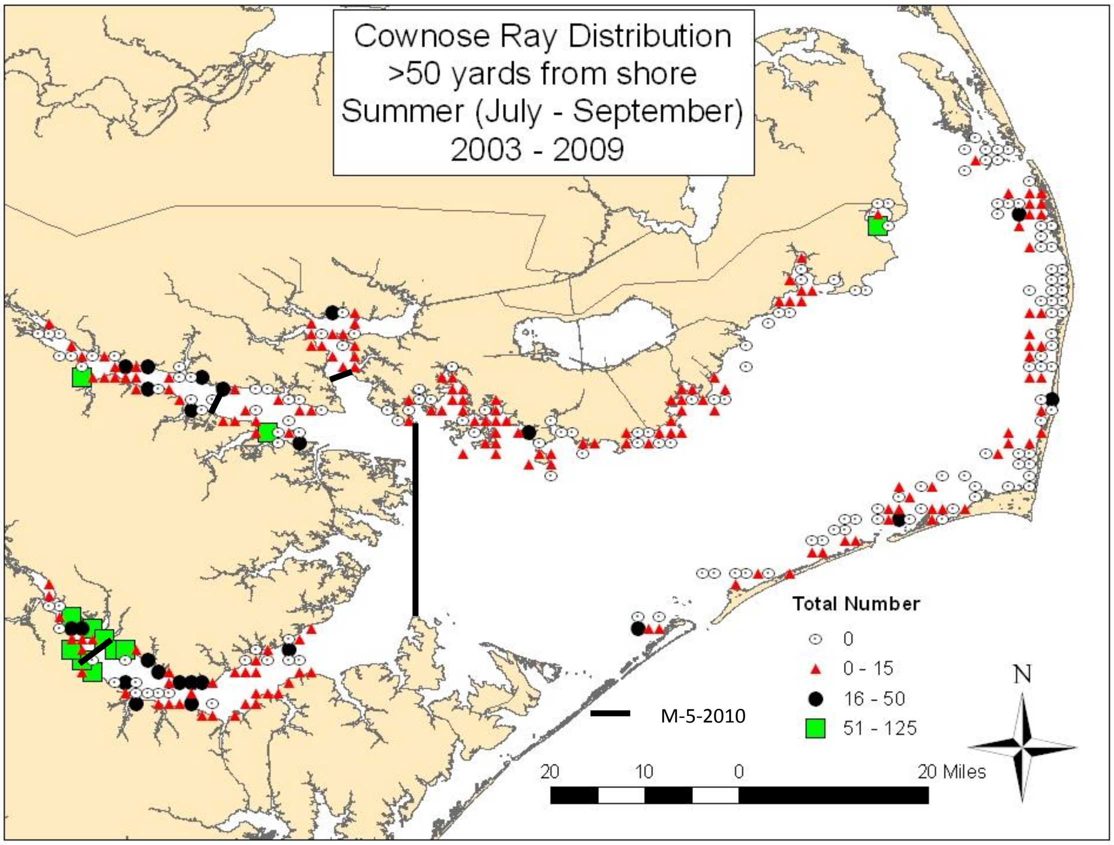

Figure 11.6.14. Summer (July – September) cownose ray distribution in samples greater than 50 yards from shore in NCDMF Program 915 Fisheries Independent Assessment.

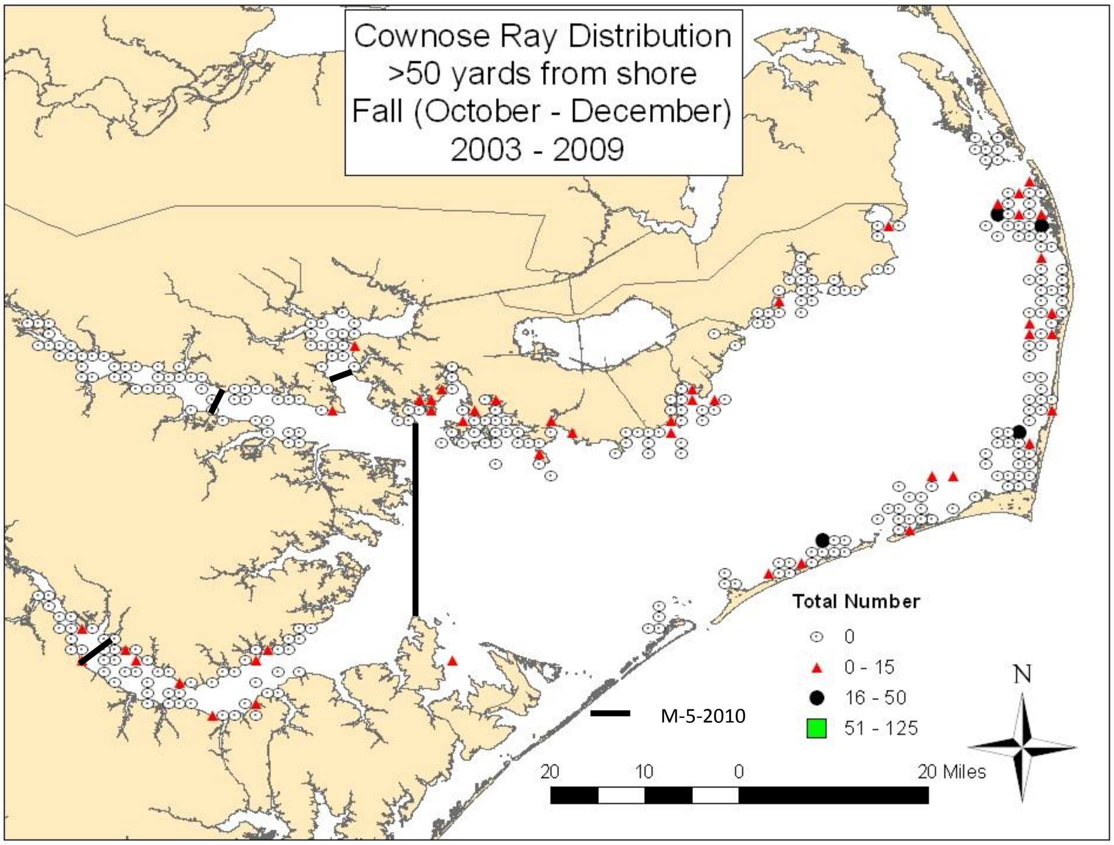

Figure 11.6.15. Fall (October. – December) cownose ray distribution in samples greater than 50 yards from shore in NCDMF Program 915 Fisheries Independent Assessment.

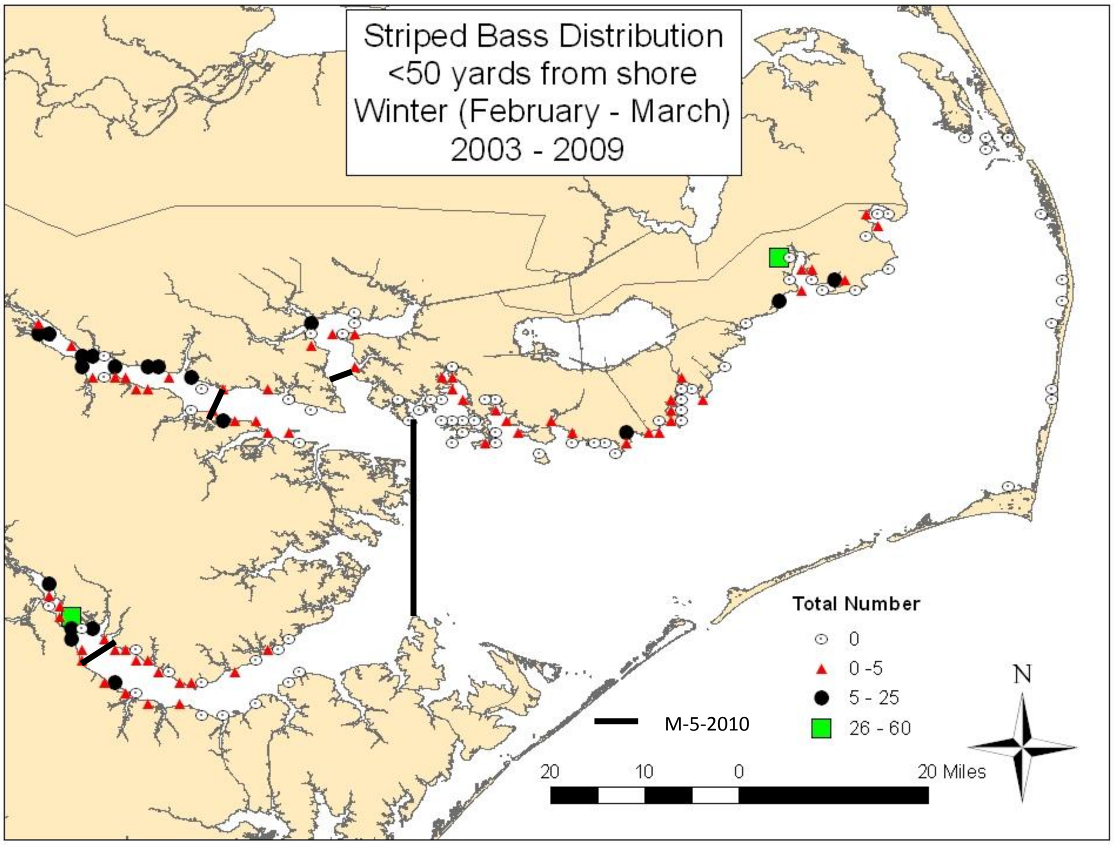

Figure 11.6.16. Winter (February – March) striped bass distribution in samples within 50 yards from shore in NCDMF Program 915 Fisheries Independent Assessment.

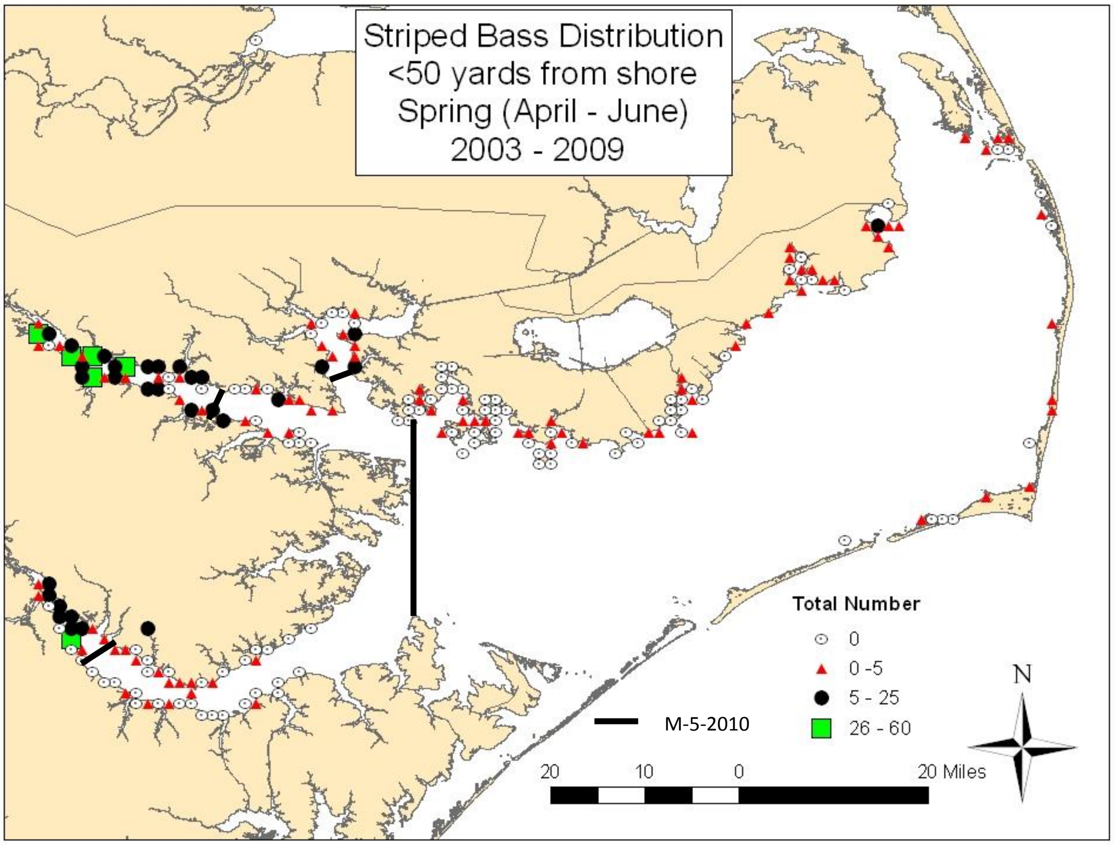

Figure 11.6.17. Spring (April – June) striped bass distribution in samples within 50 yards from shore in NCDMF Program 915 Fisheries Independent Assessment.

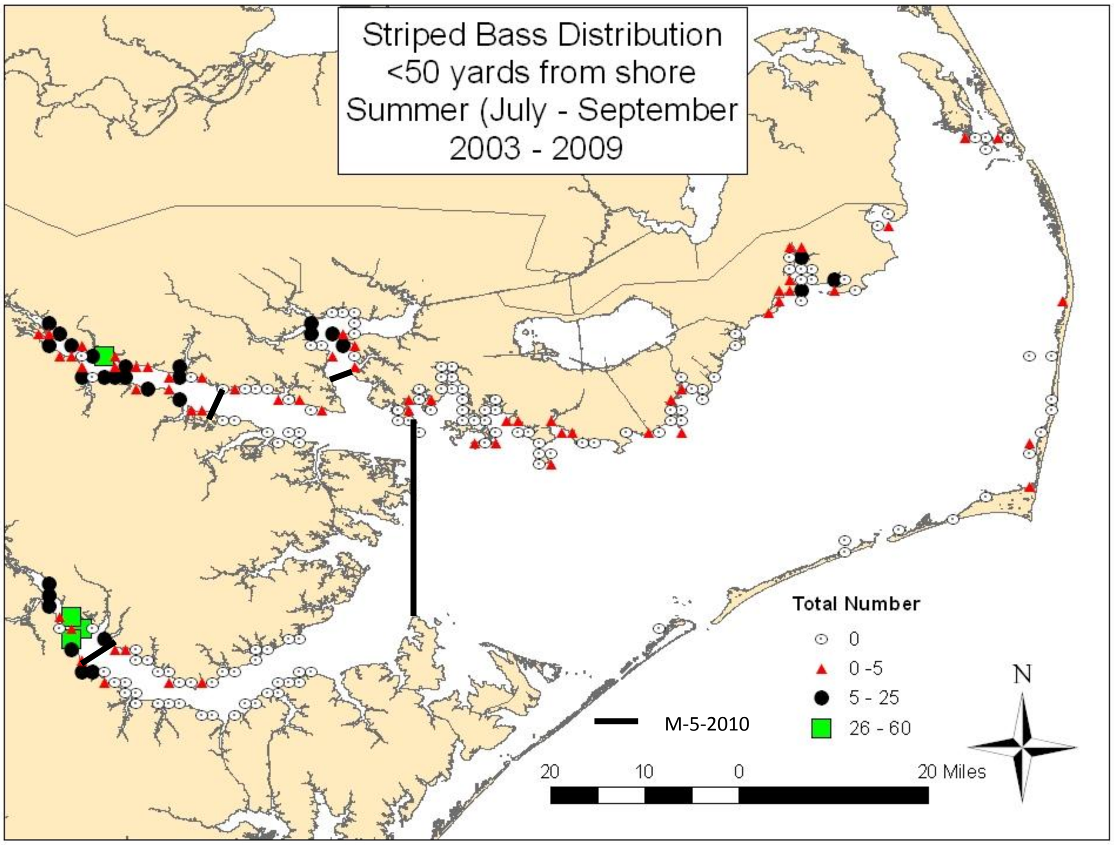

Figure 11.6.18. Summer (July – September) striped bass distribution in samples within 50 yards from shore in NCDMF Program 915 Fisheries Independent Assessment.

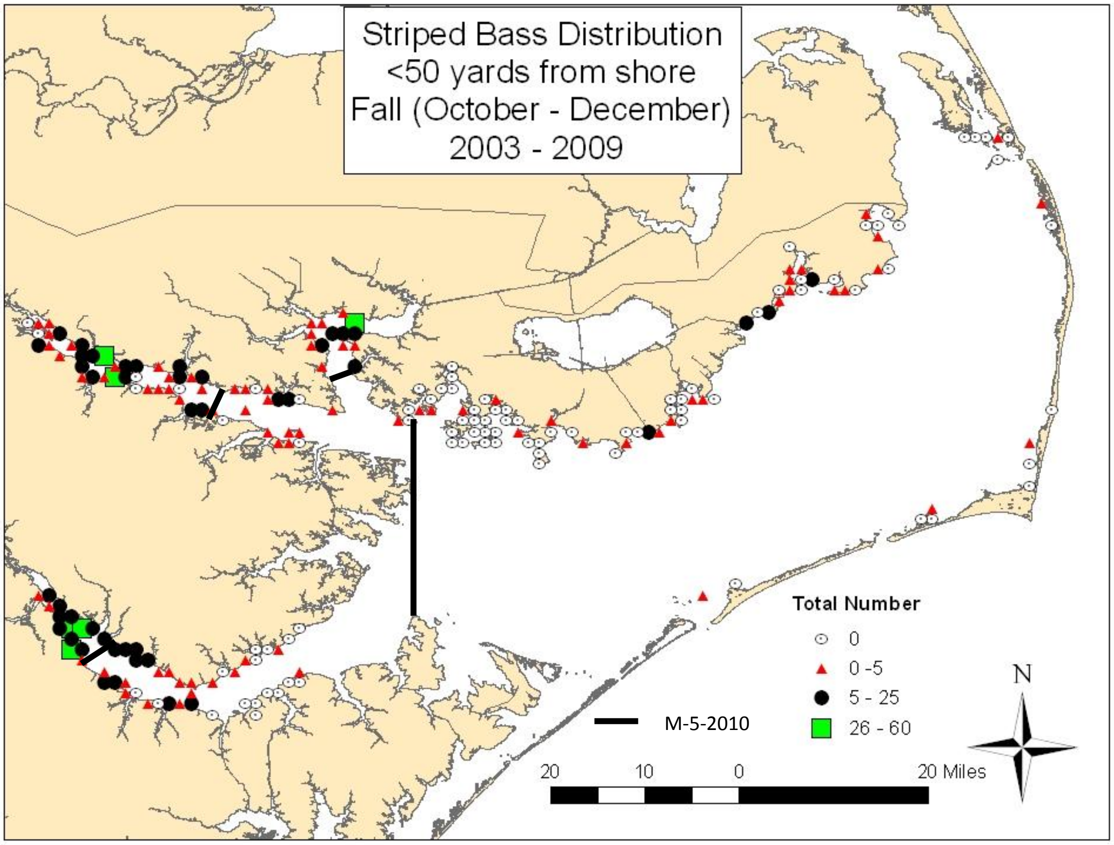

Figure 11.6.19. Fall (October. – December) striped bass distribution in samples within 50 yards from shore in NCDMF Program 915 Fisheries Independent Assessment.

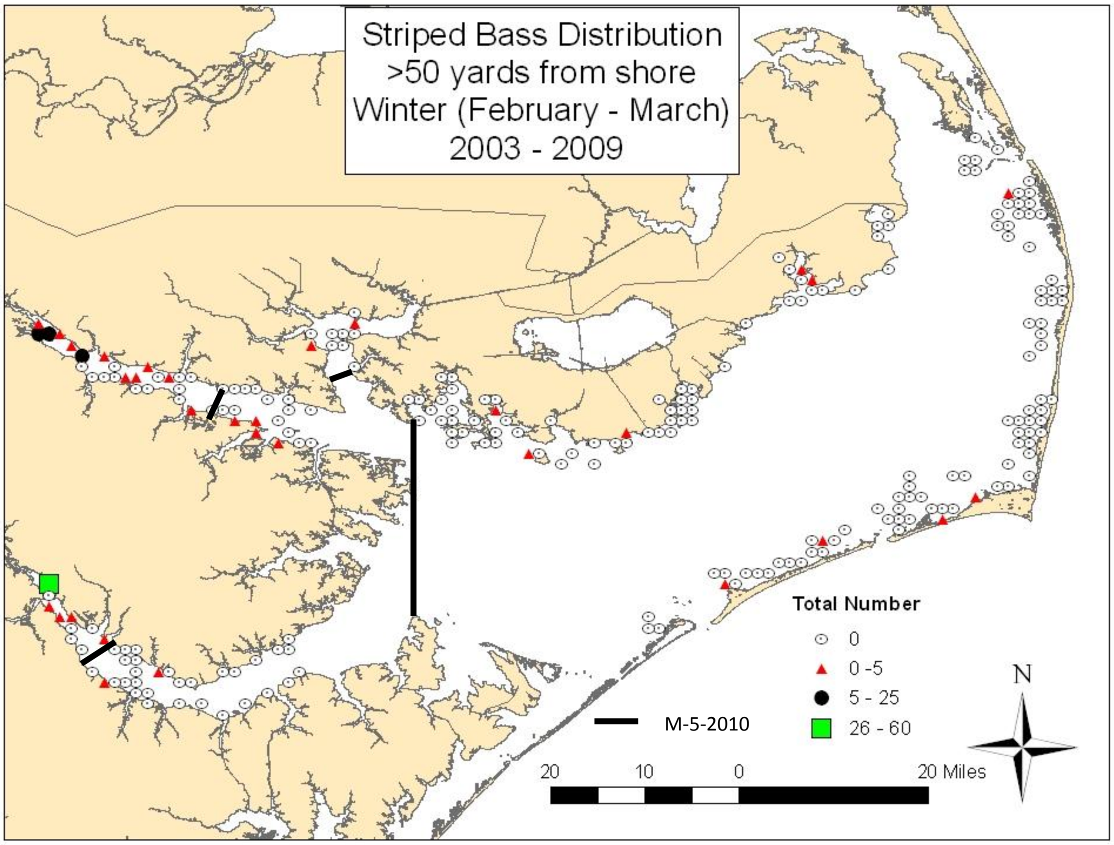

Figure 11.6.20. Winter (February – March) striped bass distribution in samples greater than 50 yards from shore in NCDMF Program 915 Fisheries Independent Assessment.

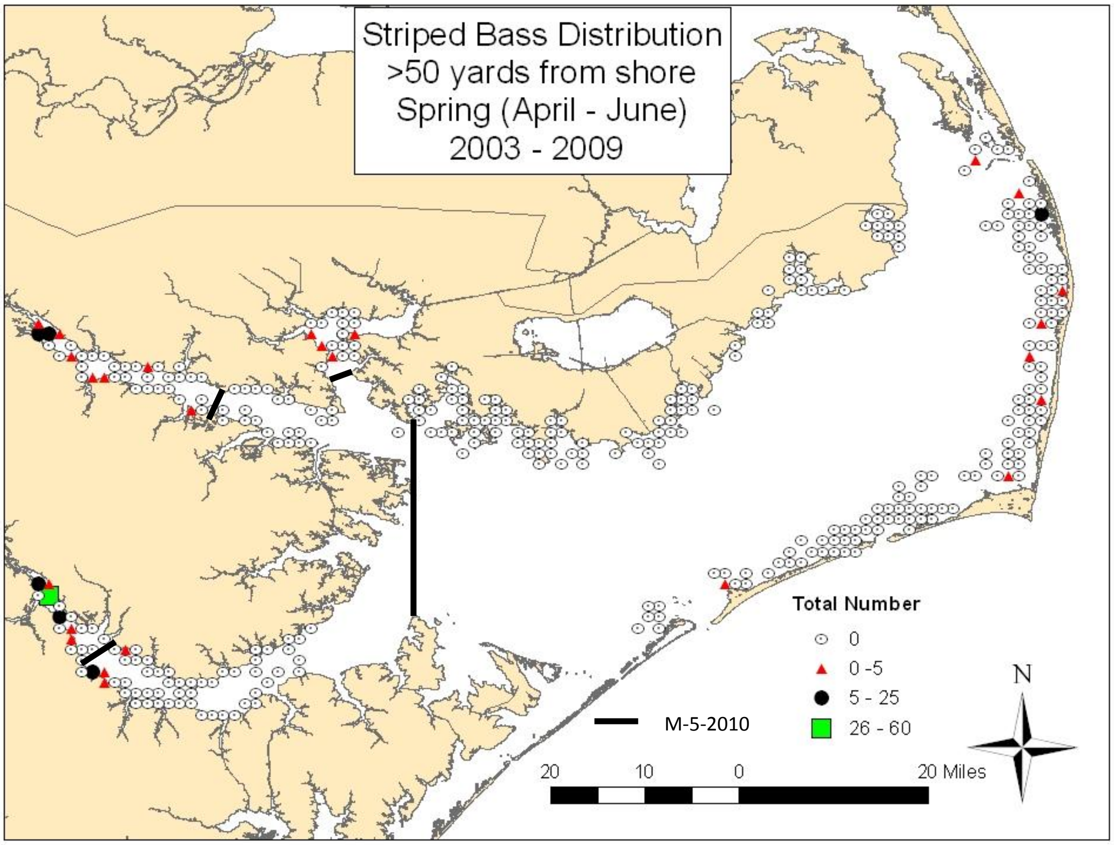

Figure 11.6.21. Spring (April – June) striped bass distribution in samples greater than 50 yards from shore in NCDMF Program 915 Fisheries Independent Assessment.

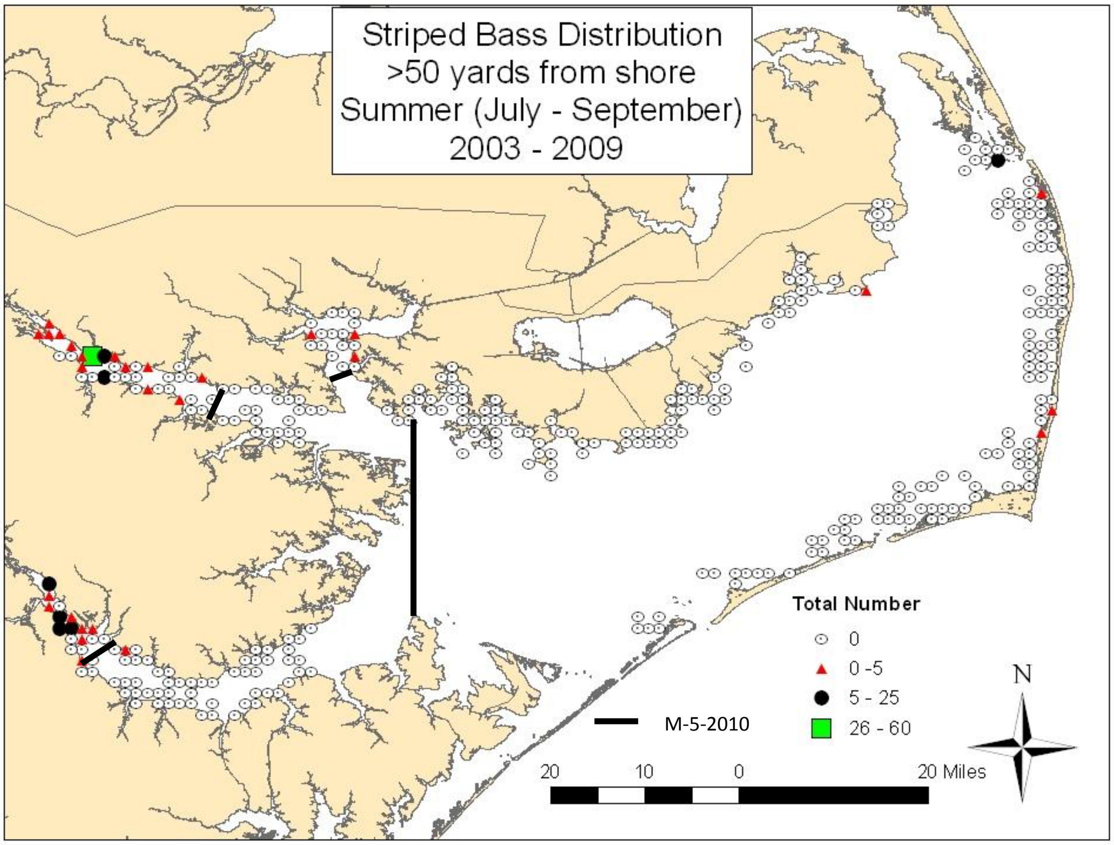

Figure 11.6.22. Summer (July – September) striped bass distribution in samples greater than 50 yards from shore in NCDMF Program 915 Fisheries Independent Assessment.

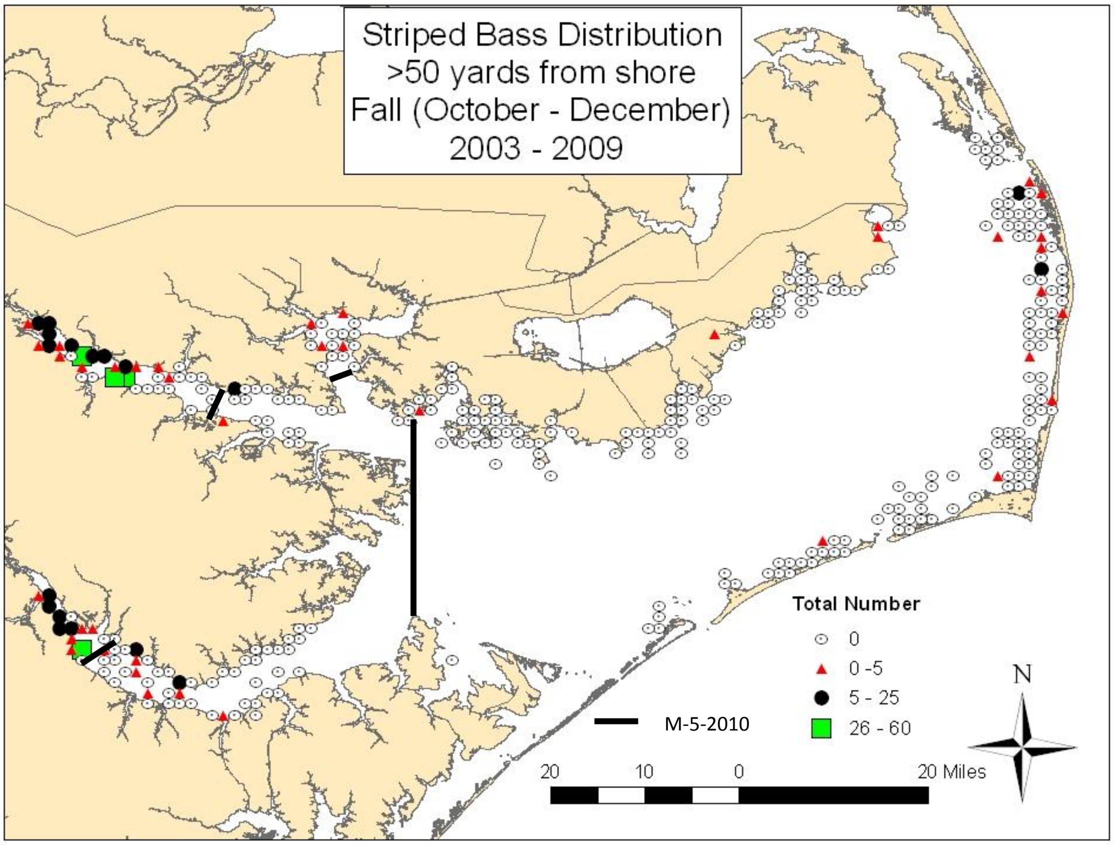

Figure 11.6.23. Fall (October – December) striped bass distribution in samples greater than 50 yards from shore in NCDMF Program 915 Fisheries Independent Assessment.

ADDENDUM A

11.6A Discard Mortality of Striped Bass from Commercial Set Gill Nets Central Southern Management Area (CSMA)

At the January 19, 2011 CSMA AC meeting during the public comment period Sheldon Cuthrell a commercial fisherman and dealer from Pamlico County submitted a proposal to move the DFS lines up the rivers (by proclamation, so they could be moved back if striped bass were observed in commercial fishing operations). Mr. Cuthrell cited interactions with cow nose rays in the deeper water and the absence of striped bass in the shallow water this time of year. Mr. Cuthrell explained that the turtle restrictions placed on the large mesh gill net fishery in May 2010 severely restricted the amount of time nets are allowed to soak, which also greatly reduces the amount of bycatch in the gill net fishery. He felt that even with moving the DFS lines upstream, the target reduction in striped bass bycatch would be met or surpassed. The AC members discussed the proposed line changes (Figure 11.6.A1) and adopted the following motion: recommend moving the 50 yard distance from shore lines upriver to the points specified in the Cuthrell map by proclamation from June 15 to August 31, at which point the DFS lines are to be restored to the original position. The motion carried seven in favor and two opposed.

In order to determine the NCWRC and NCDMF agency recommendation, Program 915 data was compiled to determine the abundance of striped bass within 50 yards from shore in the proposed area at the proposed time (June 15- August 31.) Data are presented by year in Table 11.6.1A. Overall during the selected summer timeframe moving the DFS lines, as recommended by the AC, would potentially increase striped bass interactions by 54% in the area less than 50 yards from shore and 32% in the area greater than 50 yard from shore. The distribution of striped bass for combined years 2003-2010 in these areas is shown in Figures 11.6.2A 11.6.3A for the Pamlico and Pungo rivers and Figures 11.6.4A 11.6.5A for the Neuse River.

The NCWRC and NCDMF recommend Status quo for this issue:

- Require the use of a 3 foot tie down in large mesh (>=5 inch stretch mesh) gill nets in internal coastal fishing waters upstream of the 76 °28.0000' W longitude line.
- Maintain a minimum distance from shore of 50 yards for these nets upstream of the existing DFS lines

Agencies rationale for this recommendation is based on the aforementioned data and:

1) Discard mortality in the commercial gill net fisheries represents a large percentage of total mortality in the CSMA, and significant reductions are necessary for stock improvement.

2) Changes in current commercial fishing practices within the CSMA, while potentially providing some reduction in discard mortality, have not been formally evaluated in regards to reduction in total striped bass mortality. The NCMFC and Wildlife Commission recognized the importance of this information, and approved funding through the Coastal Recreational Fishing License (CRFL) program to obtain current estimates of commercial discard mortality; funds will be released for this project effective 1 July 2011.

3) Reductions in striped bass harvest have been observed in the CSMA recreational fishery as a result of significant restrictions put in place in 2008 including a reduction in the daily creel limit, expansion of the slot limit boundary, and season closure from 1 May through 30 September. Recreational anglers agreed, reluctantly, to these changes with the

assumption that significant reductions in discard mortality would be accomplished through the DFS and tie-down requirements in the commercial gill net fisheries. The importance of the DFS and tie-down requirements was recognized by NCMFC and supported as being necessary for the recovery of CSMA striped bass populations. It was acknowledged that there would be collateral impacts to other fisheries when these measures were discussed and voted on by the NCMFC but the potential gain to striped bass balanced the loss to the other fisheries.

Table 11.6.1A Striped bass (2003-2010) for June 15 through August 31 from DMF Program 915 partitioned by river for modified Distance From Shore (DFS) lines.

		Above Cuthrell Line	Below DMF Line	Between both Lines	
Distance from Shore	Area	Striped Bass	Striped Bass	Striped Bass	All
LE 50 yards	Neuse	123	21	73	217
	Pamlico	76	3	193	272
	Pungo	14	.	8	22
	All	213	24	274	511
	Percent	42	5	54	
GT 50 yards	Neuse	71	1	18	90
	Pamlico	43	0	35	78
	Pungo	0	.	1	1
	All	114	1	54	169
	Percent	67	1	32	
Overall	Combined	327	25	328	680
	Percent	48	4	48	

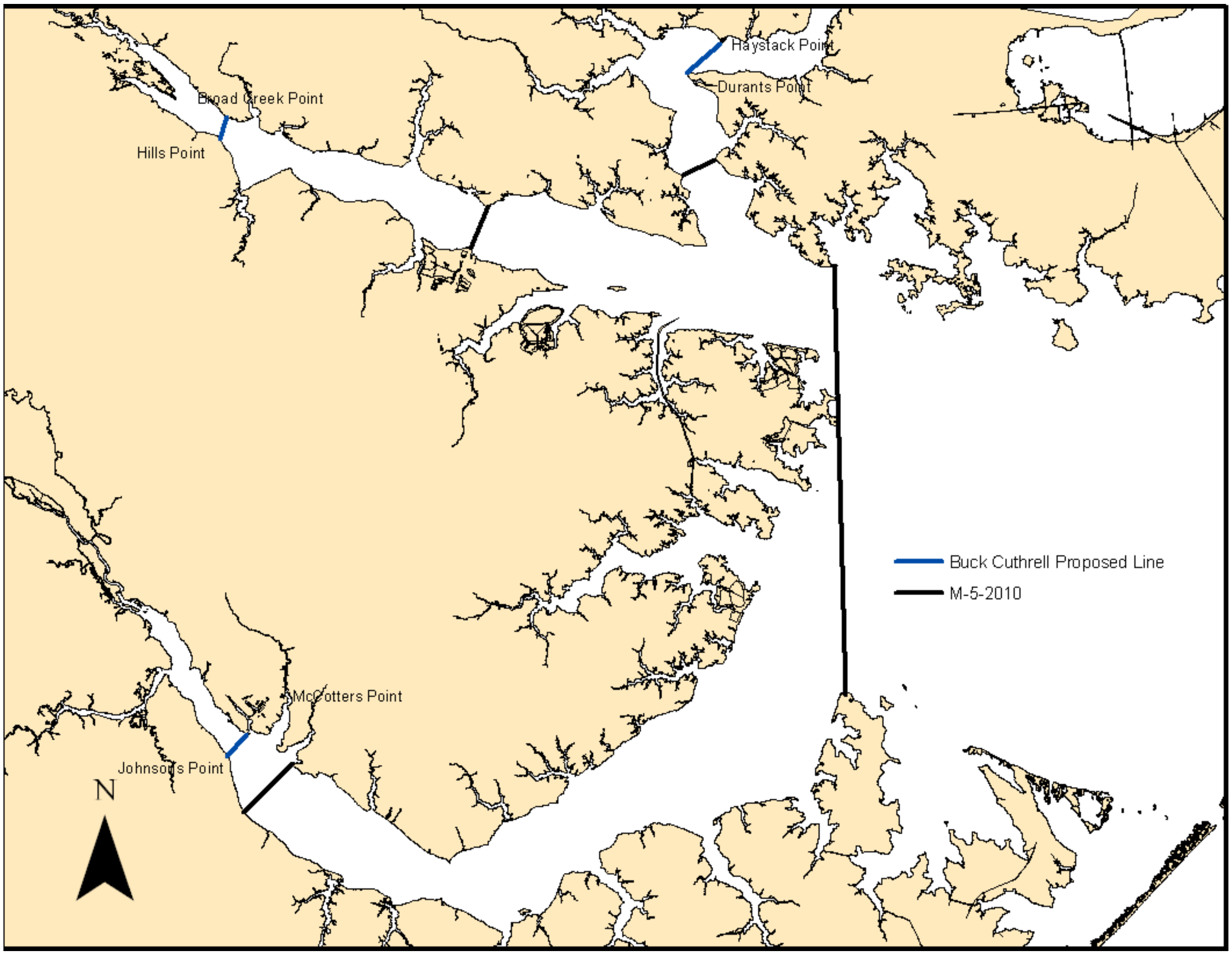

Figure 11.6.1A. Solid blue lines represent the proposed boundaries by Mr. Buck Cuthrell for the 50 yard distance from shore (DFS) lines. Current DFS boundaries (M-5-2010) are depicted by the short solid black lines within each river system upstream and west of the western Pamlico Sound DPS boundary indicated by the long solid black line

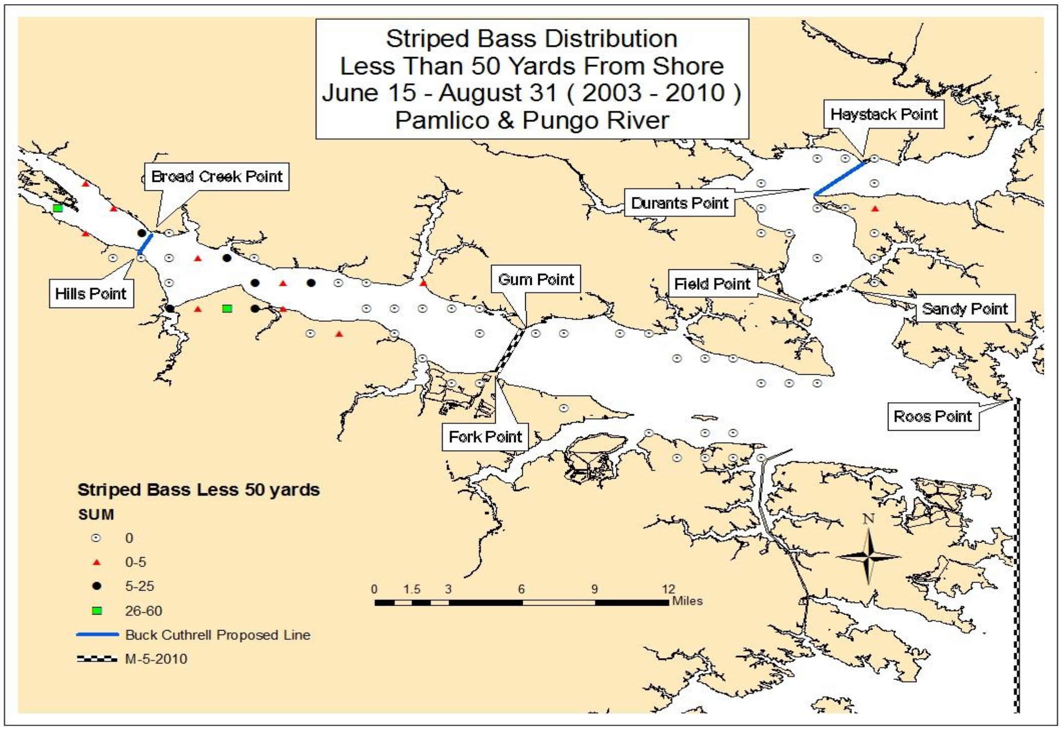

Figure 11.6.2A Striped bass distribution from June 15 – August 31 (2003-2010) in samples within 50 yards from shore in NCDMF Program 915 Fisheries Independent Assessment in the Pamlico and Pungo River.

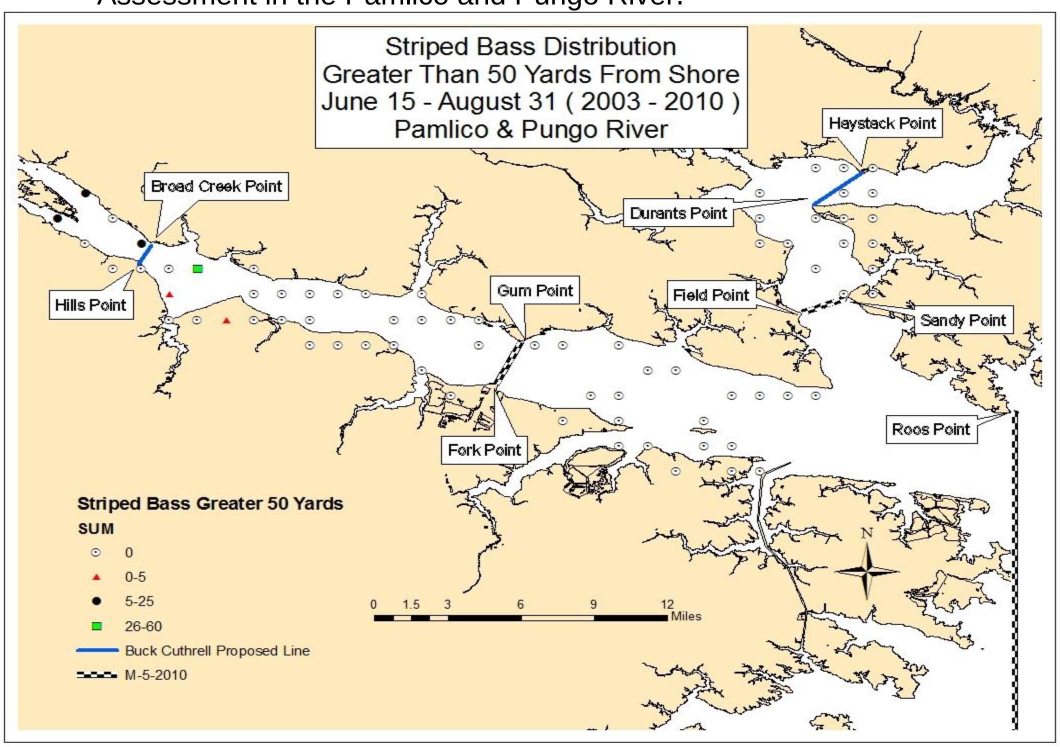

Figure 11.6.3A Striped bass distribution from June 15 – August 31 (2003-2010) in samples greater than 50 yards from shore in NCDMF Program 915 Fisheries Independent Assessment in the Pamlico and Pungo River.

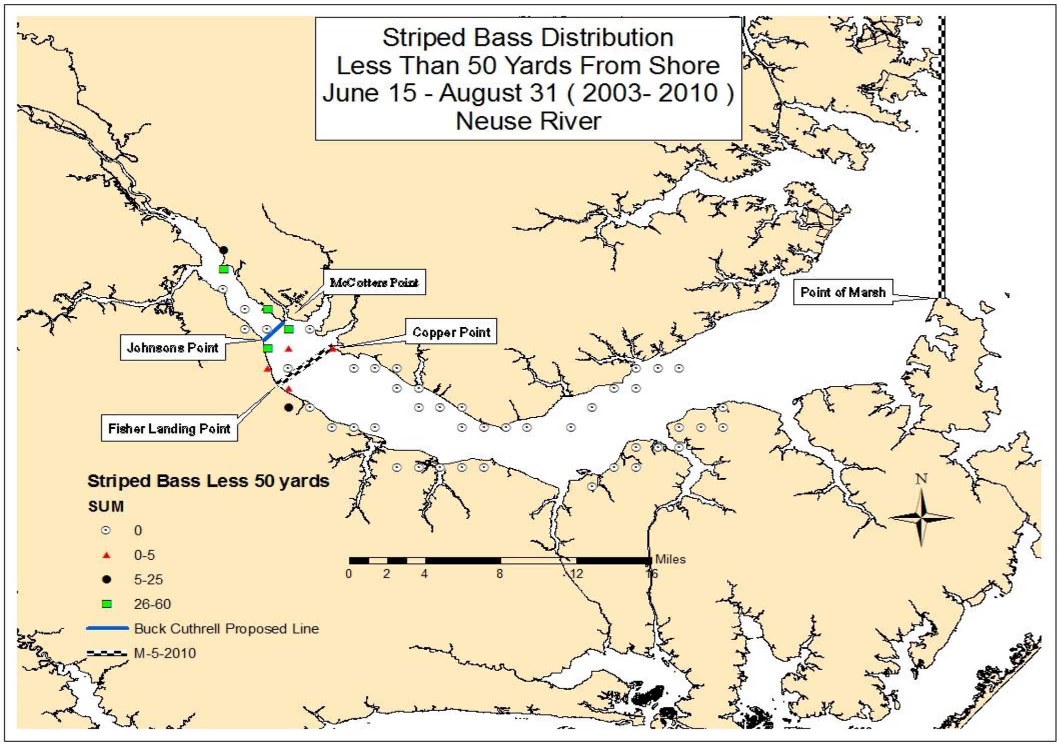

Figure 11.6.4A Striped bass distribution from June 15 – August 31 (2003-2010) in samples within 50 yards from shore in NCDMF Program 915 Fisheries Independent Assessment in the Neuse River.

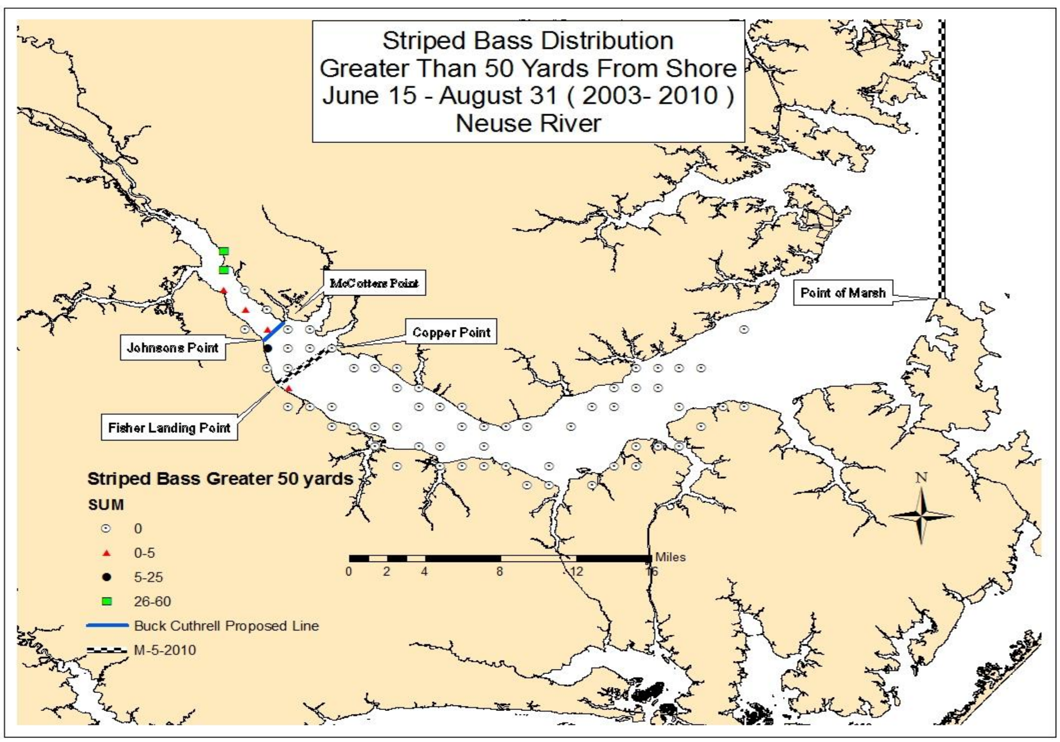

Figure 11.6.5A Striped bass distribution from June 15 – August 31 (2003-2010) in samples greater than 50 yards from shore in NCDMF Program 915 Fisheries Independent Assessment in the Neuse River.

11.7 HOOK AND LINE AS COMMERCIAL GEAR IN ESTUARINE STRIPED BASS FISHERIES

ISSUE

The use of gill nets as a commercial gear has become increasingly restricted over the past year as a result of management measures designed to reduce interactions with threatened and endangered sea turtles. Further restrictions may be employed as a result of possible listing of Atlantic sturgeon as “threatened or endangered” under the Endangered Species Act (ESA) or as a result of future federal fishery management measures. This paper examines the options for providing continued fishing opportunity, as well as a means to reduce bycatch and increase resource conservation, through the commercial use of hook-and-line gear for the estuarine striped bass fishery. Similar considerations for the ocean striped bass fishery will be examined through the Interjurisdictional (IJ) Fishery Management Plan (FMP), which encompasses Atlantic States Marine Fisheries Commission (ASMFC) managed species.

II. ORIGINATION

In March 2010, the North Carolina Marine Fisheries Commission (MFC) requested that staff broadly examine issues related to the feasibility of hook-and-line as a commercial gear statewide, irrespective of species. As a result of the information presented by staff, in November 2010 the MFC decided to study more specifically the implications of a commercial hook-and-line sector on a fishery-by-fishery basis as each FMP comes up for review. The North Carolina Estuarine Striped Bass FMP is the first FMP in the review cycle to be eligible for this in-depth consideration of a commercial hook-and-line fishery.

III. BACKGROUND

The MFC received a petition for rulemaking in February 2010, requesting that rules for red drum, spotted seatrout and a proclamation for weakfish be modified to allow for commercial levels of harvest via hook-and-line. While the intent of the petitioner was to allow commercial fishermen who were physically unable to operate other gears (e.g. gill nets, trawls, etc.) the chance to continue to harvest these species, the MFC viewed the petition as an opportunity to explore the feasibility of hook-and-line as an allowable commercial gear in all North Carolina fisheries. Another incentive to do so was the additional restrictions on the use of gill nets as a result of unauthorized interactions with threatened and endangered sea turtles (May 2010). Since then, a proposed rule has also been issued by the National Marine Fisheries Service (NMFS) to list the Carolina distinct population segment (DPS) of Atlantic sturgeon as endangered, which could have significant impacts on the use of gill nets in all joint and coastal waters of North Carolina.

A Division of Marine Fisheries (DMF) workgroup consisting of eight staff developed an information paper for the MFC that detailed (a) all existing MFC rules that would require changes to allow commercial hook-and-line fishing statewide; (b) a summary of other states with hook-and-line fisheries and their management measures; and (c) the potential impact of a commercial hook-and-line fishery on existing North Carolina FMPs. The workgroup concluded a commercial hook-and-line fishery had the potential to offset some of the economic hardship from the recent gill net restrictions. However, the workgroup advised that such a hook-and-line sector would need to be set up very carefully, on a fishery-by-fishery basis in conjunction with the current FMP review cycle (where each FMP is reviewed once every five years). Each of

North Carolina's fisheries has unique characteristics and a variety of administrative mechanisms could be needed to ensure that additional commercial opportunity is not abused (e.g. "double-dipping" or using a paying recreational charter as a commercial trip in the for-hire sector). In many fisheries, the commercial use of hook-and-line is currently allowed and there are no restrictions on the level of harvest, whereas other fisheries limit commercial hook-and-line harvest to the recreational bag limit or prohibit hook-and-line as a commercial gear entirely and would require significant rule changes and restructuring.

IV. AUTHORITY

G.S. 113-134; 113-182; 113-221.1; 143B-289.52; 15A NCAC 03M .0512

V. DISCUSSION

Currently, the only fishery for which the use of hook-and-line as a commercial gear is specifically prohibited in North Carolina is the striped bass fishery (15A NCAC 03M .0201(b)). This rule has been in effect since 1985 as a result of the coastwide stock status as determined by the Atlantic States Marine Fisheries Commission (ASMFC) and North Carolina. This prohibition was implemented to remove economic incentives to sell striped bass taken with traditional recreational gear so that commercial harvest could be limited and quantified. (For other fisheries such as spotted seatrout and American shad, the use of hook-and-line as a means of catching fish for sale is restricted to the recreational bag limit.) This provision, as well as the prohibition on the sale or purchase of hook-and-line caught striped bass, would need to be removed to allow for a commercial hook-and-line striped bass fishery.

<u>Albemarle Sound Management Area (ASMA)</u>

Removing the provision noted above would create a directed hook-and-line commercial fishery in the coastal and joint waters of the Albemarle Sound Management Area (ASMA). Currently, this is contrary to the management strategy of the 2004 North Carolina Estuarine Striped Bass FMP, but allowable under the ASMFC FMP for Atlantic Striped Bass. The ASMA commercial fishery is presently managed as a bycatch fishery; striped bass can only be taken in conjunction with other commercially important species and the catch of striped bass can be no more than 50% by weight of the combined daily harvest. To address this contradiction, the management strategy of the Estuarine Striped Bass FMP would need to be modified to allow for the directed use of commercial hook-and-line gear in the ASMA. Additionally, a new provision might need to be inserted into the striped bass rule (15A NCAC 03M .0201) specifically stating that it is unlawful to sell hook-and-line caught fish from joint waters of the Roanoke River Management Area (RRMA) or referencing the Wildlife Resources Commission (WRC) rule prohibiting such sale. The RRMA is under the authority of the WRC (15A NCAC 03Q .0108), which does not allow commercial harvest of striped bass in its jurisdiction.

The ASMA striped bass fishery has been declared recovered since 1997. There is no biological reason to not allow the commercial use of hook-and-line gear in a recovered fishery, particularly as the 275,000 pound commercial quota has not been reached in several years. Even if additional participants/effort occurred with the allowance of a commercial hook-and-line sector, the quota is monitored on a daily basis. As with other quota-monitored fisheries, the ASMA commercial striped bass fishery is closed by proclamation when the allowable harvest is projected to have been met. Additionally, the director has proclamation authority to set the daily possession limits, which generally range from seven to fifteen fish per day. These possession limits can be (and currently are) adjusted depending on the conditions of the fishery. The recreational (hook-and-line) daily bag limit of three fish would continue to be managed under existing regulations (15A NCAC 03M .0202) even if hook-and-line is allowed as a commercial gear.

One issue that must be considered is the feasibility of maintaining the current bycatch provision (i.e. no more than 50% by weight of combined daily harvest can be striped bass) in the ASMA if commercial hook-and-line harvest is allowed. On one hand, the likelihood of fishermen harvesting sufficient amounts of other finfish species via hook-and-line to meet the bycatch provision is extremely low. Hook-and-line is generally a less efficient gear than a gill net; expecting a fisherman to catch at least an equivalent weight (or more) of other species is impractical from a cost-benefit perspective. Allowing the commercial use of hook-and-line to catch striped bass, while simultaneously allowing the use of gillnets on the same vessel to catch other marketable species solely to maintain the bycatch provision does not make sense from a resource conservation perspective. On the other hand, removal of the bycatch provision specifically for hook-and-line gear could actually result in decreased catches of other species, particularly if fishermen choose to use hook-and-line rather than gill nets or pound nets. Given the physical effort and expense associated with the use of gill nets as well as the aging population of fishermen, it is likely that at least some number of participants would choose hook-and-line gear over gill nets. Finally, if the bycatch provision is removed and as a result fishermen currently using gill nets switch to using hook-and-line, the overall commercial discard mortality in the fishery would likely decrease. Hook-and-line is generally a more resource-friendly gear than a gill net and sub-legal fish could be released with a higher likelihood of survival depending on handling technique (see Section 7 for detailed discussion of hooking mortality).

Another issue is the level of effort in the commercial fishery. Although the total number of participants in the ASMA commercial striped bass fishery has generally decreased from 1994-2009 (from a high of 445 in 2000 to a low of 278 in 2008; Figure 11.7.1), there are currently 1,762 Standard Commercial Fishing License (SCFL)/Retired Standard Commercial Fishing License (RSCFL) holders in the counties surrounding the ASMA[5] and approximately 6,700 SCFL/RSCFL holders throughout the state. There is the potential that latent SCFL/RSCFL holders (i.e., those who hold licenses but rarely use them to sell fish) from any area of the state may be prompted to participate in a commercial hook-and-line fishery whether or not a bycatch provision is maintained. A number of SCFL holders are recreational fishermen who maintain a commercial license so as not to be bound by recreational harvest limits. It is possible that these fishermen could catch a daily limit and give it to friends or family rather than selling it. Those removals would not be captured on trip tickets and would therefore not be included in the total harvest. It is also possible that commercial hook-and-line effort could increase the overall number of releases. The ASMA currently experiences high rates of undersized recreational releases; significant additional commercial hook-and-line effort could potentially increase the number of releases which could in turn result in increased discard mortality. However, it is important to recognize that the number of releases will likely vary with stock size and year class strength.

[5] Counties include: Bertie, Camden, Chowan, Currituck, Dare, Gates, Hertford, Hyde, Martin, Pasquotank, Perquimans, Tyrrell, Washington

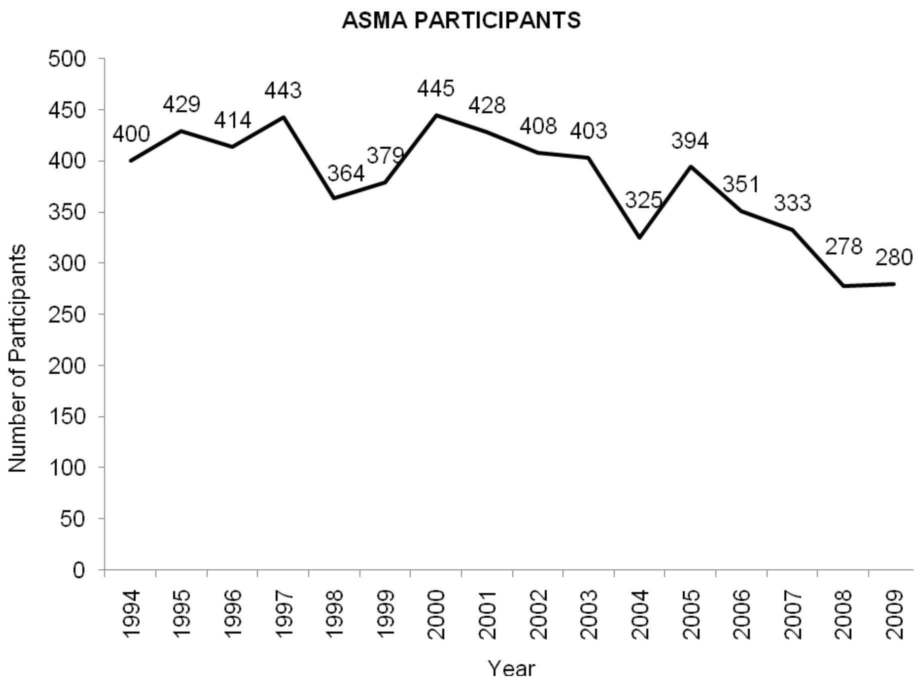

Figure 11.7.1. ASMA Annual Participants 1994-2009. Highest number of participants in 2000, lowest number of participants in 2008.

An alternate management structure might be necessary should commercial hook-and-line gear be allowed in the ASMA. The use of a permit system could be considered as a means of identifying the number of participants in the fishery; this information could then be used to adjust daily trip limits to stay within the quota. Currently, the ocean striped bass fishery is managed under a permit system whereby participants declare which of three gear types (beach seine, gill net or trawl) they plan to use in the fishery. Once declared, each participant is "locked" into that gear type for three years, although all are required to renew their permit each year. This is not a limited entry permit, i.e. any SCFL holder can apply; the intent of the permit is to provide a means of approximating the effort for the upcoming fishing year in each gear sector. However, the current permit system for the ocean striped bass fishery has not been as effective as hoped in this regard. A similar system could be instituted for the estuarine striped bass fishery if the objectives for implementing such a permit were documented and attainable. Again, this would not limit effort, but would provide a means of estimating potential effort for both hook-and-line and gill net gears. A permit could be set up with various options related to restrictions, gear types or other components specific to the permit holder. An additional consideration is the cost to administer the permit. Should the MFC choose to require a permit, a fee would require legislative approval.

If deemed necessary to hold the level of effort constant to effectively manage the fishery, a limited entry permit would need to be established in which the total number of participants in the fishery is capped and eligibility criteria developed. However, this option does not appear to be possible at this time for the ASMA commercial striped bass fishery. Current statute (G.S. 113-182.1(g)) restricts the MFC to recommending that the General Assembly limit participation in a state-managed fishery only if sustainable harvest cannot otherwise be achieved. The ASMA stock assessment has indicated that sustainable harvest is currently being achieved therefore limited entry does not appear to be an option for management.

As a note, the Fisheries Director currently has proclamation authority (15A NCAC 03M .0202) to specify the following conditions for the commercial fishery: fishing days and times, areas, possession limits, means and methods, and the submission of biological data. Proclamation authority is a very flexible tool and could be used to implement certain restrictions or conditions to better manage a commercial hook-and-line fishery, although this would need to be defined in the FMP.

Finally, the pending decision by the NMFS regarding the listing of Atlantic sturgeon from a species of concern throughout its range, to “threatened” or “endangered” for the Carolina DPS will dictate future restrictions on gill net fisheries throughout North Carolina. As noted previously, current restrictions on the use of gill nets as a result of the sea turtle settlement agreement have affected many internal waters fisheries. A decision on the proposed listing is not due until October 2011 and likely will impact the estuarine striped bass fishery. This necessitates the inclusion of adaptive management within the Estuarine Striped Bass FMP update to allow for alternative and more resource-friendly gears such as hook-and-line in the future. While the use of hook-and-line will not eliminate interactions with protected species, it is likely to reduce them. The conditions under which adaptive management could occur would need to be specified within the FMP (i.e. should Atlantic sturgeon be listed as endangered a supplement to the FMP could be initiated, etc.) as well as the mechanism by which changes would be implemented (i.e. proclamation authority, rule changes, etc).

Central Southern Management Area (CSMA)

The issue of a commercial hook-and-line fishery in the CSMA carries different considerations than those for the ASMA. Currently, there is a low-level directed fishery in the river systems of the CSMA, while the sound fisheries have a similar bycatch provision as the ASMA. The exception to this is the Cape Fear River system which is closed to all harvest of striped bass. Therefore, the management strategy in the existing FMP for the river systems of the CSMA would not have to change, although a rule change would need to occur to allow hook-and-line as a commercial gear. However, the status of the CSMA population of striped bass is concern/unknown, and the potential for additional effort could negatively impact stock recovery. Similar to the ASMA, the number of participants in the fishery has steadily decreased from a high of 290 in 1997 to a low of 103 in 2009 (Figure 11.7.2), although the number of SCFL/RSCFL holders in the counties surrounding the CSMA[6] in 2009 was 5,242, so the potential for additional effort exists. Due to geography, SCFL/RSCFL holders in certain counties (Beaufort, Washington, Tyrrell, Hyde, Dare) could easily participate in both ASMA and CSMA fisheries. The CSMA has a much shorter season than the ASMA (March/April or until quota is met) and a much smaller quota of only 25,000 pounds. Additional effort could impact how long the fishery is open. However, this is also a quota-managed fishery and requires daily reporting from dealers, so even if effort increased the fishery could be closed quickly based on quota monitoring reports.

[6] Counties include: Beaufort, Brunswick, Carteret, Craven, Dare, Hyde, New Hanover, Onslow, Pamlico, Pender

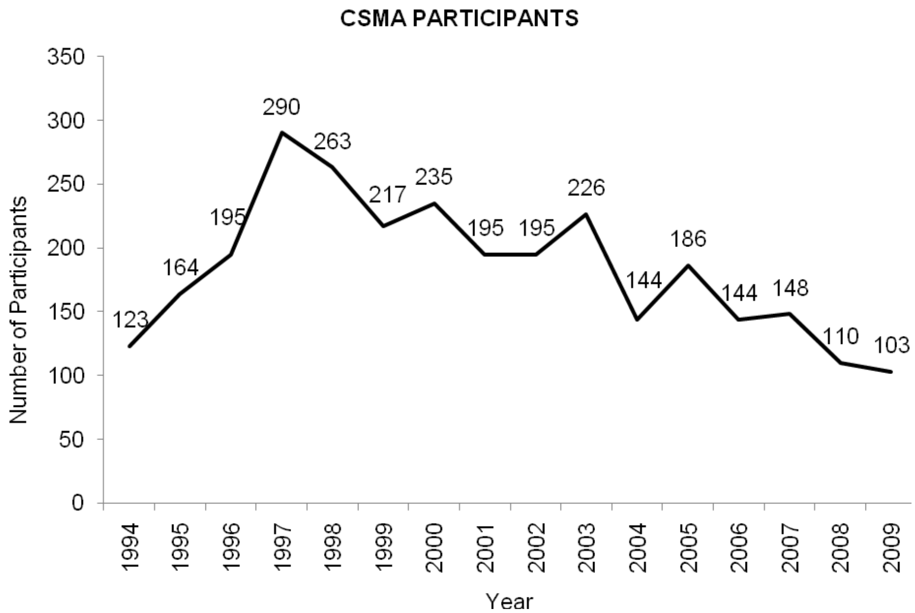

Figure 11.7.2. CSMA Annual Participants, 1994-2009. Highest number of participants in 1997, lowest number of participants in 2009.

The striped bass fishery in the CSMA is pursued differently than the fishery in the ASMA. Many fishermen in the CMA will set one piece of gear (net) for target species such as shad and set a different piece of gear for striped bass. If commercial hook-and-line gear were allowed in the CSMA, it is likely that some fishermen would prefer to use this gear rather than set a different piece of net for striped bass. One potential benefit is that this could result in less bycatch of non-target species, particularly in the rivers where there is no bycatch provision. As noted in the previous section, gill nets are expensive pieces of gear to buy and maintain and are more physically demanding than hook-and-line gear. Given the demographics of the commercial fishing population, it is possible that a number of fishermen would choose hook-and-line gear if the opportunity was available, especially in the rivers. Another potential benefit is that this could lower the overall discard mortality rate for striped bass, as there would be fewer yards of gill net set.

Similar to the ASMA, maintaining the bycatch provision for a hook-and-line sector in the CSMA sound fisheries is impractical from both a conservation as well as a cost-benefit perspective. Given the relative lack of efficiency of hook-and-line gear as compared to a gill net, fishermen would have difficulty meeting the bycatch requirement. Additionally, allowing the use hook-and-line while simultaneously maintaining the use of a gill net (on the same vessel) solely to meet the bycatch requirement seems counterintuitive from a resource conservation standpoint.

Should a hook-and-line commercial fishery be pursued in the CSMA, it is possible that different management measures would be needed between the low-level directed fishery in the rivers and the sounds. As described in the previous section, a permit could be developed with requirements and/or restrictions to track potential effort that would be available to any SCFL holder. Again, the administrative costs of a permit would need to be considered and legislative approval would be required if a fee was charged. There are also other administrative options that could be considered, such as log books. Additionally, because of the status of the CSMA stocks (concern/unknown), the use of limited entry as a management tool may be possible under G.S. 113-182.1(g) if it is determined that this is the only means of achieving sustainable harvest.

Finally, the future status of Atlantic sturgeon has the same implications for management of the CSMA striped bass fishery as it does for the ASMA fishery, and indeed all fisheries in the internal waters of North Carolina. Should the NMFS decide to list the Carolina DPS of Atlantic sturgeon as endangered, further restrictions on the use of gill nets are likely. An adaptive management component should be included in the FMP that would allow for the use of other resource-friendly gear in this fishery to offset the loss of use of gill nets. As noted in the previous section, the use of hook-and-line is more likely reduce interactions with protected species, although unlikely to eliminate such interactions. The parameters or conditions under which adaptive management could occur, as well as the mechanism for doing so, would need to be detailed in the FMP.

Considerations for both ASMA and CSMA

To fully evaluate the impact of allowing commercial hook-and-line gear in the estuarine striped bass fishery, specific details of implementation would need to be determined and several other issues addressed. One is that some commercial fishermen in North Carolina have for-hire licenses and some charter boat captains have SCFLs. These fishermen would have a distinct advantage if they were able to take clients out on a chartered “commercial” trip where clients were not subject to the recreational trip limits. In essence, the trip could be double-counted as both a commercial and recreational trip. There is also the potential that fishermen could make multiple trips in a day (i.e., one commercial and one recreational). The state of Virginia has had similar issues with their commercial hook-and-line fishery, where charter captains have claimed paying customers as “crew” in order to retain commercial sizes/catch limits. Restrictions or conditions would need to be established to prevent such situations from occurring. These could include specifying recreational limits when more than three persons are on board, requiring charter boat logbooks, requiring that crew members be registered on an annual basis, etc.

A somewhat related issue is competition for space between commercial and recreational fishing sectors. Such conflicts can arise when economically important fishery resources school in limited areas and both commercial and recreational fishermen try to occupy the same small area. Examples of such competition for space in North Carolina include the jetties at Cape Lookout and Masonboro Inlets, the beach north of Oregon Inlet during the ocean striped bass and bluefish runs, and conflicts between gillnet and recreational fishermen pursuing spotted seatrout during the winter months. “Hot spots” such as these in both the ASMA and CSMA might require additional restrictions to avoid creating new conflicts.

Finally, additional data collection may be a consideration to document harvest and participation changes if a commercial hook-and-line fishery is implemented. Dealers record the number of pounds of all species landed and all gear types used on a trip ticket, but existing paper trip tickets are not designed to associate a particular gear with a particular species landed. Electronic reporting software does allow for gear types to be linked with a particular species landed, however, only 11% of dealers are using this software. The MFC may want to consider asking hook-and-line participants (rather than dealers) to provide information such as water body/river system fished, non-target species encountered, number of fish released, etc.

VI. PROPOSED RULE(S)

SECTION .0200 - STRIPED BASS

15A NCAC 03M .0201 GENERAL

(a) Striped bass is defined as striped bass (Morone saxatilis) and its hybrids taken in coastal and joint fishing waters.

~~(b) Hook-and-line fishing equipment is not commercial fishing equipment in the striped bass fishery. It is unlawful to sell or purchase striped bass taken by hook-and-line. Striped bass taken legally with hook-and-line may be possessed and transported.~~

(b)~~(c)~~ It is unlawful to possess striped bass imported from other states less than 18 inches long (total length).

(c)~~(d)~~ It is unlawful to import, buy, sell, transport, offer to buy or sell, or possess striped bass except during any:

- (1) open striped bass season established for internal coastal waters;
- (2) open striped bass season established for the Atlantic Ocean; or
- (3) open striped bass season of another state without possession of the following:
  - (A) A bill of lading as described in 15A NCAC 03I .0114;
  - (B) A numbered, state-issued tag from the State of origin affixed through the mouth and gill cover. This tag must remain affixed until processed for consumption by the consumer.

(d)~~(e)~~ The management ~~units and recreational fishery management~~ areas for estuarine striped bass fisheries in coastal North Carolina are designated in 15A NCAC 03R .0201.

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. March 1, 1994; September 1, 1991;
Temporary Amendment Eff. May 1, 2000;
Amended Eff. April 1, 2013; October 1, 2008; October 1, 2004; April 1, 2001.

15A NCAC 03M .0202 SEASON, SIZE AND HARVEST LIMIT: INTERNAL COASTAL WATERS

(a) It is unlawful to possess striped bass from the coastal fishing waters of the Cape Fear River and its tributaries.

(b) It is unlawful to possess striped bass from the Roanoke River Management Area in a commercial fishing operation.

(c)~~(b)~~ The Fisheries Director may, by proclamation, impose any or all the following restrictions on the taking of striped bass in a commercial fishing operation or for recreational purposes in internal coastal waters during the period from October 1 through April 30:

- (1) Specify fishing days and times,
- (2) Specify areas,
- (3) Specify quantity, except possession for recreational purposes shall not exceed:
  - (A) more than three fish in any one day in the Albemarle Sound Management Area as designated in 15A NCAC 03R .0201, and
  - (B) more than two fish in any one day in the joint and coastal fishing waters of the Central Southern Management Area as designated in 15A NCAC 03R .0201.
- (4) Specify means/methods,
- (5) Specify size, but the minimum size specified shall not be less than 18 inches total length, and
- (6) Require submission of statistical and biological data.

Fish that do not meet the minimum size limit specified by proclamation shall immediately be returned to the waters from which taken regardless of condition.

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. March 1, 1996; November 1, 1991;
Temporary Amendment Eff. September 1, 1996;
Amended Eff. April 1, 1997;
Temporary Amendment Eff. July 1, 1999;
Amended Eff. <u>April 1, 2013;</u> July 1, 2008; August 1, 2000.

The following rule is listed for informational purposes only. This exact language is also found in WRC rules at 15A NCAC 10C .0110

15A NCAC 03Q .0108 MANAGEMENT RESPONSIBILITY FOR ESTUARINE STRIPED BASS IN JOINT WATERS

(a) The management areas for estuarine striped bass fisheries in coastal North Carolina are designated in 15A NCAC 03R .0201.

(b) In order to effectively manage the recreational hook and line harvest in joint waters of the Albemarle Sound-Roanoke River stock of striped bass, the Marine Fisheries Commission and the Wildlife Resources Commission deem it necessary to establish two management areas; the Albemarle Sound Management Area and the Roanoke River Management Area as designated in 15A NCAC 03R .0201. The Wildlife Resources Commission shall have principal management responsibility for the stock when it is in the joint and inland fishing waters of the Roanoke River Management Area. The Marine Fisheries Commission shall have principal management responsibility for the stock in the coastal, joint and inland waters of the Albemarle Sound Management Area. The annual quota for recreational harvest of the Albemarle-Roanoke striped bass stock shall be divided equally between the two management areas. Each commission shall implement management actions for recreational harvest within their respective management areas that will be consistent with the North Carolina Estuarine Striped Bass Fishery Management Plan.

History Note: Authority G.S. 113-132; 113-134; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. October 1, 2004; September 1, 1991.

The following rule is included for informational purposes only

15A NCAC 03Q .0109 IMPLEMENTATION OF ESTUARINE STRIPED BASS MANAGEMENT PLANS: RECREATIONAL FISHING

The Marine Fisheries and Wildlife Resources Commissions shall implement their respective striped bass management actions for recreational fishing pursuant to their respective rule-making powers. To preserve jurisdictional authority of each Commission, the following means are established through which management measures can be implemented by a single instrument in the following management areas:

(1) In the Roanoke River Management Area, the exclusive authority to open and close seasons and areas, and establish size and creel limits whether inland or joint fishing waters shall be vested in the Wildlife Resources Commission. An instrument closing any management area in joint waters shall operate as and shall be a jointly issued instrument opening or closing seasons or areas to harvest in the Roanoke River management area.

(2) In the Albemarle Sound Management Area, the exclusive authority to open and close seasons and areas and establish size and creel limits, whether coastal or joint fishing waters shall be vested in the Marine Fisheries Commission. The season shall close by proclamation if the quota is about to be exceeded. In the Albemarle Sound Management Area administered by the Marine Fisheries Commission, a proclamation affecting the harvest in joint and coastal waters, excluding the Roanoke River Management Area, shall automatically be implemented and effective as a Wildlife Resources Commission action in the inland waters and tributaries to the waters affected.

History Note: Authority G.S. 113-132; 113-134; 113-182; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. October 1, 2004; September 1, 1991.

VII. Management Options

The following management options may be applied to either the ASMA or CSMA. Different options may be chosen for each area depending on management needs.

Management Options
(+ Potential positive impact of action)
(- Potential negative impact of action)

1. Status Quo

+ No additional impact on commercial fishery or the striped bass stock
+ No additional burden on fishermen, dealers or Marine Patrol
- No additional alternative gear if increased regulations on other gear due to ESA

2. Status Quo with adaptive management

FMP would need to include a specific adaptive management statement with regard to the conditions under which a commercial hook-and-line fishery would be considered (e.g., “Upon implementation of federal mandates under new protected species legislation, commercial hook-and-line gear would be considered along with other implementing actions, and the MFC would be presented with all suggested changes for approval prior to implementation.” Other conditions – resource conservation, etc.—could also be specified)

+ No additional impact on commercial fishery or the striped bass stock
+ No additional burden on fishermen, dealers or Marine Patrol
+ Allows for alternative gear in the future(hook-and-line) if increased regulations on other gear due to ESA
+ Allows for alternative gear in the future (hook-and-line) as identified for resource conservation (e.g., to decrease bycatch)

3. Commercial hook-and-line gear allowed with no bycatch requirements and including adaptive management to account for unforeseen changes in the fishery

+ Allow fishermen the choice of a more resource- friendly gear
+ Alternative gear if increased regulations on other gears due to ESA
+ Possibly reduce bycatch and interactions with protected species

+ Possibly reduce effort and fishing mortality with other gears such as gill nets and pound nets
+ Allow fishermen who have difficulties (due to disabilities) fishing gill nets or other gear to participate in the fishery
- No bycatch requirement for hook and line gear is inconsistent with requirements for other commercial gear
- Potential significant increase in commercial participants
- Potential increase in discard mortality in the hook and line fishery
- Potential increase in amount of commercial harvest not being recorded on trip tickets due trip limits being retained for personal consumption
- Potential difficulty in determining annual discard estimates from gill net fishery if hook-and-line becomes dominant second gear on trip tickets
- Potential increase in conflict issues between recreational/commercial fishermen; particularly in “hot spot” areas such as piers, bridges, jetties, etc.
- Potential for chartered trips limits to be sold and multiple trips per day;
- Increased burden on Marine Patrol

If Option 3 is chosen, the following issues should be taken into account. These issues would also need to be considered if adaptive management is implemented under Option 2:

- Consider additional restrictions or closures of conflict “hotspots” should they arise
- Consider a means of identifying commercial hook-and-line fishermen from recreational hook-and-line fishermen
- Consider the use of a permit or license endorsement for commercial hook-and-line fishermen
- Consider the use of limited entry in the CSMA
- Consider whether or not to allow simultaneous use of hook-and-line with other gear types, or prohibit having other gears on board
- Consider requiring bycatch to be on board if both hook-and-line and gill nets are on the vessel
- Consider requiring charter vessels to declare if a trip is commercial or recreational before leaving the dock to avoid “double-dipping” by charter captains with SCFLs
- Consider limiting the number of commercial hook-and-line possession limits that can be on board a vessel (similar to limits for king mackerel vessels)
- Consider requiring submission of additional data by fishermen through the use of logbooks, permits or by proclamation
- Consider incentivizing the use of hook-and-line as a commercial gear
- Consider a definition for hook-and-line gear

VIII. Management Recommendations

NCDMF Management Recommendation:
Status quo with adaptive management – (Do not allow hook-and-line as commercial gear in the estuarine striped bass fishery unless the use of traditional gears is prohibited)

A/R Advisory Committee Management Recommendation:
Status quo – (Do not allow hook-and-line as commercial gear in the estuarine striped bass fishery; maintain traditional gears as currently allowed)

****CSMA Advisory Committee Management Recommendation:**
Status quo with adaptive management – (Do not allow hook-and-line as commercial gear in the estuarine striped bass fishery unless use of traditional gears is prohibited)

NCMFC AND NCWRC Preferred Management Option:
Selects the NCDMF Management Recommendation.

**Note: The CSMA AC did not have a quorum at the meeting where this was presented, therefore no vote was taken on this recommendation, although it was a unanimous recommendation by those members present.

Prepared by: Kathy Rawls, Sara Winslow, Michelle Duval
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Revised: April 5, 2011
Revised: April 11, 2011
Revised: November 30, 2011

11.8 CENTRAL SOUTHERN MANAGEMENT AREA STRIPED BASS MANAGEMENT MEASURES

I. ISSUE

Present implications of additional management approaches to the Central Southern Management Area striped bass fisheries.

II. BACKGROUND

In North Carolina, estuarine striped bass of the Tar/Pamlico, Neuse and Cape Fear watersheds are managed as an internal stock in a management unit recognized formally as the Central Southern Management Area (CSMA). The commercial striped bass fishery in the CSMA may have been important at the turn of the century but has remained at very low levels for the last 50 years (Chestnut and Davis 1975). Historical records for the commercial harvest of CSMA striped bass (landings by water) aren't available until 1972. Using county landings as an indicator prior to 1972, it appears commercial CSMA striped bass landing topped out in the late 1960s and early 1970s near 200,000 lbs (see Section 4, Table 4.1). With the implementation of the 25,000 lbs total allowable catch (TAC) in 1994, landings have fluctuated around that quantity, with a low of 10,200 lbs in 2008. Reliable recreational harvest estimates weren't available until the North Carolina Division of Marine Fisheries (NCDMF) implemented a creel survey in the Neuse and Tar/Pamlico rivers in 2004. Recreational harvest has varied from a high of nearly 23,000 lbs in 2004 to less than 3,000 lbs in 2008. Commercial and recreational harvest in the Cape Fear has historically been minimal.

According to the North Carolina Fisheries Reform Act, stock status is determined by the stock's ability to achieve sustainable harvest. Such an approach reflects stock biomass, and is typically used to determine whether a stock is overfished. A stock is also evaluated based on the rate of removals, e.g. the fishing mortality (F) rate, which determines whether overfishing is occurring. Actual parameters for the CSMA stock have not been determined. The CSMA striped bass stocks are listed as concern/unknown due to the lack of a quantified stock assessment, a truncated size and age distribution, and the absence of older fish. Species are designated by the NCDMF as concern because of incomplete or unavailable stock assessments, or because of indirect influences such as disease, habitat degradation, weather, or the nature of the fishery (i.e., roe fisheries). A major cause for concern over striped bass in the CSMA involves environmental conditions on the upper river spawning grounds in the spring. Dams blocking access to spawning habitat and low water flow associated with droughts, municipal withdrawals, and electrical power production frequently limit the spawning success of this species.

The CSMA stocks total mortality rate (Z), comprised of both fishing mortality (F) and natural mortality (M) rates, appears to be excessive. However, the 2008 CSMA estuarine striped bass regulatory restrictions (see Appendix 3) combined with the measures in effect as of May 2010 to protect endangered species (see Section 8), are intended to result in improvements in the age structure of the CSMA striped bass stocks. It must also be noted that any improvements are equally dependent on suitable environmental factors on the spawning grounds that are sufficient for annual spawning success. The need for continued conservation management efforts at this time are supported by the truncated size and age distributions, low abundance, and the absence of older fish in the spawning ground surveys (NCDMF 2010). Since independent sampling programs began (1994 for Neuse, 1996 for Tar, and 2002 for Cape Fear) there has been little change in the size and age distribution with few age-6 and older fish observed from any given cohort in any system.

III. CURRENT AUTHORITY

G.S. 113-134; 113-182; 113-221.1; 143B-289.52;
15A NCAC 03M .0512 Proclamation Authority in regard to FMPs
15A NCAC 03H .0103 Proclamation Authority of Fisheries Director
15A NCAC 03M .0202 Striped Bass Season, Size and Harvest Limit Internal Coastal Waters
15A NCAC 03M .0212 Compliance with Fishery Management Plans
15A NCAC 03Q .0107 Special Rules, Joint Waters
15A NCAC 03Q .0108 Management Plans for Striped Bass in Joint Waters
15A NCAC 03Q .0109 Implementation of Striped Bass Management Plans

IV. DISCUSSION

The lack of a stock assessment as the principal basis for management limits the NCDMF's ability to determine the status of the CSMA stocks and quantitatively detect overfishing. Yet using "consensus based" management measures may help to work towards a sustainable harvest. What cannot be determined is the quantified level of improvement based upon traditional stock assessment model outputs, i.e. changes in stock biomass and F rates.

The goal of the FMP process is to develop plans that ensure the long-term viability of the state's commercially and recreationally significant species or fisheries. The FMP management measures should prevent overfishing, while achieving a sustainable harvest. The degree to which the FMP for CSMA stocks succeeds will be based on new data collection programs to enable the determination of a stock status and consideration of "consensus based" measures that could provide additional protections and increase the likelihood of achieving a sustainable harvest. While data are lacking and the management agencies are not able to provide quantitative evaluations of reductions in F in the management options, this does not negate the use of a management approach that provides for a reasonable enhanced protection. These "consensus based" measures would be put in place and data collection programs implemented that in time would produce the data needed to measure F and quantifiably determine future required harvest changes. Harvest restrictions alone may not improve the stocks if adequate environmental conditions and spawning habitat are not available. Historical spawning grounds need to be assessed and have adequate flow rates throughout critical life stages (NCDMF 2010).

Fishing restrictions can be accomplished in a variety of ways. Options include quotas, size limits, bag and/or trip limits, gear restrictions, catch restrictions, seasonal closure, area closure, and limited entry. Section 2.1 of the Fisheries Reform Act (G.S. 113-182.1), concerning FMPs, states that the North Carolina Marine Fisheries Commission (NCMFC) can only recommend that the General Assembly limit participation in a fishery if the NCMFC determines that sustainable harvest in the fishery cannot otherwise be achieved. Species managed with a federal quota such as summer flounder are the only exception to this constraint, but that is not the case for CSMA stocks. Since the CSMA striped bass stock assessment did not produce reliable estimates of F, there is no value to compare to the target benchmark fishing mortality rate (F=0.22). Sustainable harvest cannot be determined at this time: therefore, limited entry is not a legal option for management. Quotas, harvest seasons, size and trip limits, and gear limitations have been the management measures used by NCDMF and North Carolina Wildlife Resource Commission (NCWRC) for CSMA striped bass. Quota considerations and size restrictions are described in greater detail as requested by the PDT in their initial assessment of further issues to address. *The gill net management measures to reduce striped bass discards in the CSMA, barbless hooks, stocking levels, and commercial hook and line fishery have been discussed in previous separate issue papers and are not being reconsidered by the Advisory Committees in this particular issue paper* but all management actions chosen will be included in the overall FMP management strategy for the CSMA.

Status Quo
One management approach is *status quo,* maintain the current CSMA striped bass management measures. For the commercial striped bass fishery the CSMA operates on a 25,000 lbs TAC. The fishery has operated with a low harvest level fishery with a spring season (usually in March), an 18 inch TL minimum size limit, and daily landing limits (10 fish) set under proclamation authority. Striped bass may be a targeted catch in the river portions of the CSMA, while Pamlico Sound has a 50% weight bycatch only provision. Finfish dealers are required to obtain a striped bass permit with a CSMA validation, report landings daily to NCDMF, and affix a sale tag to striped bass purchased from fishermen. These permit measures (See Section 7, Table 7.9) have been in place since 1997. The Cape Fear River is closed to harvest by both commercial and recreational fishermen to allow the stock to rebuild. For the recreational fishery in the remainder of the CSMA the open season is from 1 October through 30 April, the creel limit is 2 fish, and there is an 18 inch TL minimum size with a slot limit of no harvest between 22 and 27 inches TL in joint and inland waters. The implementation of the “new status quo” in 2008 for the CSMA was intended to reduce mortality by 64% (see Appendix 14.8). The actual reduction level (pounds) obtained when based on just two subsequent years (2008 and 2009) catches, ranges from 70% to 75% depending on the method used to estimate commercial discards. However given annual variation, it is not certain this reduced harvest level would be maintained in the long run.

Total Allowable Catch (Quota)
A quota is the maximum amount of fish a fishery may land within a specified period and is often used to prevent expansions in either the commercial or the recreational fisheries.   This type of harvest restriction has an administrative cost associated with monitoring the fishery (dealer permits and daily reporting). For the commercial striped bass fishery the CSMA operates on a 25,000 lbs Total Allowable Catch (TAC). The original Albemarle/Roanoke (A/R) TAC was based on an 80% reduction in the historical harvest for the years 1972-1979. The CSMA TAC was selected by the director but if it had been based on the same criteria as the A/R it would have been ~13,500 lbs. The average annual CSMA landings from 1980-1993 comes closest to the 25,000 lbs TAC level selected. Changes to the TAC could be considered, however the lack of a sustainable harvest measure does not provide a quantitative basis for what the level of the TAC should be. In addition possible increases in effort in the recreational harvest which is managed by season and trip limits could allow that sector’s harvest to expand. A quota for the recreational fishery is difficult to monitor given the number of anglers involved and the length of the season.

The 2004 FMP did not include a quota overage pay back for the CSMA. The TAC was initiated in 1994 and has been exceeded 6 times (2005, 2004, 2000, 1999, 1997, and 1996) with an overage average of 5,500 lbs. Late or non-reporting by dealers for the required daily landing reports resulted in the season staying open beyond what was warranted. During the same period the harvest has fallen short of the TAC seven times, with an average underage of 4,768 lbs (see Section 7, Table 7.9). The trip ticket program’s data and quota monitoring reports are evaluated at the end of each year. With an overage pay back provision, the pounds over the TAC from the prior commercial season would be subtracted from the next season’s TAC and season closure would be based on the reduced TAC.

Area or Seasonal Closures
Seasonal closures are intended to protect a portion of the stock in order to increase spawning stock biomass. This management tool was used for the CSMA when the season was changed from year round to the months of October through April (see Appendix 14.8). This change was recommended to reduce overall mortality and considered the impact of dead discards during the warmer months. Area closures may be used to protect habitat that is essential to critical life stages of the species or to protect the spawning stock. The Cape Fear no harvest provision (moratorium) for striped bass is a form of area closure that provides the ultimate protection from harvest for striped bass in that area.

Trip or bag limits
Trip or vessel harvest limits are generally used within the confines of a quota to prevent harvesting the available amount of fish too quickly and to avoid exceeding the quota. A creel or bag limit for the recreational fishery is the number of fish allowed to be kept during a trip by an individual or boat. The lack of a reference amount for sustainable harvest hinders a quantitative threshold for the basis of trip or bag limits. The trip limit for the commercial fishery was set at 10 fish in the 2004 FMP. Prior to that time the limit had varied, ranging from 3-20 fish per trip. The intent of the 10 fish limit was to maintain the low level targeted and bycatch fisheries and to obtain the TAC relatively quickly in order to then reduce gill net discard interactions by placing gear restrictions in the large mesh gill net fisheries (See Section 11, CSMA Discard Mortality Issue). The 2008 reduction in creel from 3 fish to 2 fish in the recreational fishery was intended to substantially reduce recreational take. Data indicates that implementing the closed season and the reduced creel resulted in over a 70% decrease in recreational harvest. Even so approximately 25% of the angler trips catch more than the 2 fish allowed (Table 11.8.1).

Table 11.8.1. Recreational number and percent of striped bass per angler trip in the CSMA from 2004-2009 during October-April. N=number of trips. (Source NCDMF CSMA creel survey).

	Fish Disposition					
Fish Per Angler Trip	Discarded		Retained		Combined	
	N	%	N	%	N	%
0*	169	25.80	28	51.85	197	27.79
1	239	36.49	19	35.19	258	36.39
2	89	13.59	6	11.11	95	13.40
3	53	8.09	0	0	53	7.48
4	30	4.58	0	0	30	4.23
5	17	2.60	1	1.85	18	2.54
6	13	1.98	0	0	13	1.83
7	8	1.22	0	0	8	1.13
8	4	0.61	0	0	4	0.56
9	3	0.46	0	0	3	0.42
10	7	1.07	0	0	7	0.99
11	3	0.46	0	0	3	0.42
12	6	0.92	0	0	6	0.85
15	5	0.76	0	0	5	0.71
16	1	0.15	0	0	1	0.14
19	1	0.15	0	0	1	0.14
20	5	0.76	0	0	5	0.71
30	2	0.31	0	0	2	0.28
Total	655	100	54	100	709	100

*Zero fish category occurs when fish from a party of fishermen are sampled as a unit. When the party catch is divided amongst all the contributors, then rounded off, the zero fish category will occur.

Size Restrictions

Size regulations are a management tool based on the species' reproduction and life history. Minimum length limits protect juvenile fish from harvest pressure and allow fish to spawn at least once, contributing to the growth of that population before capture. Maximum length limits are used to protect adult breeding stocks from fishing pressure. Harvest slot limits can be used to protect both juvenile and large adult fish. Finally, protected slot limits are used to protect medium-sized fish by only allowing small and large fish to be harvested. The inside waters 18 inch TL minimum length limit was established in 1991 statewide. The current 18 inch minimum length restriction came from the dual size limit strategy (18 inch Chesapeake Bay and 33 inch coastal waters) for striped bass developed by the ASMFC model for the coastal migratory striped bass fishery (F = 0.25) once it was re-opened in 1990. The model used at the time was straightforward spawning biomass per recruit (SPR) model linked to a stock recruitment function that was used to generate steady-state recruitment at each SSB/R level.

Striped bass size at maturity schedules for CSMA stocks are unknown. The A/R striped bass maturity schedule and fecundity was determined by Olsen and Rulifson (1992) (Table 11.8.2). Using the A/R maturity schedule as a surrogate for the CSMA, if the management objective is to allow a minimum of 50% of females to spawn at least once then the length for age-4 females would be the minimum length limit. The length distributions during the open season for the commercial and recreational catch are shown in Tables 11.8.3 and 11.8.4 respectively. The protective slot limit of 22-27 inches TL for the recreational fishery in joint and inland waters only partially contributes to meeting a 50% mature criterion. Although biologically it might make sense to propose a size limit based on size at maturity, management of a fishery also considers the potential for an increase in regulatory discards.

Table 11.8.2. Olsen and Rulifson (1992) maturity and fecundity of Roanoke River-Albemarle Sound female striped bass by age.

Age	2	3	4	5	6	7	8
Percent Mature	0	44	93	95	100	100	100
% Repeat Spawner	0	0	44	93	95	NA	NA
Eggs (1,000s)	0	196	365	533	702	871	1,040
Mean Size (FL inch)	14.3	18.7	20.9	21.9	23.0	26.6	28.6
Mean Size (TL inch)	15.4	20.0	22.1	23.2	24.3	27.3	30.0

Table 11.8.3. Length distribution of striped bass caught recreationally during October-April in the CSMA from 2004-2009. N=number measured. (Source NCDMF CSMA Creel Survey).

Total Length (in)	Pamlico Pungo N	Pamlico Pungo %	Neuse Bay N	Neuse Bay %	All N	All %
16	0	1.97	5	0.00	5	1.28
17	0	0.79	2	0.00	2	0.51
18	5	8.66	22	3.68	27	6.92
19	32	16.93	43	23.53	75	19.23
20	34	21.26	54	25.00	88	22.56
21	27	20.08	51	19.85	78	20.0
22	15	12.60	32	11.03	47	12.05
23	7	10.24	26	5.15	33	8.46
24	4	3.94	10	2.94	14	3.59
25	7	1.18	3	5.15	10	2.56
26	2	0.79	2	1.47	4	1.03
27	1	0.79	2	0.74	3	0.77
28	2	0.79	2	1.47	4	1.03
Total	136	100	254	100	390	100

Table 11.8.4. Length distribution of striped bass caught commercially during October-April in the CSMA from 2004-2009. N=number measured. (Source Program 461 and Program 466 dependent data).

Total Length (in)	Pamlico Pungo N	Pamlico Pungo %	Neuse Bay N	Neuse Bay %	Pamlico Sound N	Pamlico Sound %	All N	All %
<16*	12	1.40	0	0.00	18	14.40	30	2.04
17	44	5.14	10	2.03	1	0.80	55	3.73
18	100	11.68	30	6.10	3	2.40	133	9.03
19	142	16.59	47	9.55	5	4.00	194	13.17
20	192	22.43	100	20.33	6	4.80	298	20.23
21	183	21.38	96	19.51	5	4.00	284	19.28
22	83	9.70	95	19.31	2	1.60	180	12.22
23	34	3.97	38	7.72	0	0.00	72	4.89
24	14	1.64	20	4.07	2	1.60	36	2.44
25	9	1.05	7	1.42	0	0.00	16	1.09
26	4	0.47	8	1.63	0	0.00	12	0.81
27	10	1.17	5	1.02	2	1.60	17	1.15
28	2	0.23	5	1.02	0	0.00	7	0.48
29	2	0.23	7	1.42	2	1.60	11	0.75
30	2	0.23	3	0.61	3	2.40	8	0.54
31	4	0.47	6	1.22	0	0.00	10	0.68
32	6	0.70	5	1.02	6	4.80	17	1.15
33	2	0.23	4	0.81	8	6.40	14	0.95
34	5	0.58	2	0.41	9	7.20	16	1.09
35	0	0.00	2	0.41	7	5.60	9	0.61
36	1	0.12	0	0.00	11	8.80	12	0.81
37	1	0.12	0	0.00	18	14.40	19	1.29
38	0	0.00	0	0.00	5	4.00	5	0.34
39	2	0.23	1	0.20	5	4.00	8	0.54
40	2	0.23	0	0.00	5	4.00	7	0.48
41	0	0.00	1	0.20	1	0.80	2	0.14
42	0	0.00	0	0.00	1	0.80	1	0.07
Total	856	100	492	100	125	100	1,473	100

* Lengths recorded from observer data (Program 466) of released fish.

Gear Restrictions

Gear restrictions for the gill net fisheries were discussed in the CSMA Discard Mortality Issue Paper. As noted previously the “status quo” gear measures combined with the other gill net measures in effect as of May 2010 to protect endangered species (see Section 8), are expected to result in improvements to the age structure of the CSMA striped bass stocks resulting from reduced commercial effort.

Prohibited Take (Moratorium)

The Cape Fear River is closed to harvest by both commercial and recreational fishermen to protect the remaining stock. With access to suitable spawning habitat, the remaining stock should increase in relative abundance as well as display an expanding age structure. To measure any increases in relative stock abundance and an expanding age structure requires the NCDMF and NCWRC to monitor the stock using fishery independent surveys. Stock indicators will need to be established in order to allow restricted harvest if the population level shows improvement (NCDMF 2010). The NCWRC and NCDMF cannot quantify a stock indicator from the current monitoring programs. These same factors would apply if other areas of the CSMA were closed to all harvest.

Designating a species as game fish is a prohibited take measure for the commercial sector of a fishery. House Bill 353, Designation of Coastal Game Fish, was introduced in the 2011 legislative session and included striped bass. Passage of this legislation would allocate these fish solely to the recreational fishing sector and prohibit all sales by the commercial fishermen and purchase by consumers. In inland waters the NCWRC has designated striped bass as a game fish. The NCDMF has stated the following general concerns in regards to coastal game fish designations:

- Contrary to the Fisheries Reform Act that is the guiding legislation for managing North Carolina's coastal fisheries.
- Contrary to the strong public trust doctrine in North Carolina where coastal fishery resources belong to all of the citizens of the state.
- There is no biological evidence that declaring a species as game fish will improve stocks or guarantee sustainable harvest in the future.
- Prohibiting harvest and possession by commercial fishermen will result in increased discards.
- Giving game fish status to certain stocks will limit the commercial fisherman's flexibility, creating a hardship on this user group.

V. MANAGEMENT OPTIONS/IMPACTS

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

Status quo
+ No changes in management, control harvest at the level forecast in 2004
+ No additional restrictions on fishing practices
+ Flexibility in reacting to variable conditions
- Possibility of further depletion of the stock
- Potential to exceed quota due to non-reporting and late reporting

Total Allowable Catch or Quotas (consider pay back provision)
+ Controls harvest levels
+ Protects the stock from extremely high harvest rates
- Not sensitive to fluctuations in recruitment or availability of fish to the fishery
- Additional reporting burden to commercial dealers
- Requires maintaining existing resources from NCDMF for dealer reporting
- May restrict harvest more or less than necessary
- Overfishing may still occur if recruitment is minimal
- Potential to go over quota due to short period of high landings.

Season or area closures
+ No additional resources required to implement
+ No reporting burden on fishermen or dealers
+ Maintains reduced effort at the current level
+ Reduces bycatch mortality

- Forces fishermen to search for other sources of income
- Weather may decrease fishing opportunities during open periods
- Effort may shift into other areas reducing the effectiveness of the closure
- May adversely impact some fisheries and fishermen more than others

Trip Limits

+ Maintains the average CPUE commercially and recreationally
+ Increases percent of females entering spawning stock

+/- Decreases effort and the number fish harvested in the catch
+/- Contributes to inefficiency in taking the harvest

- Increases the regulatory discards in commercial and recreational fisheries
- Stock could suffer further decline

Size Restrictions

+ Maintains the average size of harvest
+ Increase escapement to improve the spawning stock biomass
+ Increases percent of females entering spawning stock

+/- Decreases the number of smaller or larger fish harvested in the catch
+/- Changes selectivity of commercial fishery

- Increases the regulatory discards in commercial and recreational fisheries

Prohibited Take

+ Reduce some pressure on stocks
+ No additional resources required to implement

- Loss of the commercial and recreational fisheries
- Loss of income to commercial fishermen and dealers

VI. PROPOSED RULE(S)

VII. RESEARCH NEEDS

Research needs are stated in Section 6, Status of the Stocks.

VIII. MANAGEMENT RECOMMENDATIONS

NCDMF Management Recommendation:
Maintain the status quo CSMA striped bass management measures with the addition of instituting a pound for pound pay back provision for the commercial harvest TAC.

CSMA Advisory Committee Management Recommendation
Maintain the status quo CSMA striped bass management measures with the addition of instituting a pound for pound pay back provision for the commercial harvest TAC.

NCMFC AND NCWRC Preferred Management Option:
Selects the NCDMF Management Recommendation.

Status Quo for CSMA management measures maintain the following:

CSMA Recreational Harvest (Coastal, Joint, and Inland waters)

- Unified season Oct 1 – Apr 30
- 2 fish daily creel limit

- 18 inch TL minimum size limit
- Protective slot (no harvest) 22 – 27 inches TL (joint and inland waters only)
- Harvest moratorium for Cape Fear River and its tributaries

CSMA Commercial Harvest (Coastal and Joint waters)

- TAC of 25,000 lbs and commercial fishery, excluding Pamlico Sound, is not a bycatch fishery
- 18 inch TL minimum size limit
- 10 fish or less trip limit
- Spring season only, anytime between Jan 1 – Apr 30
- Gill net mesh size restrictions and yardage limits
- 18 inch TL minimum size limit
- Discards – maintain existing gill net tie-down and distance from shoreline (DFS) measures implemented by proclamation.
- Harvest moratorium for Cape Fear River and its tributaries

Revised: November 30, 2011

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12.0 RECOMMENDED MANAGEMENT PROGRAM AND RESEARCH NEEDS

12.1 GOALS AND OBJECTIVES

The goals of Amendment 1 to the North Carolina Estuarine Striped Bass FMP are to achieve sustainable harvest through science based decision-making processes that conserve adequate spawning stock, provide and maintain a broad age structure, and protect the integrity of critical habitats. The plan will consider biological, social, and economic factors in management of the fisheries. The plan will be adaptive, involving regular reviews and responding to new information regarding any aspect of the plan.

To achieve these goals, the following objectives must be met:

1. Identify and describe population attributes, including age structure, necessary to achieve sustainable harvest.
2. Restore, improve, and protect striped bass habitat and environmental quality consistent with the Coastal Habitat Protection Plan (CHPP) to increase growth, survival and reproduction.
3. Manage the fishery in a manner that considers biological, social, and economic factors.
4. Initiate, enhance, and/or continue programs to collect and analyze biological, social, economic, fishery, habitat, and environmental data needed to effectively monitor and manage the fishery.
5. Initiate, enhance, and/or continue information and education programs to elevate public awareness of the causes and nature of issues in the striped bass stocks, habitat, and fisheries, and explain management programs.
6. Develop management measures, including regulations that consider the needs of all user groups and provide sustainable harvest.
7. Promote practices that minimize bycatch and discard mortality in recreational and commercial fisheries.

The following striped bass management issues and recommendations were developed through the FMP process, by the NCDMF and NCWRC through cooperation with the United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS), and with advice solicited from the A/R and CSMA Advisory Committees (ACs), the public, the NCMFC's Finfish and Regional ACs, as well as the scientific community. The following list of Issues includes the final Management Recommendation from the NCMFC and NCWRC.

12.2 RECREATIONAL STRIPED BASS HARVEST CLOSURE- OREGON INLET AREA/ATLANTIC OCEAN

MANAGEMENT OPTIONS

1) Status Quo – allow the fishery to continue with catch card survey (May – Oct).

2) Close the Atlantic Ocean to the harvest of striped bass from the time the ASMA recreational season closes in the spring until October 1 of each year.

NCMFC and NCWRC Preferred Management Option:

Status Quo – allow the fishery to continue with catch card survey (May – Oct).

12.3 STRIPED BASS STOCKING IN COASTAL RIVERS

MANAGEMENT OPTIONS

1) Status Quo and research needs – goal of 100,000 Phase II striped bass stocked annually per CSMA system (Tar-Pamlico, Neuse and Cape Fear) with 3,000 stocked fish tagged annually in each system.

2) Further increase the number of fish produced/released - three systems per year, goal of 150,000 Phase II per system.

3) Decrease the number of fish produced/released.

4) Eliminate the stocking programs.

NCMFC and NCWRC Preferred Management Option:

Status quo and research needs– Goal of 100,000 Phase II striped bass stocked annually per CSMA system (Tar-Pamlico, Neuse and Cape Fear) with 3,000 stocked fish tagged annually in each system.

12.4 USE OF SINGLE BARBLESS HOOKS DURING THE STRIPED BASS CLOSED SEASON

MANAGEMENT OPTIONS

1) Status quo – don't require barbless hooks and continue to educate anglers on conservative angling practices for striped bass.

2) Require the use of single barbless hooks state wide during specified timeframe.

3) Require the use of single barbless hooks in specific areas and times where striped bass are known to congregate and when anglers direct effort for striped bass in these locations.

NCMFC and NCWRC Preferred Management Option:

Status quo – don't require barbless hooks and continue to educate anglers on ethical angling practices, with additional recommendation to include mortality statistics associated with various handling techniques when possible.

12.5 STRIPED BASS MANAGEMENT AREA - ALBEMARLE SOUND MANAGEMENT AREA SOUTHERN BOUNDARY LINE ADJUSTMENT

MANAGEMENT OPTIONS

1) Status Quo – do not change the boundary point.

2) Make the necessary rule changes to create a new boundary point.

NCMFC and NCWRC Preferred Management Option:

Support the necessary rule changes to create a new boundary point.

12.6 CASHIE RIVER – CHANGE IN JOINT AND COASTAL WATERS BOUNDARY LINE

MANAGEMENT OPTIONS

1) Status Quo – do not change the boundary point.

2) Make the necessary rule changes to create a new boundary point.

NCMFC and NCWRC Preferred Management Option:

Support the necessary rule change to create a new boundary point.

12.7 DISCARD MORTALITY OF STRIPED BASS FROM COMMERCIAL SET GILL NETS CENTRAL SOUTHERN MANAGEMENT AREA

MANAGEMENT OPTIONS

1) Status Quo – continue the gill net requirement for the tie downs and restricting gill net from within 50 yards of shore by proclamation.

2) Modify DFS or tie-down area.

3) Additional restrictions (attendance, yardage limit).

4) Remove all gear restrictions.

NCMFC and NCWRC Preferred Management Option:

Status Quo – continue the gill net requirement for the tie downs and restricting gill net from within 50 yards of shore by proclamation.

12.8 HOOK AND LINE AS COMMERCIAL GEAR IN ESTUARINE STRIPED BASS FISHERIES

MANAGEMENT OPTIONS

1) Status Quo – do not allow hook and line as commercial gear.

2) Status Quo with adaptive management.

3) Commercial hook and line gear allowed with no bycatch requirements and including adaptive management to account for unforeseen changes in the fishery.

NCMFC and NCWRC Preferred Management Option:

Status Quo – do not allow hook and line as commercial gear with adaptive management.

12.9 CENTRAL SOUTHERN MANAGEMENT AREA STRIPED BASS MANAGEMENT MEASURES

MANAGEMENT OPTIONS

1) Status Quo.

2) Total Allowable Catch (TAC) or Quotas (consider a pay back provision)

3) Season or area closures

4) Trip limits

5) Size restrictions

6) Prohibited take

NCMFC and NCWRC Preferred Management Option:

Status Quo with the addition of instituting a payback provision for the commercial harvest TAC.

Status Quo for CSMA management measures maintain the following:

CSMA Recreational Harvest (Coastal, Joint, and Inland waters)

- Unified season Oct 1 – Apr 30
- 2 fish daily creel limit
- 18 inch TL minimum size limit
- Protective slot (no harvest) 22 – 27 inches TL (joint and inland waters only)
- Harvest moratorium for Cape Fear River and its tributaries

CSMA Commercial Harvest (Coastal and Joint waters)

- TAC of 25,000 lbs and commercial fishery, excluding Pamlico Sound, is not a bycatch fishery
- 18 inch TL minimum size limit
- 10 fish or less trip limit
- Spring season only, anytime between Jan 1 – Apr 30
- Gill net mesh size restrictions and yardage limits
- 18 inch TL minimum size limit
- Discards – maintain existing gill net tie-down and distance from shoreline (DFS) measures implemented by proclamation.
- Harvest moratorium for Cape Fear River and its tributaries

12.10 ALBEMARLE SOUND MANAGEMENT AREA AND ROANOKE RIVER MANAGEMENT AREA STRIPED BASS MANAGEMENT MEASURES

The management measures for the Albemarle Sound and Roanoke River Management Areas were not presented as a formal Issue Paper. The FMP Plan Development Team recommended by consensus continuing with status quo for all current management measures for these two management areas. The following were presented to the Albemarle/Roanoke Advisory Committee as the PDT recommended management measures, which they voted to approve.

Biological Reference Points

- $F_{Target} = 0.25$
- $F_{Threshold} = 0.29$

A/R stock has been managed with a Total Allowable Catch (TAC) since 1990

- Maintain current TAC of 550,000 lbs
- The TAC will continue to be split evenly between commercial and recreational sectors
- ASMA commercial TAC = 275,000 lbs
- ASMA recreational TAC = 137,500 lbs
- RRMA recreational TAC = 137,500 lbs

ASMA Commercial Harvest (TAC = 275,000 lbs)

- 18 inch TL minimum size limit (ASMFC compliance requirement)
- Continue to operate as a bycatch fishery
- Spring season, anytime between Jan 1 – Apr 30
- Fall Season, anytime between Oct 1 – Dec 31
- Daily trip limits for striped bass
- Maintain gill net mesh size and yardage restrictions
- Maintain seasonal and area closures
- Maintain attendance requirements for small mesh nets (mid – May through late November)

ASMA Recreational Harvest (TAC = 137,500 lbs)

- 18 inch TL minimum size limit
- Daily creel limit (can be adjusted as necessary to keep harvest below the TAC)
- Open 7 days a week all season (can be adjusted as necessary to keep harvest below the TAC)
- Spring season, anytime between Jan 1 – Apr 30
- Fall season, anytime between Oct 1 – Dec 31

RRMA Recreational Harvest (TAC = 137,500 lbs)

- 18 inch TL minimum size limit
- Protective slot (no harvest): 22-27 inches TL
- 2 fish daily creel, only one of which can be greater than 27 inches TL
- Harvest season in entire river opens on March 1 and closes on April 30 by rule since 2008
- Single barbless hook regulation from April 1 – June 30 in Inland waters above the US 258 Bridge

Management of TACs for ASMA and RRMA

- Short-term Overages: if the harvest point estimate exceeds the total TAC by 10% in a single year, overage is deducted from the next year and restrictive measures implemented in the responsible fishery (ies)
- Long-term Overages: five-year running average of harvest point estimate exceeds the five-year running average of the total TAC harvest by 2%, the responsible fishery exceeding the harvest limit will be reduced by the amount of the overage for the next five years. Should the target F be exceeded, then restrictive measures will be imposed to reduce F to the target level

NCMFC and NCWRC Preferred Management Option:

Status Quo with current management measures for the ASMA and RRMA.

It should also be noted that under the provisions of this plan Amendment the NCDMF Director and NCWRC Chief of Inland Fisheries will maintain the ability to establish seasons, authorize or restrict fishing methods and gear, limit quantities taken or possessed, and restrict fishing areas as deemed necessary to maintain a sustainable harvest.

12.11 RESEARCH NEEDS AND MANAGEMENT RECOMMENDATIONS FROM THE NC ESTUARINE STRIPED BASS FMP AMENDMENT 1

The Habitat and Water Quality MFC AC voted at their September 12, 2011 meeting to support and implement the following Research and Management Recommendations relative to striped bass from the 2010 Coastal Habitat Protection Plan, as well as the Research and Management Recommendations identified in Section 10, Environmental Status, of the FMP:

Recommendations that should be supported and implemented identified in the 2010 Coastal Habitat Protection Plan:

- There should be continued support and development of SHAs in NC.
- Once the SHAs have been designated there should be continued protection of these areas by the cooperating agencies.
- Work with WRC, DWQ, and others to implement management measures that will enhance water quality in areas used by striped bass.
- Work with American Rivers and other partners to accelerate dam removal in priority areas.
- Agencies should continue to protect NC coastal wetlands through the permit review process. Quantify the density and distribution of striped bass eggs, fry, and juveniles in coastal rivers to estimate potential losses to entrainment and impingement.
- Determine if contaminants are present in striped bass habitats and identify those that are potentially detrimental to various life history stages.
- Evaluate the effects of existing and future water withdrawals on water quality and quantity and fisheries habitat in coastal watersheds.

Recommendations that should be supported and implemented identified in Section 10, Environmental Status, of the NC Estuarine Striped Bass FMP Amendment 1:

- Identify and designate anadromous fish nursery areas and how early juvenile striped bass move and are distributed in NC estuarine waters.
- Identify minimum flow requirements in the Tar/Pamlico, Neuse, and Cape Fear rivers necessary for successful spawning, egg development, and larval transport to nursery grounds.
- Evaluate the impacts/effects of reverse osmosis plants on receiving waters and aquatic resources.
- Verify condition of identified SHAs used by striped bass.
- Investigate abundance and spawning contribution of striped bass in the NC and Virginia portions of the Blackwater, Nottoway and Meherrin rivers.
- Investigate striped bass use in the North Carolina portions of the Waccamaw River during the appropriate season.
- Continue to investigate the potential for passage of striped bass above Roanoke Rapids Dam.

- Support fish passage at Buckhorn Dam and Lock and Dam No.2 and No.3 and investigate anadromous fish utilization of the rock ladder at Lock and Dam No. 1.
- Investigate the feasibility of fish passage at and improved water flows from Rocky Mount Mill Dam and Tar River Reservoir Dam.
- Support the removal of Milburnie Dam in Raleigh.
- Support fish passage above the Yadkin chain of dams in North Carolina.
- Data on the density and distribution of striped bass eggs, fry, and juveniles in coastal rivers are needed so that potential losses to entrainment and impingement can be estimated.
- Identify effective engineering solutions to prevent entrainment and impingement of striped bass eggs, fry, and juveniles.
- NCDMF and NCWRC should work with DWQ and other agencies to determine and establish more stringent water quality standards in Anadromous Fish Spawning Areas.

Other research needs:

Atlantic Ocean Summer Recreational Closure

- Methodology tested to accurately capture Atlantic Ocean striped bass harvest during summer months (May-October)

Striped Bass Stocking In Coastal Rivers

- Increase surveys of stocked systems to determine percent contribution of wild versus stocked fish
- Determine if fish produced from system-specific parentage will increase stocking contribution to spawning populations
- Determine factors impacting survivability of stocked fish in each system

Discard Mortality of Striped Bass From Commercial Set Gill Nets In The CSMA

- More at-sea observations made for the gill net fishery to more accurately assess the discards from this fishery
- Explore improvements to NCDMF programs (Trip Ticket, Fish House sampling, fisherman surveys or logbooks) in order to acquire spatially and temporally accurate gill net gear parameters (e.g. yardage, mesh)
- Investigate the impacts of delayed mortality on striped bass captured in gill nets

North Carolina Coastal Stocks

- Clarify relationships between salinity, DO, temperature and catch and release mortality rates in the ASMA and CSMA
- Year round creel survey in the ASMA
- Expand tagging programs to include high reward tagging
- Conduct new analysis of relationship between JAI in Albemarle Sound and flows in Roanoke River
- More at-sea observations of the gill net fishery to accurately assess discards
- Investigate impacts of delayed mortality on striped bass captured in gill nets.

Research Needs By Section:

Section 6 Status of The Stocks

Research Recommendations from the CSMA stock assessment (2010) (H- High priority, M-Medium priority, and L- Low priority).
Life History

- Determine system of origin of fish on the spawning grounds (H).
- Acquire life history information: maturity, fecundity, size and weight at age, egg and larval survival (short term research projects) (H).
- Conduct a mark-recapture study utilizing conventional tags and telemetry approaches (expanded program) (H).
- Determine if suitable striped bass spawning conditions exist in the Tar/Pamlico, Neuse, and Cape Fear rivers (M).
- Conduct egg abundance and egg viability studies (M).
- Determine contribution of stocked fish to spawning stock (M).
- Determine extent of spawning grounds (L).

Fishery Dependent Surveys - Recreational and Commercial

- Improve discard estimates and discard biological characteristics from commercial fisheries (trip level observer coverage) (M).
- Obtain biological characteristics such as length, weight, age, and sex of recreational harvest (expanded creel surveys) (M).
- Obtain biological characteristics such as length, weight, age, and sex of commercial harvest (increased sampling, age structure collection) (M).
- Improve discard estimates and discard biological characteristics from recreational fisheries (creel survey) (L).
- Conduct delayed mortality studies for recreational and commercial gear (short term research projects) (L).

Fisheries Independent Surveys

- Conduct independent surveys that adequately capture all life stages of striped bass (H).
- Continue tagging striped bass in order to evaluate the possible contribution to the Atlantic Migratory stock and provide data to be used in stock assessment efforts. Develop means to better assess the tag recapture and reporting rate for use in tag-based stock assessments (H).
- Conduct a short term study to determine vulnerability-at-length for survey gears (L).

Section 8 Protected Species

Request funding for state observer program:

- Provides data on interactions, fisheries characterizations, and discard information
- Allows for continued proactive management
- Expensive
- Could be difficult to achieve adequate observer coverage coast wide

Apply for ITP for impacted fisheries:

- Provides a legal means of having interactions
- Provides data on protected species and fisheries characterization
- Allows for continued proactive management
- Expensive
- Could be difficult to achieve adequate observer coverage coast wide

Continue gear development research to minimize species interactions:

- Allows fisheries to continue
- Potentially increased survival of protected species
- Potentially reduces interactions
- Potential for fisheries to close due to protected species interactions while gear is being developed

Implementation of outreach programs to inform state agencies, the public, and the commercial and recreational fishing industries about issues relating to protected species and fishery management:

- Well informed public may be able to reduce interactions
- Proactive way to address the issues
- Additional staff time to develop outreach materials

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14.0 APPENDICES

14.1 NORTH CAROLINA STRIPED BASS LANDINGS 1887-1973 (CHESTNUT AND DAVIS, 1975)

Year	Pounds	Value ($)	Year	Pounds	Value ($)
1887	500,000	25,000	1951	702,000	134,000
1888	560,000	28,000	1952	647,000	121,000
1889	531,000	31,000	1953	757,000	137,000
1890	568,000	32,000	1954	1,122,000	188,000
1897	845,000	58,000	1955	736,000	120,000
1902	1,175,000	114,000	1956	764,000	119,000
1908	510,000	36,000	1957	597,000	90,000
1918	287,000	46,000	1958	1,097,000	197,000
1923	477,000	76,000	1959	872,000	158,000
1927	738,000	119,000	1960	782,000	125,000
1928	507,000	72,000	1961	550,000	88,000
1929	246,000	41,000	1962	747,000	120,000
1930	457,000	61,000	1963	736,000	115,000
1931	327,000	35,000	1964	714,000	117,000
1932	507,000	55,000	1965	484,000	77,000
1934	362,000	36,000	1966	653,000	100,000
1936	768,000	61,000	1967	1,817,000	253,000
1937	713,000,	69,000	1968	1,912,000	385,000
1938	523,000,	49,000	1969	1,568,000	326,000
1939	339,000	34,000	1970	2,318,000	479,000
1940	540,000	59,000	1971	1,449,000	314,000
1945	609,000	121,000	1972	1,261,000	358,000
1950	797,000	165,000	1973	1,752,000	592,000

14.2 NORTH CAROLINA STRIPED BASS LANDINGS AND DOLLAR VALUE BY GEAR (CHESTNUT AND DAVIS 1975).

	Haul seine		Purse seine		Pound net		Gill net		Fyke net		Trawl		Line		Dip and Bow net		Fish wheel		Other	
Year	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1887	149,422	6,831			203,335	11,553	53,279	3,706	1,250	75										
1888	161,300	6,438			270,487	15,288	57,557	3,879	1,250	75										
1889	220,766	11,912			240,221	13,732	69,112	4,892	1,250	75										
1890	288,587	11,798			260,464	14,874	77,980	5,387	1,310	79										
1897	250,918	16,875			430,620	29,824	145,635	10,033	400	20			8,300	615			6,800	496	2,400	172
1902	297,027	27,920			677,135	67,380	160,616	14,613	500	50			3,800	380			6,222	600	30,100	2,688
1908	177,000	12,000			215,000	15,000	38,000	2,700	2,400	200			6,200	500					71,000	5,700
1918	31,673	3,235	18,000	4,500	210,284	31,785	17,993	3,487	1,943	253										
1923	189,147	28,368	15,523	2,252	110,607	16,748	158,124	27,865	3,600	720										
1927	188,496	27,267	16,700	2,505	233,499	37,291	288,910	50,420	10,100	1,978										
1928	221,547	28,344	4,985	614	156,352	24,116	117,827	17,700	5,870	986					200	50				
1929	80,652	11,701			95,397	16,424	64,703	11,909	5,605	1,190										
1930	203,526	20,863	10,000	1,500	106,350	15,569	118,650	18,475	16,350	3,643					1,000	150			1,000	250
1931	185,560	16,871	5,000	750	57,550	7,198	63,900	6,862	14,500	1,845										
1932	236,600	20,848	75,000	11,250	75,200	9,115	95,675	10,007	21,000	2,125										
1934	139,300	13,405	20,000	2,000	92,400	9,240	87,300	8,730	3,000	300			11,760	1,171						
1936	138,100	11,932	100,000	5,000	319,800	25,001	194,000	17,769	11,300	960			20,000	2,000						
1937	198,300	19,372	55,000	5,500	288,700	27,826	153,500	15,006	17,400	1,720			4,600	595						
1938	212,400	19,879			205,900	19,777	84,700	7,111	19,700	1,861										
1939	47,900	4,635			158,500	15,805	126,700	12,665	6,500	650										
1940	49,300	5,423			248,600	27,346	231,000	25,410	11,000	1,210										
1945	41,700	8,284			238,200	47,576	267,300	53,036	61,300	12,260										
1950	191,700	32,090	112,800	22,560	310,000	73,216	137,200	28,311	45,000	9,000	100	30								
1951	143,200	31,535	155,000	27,250	233,600	40,115	127,300	27,345	23,800	4,950			11,300	1,715	8,000	1,200				
1952	118,600	24,692	138,100	23,670	206,200	36,026	161,700	32,690	3,700	750					8,500	1,530				
1953	189,100	32,533	112,500	21,270	274,700	47,598	150,900	29,962	5,500	1,060					16,500	3,300				
1954	74,800	14,440	101,600	20,320	696,500	104,636	242,700	47,598	6,100	1,198										
1955	54,300	8,301	36,000	6,105	334,800	51,469	307,600	53,729	3,300	495										
1956	64,900	9,735	22,500	3,375	362,600	54,390	312,700	51,635	800	120										
1957	27,800	4,170	22,700	3,405	208,700	31,305	337,800	50,670												
1958	193,100	34,758	82,800	14,904	211,500	38,070	601,800	108,324	6,800	1,224										
1959	201,400	36,320	65,000	11,700	121,800	22,090	483,300	87,346												
1960	196,700	31,472	89,800	14,368	195,300	31,248	300,500	48,080												
1961	123,300	19,728	47,700	7,632	133,600	21,376	245,100	39,216												
1962	182,400	29,184	70,000	11,200	163,100	26,096	331,800	53,088												
1963	100,600	14,416	10,000	1,600	180,400	28,864	444,800	69,028												
1964	131,600	21,581			154,400	24,878	427,300	70,095												
1965	96,900	15,081			131,400	20,809	257,200	41,111												
1966	66,800	10,275			47,700	7,166	528,800	81,310	4,800	743			9,000	1,372						
1967	285,600	37,654	50,100	9,398	52,700	9,262	1,368,500	191,412	2,100	346	56,700	4,886	300	55						
1968			24,600	5,408	92,600	15,311	1,302,500	296,649	800	156	30,200	6,028	100	18						
1969	367,900	87,769	166,700	33,018	54,200	8,119			1,700	318	117,900	27,789								
1970	588,600	135,031	246,200	46,885	198,600	38,972	617,700	127,979	600	126	665,500	130,302								
1971	306,700	69,749	59,000	11,797	92,100	19,680	541,200	119,123	6,400	1,300	443,600	92,151								

14.3 STRIPED BASS LANDINGS AND DOLLAR VALUE BY COUNTY, 1930-1968. (CHESTNUT AND DAVIS, 1975).

	Bertie		Camden		Chowan		Currituck		Dare		Gates	
Year	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1930	3,500	425	3,000	600	19,800	3,910	61,822	11,999	136,200	19,705	400	74
1931	1,800	180	3,000	450	14,500	1,450	56,760	6,621	107,300	10,947	200	20
1934	20,900	2,090	3,000	300	18,700	1,870	47,500	4,750	116,000	11,600	No data	
1936	13,700	1,255	7,300	660	15,000	1,257	34,900	3,435	474,800	34,392	3,500	350
1937	11,500	1,150	8,800	714	9,800	980	83,500	8,532	367,100	36,697	2,000	200
1938	10,600	954	4,700	470	8,600	774	96,600	9,660	278,400	26,568	2,200	198
1945	27,000	5,400	2,500	500	No data		64,500	12,900	160,000	32,000	5,000	1,000
1950	5,600	1,120	5,000	1,000	22,700	4,540	162,100	26,120	335,300	77,145	1,000	200
1951	5,600	1,400	3,200	800	9,800	2,450	100,400	25,100	310,700	46,610	5,000	1,000
1952	4,300	860	3,500	770	16,400	3,280	94,800	20,856	238,100	35,715	1,700	428
1953	16,000	3,200	4,900	1,078	20,900	4,180	77,300	15,460	269,400	41,145	1,400	280
1954	9,900	2,772	7,300	1,825	No data		24,700	4,446	98,200	19,640	4,900	980
1955	16,200	2,430	8,500	1,530	158,500	23,775	62,500	9,375	130,900	19,635	4,900	980
1956	7,300	1,095	2,500	375	199,000	29,850	23,400	3,510	266,200	39,930	No data	
1957	10,600	1,590	1,500	225	247,000	37,050	16,900	2,535	112,100	16,815	No data	
1958	7,900	1,422	10,000	1,800	311,000	55,980	22,400	4,032	348,100	62,658	No data	
1959	4,700	940	9,500	1,900	280,000	50,400	19,900	3,582	225,100	40,518	No data	
1960	8,800	1,408	15,000	2,400	72,500	11,600	31,900	5,104	356,200	56,992	No data	
1961	4,400	704	13,500	2,160	64,500	10,320	6,500	1,040	116,600	26,656	No data	
1962	3,800	608	22,300	3,568	87,400	13,984	86,000	13,760	236,100	37,776	No data	
1963	7,400	1,184	30,600	4,896	141,800	22,688	81,000	12,960	132,800	19,568	No data	
1964	7,000	1,120	55,000	8,993	82,100	13,406	58,000	9,280	181,200	29,566	No data	
1965	2,600	416	23,600	3,776	51,400	8,224	61,000	9,760	110,600	17,133	No data	
1966	3,500	534	No data		247,500	38,143	24,400	3,700	74,200	11,269	No data	
1967	4,900	896	No data		436,500	73,348	9,800	1,685	886,000	96,601	No data	
1968	4,300	663	No data		224,300	47,216	79,800	15,040	600,000	111,519	No data	

14.3 (continued)

	Hertford		Martin		Pasquotank		Perquimans		Tyrell		Washington	
Year	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1930	No data		6,000	825	25,000	4,800	60,000	9,000	12,100	1,855	80,814	1,397
1931	No data		1,500	150	11,600	2,212	30,000	3,000	6,000	600	50,800	5,080
1934	200	20	20,000	2,000	5,000	500	12,000	1,200	37,000	3,700	47,000	4,700
1936	3,000	300	6,400	770	29,800	2,640	27,200	2,448	119,200	10,750	20,100	1,809
1937	3,500	350	1,000	80	28,800	2,592	29,100	2,549	82,300	8,230	23,400	2,340
1938	3,000	270	800	64	30,500	2,440	29,000	2,320	22,000	1,925	17,600	1,179
1945	1,500	180	2,000	400	107,300	21,460	73,700	14,740	100,000	20,000	9,000	1,800
1950	1,300	260	25,000	5,000	42,600	8,520	22,500	4,500	134,000	26,800	12,500	2,500
1951	1,300	260	12,500	3,125	42,400	10,600	43,200	10,790	120,000	24,000	2,000	500
1952	1,300	286	2,400	432	58,400	11,680	36,100	7,942	82,000	14,760	13,400	2,412
1953	1,100	242	2,600	468	83,700	16,740	30,400	6,688	100,500	18,090	16,100	2,898
1954	3,000	600	3,000	600	54,500	10,900	26,200	5,240	250,000	50,000	10,500	1,680
1955	2,000	400	1,500	375	96,800	17,424	22,500	4,050	175,000	31,500	26,500	3,975
1956	No data		3,000	450	74,900	15,965	9,900	1,485	108,200	16,230	52,000	7,800
1957	600	90	1,000	150	61,400	9,210	6,900	1,035	111,600	16,740	16,300	2,445
1958	No data		500	90	159,700	28,746	10,000	1,800	195,500	35,190	9,100	1,638
1959	No data		500	90	103,000	18,540	15,000	2,700	184,500	33,210	12,800	2,304
1960	No data		600	96	93,500	14,960	25,000	4,000	130,800	20,928	7,700	1,232
1961	300	48	300	48	69,000	11,040	20,000	3,200	132,000	21,120	4,200	672
1962	200	32	100	16	80,000	12,800	30,000	4,800	124,500	19,920	7,900	1,264
1963	500	80	500	80	91,000	14,560	35,000	5,600	154,000	23,500	5,300	848
1964	1,000	160	1,900	304	147,500	24,337	20,000	3,285	113,400	18,711	6,500	1,040
1965	No data		No data		100,000	16,000	13,000	2,080	81,100	12,895	1,200	192
1966	No data		No data		99,200	15,288	No data		132,300	20,109	11,000	1,714
1967	No data		No data		100,300	16,408	No data		105,200	18,892	151,700	24,514
1968	No data		No data		769,000	15,485	No data		177,800	34,958	575,400	124,640

14.3 (continued)

	Halifax		Beaufort		Pamlico		Carteret		Craven		Hyde	
Year	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1930	No data		6,000	825	25,000	4,800	60,000	9,000	12,100	1,855	80,814	1,397
1931	No data		1,500	150	11,600	2,212	30,000	3,000	6,000	600	50,800	5,080
1934	200	20	20,000	2,000	5,000	500	12,000	1,200	37,000	3,700	47,000	4,700
1936	3,000	300	6,400	770	29,800	2,640	27,200	2,448	119,200	10,750	20,100	1,809
1937	3,500	350	1,000	80	28,800	2,592	29,100	2,549	82,300	8,230	23,400	2,340
1938	No data		12,300	1,206	3,500	350	800	40	700	70	900	90
1945	No data		6,000	1,200	3,500	700	500	100	39,800	7,960	No data	
1950	No data		22,400	6,272	1,100	330	100	25	1,800	450	500	100
1951	35,000	5,250	12,000	2,400	700	140	0		2,000	300	No data	
1952	35,500	6,390	45,200	11,300	1,000	250	0		5,500	1,650	No data	
1953	34,500	6,900	86,100	17,220	2,000	400	0		7,000	1,400	No data	
1954	No data		19,200	3,840	300	60	0		3,200	640	No data	
1955	No data		27,800	4,170	700	140	0		1,300	260	No data	
1956	No data		15,400	2,310	No data		0		600	90	No data	
1957	No data		8,400	1,260	No data		0		200	30	1,100	165
1958	No data		14,700	2,646	100	18	0		2,300	414	3,700	666
1959	No data		15,100	3,020	100	18	200	36	No Data		600	108
1960	No data		34,300	5,488	800	128	2,500	400	2,100	336	No data	
1961	No data		27,700	4,432	1,900	304	33,800	5,408	2,900	464	100	16
1962	No data		38,400	6,144	12,600	2,016	11,900	1,904	3,800	608	700	112
1963	No data		35,600	5,696	1,100	176	14,600	2,336	3,500	560	100	16
1964	No data		29,300	4,688	2,800	448	5,700	912	2,400	384	200	32
1965	No data		34,600	5,501	900	144	1,300	208	1,600	256	600	96
1966	No data		57,300	8,830	500	69	800	123	300	38	100	23
1967	No data		117,200	20,132	1,700	83	600	102	No Data		200	31
1968	No data		170,600	35,009	100	12	600	103	No Data		500	109

14.3 (continued)

	Lenoir		New Hanover	
Year	Pounds	Value	Pounds	Value
1930	4,000	1,000	No data	
1931	1,500	75	No data	
1934	2,500	250	No data	
1936	No data		No data	
1937	No data		No data	
1938	No data		500	50
1945	No data		5,300	636
1950	No data		1,300	325
1951	No data		1,400	385
1952	No data		7,400	2,220
1953	No data		3,100	930
1954	No data		800	240
1955	No data		No data	
1956	No data		1,100	165
1957	No data		1,400	210
1958	No data		1,000	180
1959	No data		500	90
1960	No data		600	96
1961	No data		2,000	320
1962	No data		1,600	256
1963	No data		1,000	160
1964	No data		400	64
1965	No data		800	128
1966	No data		1,400	211
1967	No data		2,900	501
1968	No data		1,500	278

14.4 HISTORICAL REGULATIONS

These regulations are just a few of those in place overtime.
The following rules are quoted from the referenced rule books:

North Carolina Fishing Laws- Consolidated Statutes 1923- Fisheries Commission Board

If any person fishes on Sunday with a seine, drag-net, or other kind of net, except such as is fastened to stakes, he shall be guilty of a misdemeanor, and fines not less than two hundred nor more than five hundred dollars, or imprisoned not more than twelve months.

Albemarle Sound Area
No person shall set or fish any dutch net or pound net in Roanoke River, Cashie or Middle and Eastmost rivers, or within two miles of the mouth of said rivers, or within one mile of the mouth of any other river emptying into Albemarle Sound, or less than two miles in width at its mouth, any such net set within one mile of the mouth of any other river emptying into said sound shall not extend into the main channel at its mouth.

It is unlawful to set, fish or use any gill nets of any description, either stake, anchor or drift, for commercial purposes in the Albemarle Sound west of a line drawn straight from Batt's Island on northern side of Albemarle Sound to mouth of Scuppernong River on south side of said sound, except between the hours of four o'clock and eleven o'clock p.m., and then said nets or combinations of such nets shall not be more than six hundred yards in length, and there shall not be allowed to any boat more than six hundred yards of such gill nets.

Cape Fear River
It is unlawful to fish with dutch, pod, fyke or other pound nets, or stake or stationary nets, or nets of like kind, in the waters of the Cape Fear River below the mouth of Black River, twelve miles above Wilmington, or in the waters of Northeast River below the Castle Hayne Bridge. Drift nets shall be permitted in the waters of the Cape Fear River within the territory as above described in this section, and its tributaries, between February first and May first of each year. Any person violating the provisions of this section shall be guilty of a misdemeanor and fined not less than fifty dollars or imprisoned not less than thirty days.

Pamlico and Tar River
If any person, from the fifteenth day of February to the tenth day of May of every year, from twelve o'clock meridian of Saturday until sunrise Monday morning of each week, shall fish any seine, set net, drift net, or any other net of any name or kind whatever, in the waters of Pamlico or Tar rivers and tributaries, except bow or skim nets, he shall be guilty of a misdemeanor.

Neuse River
If any person shall set or fish any dutch or pound nets in the waters of Pamlico County, or shall use any seine or drag net in the waters of said county, including the north side of Neuse River from the mouth of the river to the mouth of Upper Broad Creek, from the first day of May to the first day of January next ensuing, or shall ant any time catch fish with a seine or drag net along the shores of said county on any day of the week except Monday, Wednesday and Friday, he shall be guilty of a misdemeanor and be fined not more than fifty dollars or imprisoned not more than thirty days.

Rules and Regulations of the Department of Conservation and Development Relative to the Commercial Fisheries of North Carolina 1947

It shall be unlawful for any person, firm or corporation to take, buy, sell, offer for sale, have in his or their possession, or unnecessarily destroy, anywhere in the State of North Carolina, any fish of less size than the length specified for the several kinds of fish or for any express company, railroad company or any common carrier to accept them for shipment. Rockfish or striped bass 12 inches. Provided, that this provision shall not be construed to prevent catches of smaller fish with hook and line for sport or personal use.

Albemarle Sound Area
It shall be lawful to use purse seines not exceeding two hundred yards in length for taking rock in Albemarle Sound east of a line drawn from Laurel Point Light House to Batt's Island from October 1 to December 20 of each year.

It shall be unlawful at any time to take female (roe) striped bass (rock) with nets, seines, or by any means whatsoever in that portion of the Roanoke River between the Hart Bridge near Scotland Neck and the New Highway Bridge at Weldon. Any female or roe striped bass taken within said territory shall be released immediately at the place caught and with as little damage as possible to the fish.

It shall be unlawful for any person, firm or corporation to fish nets of any kind in Albemarle Sound and its tributaries above a line drawn from Laurel's Point Lighthouse to Batt's Island between sunset and sunrise during the shad and herring fishing seasons.

Neuse or Pamlico Rivers
It shall be unlawful to set anchor gill nets in any of the waters of Neuse or Pamlico Rivers at any season of the year.

Cape Fear River
It shall be unlawful to catch or take with nets or seines any striped bass or rock in any waters of New Hanover County.

14.5 REGULATIONS AFFECTING NC ESTUARINE STRIPED BASS STOCKS

Year	Statewide	ASMA/RRMA	Central/Southern
Prior to 1979	Minimum size limit 12 in TL, daily creel limit 25 fish (DMF/WRC)		
1979	Internal Coastal and Joint Waters- gill nets with a mesh length less than 2 ½ ISM are illegal (except area specifics)	No trawling in Albemarle and Croatan Sounds between Dec 1 and Mar 31	
1979		Roanoke River drift gill nets must be attended at all times (DMF)	
1979		Gill net mesh size changed from 3 ¼ ISM to 3 ½ ISM- western Albemarle Sound and Chowan River- summer/fall (DMF/Jul)	
1979		Defined small mesh nets (mullet nets to be used only in eastern Albemarle Sound) (DMF/Jul)	
1980	Creel limit reduced to 8 fish per day in Inland Waters (WRC)	Eliminated set gill nets in Roanoke River- Apr-May and restricted mesh size of drift gill nets (DMF/Oct)	
1980	Field possession limit reduced to one day's creel limit- Inland Waters (WRC)		
1981		Roanoke River bow netting eliminated (WRC) Possession of large dip nets prohibited in Inland Waters of the Roanoke River (WRC)	
1981		Extended drift gill net regulations to mouth of	

Year	Statewide	ASMA/RRMA	Central/Southern
		Roanoke, Middle, Eastmost and Cashie rivers proper (DMF/Oct)	
1982	Minimum size limit increased to 16 in TL in Inland Waters (WRC)		
1983		Eliminated small mesh gill nets in Currituck Sound, minimum size increased to 3 ½ ISM (Jun-Dec) (DMF/Jan)	
1983		Roanoke River- re-instituted use of set gill nets Apr-May of 3 ISM and less, no more than one drift gill net per boat (DMF Jan and Oct)	
1983		Eliminated 3 ¼ ISM gill nets (Jun-Dec) in all of Albemarle Sound and tributaries, increased minimum mesh size to 3 ½ ISM (DMF/Oct)	
1983	Prohibited possession of striped bass on vessels using trawl in Internal Coastal Waters (DMF/Jan)		
1984		First limited commercial season Oct-May (DMF/Aug)	
1984		Minimum gill net mesh size 3 ½ ISM Oct-Dec (DMF/Aug)	
1984		Eliminated gill nets in Albemarle Sound and tributaries Jun-Sep, except defined “mullet nets” (2 ½-3 ISM), floating and within 300 yd of shore (DMF/Aug)	
1984	Reduction in hook and line creel limit to 8 fish/day and increase		

Year	Statewide	ASMA/RRMA	Central/Southern
	minimum size limit to 16 in TL for Joint and Internal Coastal Waters (Jun-Sep) (DMF/Aug)		
1984	Unlawful to sell or offer for sale striped bass from Jun-Sep (DMF/Aug)		
1984	First size limit for Atlantic Ocean- 24 in TL commercial and recreational (DMF/Aug)		
1984	Closure of Atlantic Ocean, commercial and recreational, to possession by proclamation (DMF/Aug)		
1985	Reduction in creel limit to 3 fish in Inland Waters (WRC)	Prohibit sale of striped bass taken from Inland Waters of the Roanoke River (NC General Assembly)	
1984	Reduction in commercial season (Nov-Mar), unlawful to sell or possess striped bass from commercial gear except during the open season (DMF/Aug)	Revision of summer gill net use (Jun-Sep), which allowed 5 ISM and greater "flounder nets" and attendance at all times provisions for "mullet nets" in Albemarle Sound and tributaries (DMF/Aug)	
1984	Hook and line creel limit reduced to 3 fish/day Internal Coastal and Joint Waters year round. No sale of hook and line caught striped bass (DMF/Aug)		
1984	Commercial minimum size limit increased to 16 in TL in Joint Waters (DMF/Aug)		
1984	Commercial minimum size limit increased to 14 in TL in Internal		

Year	Statewide	ASMA/RRMA	Central/Southern
	Coastal Waters (DMF/Oct)		
1986	Minimum size limit increased to 16 in TL Internal Coastal waters (DMF/Oct)	Revisions to depth of water and net size for the fall gill net regulations (Oct-Dec)-increased striped bass conservation without severely impacting the harvest of white perch and catfish (DMF/Nov)	
1986	Repealed 16 in TL size limit, revert back to 14 in TL minimum size limit Internal Coastal Waters (DMF/Nov)	Established proclamation authority to open and close a portion of the striped bass season (Oct and Apr) (MFC/Nov)	
1986		Aligned Currituck Sound net regulations with the Albemarle Sound regulations relative to conservation measures (DMF/Nov)	
1986		Eliminated the possession and sale of striped bass from the spring Albemarle Sound gill net fishery and Roanoke River delta pound net fishery (DMF-effected by Aug 1985 regulations)	
1987		Eliminated all trawling in Albemarle Sound and tributaries year round (DMF/Dec)	
1987		Closed a portion of western Albemarle Sound to gill netting (Batchelor Bay area) and restricted the spring	

Year	Statewide	ASMA/RRMA	Central/Southern
		pound net fishery in the Roanoke River delta by proclamation (DMF/Aug) (remains in effect 2002)	
1988	Size limit in Atlantic Ocean will correspond to ASMFC Interstate Striped Bass FMP		
1988		Allow use of "mullet gill nets" in Currituck Sound between 2 ½ - 3 ¼ ISM, maximum 400 yds, attended at all times (Jun-Dec) (DMF/Sep)	
1989	Established proclamation authority to specify season or seasons: (a) hook and line and (b) commercial fishing equipment between 1 Oct and 30 Apr. Proclamations may specify areas, quantity, size and means/methods employed in harvest and require submission of statistical and biological data (MFC/Sep)	Closed Batchelor Bay area to anchor gill netting and restricted the possession of striped bass taken in pound nets to fish not less than 18 in TL or greater than 24 in TL.	
1989		Restricted use of small mesh "mullet gill nets" in Albemarle Sound and tributaries (DMF/Jun and Sep)	Commercial season in Internal Coastal waters closed 20 Apr (DMF/Apr)
1989		Delayed use of commercial gill nets of between 3-5 ISM in Albemarle Sound and tributaries from 1 Oct until 15 Nov, when commercial striped bass season opened	Commercial season opened 15 Nov in Internal Coastal Waters (DMF/Nov)

Year	Statewide	ASMA/RRMA	Central/Southern
		statewide. Mullet nets required attendance at all times (DMF/Oct)	
1989		Gill net mesh sizes restricted in Albemarle Sound area (DMF/Nov)	Commercial season closed in Internal Coastal Waters 22 Nov (DMF/Nov)
1989	Hook and line season closed in Internal Coastal Waters 26 Nov (DMF/Nov)		
1990		Albemarle Sound area-98,000 lb. (TAC) commercial harvest allocation to be managed on a monthly basis (DMF/Jan)	Commercial season opened 1 Jan in Internal Coastal Waters (DMF/Jan)
1990		Gill net size restrictions in Albemarle Sound area (DMF/Jan, Feb and Apr)	Commercial season closed 11 Jan in Internal Coastal Waters (DMF/Jan)
1990		Batchelor Bay area closed 1 Apr to anchor gill nets and prohibited the possession between 24 and 28 in TL and less than 18 in TL from pound nets (DMF/Mar)	Commercial season opened 21 Feb in Internal Coastal Waters (DMF/Feb)
1990		Delayed use of commercial gill nets of between 3-5 ISM from 3 Oct until 7 Jan 1991, when season opened statewide, required mullet gill nets be attended at all times (DMF/Oct)	Commercial season closed 20 Apr in Internal Coastal Waters (DMF/Apr)
1990	Hook and line season opened 1 Jan in Internal Coastal Waters (DMF/Jan)	By collateral action through proclamation (DMF) and emergency rule (WRC), striped bass season closed 10 May for hook and line possession in Joint Waters of Albemarle Sound area (DMF and WRC/May)	
1990	Hook and line season closed 24 Apr in Internal	By emergency rule season closed 10 May	

Year	Statewide	ASMA/RRMA	Central/Southern
	Coastal Waters (excluding Joint Waters) (DMF/Apr)	for hook and line possession in Inland Waters of Roanoke River (WRC/May)	
1990	By collateral action DMF and WRC, closed hook and line possession in Internal Coastal, Joint and Inland Waters 21 May (DMF and WRC/May)		
1991		ASMA commercial season opened 7 Jan and closed 9 Jan	Commercial season opened 7 Jan in all Internal Coastal Waters outside the ASMA (DMF/Jan)
1991		ASMA commercial TAC of 98,000 lbs. and managed on a monthly basis. Individual harvest permits required for fishermen or operations, 14 in TL minimum size in Internal Coastal Waters and 16 in TL in Joint Waters. Extensive gill net restrictions with specific amount or yardage of gill nets less than 5 ISM for all 1991 (DMF/Jan)	Commercial season closed by rule 30 Apr, all waters outside ASMA (DMF)
1991		ASMA opened 18 Jan with gear restrictions, harvest permittee limited to landing 3 fish/day, minimum size 20 In TL	1 Nov commercial season opened statewide, 18 in TL minimum size limit (DMF/Nov)
1991	Effective 1 Jan -16 in TL size limit established and a daily creel limit not to exceed 3 fish per person per day for all Internal Coastal, Joint and Inland Waters (DMF/WRC)	ASMA – 13 Feb harvest permittee limited to landing 5 fish/day, minimum size 18 in TL	

Year	Statewide	ASMA/RRMA	Central/Southern
1991		ASMA- 1 Mar harvest permittee limited to landing 10 fish/day, minimum size limit 18 in TL	1 Jan- hook and line season opened in all Internal Coastal waters statewide, excluding ASMA (DMF/Jan)
1991		ASMA- 25 Mar harvest permittee limited to landing 20 fish/day, minimum size 14 in TL in Internal Coastal Waters and 16 in TL in Joint Waters. Batchelor Bay area closed to anchor gill nets. Drift gill nets allowed in Roanoke, Eastmost, Middle and Cashie rivers, stationary gill nets prohibited (DMF/Mar)	1 Nov- hook and line season opened in all Internal Coastal and Joint Waters of the state, except for ASMA and RRMA
1991		ASMA- 6 Apr harvest permittee limited to landing 5 fish/day, minimum size limit 18 in TL (DMF/Apr)	By rule effective 1 Jul- 3 fish daily creel, 18 in TL minimum size, established year round for Inland Waters of the Tar, Neuse and Cape Fear rivers (WRC/Jul)
1991	By joint rule effective 1 Nov, minimum size limit for Joint Waters increased to 18 in TL (WRC and DMF/Nov)	ASMA- 13 Apr commercial season closed (DMF/Apr)	
1991	By rule effective 1 Nov, minimum size limit in Internal Coastal Waters increased to 18 in TL (DMF)	ASMA- 21 Jun- 3 ISM gill nets allowed, attended at all times (DMF/Jun)	
1991		ASMA- 3 Sep- 3-3 ½ ISM gill nets allowed with area restrictions and attendance at all times (DMF/Sep)	

Year	Statewide	ASMA/RRMA	Central/Southern
1991		ASMA- 1 Oct- 2 ½ ISM and larger gill nets allowed in southern portions of Roanoke and Croatan sounds (DMF/Oct)	
1991		ASMA- 1 Nov commercial season opened, harvest permittee limited to landing 3 fish/day, 18 in TL minimum size limit, small mesh gill nets attended at all times, with area restrictions (DMF/Nov)	
1991		ASMA- 8 Nov allowed 5 ¼ ISM and larger gill nets, consistent with 18 in TL minimum size limit (DMF/Nov)	
1991		ASMA- 22 Nov allowed 3- 3 ½ ISM gill nets unattended in waters less than 6 ft deep with restrictions (DMF/Nov)	
1991		ASMA- 20 Dec commercial season closed	

Year	Statewide	ASMA/RRMA	Central/Southern
1991		1 Jan- MFC and WRC adopted joint rules establishing the Albemarle Sound Management Area (ASMA) and the Roanoke River Management Area (RRMA). Harvest management in the two areas based upon an allocation of 29,400 lb. (TAC) per year for each area (corresponds to an 80% reduction in historical hook and line harvest) WRC management authority for hook and line harvest- Joint and Inland Waters of RRMA (Roanoke, Middle, Eastmost and Cashie rivers and their tributaries) MFC management authority for hook and line harvest in the remaining Internal Coastal, Joint and Inland Waters of the ASMA (Albemarle, Currituck, Roanoke and Croatan sounds and their tributaries) (Defined areas only apply to striped bass hook and line harvest management)	
1991		1 Jan- hook and line season opened in ASMA	
1991		By emergency rule hook and line season opened 1 Jan in RRMA (WRC/Jan)	

Year	Statewide	ASMA/RRMA	Central/Southern
1991		31 Jan- hook and line season closed in ASMA (DMF/Jan)	
1991		7 Feb- hook and line season opened in ASMA (DMF/Feb)	
1991		1 May- hook and line season closed in ASMA (DMF/May)	
1991		By emergency rule the WRC closed the hook and line season 1 May in RRMA (WRC/May)	
1991	By NC General Statute 113-292 (effective May 23, 1991) the WRC was granted proclamation authority to open and close hook and line striped bass seasons in the inland and joint waters of coastal rivers		
1991		1 Nov- hook and line season opened in ASMA, 18 in TL minimum size limit and daily creel limit of 3 fish (DMF/Nov)	
1991		30 Nov- hook and line season closed in the ASMA (DMF/Nov)	
1991		By rule effective 1 Jul, in RRMA the following were established during the open season: 1 Jan-31 Mar- Inland Waters- 1 fish daily creel, 18 in TL minimum size limit, Joint Waters- 3 fish daily creel, 18 in TL minimum size limit 1 Apr- 31 May- Inland Waters 3 fish daily	

Year	Statewide	ASMA/RRMA	Central/Southern
		creel, 18 in TL minimum size limit and NO fish between 22- 27 in TL maybe retained from US Hwy 258 to Roanoke Rapids Dam; Joint Waters- 3 fish daily creel, 18 in TL minimum size limit 1 Jun- 31 Dec- Inland Waters- 1 fish daily creel, 18 in TL minimum size limit, Joint Waters- 3 fish daily creel, 18 in TL minimum size limit	
1992		Throughout 1992 in the ASMA (excluding Croatan and Roanoke sounds) harvest permittee was limited to specific yardage of gill nets with stretched mesh less than 5 ¼ in. Gear and area restrictions varied seasonally. Stationary gill nets were prohibited in the RRMA.	21 Apr- commercial season closed in all Internal Coastal and Joint waters, outside the ASMA (DMF/Apr)
1992		ASMA- 11 Jan commercial season opened, harvest permittee limited to landing 10 fish per day (DMF/Jan)	23 Oct- commercial season opened in all Internal Coastal and Joint Waters, outside the ASMA
1992		ASMA- 3 Feb commercial harvest permittee limited to landing 5 fish per day (DMF/Feb)	
1992		ASMA- 19 Mar commercial harvest permittee limited to landing 3 fish per day. Drift gill nets allowed in Roanoke, Middle, Eastmost and Cashie rivers.	

Year	Statewide	ASMA/RRMA	Central/Southern
1992		ASMA- 16 Apr commercial season closed	
1992		ASMA- 3 Jul- small mesh gill nets must be attended at all times (DMF/Jun)	
1992		ASMA- 21 Oct- small mesh gill nets must be attended between sunrise and sunset (DMF/Oct)	
1992		ASMA- 9 Nov- commercial season opened with a closure date 20 Nov, harvest permittee limited to landing 3 fish per day (DMF/Oct)	
1992		ASMA- 23 Nov- allowed unattended small mesh gill nets (DMF/Nov)	
1992		RRMA- 1 Jan- hook and line season opened (WRC/Jan)	
1992		ASMA- 1 Jan- hook and line season opened (DMF/Dec)	
1992		RRMA- 20 Apr- hook and line season closed (WRC/Apr)	
1992		ASMA- 1 May- hook and line season closed (DMF/Apr)	
1992		ASMA- 1 Nov- hook and line season opened (DMF/Oct)	
1992		ASMA- 30 Nov- hook and line season closed (DMF/Nov)	
1993		Throughout 1993, ASMA (excluding Croatan and Roanoke sounds) harvest permittee were limited	17 Jan commercial season closed in Internal Coastal and Joint Waters

Year	Statewide	ASMA/RRMA	Central/Southern
		to specific yardage of gill nets with a stretched mesh less than 5 ¼ in. Gear and area restrictions varied seasonally. Stationary gill nets were prohibited in RRMA.	
1993		RRMA- 18 Jan drift gill nets allowed	1 Feb commercial season opened in all Internal Coastal and Joint Waters, outside ASMA
1993		ASMA- 1 Feb commercial season opened, harvest permittee limited to landing 5 fish per day, prohibited harvest from commercial gear in RRMA	5 Apr commercial season closed in Internal Coastal and Joint Waters outside the ASMA
1993		ASMA- 1 Mar commercial harvest permittee limited to landing 3 fish per day	
1993		ASMA- 5 Apr commercial season closed	
1993		ASMA- 17 May gill nets prohibited in Batchelor Bay-western Albemarle Sound and RRMA, excluding the prohibited area, gill nets in the western sound from Chowan River to the NC Power Transfer Line must be attended	
1993		ASMA- 2 Aug small mesh gill nets must be attended at all times, excluding Croatan and Roanoke sounds	
1993		ASMA- 6 Oct small	

Year	Statewide	ASMA/RRMA	Central/Southern
		mesh gill nets prohibited in water depth greater than 6 ft, excluding Croatan and Roanoke sounds	
1993		RRMA- 1 Feb hook and line season opened	
1993		ASMA- 1 Feb hook and line season opened	
1993		ASMA- 18 Apr hook and line season closed	
1993		RRMA- 25 Apr hook and line season closed	
1994		ASMA- 19 Feb recreational season open- harvest days Wed, Sat and Sun- 3 fish per person, 18 in TL minimum size limit and 15,000 pounds spring allocation	Commercial 25,000 lb. TAC for joint and internal coastal waters, outside the ASMA with the approval of the FMP by the MFC and WRC (Annual 1994-2002)
1994		ASMA- 21 February commercial season open- permittee limited to landing 10 fish per day and 18 in TL minimum size limit	Upper portions of Pamlico, Pungo, Bay and Neuse Rivers- 1 Sep gill nets less than 5 ISM must be attended at all times
1994		ASMA- 16 Mar recreational season closed	Upper portions of Pamlico, Pungo, Bay and Neuse Rivers- 12 Oct attendance lifted on all areas except upper Pamlico River
1994		RRMA- 19 Feb, hook and line season opened, possession limited to Wed, Sat and Sun, 2 Apr, lower river closed, 21 Apr, upper river closed	13 Mar commercial season closed in all Internal Coastal and Joint Waters
1994		RRMA- effective 1 Jul, protective 22 to 27 in TL slot limit extended to entire Roanoke River, 1	

Year	Statewide	ASMA/RRMA	Central/Southern
		Apr- 31 May (WRC)	
1994		ASMA- 21 Nov commercial season open- permittee limited to landing 5 fish per day and 18 in TL minimum size limit	
1994		ASMA- 23 Nov recreational season open- harvest days Wed, Sat and Sun- 3 fish per person, 18 in TL minimum size limit	
1994		ASMA- 7 Dec recreational season closed	
1994		ASMA- 21 Feb no gill nets set from 4:00 p.m. Friday until sunrise Monday	
1994		ASMA- 14 Mar- 15 Apr no gill nets set from 4:00 p.m. on Friday until sunrise Monday, 16 Apr – 31 May all gill nets attended 7 days per week, except flounder nets Batchelor Bay/ Western Albemarle Sound closed	
1994		ASMA- 1 Jun- 28 Oct small mesh gill nets 1,000 yd limit attended unless set in water less than 7 ft	
1994		ASMA- 17 Oct- 18 Nov small mesh gill nets 1,000 yd limit- attended Batchelor Bay/ Western Albemarle Sound closed	
1994		ASMA- 18 Nov no gill nets set from 4:00 p.m. Friday until sunrise	

Year	Statewide	ASMA/RRMA	Central/Southern
		Monday, small mesh gill nets attended, 3,000 yd limit- flounder nets	
1995		ASMA- 16 Jan small mesh gill nets (3 and 3 ¼) limit 800 yds, drift gill net 2 ½- 3 ISM, no flounder nets	Portions (upper and 200 yds. off shore) of Pamlico and Pungo Rivers- 20 Mar gill nets less than 5 ISM attended at all times
1995		ASMA- 1 Mar recreational season open	Portions (upper and 200 yds. off shore) of Pamlico and Pungo rivers- 8 Dec attendance lifted for gill nets less than or equal to 3 ½ ISM in nets nearshore in lower rivers
1995		ASMA- 1 Mar commercial season open- permittee limited to landing 5 fish per day, 18 in TL minimum size limit	Pamlico Sound, Pamlico, Bay and Neuse rivers- 22 Nov commercial season open, 18 in TL minimum size limit, limited to landing 10 fish per day, permit required/ sale tags
1995		ASMA- 19 Mar recreational season closed	
1995		ASMA- 4 Apr commercial harvest- permittee limited to landing 2 fish per day (striped bass not to exceed 5% of total weight of catch), 18 in TL minimum size limit, commercial season close 14 Apr; Mesh size and yardage restrictions on gill nets, area closure	
1995		ASMA- 22 Nov commercial season open, 18 in TL minimum	

Year	Statewide	ASMA/RRMA	Central/Southern
		size limit, limited to landing 2 fish per day, harvest permit required and sale tags	
1995		ASMA- 22 Nov recreational season open, harvest days Wed, Sat and Sun, 21 in TL minimum size limit, 2 fish per day	
1995		ASMA- 24 Dec recreational season closed	
1995		ASMA- 26 Dec commercial season closed	
1995		RRMA- 1 Mar, hook and line season opened, possession limited to Wed, Sat, and Sun, 9 Apr, lower river closed, 14 Apr, upper river closed	
1996		ASMA- 16 Feb commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day (not to exceed 25% by weight of total catch), permit required and sale tags, season close 15 Apr	Cape Fear River- 29 Jan commercial season open, 18 in TL minimum size limit, limited to landing 10 fish per day, permit required and sale tags, season close 30 Apr
1996		ASMA- 16 Mar recreational season open- harvest days Wed, Sat and Sun, 18 in TL minimum size limit, 3 fish per person per day	Upper portions of Pamlico, Pungo, Bay, Neuse and Trent Rivers- gill nets less than 5 ISM must be attended at all times
1996		ASMA- 31 Mar recreational season closed	Pamlico Sound, Pamlico, Pungo, Bay and Neuse rivers- 29 Feb commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, permit required and sale tags
1996		ASMA- 8 Apr	Pamlico Sound, Pamlico ,

Year	Statewide	ASMA/RRMA	Central/Southern
		commercial season, 18 in TL minimum size limit, limited to landing 3 fish per day (not to exceed 15% by weight of the total catch)	Pungo, Bay and Neuse rivers- 12 Dec commercial season open, 18 in TL size limit, limited to landing 5 fish per day (not to exceed 25% by weight of total catch), harvest permits , season close 31 Dec
1996		ASMA- 30 Nov commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day (not to exceed 25% by weight of total catch, permit required and sale tags	
1996		ASMA- 22 Dec recreational season closed	
1996		ASMA- 23 Dec commercial 18 in TL minimum size limit, limited to landing 10 fish per day (not to exceed 25% by weight of total catch), close 31 Dec	
1996		RRMA- 16 Mar, hook and line season opened, possession limited to Wed, Sat, and Sun, 10 Apr, lower river closed	
1996		RRMA- effective 1 Jul, single barbless hook rule enacted for Roanoke River, 1 Apr- 30 Jun, Roanoke River, 1 Apr- 30 June, Roanoke Rapids Lake Dam downstream to US Hwy 258 bridge (WRC)	
1997		ASMA- 15 Feb commercial season open, 18 in TL minimum	Cape Fear River- 13 Jan commercial season open, 18 in TL minimum size

Year	Statewide	ASMA/RRMA	Central/Southern
		size limit, limited to landing 3 fish per day (not to exceed 25% by weight of total catch	limit, limited to landing 10 fish per day, season close 30 Apr
1997		ASMA- 15 Mar recreational season open, 18 in TL minimum size limit, 3 fish per day, harvest days- Wed, Sat and Sun	Pamlico Sound, Pamlico, Pungo, Bay and Neuse rivers and Carteret County- 15 Feb commercial season open, 18 in TL minimum size limit, limited to landing 3 fish per day (not to exceed 25% by weight of total catch)
1997		ASMA- 23 Mar recreational season closed	Pamlico Sound, Pamlico, Pungo, Bay and Neuse rivers and Carteret County- 22 Mar commercial season closed
1997		ASMA- 24 Mar commercial, 18 in TL minimum size limit, limited to landing 7 fish per day (not to exceed 40% by weight of total catch), permit and sale tags required, season closed 15 Apr	Pamlico Sound, Pamlico, Pungo, Bay, Neuse, White Oak and all Internal Waters of Carteret County- 3 Nov commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, permit and sale tags required
1997		ASMA- 15 Nov recreational season open, 21 in TL minimum size limit, 2 fish per day, harvest days- Wed, Sat and Sun, season close 31 Dec	Pamlico Sound, Pamlico, Pungo, Bay, Neuse, White Oak and all Internal Waters of Carteret County- 19 Nov commercial season closed
1997		ASMA- 3 Nov commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day (not to exceed 50% by weight of total catch), permit required and sale tags	Portions of Pamlico, Pungo, Neuse and Trent Rivers- 24 Jan attendance required for gill nets less than or equal to 5 ISM, except gill nets less than or equal to 3 ½ ISM in nearshore (less than 200 yds from shore) in lower rivers
1997		ASMA- 5 Dec commercial season	

Year	Statewide	ASMA/RRMA	Central/Southern
		closed	
1997		RRMA- 15 Mar, hook and line season opened, possession limited to Wed, Sat, and Sun, 23 Mar, lower river closed, 2 Apr, upper river closed, upper river reopened 19 Apr for a 6 hour season to use remaining allowable harvest	
1998		ASMA- TAC commercial 125,440 lb., recreational 62,720 lb., RRMA- TAC recreational 62,720 lb.	Cape Fear River- 8 Jan commercial season open, 18 in TL minimum size limit, limited to landing 10 fish per day, permit and sale tags required, season close 30 Apr
1998		ASMA- 16 Feb commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required	Pamlico Sound, Coastal Rivers, Bays and Tributaries and Internal Waters of Carteret County- 16 Feb commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required
1998		ASMA- 14 Mar recreational season open, 18 in TL minimum size limit, 3 fish per day, harvest days- Wed, Sat and Sun	All Internal Coastal Waters- Carteret, Craven, Beaufort and Pamlico Counties and Pamlico and Pungo rivers- 1 Dec commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required, close 31 Dec
1998		ASMA- 8 Apr commercial season closed	Portions of upper Pamlico, Pungo, Neuse and Trent Rivers- 1 Dec through 30 Apr attendance requires for gill nets less than 5 ISM and within 200 yds. of

Year	Statewide	ASMA/RRMA	Central/Southern
			shore
1998		ASMA- 22 Apr recreational season closed	
1998		ASMA- 28 Oct recreational season open, 18 in TL minimum size limit, 2 fish per day, harvest days- Wed, Sat and Sun, season close 30 Dec	
1998		ASMA- 1 Dec commercial season open, 18 in TL minimum size limit, limited to landing 10 fish per day, dealer permit and sale tags required, season close 31 Dec	
1998		RRMA- 14 Mar, hook and line season opened, possession limited to Wed, Sat, and Sun, 12 Apr, lower river closed, 29 Apr, upper river closed	
1999	Internal Coastal and Joint Waters- 6 Nov recreational season open, 18 in TL minimum size limit, 3 fish per person per day	ASMA- TAC commercial 137,984 lbs., recreational 68,992 lbs., RRMA- TAC recreational 68,992 lbs.	Cape Fear River- Internal, Joint and Coastal Waters- 8 Jan commercial season open, minimum size limit 18 in TL, limited to landing 10 fish per day, dealer permit and sale tags required, season close 30 Apr
1999	All Primary Nursery Areas (PNAs) and Secondary Nursery Area (SNAs), no trawl areas (Outer Banks areas modified) and within 200 yds. of shore- 1 May through 31 Oct gill nets less than 5 ISM must be	ASMA- 1 Jan recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Wed, Sat and Sun, season close 16 Mar	All Internal Coastal Waters of Carteret, Craven, Beaufort, and Pamlico Counties, Pamlico and Pungo Rivers and Pamlico Sound- 9 Feb commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags

Year	Statewide	ASMA/RRMA	Central/Southern
	attended each year		required
1999		ASMA- 9 Feb commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit required and sale tags, season close 28 Mar	All Internal Coastal Waters of Carteret, Craven, Beaufort and Pamlico Counties, Pamlico and Pungo rivers and Pamlico Sound- 5 Apr commercial season closed
1999		ASMA-29 Mar commercial 18 in TL minimum size limit, limited to landing 10 fish per day, dealer permit and sale tags required, season closed 15 Apr	Upper Pamlico, Pungo and Neuse Rivers- 1 May gill nets less than 5 ISM must be attended at all times (year round)
1999		ASMA- 2 Apr recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Fri, Sat, Sun and Mon, season close 5 Apr	All Internal Coastal Waters Carteret, Craven, Beaufort and Pamlico Counties, Pamlico, Pungo and White Oak rivers- 1 Dec commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required, season close 31 Dec
1999		ASMA- 6 Nov recreational season open, 18 in TL min size limit, 2 fish per person per day, harvest days- Wed, Sat and Sun, season close 29 Dec	
1999		ASMA- 1 Dec commercial season open, 18 in TL minimum size limit, limited to landing 10 fish per day, dealer permit and sale tags required, season close 12 Dec	

Year	Statewide	ASMA/RRMA	Central/Southern
1999		ASMA- 13 Dec commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required, season close 31 Dec	
1999		RRMA- 13 Mar, hook and line season opened, possession limited to Wed, Sat and Sun, 7 Apr, lower river closed, 28 Apr, upper river closed	
2000	Effective 1 Jul, no striped bass 22 to 27 in TL may be possessed in the Inland Waters of Tar and Neuse river, 1 Apr-31 May	ASMA- TAC commercial 225,000 lbs., recreational 112,500 lbs., RRMA- TAC recreational 112,500 lbs.	
2000		ASMA- 1 Jan recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Wed, Fri, Sat and Sun, season close 26 Apr	Cape Fear River- 8 Jan commercial season open, 18 in TL minimum size limit, 1imited to landing 10 fish per day, dealer permit and sale tags required, season close 30 Apr
2000		ASMA- 7 Jan commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required, season close 26 Mar	Internal Coastal Waters Carteret, Craven, Beaufort and Pamlico Counties, Pungo and White Oak Rivers and Pamlico Sound- 11 Feb commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required
2000		ASMA- 27 Mar commercial, 18 in TL minimum size limit, limited to landing 10 fish per day, dealer permit and sale tags required, season close 15 Apr	Pamlico Sound- Internal Coastal Waters- 9 Mar commercial season closed

Year	Statewide	ASMA/RRMA	Central/Southern
2000		ASMA- 11 Oct recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Wed, Fri, Sat and Sun, season close 12 Nov	Internal Coastal Waters Carteret, Craven, Beaufort, and Pamlico Counties, Pungo and White Oak Rivers- 24 Mar commercial season closed
2000		ASMA- 13 Nov commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required, season close 31 Dec	Internal Coastal Waters Carteret, Craven, Beaufort, and Pamlico Counties, Pungo and White Oak Rivers- 13 Nov commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required
2000		ASMA- 15 Nov recreational season open, 18 in TL minimum size limit, 1 fish per person per day, harvest days- Wed, Fri, Sat and Sun, season close 3 Dec	Internal Coastal Waters Carteret, Craven, Beaufort, and Pamlico Counties, Pungo and White Oak Rivers- 28 Nov commercial season closed
2000		RRMA- 15 Mar, hook and line season opened, possession limited to Tue, Wed, Sat and Sun, 12 Apr lower river closed, 30 Apr upper river closed	
2001		ASMA- 5 Jan commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required, season closed 25 Mar	Cape Fear River- 8 Jan commercial season open, 18in TL minimum size limit, limited to landing 10 fish per day, dealer permit and sale tags required, season close 30 Apr
2001		ASMA- 17 Jan recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Wed, Fri, Sat and	Internal Coastal Waters Carteret, Craven, Beaufort and Pamlico Counties, Pungo and White Oak Rivers and Pamlico Sound- 12 Feb commercial

Year	Statewide	ASMA/RRMA	Central/Southern
		Sun, season close 18 Apr	season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required
2001		ASMA- 26 Mar commercial season open, 18 in TL minimum size limit, limited to landing 10 fish per day, dealer permit and sale tags required, season close 15 Apr	Pamlico Sound- Internal Coastal Waters- 2 Mar commercial season closed
2001		ASMA- 17 Oct recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Wed, Fri, Sat and Sun, season closed 25 Nov	Internal Coastal Waters Carteret, Craven, Beaufort, and Pamlico Counties, Pungo and White Oak Rivers- 14 Mar commercial season closed
2001		ASMA- 19 Nov commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required, season closed 21 Dec	Internal Coastal Waters Carteret, Craven, Beaufort, and Pamlico Counties, Pungo and White Oak Rivers- 3 Dec commercial season open, 18 in TL minimum size e limit, limited to landing 5 fish per day, dealer permit and sale tags required
2001		RRMA- 13 Mar hook and line season opened, possession limited to Tue, Wed, Sat and Sun, 22 Apr lower river closed, 29 Apr upper river closed	Internal Coastal Waters Carteret, Craven, Beaufort, and Pamlico Counties, Pungo and White Oak Rivers- 14 Dec commercial season closed
2002		ASMA- 7 Jan commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day (not to exceed 50% by	Cape Fear River- 7 Jan commercial season open, 18 in TL minimum size limit, limited to landing 10 fish per day, dealer permit and sale tags required,

Year	Statewide	ASMA/RRMA	Central/Southern
		weight of the total catch), dealer permit and sale tags required, season closed 15 Apr	season close 30 Apr
2002		ASMA- 7 Jan small mesh gill nets not to exceed 800 yds, 5 ¼ ISM and larger flounder nets limited to 3,000 yds, 5 ¼ ISM and larger shad (float) nets limited to 1,000 yds (18 Feb- 14 Apr), western Albemarle Sound area closed to gill nets	Internal Coastal Waters Carteret, Craven, Beaufort and Pamlico Counties, Pungo and White Oak Rivers and Pamlico Sound- 25 Feb commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required, season closed 16 Mar
2002		ASMA- 16 Jan recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Wed, Fri, Sat and Sun, season closed 14 Apr	Internal Coastal Waters Carteret, Craven, Beaufort and Pamlico Counties, Pungo and White Oak Rivers- 2 Dec commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required, season closed 13 Dec
2002		RRMA- hook and line season set by WRC regulations, lower river open 1 Mar- 15 Apr, upper river open 15 Mar- 30 Apr, creel limit reduced to 2 fish/day, possession allowed 7 days/week, protective 22- 27 in TL slot limit extended to include the entire open harvest season	
2002		ASMA- 4 Nov commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required, season closed 20 Dec	
2002		ASMA- 6 Nov	

Year	Statewide	ASMA/RRMA	Central/Southern
		recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Wed, Fri, Sat and Sun, season closed 29 Dec	
2003		ASMA- 6 Jan commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required, season to close15 Apr, unless closed earlier by proclamation	Cape Fear River- 9 Jan commercial season open, 18 in TL minimum size limit, limited to landing 10 fish per day, dealer permit and sale tags required, season closes 30 Apr
2003		ASMA- 15 Jan recreational season open, 18 in TL min size limit, 2 fish per person per day, harvest days- Wed, Fri, Sat and Sun, season will closed 23 Apr, re-open 25 Apr and closed 30 Apr, 18 in TL minimum size limit, 2 fish per person, harvest days- Wed, Fri, Sat and Sun	Internal Coastal Waters Carteret, Craven, Beaufort and Pamlico Counties, Pungo and White Oak Rivers and Pamlico Sound- 3 Mar commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required, season closed 31 Mar
2003		RRMA- hook and line season set by WRC regulations, lower river open 1 Mar- 15 Apr, upper river open 15 Mar- 30 Apr, creel limit reduced to 2 fish/day, possession allowed 7 days/week, protective 22- 27 in TL slot limit extended to include the entire open harvest season, only 1 of the 2	

Year	Statewide	ASMA/RRMA	Central/Southern
		fish daily creel limit may be greater than 27 in TL	
2004		ASMA – 5 Jan – Apr 6 – commercial season open, 18 in TL min. size, limited to 5 fish per day, dealer permit and sale tags required; No fall season,	
2004		ASMA- 14 Jan – 30 Apr recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Wed, Fri, Sat and Sun; 11 Oct – Dec 1 recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Wed, Fri, Sat and Sun;	
2004		RRMA- hook and line season set by WRC regulations, lower river open 1 Mar- 15 Apr, upper river open 15 Mar- 30 Apr, creel limit reduced to 2 fish/day, possession allowed 7 days/week, protective 22- 27 in TL slot limit extended to include the entire open harvest	
2005		ASMA – 3 Jan – Mar 30 – commercial season open, 18 in TL min. size, limited to 5 or 10 fish per day, dealer	

Year	Statewide	ASMA/RRMA	Central/Southern
		permit and sale tags required; 3 Oct – Nov 30 – commercial season open, 18 in TL min. size, limited to 5 or 10 fish per day, dealer permit and sale tags required;	
2005		ASMA- 5 Jan – 3 Apr recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest 7 days per week; 1Oct – Dec 31 recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest 7 days per week,	
2005		RRMA- hook and line season set by WRC regulations, lower river open 1 Mar- 27 Apr, upper river open 15 Mar- 4 May, creel limit reduced to 2 fish/day, possession allowed 7 days/week, protective 22- 27 in TL slot limit extended to include the entire open harvest,	
2006		ASMA – 1 Jan – 30 Apr – commercial season open, 18 in TL min. size, limited to 5 or 10 fish per day, dealer permit and sale tags required; 1 Oct – Nov 30 – commercial season open, 18 in TL min. size, limited to 10 fish per day, dealer permit and sale tags required	
2006		ASMA- 1 Jan – 30 Apr recreational season open, 18 in TL minimum size limit, 2 fish per	

Year	Statewide	ASMA/RRMA	Central/Southern
		person per day, harvest 7 days per week; 1 Oct – Dec 31 recreational season open, 18 in TL minimum size limit, 3 fish per person per day, harvest 7 days per week,	
2006		RRMA- hook and line season set by WRC regulations, lower river open 1 Mar- 22 Apr, upper river open 15 Mar- 30 Apr, creel limit 2 fish/day, possession allowed 7 days/week, protective 22- 27 in TL slot limit extended to include the entire open harvest,	
2007		ASMA – 1 Jan – 30 Apr – commercial season open, 18 in TL min. size, limited to 5 or 10 fish per day, dealer permit and sale tags required; 1 Oct – Nov 30 – commercial season open, 18 in TL min. size, limited to 10 fish per day, dealer permit and sale tags required,	
2007		ASMA- 1 Jan – 6 May recreational season open, 18 in TL minimum size limit, 3 fish per person per day, harvest 7 days per week; 1 Oct – Dec 31 recreational season open, 18 in TL minimum size limit, 3 fish per person per day, harvest 7 days per week,	
2007		RRMA- hook and line season set by WRC regulations, entire river season 1 Mar- 6 May, creel limit 2 fish/day,	

Year	Statewide	ASMA/RRMA	Central/Southern
		possession allowed 7 days/week, protective 22- 27 in TL slot limit extended to include the entire open harvest,	
2008		ASMA – 1 Jan – 30 Apr – commercial season open, 18 in TL min. size, limited to 5 or 15 fish per day, dealer permit and sale tags required; 1 Oct – Nov 30 – commercial season open, 18 in TL min. size, limited to 10 fish per day, dealer permit and sale tags required,	
2008		ASMA – 1 Jan – 30 Apr – commercial season open, 18 in TL min. size, limited to 5 or 15 fish per day, dealer permit and sale tags required; 1 Oct – Nov 30 – commercial season open, 18 in TL min. size, limited to 10 fish per day, dealer permit and sale tags required,	
2008		ASMA- 1 Jan – 6 May recreational season open, 18 in TL minimum size limit, 3 fish per person per day, harvest 7 days per week; 1 Oct – Dec 31 recreational season open, 18 in TL minimum size limit, 3 fish per person per day, harvest 7 days per week,	
2008		ASMA – 1 Jan – 30 Apr – commercial season open, 18 in TL min. size, limited to 5 or 15 fish per day, dealer permit and sale tags	

Year	Statewide	ASMA/RRMA	Central/Southern
		required; 1 Oct – Nov 30 – commercial season open, 18 in TL min. size, limited to 10 fish per day, dealer permit and sale tags required,	

14.6 STOCK STATUS OF ALBEMARLE SOUND-ROANOKE RIVER STRIPED BASS

Stock Status

of

Albemarle Sound-Roanoke River

Striped Bass

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March 2010

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INTRODUCTION

Striped bass (*Morone saxatilis*) are an important anadromous species that have multiple stocks along the Atlantic coast. The most important of these stocks in North Carolina is the Albemarle Sound/Roanoke River (A/R) stock. The A/R stock has an extensive assessment history. Gibson (1995) prepared the first comprehensive assessment of the A/R striped bass stock based on a CAGEAN (Deriso et al. 1985) Virtual Population Analysis (VPA) and a Brownie tag return model analysis (Brownie et al 1985). Schaaf (1997) later provided CAGEAN-based VPA results through 1996 based on the methodology established in Gibson (1995). Smith (1996) used the MARK software program to estimate survival of striped bass in Albemarle Sound through analysis of release and recovery data. Carmichael (1998) updated the CAGEAN assessment through 1997 and later developed an ADAPT VPA assessment of the A/R stock using age-specific indices from the Albemarle Sound gill net surveys, the Roanoke River spawning stock electrofishing survey, and juvenile and yearling abundance indices from Albemarle Sound (Carmichael 1999). The 1999 assessment also included an analysis of tag return data based on the MARK program. The ADAPT catch-age and MARK tag return assessment framework was updated in 2000 (Carmichael 2000). Analysis of tag return data for estimation of mortality was discontinued after 2000 as the results were deemed similar to those from the VPA and was duplicative work, with subsequent assessments addressing the catch-at-age data. The VPA stock assessment was conducted annually until 2006 to determine stock status and to evaluate potential changes to the total allowable catch (TAC) (Carmichael 2001, 2002, 2003; Grist 2004, 2005; Takade 2006). The previous stock assessments have determined that the stock was not overfished and overfishing was not occurring.

This assessment model is significantly different compared to the assessments in the past. This stock assessment was conducted using the Age Structured Assessment Program (ASAP2) instead of the VPA. For the last years of the VPA striped bass stock assessment, the results had considerable retrospective pattern that limited their use for management. This stock assessment covers the years 1982-2008. The ASAP2 model is a forward projecting statistical catch-at-age model and estimates various parameters at the earliest year and youngest age and then performs calculations going forward in time and to older ages. A major advantage of the ASAP2 model over the VPA was that the VPA assumed that the catch-at-age was estimated without error, which was unlikely as it was not possible to observe the exact age of every fish harvested or discarded. The previous model and benchmarks for the A/R stock were documented in Amendment 6 to the Atlantic States Marine Fisheries Commission (ASMFC) Atlantic Striped Bass Fishery Management Plan (FMP). The ASAP2 assessment will be used by the North Carolina Division of Marine Fisheries (NCDMF) and North Carolina Wildlife Resources Commission (NCWRC) to evaluate the status of the A/R striped bass stock. It will also be used by the North Carolina Marine Fisheries Commission (NCMFC) and Striped Bass Advisory Committee to update the North Carolina Estuarine Striped Bass Fishery Management Plan (FMP).

GENERAL LIFE HISTORY

Striped bass spawn in freshwater or nearly freshwater portions of North Carolina’s coastal rivers from late March to June depending upon water temperatures (Hill et al. 1989). Peak spawning activity occurs when water temperatures reach 62.0° – 67.0° F (16.7° – 19.4° C) on the Roanoke River (Rulifson 1990 and 1991), 66.2° F (19.0° C) on the Cape Fear (Sholar 1977; Fischer 1980), 68.0° – 70.7° F (20.0° – 21.5° C) on the Neuse (Hawkins 1979; Baker

1968), and 64.0° – 69.0° F (18.0° – 22.0° C) in the Tar River (Kornegay and Humphries 1975). Spawning behavior was characterized by brief peaks of surface activity when a mature female is surrounded by up to 50 males as eggs are broadcast into the surrounding water, and males release sperm (Setzler et al. 1980). Spawning by a given female is probably completed within a few hours (Lewis and Bonner 1966).

The larval development of striped bass is dependent upon water temperature and is usually regarded as having three stages: 1) yolk-sac larvae are 0.20 to 0.31 inch (5 – 8 mm) in total length (TL) and depend on yolk material as an energy source for 7 to 14 days; 2) fin-fold larvae (0.31 – 0.47 inch; 8 – 12 mm TL) having fully developed mouth parts and persist about 10 to 13 days; and 3) post fin-fold larvae attain lengths up to 1.18 inches (30 mm) in 20 to 30 days (Hill et al. 1989). Researchers of North Carolina stocks of striped bass (primarily Albemarle-Roanoke) divide larval development into yolk-sac and 5 days post-hatch; the survival rate is reduced as time to first feeding increases. This can become critical, because the nursery grounds where primary food sources occur are considerable distances downstream (especially the Albemarle-Roanoke stock). Larvae are totally dependent upon river flows for transport and timing of arrival to the nursery grounds where feeding is initiated. Most striped bass enter the juvenile stage at about 1.18 inches (30 mm) TL; the fins are then fully formed, and the external morphology of the young is similar to that of the adults. Juveniles are often found in schools and prefer clean sandy bottoms (Hill et al. 1989). They may spend their first two years of life maturing in and around the nursery area (Hassler et al. 1981).

Studies from 1938 through the 1990s indicate that only a small portion of striped bass spawned in the A/R system migrates out of the system to offshore waters (North Carolina Striped Bass Study Management Board 1992). Since the A/R stock has recovered and expanded, an increasing number of tag returns indicate that larger A/R striped bass are migrating to the Atlantic Ocean and to northern coastal waters. This increase in distant tag returns likely reflects an increase in survival of larger individuals and the inability of these individuals to tolerate the high summertime water temperatures of Albemarle Sound. In order to spawn successfully, striped bass require waters with suitable flows, salinities, temperatures, and other aspects of habitat quality, which make the species particularly vulnerable to river flow alterations (Rulifson et al. 1982).

REGULATIONS AND MANAGEMENT JURISDICTION

Striped bass from the A/R stock are harvested commercially within the Albemarle Sound Management Area (ASMA) and recreationally in both the Roanoke River Management Area (RRMA) and the ASMA. Commercial harvest is currently limited to the ASMA although there was a small commercial fishery operating in the Roanoke River during the first five years covered by this assessment. The commercial fishery is regulated as a bycatch fishery with a total allowable catch (TAC), size limits, daily possession limits, seasonal and gear restrictions, net attendance requirements, and permitting and reporting requirements all imposed to prevent TAC overages and limit discard losses. The recreational fishery within the RRMA is regulated through a creel limit, minimum size limit including a protective slot, and a fixed length spring season, while the ASMA fishery is regulated through a creel limit, minimum size, and variable spring and fall seasons that close once harvest targets are reached or set season closure dates are reached. The current TAC for the A/R system is 550,000 lb, split evenly between the commercial and recreational sectors, with 275,000 lb allocated to ASMA commercial fisheries, 137,500 lb allocated to ASMA recreational fisheries, and 137,500 lb allocated to RRMA recreational fisheries (Table 1). Total catch (harvest and discards) in all fisheries from 1991 to

2004 has generally tracked with the TAC increases (Figure1). The regulation changes for the ASMA and RRMA are fully listed in Appendix 3.

The A/R striped bass stock is managed by the NCDMF, the NCWRC, and the South Atlantic Fisheries Coordination Office (SAFCO) of the US Fish and Wildlife Service (USFWS) under guidelines established in the ASMFC Interstate Fishery Management Plan (FMP) for Atlantic Striped Bass and the North Carolina Estuarine Striped Bass FMP. The current management regime is specified in Amendment 6 to the ASMFC FMP (ASMFC 2003). The NCDMF and NCWRC developed an annual North Carolina striped bass management program in cooperation with the USFWS SAFCO that determines seasons, possession limits, and size limits for the ASMA and the RRMA fisheries. The ASMA includes Albemarle Sound and all its joint and inland water tributaries, (except for the Roanoke, Middle, Eastmost, and Cashie rivers), Currituck Sound, Roanoke, and Croatan sounds and all of their joint and inland water tributaries, including Oregon Inlet, north of a line from Roanoke Marshes Point to the north point of Eagle Nest Bay. The RRMA includes the Roanoke River and its joint and inland water tributaries, including Middle, Eastmost, and Cashie rivers, up to the Roanoke Rapids Dam (NCDMF 2004).

The NCDMF and NCWRC were obligated under the ASMFC Striped Bass FMP to perform specific monitoring and assessment activities and to achieve specific management targets. Monitoring requirements include evaluating spawner and juvenile abundance, collecting commercial and recreational catch statistics, and collecting biological data to characterize the catch. Results of these activities were summarized in an annual report to the ASMFC (NCDMF 2009). Striped bass management targets were based on specific fishing mortality, or F rates. The current fishing mortality limit is 0.27 as specified in Amendment 6 to the ASMFC Striped Bass FMP (ASMFC 2003). The target fishing mortality, as recommended by the 2004 North Carolina Estuarine Striped Bass FMP for the A/R Stock, is 0.22 based on an $SPR_{20\%}$ (NCDMF 2004).

COMMERCIAL FISHERY DESCRIPTION

Striped bass are landed commercially in the ASMA primarily with anchored gill nets, followed by pound nets. Insignificant landings occur in fyke nets and crab pots. Catch (harvest and discards) in the commercial fishery since 1982 has ranged from 97,061 lb in 1989 to 477,343 lb in 1984 (Table 2). Since the stock was declared recovered in 1997, catch has ranged from 183,103 lb in 2008 to 428,669 lb in 2003. Catch in the commercial fishery has shown an overall decline since 2004 (Figure 2). This decline in catch was due to combined declines in harvest and discard estimates in the anchored gill net fishery from 2004 to 2007 (Table 2).

Commercial harvest since 1991 has been limited by TACs, and rose steadily in conjunction with TAC increases from 95,671 lb in 1997 to the peak in 2004 of 273,666 lb (Tables 1 and 2). This peak in harvest occurred after the last TAC increased in 2003 to the current commercial TAC of 275,000 lb. Since the peak in 2004, harvest declined to 156,314 lb in 2006, rose to 173,509 lb in 2007, and fell again to 74,926 lb in 2008 (Figure 3).

The maximum age observed in the 2008 harvest was 16, although the majority (78.9%) was composed of ages 4 through 6 (Table 3, Figure 4). The majority (96.3%) of commercial discards in 2008 were comprised of ages 2 and 3 (Table 3). Harvest and discard distributions for 2008 by fisheries are shown in Figure 5.

RECREATIONAL FISHERY DESCRIPTION

Striped bass are landed recreationally in the ASMA and RRMA through hook and line, primarily by trolling artificial lures and live or cut bait. In recent years, the catch and release fly fishery in the RRMA has seen an increase in angler effort. Combined recreational catch from both management areas has ranged from 13,095 lb in 1985 to 290,868 lb in 2004 (Table 2). Since 1997, catch steadily increased from 111,516 lb to a peak in 2004. Since 2004, catch has been in an overall decline (Figure 2). The majority of the catch in 2008 (90.6%) was comprised of ages 2–5, while ages 3 and younger accounted for 64.8% of discards (Table 3).

Since 1991, recreational harvest in the ASMA and RRMA has been limited by TACs, and rose steadily from 55,653 lb in 1997 to the peak in 2000 at 235,747 lb. Harvest remained above 200,000 lbs through 2002. Harvest dropped to 90,964 lbs in 2003 due in part to flood conditions during the Roanoke River spring fishery and Hurricane Isabel during the ASMA fall fishery. Harvest in 2004 was 219,100 lbs and has since steadily declined to 64,353 lb in 2008. The maximum age observed in the 2008 harvest was 13, although the majority of the harvest (75.8%) was comprised of ages 3 and 4 (Table 3, Figure 4). Harvest and discard distributions for 2008 by fishery are shown in Figure 5.

Recreational use of commercial gear (i.e. gill nets, crab pots, trawls) is allowed on a limited basis through the NCDMF Recreational Commercial Gear License (RCGL). However, all recreational size limits, daily creel limits, and seasons must be adhered to. Harvest in this fishery is minimal as estimated through mail surveys to RCGL holders (Table 4). Due to budget cuts funding for the mail in survey was discontinued in 2007.

ASSESSMENT DATA

FISHERY DEPENDENT DATA

Commercial Data

North Carolina commercial landings data have been collected through the North Carolina Trip Ticket Program (NCTTP) since 1994. Between 1978 and 1993, landings information was gathered through the National Marine Fisheries Service (NMFS)/North Carolina Cooperative Statistics program. Reporting was voluntary during this period, with North Carolina and NMFS port agents sampling the state’s major dealers (Lupton and Phalen 1996). Since 1994, the reporting of commercial landings has been mandatory. For further information on the sampling methodology for the NCTTP, see Lupton and Phalen (1996). Commercial landings data for the ASMA fishery were collected through daily dealer reports and the NCTTP. The commercial fishery was sampled to determine size, age, and sex composition of the harvest; these data were used to convert commercial pounds into commercial catches at age (Table 5). Numbers of fish per year class were assigned using the following formula:

$$YC_N = L_T \text{ x } WTSYC_{S\%} / WTSYC_{SAVG}$$

where YC_N is the number of individuals per year class, L_T is total landings, $WTSYC_{S\%}$ is the sample percent weight per sex, per year class, and $WTSYC_{SAVG}$ is the sample average weight per individual, per sex, per year class. Commercial landings in the RRMA during the early

1980s averaged several thousand fish (Table 6); there has been no commercial fishery within the Roanoke River since 1986.

NCDMF personnel have a target of 600 samples from the spring fishery and 300 samples from the fall fishery. Fish were sampled monthly from various fish houses throughout the ASMA, throughout each season. Fish were measured to the nearest mm for fork length (FL) and TL and weighed to the nearest 0.01 kg. Sex was determined using the Sykes (1957) method and scales were removed from the left side of the fish, above the lateral line and between the posterior of the first dorsal fin and the insertion of the second dorsal fin. Scales were cleaned and pressed on acetate sheets using a Carver heated hydraulic press. NCDMF employees read scales using a microfiche reader set on 24x or 33x magnification. For each sex, a minimum of 15 scales per 25 mm size class was read and subsequently used to assign ages to the remainder of the sample. Age and year class were assigned according to conventions developed by the ASMFC Striped Bass Scientific and Statistical Committee.

Recreational Data

In the fall of 2005 the NCDMF changed the design of its ASMA striped bass creel survey to more accurately reflect fishing pressure and harvest estimates. This new design was the same design as used by NCDMF personnel for striped bass creel surveys in the Central/Southern District, and NCWRC personnel for striped bass creel surveys in the RRMA, allowing for a more statistically valid comparison of effort and harvest data between the various management areas.

Catch and effort data were collected through on-site interviews at boat ramps during allowed harvest days for each of four ASMA sampling zones (Figure 6). Statistics were calculated through a non-uniform probability access-point creel survey (Pollock et al. 1994). Site probabilities were set in proportion to the likely use of a site according to time of day, day of week, and season. Probabilities for this survey were assigned based on seasonal striped bass fishing pressure observed during past surveys, in addition to anecdotal information (personal communication, NCDMF, Sara Winslow and Kathy Rawls). Probabilities can be adjusted during the survey period according to angler counts to provide more accurate estimates. Morning and afternoon periods were assigned unequal probabilities of conducting interviews, with each period representing half a fishing day. A fishing day was defined as one and a half hours after sunrise until one hour after sunset. These values varied among sites within zones due to differing fishing pressure.

Striped bass sampled during the surveys were measured for TL (mm) and weighed to the nearest 0.1 kg. No scales were collected for ageing purposes. Estimations of age composition were based on age-length keys generated from the Independent Gill Net Survey (IGNS) and commercial harvest samples (Table 7).

The NCWRC conducts an annual spring creel survey on the Roanoke River to determine striped bass harvest and discard rates, collect length and weight samples from the fishery, and monitor effort (Table 8). Recreational statistics are calculated through the use of a non-uniform probability stratified access-point creel survey design (Pollock et al. 1994). The most recent data included within this assessment was collected in the RRMA to estimate recreational fishing effort, harvest of striped bass and other species, and numbers of striped bass caught and released from the RRMA for the period 1 March – 24 May 2008.

The survey was stratified by area (zone), time (period), and kind of day (weekdays and weekend days). The upper zone (1) included the river segment from Roanoke Rapids Lake Dam downstream to the U.S. Highway 258 Bridge near Scotland Neck (Figure 7). The lower zone (2) extended from U.S. Highway 258 Bridge downstream to Albemarle Sound. Because past experience has shown differential catch rates through progression of the open harvest season, the survey was stratified into 2-week sample periods. Within periods, fishing effort and catch was also known to vary as a function of day type so samples and estimates were further stratified by kind of day. Selection of access points where interviews occurred was based upon probability of use data generated from prior creel surveys on Roanoke River. Probability of fishing activity for time of day (0.4 for AM and 0.6 for PM during periods one and two, and equal probabilities during all other periods) was estimated based upon prior experience with the Roanoke River striped bass fishery.

During 2008, the striped bass harvest season extended from 1 March to 30 April in the entire river. Three-hour interview sessions were held on two weekdays and both weekend days each week in each zone when the striped bass harvest season was open. Creel clerks interviewed anglers as they completed fishing trips at boating access areas. Data collected from each fishing party interviewed included date and time of the interview, hours fished, number of anglers in the party, harvest of striped bass, hickory shad (*Alosa mediocris*), largemouth bass (*Micropterus salmoides*), and other species, number of striped bass released, bait use, and the county of residence of the anglers. Creel samples were also conducted in the upper zone from 1 May to 24 May to estimate angling effort and the numbers of striped bass caught and released once the fishery was closed to harvest. Recreational catches were assigned to sex and length classes based on creel survey samples and ages were assigned based on an age-length key developed from the spawning stock assessment.

Estimates of striped bass catch and effort for each sample day were made by expanding interview data by the sample unit probability (product of the access point probability and time of day probability) (Pollock et al. 1994). Within sample periods, catch and effort estimates for weekdays and weekend days were separately averaged. The averages were then expanded to the total number of days of each type for that sample period. Separate estimates of catch and effort were made for each zone.

Discard Estimates

Bycatch losses for the ASMA commercial gill net fisheries were estimated by determining: total gill net trips by gill net category, average yards per trip per gill net category, striped bass catch rates, and striped bass at-net mortality rates.

Total number of commercial gill net trips by gill net category was determined using the NCTTP. Each time fish were sold to a licensed seafood dealer in North Carolina, a trip ticket was completed. Each trip ticket included the weight in pounds for each species sold, the gear types used (e.g., trawl, gill net, pound net, etc.), and the area fished. While the total number of gill net trips was easily obtained, assumptions were required to determine the mesh size/sizes used in each trip. Three trip categories were established: 1) flounder, 2) American shad, and 3) other/small mesh. Predominant mesh sizes were then determined for each category. Based on at-sea observer coverage and gill net mesh regulations, the predominate mesh size used in the white perch (*Morone americana*) fishery is the 3.25 inch stretched mesh (ISM), while 5.5 ISM is used in the flounder (*Paralichthys spp.*) and American shad (*Alosa sapidissima*) fisheries. Assuming that size selectivity of 3.25 ISM nets would not result in substantial catches of flounder or American shad, and that flounder and American shad trips could be categorized based on catch characteristics, each trip was examined for species composition and assigned to one of the three designated categories based on the primary species landed. If flounder composition was greater than or equal to 10.0% and American shad composition was less than flounder, then the target trip was equal to a flounder trip. If shad composition was greater than flounder composition or American shad pounds were equal or greater than 30 lb, then the target trip was equal to a shad trip. Otherwise, the trip was equal to other/small mesh.

This procedure worked well when estimating the number of flounder trips, largely because regulations require setting gill nets during the flounder season so as to fish on the bottom and not to exceed a vertical height of 48 in. This gear configuration has very little bycatch associated with it in the ASMA, and usually other gill net types are not fished simultaneously with the flounder gill nets, so the trip would not be lost to another category. This is not the case when estimates of trips were made for the American shad and the other/small mesh category. These fisheries occur simultaneously during the American shad net season (1 January – 14 April) and fishermen typically employ both American shad nets and small mesh nets in a single trip. Although both American shad nets (5.5 ISM in the ASMA) and small mesh (3.25 ISM in the majority of the ASMA) gill nets were likely used in any given trip, trips were counted as either American shad or other/small mesh trips depending on the catch composition. This method of categorizing trips based on species composition had a direct effect on the distribution of discards between the shad and other/small mesh trip categories.

The NCTTP does not gather information about the number of yards fished during gill net trips. If there is not sufficient observer coverage available in a year to determine average yards per trip per category, then the maximum allowed yardage is used in the calculation. Likewise, if there is not enough observer coverage in a given year to determine catch rates per gill net category, then catch rates from the NCDMF Independent Gill Net Survey (IGNS) are used. Mortality rate (at-net mortality; delayed mortality is not estimated) information is derived from multiple sources. The DMF imposes mandatory net attendance for all small mesh gill net trips in the ASMA during the summer months due to the strong positive correlation between striped bass discard mortality and increased water temperature. Therefore, data collected through Fishery Resource Grants (FRG) researching striped bass discard mortality rates for attended gill nets in the ASMA was used in the bycatch analysis for striped bass losses in the other/small mesh nets during the months of May through October. For the remainder of the year, if adequate observer coverage is not available, mortality rates from the IGNS are used.

For any given category, once the number of trips, yards per trip, striped bass catch rates (# striped bass per yard of gill net), and striped bass at net mortality rates were determined; striped bass bycatch losses were calculated using the following formula:

$$B^{L} = [\, T^{\#} \times Y^{\#} \times B^{stb} \times M \,] - H$$

where B^{L} = bycatch losses, $T^{\#}$ = total number of gill net trips, $Y^{\#}$ = yards per trip, B^{stb} = bycatch of striped bass per yard of gill net, M = discard mortality, and H = harvest.

Discards by mesh size (large vs. other/small) were proportioned into year classes based on the composition of year classes in the 3.0 and 3.5 ISM and the 5.5 ISM nets respectively from the IGNS. The pounds were then converted into numbers based on mean weight at age for a particular year class.

Commercial discards peaked in 1995 and have generally declined since that time, averaging 63,246 fish and 161,660 lb from 1994 to 2002. The 2005 discard estimates of 19,075 fish at a weight of 45,394 lb was the lowest number of striped bass discarded and second lowest discarded by weight (Tables 2 and 9) and were based on striped bass catch rates from observer trips. The lowest discard by weight occurred in 2007, and was likely the result of a large number of discarded age-1 fish (Table 9). The 2005 cohort accounted for 47.5% of the estimated discards in 2007. Discard estimates for 2008 increased to 108,177 lb due in part to strong 2005 & 2006 cohorts

Data available since 1991 from the Roanoke River creel survey allowed for estimation of recreational discards both during the open season and after the season closes. However, 2000 and 2001 estimates of discards after the season were based on sampling from previous years because post-season monitoring was discontinued; similarly, no post-season discard estimate was included for 2004. Length and age distributions of the discarded fish were determined from the spawning stock assessment survey. The mortality rate for fish discarded in the Roanoke River was assumed to be 6.4% based on findings within the system reported by Nelson (1998). Total discards averaged around 4,000 fish with no noticeable trend from 1991 to 1995 and then increased sharply in 1996 and 1997. Discards averaged around 12,000 fish from 1996 to 2001, then dropped sharply to 3,570 fish in 2002 and again to 2,449 fish in 2003 (Table 10). In 2004, recreational discards increased to 18,391 fish, the highest in the series before declining in 2005 to 10,090 fish (Table 10). From 2005 to the terminal year of 2008, discards increased slightly to an estimate of 12,137 fish.

Discards from the ASMA recreational fishery were available for 2000 to 2008 through the creel survey, with estimates available for the spring and fall open seasons but not during the closed seasons. Discard losses were based on the same release mortality of 6.4% used for the Roanoke River estimates (Nelson 1998) (Table 11). Seasonal discard losses were allocated into age categories based on angler responses obtained from the creel survey. Discards were apportioned into three length categories: undersized, over the creel, or legal. There were no length estimates for undersized discards, so the age was apportioned as the age distribution of 17 in TL fish observed in the IGNS, as the minimum size limit is 18 in TL. For the other two categories, lengths were assigned based on the distribution of fish measured during the survey. An age length key obtained from the IGNS was then applied. The ASMA recreational discards have declined from a series high of 5,047 fish in 2000 to 605 fish in 2006. The 2008 recreational discard of 2,366 fish was comprised mainly of fish from the 2005 year class (Table 11). Discards from RCGL holders were only available for 2004. Of the 35 striped bass discarded from RCGL gear, all were 2 to 6 year old fish (Table 12).

Fishery-specific harvest and discard losses at age were summed to produce a total catch at age matrix for the A/R striped bass stock (Table 13). Total harvest in numbers of fish reached a series high in 2000 of 195,467 fish and declined by about 11.5% to 174,827 fish in 2001, and 17.4% in 2003 to 161,427 fish. The 2006 and 2007 harvest and discard estimates were much lower than recent years, with the 2008 estimates of harvest and discard increasing to a total of 126,356 fish (Table 13).

Weight-at-age

Catch weights at age were calculated from annual mean weights at age for each sampled fishery component (commercial landings, NCWRC spawning ground survey for the Roanoke River recreational fishery, NCDMF independent gill net survey, and Albemarle Sound recreational fishery). To account for stratification of age and weight sampling, fishery weights-at-age were mean-weighted by the total length sample. Fishery specific weights at age were then weighted by the percent contribution of each fishery to the total catch at age by year and age to derive a composite stock catch weight at age (Table 14). Weight-at-age for 1982 – 1990 was based solely on NCDMF commercial samples as none of the other programs existed at that time. Starting in 1991 mean weight at age was collected from NCDMF commercial fishery sampling and NCDMF Independent Gill Net Survey. In 1997 weights from the electrofishing spawning ground survey were added to yearly collections. Where necessary, missing values at age were replaced first with other available fishery component data, and secondly with the average of the observed values for that age two years prior and after the missing data point. The Striped Bass Plan Development Team felt that there were sufficient weights-at-age from fish house sampling, the IGNS, and the spawning grounds survey to estimate the weight-at-age directly rather than estimating the relationship through a von Bertalanffy equation.

FISHERY INDEPENDENT DATA

Juvenile Abundance Monitoring

Trawl sampling was conducted bi-weekly for eight weeks starting in mid-July at seven established locations in the western Albemarle Sound area. Sampling gear was a semi-balloon trawl with a 5.5 m (18 ft) head rope, constructed of 38.1 mm (1.5 in) stretched mesh webbing in the body and 12.7 mm (0.5 in) in the cod end. Tow times were 15 minutes in the western sound, at a speed of approximately 2.4 knots. Sampling has been conducted at the same seven stations in the western sound since 1955.

Trawl sites were located at the edge of breaks and contours, usually within the 2.4 m – 3.7 m (8 ft – 12 ft) depth profile, but can be as shallow as 1.2 m (4 ft) and deep as 4.9 m (16 ft). Most trawls sites were located within 1,000 m (3,281 ft) of shore. These habitat types are a preferred nursery habitat for striped bass YOY in the Albemarle Sound as they increase in size and move from the near-shore nursery areas to more open water habitats. All striped bass captured were counted and a sub sample (maximum of 30) was measured (mm; TL and FL) (Figures 8 and 9; Table 15).

Albemarle Sound Fishery Independent Gill Net Survey

The NCDMF monitored the adult striped bass population in Albemarle Sound through spring (March – May) and fall (November – February) with fishery-independent gill net surveys and collected data on size, age, sex, and abundance (Table 16 and 17). The NCDMF IGNS is a stratified, random, multiple mesh gill net survey which began in 1990 to monitor the A/R striped bass population. The use of 12 different mesh sizes allowed for the capture of fish age one and older. Albemarle Sound, Croatan Sound, and Alligator River sample zones (Zones II–VII) were selected for this survey, based on previous sampling and historical abundance information (Street and Johnson 1977; Figure 10). Six sample zones were divided into one-mile square quadrants with an average of 22 quadrants per zone. Zones and quadrants were randomly selected to reduce bias. All zones were sampled equally, except in the spring when effort was shifted to Zone II. Eight foot deep nets were deployed end to end, perpendicular to the shore forming a line, with a navigational fairway located between every third net. In quadrants that contained both shoal and deep water areas, the nets were set in each area to assure a more complete assessment of the seasonal utilization of different habitat types and portions of the water column. Replicate nets were fished at different depths so that comparisons could be made between net type and manner fished. The fishing year was divided into two segments: (1) fall/winter survey period, 1 November through 28 February; and (2) spring survey period, 1

March through late May. The sampling methods remained the same during each sampling season. Areas fished, sampling frequency, and sampling effort was altered seasonally.

For the fall/winter segment, two survey crews fished replicate 40-yard anchored, floating, and sinking monofilament gill nets from 2.5 to 4.0 inch stretched mesh (ISM) in one-half inch increments with a twine size of 0.33 mm (#104), 5.0 to 7.0 ISM with a twine size of 0.40 mm (#139) and 8.0 ISM and 10.0 ISM, with a twine size of 0.57 mm (#277). Heavier twine sizes in the larger mesh nets were intended to improve retention of larger, heavier fish. Gill nets were constructed with a hanging coefficient of 0.50. Each crew sampled each of the six zones, providing 24 fishing days per month and a total of 96 fishing days for the season. A fishing day was defined as one crew, fishing the full complement of nets specified, for that segment, for one day (24 hours). Gear soak time was 48 hours for each selected quadrant. Each 40-yard net, fished for 24 hours, was considered to be one unit of effort. Monthly effort for all mesh sizes was equal, except when nets were damaged, hampered by debris in rough weather, or not set due to inclement weather. Separate lines of floating and sinking gill nets of each mesh/twine size were employed to assess use of different water depths and to achieve coverage of the water column. Nets were separated within the quadrants to eliminate interference caused by one line fishing too close to another.

In the spring segment, gill net effort was concentrated in western Albemarle Sound (Zone II) near the mouth of the Roanoke River (Figure 11). The shift to Zone II was designed to increase the chance of intercepting mature striped bass congregated in this area during their migration to the Roanoke River spawning grounds. Effort was concentrated in this zone to determine differences in the size, age, and sex composition of the spring spawning migration relative to the fall/winter resident population. Zone II was sub-divided into southern and northern areas (Figure 11). The southern area, adjacent to the Roanoke River, received increased effort at a 2:1 ratio south to north, based on the historical seasonal abundance of mature striped bass (Harriss et al. 1985). Quadrants sampled were randomly selected as previously noted. Fishing effort was conducted continuously, seven days a week, until the end of late May.

During both the fall/winter segment and spring segment, healthy striped bass that survived entanglement were tagged with internal anchor tags and then measured to the nearest mm for FL and TL. Scales were removed from the left side of the fish, above the lateral line and between the posterior of the first dorsal fin and the insertion of the second dorsal fin. When possible, sex was determined by applying directional pressure to the abdomen towards the vent and observing the presence of milt or eggs.

For both the fall/winter and spring segment, fish that did not survive entanglement were processed at the NCDMF laboratory. Fish were measured to the nearest mm for FL and TL and weighed to the nearest 0.01 kg. Sex was determined by visual inspection and scales were removed as previously described. Scales were cleaned and pressed on acetate sheets using a Carver heated hydraulic press. Scales were read using a microfiche reader set on 24x or 33x magnification. For each sex, a minimum of 15 scales per 25 mm size class was read and subsequently used to assign ages to the remainder of the sample.

Spawning Stock Assessment

The NCWRC electrofishing survey on the Roanoke River spawning grounds began in 1991 to meet the ASMFC FMP requirements to monitor spawning stock abundance (Table 18). Information on sex, age, and size composition of the spawning stock was also provided.

NCWRC personnel collected striped bass weekly between mid-April and May, from the Roanoke River near Weldon, North Carolina. A boat-mounted electrofishing unit (Smith-Root 7.5 GPP) was used (1 dip netter) to capture fish during daylight hours. Sampling began as the water temperature approached 15.0° C (59.0° F) and ended when striped bass spawning was complete; optimum spawning temperatures range from 18.0° to 22.0° C (64.4° to 71.6° F) for striped bass in the Roanoke River. Electrofishing was conducted in the vicinity of Roanoke Rapids, river mile (RM) 137, and Weldon (RM 130), the historical spawning area for Roanoke River striped bass. Sample stations which were accessible on most river levels and represented various main river channel and secondary channel habitats (strata) were established. Sampling was conducted at stations randomly selected within strata. To minimize size selection during sampling, striped bass were picked up as they were encountered regardless of size. Actual electrofishing time (seconds) was recorded for each sample station. Relative abundance of striped bass for each sample was indexed by CPUE and expressed as number of fish captured per hour (fish/h). Water temperature (°C) was recorded each sample day.

Sex was determined for each captured fish by applying directional pressure to the abdomen toward the vent and observing the presence of milt or eggs. Each fish was measured to the nearest mm for TL and weighed (kg). Scales were removed from a subsample of fish (target maximum of 5 fish of each 25-mm size group and sex per sample day), from the left side of the fish, above the lateral line and between the posterior of the first dorsal fin and the insertion of the second dorsal fin.

Scales were analyzed at 33x magnification on a microfiche reader and annuli were counted and ages assigned. Proportions of each age group within each 25-mm size group were computed and expanded to the total number of fish within each size group. Mean lengths at age were calculated from lengths of aged fish only.

LIFE HISTORY PARAMETERS

Natural Mortality

The natural mortality rate (M) was assumed to be the same as that used in the coastal assessment, (M = 0.15) estimated by Hoenig (1983). This M was assumed for all ages. The workgroup decided to maintain the age-constant M to be consistent with the M assumptions made by the coastwide Atlantic striped bass stock assessment.

Maturation, Fecundity, and Maturity Schedule

Information on rates of maturation and fecundity are unavailable for coastal North Carolina stocks except the A/R stock. Research conducted on this stock indicates that females begin reaching sexual maturity in approximately 3 years, at sizes of 22-24 inches TL (Olsen and Rulifson 1992, Trent and Hassler 1968). Specifically, about 45% of the Roanoke females have reached sexual maturity by age 3; however, the viability of the eggs and resultant contribution of the progeny to the forming year class is unknown (Olsen and Rulifson 1992). Previous investigators determined the age at first maturity to be age 3 for male and age 4 for females (Trent and Hassler 1968; Harris and Burns 1983; Harris et al. 1984). In general, there is a strong positive correlation between the length, weight, and age of a female striped bass and the number of eggs it produces. All Roanoke River females are mature by age 6, and a curvilinear relationship exists between the fish age and the number of eggs produced, with greatest increase between age 6 and age 10. Potential fecundity estimates range from approximately 181,000 eggs for age 3 to 5,000,000 eggs for age 16 (Olsen and Rulifson 1992). Lewis (1962) noted that some females in the Roanoke River, age seven and older, did not spawn annually.

The female maturation schedule incorporated was that of Olsen and Rulifson (1992), based on sampling in the Roanoke River and Albemarle Sound during 1989 and 1990. The percent of individuals that were mature was 0% at age 0 – 2, 48% at age 3, 94% at age 4, 95% at age 5, and 100% at age 6+.

Growth Pattern/Rates

Growth rates for the A/R stock are rapid during the first three years of life, and then decrease to a relatively slow rate as the fish reaches sexual maturity. Striped bass grow approximately 270 mm during their 1st year, 150 mm during their 2nd year, 70 mm during their 3rd year, and 40-20 mm yearly thereafter (Olsen and Rulifson 1991). Mean lengths at age from large samples of Roanoke River striped bass sampled on the spawning grounds indicate female striped bass grow faster than males. Growth rates for young-of-year striped bass ranged from 0.272 mm per day to 0.664 per day determined from a 20-year time series during 1955-1978 (Hassler et al. 1981). Statistically significant differences were found in these yearly growth rates. Additional analyses indicated positive correlation with young-of-year growth rates and river discharge. Hassler speculated that increased river discharge transports greater amount of organic detritus to the estuary, which results in high productivity and faster growth rates for young-of-year striped bass.

METHODS

ASAP2 MODEL

The model selected to estimate mortality and abundance was a forward projecting statistical catch at age model called the Age Structured Assessment Program or ASAP2 (NOAA Fisheries Toolbox 2008a). The forward calculation method used for ASAP2 does not require the catch at age to be calculated without error. This means that the model will not attempt to fit the catch at age values perfectly. This is an advantage because the catch-at-age cannot be directly observed and the estimated catch-at-age, while based on sound sampling, should not be assumed to be the exact ages removed through the catch. This version of ASAP also allows the flexibility to use different selectivity curves for various gears and when regulatory changes cause shifts within the fishery. Model parameters were estimated in phases, which allow parameters to be estimated in smaller batches rather than all at once. Catchability in the first year, the annual fully selected fishing mortality (F_{mult}) in the first year, and unexploited stock size was estimated in phase one. The F_{mult} is an estimated parameter that is the basis for all other fishing mortality (F) calculations. Phase two estimated the abundance in numbers (N) in the first year, and phase three estimated F_{mult} deviations. Phase four estimated recruitment deviations and phase five estimated the stock recruitment steepness. Equations related to the ASAP2 model can be found in the technical documentation bundled with the model, as well as the AD Model Builder code (NOAA Fisheries Toolbox 2008a). Tuning followed the methods suggested in the User Manual, where the goal is to reduce the root mean squared error to fall inside the confidence bounds for the samples size's N(0,1) distribution, with tuning coefficients of variation (CV) listed in Table 19, with the root mean squared error listed in Table 20 (NOAA Fisheries Toolbox 2008c). Low CV values indicate a tighter fit than higher CV values. Along with the model estimates of F, model results were used to calculate exploitation, which is the estimated harvest or catch divided by the population estimate. Exploitation was calculated for the total catch (harvest and discard of all fisheries) and for the individual fishery harvest.

The model was configured using four catch at age matrices: 1) the commercial Albemarle Sound fishery, 2) the recreational fishery for Albemarle Sound only, 3) the recreational fishery for the Roanoke River only, and 4) the brief Roanoke River commercial fishery (1982-1986). There were three additional discard at age matrices that were related to the catch at age matrices for each of the fisheries (Table 21).

The index selection process occurred in steps. The striped bass data workgroup met to determine which surveys were appropriate for indices and how best to calculate those indices. The fishery independent indices were calculated at the individual age level and only those ages considered to be fully selected to the survey gear or fully available in the system were included. All fishery independent indices were both sexes combined.

The selectivity was partially calculated by the striped bass data workgroup using the available fishery data. These calculations determined the fully-selected ages for all fisheries and periods. This stock assessment used the by-age calculation method in the ASAP2 model. The selectivity periods were chosen to cover the different fisheries, and changed over time to reflect the changes in the fishery regulation. The four fisheries were the Albemarle Sound commercial fishery, the Albemarle Sound recreational fishery, the Roanoke River recreational fishery, and the brief Roanoke River commercial fishery (Table 22). Typically, fishery selectivity curves are asymptotic in shape. Different curve shapes can be used to describe the fishery. However, the Albemarle Sound and Roanoke River systems have been extensively managed, including restrictions on permissible gill net mesh sizes and minimum size limits for the commercial fishery, and minimum and slot limits for the recreational fisheries. For the Albemarle Sound striped bass fisheries, the data work group recognized that the fishery has focused on a handful of age classes, primarily age 4 – 6. The focus on ages 4 – 6 is primarily the result of regulations restricting minimum size limits and mesh sizes to the size ranges of fish ages 4 – 6. In recent years, the commercial and Roanoke River recreational fishery have been managed to reduce or eliminate fishing pressure on older, larger fish. For this stock assessment, the fully-selected ages were age-4 for the Albemarle Sound commercial fishery, age-5 for the Albemarle Sound recreational fishery, age-4 for the Roanoke River recreational fishery, and age-4 for the Roanoke River commercial fishery. The remaining ages were determined by the ASAP2 model and apply to the entire time period for that fishery. Selectivity modifications were primarily the result of minimum size limit changes in the commercial and recreational fisheries (NCDMF 2005).

YIELD-PER-RECRUIT

Yield-per-recruit (YPR) and biomass-per-recruit (BPR) models, as configured in the NOAA Fisheries Toolbox, were used to determine F and spawning stock biomass (SSB) thresholds (NOAA Fisheries Toolbox 2008b). The ASAP2 model does calculate F benchmarks internally, but cautioned that those benchmarks were not reliable if there have been changes in selectivity over time or between fisheries. The selectivity used in the YPR was an average of the selectivities in the terminal year, which was calculated by dividing the sum of the directed F by the maximum F of the vector. Several different benchmarks were calculated to determine the most appropriate for management. The benchmarks were $F_{25\%}$, $F_{30\%}$, $F_{35\%}$, $F_{40\%}$, and $F_{45\%}$ and their associated spawning stock biomass (SSB). The associated SSB values were calculated by taking the calculated SSB per recruit value and multiplying it by the ASAP2 estimated average recruitment for the last seven years. The stock does have a spawner-recruit relationship, however the fit appeared poor at higher SSB levels where the observed recruitment was below the predicted line. The data workgroup determined that empirical data should be used for future estimates of recruitment, which precludes calculating maximum sustainable yield (MSY) and similar benchmarks.

ASSESSMENT ASSUMPTIONS

The ASAP2 model and other forward projection models have several inherent assumptions. As mentioned previously, this forward-projecting model does not assume that the catch at age matrices were determined without error. Forward projecting models tune to the catch at age matrix and the incorporated indices. Indices were assumed to reflect the actual population abundance. Influences on abundance measurements (e.g. regulation changes in a dependent index) beyond natural and usual fishing removals must be considered in the analysis. Since the model was projecting forward, the beginning of the time series was the most uncertain. This model also requires assumptions about the level of fit with most of the input data, leading to large numbers of estimated output parameters. These parameters include catchability in the first year, F_{mult} in the first year, unexploited stock size, numbers of fish (N) in the first year, F_{mult} deviations, recruitment deviations, and the stock recruitment steepness. Another assumption was that the catch at age matrices from the various surveys provided a more precise measurement of the actual catch at age than the discard at age matrices. In general, the indices were assumed to be less precise than the catch at age because the catch at age was an estimate of absolute catch while the indices were proportional to but not absolute estimates of population abundance. Average F over ages 4 to 6 was chosen for determination of stock status values as those ages encompass fish that were likely to be fully selected to most gear types. These were also the ages that were fully vulnerable to harvest given the regulation changes and restrictions across all the fisheries. The A/R stock was assumed to be closed, meaning that migration in and out of the stock was limited.

RESULTS

ABUNDANCE

Total abundance showed an increasing trend for most of the time series (Figure 12 and Table 23). Total abundance peaked in 2007 at 2,051,000 fish. Prior to 1994, the total abundance was less than one million fish, while every year since 1994 the total abundance has been greater than one million fish. The age-9+ fish have increased significantly, beginning in 1997 (Table 23). The terminal year age-9+ abundance was estimated to be 258,000 fish, which was a significant increase from the 1982 age-9+ abundance of 15,000 fish.

RECRUITMENT

Recruitment (age-1 fish) was below the estimated time series average (312,111 fish) for the first eight years of the stock assessment (Figure 13 and age-1 of Table 23). In contrast, only three of the last eight years were below the time series average for age-1 fish. Recruitment estimated for the terminal year (2008) was 202,000 fish. Peak recruitment of 618,000 fish occurred in 2006, and the minimum recruitment (45,000 fish) during the time series occurred in 1988 (Figure 13 and Table 22). It should be noted that the recruitment values can be subject to retrospective bias and may not be accurate reflections of recruitment size for several years.

FISHING MORTALITY AND EXPLOITATION

The overall trend of fishing mortality (F) was a recent decline from the earliest part of the time series. The average F on ages 4-6 peaked once in 1984 at 1.01 (Figure 14 and Table 24). After 1988, there was a decline in F to one of the lowest in the time series in 1995 at 0.13. The F then began to slowly increase and hit a plateau from 2000 through 2004. Since 2004, the F has decreased from 0.34 to 0.10, the lowest in the time series. The directed F for the different fisheries show that F was highest in 1984 and 1985 for the commercial fishery and decreased after that, remaining low and relatively stable since 1990 as evidenced by examining the peak F for each year (Figure 15). The F for the Albemarle Sound recreational fishery experienced a large decline from 1991 to 1992, then was highest in 2004 and has remained fairly low since then (Figure 15). The Albemarle Sound recreational F was less than the commercial F throughout the time series. The F was highest for the Roanoke River recreational fishery in 1988, with all other estimates of F much lower than the 1988 value (Figure 15). The Albemarle Sound commercial fishery consistently had the highest directed F of all the fisheries. All F rates with the exception of the average F for age 4 – 6 are unweighted, while the average F is weighted by the numbers of fish at age in the population.

Exploitation is the proportion of the striped bass stock that is caught over the course of the year. The overall striped bass exploitation rates have decreased from a high in 1984 of 0.36 to the terminal year exploitation rate of 0.07 (Table 24). The exploitation rate declined sharply from 1988 to 1989, going from 0.33 to 0.12. Since 1989, the overall exploitation rate has remained below 0.12, the lowest exploitation rate estimate prior to 1990. Of the four fisheries that have occurred on the A/R striped bass stock, the ASMA commercial fishery has consistently had the highest exploitation rates (Tables 25 – 28). Because of this, the ASMA commercial fishery exploitation pattern has been similar to that of the overall exploitation rates (Tables 25 and 26). The remaining fisheries did not experience an exploitation rate higher than 0.08 (Tables 26 – 28).

SPAWNING STOCK BIOMASS (SSB)

Spawning stock biomass has been increasing since 1991. In 1991, the estimated SSB was 267,377 lb, with the highest SSB occurring in the terminal year at 3,998,921 lb (Figure 16 and Table 30). Between 1991 and 2008, there have been consistent gains in SSB. The lowest SSB occurred in 1985 at 244,823 lb.

STOCK-RECRUIT RELATIONSHIP

The ASAP2 model attempted to estimate a stock-recruitment relationship based on the data available. The current stock-recruit relationship was fit to a Beverton-Holt stock-recruitment relationship, with an estimated alpha of 1567.58, a beta of 1972.09, and steepness of 0.70 (Figure 17). However, the observed recruitment values at SSB levels greater than 1,000,000 lb, were much lower than those predicted by the stock-recruitment relationship. The data workgroup determined that the estimated stock-recruit relationship would not be appropriate for estimating benchmarks or conducting projections. For investigative purposes, a Ricker stock-recruit relationship was fit and that method appeared to have a better fit at the higher biomass levels than the Beverton-Holt method (Figure 18). Initial runs to determine reference points using the Ricker model were not successful and further research into the stock recruitment relationship is recommended.

STOCK STATUS DETERMINATION

Fisheries Reform Act Criteria

According to the North Carolina Fisheries Reform Act (FRA), population status is determined by the stock's ability to achieve sustainable harvest. Such an approach reflects stock biomass, and is typically used to determine whether a stock is overfished. A stock is also evaluated based on the rate of removals, e.g. the F rate, which determines whether overfishing is occurring. The NCMFC also has a policy of only considering management measures that have at least a 50% probability of achieving sustainable harvest.

YPR and Biological Reference Points

With the lack of any significant stock-recruitment relationship, it was not possible to generate traditional MSY benchmarks. Benchmarks require a stock-recruitment relationship. It was possible to use spawning potential ratio (SPR) as a proxy, which estimates a proportion of the spawning population remaining relative to the spawning population of an unfished stock with a maximum age of 30. The unfished stock calculation was based on M, overall fishery selectivity, weight at age, maturity, and average recruitment. Changes between stock assessments, like the recalculation of the weight at age matrix or changes in the estimated average recruitment will result in estimating different levels of unfished SSB. Levels of SPR ranging from 20% to 50% have been found to be appropriate for different stocks and life histories. Some historical examinations of SPR showed increasing risk of recruitment overfishing at levels smaller than 30% (Walters and Martell 2004).

Based on the range of possible reference fishing mortality rates from $F_{25\%}$ to $F_{45\%}$, $F_{0.1}$ and F_{Max} an F threshold for this stock was determined to be between F=0.75 and F=0.25 (Figure 14 and Table 31). Estimated fishing mortality has been at or below all overfishing levels since 2005 (Figure 14). Since 1991, the fishing mortality rate has only been above the $F_{40\%}$ three times and has not been above the $F_{30\%}$ (Figure 14). Based on the reference SSB levels associated with the range of fishing mortality thresholds from $F_{25\%}$ to $F_{40\%}$, the estimated threshold spawning stock biomass was between 1,045,749 lb and 4,174,055 lb (Figure 16 and Table 31). The estimated SSB also has a very wide standard deviation range, more than 1.6 million lb range in the terminal year. The SSB has been estimated to be above the $SSB_{25\%}$

since 1999 and above the $SSB_{40\%}$ since 2005, suggesting that the A/R stock is not currently overfished (Figure 16). The estimated SSB has not been above the $SSB_{45\%}$ during the time series, though the +1 standard deviation did go above that benchmark in 2005. However, the -1 standard deviation has not been above the $SSB_{35\%}$ during the most recent period. The difference was considerable, as one standard deviation could be the difference between the stock being above the target or currently have overfishing occurring. As the stock likely does not have overfishing is not occurring, but the considerable variation makes it difficult to determine if the stock is not overfished. It should be noted that there was considerable uncertainty in the recent SSB years (Figure 16).

MEASURES OF PRECISION AND RETROSPECTIVE ANALYSIS

A variety of procedures were available to evaluate model fit, including the different fishery residuals, the observed versus predicted plots for the catch-at-ages and indices, bootstrap estimates of precision and bias, and retrospective patterns. The fit of the observed indices to the model predicted indices was examined. The residuals for all four fishery catches show no pattern (Figures 19-22). The Albemarle Sound commercial fishery catch-at-age fits were best earlier in the time series and there were both over and underestimation at age throughout the time series (Figure 23). The Albemarle Sound recreational fishery catch-at-age fits were in general not as good as the fits of the commercial fishery and had both over and underestimation (Figure 24). The Roanoke River recreational fishery catch-at-age had better fits than the either Albemarle Sound fishery (Figure 25). The Roanoke River commercial fishery has the shortest catch-at-age and also had the best fitting of the catch-at-ages (Figure 26). The best index fits were with the fall Albemarle Sound IGNS for ages 4 and 5 and the Roanoke River spawning survey ages 3 and 4 (Figures 27 – 29). In general, those indices with good fits did so at higher CV levels than those used for the final model. Other indices were not well fit by the model. The age-0 index was not well fit, given the multiple high peaks that were not predicted by the model (Figure 30). The age-1 index had a better fit, though the high values from 1994 to 1997 were not predicted (Figure 30).

The Monte Carlo Markov Chain (MCMC) method examined the normality of the estimates generated by the model, using 500 iterations and a thinning rate of 200. The F MCMC curves all appeared to be more normal in shape, except for the last few years when the curves appear to be slightly skewed (Figure 31). The SSB estimates were slightly skewed towards higher values in the curves and they do not have cumulative distribution inflection points that pass directly through the median (Figure 32). Ideal model fit would result in completely normal estimate distributions, which did not occur in this case, but this configuration of indices and weighting resulted in the closest normal behavior of the runs. The uncertainty in the terminal estimates of F and SSB and the benchmarks could not be investigated because the current model configuration does not have the capability to input benchmark values calculated externally from the model. In the future, this would be a useful diagnostic.

In the retrospective analysis, the current model configuration was applied to previous years, truncating the data series. The analysis looks at the consistency of the same parameter estimates as “new” data (in the form of successive years) were introduced (NRC 1998). When estimates were biased, there was a systematic increase or decrease in estimated values as data were truncated. Estimated F from 2004 to 2008 had relatively little retrospective bias, though the 2004 estimates were slightly higher than the other years of the analysis (Figure 33). Spawning stock biomass showed a retrospective pattern to overestimate SSB in 2006 and 2007 and underestimate SSB in 2004 and 2005 (Figure 34). Age-1 abundance was overestimated and underestimated without clear trend, but estimation of the terminal year tended to be poor (Figure 35). Retrospective biases for total abundance showed some trend to overestimate in the terminal year (Figure 36). The mix of overestimations and underestimations makes it unclear if the issue was completely systematic.

DISCUSSION

Based on outputs provided by the ASAP2 model, the Albemarle Sound/Roanoke River striped bass stock is currently not overfished and overfishing is not occurring. While the stock has continued to experience periodic overfishing during the time series, there have been improvements in the stock's condition. In 2008, F hit a time series low (Figure 14), and the SSB reached a time series high (Figure 16). The abundance of age-9+ fish has also increased significantly (Table 23) and the recent recruitment of age-1 fish has been generally above average (Figure 13). The sampled age structure on the spawning grounds and in the IGNS has continued to expand and currently includes fish up to age-17. There has also been consistent strong recruitment of two and three year old fish observed in the IGNS and spawning area electrofishing survey. Therefore, improvements have occurred in the stock since the beginning of the time series in 1982.

The SSB estimates from the ASAP2 model were much larger than the estimates from the previous VPA runs, which regularly estimated the converged SSB to be under 400,000 lb. There were several possible reasons that contributed to the significantly higher estimates. The first was the increase in weight at age by having a plus group starting at age-9 rather than age-8. The age-8+ weight at age used in the VPA stock assessments was closer to the currently estimated age-8 weight at age (Table 14). The higher age-9+ weight at age when compared to the old age-8+ weight will lead to higher estimated biomass at age for the age-9+ fish. Another factor was the notable increase in age-9+ fish in the population (Table 23). This kind of increase had not been seen in the previous results, so alternate runs were conducted to understand the reason for the increase, which appeared to be the relatively large increase of age-9+ fish and their combined weight (Appendix 1). Another potential reason for the increased age-9+ fish could be the result of the domed selectivity, which would require a large population at age to sustain the increased landings at such low selectivity. The workgroup felt that the base run remained the best run for management purposes. The reasons for the greatly increased catch of fish at age-9+ may need to be examined more closely. For all these reasons, the PDT felt it was not possible to determine SSB benchmarks.

The current data limitations include adult indices that do not cover the entire stock assessment time period, a maturity schedule that was estimated in 1982, limited observer coverage for estimating commercial discards, and the closed stock assumption. The lack of adult indices in early years means the model has limited information to calculate the striped bass abundance prior to 1991 (Tables 16 - 18). The limited observer coverage resulted in potentially inaccurate estimations of commercial discards. The estimates may be over or underestimations, but in years when no observer coverage was available the estimates do tend to be much higher than the annual discard estimates based on the observer coverage (Table 9). Any changes in the maturity at age could result in higher or lower estimates of SSB, depending on the changes to the maturity schedule. Potential changes to the maturity schedule could also change the SPR estimates, as maturity is one of the factors used to calculate the unfished spawning stock. Finally, the stock is assumed to be closed to all migration. If there is out migration involving the stock, particularly if fish leave the defined stock and spend extensive time outside of the ASMA, the model would include those fish within the estimate of overall fishing mortality. These limitations were also considered to understand the uncertainty of the stock assessment. The recommendation of the PDT was that the stock assessment should only be used for management with a full understanding of the limitations and with caution.

Overall landings have been down since 2004 and the fishery has consistently failed to reach the 550,000 lb TAC. Some of these decreases can be attributed to sources other than a declining stock. Delayed arrival of fish on the spawning grounds as a byproduct of cold water temperatures or extreme flow regimes has resulted in closure of the harvest season well before the TAC had been reached in the RRMA. The reason for the declines in the ASMA recreational fishery is currently unknown; however, the possibility remains that the inability to harvest the TAC could be the result of decreased abundance or availability and not the result of regulatory issues or fishing ability. Recent years have experienced unusual environment events and the overall JAI has been below average. In 2003, flow was high on the Roanoke River that were believed to have resulted in a poor cohort. In 2004, the Roanoke River experienced a rapid warming and the resulting cohort was also poor. The extent of environment impacts on cohort formation is a future research need.

In recent years, there has been considerable speculation and limited evidence of range expansion of the A/R striped bass stock. Of note are tag returns from fish as far north as Maine and returns from fish in the region of North Carolina’s Central/Southern striped bass stock. Approximately 9.5% of all tag returns for fish 28 in or larger were from outside the ASMA. Critical to future management is a better understanding of the contribution of large migratory fish from the A/R stock to other Atlantic coastal fisheries; striped bass that leave the A/R management area can be erroneously included within estimates of fishing mortality. This assessment allowed for domed selectivity in all fisheries in part to account for out migration and unavailability of a percentage of these larger fish. However, this technique could also underestimate the numbers of older fish ($\geq$ age 9) being caught within the A/R system.

Many of the indices did not exhibit good fits. One potential reason for poor fitting among indices are conflicting trends in the data. An example of this are the age-6 estimates for the IGNS fall/winter survey and the Roanoke River spring electrofishing survey (Figures 19 and 20). The fall/winter survey has peaks in 1996, 1997, 1999, 2004, and 2006. The Roanoke River electrofishing survey has its largest peaks in 1995 and 2002. Depending on the behavior of other survey information, the model may split the difference between conflicting data points, reducing the impact of high or low estimates. Indices are assumed to reflect the abundance of the stock, so indices exhibiting different trends may not be fully reflecting trends in overall stock abundance. The inability of the age-0 index to correlate with other independent survey data has also been problematic throughout the time series. Estimates of JAI are often not supported by similar strong or weak year classes observed in the IGNS or the spawning grounds surveys. It is possible that the conflicting indices may mask other sources of error in the stock assessment, like a systematic retrospective pattern.

This stock assessment does have conflicting signals that require discussion before the results should be used for management. The stock assessment results indicate that the A/R striped bass stock is not overfished and overfishing is not occurring (Figures 14 and 16). According to these results, the stock has been increasing steadily since 1989, with a recent slight decrease in overall abundance (Figure 12). There has also been an increase in the numbers of older fish in the commercial catch since 2002 and the population since 1997 (Tables 4 and 22). The independent indices have expanded to the maximum age of 17, determined through scale aging. These results indicate that the stock has undergone significant improvements.   The adult indices do not indicate as dramatic an increase in abundance. While some indices at age have an increasing trend over time, like the trend in the age-4 Roanoke River index, most of the indices lack a strong trend (Figures 27 – 29). The indices also do not show a decreasing trend. Through an examination of the adult indices, it would appear that the stock has been relatively constant since the inception of the independent collection programs in 1991. There has been a concerning trend in recent years concerning the catch, as the TAC has not been reached since 2004. A decrease in catch can be a sign of a decreasing availability to the fishery. The loss of availability could be the result of decreased abundance. In recent years, seasons have been extended in the ASMA to attempt to catch the TAC without success. The recruitment has also been below average in recent years, which can have long term implications for overall stock health. The current fishery targets fish primarily ages 4 to 6, while age-9+ have become a progressively larger part of the SSB. Therefore, the SSB is not a direct reflection of the fishable biomass. The age 4 to 6 fish have not increased dramatically in recent years. This difference is important when considering increases in TAC or other regulation changes. Given the conflicting signals from the stock assessment estimates and the raw data, it is recommended that the results be used with considerable caution.

The PDT examined several alternative configurations to determine the best fit. In particular, the PDT considered a model with constant fishery selectivity over time. This configuration was considered to determine if an equally or potentially better fitting model could occur with fewer parameters. The model results were similar, but the PDT felt it was preferable to maintain the model with multiple selectivity periods per fishery. The multiple selectivity periods per fishery would more closely reflect the changes in fishery regulations, while the single selectivity per fishery would average the changes in selectivity over time.

RESEARCH RECOMMENDATIONS

It is highly recommended that the following research recommendations be researched and addressed prior to the next benchmark stock assessment. The catch-at-age and weight-at-age estimates be confirmed in some manner. The aging methods should be validated, which may be accomplished through an exchange with other agencies. The JAI should be fully investigated for validation. Some of the modeling methods should be further investigated, including alternative stock-recruitment models and alternate ASAP2 configurations that may reduce the number of model parameters. Some input parameters, like M, should have likelihood profiles developed to better evaluate robustness.

Improve precision of weight measurements of age 1 and age 2 fish are needed. Very few fish of these ages appeared in the NCDMF sampling programs and resulted in high variability.

Improved estimates of discard losses from the ASMA commercial fishery are needed, including expanding the current observer program to include more traditional striped bass fishing areas. This program has already proven useful in estimating discard losses. Discard estimation from both the Roanoke River and Albemarle Sound recreational fisheries following season closures needs to be more adequately assessed.

Re-evaluate hook and release mortality rates from ASMA and RRMA recreational fisheries incorporating different hook types and angling methods at various water temperatures (e.g. live bait, artificial bait, and fly fishing).

As the stock increases in abundance, it is likely the range will increase within and beyond the Albemarle Sound Management Area. Substantial year-round fisheries are developing just beyond the bounds of the current management area. Because these fish are probably of Albemarle-Roanoke origin, failure to include them in the catch at age creates an unknown bias in the results. A special concern is the year-round harvest of large fish around Oregon Inlet. Although legally harvested at 2 fish per day year-round within the Atlantic Ocean regulatory boundaries, it is likely that larger, older A/R fish use the Oregon Inlet area as a summertime refuge. The NCDMF has established a Catch Card and Tagging requirement for the Atlantic Ocean recreational fishery during May – October. This is intended to provide a reliable estimate of harvest for this time period, however, lack of participation may be influencing the results.

Evaluate the stock definition in light of the current abundance and expanding age structure. Increased coastal migration is likely as the population, and especially the age structure, expands. The current stock definition is based on research conducted when the population was much smaller and much younger on average than it is now.

Re-examine striped bass maturity rates. The female maturity schedule, based on sampling during 1989 and 1990, indicated significant maturity of age 3 fish. Olsen and Rulifson (1992) note that their results increased maturity at age 3, from 5 – 15% in the early 1980's to over 40% in the late 1980s, and cited poor environmental conditions and fishing pressure among potential causes. Given changes in both environmental conditions and fishing pressure since the time of the study, it is possible that the maturity of younger fish has again shifted.

Re-evaluate delayed mortality rates in the gill net fisheries to generate improved estimates of commercial discard.

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Table 1. Changes in the total allowable catch in pounds for the ASMA/RRMA, NC 1991-2008.

	Total Allowable Catch		
Regulatory Period	ASMA Commercial	ASMA Recreational	RRMA Recreational
1991-1997	98,000	27,400	27,400
1998	125,000	62,720	62,720
1999	137,984	68,992	68,992
2000-2002	225,000	112,500	112,500
2003-2008	275,000	137,500	137,500

Table 2. Striped bass commercial and recreational harvest and discard in pounds from ASMA/RRMA, NC 1982-2008. River is the RRMA and Sound includes all other ASMA waters.

	Commercial			Recreational				Totals			
	Harvest	Harvest	Discard	Harvest	Harvest	Discard	Discard	(harvest + discard)		Grand	Harvest
Year	Sound	River	Sound	Sound	River	Sound	River	Commercial	Recreational	Total	Total
1982	228,004	17,369		24,098	23,693			245,373	47,791	293,164	293,164
1983	228,742	8,861		27,320	26,861			237,603	54,181	291,784	291,784
1984	475,640	1,703		17,181	16,892			477,343	34,073	511,416	511,416
1985	269,671	6,200		6,603	6,492			275,871	13,095	288,966	288,966
1986	172,683	50		18,755	18,440			172,733	37,195	209,928	209,928
1987	228,861			37,621	36,989			228,861	74,610	303,471	303,471
1988	108,791			52,434	74,639			108,791	127,073	235,864	235,864
1989	97,061			26,857	32,107			97,061	58,964	156,025	156,025
1990	103,757			36,976	42,204			103,757	79,180	182,937	182,937
1991	108,460			30,021	72,529		17,048	108,460	119,598	228,058	211,010
1992	100,544			51,167	36,016		4,370	100,544	91,553	192,097	187,727
1993	109,475			54,835	45,146		11,546	109,475	111,527	221,002	209,456
1994	102,201		151,811	39,704	28,084		12,613	254,012	80,401	334,413	169,989
1995	89,502		348,256	30,564	28,884		14,540	437,758	73,988	511,746	148,950
1996	89,624		200,429	29,185	28,173		36,634	290,053	93,992	384,045	146,982
1997	95,671		120,840	26,724	28,929		55,863	216,511	111,516	328,027	151,324
1998	122,454		135,856	64,885	73,527		21,150	258,310	159,562	417,872	260,866
1999	155,176		139,043	60,897	72,966		31,512	294,219	165,375	459,594	289,039
2000	218,888		137,997	116,163	119,584	11,951	33,811	356,885	281,509	638,394	454,635
2001	220,227		92,047	118,533	112,825	10,541	29,284	312,274	271,183	583,457	451,585
2002	222,834		128,665	92,649	112,698	7,709	10,898	351,499	223,954	575,453	428,181
2003	266,555		162,114	51,794	39,170	5,278	8,597	428,669	104,839	533,508	357,519
2004	273,666		89,832	98,403	120,697	9,245	62,523	363,498	290,868	654,366	492,766
2005	232,645		45,394	63,477	107,530	3,360	34,312	278,039	208,679	486,718	403,652
2006	156,314		54,529	35,985	84,523	1,452	13,799	210,843	135,759	346,602	276,822
2007	173,509		43,476	26,633	64,986	1,914	11,330	216,985	104,863	321,848	265,128
2008	74,926		108,177	31,628	32,725	4,969	37,625	183,103	106,947	290,050	139,279

Table 3. Striped bass landings and discards at age in numbers of fish for commercial and recreational fisheries from the ASMA/RRMA, NC 2008.

Age	Albemarle Sound Commercial Harvest	Albemarle Sound Commercial Discard	Albemarle Sound Recreational Harvest	Albemarle Sound Recreational Discard	Roanoke River Recreational Harvest	Roanoke River Recreational Discard	Total
1						24	24
2		31,437		355	158	1,875	33,825
3	473	38,733	3,858	2,011	4,741	5,144	54,960
4	5,931	452	2,943		3,856	2,577	15,759
5	6,377	1,442	2,140		1,138	1,235	12,332
6	2,195	771	936		569	809	5,280
7	2,620	58	75		48	240	3,041
8	292		55			109	456
9	145		13		16	124	298
10	78		13		16		107
11	114						114
12	51						51
13	38		13				51
14	38						38
15							0
16	19						19
Total	18,371	72,893	10,046	2,366	10,542	12,137	126,355

Table 4. Striped bass RCGL landings at age in thousands of fish from Albemarle Sound, NC 2004-2006.

	Age									
Year	1	2	3	4	5	6	7	8	9+	Total
2004	0.000	0.055	0.066	0.071	0.065	0.031	0.003	0.001	0.003	0.293
2005	0.003	0.093	0.152	0.250	0.199	0.055	0.005	0.010	0.006	0.774
2006	0.000	1.121	0.348	0.440	0.420	0.322	0.063	0.017	0.032	2.762

Table 5. Striped bass commercial landings at age in thousands of fish from Albemarle Sound, NC 1982 to 2008.

	Age									
Year	1	2	3	4	5	6	7	8	9+	Total
1982	0.000	31.449	22.724	6.186	3.190	1.172	0.195	0.000	0.195	65.111
1983	0.000	23.841	27.694	11.921	4.070	2.253	1.672	0.800	0.436	72.687
1984	0.000	101.035	5.889	23.244	18.285	2.789	2.324	0.000	1.395	154.961
1985	11.562	80.428	30.113	2.287	1.271	0.762	0.508	0.127	0.000	127.058
1986	0.000	48.219	7.860	4.554	0.000	0.437	0.437	0.000	0.873	62.380
1987	0.000	31.392	13.525	12.160	4.157	0.248	0.000	0.434	0.124	62.040
1988	0.000	17.717	9.843	4.640	1.687	0.703	0.176	0.281	0.105	35.152
1989	0.000	13.577	9.073	7.947	1.383	0.129	0.064	0.000	0.000	32.173
1990	0.000	33.369	3.359	5.241	1.389	0.493	0.269	0.269	0.403	44.792
1991	0.000	6.820	19.875	4.157	0.877	0.292	0.292	0.000	0.162	32.475
1992	0.000	0.000	8.163	18.226	0.187	0.062	0.062	0.064	0.000	26.764
1993	0.000	0.000	1.076	15.794	10.965	0.756	0.262	0.116	0.116	29.085
1994	0.000	0.000	0.130	3.095	7.035	11.018	0.281	0.000	0.087	21.646
1995	0.000	0.000	0.240	4.829	11.161	3.647	0.160	0.000	0.000	20.037
1996	0.000	0.000	1.735	1.925	6.311	7.321	1.294	0.316	0.190	19.092
1997	0.000	0.000	0.997	3.846	3.647	9.107	3.462	0.274	0.040	21.373
1998	0.000	0.000	1.599	7.233	9.701	6.549	3.253	0.045	0.134	28.514
1999	0.000	0.000	0.000	3.344	20.972	9.513	1.134	0.230	0.430	35.623
2000	0.000	0.000	0.000	6.380	23.169	14.119	2.158	0.516	0.564	46.906
2001	0.000	0.000	2.818	16.908	25.018	3.361	0.445	0.643	0.246	49.439
2002	0.000	0.000	1.165	10.785	18.074	4.411	1.178	1.119	3.236	39.968
2003	0.000	0.000	4.779	15.036	15.270	5.584	1.505	0.515	2.141	44.830
2004	0.000	0.000	3.100	16.840	10.756	2.366	1.001	1.457	6.557	42.077
2005	0.000	0.000	0.707	9.151	19.515	7.864	1.854	0.764	3.244	43.099
2006	0.000	0.000	0.407	7.241	16.263	5.661	0.558	0.379	3.109	33.618
2007	0.000	0.000	0.168	3.953	13.225	5.473	1.217	0.583	2.958	27.577
2008	0.000	0.000	0.473	5.931	6.377	2.195	2.620	0.292	0.483	18.371

Table 6. Striped bass commercial landings at age in thousands of fish from Roanoke River, NC 1982-1986.

	Age									
Year	1	2	3	4	5	6	7	8	9+	Total
1982	0.000	1.157	0.838	0.658	0.400	0.426	0.110	0.070	0.015	3.674
1983	0.000	0.064	0.384	0.295	0.279	0.144	0.111	0.040	0.024	1.341
1984	0.000	0.199	0.017	0.068	0.059	0.026	0.009	0.013	0.004	0.395
1985	0.000	1.347	0.834	0.089	0.213	0.000	0.053	0.000	0.000	2.536
1986	0.000	0.007	0.005	0.003	0.000	0.000	0.000	0.000	0.000	0.015

Table 7. Striped bass recreational landings at age in thousands of fish from Albemarle Sound, NC 1982-2008.

	Age									
Year	1	2	3	4	5	6	7	8	9 +	Total
1982	0.000	3.598	2.600	0.708	0.365	0.134	0.022	0.000	0.022	7.449
1983	0.000	2.327	2.703	1.164	0.397	0.220	0.163	0.078	0.043	7.095
1984	0.000	3.662	0.213	0.843	0.663	0.101	0.084	0.000	0.051	5.617
1985	0.290	2.016	0.755	0.057	0.032	0.019	0.013	0.003	0.000	3.185
1986	0.000	5.239	0.854	0.495	0.000	0.047	0.047	0.000	0.095	6.777
1987	0.000	5.160	2.223	1.999	0.683	0.041	0.000	0.071	0.020	10.197
1988	0.000	1.711	2.762	4.185	3.473	2.152	1.677	0.610	0.373	16.943
1989	0.000	2.128	2.876	1.976	1.353	0.338	0.098	0.062	0.071	8.902
1990	0.000	9.896	3.703	1.245	0.683	0.208	0.176	0.032	0.016	15.959
1991	0.000	2.501	6.397	0.065	0.026	0.000	0.000	0.000	0.000	8.989
1992	0.000	0.092	9.912	3.342	0.137	0.092	0.023	0.023	0.000	13.621
1993	0.000	0.145	2.133	10.990	1.193	0.108	0.000	0.000	0.000	14.569
1994	0.000	0.017	0.749	2.485	5.090	0.085	0.000	0.000	0.000	8.426
1995	0.000	0.000	0.554	2.137	3.680	0.919	0.053	0.000	0.000	7.343
1996	0.000	0.000	0.561	2.163	3.725	0.930	0.054	0.000	0.000	7.433
1997	0.000	0.106	3.100	0.784	1.125	0.353	0.009	0.000	0.000	5.477
1998	0.000	0.000	0.092	11.431	6.114	1.316	0.627	0.024	0.000	19.604
1999	0.000	0.000	0.428	6.903	7.059	2.103	0.344	0.026	0.015	16.878
2000	0.000	0.000	0.003	19.792	14.359	3.311	0.439	0.097	0.038	38.039
2001	0.000	0.000	12.033	20.777	6.819	0.411	0.020	0.019	0.000	40.079
2002	0.000	0.000	4.564	13.910	8.491	0.695	0.171	0.059	0.008	27.898
2003	0.000	0.000	4.173	7.704	3.371	0.431	0.112	0.044	0.047	15.882
2004	0.000	0.000	0.252	11.258	12.630	3.248	0.420	0.168	0.028	28.004
2005	0.000	0.072	2.206	7.875	6.729	0.893	0.021	0.087	0.074	17.957
2006	0.000	0.048	0.903	3.414	5.135	1.094	0.019	0.060	0.037	10.710
2007	0.000	0.000	0.532	2.797	2.823	0.807	0.093	0.023	0.068	7.143
2008	0.000	0.000	3.858	2.943	2.140	0.936	0.076	0.055	0.039	10.047

Table 8. Striped bass recreational landings at age in thousands of fish from Roanoke River, NC 1982-2008.

					Age					
Year	1	2	3	4	5	6	7	8	9+	Total
1982	0.000	2.307	1.670	1.311	0.798	0.850	0.220	0.139	0.029	7.324
1983	0.000	0.335	1.995	1.535	1.451	0.746	0.579	0.209	0.126	6.976
1984	0.000	2.789	0.237	0.950	0.828	0.359	0.122	0.177	0.061	5.523
1985	0.000	1.663	1.030	0.110	0.263	0.000	0.066	0.000	0.000	3.132
1986	0.000	3.072	2.052	1.539	0.000	0.000	0.000	0.000	0.000	6.663
1987	0.000	5.224	2.467	1.634	0.541	0.040	0.080	0.040	0.000	10.026
1988	0.000	1.680	2.721	4.109	8.146	0.000	0.000	0.000	0.000	16.656
1989	0.000	2.088	2.834	1.948	1.893	0.000	0.000	0.000	0.000	8.763
1990	0.000	9.714	3.643	1.245	1.093	0.000	0.000	0.000	0.000	15.695
1991	0.000	2.310	23.387	0.730	0.507	0.000	0.000	0.000	0.000	26.934
1992	0.000	0.168	10.458	2.731	0.034	0.000	0.000	0.000	0.000	13.391
1993	0.000	0.000	3.896	9.669	0.759	0.000	0.000	0.000	0.000	14.324
1994	0.000	0.000	1.549	4.134	2.469	0.132	0.000	0.000	0.000	8.284
1995	0.000	0.000	0.514	1.233	3.460	2.210	0.034	0.000	0.007	7.458
1996	0.000	0.000	1.899	2.736	2.201	1.364	0.167	0.000	0.000	8.367
1997	0.000	0.031	3.794	3.285	1.275	0.694	0.225	0.051	0.010	9.365
1998	0.000	0.024	3.190	13.344	4.724	1.339	0.244	0.146	0.097	23.108
1999	0.000	0.066	5.016	10.916	4.897	1.426	0.066	0.079	0.013	22.479
2000	0.000	0.103	13.334	18.653	4.265	1.515	0.128	0.128	0.077	38.203
2001	0.000	0.000	9.815	15.133	7.273	2.190	0.195	0.195	0.430	35.231
2002	0.000	0.019	3.347	18.107	11.094	3.253	0.282	0.112	0.208	36.422
2003	0.000	0.000	0.979	5.839	3.018	0.489	0.049	0.163	0.602	11.139
2004	0.000	0.000	10.198	12.845	7.518	4.189	0.145	0.109	0.477	35.481
2005	0.000	0.000	8.861	15.125	6.824	2.139	0.178	0.280	0.660	34.067
2006	0.000	0.000	2.682	16.304	4.788	1.245	0.072	0.024	0.219	25.334
2007	0.000	0.000	1.007	6.644	10.456	1.062	0.082	0.054	0.000	19.305
2008	0.000	0.158	4.741	3.856	1.138	0.569	0.048	0.000	0.032	10.542

Table 9. Commercial striped bass discards at age in thousands of fish from Albemarle Sound, NC 1994-2008.

	Age									
	1	2	3	4	5	6	7	8	9	Total
1994	0.000	11.600	2.320	9.668	15.069	0.180	0.180	0.060	0.060	39.137
1995	0.000	115.965	2.906	6.409	17.754	2.267	0.000	0.000	0.000	145.301
1996	0.000	10.910	6.690	1.676	6.031	14.523	0.435	0.000	0.000	40.265
1997	0.000	21.801	23.059	7.487	1.318	6.151	11.862	2.197	0.000	73.875
1998	0.000	7.140	31.706	13.633	8.763	5.465	1.557	0.087	0.112	68.463
1999	0.000	2.467	16.777	20.807	10.104	5.482	0.296	0.000	0.000	55.933
2000	0.000	0.630	8.666	24.641	13.993	5.862	0.556	0.125	0.000	54.473
2001	0.795	13.774	12.401	7.533	0.617	0.061	0.000	0.000	0.000	35.181
2002	0.000	22.338	4.130	15.329	14.431	0.357	0.000	0.000	0.000	56.585
2003	0.000	4.699	62.724	10.628	6.235	1.150	0.072	0.000	0.000	85.508
2004	0.000	13.937	22.805	14.113	3.066	0.671	0.124	0.000	0.000	54.716
2005	0.000	2.606	6.732	5.836	3.275	0.588	0.020	0.018	0.000	19.075
2006	0.000	2.869	7.385	6.733	4.247	0.837	0.032	0.027	0.000	22.130
2007	6.197	18.650	10.491	1.464	1.715	0.709	0.016	0.000	0.000	39.242
2008	0.000	31.437	38.733	0.452	1.442	0.771	0.058	0.000	0.000	72.893

Table 10. Striped bass recreational discards at age in thousands of fish from Roanoke River, NC 1991-2008.

	Age									
	1	2	3	4	5	6	7	8	9	Total
1991	0.000	4.441	1.585	0.109	0.042	0.030	0.036	0.024	0.012	6.279
1992	0.000	0.131	1.181	0.174	0.014	0.004	0.004	0.005	0.005	1.518
1993	0.000	0.059	1.102	2.303	0.136	0.008	0.008	0.004	0.013	3.633
1994	0.000	0.027	0.402	1.289	1.869	0.094	0.023	0.004	0.004	3.712
1995	0.000	0.607	0.192	0.264	1.206	1.447	0.087	0.008	0.004	3.815
1996	0.012	0.600	4.361	1.813	1.629	1.629	0.367	0.037	0.012	10.460
1997	0.000	6.583	5.991	2.569	0.993	1.074	0.522	0.221	0.100	18.053
1998	0.042	1.203	2.590	1.567	0.611	0.261	0.125	0.093	0.055	6.547
1999	0.013	1.042	5.308	2.490	0.937	0.419	0.151	0.197	0.092	10.649
2000	0.110	1.678	5.941	3.264	0.833	0.661	0.190	0.061	0.061	12.799
2001	0.003	0.679	5.128	2.908	1.242	0.544	0.226	0.106	0.109	10.945
2002	0.057	0.093	0.618	1.303	0.660	0.389	0.196	0.104	0.150	3.570
2003	0.006	0.583	0.475	0.699	0.297	0.137	0.094	0.046	0.112	2.449
2004	0.000	0.899	12.150	2.544	1.152	1.000	0.215	0.089	0.342	18.391
2005	0.002	0.358	5.072	2.801	0.882	0.493	0.190	0.103	0.189	10.090
2006	0.008	0.648	1.778	0.890	0.427	0.279	0.083	0.038	0.043	4.194
2007	0.007	0.519	1.425	0.714	0.342	0.224	0.067	0.030	0.034	3.362
2008	0.024	1.875	5.144	2.577	1.235	0.809	0.240	0.109	0.124	12.137

Table 11. Striped bass recreational discard at age in thousands of fish from Albemarle Sound, NC 2000-2008.

	Age									
	1	2	3	4	5	6	7	8	9	Total
2000	0.4	0.515	1.944	1.799	0.343	0.035	0.008	0	0.003	5.047
2001	0	0.041	0.662	1.785	1.306	0.132	0.017	0.006	0.003	3.952
2002	0	1.171	0.133	1.159	0.803	0.025	0.003	0.001	0.004	3.299
2003	0	0.48	0.06	0.598	0.46	0.015	0.002	0.001	0.003	1.619
2004	0	0.493	0.593	0.634	0.581	0.273	0.023	0.009	0.023	2.629
2005	0.004	0.097	0.253	0.494	0.43	0.07	0.005	0.003	0.001	1.357
2006	0	0.09075	0.51425	0	0	0	0	0	0	0.605
2007	0	0.1305	0.7395	0	0	0	0	0	0	0.87
2008	0	0.3549	2.0111	0	0	0	0	0	0	2.366

Table 12. Striped bass RCGL discard at age in numbers from Albemarle Sound, NC 2004.

	Age									
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
2004	**0**	**7**	**8**	**8**	**8**	**4**	**0**	**0**	**0**	**35**

Table 13. Striped bass total catch in thousands of fish for ages 1 to 9+ from ASMA/RRMA, NC 1982-2008. Total catch includes landings and discard losses.

	Age									
Year	1	2	3	4	5	6	7	8	9+	Total
1982	0.000	38.511	27.832	8.863	4.753	2.582	0.547	0.209	0.261	83.558
1983	0.000	26.567	32.776	14.915	6.197	3.363	2.525	1.127	0.629	88.099
1984	0.000	107.685	6.356	25.105	19.835	3.275	2.539	0.190	1.511	166.496
1985	11.852	85.454	32.732	2.543	1.779	0.781	0.640	0.130	0.000	135.911
1986	0.000	56.537	10.771	6.591	0.000	0.484	0.484	0.000	0.968	75.835
1987	0.000	41.776	18.215	15.793	5.381	0.329	0.080	0.545	0.144	82.263
1988	0.000	21.108	15.326	12.934	13.306	2.855	1.853	0.891	0.478	68.751
1989	0.000	17.793	14.783	11.871	4.629	0.467	0.162	0.062	0.071	49.838
1990	0.000	52.979	10.705	7.731	3.165	0.701	0.445	0.301	0.419	76.446
1991	0.000	16.072	51.244	5.061	1.452	0.322	0.328	0.024	0.174	74.677
1992	0.000	0.391	29.714	24.473	0.372	0.158	0.089	0.092	0.005	55.294
1993	0.000	0.204	8.207	38.756	13.053	0.872	0.270	0.120	0.129	61.611
1994	0.000	11.644	5.150	20.671	31.532	11.509	0.484	0.064	0.151	81.205
1995	0.000	116.572	4.406	14.872	37.261	10.490	0.334	0.008	0.011	183.954
1996	0.012	11.510	15.246	10.313	19.897	25.767	2.317	0.353	0.202	85.617
1997	0.000	28.521	36.941	17.971	8.358	17.379	16.080	2.743	0.150	128.143
1998	0.042	8.367	39.177	47.208	29.913	14.930	5.806	0.395	0.398	146.236
1999	0.013	3.575	27.529	44.460	43.969	18.943	1.991	0.532	0.550	141.562
2000	0.510	2.926	29.888	74.529	56.962	25.503	3.479	0.927	0.743	195.467
2001	0.798	14.494	42.857	65.044	42.275	6.699	0.903	0.969	0.788	174.827
2002	0.057	23.621	13.957	60.593	53.553	9.130	1.830	1.395	3.606	167.742
2003	0.006	5.762	73.190	40.504	28.651	7.806	1.834	0.769	2.905	161.427
2004	0.000	15.329	49.098	58.234	35.703	11.747	1.928	1.832	7.427	181.298
2005	0.006	3.133	23.831	41.282	37.655	12.047	2.268	1.255	4.168	125.645
2006	0.008	3.655	13.669	34.582	30.860	9.116	0.764	0.528	3.408	96.591
2007	6.204	19.300	14.363	15.572	28.561	8.275	1.475	0.690	3.060	97.499
2008	0.024	33.824	54.960	15.759	12.332	5.280	3.042	0.456	0.678	126.356

Table 14. Striped bass weight at age of the catch in kilograms from ASMA/RRMA, NC 1982-2008.
1982-1990 values were from commercial fishery sampling.
1991 – 2008 were mean weights at age from NCDMF commercial fishery sampling, Albemarle Sound gill net survey, and NCWRC Spawning Grounds Electrofishing Survey weighted by their respective fishery catch magnitudes.

	Age								
Year	1	2	3	4	5	6	7	8	9+
1982	0.546	0.691	1.614	3.168	3.628	4.072	5.050	5.276	6.816
1983	0.509	0.704	1.663	2.209	3.140	4.325	5.070	6.078	7.34
1984	0.584	0.742	1.481	2.406	2.943	4.198	5.303	5.395	7.34
1985	0.606	0.819	1.378	1.904	3.236	3.805	4.798	6.325	9.358
1986	0.740	0.899	1.653	2.253	3.843	4.405	4.424	6.791	11.882
1987	0.662	0.938	1.671	2.329	3.066	3.584	6.091	6.180	9.358
1988	0.633	0.759	1.492	2.181	3.048	3.529	4.686	5.642	11.882
1989	0.661	0.685	1.473	2.234	3.096	3.811	5.083	5.280	9.358
1990	0.470	0.811	1.251	2.216	2.789	4.141	5.103	5.280	10.495
1991	0.368	0.722	1.323	1.791	2.403	3.570	6.303	5.074	6.337
1992	0.541	0.722	1.212	1.745	2.548	3.385	5.183	5.074	7.014
1993	0.488	0.641	1.239	1.495	1.793	3.050	4.356	5.074	6.337
1994	0.425	0.844	1.276	1.557	1.760	2.486	3.768	5.074	6.918
1995	0.339	0.525	1.251	1.753	1.942	2.206	2.828	5.074	7.014
1996	0.311	0.333	0.911	1.474	1.845	2.103	2.500	4.927	9.017
1997	0.282	0.571	0.905	1.366	1.882	2.072	2.367	4.043	10.228
1998	0.209	0.451	0.787	1.245	1.733	2.302	2.526	5.074	7.391
1999	0.269	0.478	1.419	1.222	1.713	2.176	2.989	4.432	8.931
2000	0.311	0.491	0.860	1.146	1.588	2.068	2.954	3.856	8.931
2001	0.313	0.643	0.995	1.298	1.809	2.367	3.732	6.091	8.446
2002	0.187	0.397	1.036	1.216	1.615	2.190	3.382	5.513	8.941
2003	0.260	0.517	1.401	1.648	2.059	2.608	3.904	6.165	8.121
2004	0.239	0.418	0.867	1.284	1.747	2.239	3.329	4.505	8.733
2005	0.187	0.501	0.927	1.286	1.800	2.405	3.663	5.197	9.639
2006	0.220	0.288	0.868	1.413	1.736	2.132	3.885	5.006	9.857
2007	0.213	0.516	0.974	1.331	1.788	2.412	3.639	4.464	10.441
2008	0.364	0.610	1.060	1.449	1.952	2.439	3.078	4.405	10.006

Table 15. Geometric mean for striped bass juvenile and yearling index values from western Albemarle Sound, NC 1982-2008. Indices were lagged one year in the stock assessment.

Year	JAI	Age-1
1982	0.531	0.082
1983	0.411	0.306
1984	0.131	0.117
1985	0.123	0.048
1986	0.072	0.000
1987	0.194	0.073
1988	1.327	0.025
1989	1.950	0.000
1990	0.558	0.165
1991	0.439	0.293
1992	0.744	0.177
1993	17.310	0.089
1994	14.948	1.000
1995	3.067	2.619
1996	9.767	1.510
1997	1.673	1.089
1998	2.772	0.345
1999	0.460	0.451
2000	19.983	0.371
2001	1.298	0.552
2002	2.104	0.167
2003	0.194	0.177
2004	0.834	0.118
2005	9.542	0.093
2006	1.424	0.186
2007	2.285	0.064
2008	1.432	0.038
Mean	3.540	0.376

Table 16. Striped bass catch-at-age per 100 net days from the Albemarle Sound independent spring gill net survey, NC 1991-2008.

	Age								
Year	1	2	3	4	5	6	7	8	9+
1991	2.450	98.233	17.390	0.281	0.161	0.080	0.000	0.000	0.000
1992	0.277	12.869	34.686	2.948	0.277	0.035	0.000	0.035	0.000
1993	0.000	5.312	7.287	13.652	1.185	0.044	0.000	0.000	0.000
1994	0.000	1.132	1.919	5.856	11.270	0.098	0.000	0.000	0.049
1995	0.000	60.308	6.308	11.231	19.436	4.359	0.256	0.051	0.051
1996	0.000	5.151	30.589	3.346	12.533	11.790	1.753	0.000	0.000
1997	0.000	7.959	36.382	27.028	5.943	8.682	2.171	0.052	0.000
1998	0.000	6.076	28.235	48.036	14.982	4.034	1.310	0.052	0.000
1999	0.000	2.660	13.410	33.200	21.500	4.220	0.550	0.000	0.050
2000	0.000	0.696	6.415	33.168	39.980	9.000	1.392	0.298	0.000
2001	0.000	0.570	20.120	53.760	20.320	0.860	0.200	0.290	0.100
2002	0.000	12.810	2.540	36.580	34.390	1.140	0.090	0.350	0.000
2003	0.000	1.543	17.110	13.043	7.223	1.192	0.280	0.416	0.160
2004	0.000	19.969	24.589	23.306	19.148	8.932	0.411	0.154	0.411
2005	0.204	2.902	12.067	45.723	10.642	1.375	0.153	0.509	0.305
2006	0.000	39.432	6.253	29.974	18.863	3.512	0.310	0.258	0.258
2007	0.052	19.501	11.336	7.384	7.904	2.808	0.676	0.624	0.572
2008	0.167	26.710	96.670	3.498	3.664	2.554	0.278	0.167	0.278

Table 17. Striped bass catch-at-age per 100 net days from the Albemarle Sound independent fall/winter gill net survey, NC 1991-2008.

	Age								
Year	1	2	3	4	5	6	7	8	9+
1991	0.124	37.562	17.475	1.741	0.000	0.062	0.000	0.000	0.000
1992	0.000	5.889	30.208	6.010	0.000	0.000	0.000	0.000	0.000
1993	0.095	4.714	6.143	30.143	1.190	0.190	0.286	0.095	0.048
1994	0.000	4.040	2.693	9.861	23.241	0.217	0.130	0.087	0.087
1995	0.000	36.631	6.596	8.399	16.974	2.551	0.044	0.044	0.044
1996	0.000	5.224	13.502	2.523	5.091	5.002	0.310	0.000	0.000
1997	0.000	7.639	30.816	16.237	3.623	5.063	1.091	0.087	0.000
1998	0.000	6.250	22.030	20.612	3.768	1.064	0.488	0.089	0.000
1999	0.000	5.672	15.445	45.332	22.688	6.283	0.262	0.087	0.040
2000	0.000	5.409	5.717	19.525	15.963	2.726	0.176	0.044	0.044
2001	0.000	0.450	5.680	15.400	14.020	1.600	0.190	0.040	0.040
2002	0.000	24.610	2.400	15.370	7.240	0.200	0.050	0.000	0.000
2003	0.000	1.262	16.936	7.258	5.155	1.368	0.000	0.000	0.000
2004	0.000	14.137	16.438	20.731	21.304	10.075	1.180	1.659	0.599
2005	0.000	3.324	6.250	17.819	18.307	2.926	0.133	0.133	0.044
2006	0.000	24.405	4.051	10.260	13.254	9.159	1.189	0.044	0.264
2007	0.000	3.843	6.890	1.193	5.521	3.534	0.309	0.000	0.000
2008	0.000	12.348	52.304	9.888	1.655	0.850	0.671	0.134	0.045

Table 18. Striped bass catch-at-age per hour from the Roanoke River spawning grounds survey, NC 1991-2008.

	Age								
Year	1	2	3	4	5	6	7	8	9+
1991	0	73.4	26.2	1.8	0.7	0.5	0.6	0.4	0.2
1992	0	10.9	98.5	14.5	1.2	0.3	0.3	0.4	0.4
1993	0	1.4	26	54.3	3.2	0.2	0.2	0.1	0.3
1994	0	1.3	19.6	62.9	91.2	4.6	1.1	0.2	0.2
1995	0	16.1	5.1	7	32	38.4	2.3	0.2	0.1
1996	0.1	4.9	35.6	14.8	13.3	13.3	3	0.3	0.1
1997	0	65.6	59.7	25.6	9.9	10.7	5.2	2.2	1
1998	1.3	37.4	80.5	48.7	19	8.1	3.9	2.9	1.7
1999	0.2	15.9	81	38	14.3	6.4	2.3	3	1.4
2000	1.4	21.2	75.2	41.4	10.5	8.4	2.4	1.6	0.8
2001	0.05	23.4	176.8	100.2	42.8	18.7	7.8	3.6	5.15
2002	4.8	7.7	52.5	111	56.3	33.1	16.8	8.9	12.7
2003	0.6	66.25	54.1	79.5	33.8	15.5	10.7	5.3	12.8
2004	0	9.6	103.8	23.7	12.1	11.7	4.5	2.3	12.9
2005	0.1	12.1	170.8	94.3	29.7	16.7	6.4	3.5	6.4
2006	1.3	22.04	49.99	190.95	50.32	17.38	9.14	4.15	14.27
2007	2.5	14.6	36.84	49.51	84.6	17.29	5.75	3.93	10.3
2008	3.66	152.84	104.49	26.32	9.01	9.75	3.78	1.55	8.81

Table 19. Tuning coefficient of variation (CV) estimates used in the final configuration of ASAP2.

Data	CV
Fmult in the First Year	2.00
N in the First Year	0.10
Fmult Deviations	0.45
Recruitment Deviations	0.80
Steepness	1.00
Selectivity	1.50
ASMA Commercial Catch	0.10
ASMA Recreational Catch	0.10
RRMA Commercial Catch	0.10
RRMA Recreational Catch	0.10
Age-2 Spring IGNS Index	2.00
Age-3 Spring IGNS Index	0.90
Age-4 Spring IGNS Index	0.80
Age-5 Spring IGNS Index	0.75
Age-6 Spring IGNS Index	1.50
Age-7 Spring IGNS Index	1.30
Age-8 Spring IGNS Index	1.70
Age-2 Fall/Winter IGNS Index	1.40
Age-3 Fall/Winter IGNS Index	0.75
Age-4 Fall/Winter IGNS Index	0.60
Age-5 Fall/Winter IGNS Index	0.70
Age-6 Fall/Winter IGNS Index	1.50
Age-7 Fall/Winter IGNS Index	2.00
Age-2 RR Spawning Survey	1.50
Age-3 RR Spawning Survey	0.70
Age-4 RR Spawning Survey	0.80
Age-5 RR Spawning Survey	0.70
Age-6 RR Spawning Survey	0.50
Age-7 RR Spawning Survey	0.80
Age-8 RR Spawning Survey	0.80
Age-9+ RR Spawning Survey	1.00
JAI	2.90
Age-1 Index	2.00

Table 20. Root mean squared error in the final configuration of ASAP2.

Data	RMSE
Fmult in the First Year	0.76
N in the First Year	1.23
Fmult Deviations	1.02
Recruitment Deviations	1.08
Selectivity	1.04
ASMA Commercial Catch	0.40
ASMA Recreational Catch	0.31
RRMA Commercial Catch	0.27
RRMA Recreational Catch	0.32
Age-2 Spring IGNS Index	1.09
Age-3 Spring IGNS Index	1.02
Age-4 Spring IGNS Index	1.08
Age-5 Spring IGNS Index	1.09
Age-6 Spring IGNS Index	0.99
Age-7 Spring IGNS Index	0.95
Age-8 Spring IGNS Index	0.91
Age-2 Fall/Winter IGNS Index	1.06
Age-3 Fall/Winter IGNS Index	1.04
Age-4 Fall/Winter IGNS Index	1.09
Age-5 Fall/Winter IGNS Index	1.05
Age-6 Fall/Winter IGNS Index	0.98
Age-7 Fall/Winter IGNS Index	1.05
Age-2 RR Spawning Survey	0.94
Age-3 RR Spawning Survey	0.92
Age-4 RR Spawning Survey	0.95
Age-5 RR Spawning Survey	1.04
Age-6 RR Spawning Survey	1.02
Age-7 RR Spawning Survey	0.90
Age-8 RR Spawning Survey	0.92
Age-9+ RR Spawning Survey	0.98
JAI	1.06
Age-1 Index	0.99

Table 21. Major input data for the ASAP2 model.

	Start	End
Catch-at-age		
ASMA Commercial Fishery	1982	2008
RRMA Commercial Fishery	1982	1986
ASMA Recreational Fishery	1982	2008
RRMA Recreational Fishery	1982	2008
Discard-at-age		
ASMA Commercial Fishery	1994	2008
ASMA Recreational Fishery	2000	2008
RRMA Recreational Fishery	1991	2008
Weight-at-age	1982	2008
Independent Indices		
Spring ASMA IGNS (ages 2 to 8)	1991	2008
Fall/Winter ASMA IGNS (ages 2 to 7)	1991	2008
Roanoke River Spawning Survey (ages 3 to 9)	1991	2008
Hassler Trawl Survey (YOY and age-1)	1982	2008

Table 22. ASAP2 estimates of striped bass selectivity by fishery and period from ASMA/RRMA, NC 2008.

Fishery/Period	1	2	3	4	5	6	7	8	9+
Albemarle Sound Commercial									
1982-1984	0.00	1.00	1.00	1.00	1.00	0.53	0.66	0.08	0.10
1985-1990	0.00	1.00	0.84	0.75	1.00	0.30	0.24	0.24	0.05
1991-2008	0.00	0.11	0.35	1.00	1.00	0.95	0.28	0.11	0.09
Albemarle Sound Recreational									
1982-1984	0.00	1.00	1.00	1.00	0.95	0.48	0.03	0.00	0.00
1985-1990	0.00	0.48	1.00	1.00	0.73	0.28	0.18	0.34	0.03
1991-2008	0.00	0.02	0.33	1.00	1.00	0.32	0.05	0.05	0.02
Roanoke River Recreational									
1982-1984	0.00	0.52	1.00	1.00	1.00	1.00	1.00	0.71	0.11
1985-1990	0.00	0.50	1.00	1.00	1.00	1.00	1.00	0.18	0.05
1991-2001	0.00	0.04	0.58	1.00	0.74	0.39	0.09	0.09	0.02
2002-2008	0.00	0.03	0.39	1.00	0.76	0.30	0.06	0.05	0.03
Roanoke River Commercial									
1982-1986	0.00	0.56	1.00	1.00	1.00	1.00	1.00	0.70	0.08

Table 23. Estimated annual abundance of striped bass at age in thousands of fish from ASMA/RRMA, NC 1982-2008. Results from the ASAP2 model.

	Age									
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
1982	58	117	74	30	16	9	6	4	15	329
1983	193	50	67	40	16	9	6	4	15	400
1984	186	166	25	33	20	8	6	4	15	463
1985	140	160	50	7	10	6	4	2	15	394
1986	86	121	68	23	4	4	4	3	14	327
1987	55	74	69	40	14	2	3	3	14	274
1988	45	47	37	34	21	7	1	2	14	208
1989	291	39	25	18	17	10	4	1	13	418
1990	581	250	21	13	9	9	7	3	12	905
1991	391	500	160	13	8	6	6	5	12	1,101
1992	221	336	412	103	6	4	3	5	14	1,104
1993	143	190	284	323	69	4	3	3	16	1,035
1994	316	123	162	230	238	51	3	2	16	1,141
1995	494	271	104	130	164	170	38	2	15	1,388
1996	432	425	231	85	96	122	131	32	15	1,569
1997	472	372	360	182	59	68	90	109	40	1,752
1998	463	406	314	282	124	40	49	74	125	1,877
1999	427	398	342	241	182	81	28	40	168	1,907
2000	329	367	336	265	160	123	58	23	175	1,836
2001	449	283	307	246	153	95	82	47	167	1,829
2002	432	386	239	233	155	99	68	67	181	1,860
2003	375	371	325	183	143	98	69	55	209	1,828
2004	202	323	314	258	125	99	71	57	224	1,673
2005	248	174	271	236	153	76	67	57	236	1,518
2006	618	213	147	211	154	102	55	55	248	1,803
2007	578	532	181	118	149	111	78	46	258	2,051
2008	202	497	452	145	83	108	85	65	258	1,895

Table 24. Estimated striped bass fishing mortality by age and year, averaged across ages 4-6, from ASMA/RRMA, NC 2008. Results from the ASAP2 model.

					Age					
Year	1	2	3	4	5	6	7	8	9+	F 4-6
1982	0.00	0.41	0.46	0.46	0.46	0.29	0.31	0.10	0.04	0.43
1983	0.00	0.52	0.55	0.55	0.55	0.32	0.35	0.08	0.05	0.52
1984	0.00	1.05	1.07	1.07	1.07	0.59	0.69	0.11	0.11	1.01
1985	0.00	0.70	0.62	0.56	0.72	0.24	0.20	0.18	0.04	0.55
1986	0.00	0.41	0.40	0.36	0.44	0.16	0.14	0.11	0.02	0.35
1987	0.00	0.54	0.55	0.51	0.60	0.24	0.20	0.15	0.03	0.52
1988	0.00	0.48	0.59	0.57	0.60	0.32	0.28	0.16	0.03	0.55
1989	0.00	0.45	0.50	0.47	0.52	0.23	0.20	0.14	0.03	0.43
1990	0.00	0.30	0.37	0.35	0.37	0.18	0.16	0.10	0.02	0.31
1991	0.00	0.04	0.29	0.68	0.61	0.42	0.11	0.06	0.03	0.60
1992	0.00	0.02	0.09	0.25	0.23	0.16	0.04	0.02	0.01	0.24
1993	0.00	0.01	0.06	0.15	0.14	0.10	0.03	0.01	0.01	0.15
1994	0.00	0.02	0.07	0.19	0.18	0.15	0.04	0.02	0.01	0.18
1995	0.00	0.01	0.06	0.15	0.14	0.11	0.03	0.01	0.01	0.13
1996	0.00	0.02	0.09	0.22	0.20	0.15	0.04	0.02	0.01	0.19
1997	0.00	0.02	0.09	0.24	0.22	0.18	0.05	0.02	0.02	0.22
1998	0.00	0.02	0.11	0.28	0.27	0.20	0.06	0.03	0.02	0.27
1999	0.00	0.02	0.10	0.26	0.24	0.19	0.05	0.03	0.02	0.24
2000	0.00	0.03	0.16	0.40	0.37	0.26	0.07	0.04	0.02	0.36
2001	0.00	0.02	0.13	0.31	0.29	0.19	0.05	0.03	0.01	0.28
2002	0.00	0.02	0.12	0.34	0.31	0.21	0.06	0.03	0.02	0.30
2003	0.00	0.02	0.08	0.23	0.22	0.17	0.05	0.02	0.02	0.21
2004	0.00	0.03	0.13	0.37	0.35	0.23	0.06	0.03	0.02	0.34
2005	0.00	0.02	0.10	0.28	0.26	0.17	0.05	0.02	0.02	0.25
2006	0.00	0.01	0.07	0.20	0.18	0.12	0.03	0.02	0.01	0.17
2007	0.00	0.01	0.07	0.19	0.18	0.12	0.03	0.02	0.01	0.16
2008	0.00	0.01	0.04	0.12	0.11	0.07	0.02	0.01	0.01	0.10

Table 25. Estimated striped bass exploitation by age and year, including totals, from ASMA/RRMA, NC 2008.

	Age									
Year	1	2	3	4	5	6	7	8	9+	Total
1982	0.00	0.33	0.38	0.30	0.30	0.29	0.09	0.05	0.02	0.25
1983	0.00	0.53	0.49	0.37	0.39	0.37	0.42	0.28	0.04	0.22
1984	0.00	0.65	0.25	0.76	0.99	0.41	0.42	0.05	0.10	0.36
1985	0.08	0.53	0.65	0.36	0.18	0.13	0.16	0.07	0.00	0.34
1986	0.00	0.47	0.16	0.29	0.00	0.12	0.12	0.00	0.07	0.23
1987	0.00	0.56	0.26	0.39	0.38	0.16	0.03	0.18	0.01	0.30
1988	0.00	0.45	0.41	0.38	0.63	0.41	0.00	0.45	0.03	0.33
1989	0.00	0.46	0.59	0.66	0.27	0.05	0.04	0.00	0.01	0.12
1990	0.00	0.21	0.51	0.59	0.35	0.08	0.06	0.10	0.03	0.08
1991	0.00	0.03	0.32	0.39	0.18	0.05	0.05	0.00	0.01	0.07
1992	0.00	0.00	0.07	0.24	0.06	0.04	0.03	0.02	0.00	0.05
1993	0.00	0.00	0.03	0.12	0.19	0.22	0.09	0.04	0.01	0.06
1994	0.00	0.09	0.03	0.09	0.13	0.23	0.16	0.03	0.01	0.07
1995	0.00	0.43	0.04	0.11	0.23	0.06	0.01	0.00	0.00	0.13
1996	0.00	0.03	0.07	0.12	0.21	0.21	0.02	0.01	0.01	0.05
1997	0.00	0.08	0.10	0.10	0.14	0.26	0.18	0.03	0.00	0.07
1998	0.00	0.02	0.12	0.17	0.24	0.37	0.12	0.01	0.00	0.08
1999	0.00	0.01	0.08	0.18	0.24	0.23	0.07	0.01	0.00	0.07
2000	0.00	0.01	0.09	0.28	0.36	0.21	0.06	0.04	0.00	0.11
2001	0.00	0.05	0.14	0.26	0.28	0.07	0.01	0.02	0.00	0.10
2002	0.00	0.06	0.06	0.26	0.35	0.09	0.03	0.02	0.02	0.09
2003	0.00	0.02	0.23	0.22	0.20	0.08	0.03	0.01	0.01	0.09
2004	0.00	0.05	0.16	0.23	0.29	0.12	0.03	0.03	0.03	0.11
2005	0.00	0.02	0.09	0.17	0.25	0.16	0.03	0.02	0.02	0.08
2006	0.00	0.02	0.09	0.16	0.20	0.09	0.01	0.01	0.01	0.05
2007	0.01	0.04	0.08	0.13	0.19	0.07	0.02	0.02	0.01	0.05
2008	0.00	0.07	0.12	0.11	0.15	0.05	0.04	0.01	0.00	0.07

Table 26. Estimated striped bass exploitation by age and year for the ASMA commercial fishery harvest, including totals, from ASMA/RRMA, NC 2008.

					Age					
Year	1	2	3	4	5	6	7	8	9+	Total
1982	0.00	0.27	0.31	0.21	0.20	0.13	0.03	0.00	0.01	0.20
1983	0.00	0.48	0.41	0.30	0.25	0.25	0.28	0.20	0.03	0.18
1984	0.00	0.61	0.24	0.70	0.91	0.35	0.39	0.00	0.09	0.33
1985	0.08	0.50	0.60	0.33	0.13	0.13	0.13	0.06	0.00	0.32
1986	0.00	0.40	0.12	0.20	0.00	0.11	0.11	0.00	0.06	0.19
1987	0.00	0.42	0.20	0.30	0.30	0.12	0.00	0.14	0.01	0.23
1988	0.00	0.38	0.27	0.14	0.08	0.10	0.00	0.14	0.01	0.17
1989	0.00	0.35	0.36	0.44	0.08	0.01	0.02	0.00	0.00	0.08
1990	0.00	0.13	0.16	0.40	0.15	0.05	0.04	0.09	0.03	0.05
1991	0.00	0.01	0.12	0.32	0.11	0.05	0.05	0.00	0.01	0.03
1992	0.00	0.00	0.02	0.18	0.03	0.02	0.02	0.01	0.00	0.02
1993	0.00	0.00	0.00	0.05	0.16	0.19	0.09	0.04	0.01	0.03
1994	0.00	0.09	0.02	0.06	0.09	0.22	0.15	0.03	0.01	0.05
1995	0.00	0.43	0.03	0.09	0.18	0.03	0.00	0.00	0.00	0.12
1996	0.00	0.03	0.04	0.04	0.13	0.18	0.01	0.01	0.01	0.04
1997	0.00	0.06	0.07	0.06	0.08	0.22	0.17	0.02	0.00	0.05
1998	0.00	0.02	0.11	0.07	0.15	0.30	0.10	0.00	0.00	0.05
1999	0.00	0.01	0.05	0.10	0.17	0.19	0.05	0.01	0.00	0.05
2000	0.00	0.00	0.03	0.12	0.23	0.16	0.05	0.03	0.00	0.06
2001	0.00	0.05	0.05	0.10	0.17	0.04	0.01	0.01	0.00	0.05
2002	0.00	0.06	0.02	0.11	0.21	0.05	0.02	0.02	0.02	0.05
2003	0.00	0.01	0.21	0.14	0.15	0.07	0.02	0.01	0.01	0.07
2004	0.00	0.04	0.08	0.12	0.11	0.03	0.02	0.03	0.03	0.06
2005	0.00	0.01	0.03	0.06	0.15	0.11	0.03	0.01	0.01	0.04
2006	0.00	0.01	0.05	0.07	0.13	0.06	0.01	0.01	0.01	0.03
2007	0.01	0.04	0.06	0.05	0.10	0.06	0.02	0.01	0.01	0.03
2008	0.00	0.06	0.09	0.04	0.09	0.03	0.03	0.00	0.00	0.05

Table 27. Estimated striped bass exploitation by age and year for the ASMA recreational fishery harvest, including totals, from ASMA/RRMA, NC 2008.

					Age					
Year	1	2	3	4	5	6	7	8	9+	Total
1982	0.00	0.03	0.04	0.02	0.02	0.01	0.00	0.00	0.00	0.02
1983	0.00	0.05	0.04	0.03	0.02	0.02	0.03	0.02	0.00	0.02
1984	0.00	0.02	0.01	0.03	0.03	0.01	0.01	0.00	0.00	0.01
1985	0.00	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.01
1986	0.00	0.04	0.01	0.02	0.00	0.01	0.01	0.00	0.01	0.02
1987	0.00	0.07	0.03	0.05	0.05	0.02	0.00	0.02	0.00	0.04
1988	0.00	0.04	0.07	0.12	0.17	0.31	0.00	0.31	0.03	0.08
1989	0.00	0.05	0.12	0.11	0.08	0.03	0.02	0.00	0.01	0.02
1990	0.00	0.04	0.18	0.10	0.08	0.02	0.03	0.01	0.00	0.02
1991	0.00	0.01	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.01
1992	0.00	0.00	0.02	0.03	0.02	0.02	0.01	0.00	0.00	0.01
1993	0.00	0.00	0.01	0.03	0.02	0.03	0.00	0.00	0.00	0.01
1994	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.01
1995	0.00	0.00	0.01	0.02	0.02	0.01	0.00	0.00	0.00	0.01
1996	0.00	0.00	0.00	0.03	0.04	0.01	0.00	0.00	0.00	0.00
1997	0.00	0.00	0.01	0.00	0.02	0.01	0.00	0.00	0.00	0.00
1998	0.00	0.00	0.00	0.04	0.05	0.03	0.01	0.00	0.00	0.01
1999	0.00	0.00	0.00	0.03	0.04	0.03	0.01	0.00	0.00	0.01
2000	0.00	0.00	0.01	0.08	0.09	0.03	0.01	0.00	0.00	0.02
2001	0.00	0.00	0.04	0.09	0.05	0.01	0.00	0.00	0.00	0.02
2002	0.00	0.00	0.02	0.06	0.06	0.01	0.00	0.00	0.00	0.02
2003	0.00	0.00	0.01	0.05	0.03	0.00	0.00	0.00	0.00	0.01
2004	0.00	0.00	0.00	0.05	0.11	0.04	0.01	0.00	0.00	0.02
2005	0.00	0.00	0.01	0.04	0.05	0.01	0.00	0.00	0.00	0.01
2006	0.00	0.00	0.01	0.02	0.03	0.01	0.00	0.00	0.00	0.01
2007	0.00	0.00	0.01	0.02	0.02	0.01	0.00	0.00	0.00	0.00
2008	0.00	0.00	0.01	0.02	0.03	0.01	0.00	0.00	0.00	0.01

Table 28. Estimated striped bass exploitation by age and year for the RRMA recreational fishery harvest, including totals, from ASMA/RRMA, NC 2008.

	Age									
Year	1	2	3	4	5	6	7	8	9+	Total
1982	0.00	0.02	0.02	0.04	0.05	0.09	0.04	0.03	0.00	0.02
1983	0.00	0.01	0.03	0.04	0.09	0.08	0.10	0.05	0.01	0.02
1984	0.00	0.02	0.01	0.03	0.04	0.04	0.02	0.04	0.00	0.01
1985	0.00	0.01	0.02	0.02	0.03	0.00	0.02	0.00	0.00	0.01
1986	0.00	0.03	0.03	0.07	0.00	0.00	0.00	0.00	0.00	0.02
1987	0.00	0.07	0.04	0.04	0.04	0.02	0.03	0.01	0.00	0.04
1988	0.00	0.04	0.07	0.12	0.39	0.00	0.00	0.00	0.00	0.08
1989	0.00	0.05	0.11	0.11	0.11	0.00	0.00	0.00	0.00	0.02
1990	0.00	0.04	0.17	0.10	0.12	0.00	0.00	0.00	0.00	0.02
1991	0.00	0.01	0.16	0.06	0.07	0.01	0.01	0.00	0.00	0.03
1992	0.00	0.00	0.03	0.03	0.01	0.00	0.00	0.00	0.00	0.01
1993	0.00	0.00	0.02	0.04	0.01	0.00	0.00	0.00	0.00	0.02
1994	0.00	0.00	0.01	0.02	0.02	0.00	0.01	0.00	0.00	0.01
1995	0.00	0.00	0.01	0.01	0.03	0.02	0.00	0.00	0.00	0.01
1996	0.00	0.00	0.03	0.05	0.04	0.02	0.00	0.00	0.00	0.01
1997	0.00	0.02	0.03	0.03	0.04	0.03	0.01	0.00	0.00	0.02
1998	0.00	0.00	0.02	0.05	0.04	0.04	0.01	0.00	0.00	0.02
1999	0.00	0.00	0.03	0.06	0.03	0.02	0.01	0.01	0.00	0.02
2000	0.00	0.00	0.06	0.08	0.03	0.02	0.01	0.01	0.00	0.03
2001	0.00	0.00	0.05	0.07	0.06	0.03	0.01	0.01	0.00	0.03
2002	0.00	0.00	0.02	0.08	0.08	0.04	0.01	0.00	0.00	0.02
2003	0.00	0.00	0.00	0.04	0.02	0.01	0.00	0.00	0.00	0.01
2004	0.00	0.00	0.07	0.06	0.07	0.05	0.01	0.00	0.00	0.03
2005	0.00	0.00	0.05	0.08	0.05	0.03	0.01	0.01	0.00	0.03
2006	0.00	0.00	0.03	0.08	0.03	0.01	0.00	0.00	0.00	0.02
2007	0.00	0.00	0.01	0.06	0.07	0.01	0.00	0.00	0.00	0.01
2008	0.00	0.00	0.02	0.04	0.03	0.01	0.00	0.00	0.00	0.01

Table 29. Estimated striped bass exploitation by age and year for the RRMA commercial fishery harvest, including totals, from ASMA/RRMA, NC 2008.

	Age									
Year	1	2	3	4	5	6	7	8	9+	Total
1982	0.00	0.01	0.01	0.02	0.03	0.05	0.02	0.02	0.00	0.01
1983	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.01	0.00	0.00
1984	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1985	0.00	0.01	0.02	0.01	0.02	0.00	0.01	0.00	0.00	0.01
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 30. Striped bass spawning stock biomass in thousands of pounds by year from ASMA/RRMA, NC 2008. Results from the ASAP2 model with +/- 1 standard deviations.

Year	-1 Std Dev	SSB	+1 Std Dev
1982	297,249	341,099	384,971
1983	289,908	333,868	377,806
1984	223,527	264,180	304,833
1985	200,577	244,823	289,070
1986	262,372	313,630	364,865
1987	269,427	309,838	350,248
1988	274,211	319,538	364,865
1989	225,224	262,593	299,961
1990	219,448	258,823	298,175
1991	231,309	267,377	303,444
1992	463,103	529,881	596,681
1993	723,513	829,666	935,818
1994	885,773	1,025,921	1,166,069
1995	974,223	1,140,540	1,306,856
1996	1,035,820	1,224,029	1,412,215
1997	1,387,788	1,646,236	1,904,684
1998	1,762,883	2,099,793	2,436,704
1999	2,238,574	2,669,225	3,099,876
2000	2,192,277	2,636,398	3,080,520
2001	2,364,943	2,858,250	3,351,556
2002	2,445,566	2,982,238	3,518,909
2003	2,689,772	3,285,153	3,880,533
2004	2,613,029	3,223,776	3,834,523
2005	2,905,252	3,619,947	4,334,641
2006	2,983,163	3,740,804	4,498,445
2007	3,124,083	3,937,875	4,751,668
2008	3,184,379	3,998,921	4,813,463

Table 31. Estimated striped bass biological reference points from ASMA/RRMA, NC 2008. Results from the YPR model with SPR levels ranging from 25% to 45%, $F_{0.1}$, and F_{Max}.

SPR	F	YPR	SSB (lb)
F25%	0.45	0.75	2,319,110
F30%	0.38	0.72	2,782,921
F35%	0.33	0.68	3,246,469
F40%	0.29	0.64	3,710,489
F45%	0.25	0.60	4,174,055
F0.1	0.45	0.75	2,327,741
Fmax	0.75	0.80	1,045,749

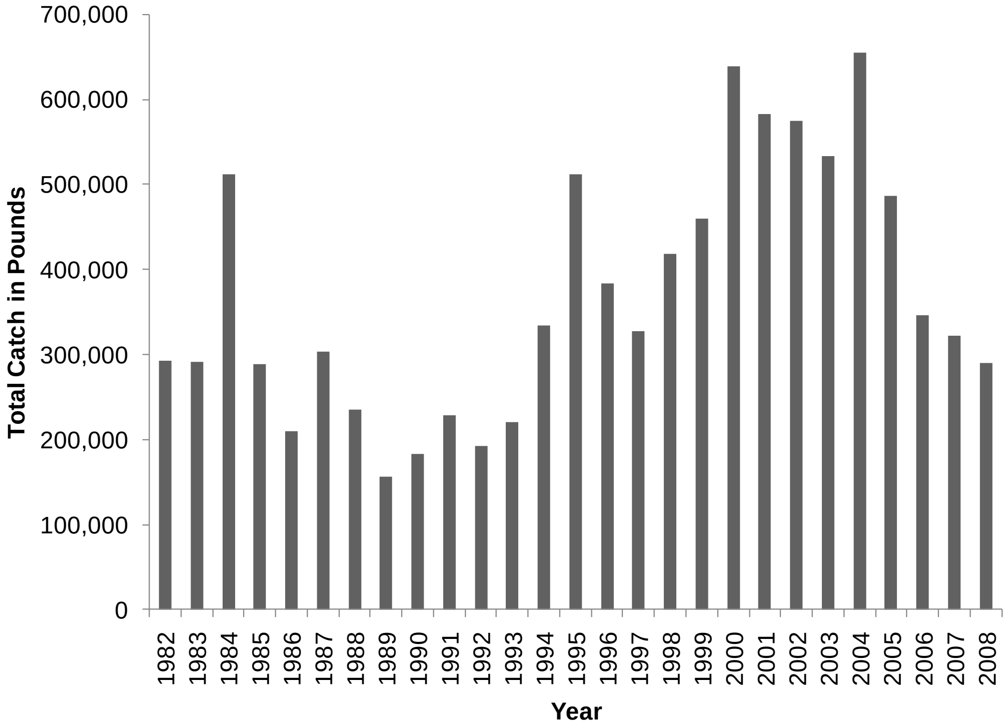


Figure 1. Total catch of striped bass in pounds from the ASMA/RRMA, NC 1982-2008. Includes landings and estimated discard losses.

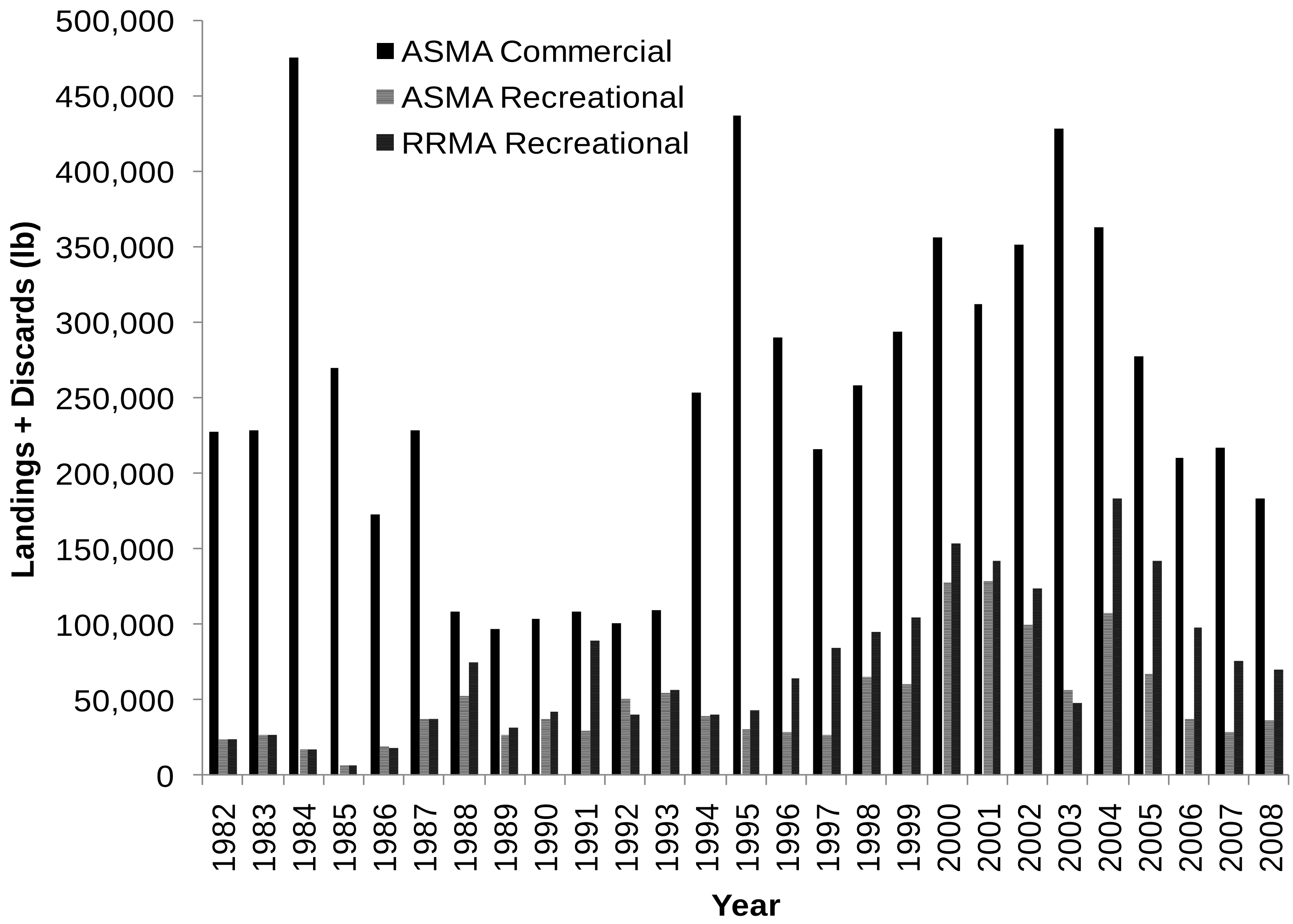


Figure 2. Total catch of striped bass in pounds from the ASMA/RRMA, NC 1982-2008 by fishery. Includes landings and estimated discard losses.

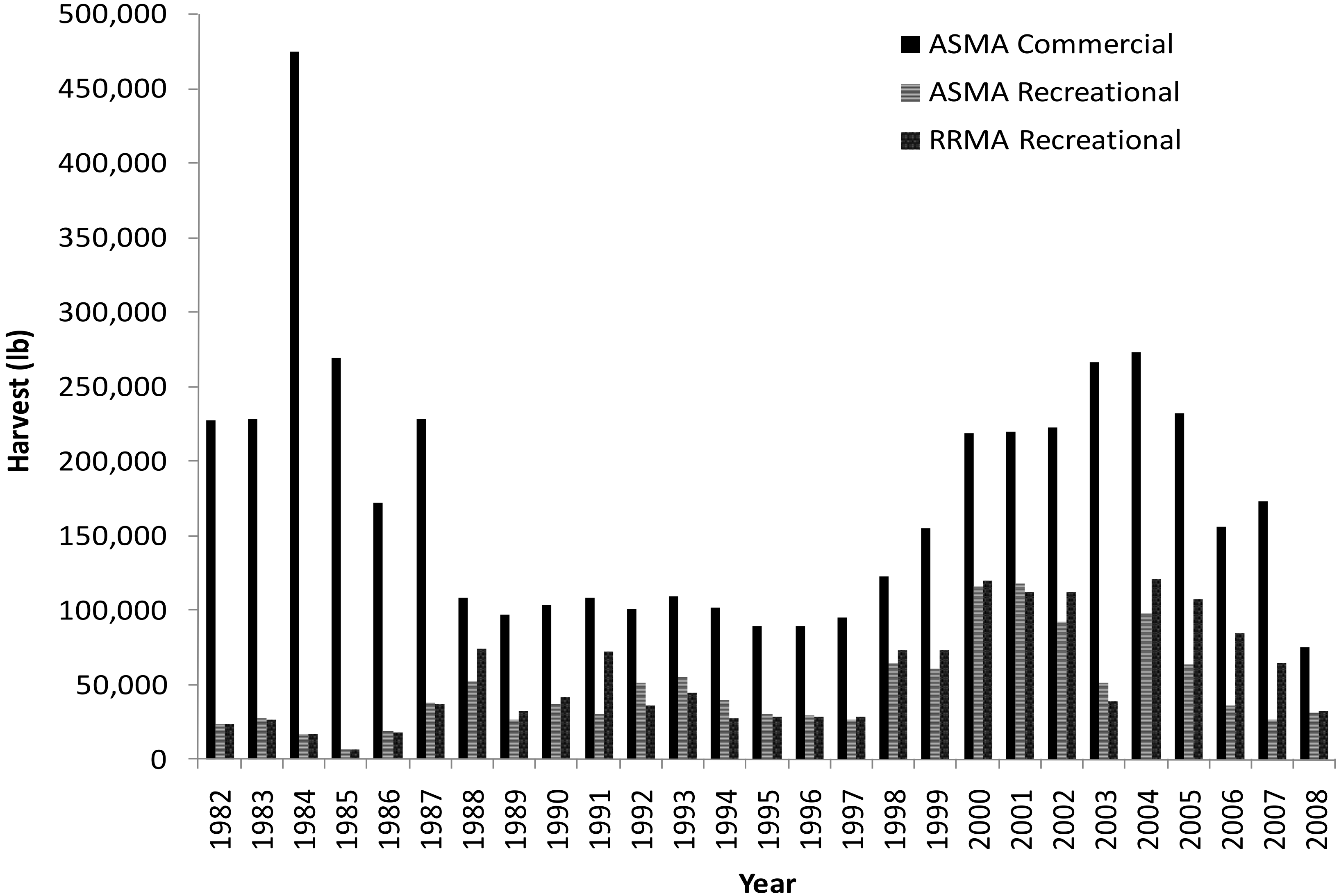


Figure 3. Total striped bass landings in pounds by fishery from the ASMA/RRMA, NC 1982-2008. Represents only landed harvest, does not include discards.

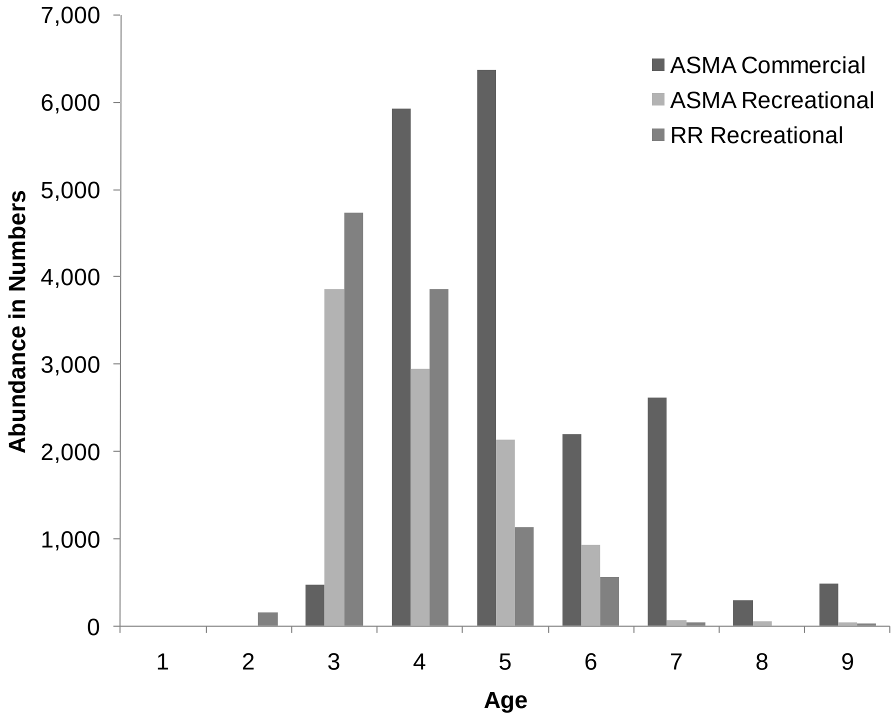


Figure 4. Striped bass age distribution for landings from the ASMA/RRMA, NC 2008.

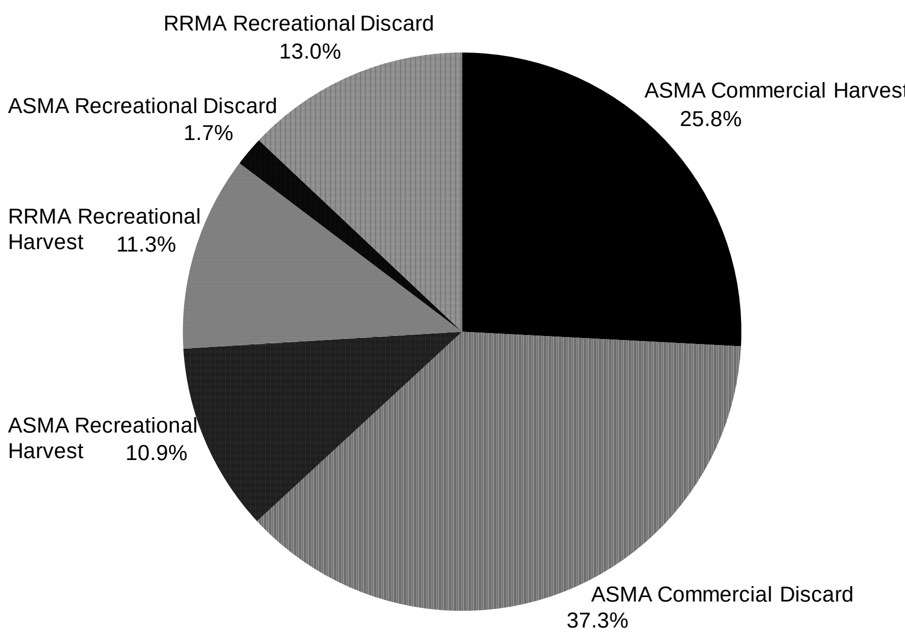


Figure 5. Disposition of striped bass total catch in pounds from the ASMA/RRMA, NC 2008.

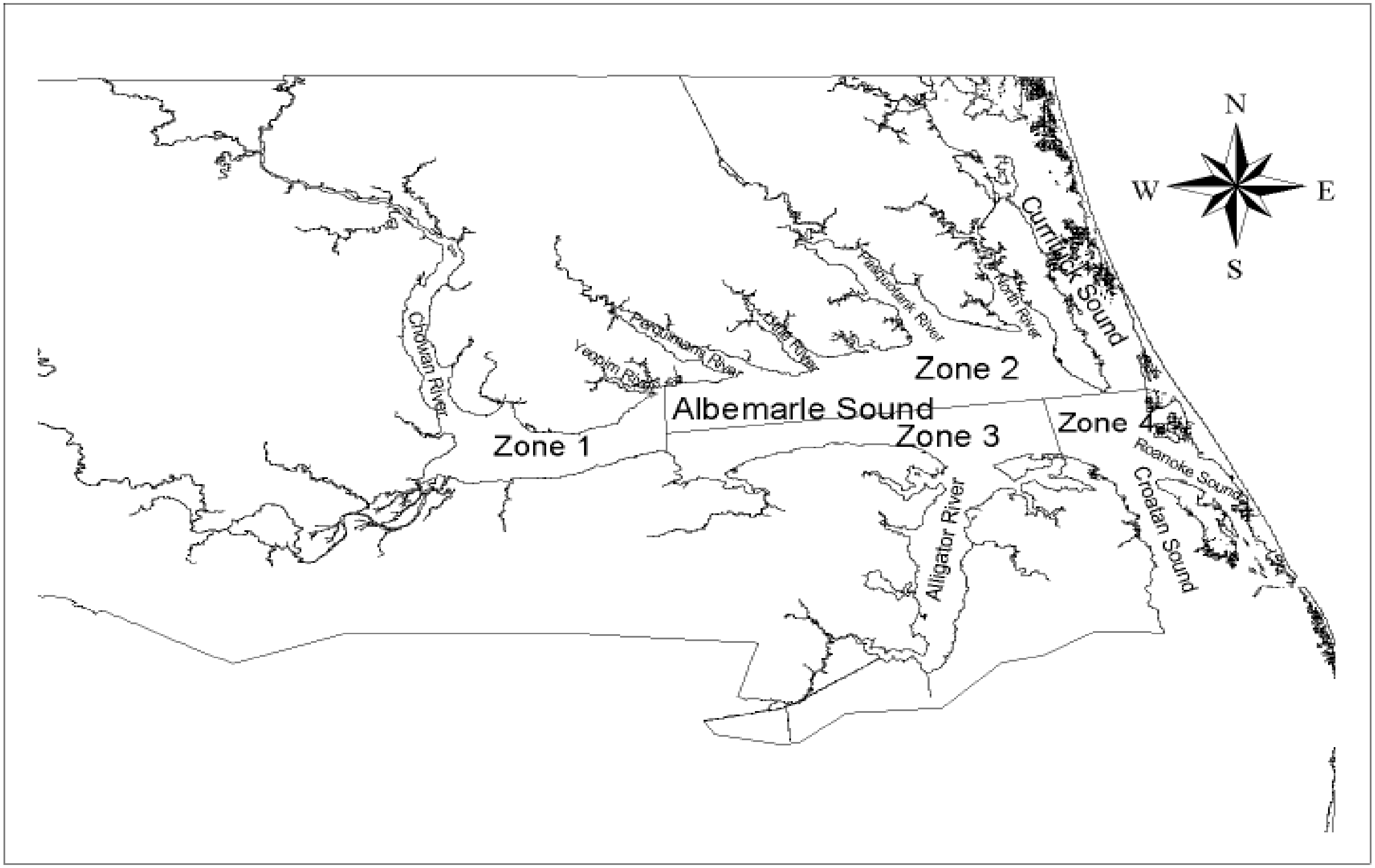


Figure 6. Zones sampled by the striped bass creel survey during the recreational seasons in the ASMA, NC 2008.

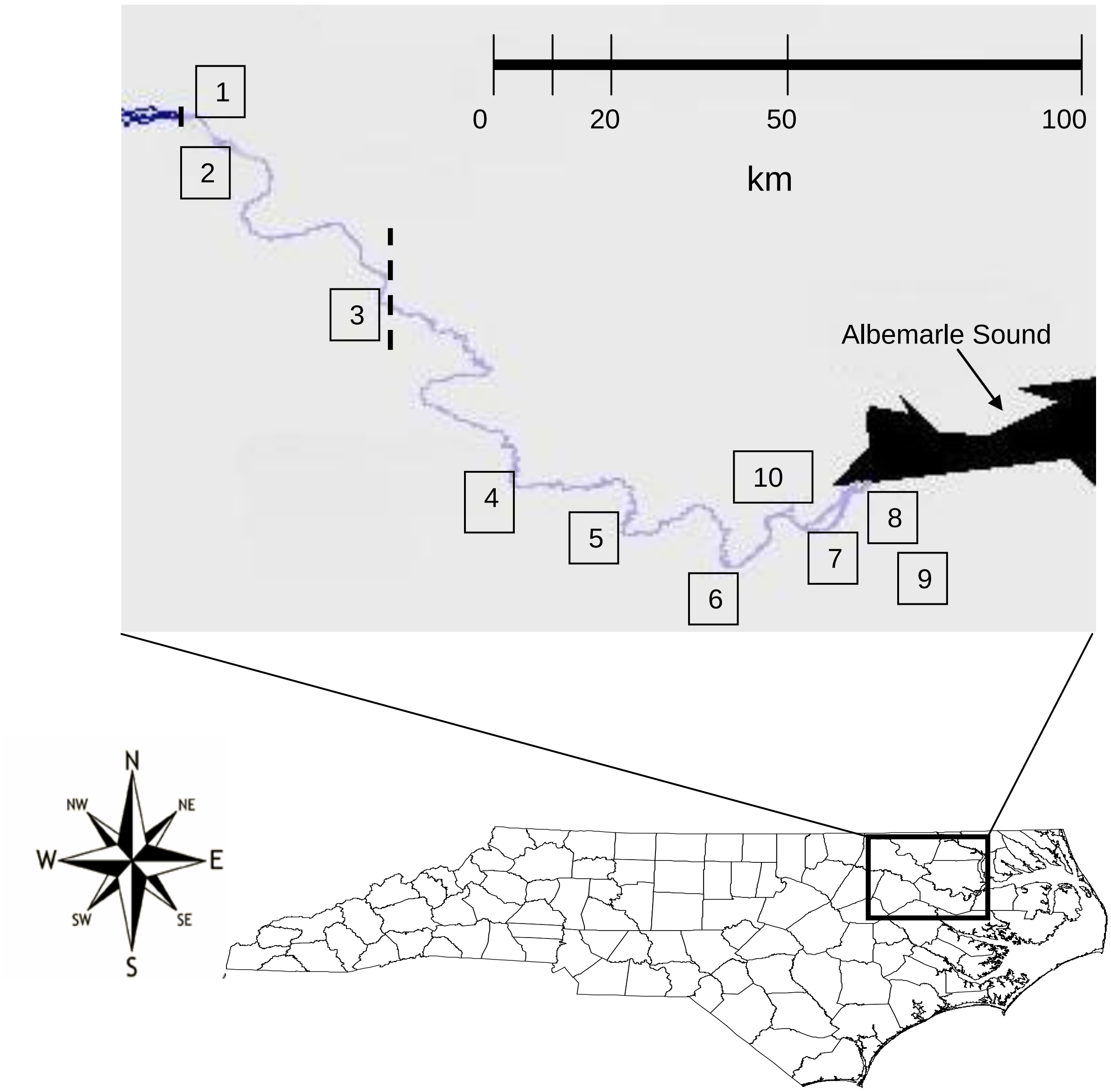


Figure 7. Map of angler creel survey interview locations on the Roanoke River during spring 2008. The dashed line indicates the demarcation point between the upper and lower zones. Zone 1 access areas as numbered in the boxes include: 1) Gaston (US HWY 48); 2) Weldon; and 3) Scotland Neck (Edwards Ferry US HWY 258). Zone 2 access areas include: 4) Hamilton; 5) Williamston; 6) Jamesville; 7) Plymouth; 8) US HWY 45; 9) Conaby Creek; and 10) Sans Souci (Cashie River).

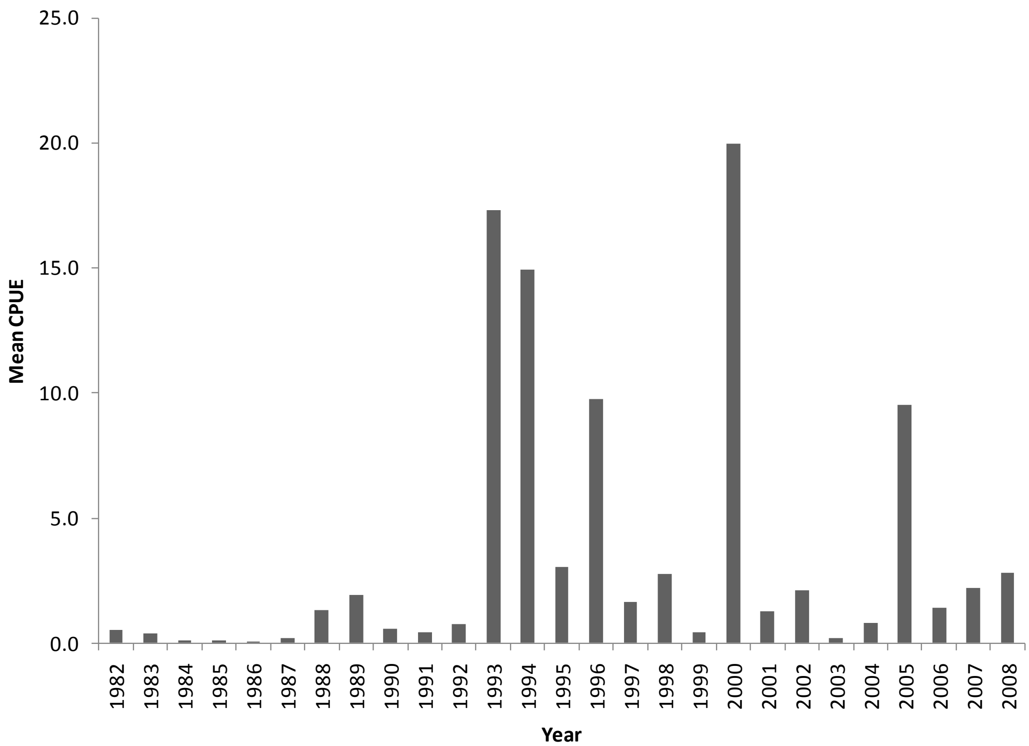


Figure 8. Annual geometic mean catch per tow of age-0 striped bass in western Albemarle Sound, NC 1982-2008.

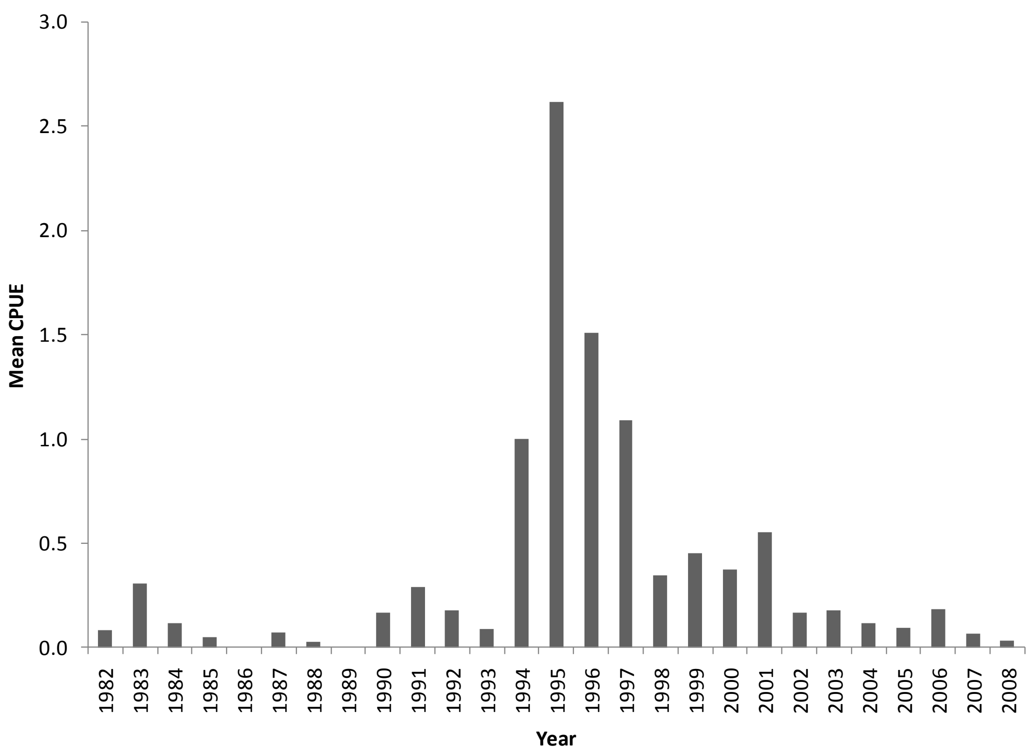


Figure 9. Annual geometic mean catch per tow of age-1 striped bass in western Albemarle Sound, NC 1982-2008.

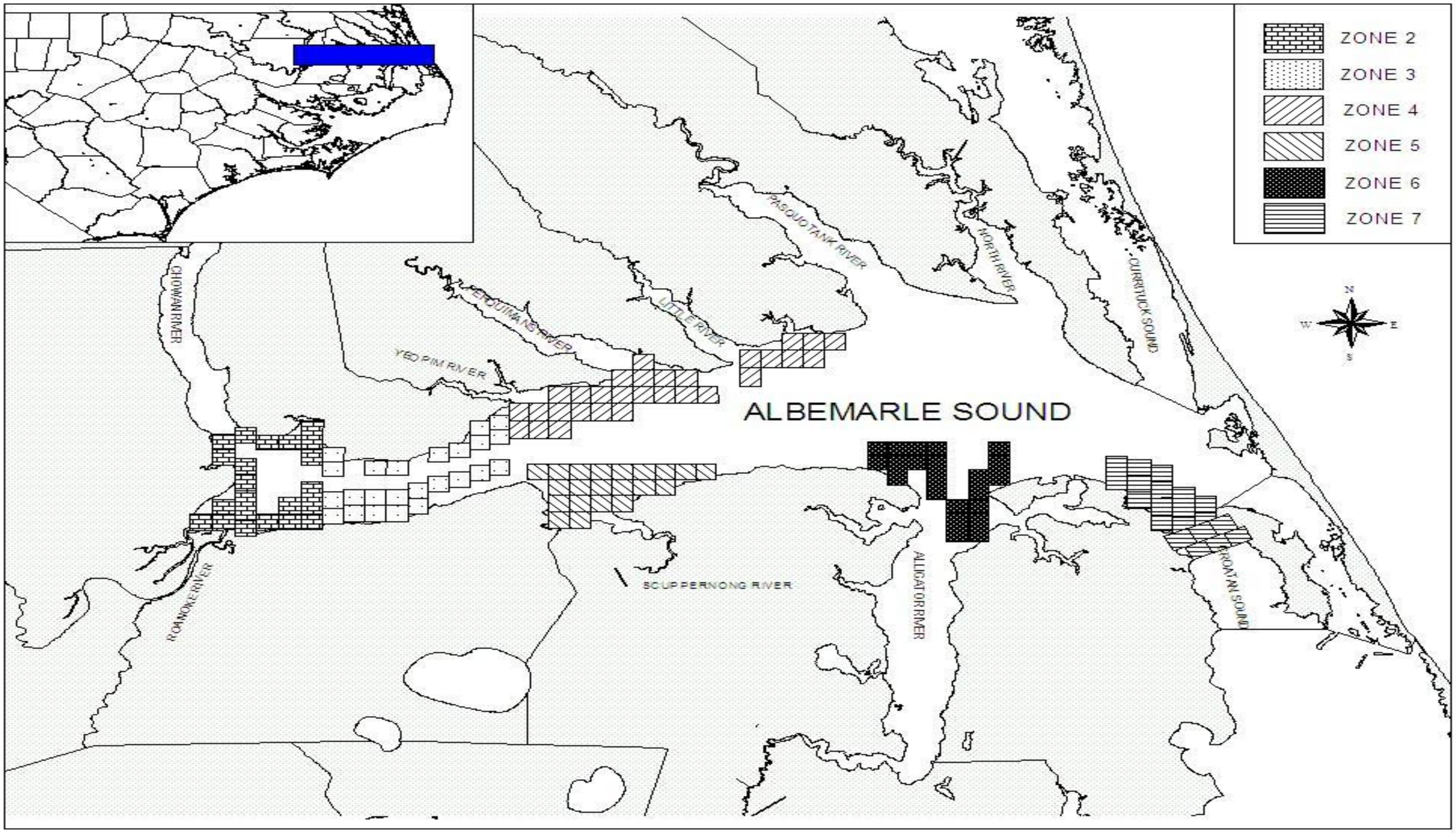


Figure 10. Sample zones for the NCDMF Independent Gill Net Survey, Albemarle and Croatan Sounds, NC 2008.

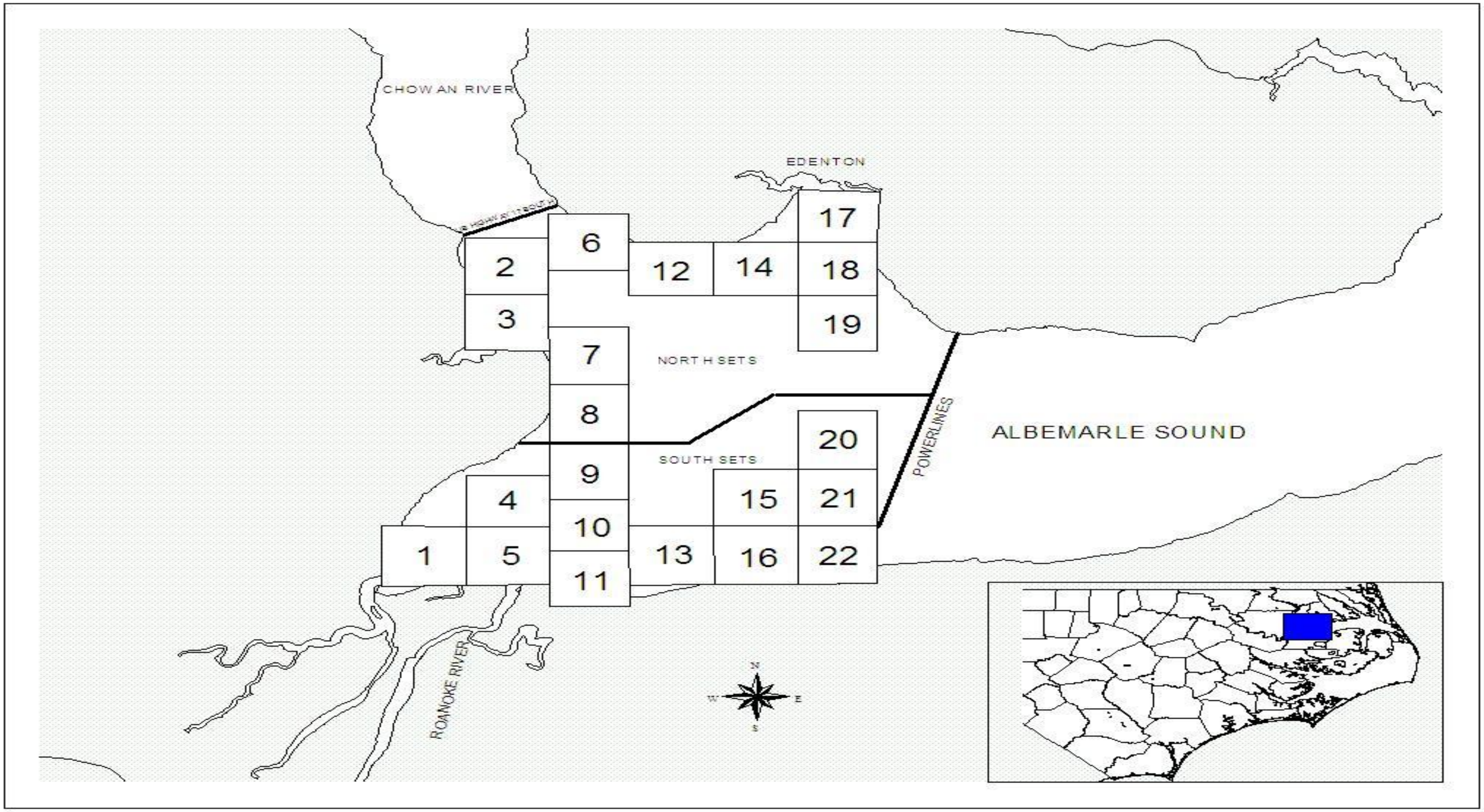


Figure 11. Sample Zone II and the north/south quadrants for the spring NCDMF Independent Gill Net Survey, Albemarle Sound, NC 2008.

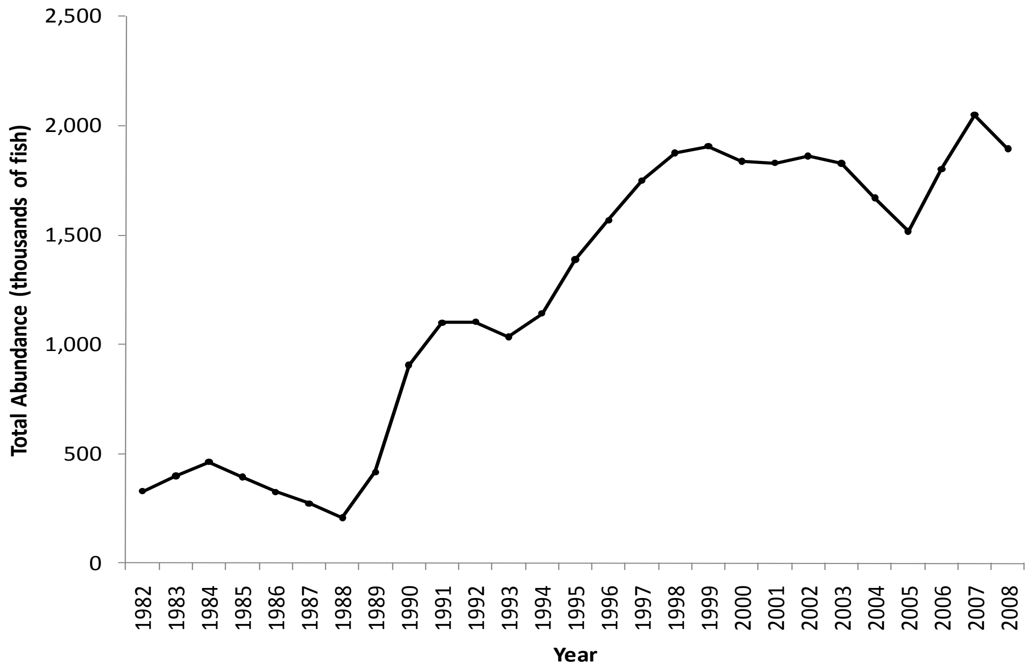


Figure 12. Estimated total annual abundance of striped bass from ASMA/RRMA, NC 1982-2008.

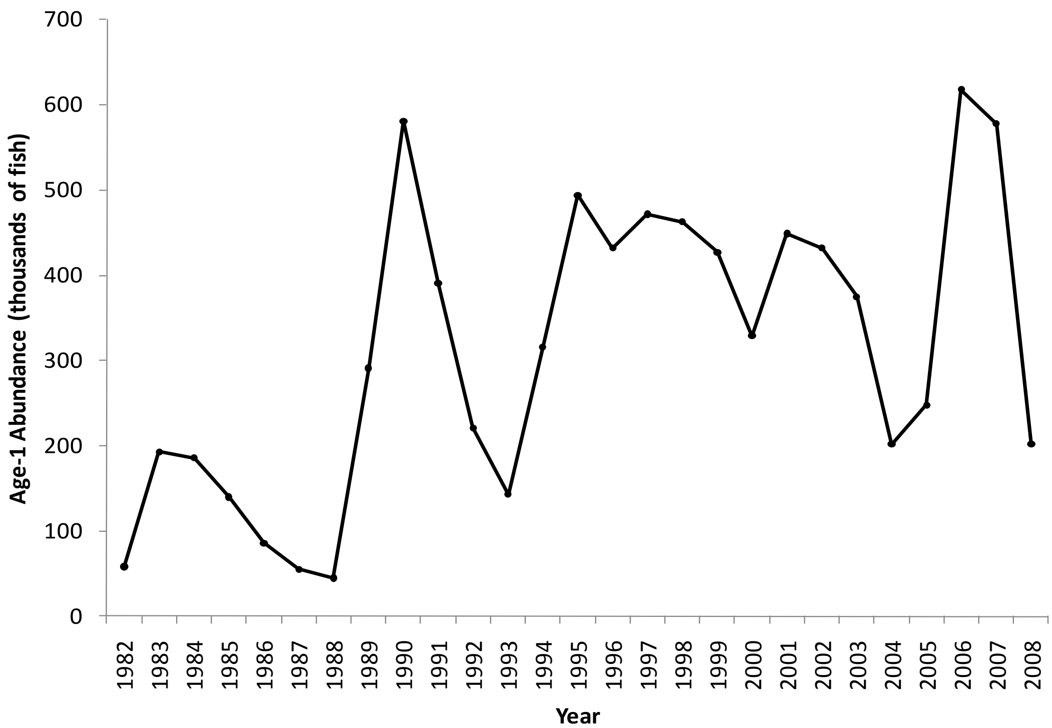


Figure 13. Estimated recruitment of striped bass at age-1 from ASMA/RRMA, NC 1982-2008.

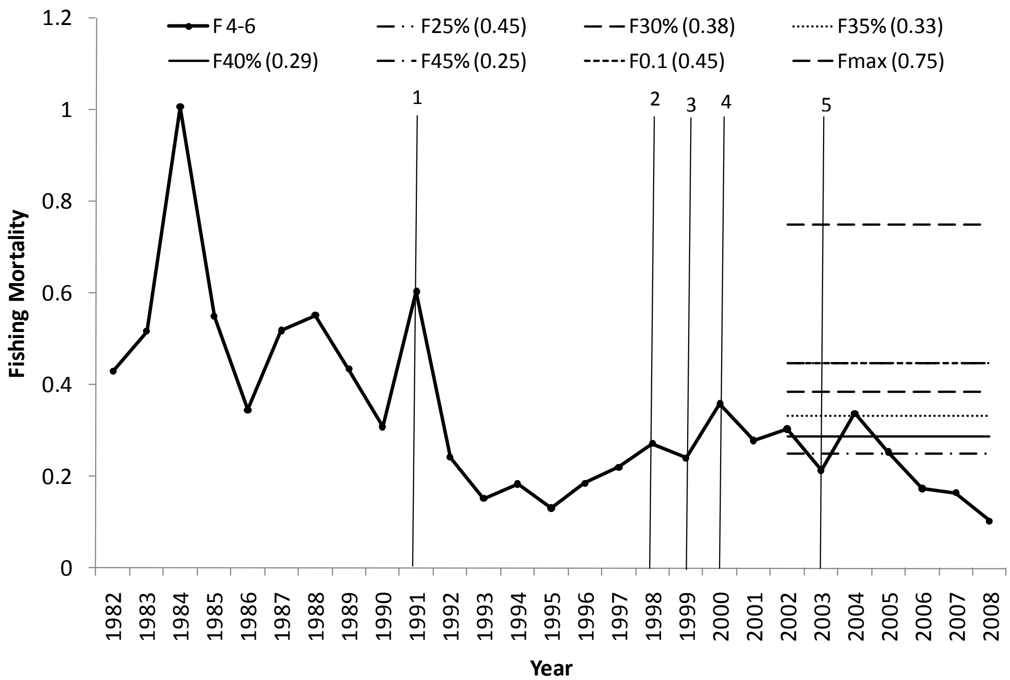


Figure 14. Trend in age 4-6 striped bass fishing mortality from ASMA/RRMA, NC 1982-2008. Fishing mortality biological reference points included. The vertical lines indicate changes in the TAC as follows: 1) 156,800 lb, 2) 250,440 lb, 3) 275,968 lb, 4) 450,000 lb, and 5) 550,000 lb.

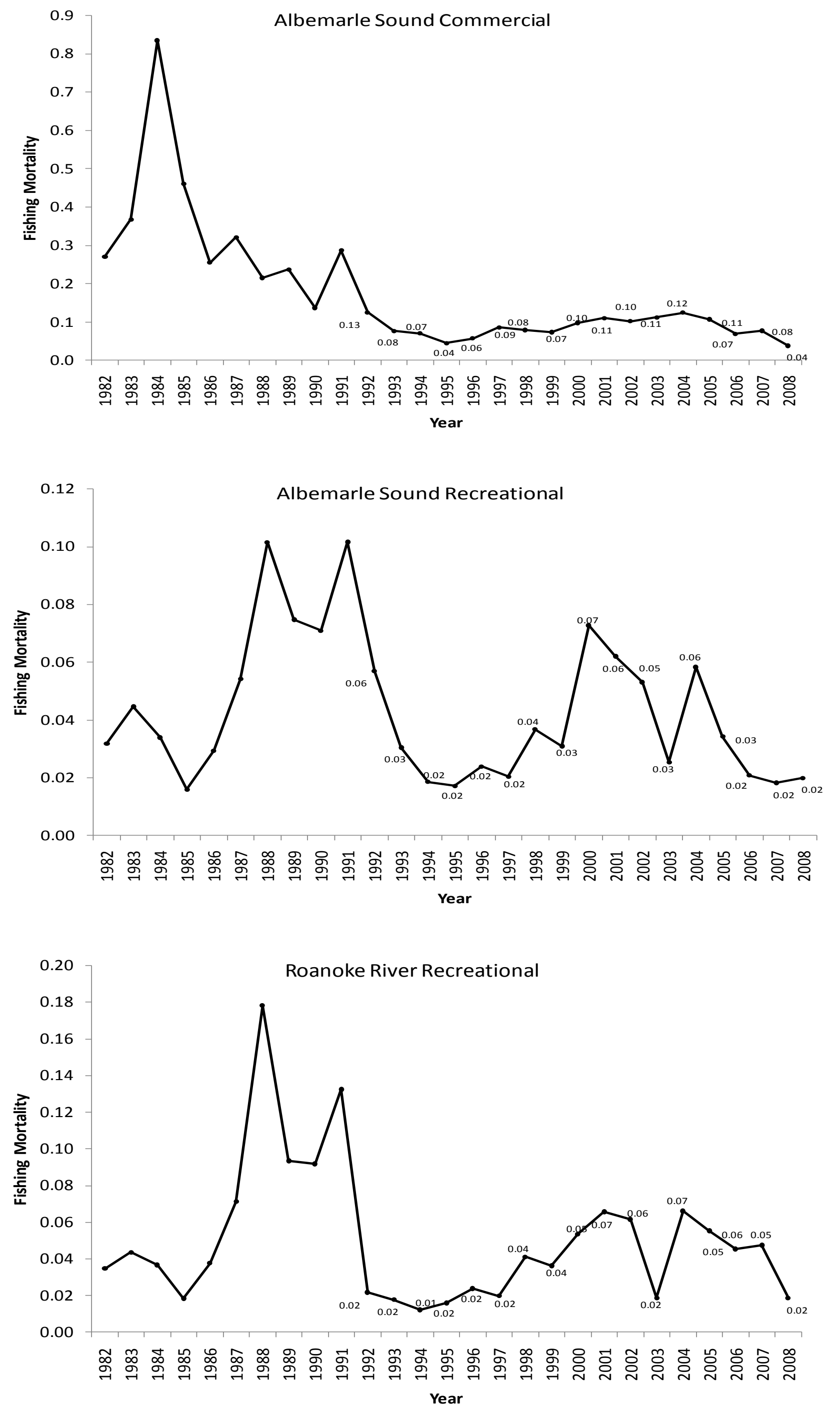


Figure 15. Directed fishing mortality (excludes discard) of striped bass by fishery from ASMA/RRMA, NC 1982-2008.

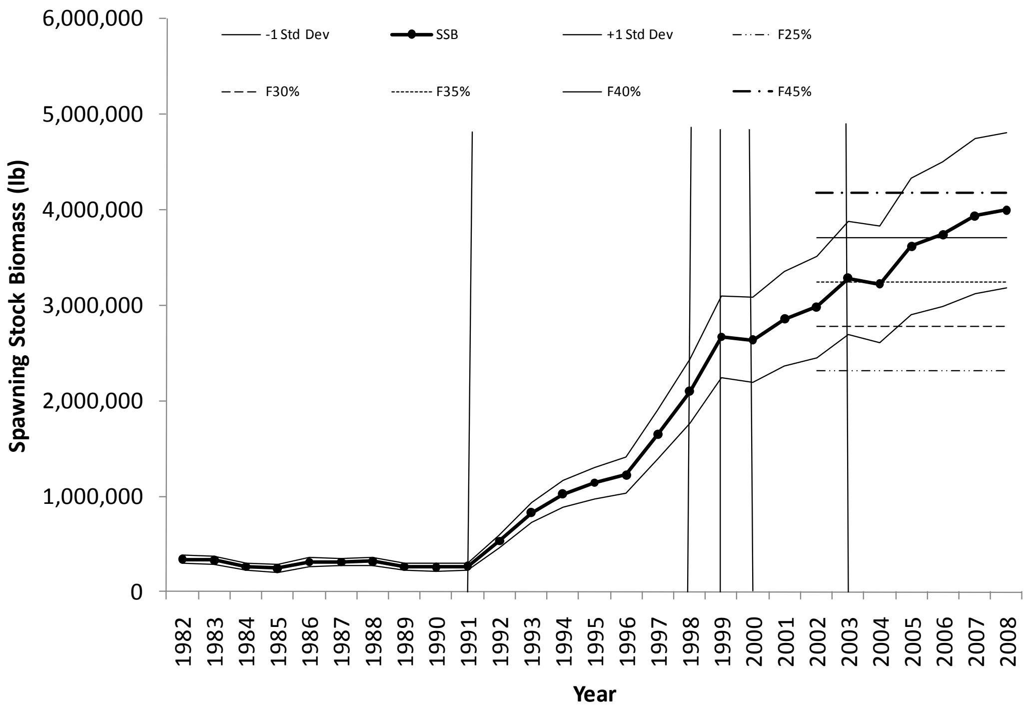


Figure 16. Spawning stock biomass of female striped bass in pounds from ASMA/RRMA, NC 1982-2008. Includes the range of potential biological reference points. The vertical lines indicate changes in the TAC as follows: 1) 156,800 lb, 2) 250,440 lb, 3) 275,968 lb, 4) 450,000 lb, and 5) 550,000 lb.

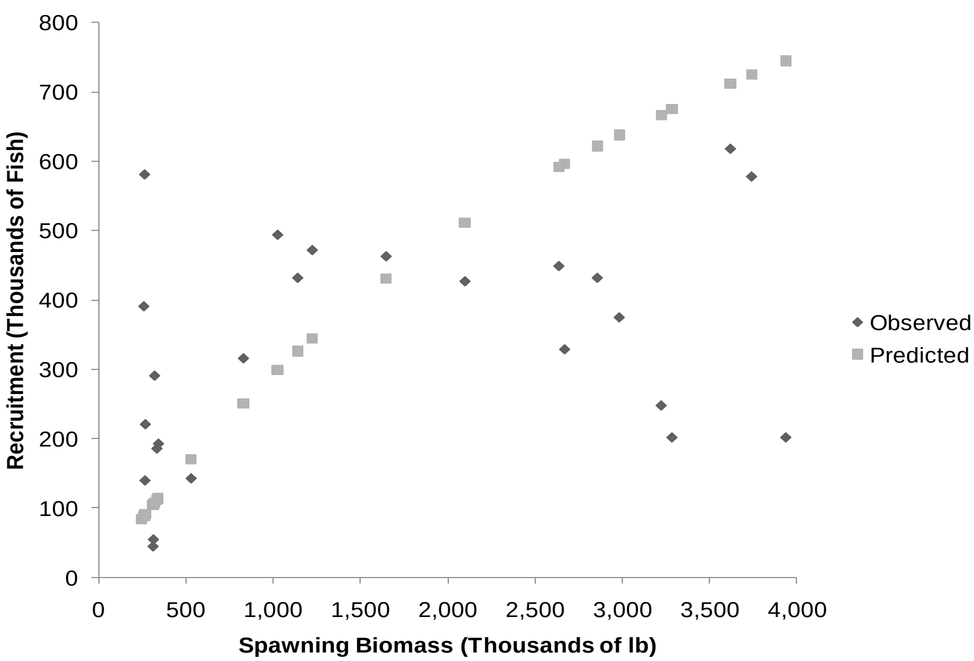


Figure 17. Stock-recruit relationship estimated from ASAP2 for striped bass recruits in numbers of fish from female SSB.

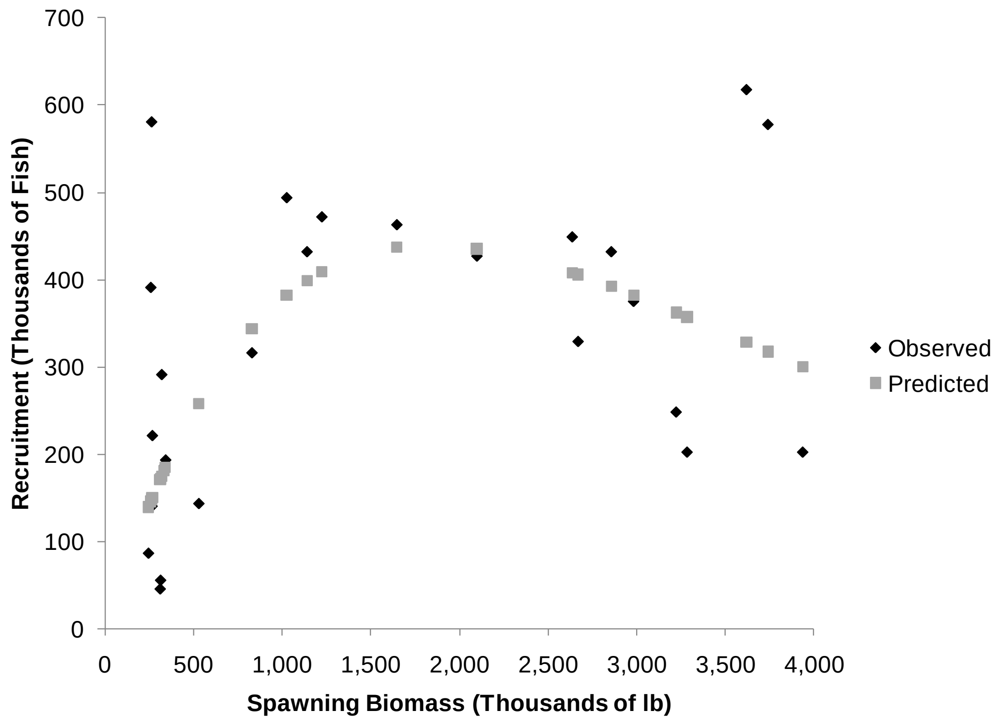


Figure 18. Stock-recruit relationship estimated by a Ricker model for striped bass recruits in numbers of fish from female SSB.

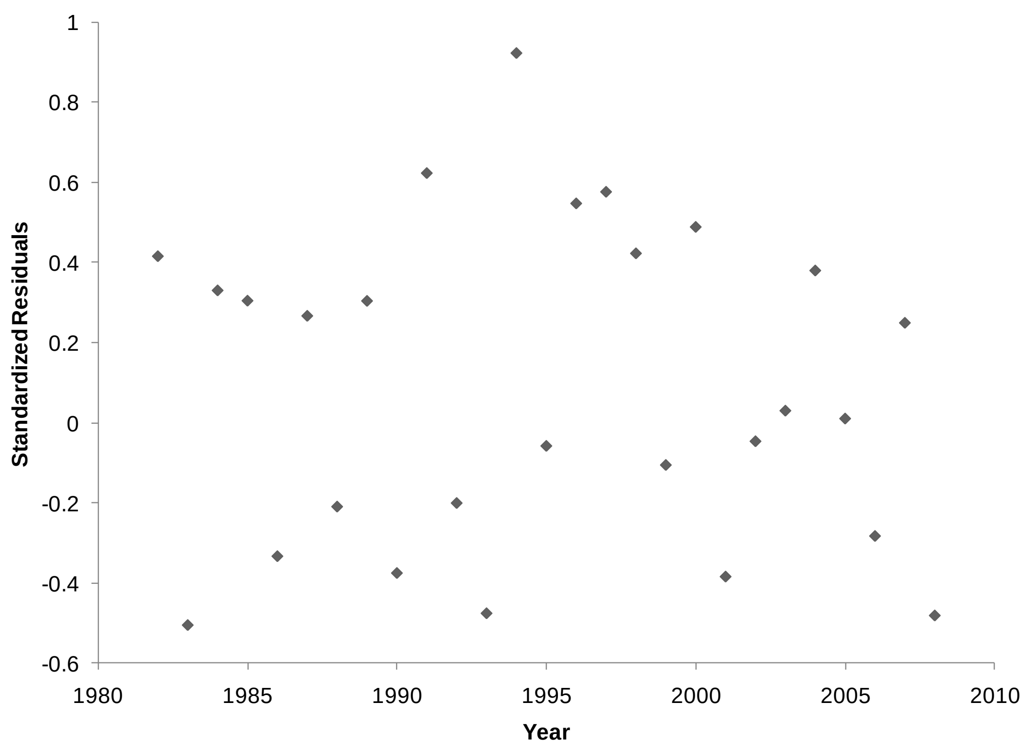


Figure 19. Standardized residuals for the Albemarle Sound commercial fishery from the ASAP2 model.

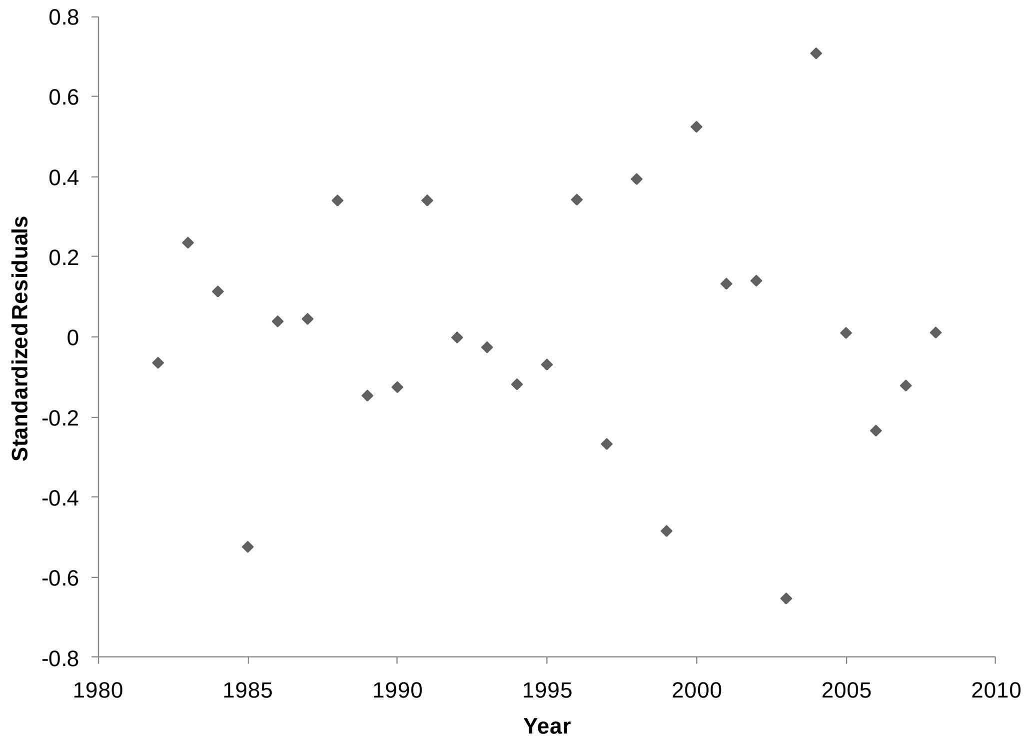


Figure 20. Standardized residuals for the Albemarle Sound recreational fishery from the ASAP2 model.

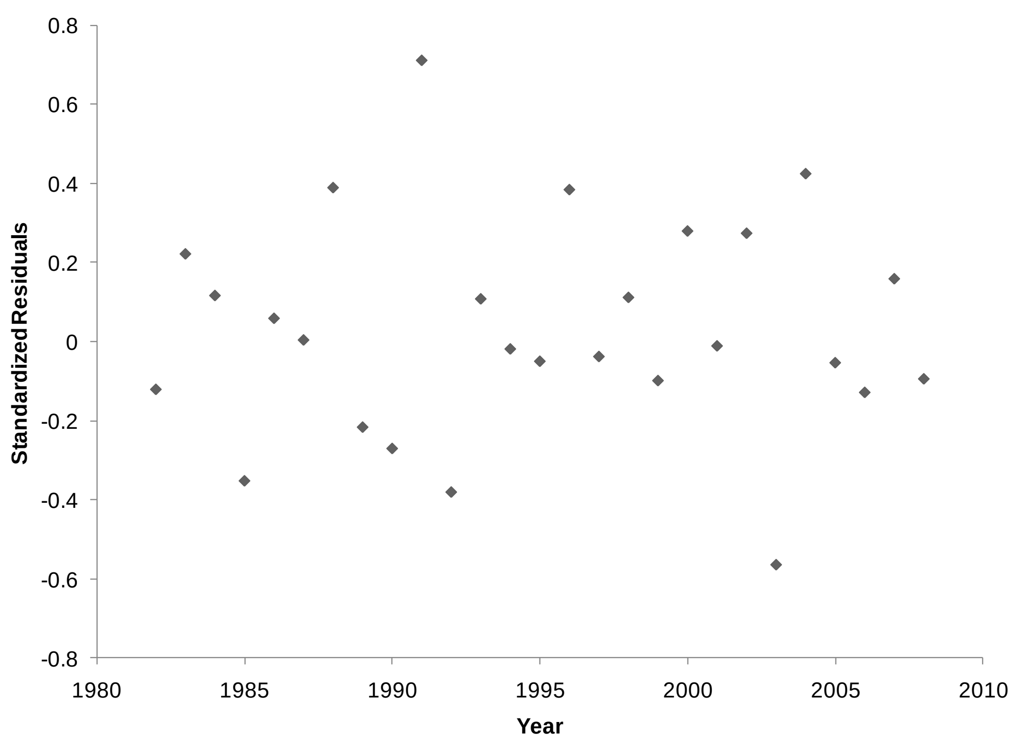


Figure 21. Standardized residuals for the Roanoke River recreational fishery from the ASAP2 model

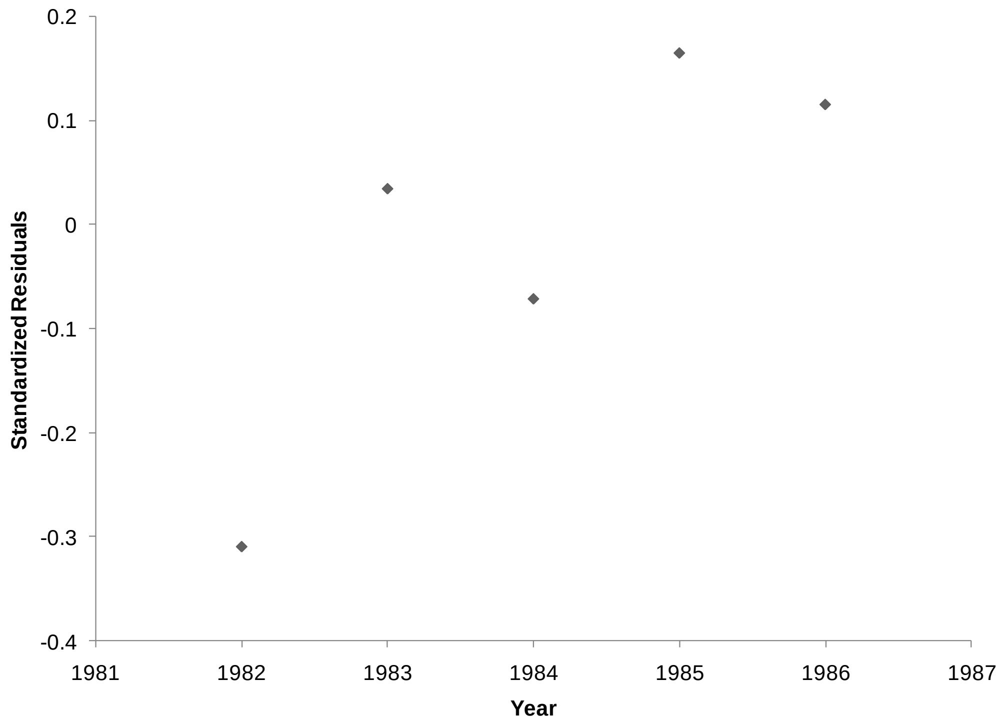


Figure 22. Standardized residuals for the Roanoke River commercial fishery from the ASAP2 model.

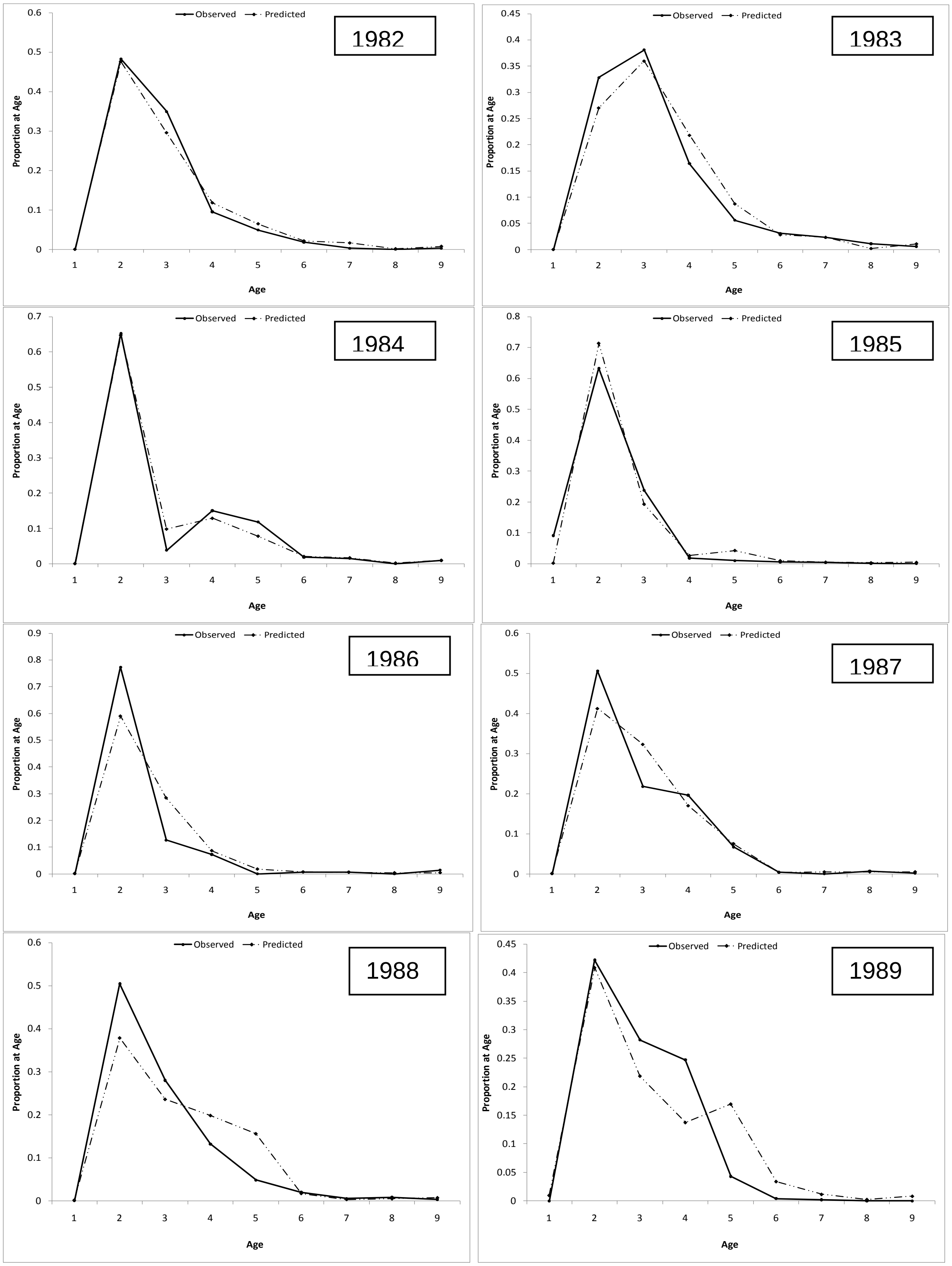


Figure 23. The Albemarle Sound commercial catch-at-age observed and predicted catch-at-ages by year. Page one covers 1982-1989.

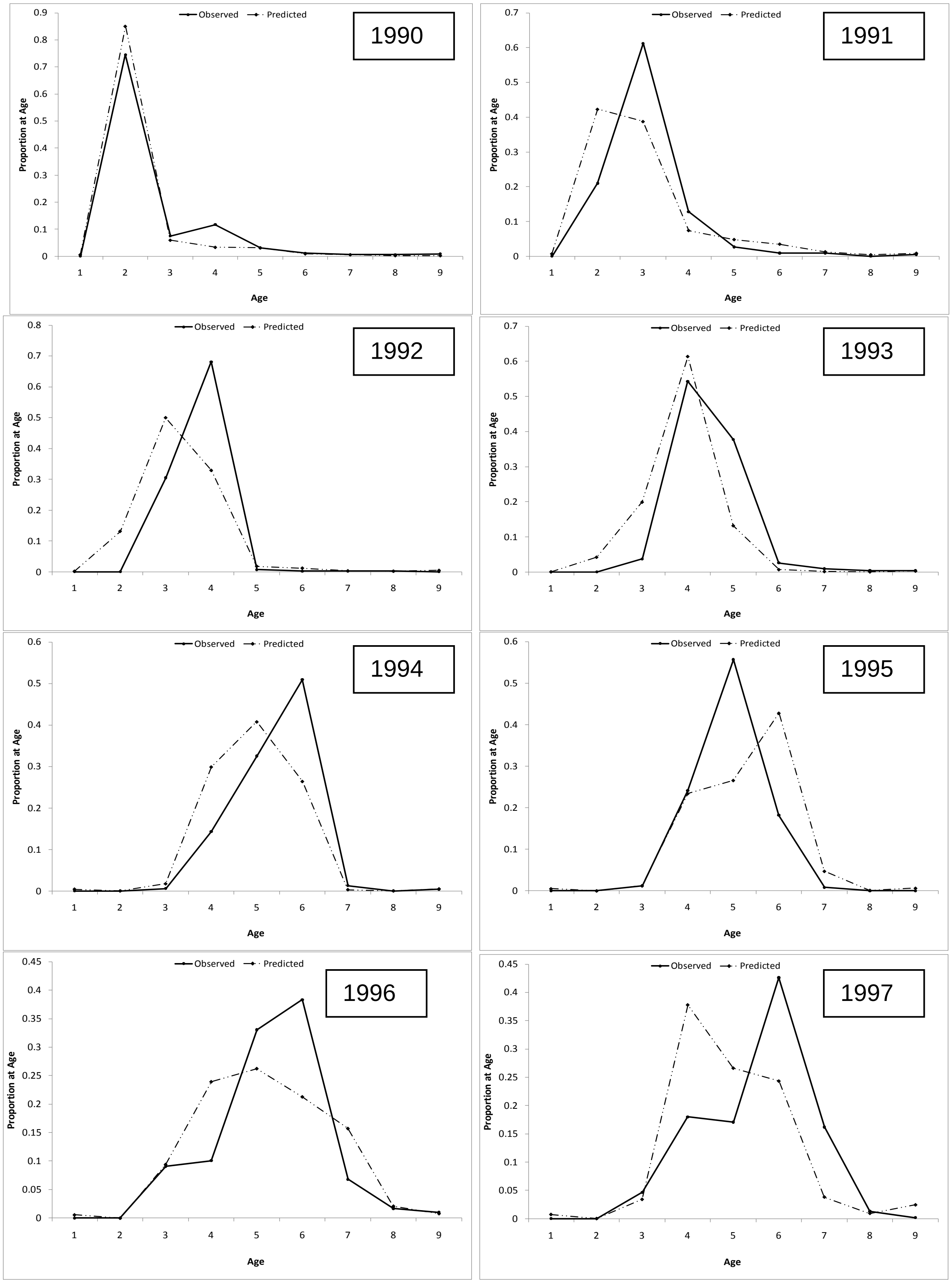


Figure 23. Continued for years 1990-1997.

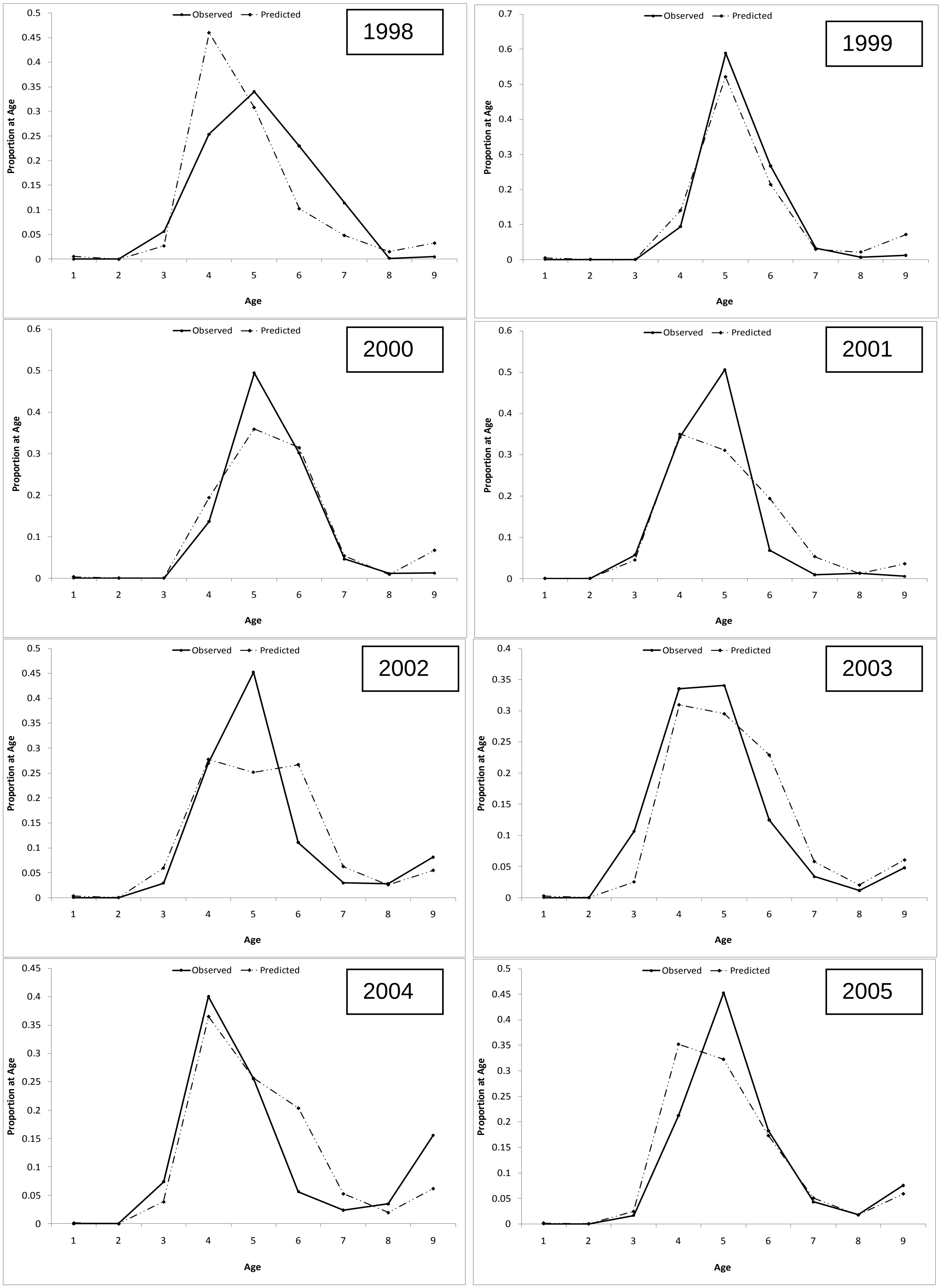


Figure 23. Continued for years 1998-2005.

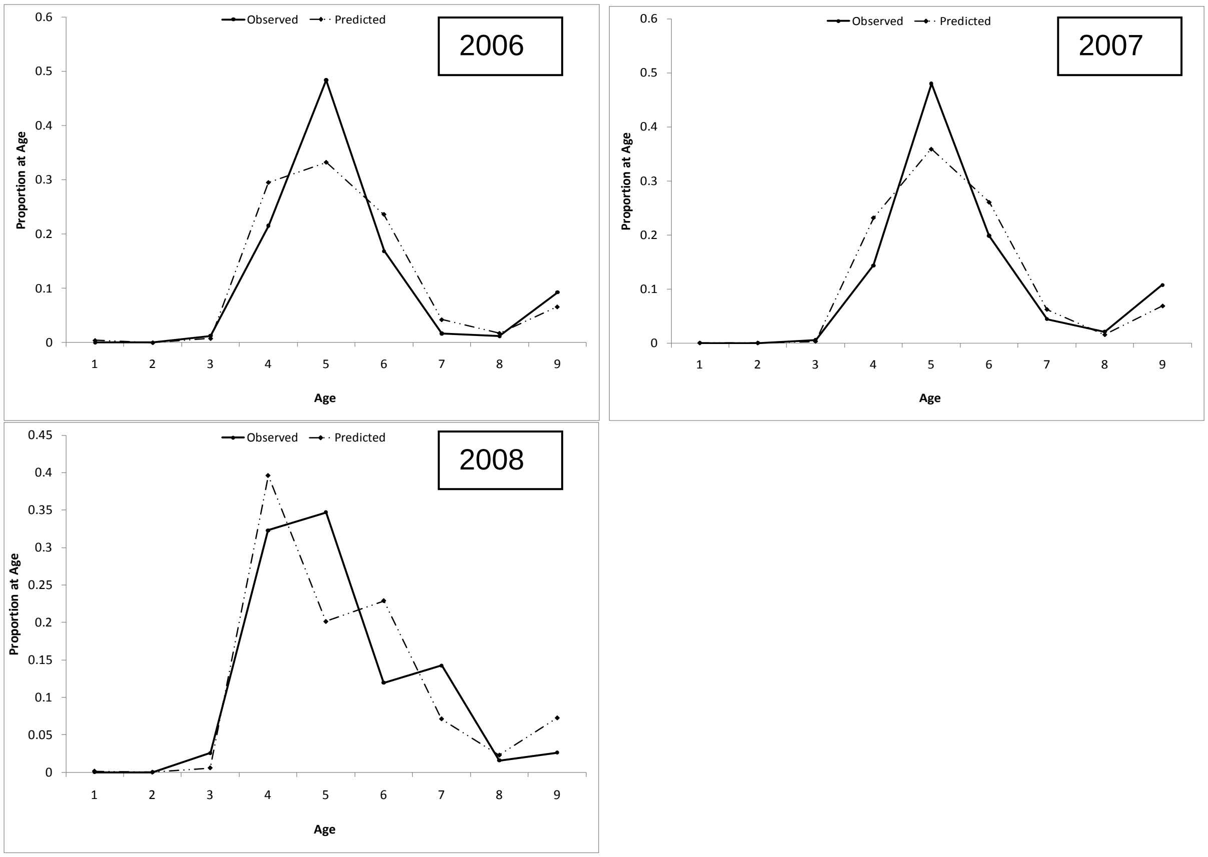


Figure 23. Continued for years 2006-2008.

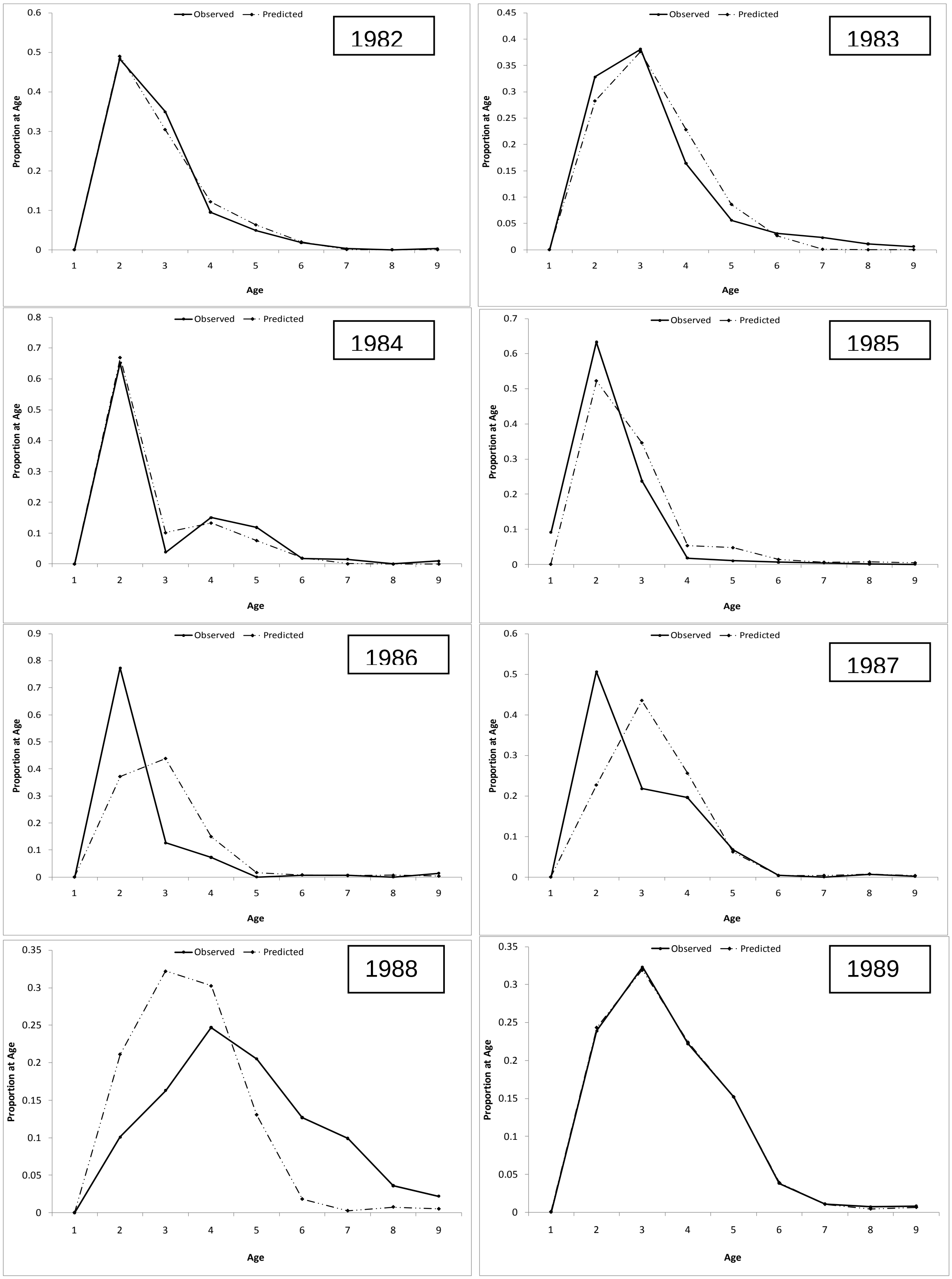

1982
1983
1984
1985
1986
1987
1988
1989
Observed
Predicted
Proportion at Age
Age

Figure 24. The Albemarle Sound recreational catch observed and predicted catch-at-ages by year. Page one covers 1982-1989.

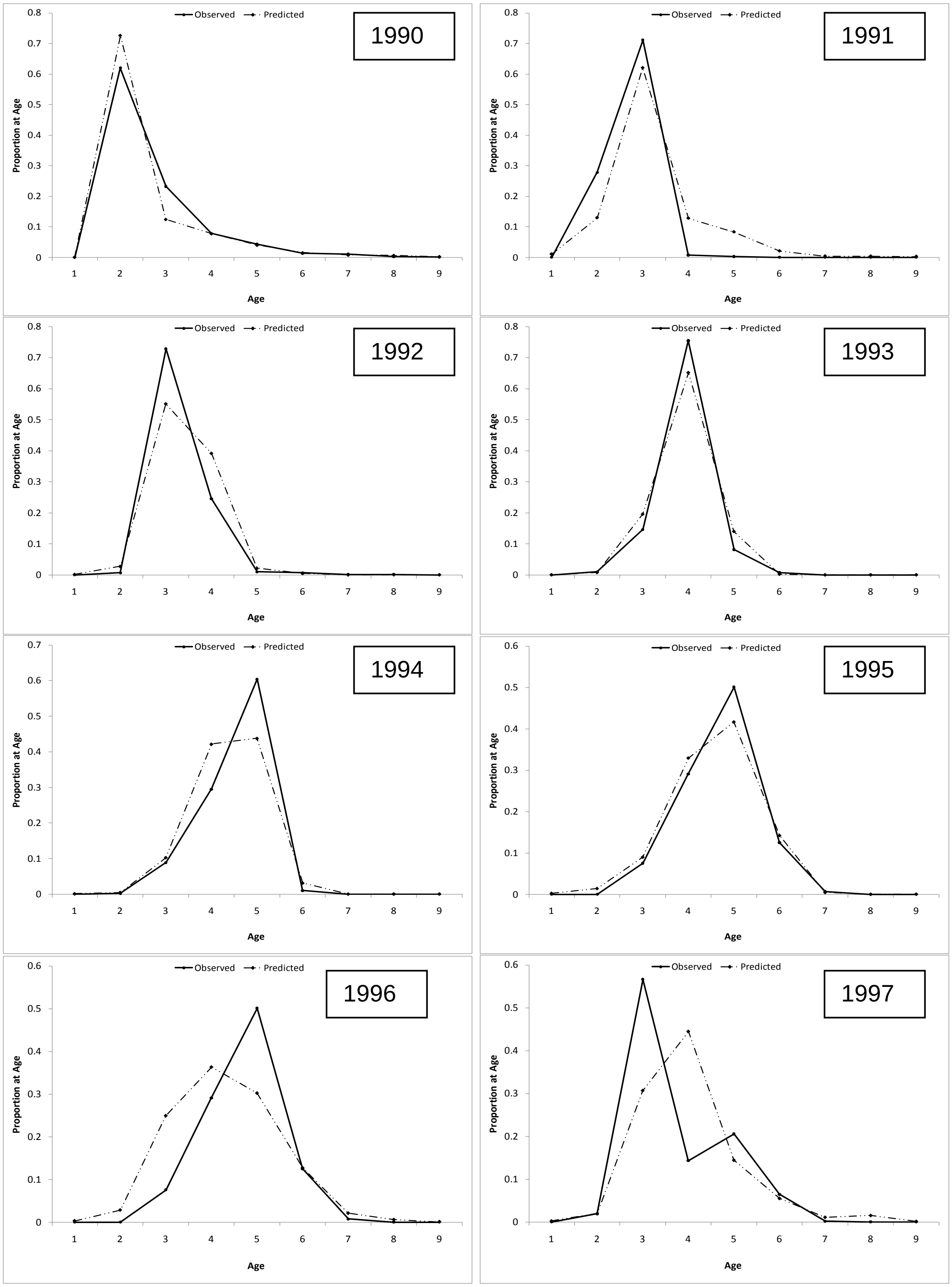


Figure 24. Continued for years 1990-1997.

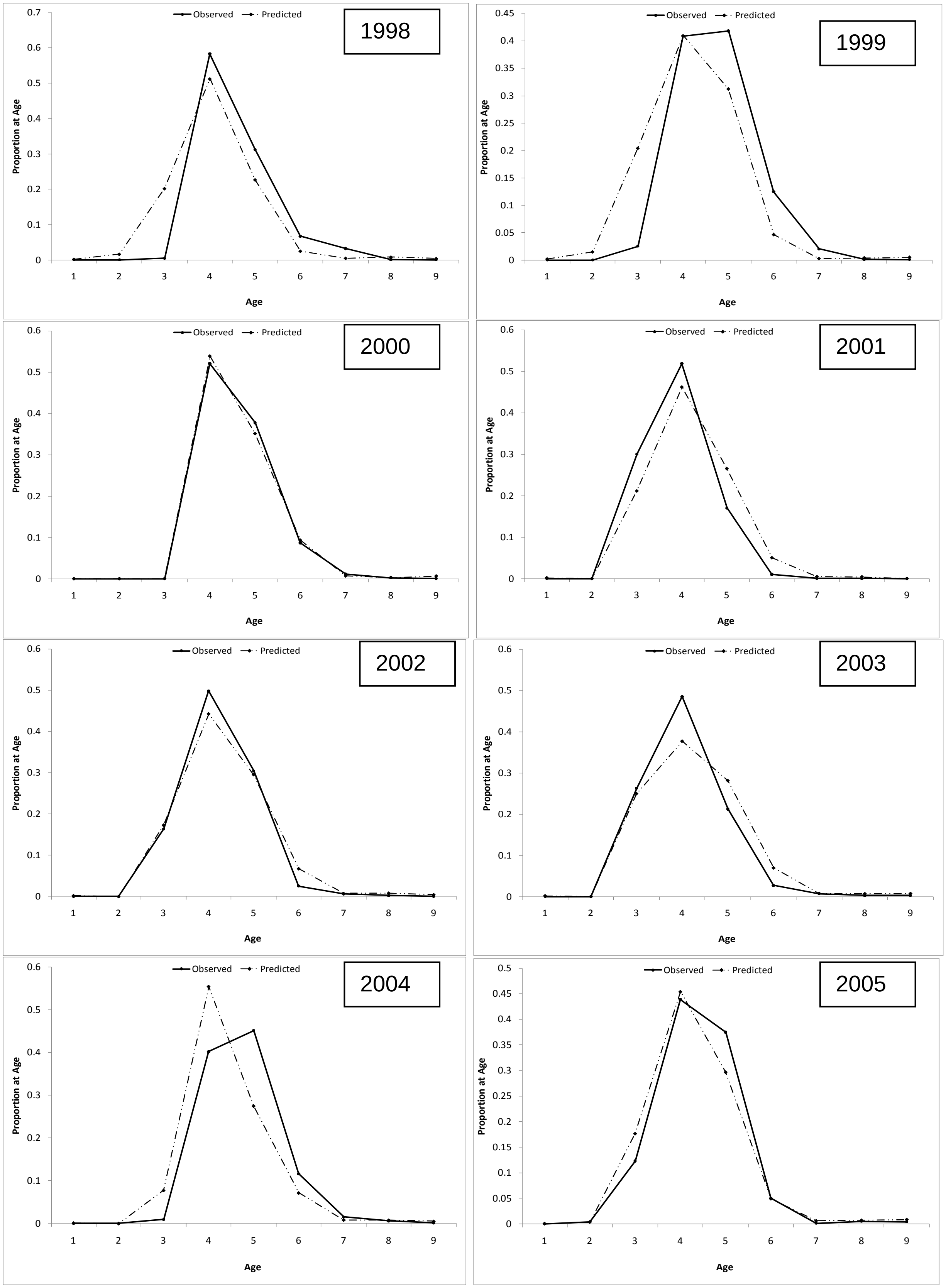

1998
1999
2000
2001
2002
2003
2004
2005
Observed
Predicted
Proportion at Age
Age

Figure 24.	Continued for years 1998-2005.

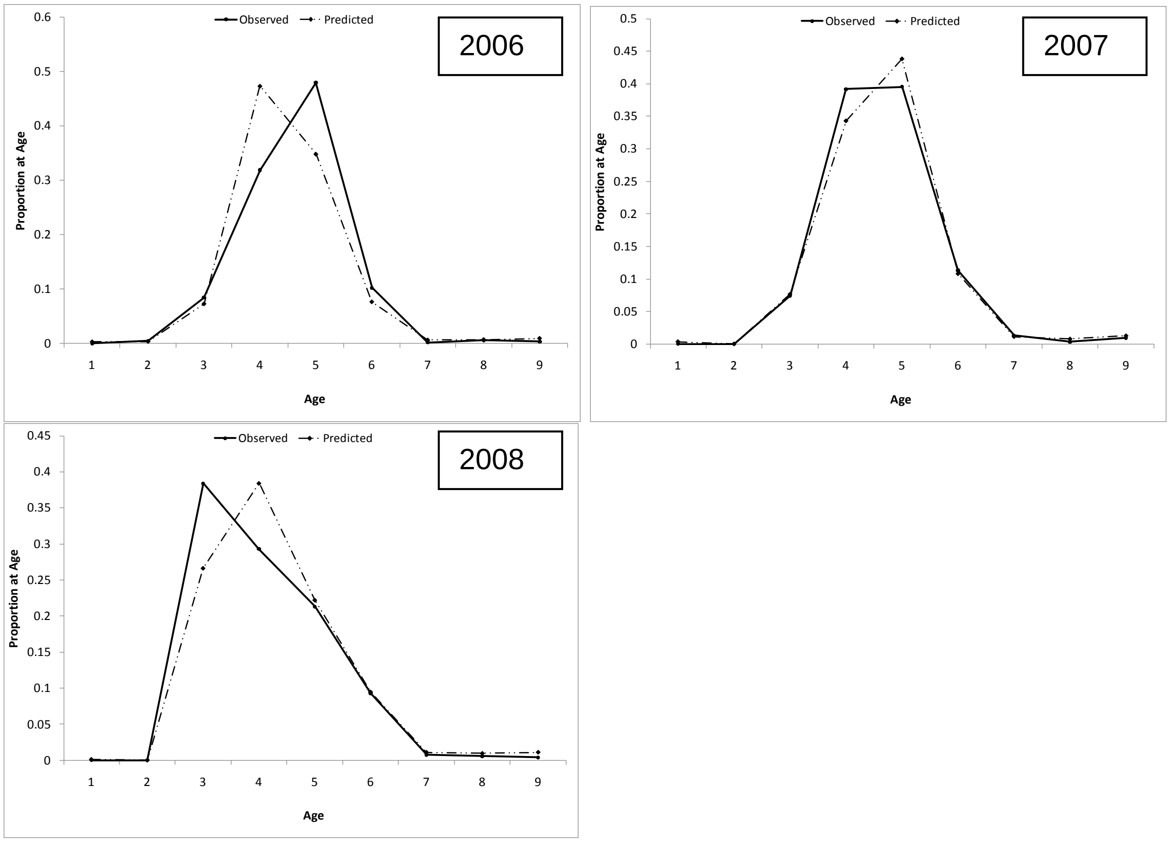


Figure 24.	Continued for years 2006-2008.

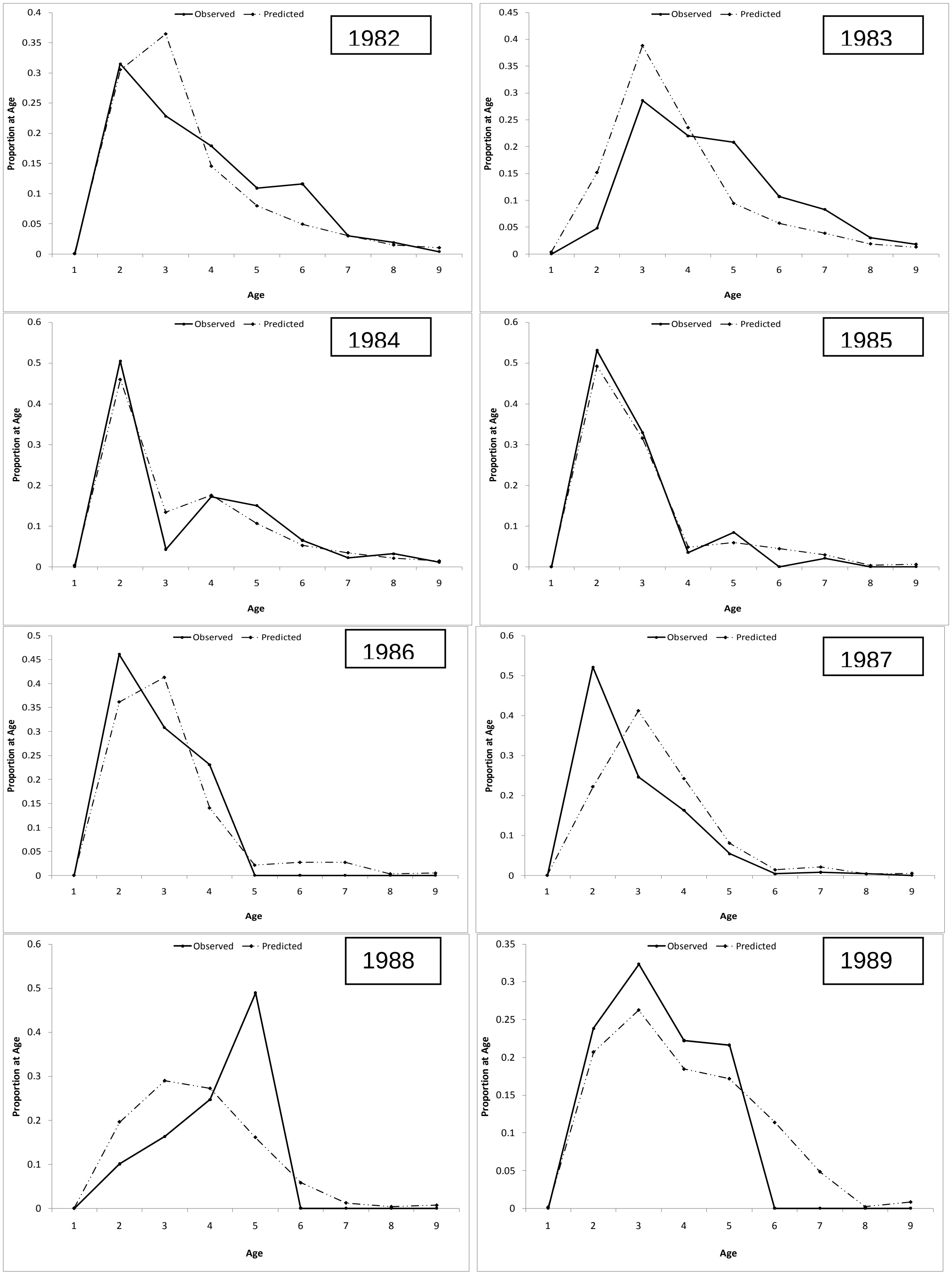

1982
1983
1984
1985
1986
1987
1988
1989
Observed
Predicted
Proportion at Age
Age

Figure 25. The Roanoke River recreational catch observed and predicted catch-at-ages by year. Page one covers 1982-1989.

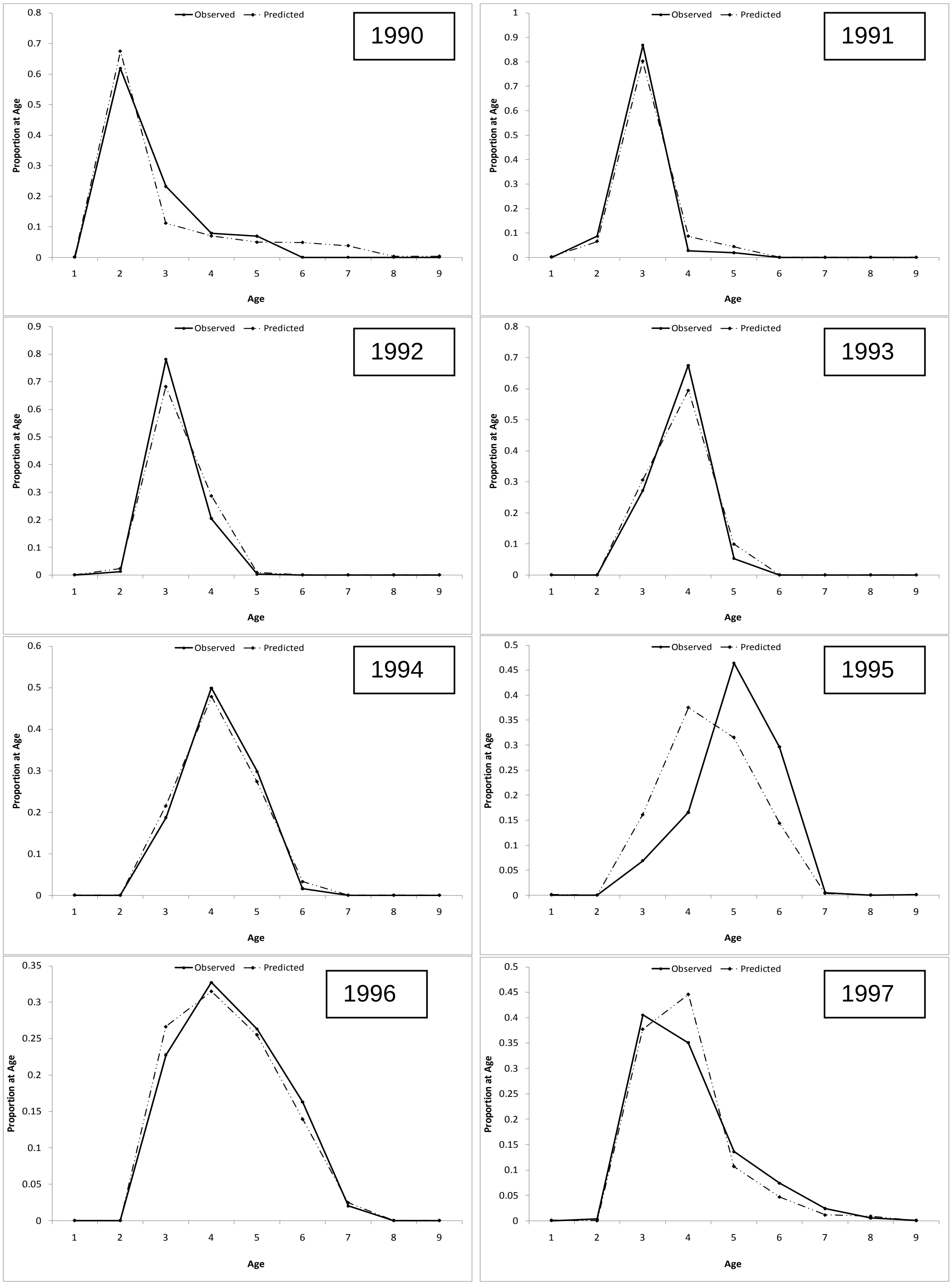
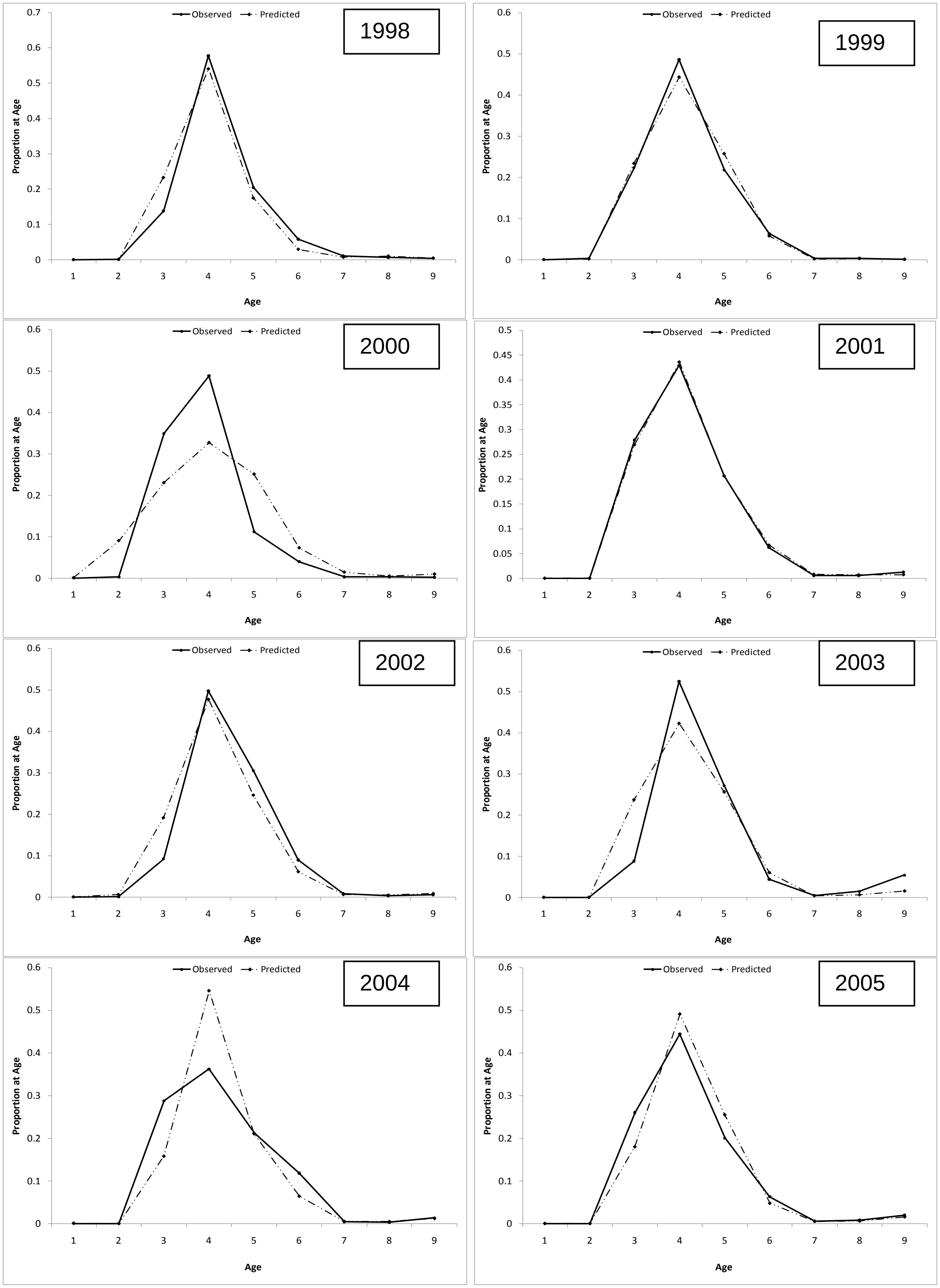


Figure 25. Continued for years 1990-1997.



1998
1999
2000
2001
2002
2003
2004
2005
Observed
Predicted
Proportion at Age
Age

Figure 25. Continued for years 1998-2005.

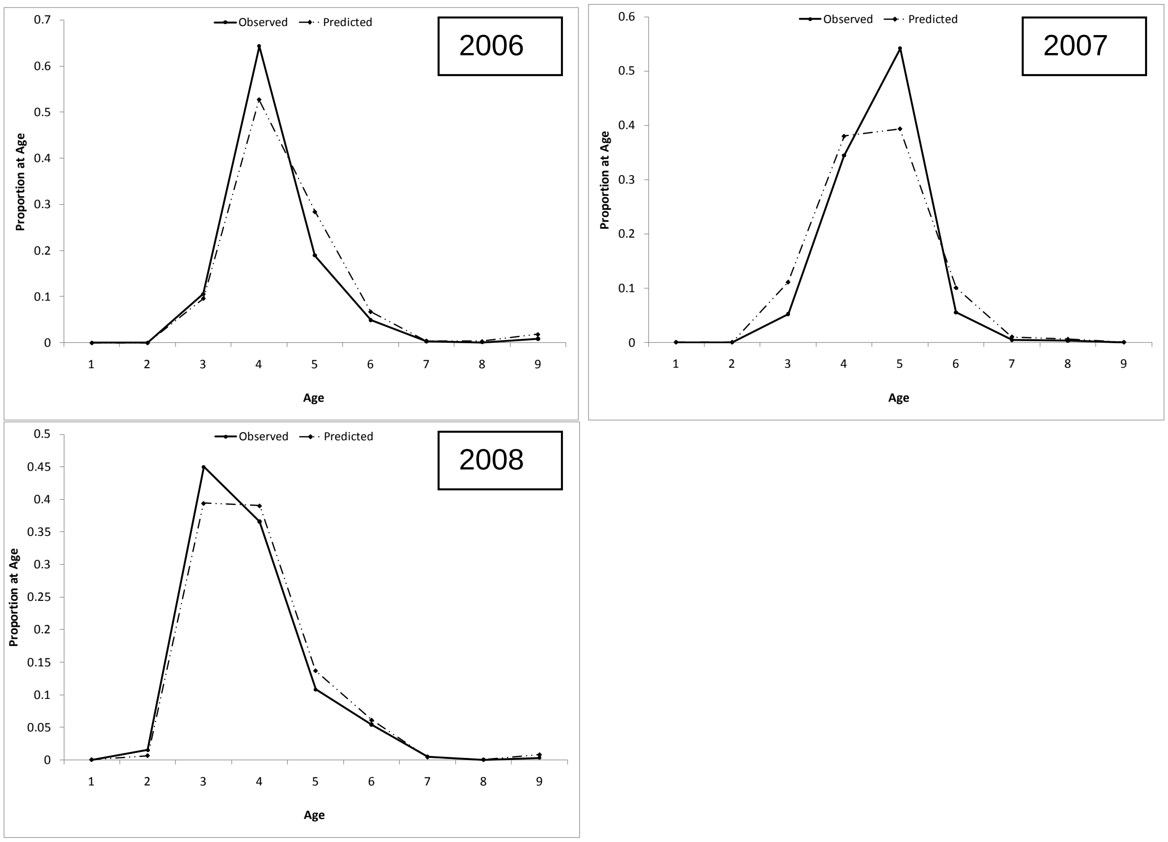


Figure 25. Continued for years 2006-2008.

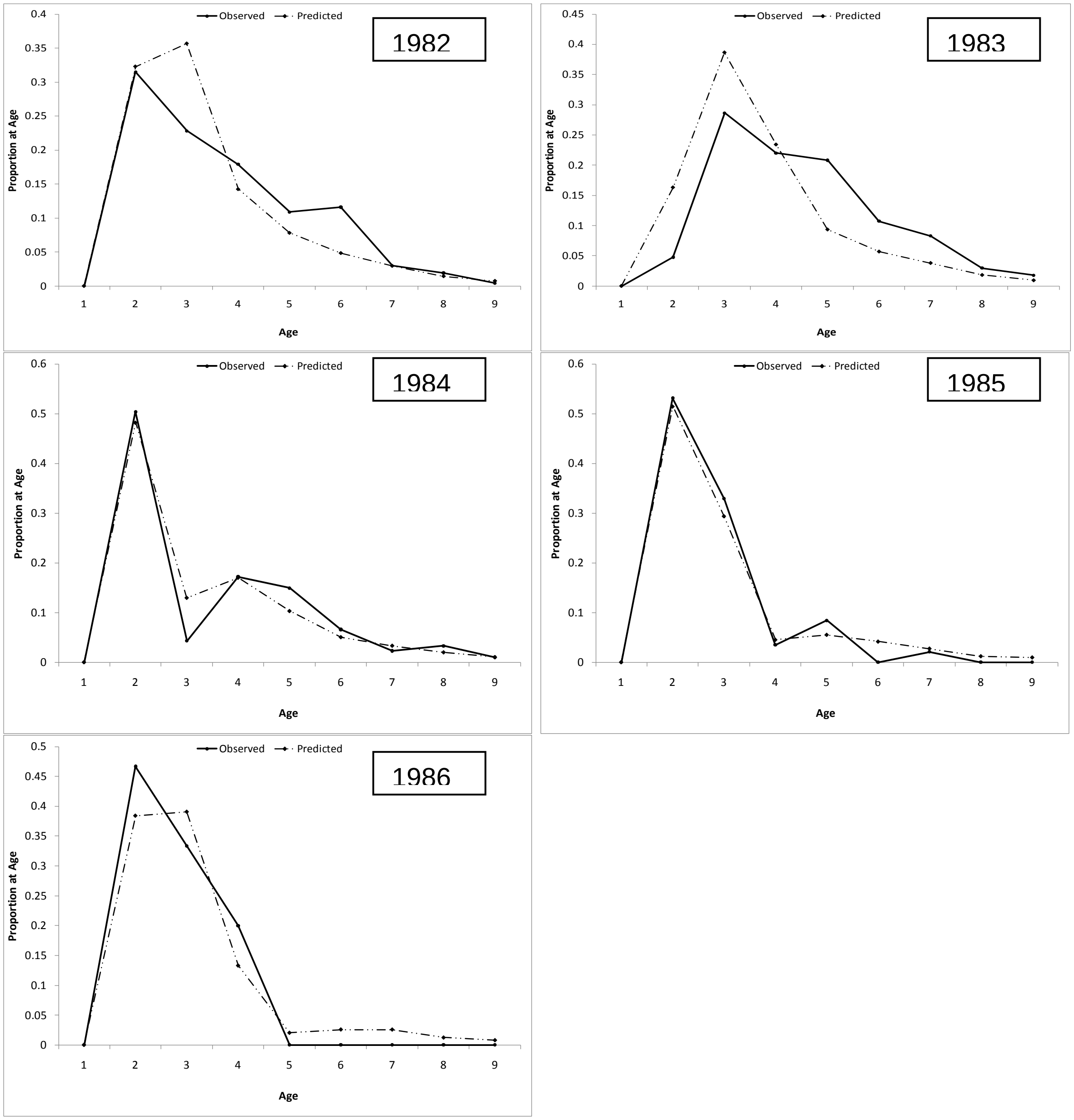


Figure 26. The Roanoke River commercial catch observed and predicted catch-at-ages by year. Page one covers 1982-1986.

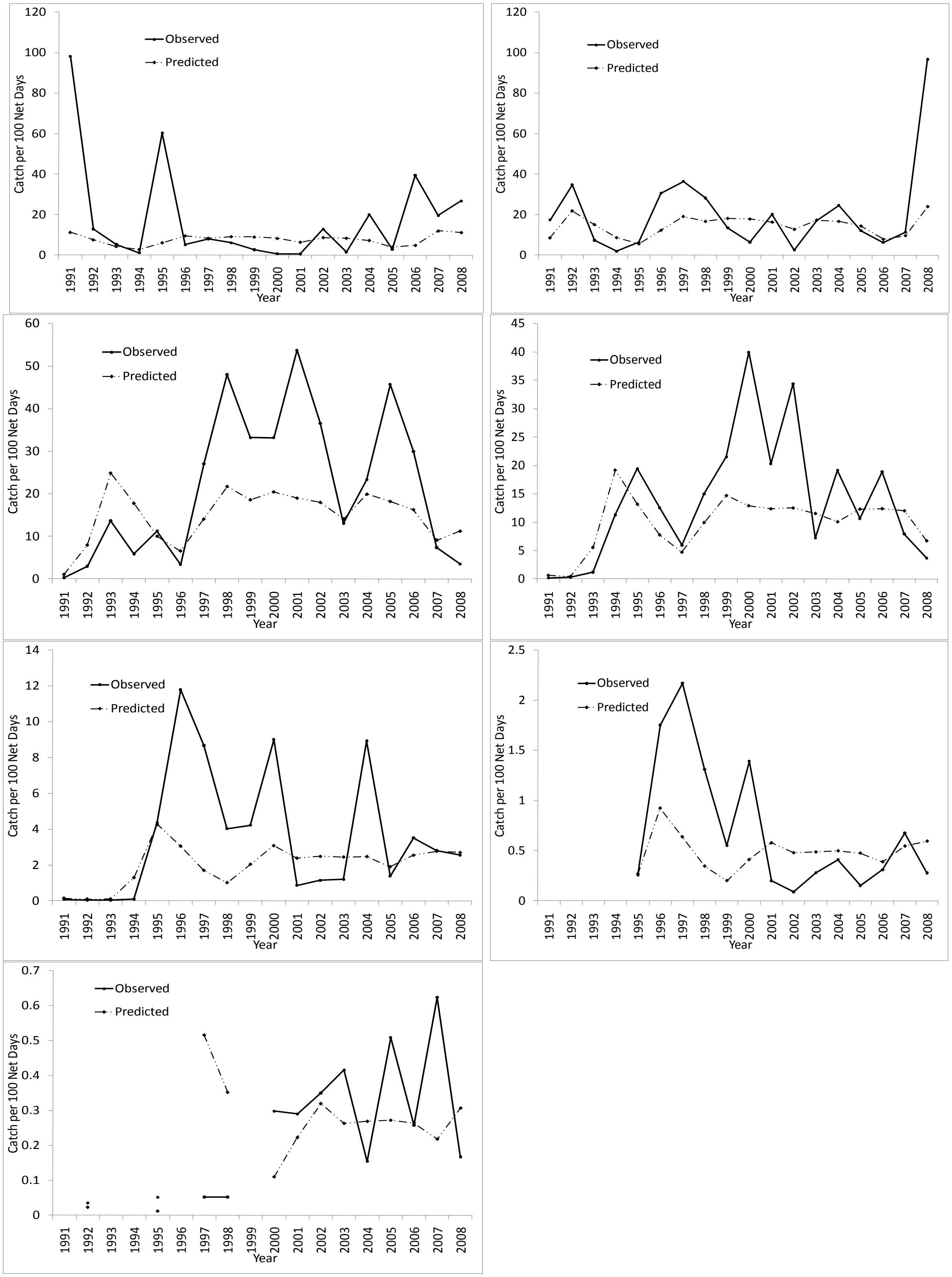


Figure 27. Striped bass index fits for spring IGNS index for ages 2 – 8 from Albemarle Sound, NC 1991-2008

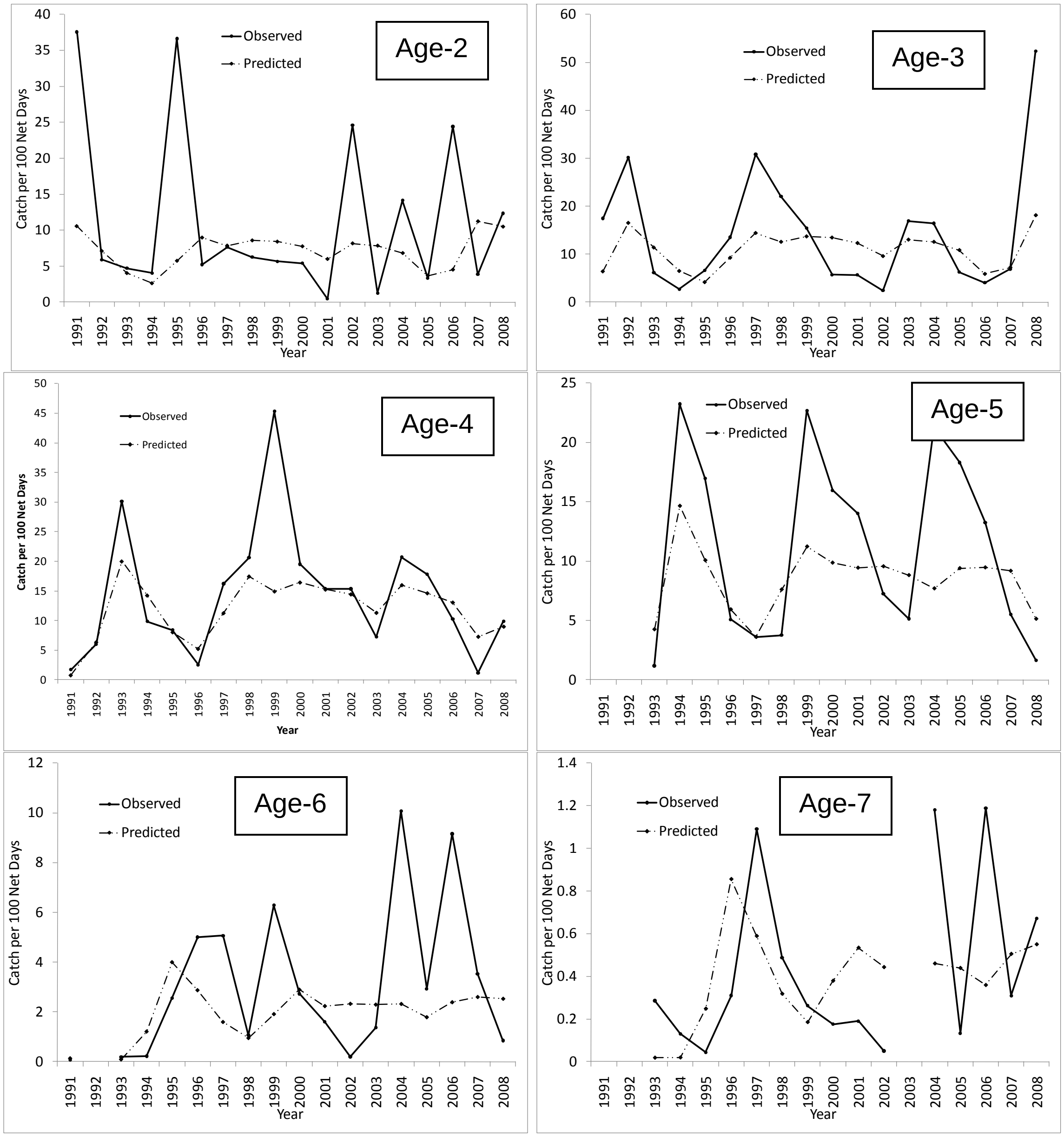


Figure 28. Striped bass index fits for the fall/winter IGNS index for ages 2-7 from Albemarle Sound, NC 1991-2008.

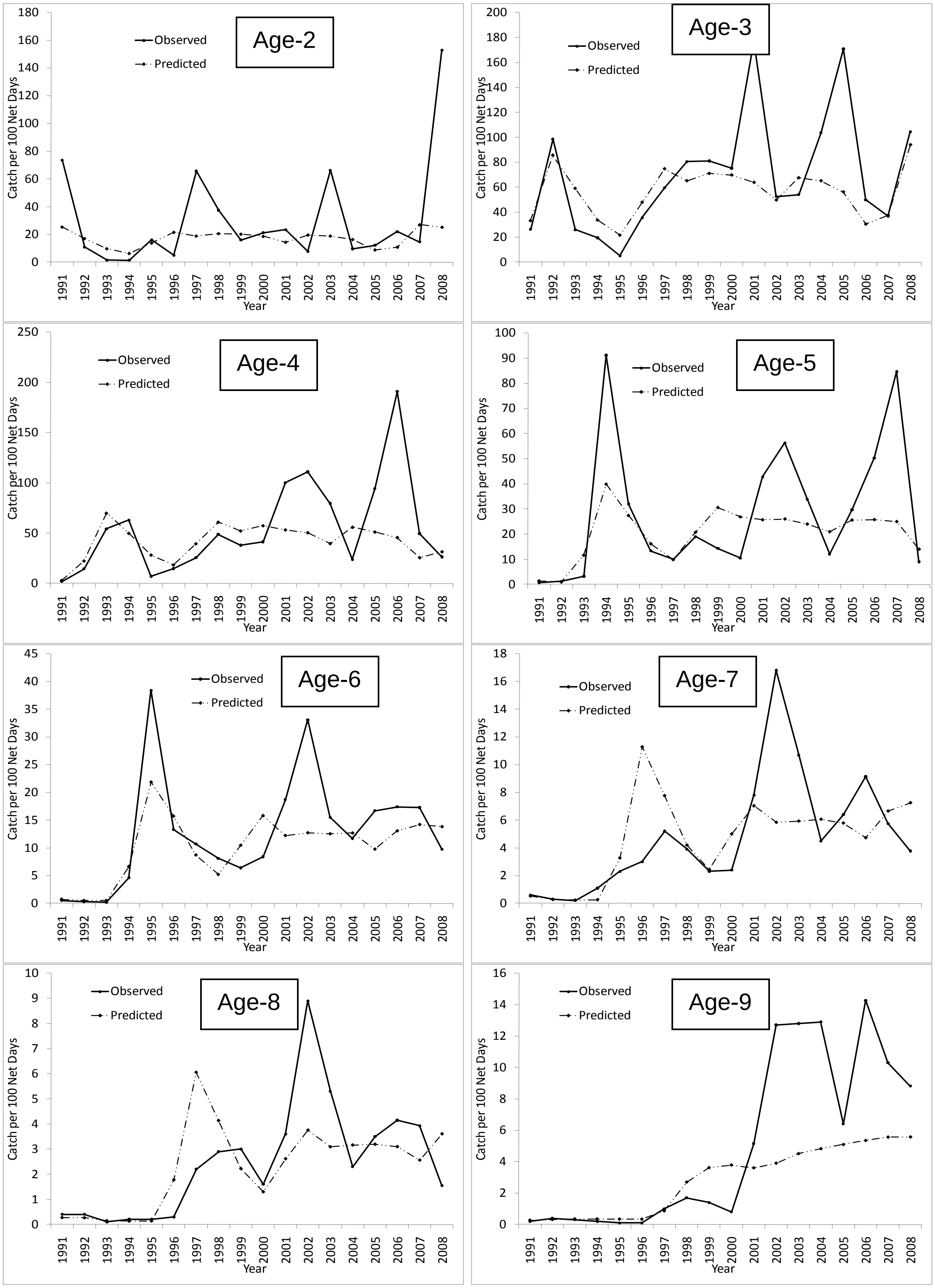


Figure 29. Striped bass index fits for the Roanoke River spawning survey index for ages 2-9 from Roanoke River, NC 1991-2008.

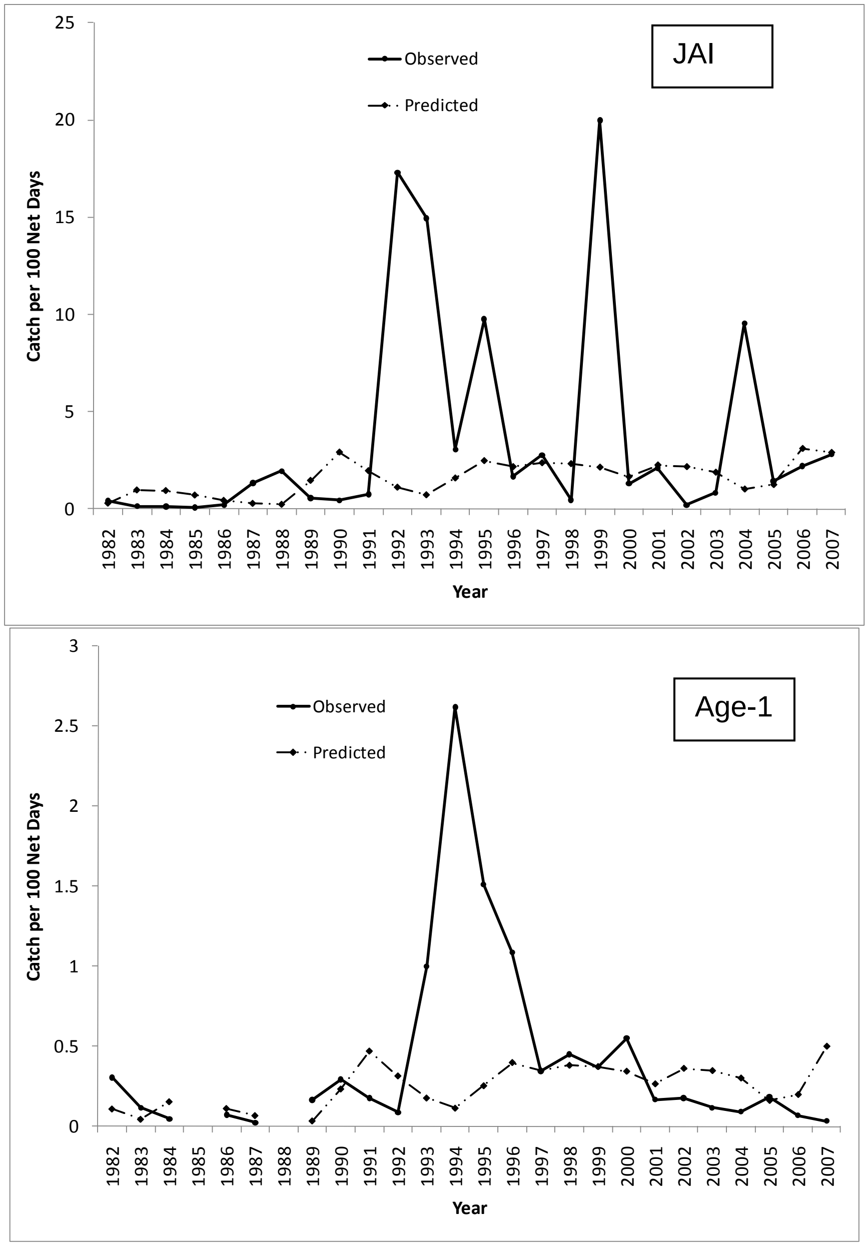


Figure 30. Striped bass index fits for the JAI and age-1 indices from Albemarle Sound, NC 1982-2008.

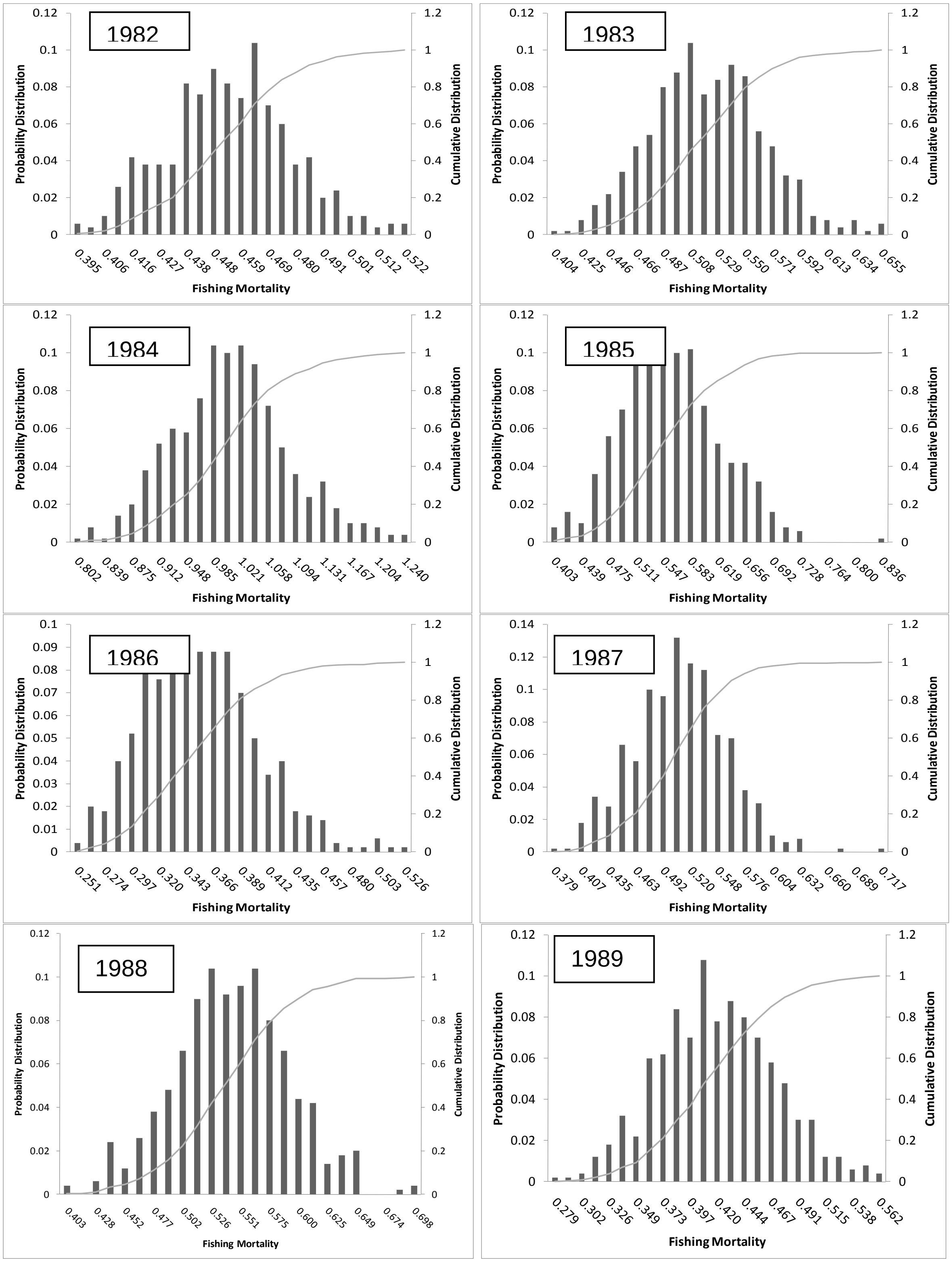


Figure 31. MCMC estimates of striped bass fishing mortality over 500 iterations for all years from ASMA/RRMA, NC. The bar graph is the probability distribution while the smoothed line is the cumulative distribution. Page one covers 1982-1989.

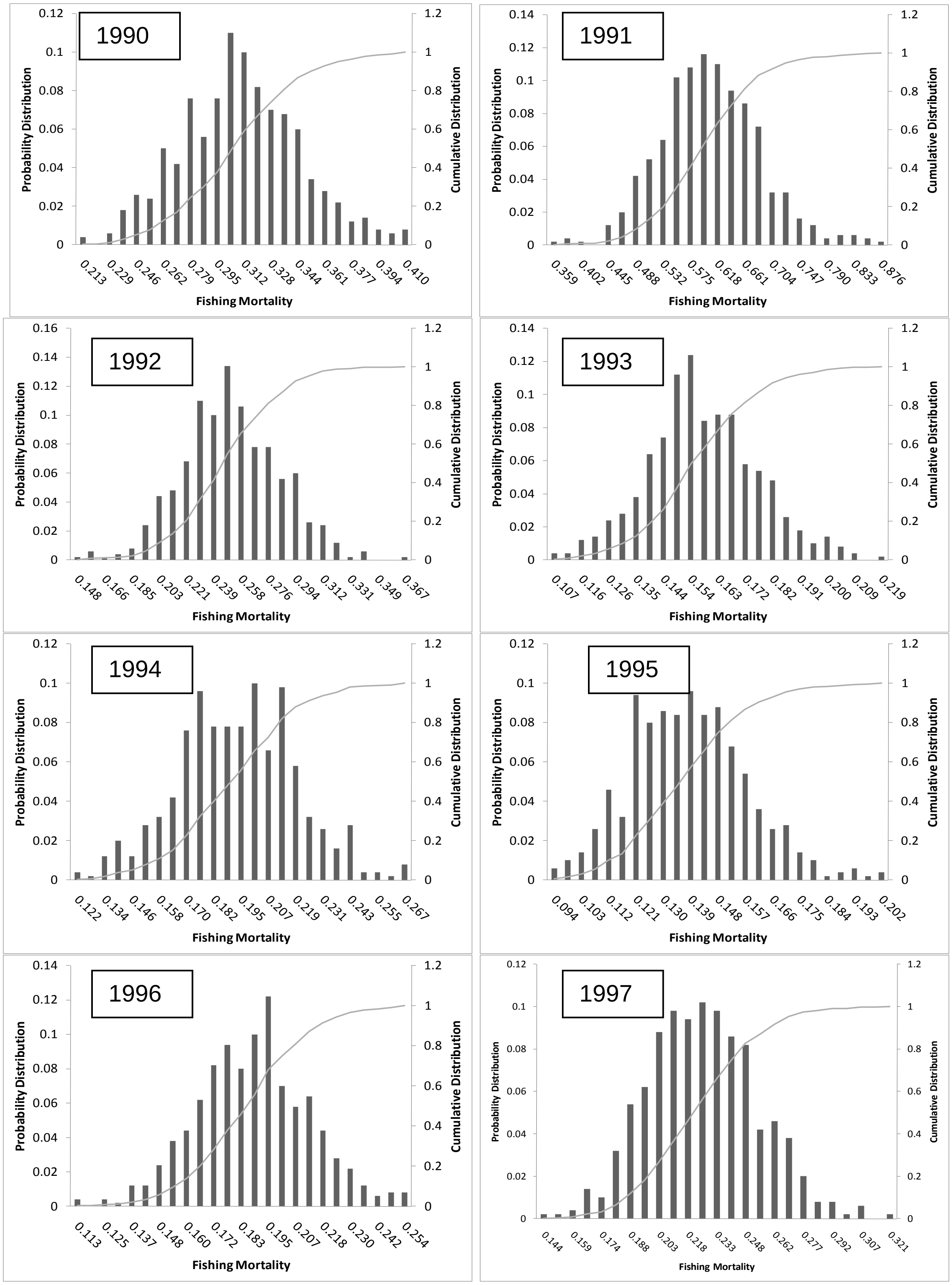


Figure 31. Continued for years 1990-1997.

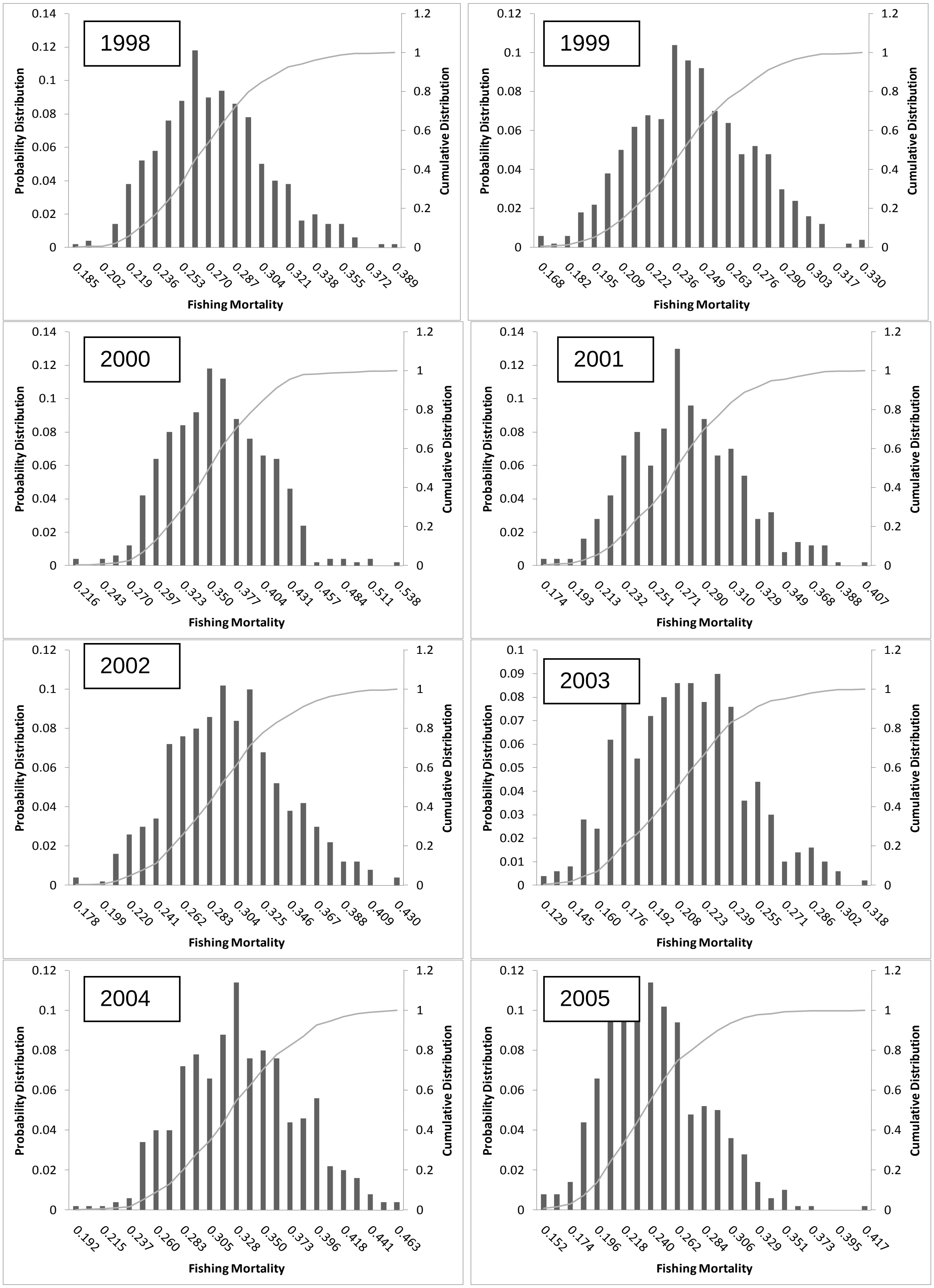


Figure 31. Continued for years 1998-2005.

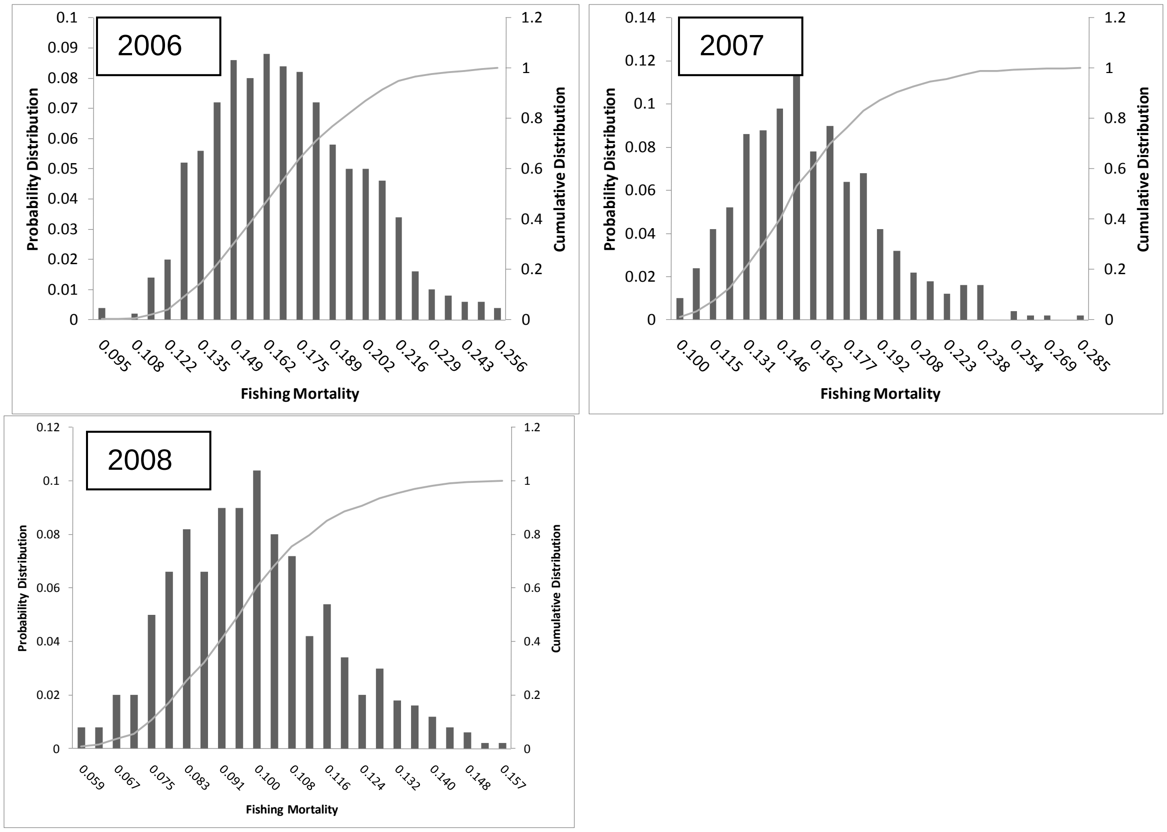


Figure 31. Continued for years 2006-2008.

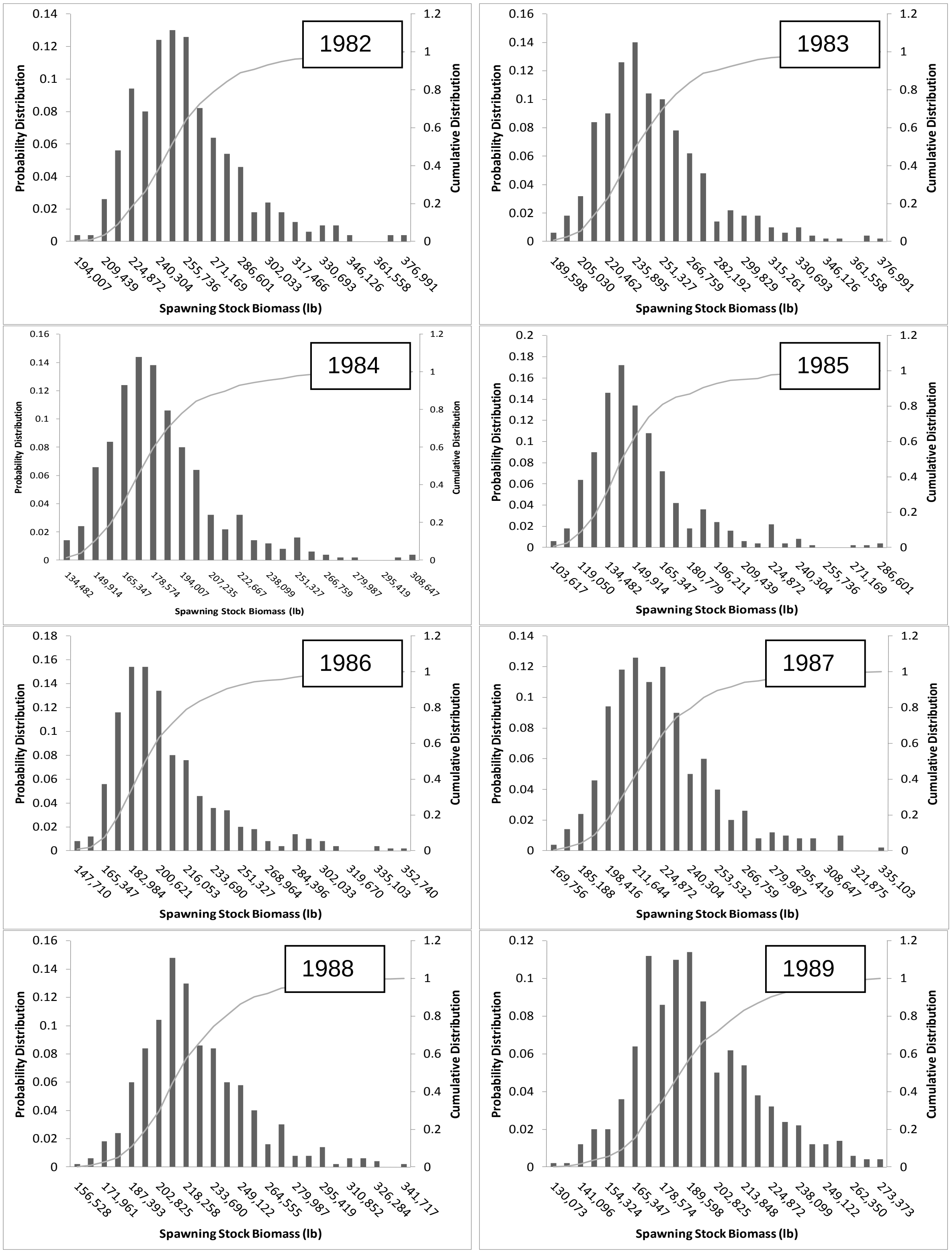


Figure 32. MCMC estimates of striped bass SSB over 500 iterations for all years from ASMA/RRMA, NC. The bar graph is the probability distribution while the smoothed line is the cumulative distribution. Page one covers 1982-1989.

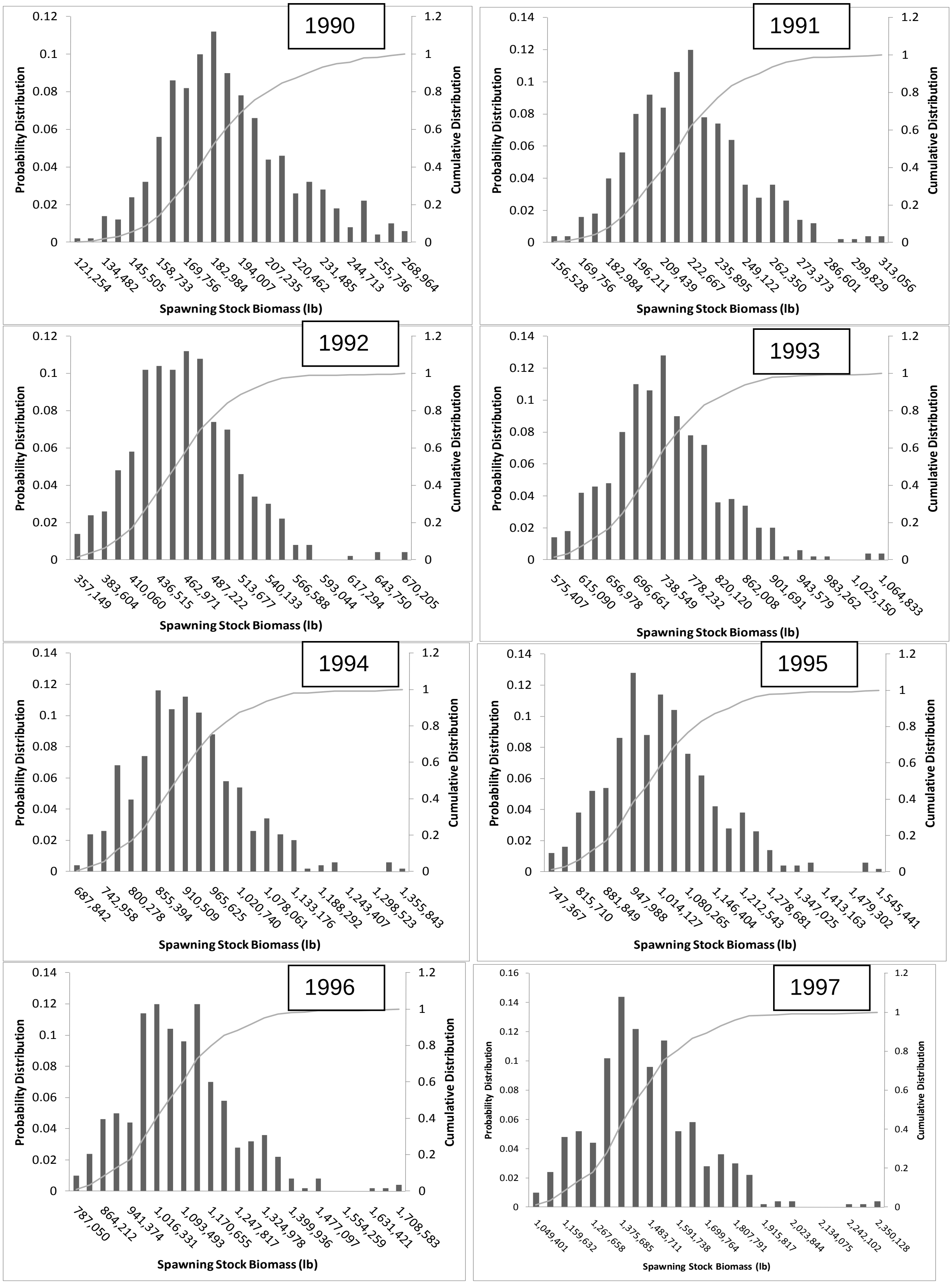


Figure 32. Continued for years 1990-1997.

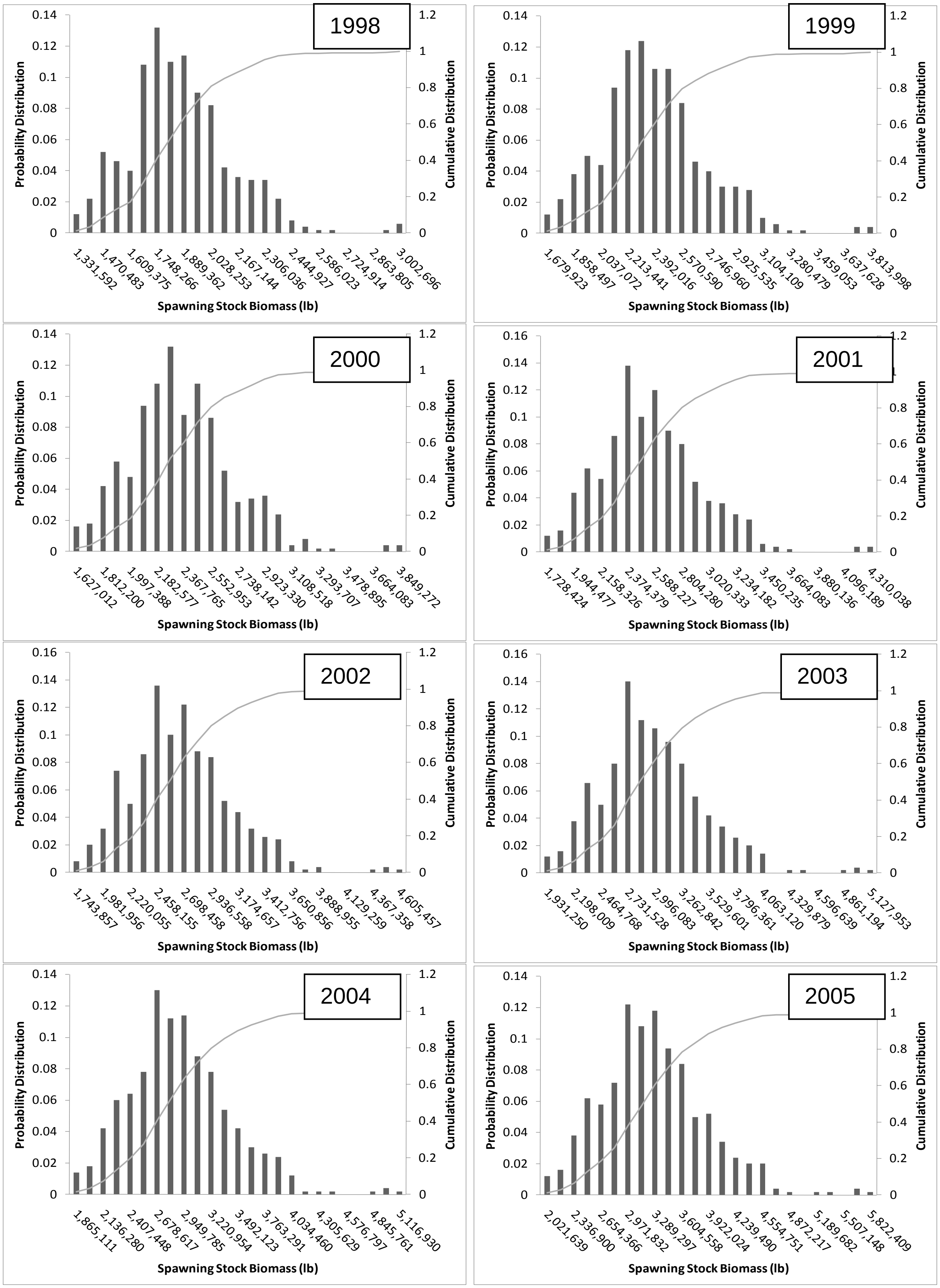


Figure 32. Continued for years 1998-2005.

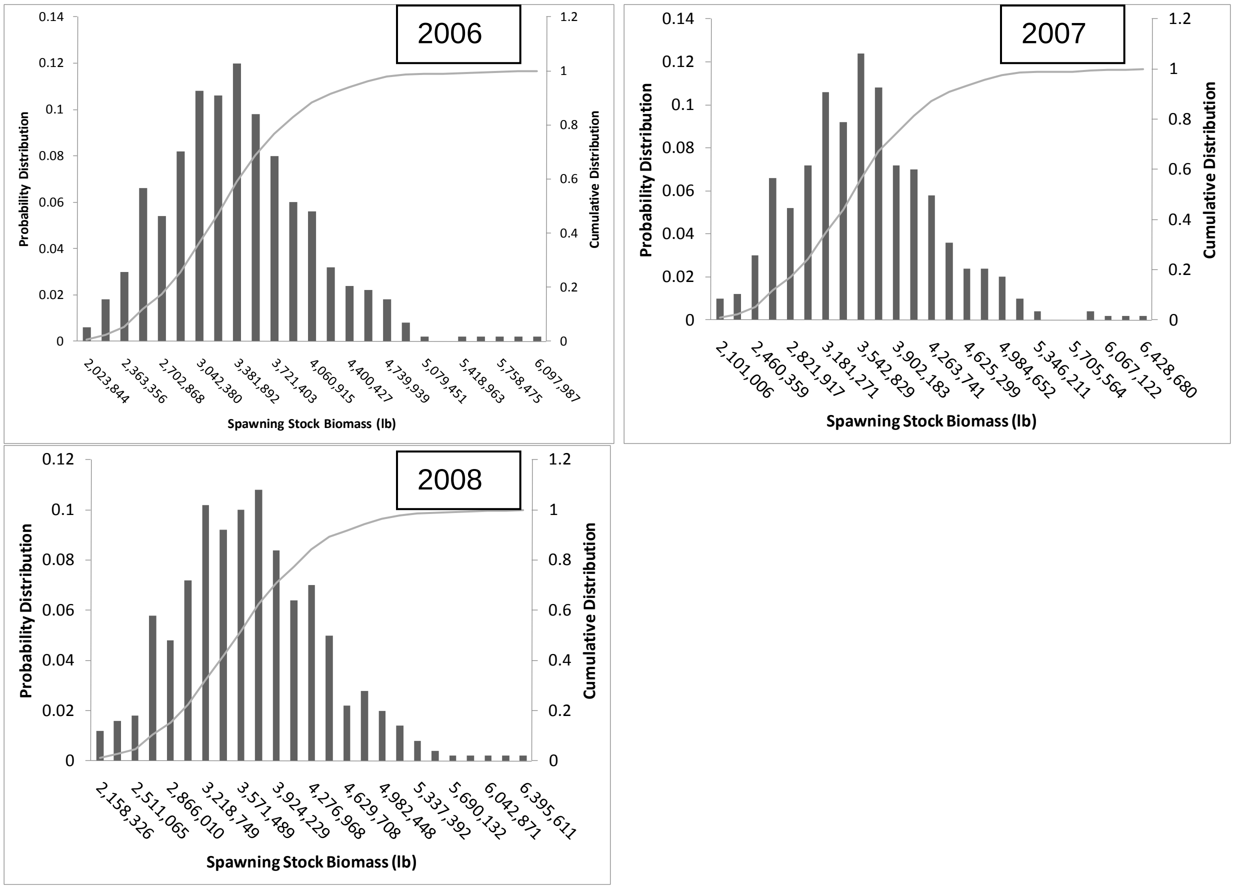


Figure 32. Continued for years 2006-2008.

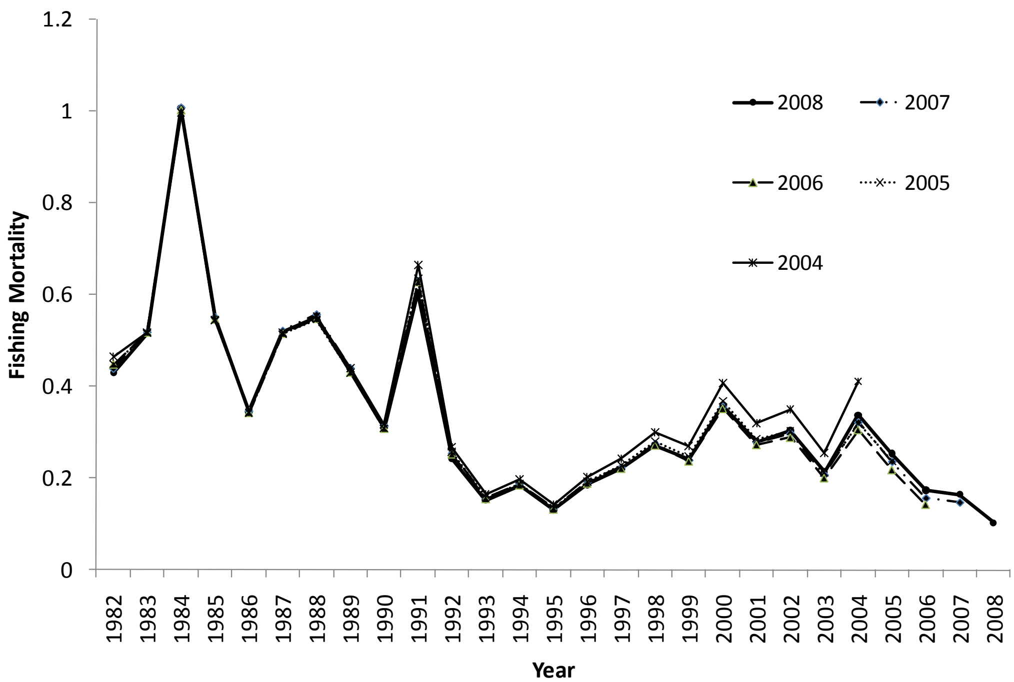


Figure 33. Retrospective trend in striped bass fishing mortality from the ASAP2 model, for terminal years from ASMA/RRMA, NC 2004-2008.

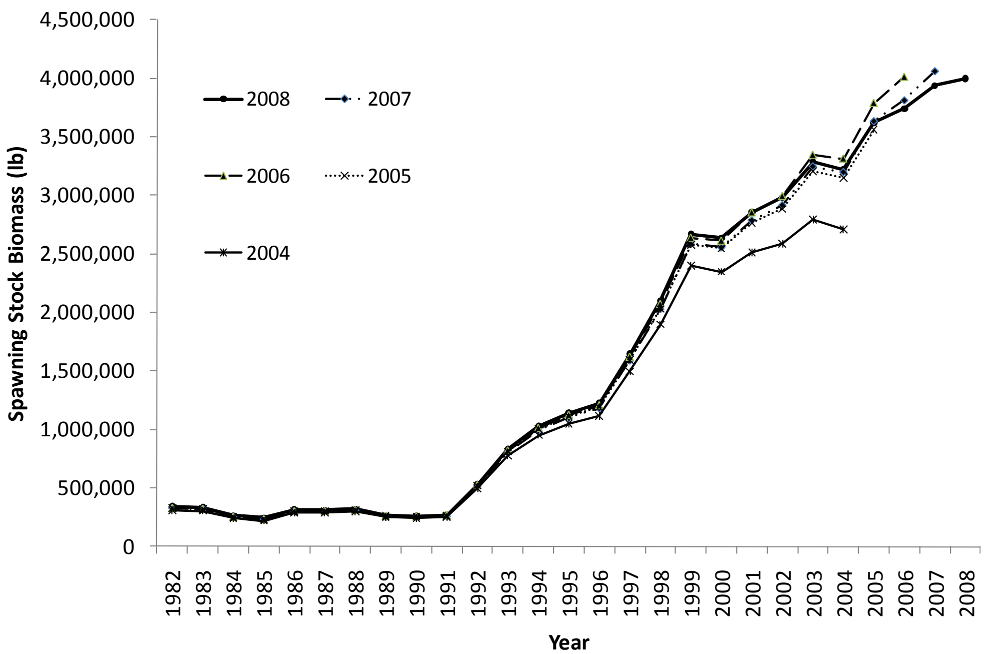


Figure 34. Retrospective trend in striped bass SSB in pounds from the ASAP2 model, for terminal years from ASMA/RRMA, NC 2004-2008.

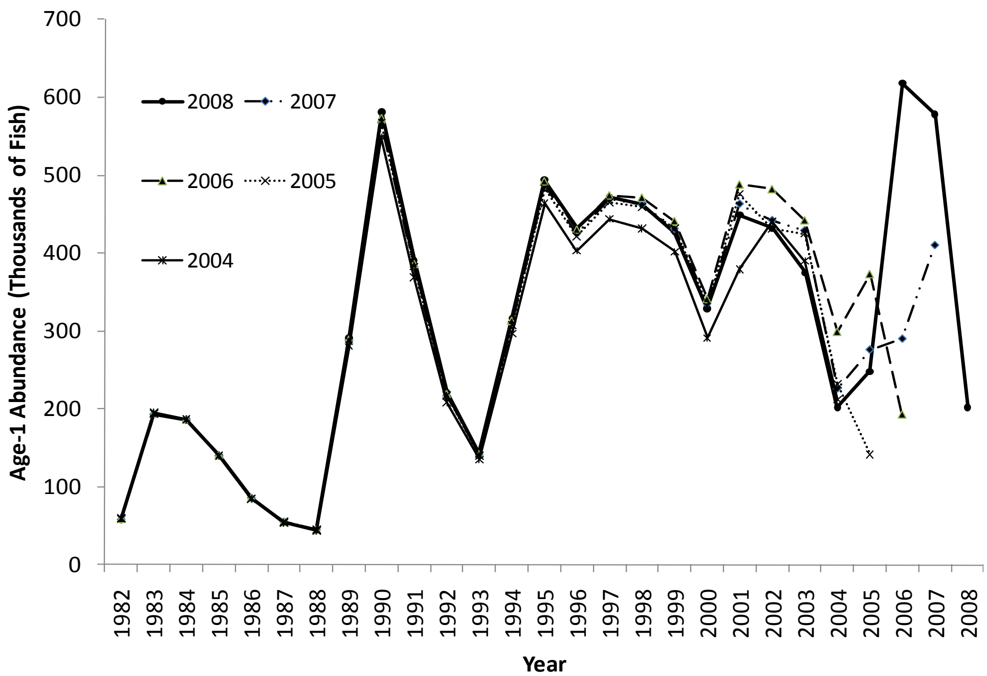


Figure 35. Retrospective trend in striped bass age-1 recruitment in numbers of fish from the ASAP2 model for the terminal years from ASMA/RRMA, NC 2004-2008.

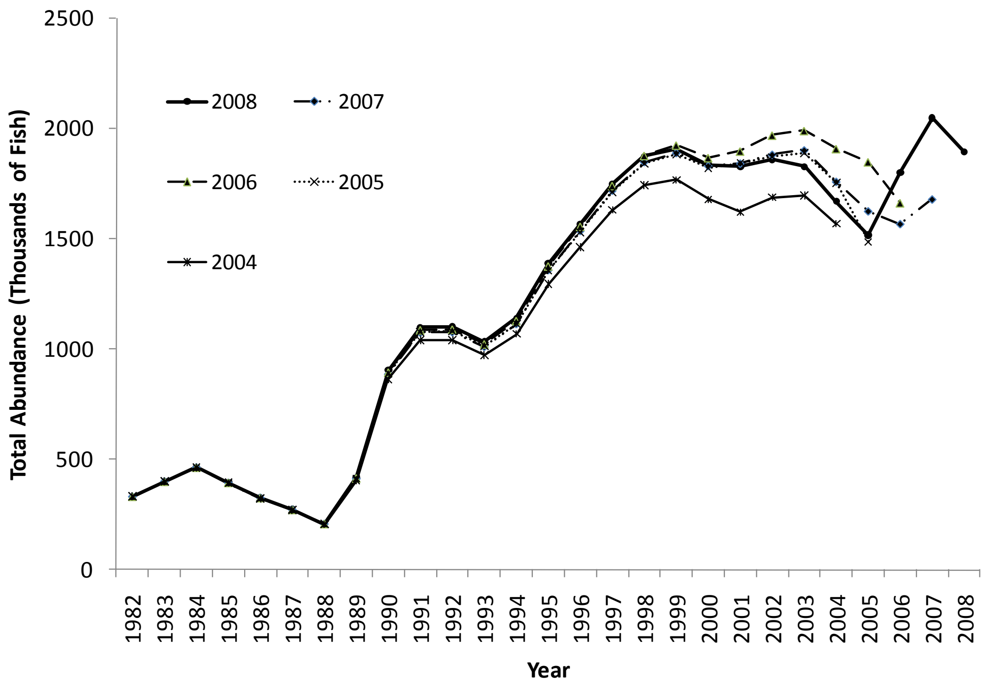


Figure 36. Retrospective trend in striped bass total abundance in numbers of fish from the ASAP2 model for the terminal years from ASMA/RRMA, NC 2004-2008.

APPENDIX 1: ALTERNATE SELECTIVITY FOR AGE-9+

INTRODUCTION

After examining the abundance estimates, it was noticed that the estimates of age-9+ fish having increased significantly starting in 2001 (Table 21). The workgroup felt that this increase needed to be fully explored to understand why it was estimated and if it was reasonable to have such high estimates.

The workgroup examined the harvest estimates and noticed that there were higher estimates of age-9+ fish in the ASMA commercial harvest (Table 21). The workgroup felt that these estimates were likely the cause of the significant increase in recent years, as the selectivity was the same for the entire 1991 - 2008 time period and estimated that very few age-9+ fish would be caught. The workgroup decided it was necessary to run scenarios that would change the selectivity for 2001 to 2008 for the ASMA commercial fishery to understand the behavior of these estimates and determine if those estimates would be more appropriate for management.

RESULTS

The selectivity vectors were updated to create an ASMA commercial fishery period from 2001 to 2008 with fixed selectivities that were much higher than the original estimates for ages 8 and 9+ (Table A.1.1). All other fixed ages for full selectivity remained the same and the 2001 to 2008 vector used the same fixed fully-selected ages as the 1991 to 2000 ASMA commercial fishery estimates.

The average F estimates were generally slightly higher in the alternate selectivity run when compared to the average F estimates from the base run (Figure A.1.1). The SSB estimates had the same pattern between the alternate and base runs (Figure A.1.2). However, the estimated SSB levels were lower for the alternate runs, with the highest estimated SSB reaching 866,870 lb in the terminal year.

The estimates of total abundance had a similar pattern between the alternate and base runs (Figure A.1.3). Like the SSB estimates, the alternate run estimates of total abundance were lower than the estimates from the base run, with a terminal year estimate of 1,183,770 fish.

DISCUSSION

The workgroup did believe there was a possible explanation for increased selectivity on age-9+ fish. In recent years, it has been reported that there has been targeting of large fish with mesh sizes larger than the legal sizes for the ASMA. It is unclear the extent that this may be occurring, but even a relatively small amount of targeting could result in increases in the estimated abundance as few fish at large sizes would be able to be caught with the given legal mesh sizes. It is also possible that large fish could be caught in pound nets that were set in the ASMA, which would not have a selectivity pattern like the gill net fisheries.

While the workgroup felt that the alternate selectivity may be a more accurate reflection of what is going on in the fishery, ultimately the workgroup also felt that the assumptions being made were too significant. It is unknown how much assumed targeting of larger fish may be occurring, if these fish are incidental catch from the pound net fishery, or if the fish may have been caught in areas outside the ASMA and not recorded in a manner that reflects the stock. With these open questions, the workgroup felt the most appropriate action was to use the original base run and acknowledge these issues with the age-9+ fish.

Table A.1.1. ASAP2 estimates of striped bass selectivity by fishery and period from ASMA/RRMA, NC 2008 for the alternate selectivity run.

	Age								
Fishery/Period	1	2	3	4	5	6	7	8	9+
Albemarle Sound Commercial									
1982-2008	0.00	0.69	0.56	1.00	1.00	0.91	0.70	0.15	0.90
Albemarle Sound Recreational									
1982-2008	0.00	0.15	0.31	0.72	1.00	0.68	1.00	0.54	0.19
Roanoke River Recreational									
1982-2008	0.00	0.15	0.47	1.00	1.00	0.46	0.17	0.19	0.14
Roanoke River Commercial									
1982-1986	0.00	0.50	0.51	1.00	1.00	1.00	0.30	0.01	0.00

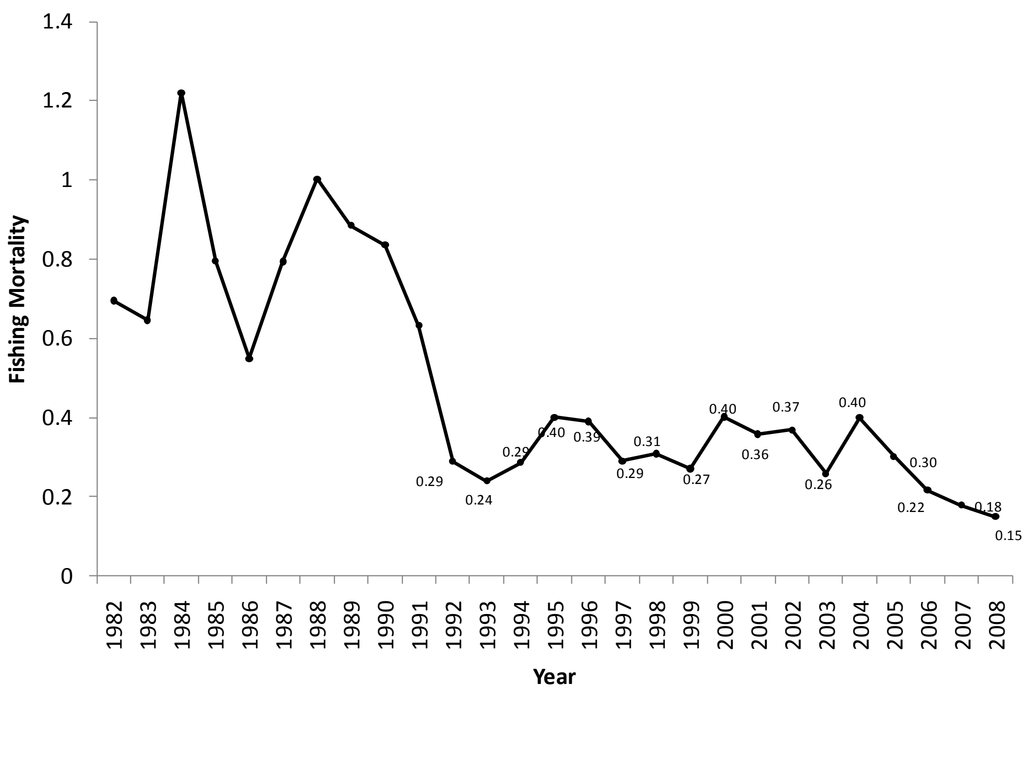


Figure A.1.1. Trend in age 4-6 striped bass fishing mortality from ASMA/RRMA, NC 1982-2008 for the alternate run.

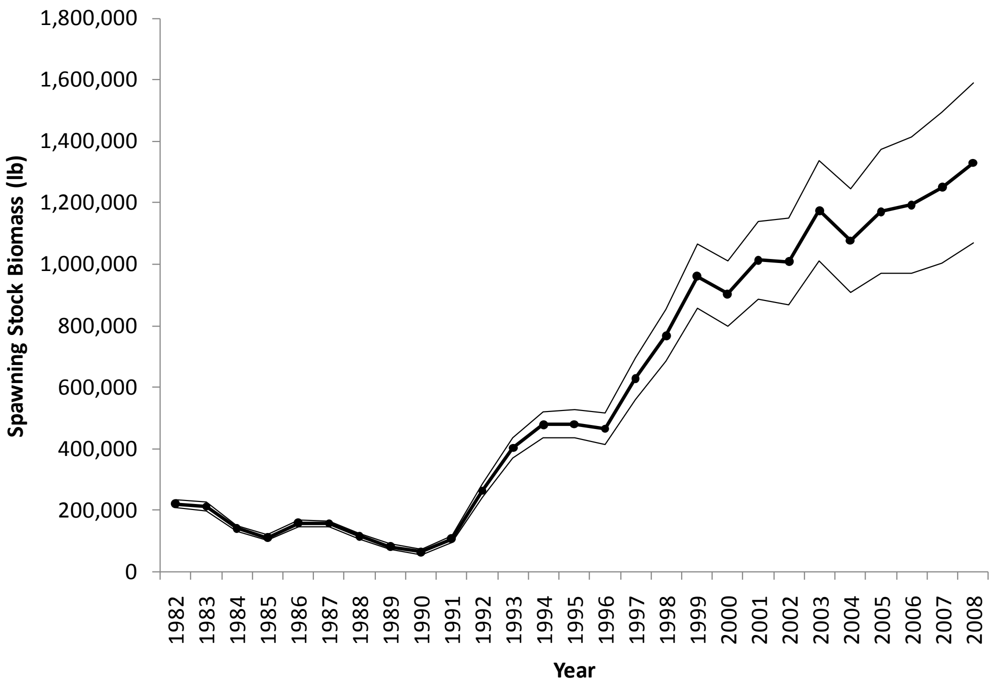


Figure A.1.2. Spawning stock biomass of female striped bass in thousands of pounds from ASMA/RRMA, NC 1982-2008 for the alternate run.

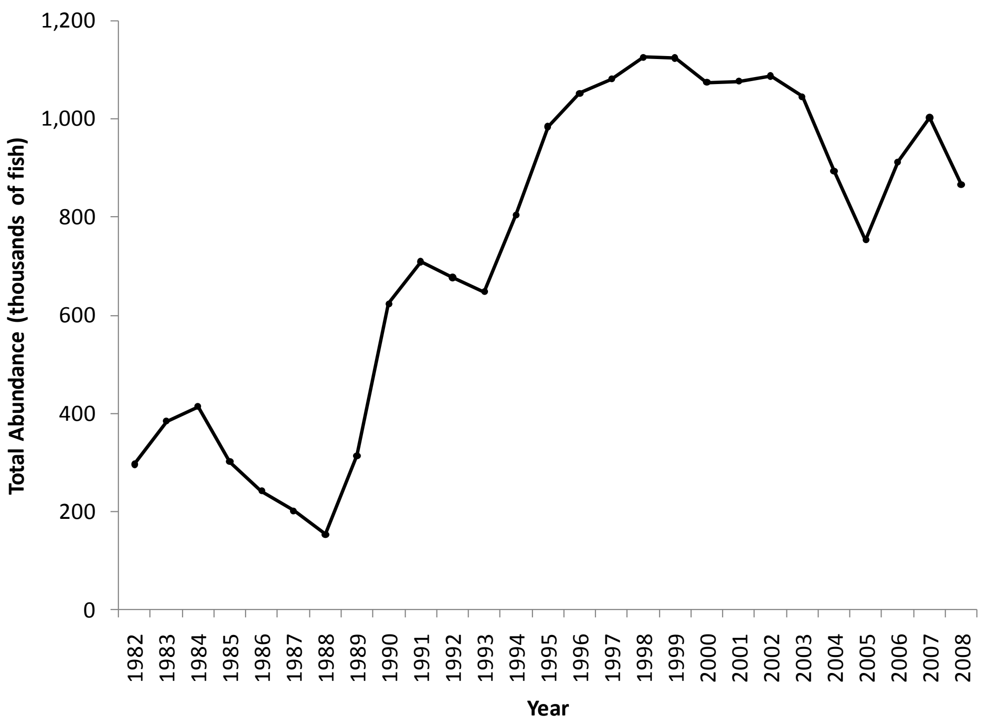


Figure A.1.3. Estimated total annual abundance of striped bass in thousands of fish from ASMA/RRMA, NC 1982-2008 for the alternate run.

APPENDIX 2: PROJECTIONS FOR BIOLOGICAL REFERENCE POINTS

INTRODUCTION

Projections are a tool to determine how to end overfishing and rebuild a stock to a sustainable level. Projections can also be used to examine the long term behavior of biological reference points. The estuarine striped bass PDT examined the 'what-if' scenario for SSB, harvest, and discards if fishing mortality were held constant at the proposed biological reference point levels (Table 29). The fifteen year projection period was chosen as it was the longest time frame the projections could successfully estimate.

RESULTS

All the results showed the magnitude of the different biological reference points. The final year SSB estimates ranged from 3,194,499 lb for a constant $F_{25\%}$ up to 5,297,709lb for a constant $F_{45\%}$ (Figure A.2.1). The projected harvest estimates in the final year ranged from 518,086 lb for the constant $F_{25\%}$ down to 423,288 lb for the constant $F_{45\%}$ (Figure A.2.2). The projected discards for the terminal year ranged from 171,961 lb for the constant $F_{25\%}$ down to 119,050 lb for the constant $F_{45\%}$ (Figure A.2.3). The harvest and discard projections have similar patterns and were only differentiated by the magnitude of the removals.

DISCUSSION

In general, the higher the SPR level, the lower the biological reference point F rate and the higher projected long term SSB. For the F levels between 35% and 45%, the projection indicated that some increases in SSB will occur if fishing is kept at those constant F rates. If fishing were held constant at the $F_{25\%}$ or $F_{30\%}$, the long term SSB would be lower than the current SSB level.

The sharp increase in harvest and discard projected in 2010 is likely the result of a large year class estimated by the ASAP2 model fully recruiting to the fishery. The long term projections rely on the average recruitment since 1997, which will not have the year to year variability that may occur in the stock.

All the projected harvest levels are below the current TAC of 550,000 lb. However, the projected discards are all higher than the 2007 discard estimate, which was the last year that sufficient observer coverage was available for discard calculation. It is possible that the projections were overestimating the discard because of the terminal year commercial estimate. High discard levels could result in lower long term landings at the biological reference point levels. These projections should be re-examined in the near future when observer data can be used for the calculation of the commercial discard.

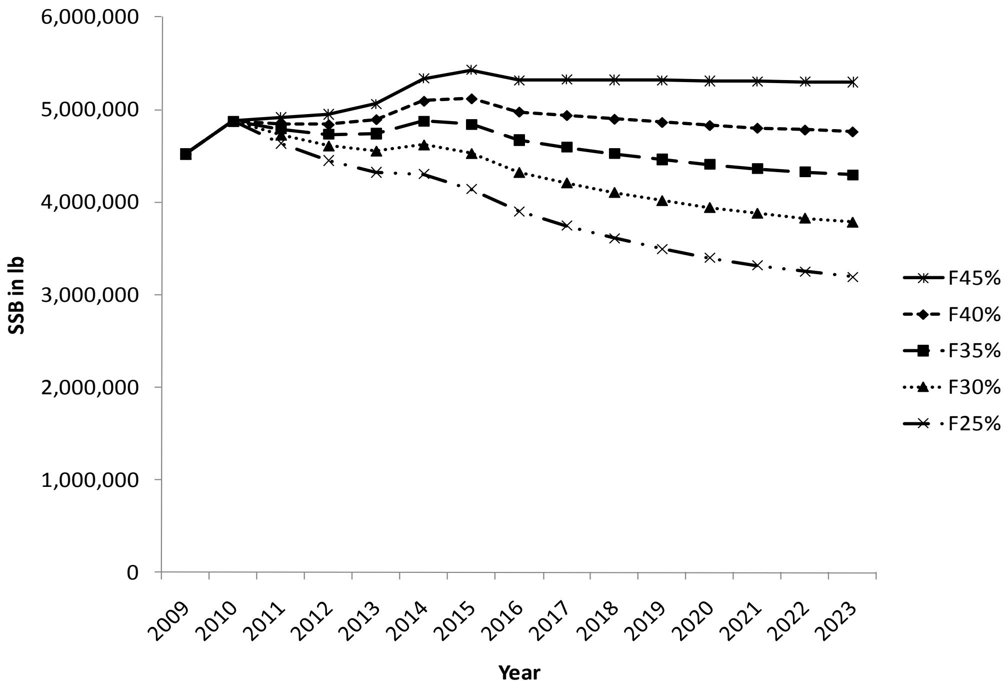


Figure A.2.1. Projected spawning stock biomass of female striped bass in pounds from ASMA/RRMA, NC 2009-2023, for the proposed biological reference point F rates.

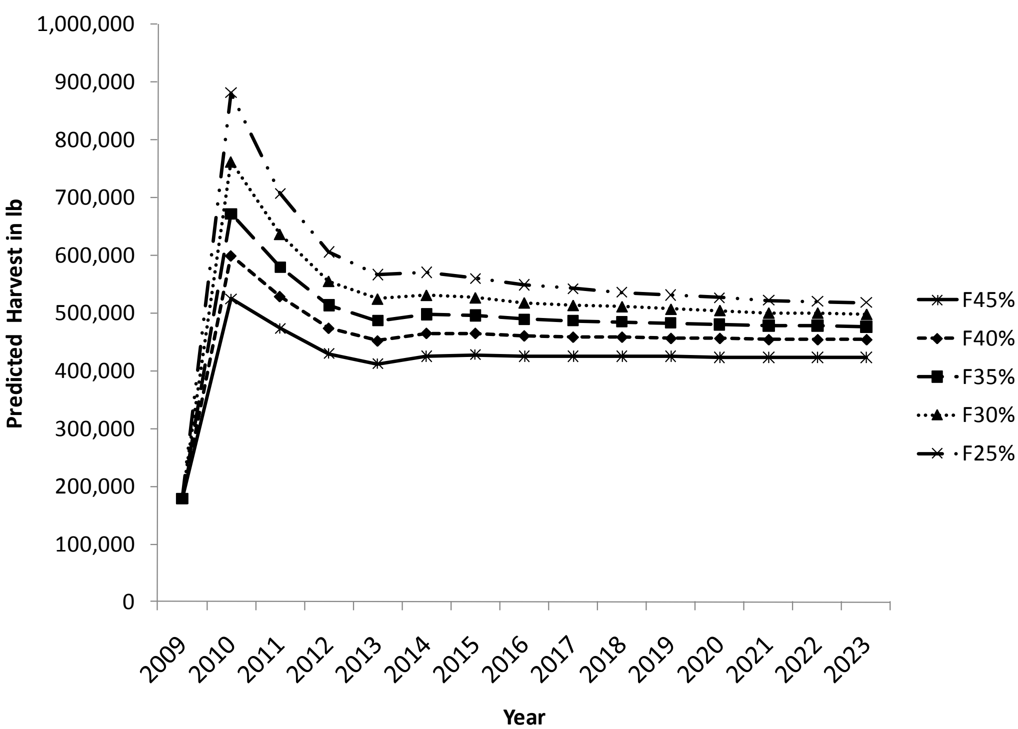


Figure A.2.2. Projected harvest of striped bass in pounds from ASMA/RRMA, NC 2009-2023, for the proposed biological reference point F rates.

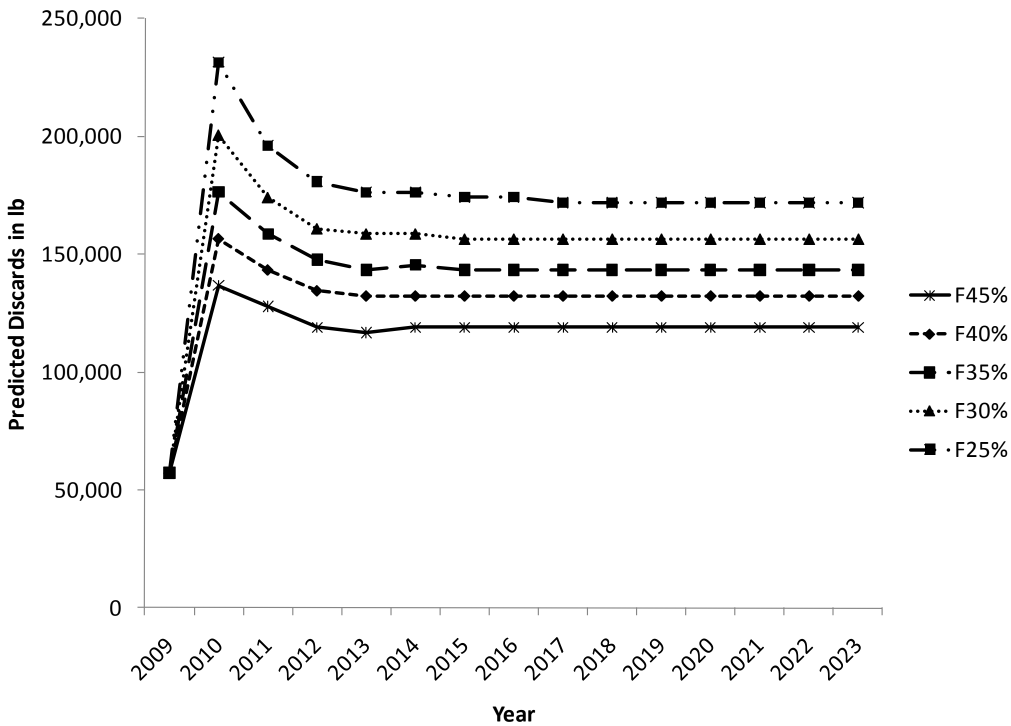


Figure A.2.3. Projected discard of striped bass in pounds from ASMA/RRMA, NC 2009-2023, for the proposed biological reference point F rates.

APPENDIX 3: ASMA/RRMA REGULATIONS, 1979-2008

The following are the regulations (rules or proclamations) resulting in conservation and /or reduction of striped bass harvest for coastal North Carolina. (ASMA-Albemarle Sound Management Area, RRMA- Roanoke River Management Area, DMF- NC Division of Marine Fisheries, WRC- NC Wildlife Resources Commission, TL- Total length, ISM- inch stretched mesh, TAC- Total Allowable Catch)

Year	Statewide	ASMA/RRMA
Prior to 1979	Minimum size limit 12 in TL, daily creel limit 25 fish (DMF/WRC)	
1979	Internal Coastal and Joint Waters- gill nets with a mesh length less than 2 ½ ISM are illegal (except area specifics)	No trawling in Albemarle and Croatan Sounds between Dec 1 and Mar 31
		Roanoke River drift gill nets must be attended at all times (DMF)
		Gill net mesh size changed from 3 ¼ ISM to 3 ½ ISM- western Albemarle Sound and Chowan River- summer/fall (DMF/Jul)
		Defined small mesh nets (mullet nets to be used only in eastern Albemarle Sound) (DMF/Jul)
1980	Creel limit reduced to 8 fish per day in Inland Waters (WRC)	Eliminated set gill nets in Roanoke River- Apr-May and restricted mesh size of drift gill nets (DMF/Oct)
	Field possession limit reduced to one day's creel limit- Inland Waters (WRC)	
1981		Roanoke River bow netting eliminated (WRC) Possession of large dip nets prohibited in Inland Waters of the Roanoke River (WRC)
		Extended drift gill net regulations to mouth of Roanoke, Middle, Eastmost and Cashie rivers proper (DMF/Oct)
1982	Minimum size limit increased to 16 in TL in Inland Waters (WRC)	
1983		Eliminated small mesh gill nets in Currituck Sound, minimum size increased to 3 ½ ISM (Jun-Dec) (DMF/Jan)
		Roanoke River- re-instituted use of set gill nets Apr-May of 3 ISM and less, no more than one drift gill net per boat (DMF Jan and Oct)
		Eliminated 3 ¼ ISM gill nets (Jun-Dec) in all of Albemarle Sound and tributaries, increased

		minimum mesh size to 3 ½ ISM (DMF/Oct)
Year	**Statewide**	**ASMA/RRMA**
	Prohibited possession of striped bass on vessels using trawl in Internal Coastal Waters (DMF/Jan)	
1984		First limited commercial season Oct-May (DMF/Aug)
		Minimum gill net mesh size 3 ½ ISM Oct-Dec (DMF/Aug)
		Eliminated gill nets in Albemarle Sound and tributaries Jun-Sep, except defined “mullet nets” (2 ½-3 ISM), floating and within 300 yd of shore (DMF/Aug)
	Reduction in hook and line creel limit to 8 fish/day and increase minimum size limit to 16 in TL for Joint and Internal Coastal Waters (Jun-Sep) (DMF/Aug)	
	Unlawful to sell or offer for sale striped bass from Jun-Sep (DMF/Aug)	
	First size limit for Atlantic Ocean- 24 in TL commercial and recreational (DMF/Aug)	
	Closure of Atlantic Ocean, commercial and recreational, to possession by proclamation (DMF/Aug)	
1985	Reduction in creel limit to 3 fish in Inland Waters (WRC)	Prohibit sale of striped bass taken from Inland Waters of the Roanoke River (NC General Assembly)
	Reduction in commercial season (Nov-Mar), unlawful to sell or possess striped bass from commercial gear except during the open season (DMF/Aug)	Revision of summer gill net use (Jun-Sep), which allowed 5 ISM and greater “flounder nets” and attendance at all times provisions for “mullet nets” in Albemarle Sound and tributaries (DMF/Aug)
	Hook and line creel limit reduced to 3 fish/day Internal Coastal and Joint Waters year round. No sale of hook and line caught striped bass (DMF/Aug)	
	Commercial minimum size limit increased to 16 in TL in Joint Waters (DMF/Aug)	
	Commercial minimum size limit increased to 14 in TL in Internal Coastal Waters (DMF/Oct)	

Year	Statewide	ASMA/RRMA
1986	Minimum size limit increased to 16 in TL Internal Coastal waters (DMF/Oct)	Revisions to depth of water and net size for the fall gill net regulations (Oct-Dec)- increased striped bass conservation without severely impacting the harvest of white perch and catfish (DMF/Nov)
	Repealed 16 in TL size limit, revert back to 14 in TL minimum size limit Internal Coastal Waters (DMF/Nov)	Established proclamation authority to open and close a portion of the striped bass season (Oct and Apr) (MFC/Nov)
		Aligned Currituck Sound net regulations with the Albemarle Sound regulations relative to conservation measures (DMF/Nov)
		Eliminated the possession and sale of striped bass from the spring Albemarle Sound gill net fishery and Roanoke River delta pound net fishery (DMF- effected by Aug 1985 regulations)
1987		Eliminated all trawling in Albemarle Sound and tributaries year round (DMF/Dec)
		Closed a portion of western Albemarle Sound to gill netting (Batchelor Bay area) and restricted the spring pound net fishery in the Roanoke River delta by proclamation (DMF/Aug) (remains in effect 2002)
1988	Size limit in Atlantic Ocean correspond to ASMFC Interstate STB FMP	
		Allow use of "mullet gill nets" in Currituck Sound between 2 ½ - 3 ¼ ISM, maximum 400 yds, attended at all times (Jun-Dec) (DMF/Sep)
1989	Established proclamation authority to specify season or seasons: (a) hook and line and (b) commercial fishing equipment between 1 Oct and 30 Apr. Proclamations may specify areas, quantity, size and means/methods employed in harvest and require submission of statistical and biological data (MFC/Sep)	Closed Batchelor Bay area to anchor gill netting and restricted the possession of striped bass taken in pound nets to fish not less than 18 in TL or greater than 24 in TL.
		Restricted use of small mesh "mullet gill nets" in Albemarle Sound and tributaries (DMF/Jun and Sep)
		Delayed use of commercial gill nets of between 3-5 ISM in Albemarle Sound and tributaries from 1 Oct until 15 Nov, when commercial striped bass season opened statewide. Mullet nets

		required attendance at all times (DMF/Oct)
Year	**Statewide**	**ASMA/RRMA**
		Gill net mesh sizes restricted in Albemarle Sound area (DMF/Nov)
	Hook and line season closed in Internal Coastal Waters 26 Nov (DMF/Nov)	
1990		Albemarle Sound area- 98,000 lb (TAC) commercial harvest allocation to be managed on a monthly basis (DMF/Jan)
		Gill net size restrictions in Albemarle Sound area (DMF/Jan, Feb and Apr)
		Batchelor Bay area closed 1 Apr to anchor gill nets and prohibited the possession between 24 and 28 in TL and less than 18 in TL from pound nets (DMF/Mar)
		Delayed use of commercial gill nets of between 3-5 ISM from 3 Oct until 7 Jan 1991, when season opened statewide, required mullet gill nets be attended at all times (DMF/Oct)
	Hook and line season opened 1 Jan in Internal Coastal Waters (DMF/Jan)	By collateral action through proclamation (DMF) and emergency rule (WRC), striped bass season closed 10 May for hook and line possession in Joint Waters of Albemarle Sound area (DMF and WRC/May)
	Hook and line season closed 24 Apr in Internal Coastal Waters (excluding Joint Waters) (DMF/Apr)	By emergency rule season closed 10 May for hook and line possession in Inland Waters of Roanoke River (WRC/May)
	By collateral action DMF and WRC, closed hook and line possession in Internal Coastal, Joint and Inland Waters 21 May (DMF and WRC/May)	
1991		ASMA commercial season opened 7 Jan and closed 9 Jan
		ASMA commercial TAC of 98,000 lbs and managed on a monthly basis. Individual harvest permits required for fishermen or operations, 14 in TL minimum size in Internal Coastal Waters and 16 in TL in Joint Waters. Extensive gill net restrictions with specific amount or yardage of gill nets less than 5 ISM for all 1991 (DMF/Jan)
		ASMA opened 18 Jan with gear restrictions, harvest permittee limited to landing 3 fish/day, minimum size 20 In TL

Year	Statewide	ASMA/RRMA
	Effective 1 Jan -16 in TL size limit established and a daily creel limit not to exceed 3 fish per person per day for all Internal Coastal, Joint and Inland Waters (DMF/WRC)	ASMA – 13 Feb harvest permittee limited to landing 5 fish/day, minimum size 18 in TL
		ASMA- 1 Mar harvest permittee limited to landing 10 fish/day, minimum size limit 18 in TL
		ASMA- 25 Mar harvest permittee limited to landing 20 fish/day, minimum size 14 in TL in Internal Coastal Waters and 16 in TL in Joint Waters. Batchelor Bay area closed to anchor gill nets. Drift gill nets allowed in Roanoke, Eastmost, Middle and Cashie rivers, stationary gill nets prohibited (DMF/Mar)
		ASMA- 6 Apr harvest permittee limited to landing 5 fish/day, minimum size limit 18 in TL (DMF/Apr)
	By joint rule effective 1 Nov, minimum size limit for Joint Waters increased to 18 in TL (WRC and DMF/Nov)	ASMA- 13 Apr commercial season closed (DMF/Apr)
	By rule effective 1 Nov, minimum size limit in Internal Coastal Waters increased to 18 in TL (DMF)	ASMA- 21 Jun- 3 ISM gill nets allowed, attended at all times (DMF/Jun)
		ASMA- 3 Sep- 3-3 ½ ISM gill nets allowed with area restrictions and attendance at all times (DMF/Sep)
		ASMA- 1 Oct- 2 ½ ISM and larger gill nets allowed in southern portions of Roanoke and Croatan sounds (DMF/Oct)
		ASMA- 1 Nov commercial season opened, harvest permittee limited to landing 3 fish/day, 18 in TL minimum size limit, small mesh gill nets attended at all times, with area restrictions (DMF/Nov)
		ASMA- 8 Nov allowed 5 ¼ ISM and larger gill nets, consistent with 18 in TL minimum size limit (DMF/Nov)
		ASMA- 22 Nov allowed 3- 3 ½ ISM gill nets unattended in waters less than 6 ft deep with restrictions (DMF/Nov)
		ASMA- 20 Dec commercial season closed

Year	Statewide	ASMA/RRMA
		1 Jan- MFC and WRC adopted joint rules establishing the Albemarle Sound Management Area (ASMA) and the Roanoke River Management Area (RRMA). Harvest management in the two areas based upon an allocation of 29,400 lb (TAC) per year for each area (corresponds to an 80% reduction in historical hook and line harvest) WRC management authority for hook and line harvest- Joint and Inland Waters of RRMA (Roanoke, Middle, Eastmost and Cashie rivers and their tributaries) MFC management authority for hook and line harvest in the remaining Internal Coastal, Joint and Inland Waters of the ASMA (Albemarle, Currituck, Roanoke and Croatan sounds and their tributaries) (Defined areas only apply to striped bass hook and line harvest management)
		1 Jan- hook and line season opened in ASMA
		By emergency rule hook and line season opened 1 Jan in RRMA (WRC/Jan)
		31 Jan- hook and line season closed in ASMA (DMF/Jan)
		7 Feb- hook and line season opened in ASMA (DMF/Feb)
		1 May- hook and line season closed in ASMA (DMF/May)
		By emergency rule the WRC closed the hook and line season 1 May in RRMA (WRC/May)
	By NC General Statute 113-292 (effective May 23, 1991) the WRC was granted proclamation authority to open and close hook and line striped bass seasons in the inland and joint waters of coastal rivers	
		1 Nov- hook and line season opened in ASMA, 18 in TL minimum size limit and daily creel limit of 3 fish (DMF/Nov)
		30 Nov- hook and line season closed in the ASMA (DMF/Nov)

Year	Statewide	ASMA/RRMA
		By rule effective 1 Jul, in RRMA the following were established during the open season: 1 Jan- 31 Mar- Inland Waters- 1 fish daily creel, 18 in TL minimum size limit, Joint Waters- 3 fish daily creel, 18 in TL minimum size limit; 1 Apr-31 May- Inland Waters 3 fish daily creel, 18 in TL minimum size limit and NO fish between 22-27 in TL maybe retained from US Hwy 258 to Roanoke Rapids Dam; Joint Waters- 3 fish daily creel, 18 in TL minimum size limit 1 Jun- 31 Dec- Inland Waters- 1 fish daily creel, 18 in TL minimum size limit, Joint Waters- 3 fish daily creel, 18 in TL minimum size limit
1992		Throughout 1992 in the ASMA (excluding Croatan and Roanoke sounds) harvest permittee was limited to specific yardage of gill nets with stretched mesh less than 5 ¼ in. Gear and area restrictions varied seasonally. Stationary gill nets were prohibited in the RRMA.
		ASMA- 11 Jan commercial season opened, harvest permittee limited to landing 10 fish per day (DMF/Jan)
		ASMA- 3 Feb commercial harvest permittee limited to landing 5 fish per day (DMF/Feb)
		ASMA- 19 Mar commercial harvest permittee limited to landing 3 fish per day. Drift gill nets allowed in Roanoke, Middle, Eastmost and Cashie rivers.
		ASMA- 16 Apr commercial season closed
		ASMA- 3 Jul- small mesh gill nets must be attended at all times (DMF/Jun)
		ASMA- 21 Oct- small mesh gill nets must be attended between sunrise and sunset (DMF/Oct)
		ASMA- 9 Nov- commercial season opened with a closure date 20 Nov, harvest permittee limited to landing 3 fish per day (DMF/Oct)
		ASMA- 23 Nov- allowed unattended small mesh gill nets (DMF/Nov)
		RRMA- 1 Jan- hook and line season opened (WRC/Jan)
		ASMA- 1 Jan- hook and line season opened (DMF/Dec)
		RRMA- 20 Apr- hook and line season closed (WRC/Apr)
		ASMA- 1 May- hook and line season closed

		(DMF/Apr)
Year	**Statewide**	**ASMA/RRMA**
		ASMA- 1 Nov- hook and line season opened (DMF/Oct)
		ASMA- 30 Nov- hook and line season closed (DMF/Nov)
1993		Throughout 1993, ASMA (excluding Croatan and Roanoke sounds) harvest permittee were limited to specific yardage of gill nets with a stretched mesh less than 5 ¼ in. Gear and area restrictions varied seasonally. Stationary gill nets were prohibited in RRMA.
		RRMA- 18 Jan drift gill nets allowed
		ASMA- 1 Feb commercial season opened, harvest permittee limited to landing 5 fish per day, prohibited harvest from commercial gear in RRMA
		ASMA- 1 Mar commercial harvest permittee limited to landing 3 fish per day
		ASMA- 5 Apr commercial season closed
		ASMA- 17 May gill nets prohibited in Batchelor Bay-western Albemarle Sound and RRMA, excluding the prohibited area, gill nets in the western sound from Chowan River to the NC Power Transfer Line must be attended
		ASMA- 2 Aug small mesh gill nets must be attended at all times, excluding Croatan and Roanoke sounds
		ASMA- 6 Oct small mesh gill nets prohibited in water depth greater than 6 ft, excluding Croatan and Roanoke sounds
		RRMA- 1 Feb hook and line season opened
		ASMA- 1 Feb hook and line season opened
		ASMA- 18 Apr hook and line season closed
		RRMA- 25 Apr hook and line season closed
1994		ASMA- 19 Feb recreational season open- harvest days Wed, Sat and Sun- 3 fish per person, 18 in TL minimum size limit and 15,000 pounds spring allocation
		ASMA- 21 February commercial season open- permittee limited to landing 10 fish per day and 18 in TL minimum size limit
		ASMA- 16 Mar recreational season closed
		RRMA- 19 Feb, hook an line season opened, possession limited to Wed, Sat and Sun, 2 Apr, lower river closed, 21 Apr, upper river closed
		RRMA- effective 1 Jul, protective 22 to 27 in TL slot limit extended to entire Roanoke River, 1 Apr- 31 May (WRC)

Year	Statewide	ASMA/RRMA
		ASMA- 21 Nov commercial season open- permittee limited to landing 5 fish per day and 18 in TL minimum size limit
		ASMA- 23 Nov recreational season open- harvest days Wed, Sat and Sun- 3 fish per person, 18 in TL minimum size limit
		ASMA- 7 Dec recreational season closed
		ASMA- 21 Feb no gill nets set from 4:00 p.m. Friday until sunrise Monday
		ASMA- 14 Mar- 15 Apr no gill nets set from 4:00 p.m. on Friday until sunrise Monday, 16 Apr – 31 May all gill nets attended 7 days per week, except flounder nets Batchelor Bay/ Western Albemarle Sound closed
		ASMA- 1 Jun- 28 Oct small mesh gill nets 1,000 yd limit attended unless set in water less than 7 ft
		ASMA- 17 Oct- 18 Nov small mesh gill nets 1,000 yd limit- attended Batchelor Bay/ Western Albemarle Sound closed
		ASMA- 18 Nov no gill nets set from 4:00 p.m. Friday until sunrise Monday, small mesh gill nets attended, 3,000 yd limit- flounder nets
1995		ASMA- 16 Jan small mesh gill nets (3 and 3 ¼) limit 800 yds, drift gill net 2 ½- 3 ISM, no flounder nets
		ASMA- 1 Mar recreational season open
		ASMA- 1 Mar commercial season open- permittee limited to landing 5 fish per day, 18 in TL minimum size limit;
		ASMA- 19 Mar recreational season closed
		ASMA- 4 Apr commercial harvest- permittee limited to landing 2 fish per day (striped bass not to exceed 5% of total weight of catch), 18 in TL minimum size limit, commercial season close 14 Apr Mesh size and yardage restrictions on gill nets, area closure
		ASMA- 22 Nov commercial season open, 18 in TL minimum size limit, limited to landing 2 fish per day, harvest permit required and sale tags
		ASMA- 22 Nov recreational season open, harvest days Wed, Sat and Sun, 21 in TL minimum size limit, 2 fish per day
		ASMA- 24 Dec recreational season closed
		ASMA- 26 Dec commercial season closed

Year	Statewide	ASMA/RRMA
		RRMA- 1 Mar, hook and line season opened, possession limited to Wed, Sat, and Sun, 9 Apr, lower river closed, 14 Apr, upper river closed
1996		ASMA- 16 Feb commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day (not to exceed 25% by weight of total catch), permit required and sale tags, season close 15 Apr
		ASMA- 16 Mar recreational season open- harvest days Wed, Sat and Sun, 18 in TL minimum size limit, 3 fish per person per day
		ASMA- 31 Mar recreational season closed
		ASMA- 8 Apr commercial season, 18 in TL minimum size limit, limited to landing 3 fish per day (not to exceed 15% by weight of the total catch)
		ASMA- 30 Nov commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day (not to exceed 25% by weight of total catch, permit required and sale tags
		ASMA- 22 Dec recreational season closed
		ASMA- 23 Dec commercial 18 in TL minimum size limit, limited to landing 10 fish per day (not to exceed 25% by weight of total catch), close 31 Dec
		RRMA- 16 Mar, hook and line season opened, possession limited to Wed, Sat, and Sun, 10 Apr, lower river closed
		RRMA- effective 1 Jul, single barbless hook rule enacted for Roanoke River, 1 Apr- 30 Jun, Roanoke River, 1 Apr- 30 June, Roanoke Rapids Lake Dam down stream to US Hwy 258 bridge (WRC)
1997		ASMA- 15 Feb commercial season open, 18 in TL minimum size limit, limited to landing 3 fish per day (not to exceed 25% by weight of total catch
		ASMA- 15 Mar recreational season open, 18 in TL minimum size limit, 3 fish per day, harvest days- Wed, Sat and Sun
		ASMA- 23 Mar recreational season closed

Year	Statewide	ASMA/RRMA
		ASMA- 24 Mar commercial, 18 in TL minimum size limit, limited to landing 7 fish per day (not to exceed 40% by weight of total catch), permit and sale tags required, season closed 15 Apr
		ASMA- 15 Nov recreational season open, 21 in TL minimum size limit, 2 fish per day, harvest days- Wed, Sat and Sun, season close 31 Dec
		ASMA- 3 Nov commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day (not to exceed 50% by weight of total catch), permit required and sale tags
		ASMA- 5 Dec commercial season closed
		RRMA- 15 Mar, hook and line season opened, possession limited to Wed, Sat, and Sun, 23 Mar, lower river closed, 2 Apr, upper river closed, upper river reopened 19 Apr for a 6 hour season to use remaining allowable harvest
1998		ASMA- TAC commercial 125,440 lb, recreational 62,720 lb, RRMA- TAC recreational 62,720 lb
		ASMA- 16 Feb commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required
		ASMA- 7 Mar commercial 18 in TL minimum size limit, limited to landing 10 fish per day, dealer permit and sale tags required
		ASMA- 14 Mar recreational season open, 18 in TL minimum size limit, 3 fish per day, harvest days- Wed, Sat and Sun
		ASMA- 8 Apr commercial season closed
		ASMA- 22 Apr recreational season closed
		ASMA- 28 Oct recreational season open, 18 in TL minimum size limit, 2 fish per day, harvest days- Wed, Sat and Sun, season close 30 Dec
		ASMA- 1 Dec commercial season open, 18 in TL minimum size limit, limited to landing 10 fish per day, dealer permit and sale tags required, season close 31 Dec
		RRMA- 14 Mar, hook and line season opened, possession limited to Wed, Sat, and Sun, 12 Apr, lower river closed, 29 Apr, upper river closed
1999	Internal Coastal and Joint Waters- 6 Nov recreational season open, 18 in TL minimum size limit, 3 fish per person per day	ASMA- TAC commercial 137,984 lbs, recreational 68,992 lbs, RRMA- TAC recreational 68,992 lbs

Year	Statewide	ASMA/RRMA
	All Primary Nursery Areas (PNAs) and Secondary Nursery Area (SNAs), no trawl areas (Outer Banks areas modified) and within 200 yds. of shore- 1 May through 31 Oct gill nets less than 5 ISM must be attended each year	ASMA- 1 Jan recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Wed, Sat and Sun, season close 16 Mar
		ASMA- 9 Feb commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit required and sale tags, season close 28 Mar
		ASMA-29 Mar commercial 18 in TL minimum size limit, limited to landing 10 fish per day, dealer permit and sale tags required, season closed 15 Apr
		ASMA- 2 Apr recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Fri, Sat, Sun and Mon, season close 5 Apr
		ASMA- 6 Nov recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Wed, Sat and Sun, season close 29 Dec
		ASMA- 1 Dec commercial season open, 18 in TL minimum size limit, limited to landing 10 fish per day, dealer permit and sale tags required, season close 12 Dec
		ASMA- 13 Dec commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required, season close 31 Dec
		RRMA- 13 Mar, hook and line season opened, possession limited to Wed, Sat and Sun, 7 Apr, lower river closed, 28 Apr, upper river closed
2000	Effective 1 Jul, no striped bass 22 to 27 in TL may be possessed in the Inland Waters of Tar and Neuse river, 1 Apr-31 May	ASMA- TAC commercial 225,000 lbs, recreational 112,500 lbs, RRMA- TAC recreational 112,500 lbs
		ASMA- 1 Jan recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Wed, Fri, Sat and Sun, season close 26 Apr
		ASMA- 7 Jan commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required, season close 26 Mar

Year	Statewide	ASMA/RRMA
		ASMA- 27 Mar commercial, 18 in TL minimum size limit, limited to landing 10 fish per day, dealer permit and sale tags required, season close 15 Apr
		ASMA- 11 Oct recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Wed, Fri, Sat and Sun, season close 12 Nov
		ASMA- 13 Nov commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required, season close 31 Dec
		ASMA- 15 Nov recreational season open, 18 in TL minimum size limit, 1 fish per person per day, harvest days- Wed, Fri, Sat and Sun, season close 3 Dec
		RRMA- 15 Mar, hook and line season opened, possession limited to Tue, Wed, Sat and Sun, 12 Apr lower river closed, 30 Apr upper river closed
2001		ASMA- 5 Jan commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required, season closed 25 Mar
		ASMA- 17 Jan recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Wed, Fri, Sat and Sun, season close 18 Apr
		ASMA- 26 Mar commercial season open, 18 in TL minimum size limit, limited to landing 10 fish per day, dealer permit and sale tags required, season close 15 Apr
		ASMA- 17 Oct recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Wed, Fri, Sat and Sun, season closed 25 Nov
		ASMA- 19 Nov commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required, season closed 21 Dec
		RRMA- 13 Mar hook and line season opened, possession limited to Tue, Wed, Sat and Sun, 22 Apr lower river closed, 29 Apr upper river closed

Year	Statewide	ASMA/RRMA
2002		ASMA- 7 Jan commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day (not to exceed 50% by weight of the total catch), dealer permit and sale tags required, season closed 15 Apr
		ASMA- 7 Jan small mesh gill nets not to exceed 800 yds, 5 ¼ ISM and larger flounder nets limited to 3,000 yds, 5 ¼ ISM and larger shad (float) nets limited to 1,000 yds (18 Feb- 14 Apr), western Albemarle Sound area closed to gill nets,
		ASMA- 16 Jan recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Wed, Fri, Sat and Sun, season closed 14 Apr,
		RRMA- hook and line season set by WRC regulations, lower river open 1 Mar- 15 Apr, upper river open 15 Mar- 30 Apr, creel limit reduced to 2 fish/day, possession allowed 7 days/week, protective 22- 27 in TL slot limit extended to include the entire open harvest season
		ASMA- 4 Nov commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required, season closed 20 Dec
		ASMA- 6 Nov recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Wed, Fri, Sat and Sun, season closed 29 Dec
2003		ASMA TAC commercial 275,000, recreational 137,500. RRMA TAC recreational 137,500.
		ASMA- 6 Jan commercial season open, 18 in TL minimum size limit, limited to landing 5 fish per day, dealer permit and sale tags required, season to close15 Apr, unless closed earlier by proclamation
		ASMA- 15 Jan recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Wed, Fri, Sat and Sun, season will close 23 Apr, unless closed earlier by proclamation

Year	Statewide	ASMA/RRMA
		RRMA- hook and line season set by WRC regulations, lower river open 1 Mar- 15 Apr, upper river open 15 Mar- 30 Apr, creel limit reduced to 2 fish/day, possession allowed 7 days/week, protective 22- 27 in TL slot limit extended to include the entire open harvest season, only 1 of the 2 fish daily creel limit may be greater than 27 in TL
2004		ASMA – 5 Jan – Apr 6 – commercial season open, 18 in TL min. size, limited to 5 fish per day, dealer permit and sale tags required; No fall season,
		ASMA- 14 Jan – 30 Apr recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Wed, Fri, Sat and Sun; 11 Oct – Dec 1 recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest days- Wed, Fri, Sat and Sun;
		RRMA- hook and line season set by WRC regulations, lower river open 1 Mar- 15 Apr, upper river open 15 Mar- 30 Apr, creel limit reduced to 2 fish/day, possession allowed 7 days/week, protective 22- 27 in TL slot limit extended to include the entire open harvest
2005		ASMA – 3 Jan – Mar 30 – commercial season open, 18 in TL min. size, limited to 5 or 10 fish per day, dealer permit and sale tags required; 3 Oct – Nov 30 – commercial season open, 18 in TL min. size, limited to 5 or 10 fish per day, dealer permit and sale tags required;
		ASMA- 5 Jan – 3 Apr recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest 7 days per week; 1Oct – Dec 31 recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest 7 days per week,
		RRMA- hook and line season set by WRC regulations, lower river open 1 Mar- 27 Apr, upper river open 15 Mar- 4 May, creel limit reduced to 2 fish/day, possession allowed 7 days/week, protective 22- 27 in TL slot limit extended to include the entire open harvest,

Year	Statewide	ASMA/RRMA
2006		ASMA – 1 Jan – 30 Apr – commercial season open, 18 in TL min. size, limited to 5 or 10 fish per day, dealer permit and sale tags required; 1 Oct – Nov 30 – commercial season open, 18 in TL min. size, limited to 10 fish per day, dealer permit and sale tags required
		ASMA- 1 Jan – 30 Apr recreational season open, 18 in TL minimum size limit, 2 fish per person per day, harvest 7 days per week; 1 Oct – Dec 31 recreational season open, 18 in TL minimum size limit, 3 fish per person per day, harvest 7 days per week,
		RRMA- hook and line season set by WRC regulations, lower river open 1 Mar- 22 Apr, upper river open 15 Mar- 30 Apr, creel limit 2 fish/day, possession allowed 7 days/week, protective 22- 27 in TL slot limit extended to include the entire open harvest,
2007		ASMA – 1 Jan – 30 Apr – commercial season open, 18 in TL min. size, limited to 5 or 10 fish per day, dealer permit and sale tags required; 1 Oct – Nov 30 – commercial season open, 18 in TL min. size, limited to 10 fish per day, dealer permit and sale tags required,
		ASMA- 1 Jan – 6 May recreational season open, 18 in TL minimum size limit, 3 fish per person per day, harvest 7 days per week; 1 Oct – Dec 31 recreational season open, 18 in TL minimum size limit, 3 fish per person per day, harvest 7 days per week,
		RRMA- hook and line season set by WRC regulations, entire river season 1 Mar- 6 May, creel limit 2 fish/day, possession allowed 7 days/week, protective 22- 27 in TL slot limit extended to include the entire open harvest,
2008		ASMA – 1 Jan – 30 Apr – commercial season open, 18 in TL min. size, limited to 5 or 15 fish per day, dealer permit and sale tags required; 1 Oct – Nov 30 – commercial season open, 18 in TL min. size, limited to 10 fish per day, dealer permit and sale tags required,
		ASMA- 1 Jan – 6 May recreational season open, 18 in TL minimum size limit, 3 fish per person per day, harvest 7 days per week; 1 Oct – Dec 31 recreational season open, 18 in TL minimum size limit, 3 fish per person per day, harvest 7 days per week,

Year	Statewide	ASMA/RRMA
		RRMA- hook and line season set by WRC regulations, entire river season 1 Mar- 30, creel limit 2 fish/day, possession allowed 7 days/week, protective 22- 27 in TL slot limit extended to include the entire open harvest,

APPENDIX 4: INDEX SENSITIVITY ANALYSES

INTRODUCTION

In order to best understand the behavior of different model inputs, variations of the final model configuration can be investigated. The final configuration of the AR striped bass ASAP2 model contained indices that conflicted with each other. To understand the impact of the different indices on the model estimates, several runs were completed isolating each of the indices.

RESULTS

Spring IGNS Indices

The configuration using only the spring IGNS indices at age resulted in different model estimates than the full model configuration. In comparison to the full model, the estimates of F were higher since 1998 (Figure A.4.1). The estimates of both SSB and total abundance were lower than the estimates of the full model since 1998 and 1995, respectively (Figures A.4.2 and A.4.3).

Fall/Winter IGNS Indices

The configuration using only the fall/winter IGNS indices at age resulted in different model estimates than the full model configuration. In comparison to the full model, the estimates of F were lower in some of the earlier years of the time series, but then higher in the more recent years (Figure A.4.4). The estimates of both SSB and total abundance were higher than the full model estimates in the earlier years then become lower than the estimates of the full model in the most recent years (Figures A.4.5 and A.4.6).

Roanoke River Spawning Survey Indices

The configuration using only the Roanoke River spawning surveys resulted in estimates that were very similar to the estimates of the full ASAP2 mode. There was little difference between the two configurations for the major estimates of F, SSB, and total abundance (Figures A.4.7 – A.4.9).

JAI and Age-1 Indices

The configuration using only the JAI and age-1 indices resulted in different model estimates than the full model configuration. In comparison to the full model, the estimates of F were lower in some of the earlier years of the time series, but then much higher in the more recent years (Figure A.4.10). The estimates of both SSB and total abundance were higher than the full model estimates in the earlier years then become much lower than the estimates of the full model in the most recent years (Figures A.4.11 and A.4.12).

DISCUSSION

Overall, using a single index source does have some impact on the absolute values of the model estimates. The greatest differences occurred when the indices were only the JAI and age-1. The Roanoke River indices resulted in nearly identical estimates as the full model, which may be an indication of the importance of the Roanoke River indices to the full model in comparison to the other index sources. It should be noted that most of the index configurations did not result in different patterns than the full model.

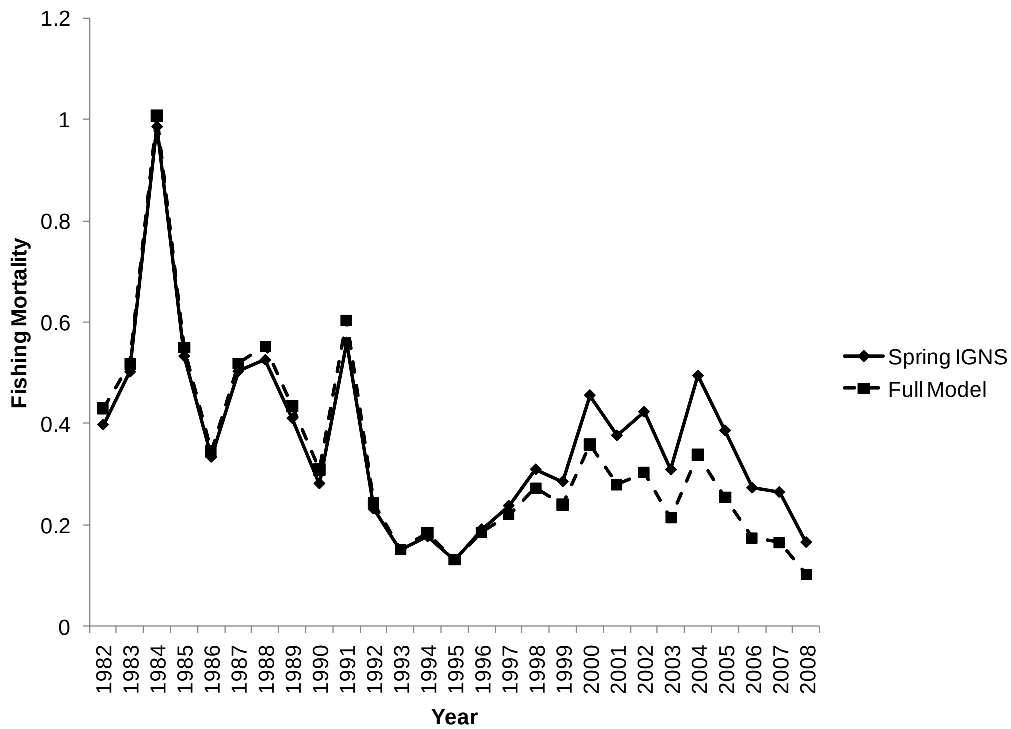


Figure A.4.1. Trend in age 4-6 striped bass fishing mortality from ASMA/RRMA, NC 1982-2008 configured only using the spring IGNS at age indices.

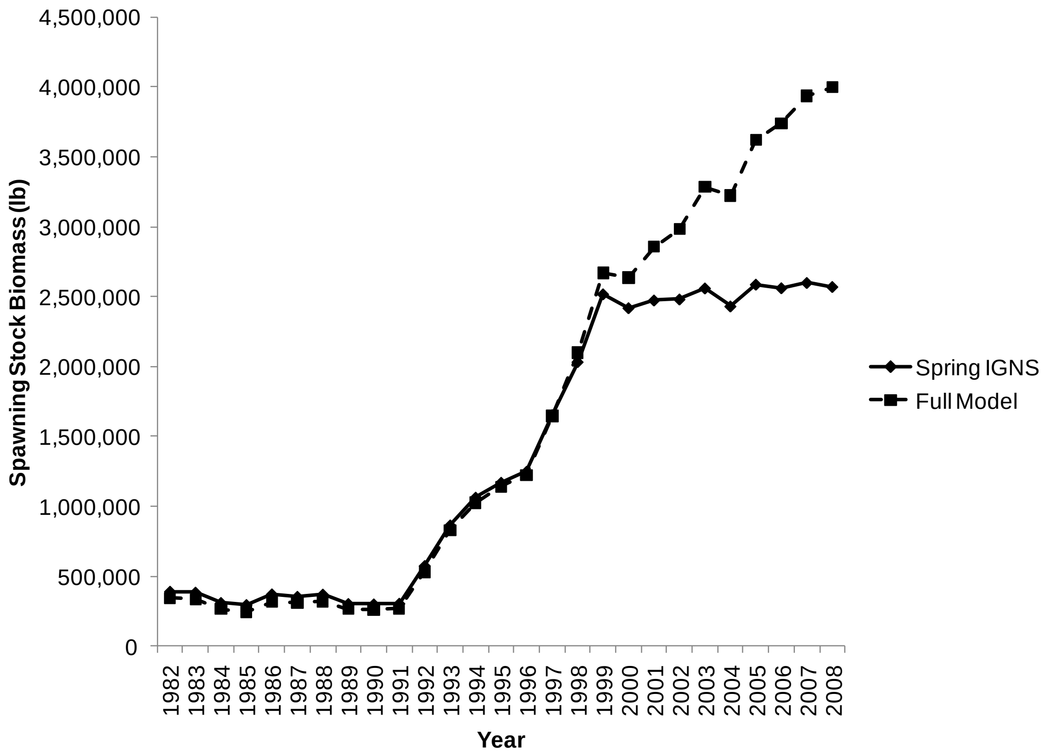


Figure A.4.2. Spawning stock biomass of female striped bass in thousands of pounds from ASMA/RRMA, NC 1982-2008 using the spring IGNS at age indices.

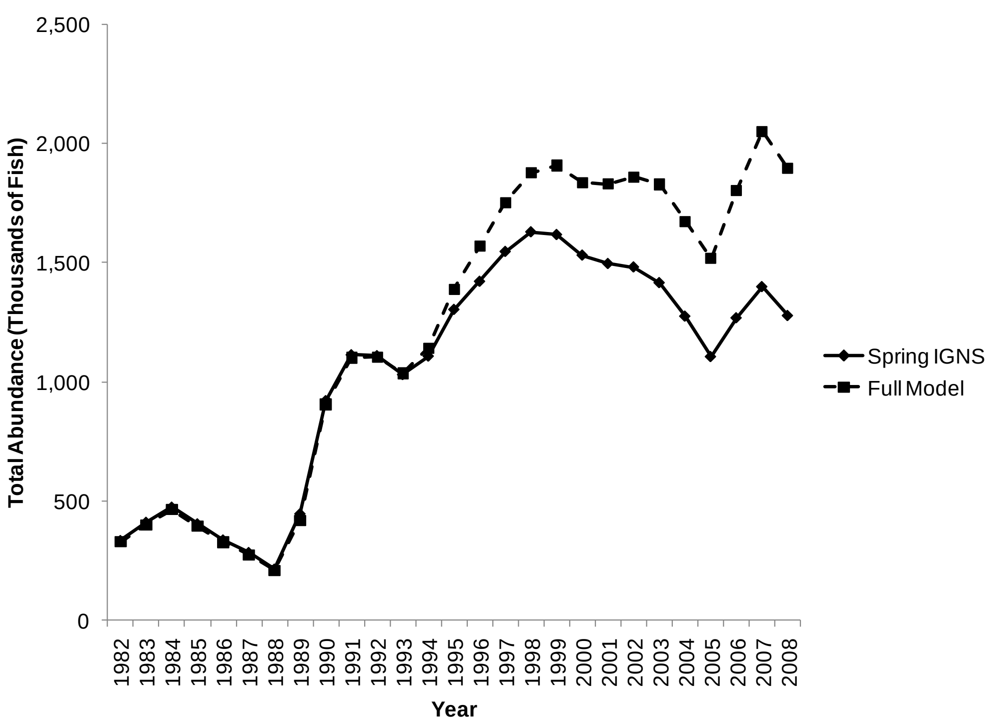


Figure A.4.3. Estimated total annual abundance of striped bass in thousands of fish from ASMA/RRMA, NC 1982-2008 using the spring IGNS at age indices.

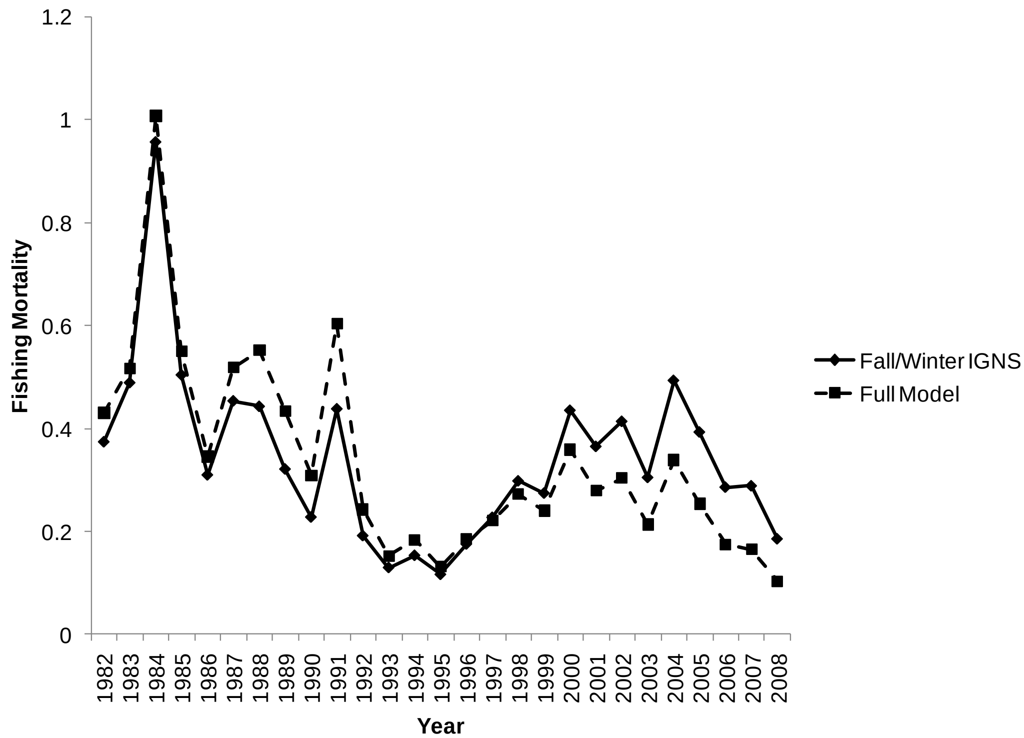


Figure A.4.4. Trend in age 4-6 striped bass fishing mortality from ASMA/RRMA, NC 1982-2008 configured only using the fall/winter IGNS at age indices.

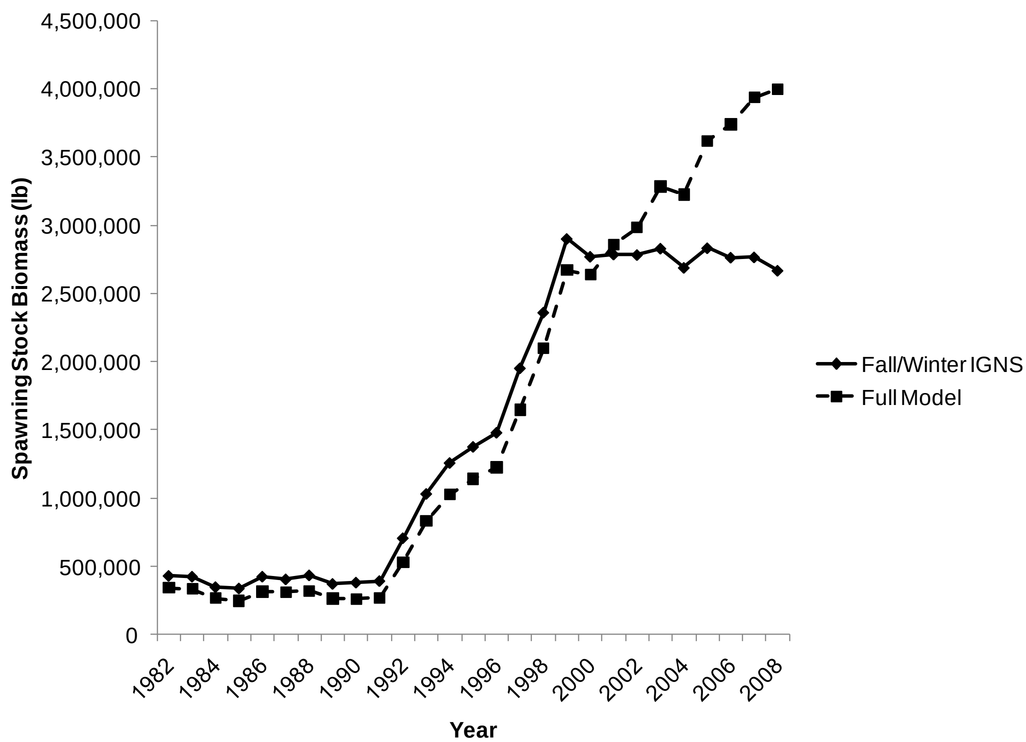


Figure A.4.5. Spawning stock biomass of female striped bass in thousands of pounds from ASMA/RRMA, NC 1982-2008 using the fall/winter IGNS at age indices.

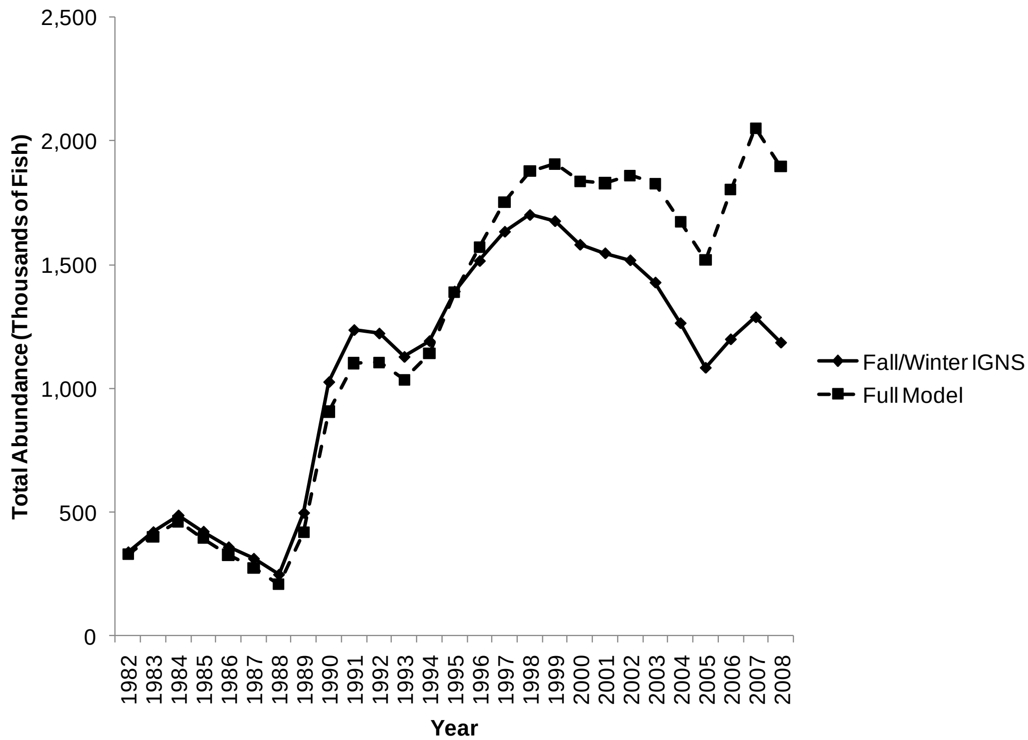


Figure A.4.6. Estimated total annual abundance of striped bass in thousands of fish from ASMA/RRMA, NC 1982-2008 using the fall/winter IGNS at age indices.

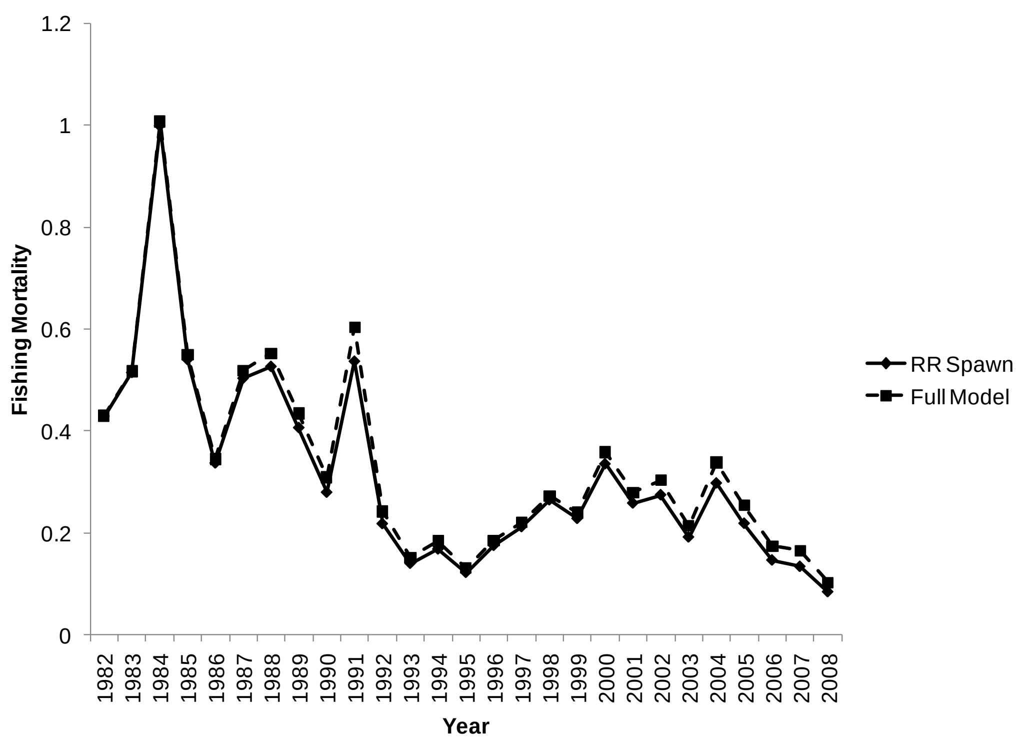


Figure A.4.7. Trend in age 4-6 striped bass fishing mortality from ASMA/RRMA, NC 1982-2008 configured only using the Roanoke River spawning survey at age indices.

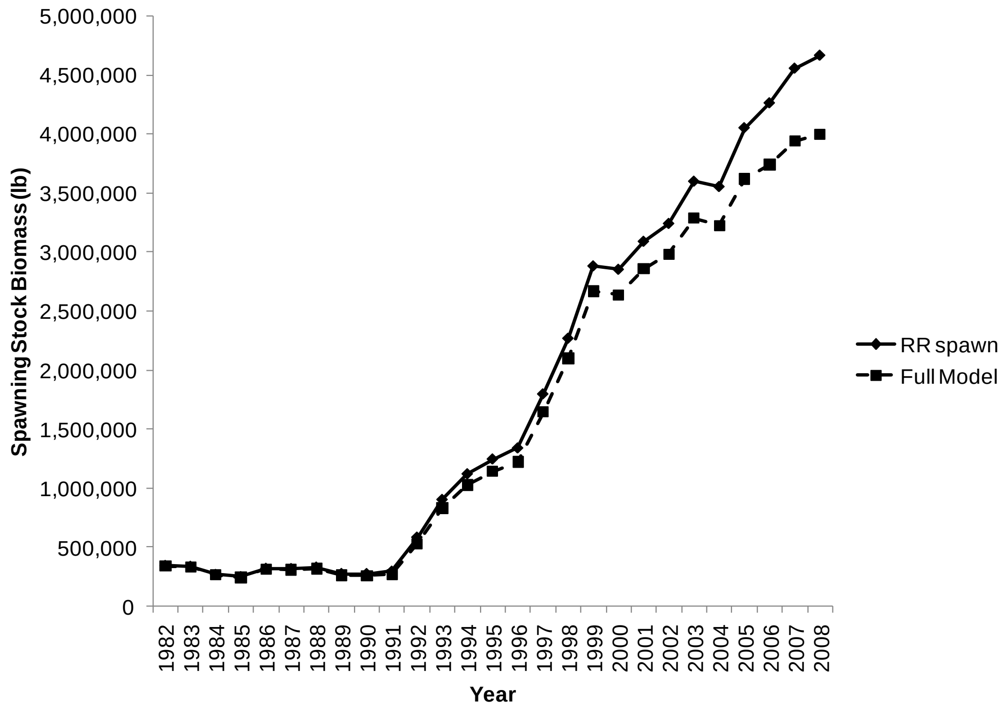


Figure A.4.5. Spawning stock biomass of female striped bass in thousands of pounds from ASMA/RRMA, NC 1982-2008 using the Roanoke River spawning survey at age indices.

Figure A.4.9. Estimated total annual abundance of striped bass in thousands of fish from ASMA/RRMA, NC 1982-2008 using the Roanoke River spawning survey at age indices.

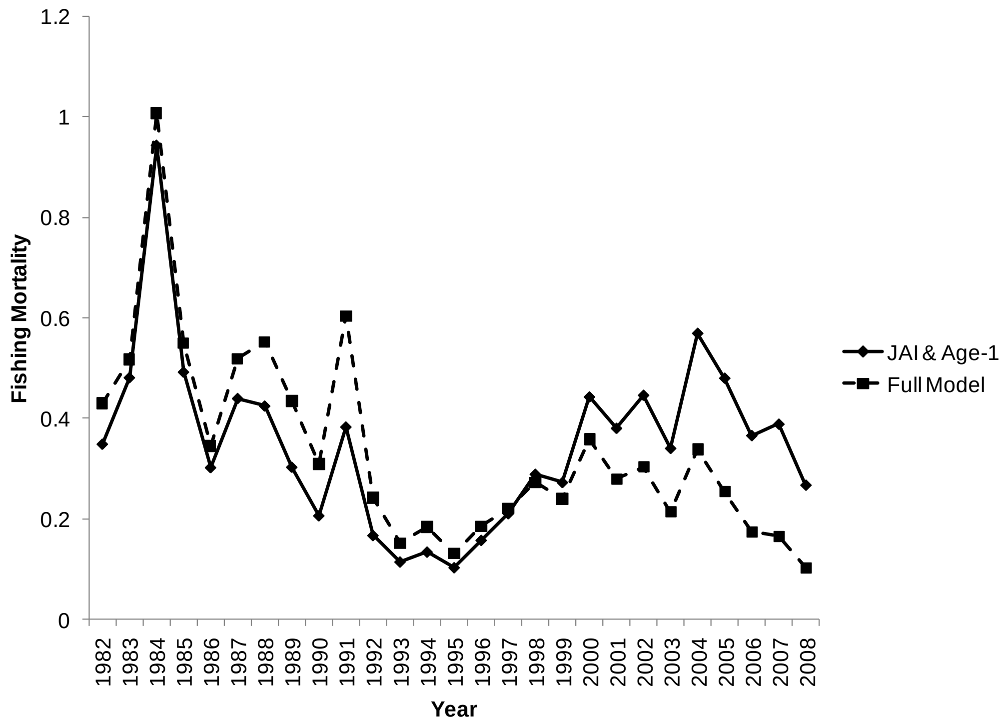


Figure A.4.10. Trend in age 4-6 striped bass fishing mortality from ASMA/RRMA, NC 1982-2008 configured only using the JAI and age-1 indices.

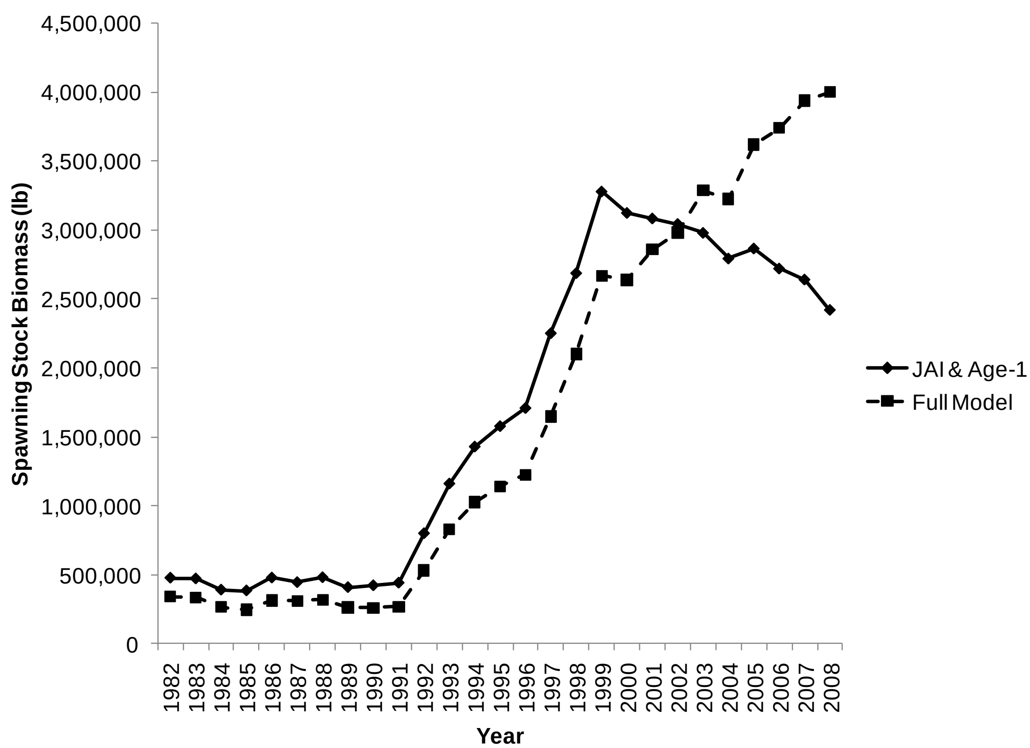


Figure A.4.11. Spawning stock biomass of female striped bass in thousands of pounds from ASMA/RRMA, NC 1982-2008 using the JAI and age-1 indices.

Figure A.4.12. Estimated total annual abundance of striped bass in thousands of fish from ASMA/RRMA, NC 1982-2008 using the JAI and age-1 indices.

APPENDIX 5: VIRTUAL POPULATION ANALYSIS (VPA)

INTRODUCTION

The change from a virtual population analysis (VPA) to a forward-projecting model is considered a significant model change. In order to understand the impact of the model change, it has been recommended to perform comparison runs using the VPA. It is important to note that the VPA run is not considered usable for management and was only conducted for diagnostic purposes.

RESULTS

The estimates from the VPA were notably different than those of the fully configured ASAP2 model. The F estimates throughout the time series were higher than those of the fully configured base model (Figure A.5.1). The estimates of female SSB were significantly lower than the same estimates from the ASAP2 model (Figure A.5.2). The estimates of total abundance were also lower for the VPA when compared to the ASAP2 model (Figure A.5.3 and Table A.5.1).

DISCUSSION

Overall, the VPA estimated a stock that was experiencing higher levels of F and lower levels of both spawning and total abundance. There were complications with all the runs that should be noted. For several of the years there was a error indicating that the estimated abundances at age were not possible. In those cases, the abundance at age for a year was lower than the subsequent abundance at age+1 for year+1. This may be an indication of solving problems and the resulting estimates may not be valid. The errors may also explain why the recent decreasing catch levels have not resulted in a corresponding increase in SSB. Previous occurrences of these errors resulted in the decision to change models to the ASAP2.

Figure A.5.1. Trend in age 4-6 striped bass fishing mortality from ASMA/RRMA, NC 1982-2008 configured in the VPA.

Figure A.5.2. Spawning stock biomass of female striped bass in thousands of pounds from ASMA/RRMA, NC 1982-2008 configured using the VPA.

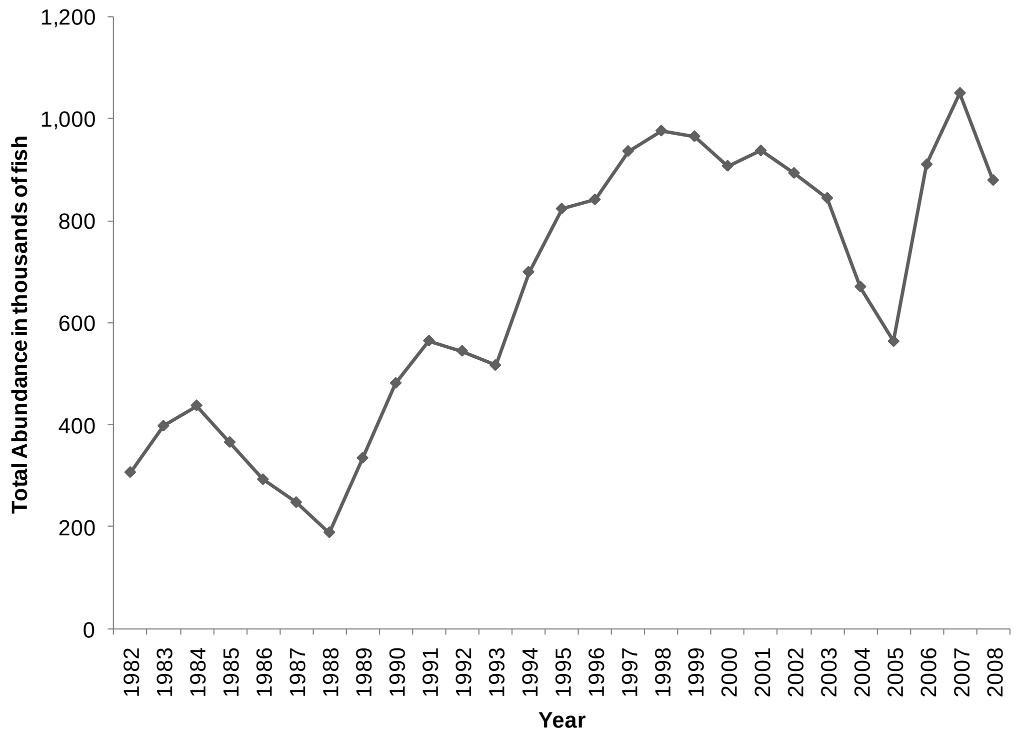


Figure A.5.3. Estimated total annual abundance of striped bass in thousands of fish from ASMA/RRMA, NC 1982-2008 configured with the VPA.

Table A.5.1. Estimated total annual abundance of striped bass by age in thousands of fish from ASMA/RRMA, NC 1982-2008 configured with the VPA.

	Age									
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
1982	52	125	82	23	13	6	3	1	1	306
1983	210	45	72	45	12	7	3	2	1	397
1984	176	181	14	32	25	4	3	0	2	437
1985	143	151	57	6	4	3	1	0	0	365
1986	101	112	52	19	3	2	2	0	1	292
1987	65	87	45	35	10	3	1	1	0	247
1988	50	56	37	22	15	4	2	1	1	188
1989	236	43	28	18	7	1	1	0	0	334
1990	239	203	21	11	4	2	1	0	0	481
1991	221	205	126	8	2	1	1	0	0	564
1992	128	190	162	61	2	1	0	0	0	544
1993	97	111	164	112	30	2	0	0	0	516
1994	312	83	95	133	61	14	1	0	0	699
1995	298	268	61	77	95	23	1	0	0	823
1996	301	257	124	48	52	48	10	1	0	841
1997	291	259	210	92	32	27	18	7	0	936
1998	288	250	196	147	63	20	7	1	4	976
1999	258	248	208	133	83	27	4	1	3	965
2000	209	222	210	153	73	31	6	1	2	907
2001	334	180	188	153	63	11	4	2	2	937
2002	245	287	141	122	72	16	4	2	4	893
2003	227	211	225	109	50	13	5	1	3	844
2004	84	195	176	126	56	17	4	3	9	670
2005	147	73	154	107	55	16	4	2	5	563
2006	538	127	60	110	54	13	3	1	4	910
2007	352	463	106	39	63	18	3	2	4	1,050
2008	66	297	381	78	19	28	8	1	1	879

14.7 CATCH CURVE EXPLOITATION ESTIMATES FOR NEUSE RIVER AND TAR/PAMLICO RIVER STRIPED BASS STOCKS

Catch Curve Exploitation Estimates for Neuse River and Tar/Pamlico River Striped Bass (*Morone saxatilis*) Stocks

October 11, 2010

North Carolina Division of Marine Fisheries

P.O. Box 769

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EXECUTIVE SUMMARY

In North Carolina, estuarine striped bass (*Morone saxatilis*) of the Tar/Pamlico, Neuse and Cape Fear watersheds are managed as an internal stock in a management unit recognized formally as the Central Southern Management Area (CSMA) (NCDMF 2004). The 2004 FMP estimates of total mortality for the Tar River and Neuse River striped bass stocks indicated that cohort mortality was excessive, higher than the target F (0.22). The 2004 FMP specified a number of specific management actions but also allowed for additional data collection in the CSMA prior to determining management measures for both the commercial and recreational fishing sectors. The objective of this analysis was to evaluate total mortality rates for the Neuse River and Tar/Pamlico River striped bass stocks as guidance in establishing management recommendations for the CSMA and to update the status of the stock since the 2004 FMP amendment. Examination of results will determine if the available data and analytical techniques are sufficient to meet this objective.

Data available for the CSMA striped bass stocks included abundance, length, and age data collected from independent gill net and spawning grounds electrofishing surveys. Sufficient survey data were available for the Neuse and Tar/Pamlico rivers. The model selected to estimate mortality was the catch curve method.

Since the 2004 FMP, size and age distributions in these systems have not changed with few fish >age 6 collected from a given cohort. The size and age distributions, low abundance, and the absence of older fish support continued management efforts to promote enhancement of the striped bass fisheries in each system. The absence of strong year classes makes it difficult to follow trends in cohort abundance over time. Large confidence intervals around estimates of Z indicate a significant lack of precision in routine catch curve analysis. The large confidence intervals and lack of precision in the catch curve estimates of Z made them unusable for stock status determination. There is no other quantitative stock assessment technique to determine if the stocks are overfished, hence the stock status continues to be formally designated as unknown. It is suspected that improvements in stock dynamics would only be detected as a result of large changes in population characteristics. For this reason, catch curve results (especially annual estimates of mortality) should be supplemented with additional quantitative information (such as trends in mean CPUE) whenever management decisions are considered. Simple index analyses did not indicate any significant trends for the Neuse or Tar/Pamlico rivers in either CPUE by age or mean length at age. These findings continue to justify the need for management measures that will reduce total mortality. Critical data needs for determining future stock status are identified.

CSMA STRIPED BASS WORKING GROUP

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INTRODUCTION

The stated purpose of the 2004 North Carolina Estuarine Striped Bass Fisheries Management Plan (FMP) was to institute management programs and measures that would promote recovery of striped bass stocks in areas where long-term well being was in jeopardy, conserve adequate spawning stock, and protect the integrity of critical habitats (NCDMF 2004). In North Carolina, estuarine striped bass (*Morone saxatilis*) of the Tar/Pamlico, Neuse and Cape Fear watersheds are managed as an internal stock in a management unit recognized formally as the Central Southern Management Area (CSMA) (NCDMF 2004). The CSMA boundaries are defined as all internal coastal, joint and contiguous inland waters south of a line beginning at Roanoke Marshes Point running southeasterly to the north point of Eagle Nest Bay all the way to the South Carolina state line (Figure 1).

In 2003, the first stock assessment was conducted for striped bass populations within the CSMA and concluded the stocks were experiencing excessive mortality (Carmichael and Waters 2003). Data input for this initial assessment were obtained from electrofishing surveys conducted by the North Carolina Wildlife Resources Commission (NCWRC) on the spawning grounds of the Tar and Neuse rivers, and at that time represented the only existing sources of quantifiable information on striped bass abundance from these systems. Age, size, and catch information collected through these electrofishing spawning ground surveys provided a time series of fishery independent abundance at age that were used to estimate total mortality (Z) through catch curve analysis.

The electrofishing survey catch rates were evaluated as an indicator of recruitment strength and compared with stocking rates to determine if observed cohort abundance could be correlated with stocking rates over time. The NCWRC and the North Carolina Division of Marine Fisheries (NCDMF) have been stocking phase I (1-2 inches TL) and phase II (5-8 inches TL) striped bass in the CSMA drainages in an attempt to increase numbers of spawning adults since 1980. Phase II fish have been released in the Cape Fear, Neuse and Tar/Pamlico rivers on a rotating basis (1980–2003) with varying numbers of stocked fish by year in each system. Since 2004, stocking of phase II fish have occurred in two systems annually, with a goal of 100,000 fish per stocking; this action was a stipulated management measure in the 2004 Estuarine Striped Bass FMP. Carmichael and Waters (2003) found that although total mortality (Z) was more strongly correlated with stocking intensity in the Tar River than it was in the Neuse River, the relationship was weak and provided little evidence that stocking was an effective tool for regulating mortality.

The index-based method of catch curve analysis was the sole quantitative technique available to assess the status of striped bass populations in the CSMA. The CSMA commercial fishery had been regulated since 1994 with an annual quota of 25,000 pounds. With an annual quota in place, tracking commercial landings as an indicator of stock abundance has limited utility. Although current and historical harvest data for the commercial sector was available, this was not the case for recreational harvest. Beginning in 2004, ongoing and new data collection programs helped quantify commercial and recreational striped bass harvest, and provided estimates of striped bass discards in each of these fisheries. A recreational creel survey implemented on the Neuse and Tar/Pamlico rivers in 2004 provided the first reliable estimate of recreational harvest within these two systems. Recreational harvest on the Neuse and Tar/Pamlico rivers (combined) averaged 14,102 lb annually from 2004 to 2007 while 2008 and 2009 harvest estimates were much lower (3,027 lb average). To characterize the population structure in more open waters within the CSMA, NCDMF began a fishery-independent gill net survey (Program 915) on the Neuse and Tar/Pamlico rivers in 2003, and the Cape Fear River in 2006. Similar expansions in electrofishing data collection were made by NCWRC on presumed spawning grounds in the Cape Fear River in 2003. Electrofishing surveys have continued on the spawning grounds in the Neuse (1994–2010) and Tar (1996–2010) rivers. NCDMF also increased on-the-water (observer) sampling effort from 2004 to 2006 in the Neuse and Tar/Pamlico rivers to obtain temporal and spatial estimates of commercial catches. This observer data was used to quantify commercial striped bass discards and to describe striped bass size and release condition.

The 2004 FMP specified a number of specific management actions but also allowed for additional data collection in the CSMA prior to determining management measures for both the commercial and recreational fishing sectors. The NCDMF and NCWRC presented two issue papers in 2007 which provided a strong rationale for implementing additional harvest restrictions (NCWRC 2007, NCDMF 2007). Regulatory actions were implemented in July 2008 by the NCWRC and the North Carolina Marine Fisheries Commission (NCMFC) with the objective of reducing overall fishing mortality in the Neuse and Tar/Pamlico rivers by ~64% and disallowing commercial and recreational harvest in the Cape Fear River. This target reduction in fishing mortality was based on examination of fishing mortality (F) rates developed by Carmichael and Waters (2003) for these systems and the target F benchmark established in the 2004 FMP. The relative contribution of harvest components from the various fisheries and basic trends in catch were also considered.

For the Neuse and Tar/Pamlico rivers, striped bass discards from large mesh gill nets were identified as the primary source of fishing mortality within the CSMA. To identify ways to reduce discard mortality, NCDMF examined the effectiveness of tie-downs for gill nets to reduce striped bass bycatch during seasons closed to harvest, and evaluated the effect of prohibiting large mesh gill netting within various distances from shore. To address discards from the commercial large mesh gill net fishery, large mesh gill nets were required in May 2008 to be tied down such that the vertical height did not exceed three feet, and the nets to be set a minimum distance of 50 yards from shore. This requirement goes into effect at the close of the commercial striped bass season (April) and remains in effect until the end of the calendar year. These restrictions were warranted in the commercial fishery while still maintaining the flounder harvest. Upstream delineation of the distance from shore regulation was established based on seasonal and temporal distribution of striped bass as calculated by the NCDMF observer program and Program 915.

Significant changes in recreational regulations also occurred in 2008, including the establishment of a closed season from 1 May to 30 September. Reduction in the daily creel limit from 3 fish to 2 fish, and a protective slot limit of 22–27 inches (TL) was enacted throughout the Tar/Pamlico and Neuse river basins in joint and inland waters. The 18 inch total length minimum size limit for the commercial and recreational fisheries was maintained in coastal waters, as was the 25,000 pound annual quota for the CSMA commercial fishery.

The objective of this analysis was to evaluate total mortality rates for the Neuse River and Tar/Pamlico River striped bass stocks as guidance in establishing management recommendations for the CSMA and to update the status of the stock since the 2004 FMP amendment. Examination of results will determine if the available data and analytical techniques are sufficient to meet this objective.

METHODS

FISHERY DEPENDENT DATA SOURCES

Commercial Data

North Carolina commercial landings data have been collected through the North Carolina Trip Ticket Program (NCTTP) since 1994 when the reporting of commercial landings was made mandatory. For further information on the sampling methodology for the NCTTP, see Lupton and Phalen (1996). Commercial landings data for the CSMA fisheries for the Neuse, Pamlico/Pungo, and Cape Fear rivers were collected through the NCTTP (Table 1).

Commercial length frequency data were obtained by the NCDMF fishery dependent port sampling of commercial catches targeting a variety of fish, shellfish and crustaceans year round throughout the state. For striped bass the primary commercial finfisheries sampled was estuarine gill net fisheries. The estuarine gill net sampling program began in 1991. Estuarine gill net sampling occurs year round throughout the state with variable degrees of sampling intensity in different areas and times of year. Fish house samples come from both small (< 5 inch stretched mesh) and large mesh (≥ 5 inch stretched mesh) catches, but the majority of the samples come from large mesh catches. Lengths were collected by gear, market grade and area fished at fish houses along the North Carolina coast. Individual fish were measured (mm, FL) and total weight (0.1 kg) of all fish measured in aggregate was obtained. Length frequencies obtained from a sample were converted to TL inch groups and number by inch categories were then expanded to the total catch using the total weights from the trip ticket. All expanded catches were then combined to describe a given commercial gear for a specified time period. In a similar fashion on water samples of the striped bass catch (harvest and discards) were taken under the NCDMF observer program, with the sampling occurring in the CSMA river systems primarily from 2004-2006.

Recreational Data

A comprehensive creel survey was initiated in January 2004 to identify the recreational component of striped bass harvests in the CSMA. The survey area included the Neuse, Tar/Pamlico, and Pungo rivers. A non-uniform probability stratified access-point survey (Pollock et al. 1994, NCDMF 2009) was utilized for site selections as well as effort and catch estimation. Returning fishing parties were interviewed to obtain information regarding the trip, catch (mm, FL), and socioeconomic attributes of striped bass anglers. Survey results were expanded to estimate total striped bass catch and effort in the CSMA. Harvested fish were identified, enumerated, measured, and weighed to the nearest 0.1 kg, while information on discarded fish was obtained from the angler(s) to acquire the number and status of discarded individuals. Scale collections were taken from available fish to determine age of individuals. Length frequencies obtained from a sample were converted to TL inch groups and number by inch categories were then expanded to the total catch.

FISHERY INDEPENDENT DATA SOURCES

NCWRC Spawning Grounds Surveys

Adult striped bass were collected annually during the spawning season using boat-mounted electrofishing gear (Smith-Root 7.5 GPP) from the Neuse River since 1994, from the Tar River since 1996, and from the Cape Fear since 2003. Weekly sampling was conducted from late March through mid-May. Current sampling sites have limited to no observed spawning, but are considered spawning grounds. Electrofishing time (s) was recorded, and striped bass abundance was calculated using catch per unit effort (CPUE), expressed as number of fish per electrofishing hour. To minimize size selection during sampling, striped bass were netted as they were encountered regardless of size. Total length (mm) and weight (g or kg) was measured for each striped bass collected, and sex was determined by applying directional pressure on the abdomen to observe the release of eggs or milt. Scales were removed from the left side between the lateral line and the dorsal fins from at least 10 fish from each 25-mm length group for each sex. Scales were placed in a labeled envelope and stored for ageing. For each scale sample to age, a range of four to six scales of uniform size were cleaned with water and placed on a microfiche reader. Annuli were counted at 30X to 33X magnification and ages assigned for data analysis.

NCWRC Neuse River Sample Design

Sampling in the Neuse River was conducted from Raleigh (Milburnie Dam) downstream to Kinston, approximately 128 river miles (Figure 2). Prior to the removal of Quaker Neck Dam near Goldsboro in 1998, sample stations were located near Goldsboro (upstream and downstream of Quaker Neck Dam), Seven Springs, and Kinston. Since 1998, stations downstream of Goldsboro have been abandoned, and sampling has expanded upstream to include stations at Goldsboro (upstream and downstream of the Quaker Neck Dam site), Richardson's Bridge, Smithfield, Wilson's Mills, Clayton, Poole Road (Raleigh), and Milburnie Dam (Raleigh) (Table 2). A minimum of three to four sites were sampled weekly depending on river flow. Beginning in 2005, low striped bass catches resulted in longer sampling runs than the previous 15-minute electrofishing periods, and several sites in the mid reaches of the spawning grounds were eliminated due to navigation difficulties.

NCWRC Tar River Sample Design

Sampling in the Tar River was conducted from Rocky Mount downstream to Tarboro, approximately 40 river miles (Figure 2). This area was divided into three stations, which were each sampled weekly. Station 1 began at Battle Park in Rocky Mount and ended at the Bourne Farms access area off U.S. 64 Business. Station 2 began at the Bourne Farms access area and ended at the NCWRC access area on N.C. 33 in Tarboro. Station 3 began at the NCWRC access area at N.C. 33 and ended at the City of Tarboro access area off U.S. 64. Sampling consisted of 30-minute segments of electrofishing alternated with 30 minutes of drifting at each of the stations, with a minimum of two hours of electrofishing conducted at each station (Table 3). Electrofishing and drifting start points were alternated each trip to allow a systematic coverage of each station during the spawning season.

NCWRC Cape Fear River Sample Design

Since 2005, all stock assessment sampling effort for striped bass in the Cape Fear River has been conducted at three fixed sites located immediately below each of the lock and dams located at Duart, Elizabethtown, and Reigelwood, North Carolina (Figure 2, Table 4). Prior to 2005, sampling effort for striped bass in the Cape Fear River was exploratory at the three lock and dam sites and concentrated in the lower river at the following sites; Alligator Creek, Brunswick River and Cape Fear River at mile marker 63. Sampling effort was pooled for all 6 sites in 2003 and 2004. Effort was concentrated at these sites primarily to collect striped bass for a sonic tagging study being conducted by Coastal Zone Resources Inc. (CZR) to evaluate fish passage at Lock and Dam 1 prior to construction of a rock arch rapids structure, and to gather baseline data for comparison of post-construction monitoring. From 2005 to 2008, sampling consisted of two, 15-minute samples (total of 30-minutes per bank; 1 hour per site) of electrofishing along each bank, beginning at the dam and proceeding downstream. Since 2009, sampling has consisted of one, 15-minute sample along each bank for a total of 30 minutes per site.

NCDMF Program 915 Survey Design

Striped bass were collected from NCDMF Program 915 from February through mid-December using gill nets to sample shallow strata (< 6 ft) and deep strata (> 6 ft; changed to 6 ft contour in 2005) in the Neuse, Pamlico, Pungo, and Cape Fear rivers (Figures 3 and 4). Each net gang consists of eight separate 30-yard segments of 3, 3 ½, 4, 4 ½, 5, 5 ½, 6, and 6 ½ inch stretched mesh, for a total of 240 yards of nets combined. Catches from this array of gill nets comprised a single sample. Two samples (one shallow, one deep) totaling 480 yards of gill nets fished, were completed in each trip (Figure 5). Gear was typically deployed within an hour of sunset and fished the following morning with effort made to keep all soak times within 12 hours. The 12-hour soak time allowed for uniform effort and kept the study in compliance with the terms and conditions mandated by the Section 7 permit issued by the U.S. Fish and Wildlife Service. Soak times in the Cape Fear River were further modified due to interactions with sea turtles in June 2007; soak times from April to September were reduced to four hours and gear was deployed two hours before sunset. Set and fish times were recorded, and abundance was calculated as CPUE, expressed as fish per sample (Pamlico, Pungo and Neuse rivers) or fish per sample hour (Cape Fear River). Striped bass were measured to the nearest mm fork length (FL) and a total weight of all measured fish was taken. Striped bass measurements from Program 915 were converted from fork length to total length using a conversion factor ($TL = e^{(0.12138+0.98645*(\log(FL)))}$) from NCDMF aged samples. Age and reproductive samples were also taken but these samples have not been analyzed and reproductive samples were not retained.

CATCH CURVE PRINCIPLES

Catch curve analysis has been used since the early 1900s for estimating mortality from catch or survey age abundance data. Mortality is one of the key components in understanding the population dynamics of fish species. Total mortality (Z) is often estimated from the sequential decline observed in subsequent ages or cohorts of fish. The methods used to analyze this decline are collectively called catch-curve methods. Plots of catch versus age typically produce a convex curve, and it is assumed that the peak of the curve corresponds to the age of “full recruitment” with all fish older than this age fully vulnerable to the fishing gear (Ricker 1975). It is important to note that full recruitment and vulnerability are assumptions and that often the age of peak recruitment can change due to year-class variability. The ascending left limb represents age-classes of fish that are not fully vulnerable to the gear used in the fishery or survey (not fully recruited to the fishery); catches of fish in these age-classes are not useful for estimating the total mortality rate. The descending limb, to the right of the peak, represent declining abundance with increasing age and is due to total mortality. Total mortality is the sum of both fishing (F) and natural (M) mortality. To estimate mortality from a catch curve, observed catches at age are transformed using the natural logarithm to produce a linear relationship. The slope and y-intercept of a line through the observed points of the declining limb are estimated through linear regression. Total mortality (Z) is estimated by the slope parameter of the fitted line. The confidence interval for the slope is also the confidence interval for Z.

Catch curves can be applied to annual data expressed as catches across ages within a year, or to cohort data, expressed as catches across years of fish born in the same year. Annual catch curves assume that recruitment is constant from year to year, ages are accurately determined, fishing and natural mortality are constant, and vulnerability is constant above the fully recruited age (Hilborn and Walters 1992). Cohort catch curves do not require that recruitment be constant, but a cohort must be accurately sampled through time. The cohort analysis can only be performed on complete or mostly complete cohorts, excluding recent cohorts from analysis. The requirement to track a cohort (year class) throughout its lifespan over time can greatly limit the amount of information available (number of complete cohorts); especially when the time series of catch data is short or the life span of the species is long. Catch curves applied to cohorts normally provide more robust estimates of mortality than annual catch curves because recruitment is rarely constant from year to year. However, changes in survey sampling efficiency through time could bias the cohort catch curves. For example, survey sampling efficiency may vary from year to year such that in some years sampling effort is higher in areas where striped bass are concentrated. If this should occur during the early cohort ages (inflating the early ages catch per unit effort relative to later ages), there could be a resulting overestimation of Z (steeper slope) due to this sampling artifact. Cohort catch curves also cannot be used to determine Z or F for a given year. Instead, the cohort catch curves estimate the Z or F over the life of that cohort, which includes multiple years.

Deviations from a linear pattern in the declining limb can result from violations of the model assumptions. This is evident in catch curves that are “bumpy”, convex, concave, or offset rather than linear in the right descending limb. Confidence intervals for catch curves are impacted by how closely the actual points fit the modeled linear regression. It should be noted that the sample size in these calculations is the number of fish by age points on the descending limb of the catch curve. Sample size, and thus power, for most analyses is small. Therefore, relatively large differences in Z must be observed before statistical differences will be identified. This limitation may impact how well this technique can establish reliable changes in Z over different management regimes.

DATA ANALYSIS

Catch curve analyses, both annual and cohort, were conducted using catch at age data from the NCDMF Program 915 survey and the NCWRC spawning ground surveys (Tables 5–9). Despite similar surveys conducted in the Cape Fear River, survey data in that system was not included and considered insufficient for analysis because the time series was too short with mostly incomplete cohort comprised of relatively few fish captured compared to the other systems within the CSMA. While Program 915 was also conducted in Pamlico Sound, striped bass caught from that area were excluded from this analysis because the fish could not be attributed to a specific river system stock. To compare the results of both surveys appropriately, most analyses (except for a male-only analysis for comparison with results of Carmichael and Waters 2003) were based on combined catch of males and females because the NCDMF Program 915 did not assess CPUE by sex.

All striped bass were assigned an age based on age-length keys with age assignments initially made using data originating from each river system. However, discrepancies in mean length at age between systems were observed during catch curve analysis, with Neuse River estimates consistently higher than other coastal river systems (Figure 6). These discrepancies may have been a result of differential growth (river specific conditions and/or unknown stocking effects), inaccurate ageing, or low sample sizes within certain 25-mm bin groups. Given the time constraints in developing the updated CSMA stock assessment, sufficient evaluation of reasons for the noticeable differences in mean length at age between the Neuse River and the other coastal systems could not be conducted. To mitigate for these complexities an age length key was developed from Tar River scale data pooled among a series of years to estimate annual catch at age for Neuse River striped bass. Regarding Tar River age analysis, a combination of otoliths and scales were used for age assignments as part of an independent research project conducted between 2002 and 2004 in this system. Agreement between otoliths and scale ages was not validated as part of that study, and differences in mean length at age between structures was documented. To maintain consistency with the catch at age analysis over time, Tar River striped bass aged with otoliths from 2002–2004 were excluded from development of age length keys for the current analysis. Sex specific age length key assignments using available scale data were as follows: 1) pooled 1996–2001 Tar River data were applied to annual catch at age estimates for the Neuse River from 1994–2001; 2) pooled 2005–2009 Tar River data were applied to annual catch at age estimates for both the Neuse River from 2002–2009 and for the Tar River from 2002–2004; and 3) 1996–2001 and 2005–2009 Tar River age length keys were based on year-specific data from the Tar River. Development of new aging protocols will be accomplished by the WRC prior to the next stock assessment in an attempt to improve age assignment techniques and reconcile discrepancies between systems. If Neuse River mean length at age was truly a function of differential growth among systems and not aging error, then bias was introduced in the current analysis. System-specific, annual age length keys need to be used to avoid confounding the data; this will be a high priority objective for future stock assessments in the CSMA.

Cohort and annual catch curve results were examined for each system to determine if estimates of Z from the separate NCDMF and NCWRC surveys fell within the confidence intervals of both sets of data. This visual examination of survey overlaps was done in lieu of a parametric statistical test because the inherent low sample size would limit the power of the analysis. Also the comparative plots allowed for the determination of points (year and survey) located outside the confidence intervals and whether those points were above or below the confidence intervals.

Mortality estimates from catch curves for sexes combined and for males only were compared in this study to provide reference comparisons with similar mortality estimates calculated by Carmichael and Waters (2003). Fishing mortality (F) was estimated by subtracting the natural mortality (M=0.15) from the estimated Z. For each survey and system, an overall F rate for the period was estimated by taking the mean of the annual or cohort F estimates (only completed cohorts used).

For the NCWRC spawning ground surveys, annual striped bass catches by age were divided by annual survey effort in electrofishing hours to calculate CPUE, thereby standardizing catch by annual effort to account for varying survey effort (electrofishing hours) over time. For the NCDMF survey, the CPUE was defined as the number of striped bass captured at age (minimum effort of 160 samples per year was constant for each system). Total mortality was calculated over a range of ages from the age of full recruitment to the survey sampling gear (determined for each year as the age having the greatest catch rate in that year, which typically occurred at age-3) through the maximum observed age. Catch curves were only constructed when at least three fully recruited ages were present in the descending limb and a minimum of three individuals for each age. In most years, five ages contributed to the estimate of mortality, but in some years as few as three ages contributed to this estimate. Ages were not grouped into a plus group for this analysis, unlike the plus group generated for the A/R stock assessment. Natural mortality (M) was assumed to be the same as the coastal assessment (M = 0.15) estimated using a method developed by Hoenig (1983) based on maximum age. This M was constant for all ages and included all sources not attributed to fishing mortality. The age-constant M was consistent with the M assumptions made by both the Atlantic States Marine Fisheries Commission (ASMFC) Coastwide Atlantic Migratory Striped Bass Stock Assessment and the Albemarle Sound/Roanoke River (A/R) Striped Bass Stock Assessment.

The first cohort included in the series of cohort catch curves was for the birth year that accounted for the observed catch of age-3 fish. For the NCWRC surveys, 1989 was the first cohort used for the Neuse River with the 1992 cohort the first used for the Tar River. The first included cohorts for the NCDMF survey data were for the year 2000. The ending cohort year for all surveys was 2003, with 2002 and 2003 representing a partial or incomplete series (Program 915 began July 2003).

Both exploitation rate and proportional standard error (PSE) were calculated. The exploitation rate was calculated using the estimated F and assumed M values by year or cohort (Exploitation Rate= $F * (1-e^{(-F-M)}) / (F+M)$). The PSE was calculated by dividing the standard error by Z, then multiplying by 100 (PSE = (SE/Z)*100).

A preliminary yield per recruit analysis was conducted for the Tar/Pamlico River system. The data used were an estimated fishery selectivity at age based on the NCDMF Program 915 selectivity for the Pamlico River, the average weight at age for the Tar River collected by the NCWRC electrofishing survey, the maturity schedule calculated for the A/R stock, and the estimated coastwide M of 0.15.

RESULTS

CATCH CURVE ANALYSIS

Neuse River, NCWRC Spawning Ground

Complete cohorts from 1991 to 2001 were analyzed from the Neuse River survey based on observed catches between age 3 and age 10. Estimates were also conducted for four partial cohorts. Analyses of the 1989 through 1990 cohorts were limited because the youngest age observed in the catch was four or five. The 2002 and 2003 cohort estimates were considered preliminary because older ages were not observed, though 2003 did not have sufficient data to estimate Z or F. However, recent cohorts (2001–2003) have also had very few or no fish older than age 6. The 1989–1990 and 2002–2003 cohorts were not used in calculating the average since the observed catch record was incomplete for these cohorts. Subtracting natural mortality (M=0.15) from Z provides an estimate of fishing mortality (F) (Table 10). The estimated Z ranged from 0.18 to 1.14. Confidence intervals in some years were broad due to high standard error (SE) of the estimated slope and small numbers of observations (PSE, range = 3–139). The exploitation rates ranged from 2.9% to 63.0%. Total mortality has little trend over time, with a high in the 1998 cohort and declining Z in the subsequent cohorts (Figure 7). Observed and predicted catch values are shown in Figure 8. Annual catch curve estimates from the Neuse River spawning grounds survey gave similar results, with broad confidence intervals and Z values ranging between 0.23 and 1.15 for 1994–2009 (Table 11; Figure 9). Observed and predicted catch values are shown in Figure 10.

Neuse River, NCDMF Program 915

Cohorts from 2000 to 2001 were analyzed from the Program 915 Neuse River data based on observed catches between age 3 and age 7. Estimates were feasible for the incomplete 2002 and 2003 cohorts, although these estimates were considered preliminary because catches for older ages were not yet observed, with no fish available older than age 8. However, all of the cohorts had very few or no fish older than age 6. Estimated slope parameters, the measure of total mortality (Z), ranged from 0.50–0.88 for 2000–2003 (Table 12). Confidence intervals across years were fairly uniform (PSE, range = 38–93). The exploitation rates ranged from 29.5% to 46.5% for complete cohorts. Total mortality indicated little trend over time, with a high in the 2003 cohort (Figure 11). Observed and predicted catch values are shown in Figure 12, with full recruitment occurring at age 3. Annual catch curve analysis of the NCDMF Program 915 data for the Neuse River provided similar results, with broad confidence intervals and estimates of Z ranging between 0.41 and 1.24 for 2003–2009 (Table 13; Figure 13). Observed and predicted catch values are shown in Figure 14.

Tar/Pamlico River, NCWRC Spawning Grounds

Cohorts from 1993 to 2001 were analyzed from the Tar River survey based on observed catches between age 3 and age 11. Estimates were available for the 1992 and 2002–2003 cohorts, although they were based on potentially incomplete information and were therefore preliminary. These estimates were included to expand the time series of mortality estimates for comparison, but were not included in the calculation of the average Z. Estimated Z for the 1993 to 2001 cohorts range from 0.33 to 1.45 (Table 14). Confidence intervals vary by year due to few observations (i.e., few ages between recruitment and maximum observed) as well as high standard errors (PSE, range = 19–233). The exploitation rates for complete cohorts ranged from 16.9% to 70.0%. Estimates of total mortality do not exhibit a strong trend (Figure 15). Plots of observed and predicted values show some deviation from linear trends, and therefore provided some indication that mortality has changed over time (Figure 16). Deviations from a linear decline, which may indicate changes in exploitation over time, were apparent in several years, 1993–1995. Annual catch curve examinations revealed broad confidence intervals and estimates of Z ranging between 0.26 and 1.88 for 1996–2008 (Table 15; Figure 17). Observed and predicted catch values for the Tar/Pamlico River spawning grounds survey are shown in Figure 18.

Tar/Pamlico River, NCDMF Program 915

Cohorts from 2000 to 2001 were analyzed from the NCDMF Program 915 Pamlico River data based on observed catches between age 3 and age 9. Estimates were feasible for the incomplete 2002 and 2003 cohorts, however estimates were considered preliminary due to limited observations of older ages. The oldest ages in 2000 and 2001 and the oldest two ages in 2002, while shown, were not used because the sample sizes were below the minimum size required for analysis. Estimated slope parameters, the measure of Z, range from 0.88–1.15 for 2000–2003 (Table 16). Confidence intervals across years were generally large (PSE, range = 8–109) with the exception of the 2002 partial cohort. The complete cohort exploitation rates ranged from 51.6% to 55.4%. Total mortality had little trend over time, with the highest estimate observed for the 2003 cohort (Figure 19). Observed and predicted catch values are shown in Figure 20. Annual catch curve analysis for the Tar/Pamlico River provided similar results, with Z ranging slightly lower at 0.37–1.61 for 2003-2009 (Table 17, Figure 21). Observed and predicted catch values are shown in Figure 22.

Comparative Analysis

<u>NCWRC Spawning Grounds and NCDMF Program 915</u>

The Neuse River cohort catch curves had Z point estimates (2002 for the Program 915 survey) that fell outside of the 90% confidence intervals of the other survey (Figure 23; Tables 10 and 12). The Tar/Pamlico River cohort catch curve Z estimates fell within the comparative confidence intervals, except for the 2002 cohort Z for the NCWRC survey (Figure 24; Tables 14 and 16) which occurred above the upper confidence interval of the NCDMF survey estimate. The Z values from either survey for the Neuse River annual catch curves did not fall within the comparative survey confidence intervals for multiple years (Figure 25; Tables 11 and 13). In contrast, the Tar/Pamlico River annual catch curve Z estimates for both surveys fell within or were close to a similar range of confidence intervals. Also, Z values were similar through time between surveys (Figure 26; Tables 15 and 17).

<u>Males Only and Sexes Combined</u>

Analysis of trends in Z (male only versus sexes combined) indicated the Neuse River cohort analysis generally had Z estimates occur within the range of confidence intervals of the comparative factor, with exceptions occurring in review of the 1999 and 2001 cohorts (Figure 27). The Neuse River annual analysis had all Z estimates occur within the range of confidence intervals of the comparative factor except in 1995, 2000, and 2007 (Figure 28). Estimates of Z from Tar River cohort analysis from male only data and when both sexes were combined fell within the range of confidence intervals for both factors (Figure 29). The Tar River annual analysis had multiple instances of Z estimates outside confidence intervals from the comparative factor prior to 2005 (Figure 30). Since 2005, the Z estimates have remained within the comparative confidence interval estimates.

<u>Current Z estimates with Carmichael and Waters (2003)</u>

The average of the cohort total (Z) and fishing (F) mortality with both sexes combined was computed using the same time periods used by Carmichael and Waters (2003). A comparison between the two assessment time frames shows what the Z values would be if the CPUE input criteria (sexes combined, Tar River age based) had been the same. The original reported values of F and Z from the 2003 assessment were generally twice the current cohort estimate for the same time period (Tables 18 and 19). Using the same input criteria for the average cohort Z and F, the Neuse and Tar rivers average increased slightly with the increased number of cohorts (Table 17) available in the full time period in this assessment. For the average annual Z and F, the Tar River averages decreased with the current report while the Neuse River estimates remained nearly the same (Table 19). Due to significant deviations in age-length assignment methodologies, direct comparisons between assessments have limited value, including changing the sole system used to calculate the age-length key for all other systems and surveys.

TREND ANALYSIS

Fishery Dependent Harvest and Length Frequencies

Harvest for the Neuse River ranged from a high of 8,288 lb in 1994 to a low of 4,121 lb in 2002 and generally varied without trend since 1994 (Table 1). The Pamlico/Pungo harvest ranged from 16,749 lb to 866 lb (Table 1). While in general the highest landings occurred since 1999, there was only limited increasing trend in the commercial data. The recreational time series were short for both the Neuse and Pamlico rivers, but have declined since 2004 (Table 24).

The commercial fishery was sampled to determine size, age, and sex composition of the harvest. Striped bass lengths (TL inch) from the inshore gill net fishery are shown in Tables 20 and 21 and the lengths from the commercial observer program for gill nets are shown Table 22 and 23. Commercial gill net length frequencies had the highest totals between the lengths of 21 inches to 23 inches for both the Neuse and Pamlico rivers (Tables 20 and 21). The Neuse River gill net samples had a slightly higher percentage of fish 27 inches or larger than the surveys had of fish age-8 or older (10% rather than 6% and 3%). The differences between the commercial catch-at-length and the survey catch-at-ages in the Neuse River should be more closely examined to determine the underlying reasons for the differences in older/larger fish. The Tar/Pamlico River percentages were approximately 4% for the commercial gill net catch-at-length and the NCWRC electrofishing survey, but the percentage of fish age-8 and older was lower in the NCDMF Program 915 survey at 1%. The commercial observer data had the highest length frequencies totals for the Neuse River in the same 21 inches to 23 inches range and an 10% fish 27 inches and over, but the Pamlico River length frequencies were high at a larger range from 19 inches to 22 inches but with a percent 27 inches and over of 4%.

For recreational data from January 2004 to June 2009, 3,951 survey assignments were conducted resulting in 24,332 intercepts, including 13,134 with fishing activity. A total of 3,186 interviews were anglers targeting striped bass over 12,497 fishing hours, resulting in a reported catch of 10,017 striped bass. Only full calendar years were used for landings and length frequencies (Tables 24-26). The recreational length frequencies covered a slightly lower range in the Neuse River, with the highest frequencies ranging from 19 inches to 21 inches and with a percentage 27 inches and over of approximately 6%. The Pamlico River length frequencies covered a larger range of high frequencies, from 19 inches to 23 inches, when compared to the commercial gill net length frequencies and a large fish percentage of approximately 4%.

Catch curve analysis was not conducted on the commercial and recreational data. The NCDMF observer program data was determined to have insufficient observations for analysis, either in terms of total annual sample collected or in number of years available (Tables 22 and 23). Low annual sample size was an issue with all length data collected from the Neuse River (Tables 20 and 25). There were also concerns about conducting catch curves on fishery dependent data that may be subject to the 2008 regulation changes, which would shorten the current and already relatively short time series available.

Annual CPUE Estimates

Annual CPUE estimates from NCWRC spawning grounds surveys on the Tar River between 1996–2009 ranged from a low of 19.5 fish/h in 1996 to a high of 80.2 fish/h in 2005 (Table 13, Figure 35). For the Neuse River over the period 1994–2009, CPUE estimates ranged from a low of 4.8 fish/h in 2006 to a peak of 22.7 fish/h in 2009 (Table 12, Figure 36). Cape Fear River CPUE estimates were consistently lower than the other systems, with 2003–2009 values ranging from a low of 0.7 fish/h to only 13.7 fish/h (Table 13). The lower Cape Fear River CPUE may be a mix of low abundance, sampling location, and river size when compared to the other systems. From the NCDMF Program 915 survey (2003–2009) the CPUE (catch/sample) for the Tar River ranged from 0.7 to 1.7 and the Neuse River CPUE ranged from 0.6 to 1.2 (Tables 15 and 16, Figures 37 and 38).

Catch At Age Estimates

In general, the catch curves included ages 3 through 6 for the Neuse River; therefore, those ages were examined for patterns in CPUE over time. For the NCWRC spawning grounds survey, ages 4 and 5 varied over time without trend and were generally similar to each other (Figure 31). Age-6 abundance for the spawning grounds survey showed decreasing trends through the time series, with age-3 catch decreasing beginning in 2001 before rebounding in 2006 (Figure 31). The NCDMF Program 915 age classes generally varied without trend, with the exception of age-6 that appeared to decrease over the time series (Figure 32).

For the Tar/Pamlico River system, in general the catch curves included ages 3 through 7; therefore, those ages were examined for CPUE over time. For the NCWRC spawning grounds survey, ages 3 through 5 varied throughout the time series without trend until the most recent years when there appeared to be an increase (Figure 33). Since 2005, there has been an increase in age-3 fish observed in the survey. Age-6 abundance on the Tar/Pamlico River peaked in 2000 and 2001, while age-7 catch increased to a high in 2000 before declining beginning in 2004 (Figure 33). The NCDMF Program 915 CPUE at age varied with little trend for ages 3 through 6, with age-7 showing a decreasing trend since 2004 (Figure 34).

Mean Length at Age

Mean total length at age was calculated by year for the Tar River to examine potential changes in growth over time. The Tar River analysis was conducted over ages 3 through 7, the primary age range used in the catch curve analyses. Trends in mean length over ages 3 through 7 varied without trend since NCWRC spawning grounds sampling began on the Tar River in 1996 (Figure 39). This analysis was not conducted on the Neuse River due to discrepancies in initial comparisons of mean length at age among systems as explained in the Methods Section.

DISCUSSION

The 2004 FMP estimates of total mortality for the Tar River and Neuse River striped bass stocks indicated that cohort mortality was excessive, higher than the target F (0.22). Since then, size and age distributions in these systems have not changed with few fish >age-6 collected from a given cohort. The size and age distributions, low abundance, and the absence of older fish support continued management efforts to promote enhancement of the striped bass fisheries in each system. The absence of strong year classes, whether due to the actual absence of strong year classes or if confounded with ageing error, makes it difficult to follow trends in cohort abundance over time. Fish fully recruited to the sampling gear, age-3 or age-4 (the ages typically harvested by both fishing sectors), compose the majority of annual survey catches with these fish declining rapidly in abundance in subsequent years and resulting high Z estimates. The highly variable estimates of Z are the result of the limited numbers of fully recruited age classes of striped bass surveyed. Large confidence intervals around estimates of Z indicate a significant lack of precision in routine catch curve analysis. The large confidence intervals and lack of precision in the catch curve estimates of Z made them unusable for stock status determination. There is no other quantitative stock assessment technique to determine if the stocks are overfished, hence the stock status for the CSMA continues to be formally designated as unknown. It is suspected that improvements in stock dynamics would only be detected as a result of large changes in population characteristics. For this reason, catch curve results (especially annual estimates of mortality) should be supplemented with additional quantitative information (such as trends in mean CPUE) whenever management decisions are considered. Simple index analyses did not indicate any significant trends for the Neuse or Tar/Pamlico rivers in either CPUE by age or mean length at age (Tar/Pamlico River only). These findings continue to justify the need for management measures that will reduce total mortality.

Based on the time series of catch rates and mean length at age from NCWRC electrofishing surveys within the CSMA, several observations may be made. The peak in electrofishing CPUE across all systems for the entire time series was 80.2 fish/ hour in the Tar River in 2005. In contrast, catch rates from the A/R stock on the spawning grounds averaged 114 fish/h during the period 1991–1996 when the stock was considered overfished; catch rates since the A/R stock was declared recovered averaged 257 fish/hour (1997–2008). Examination of trends in CPUE for the Neuse, Tar and Cape Fear rivers continues to indicate low numbers of fish are returning to the spawning grounds in these systems each year. However, historical age structure for these systems is not known and is assumed comparable with other estuarine striped bass stocks. Sufficient recovery time with the current regulations will be necessary to understand appropriate age structure for the CSMA. Striped bass abundance in each system persists at relatively low levels with only minor annual variation.

Analysis of mean length at age data for the Tar River varied without trend, suggesting minor changes in growth over the assessment period. Formal validation of ageing techniques for striped bass collected within the CSMA must be accomplished before differences in growth rates within and among systems can be evaluated. A standard striped bass ageing protocol was developed by ASMFC. The adoption of this protocol by all entities ageing striped bass stocks in North Carolina is warranted.

ANALYTICAL LIMITATIONS

Catch curves are a useful tool, but are rarely used as the primary means for determining stock status. The primary issues with using catch curves result from violating the assumptions of the catch curve model. The primary assumptions include: 1) survival rate is uniform with age, 2) no change in mortality rate over time; and 3) samples are randomly taken from all age-groups, and the age-groups are equal in numbers when they recruit to the fishery (Ricker 1975). As with most methods, catch curves assume there is no migration into or out of the individual systems. Changes in survey sampling efficiency through time may also influence results of cohort catch curves. Violations of model assumptions can result in non-linear deviations in the descending limb of the curve. In these instances, an uneven pattern is observed across many years, cohorts and systems. This may indicate that recruitment may not be constant over time as a result of either natural variation or varying levels of stocking contribution within the major systems of the CSMA. Annual variations in stocking levels of hatchery reared fish in the Neuse and Tar rivers may violate the assumption for the annual model that recruitment was constant; therefore, cohort catch curves may be more appropriate. Although the reasons for inconsistent recruitment within the CSMA may vary, some combination of variable spring flow regimes, summer nursery area water quality and occasional influx of striped bass from the A/R stock may be responsible (NCWRC 2007). Also new regulations were implemented in July 2008 with the intention of reducing mortality for the CSMA stocks, thereby likely violating the constant mortality assumption for both annual and cohort models for the 2009 data. The fact that most of the regressions were performed on three to five ages (data points) in the descending limb contributed to increases in error and decreases in precision of the estimates. This small sample size is a result of truncated age distributions within each system and was a primary factor in the resulting large standard errors and confidence intervals.

The input data limitations for these analyses are twofold: 1) limitations inherent to the surveys collecting the data and 2) analytical limitations resulting from data that are not complete or that were not collected. Analyses of catch curve data were deterred by the lack of well-defined, concentrated spawning grounds in the CSMA as opposed to those found on the Roanoke River. Collections of spawning striped bass from the Neuse River have ranged spatially from near Goldsboro to the base of Milburnie Dam, a distance of almost 70 miles. In addition, spring streamflow and associated navigability significantly affect accessibility to spawning areas and may inflate or underestimate striped bass abundance within and among seasons. During annual NCWRC electrofishing surveys, fluctuations in CPUE have been documented over short periods of time. For example, in 2007, Neuse River CPUE at Raleigh declined from 51 fish/h to 10 fish/h over a two-day period. In 2010, CPUE at two Goldsboro sites on April 13 was 30 and 22 fish/h but declined to 13 and 3 fish/h, respectively, within two days. This suggests that fish abundance in a localized area is highly variable within a short period of time and may be related to changes in streamflow or natural movement patterns. Future analyses may be able to use statistical techniques like a generalized linear model (GLM) to standardize some of the effects of flow rate and location. However, standardize site measurements of flow were only recently added to the survey design and the GLM technique could not be attempted at this time. In addition, because fish occurrence is not homogenous throughout the spawning area, the exclusion of sample sites during periods of low streamflow and poor navigation may also affect CPUE.

Previous studies on the Neuse River suggest that striped bass migration may be affected by streamflow, an additional confounding effect on annual estimates of catch at age. Bowman (2001) reported upstream movement of striped bass on the spawning grounds after increases in river discharge. That study reported increased migration distance (upstream movement 20 miles further in 2000 versus 1999) in the second year of the study when average streamflow was higher. Bowman (2001) also suggested that striped bass in the Neuse River require at least 1,765 ft^3/s to move upstream of the fall line and a minimum of 2,648 ft^3/s to gain access to spawning habitat upstream of the fall line. Spawning grounds surveys conducted by the NCWRC were consistent with this finding as nearly 30% of the variability in CPUE near Raleigh could be explained by streamflow. Striped bass possess the ability to travel great distances in a short period of time and may be present on the spawning grounds for a short amount of time. The NCDMF recorded the recapture of a 40-inch female striped bass tagged on the spawning grounds of the Roanoke River in Weldon, NC, that was recaptured 18 days later about 500 miles away in New Jersey (Winslow et al. 2010). Carmichael et al. (1998) recorded residency time of telemetered female striped bass on the spawning grounds of the Roanoke River to be as short as eight days, while Beasley and Hightower (2000) reported seven days as the shortest residency time for a telemetered striped bass on the Neuse River. Bowman (2001) also found that telemetered Neuse River striped bass can travel up to 12 miles per day during their migration to the spawning grounds. These studies suggest that concentrations of striped bass may be vulnerable to electrofishing for only a short period of time on the spawning grounds and that cohort abundance may be strongly influenced by sample date and frequency. The presence of diffuse spawning grounds, effects of streamflow, navigability, and fish movement contribute to variability in annual CPUE estimates; limitations inherent within spawning grounds electrofishing data may only be overcome through substantial increases in population size.

Similar limitations with field collection programs were observed in the NCDMF Program 915 survey, which by design is a multispecies survey. The NCDMF Program 915 sampling was designed to collect all species susceptible to the array of gillnets (ranging from 3" to 6.5") within the sampling area and not specifically striped bass. Size selectivity for various gill net mesh sizes occurs as larger mesh sizes tend to capture larger individuals (Murphy and Willis 1996). Vulnerability of larger striped bass to the sampling gear may be less than smaller striped bass. Also, the NCDMF Program 915 survey samples only river habitats 6 ft in depth or less. If older fish have a different spatial distribution than younger fish, then survey results may underestimate abundance of older fish.

Several important data sources that would have strengthened the assessment of striped bass stocks with the CSMA were either not available, or were substituted from neighboring systems. For example, life history parameters have not been characterized for stocks within the CSMA and assumptions were made based on results collected from the Albemarle Sound/Roanoke River striped bass population. Natural mortality is an important life history parameter that can be difficult to determine for specific stocks. Natural mortality (M = 0.15) estimated by the Hoenig (1983) equation is an assumed fixed constant based on the life history parameters set for the Atlantic coast migratory striped bass. The maximum age for the CSMA stocks is currently unknown and might be different, as this stock does not contribute to the Atlantic migratory striped bass stock. The natural mortality of 0.15 is based from an assumed maximum age of more than 30 years, while the CSMA currently rarely encounters fish older than age-10. Without a clearly defined and agreed upon M estimate, F-based benchmarks will be difficult to calculate with a high level of certainty. In addition, natural mortality estimates for striped bass in CSMA may not be constant and may vary by size, age, or sex of the fish as well as influences from food availability, predator numbers, parasite load, fish density, or water quality. Although difficult to estimate, the ability to refine the natural mortality parameter for striped bass in the CSMA should be explored.

EMPIRICAL REFERENCE POINTS

There has not been adequate time since the implementation of the management measures from the 2004 FMP and the subsequent 2008 commercial and recreational regulation changes to see any signs of change to the stocks in the ongoing data collection programs. Even so, it is imperative that a set of reference points be considered to identify positive changes in the CSMA stocks. The task remains, however, to identify measurable population reference points that would signal these changes. Initial runs of a yield per recruit based solely on the Tar/Pamlico River indicated F benchmarks between 0.21 to 0.34, with corresponding spawning potential ratios between 40% to 25%. However, without reliable and relatively precise system estimates of F, it is not possible to use them for management. Potential CSMA stock reference points might include: 1) proportion of age 6–10 striped bass in NCWRC spawning ground survey; 2) proportion of age 6–10 striped bass in NCDMF Program 915 gill net survey; 3) egg/larvae indices; 4) egg/larvae to spawning female relationship; and 5) recreational and commercial catch and effort data.

Caddy (2004) suggests the use of a broad range of fisheries indicators and reference points to reflect life histories and fishery characteristics understood and agreed to by managers and stakeholders. It was also suggested that stock recovery measures relying on few indices severely limited stock recovery efforts. Age structure improvements in the spawning ground survey and Program 915 gill net survey would suggest when older fish are more abundant in these systems. While annual striped bass egg/larvae indices currently do not exist, this information would provide spawning characteristics as well as indicate years of variable recruitment. In conjunction with the spawning ground survey, annual egg/larvae to spawning female relationship would describe spawning in these systems. Additionally, assessment of trends in recreational and commercial effort and landings would assist managers in identifying gross changes in the fishery. If these indicators were applied in a “traffic light” approach, there would be levels of high, medium, and low concern that would allow managers to apply preventative management appropriately. As an example, a proportion of striped bass caught in surveys over a certain age could be a level indicator. The proportion would indicate the expansion or contraction of the age structure of the stock. Then there would be a management trigger, occurring at some level or decreasing amount of older striped bass. This approach could not be initiated until the previously noted aging issues are resolved and accurate catch at age determined for each system.

The federal management system (ASMFC and Regional Councils) is also charged with the evaluation of stock condition and establishment of benchmarks for stocks with limited data like the CSMA. To establish benchmarks for data limited stocks, managers need to evaluate: the vulnerability of the fish population to fishing pressure, the uncertainties in scientific information about the status of the fish population, and the uncertainties in the effectiveness of management tactics. Assessing the vulnerability of stocks was recently highlighted by the National Marine Fisheries Service (NMFS) as an important factor in a productivity and susceptibility analysis (PSA), a semi-quantitative risk assessment tool that relies on the life history characteristics of a stock (i.e., productivity) and its susceptibility to the fishery in question (Patrick et al. 2009). Patrick et al. (2009) demonstrated the practical utility of this management approach (by evaluating multiple fisheries (under data rich and data poor scenarios) that exhibited varying levels of productivity, susceptibility and data quality. Approaches such as these should be investigated for guiding management of the CSMA stocks.

An assessment of striped bass stock status generally requires a sense of stock expectations, usually stemming from a baseline involving measurements of life stage parameters or historical landings. Unfortunately, this is not the case in the CSMA. A baseline for “good” population condition has not yet been established. In the absence of such a baseline, a rough comparison to populations in other striped bass rivers may provide some insight into potential striped bass carrying capacity.

Given the limited historical data for the CSMA, it is difficult to determine if there has been a period in modern times when the stocks were at “high” levels. In the commercial fishery from the 1930s through the 1960s the Pamlico Sound, Pamlico, Tar, Neuse and Cape Fear rivers accounted for 1.5–12.9% of the total striped bass landings in North Carolina (average of 5.9%, ~49,000 lb)(Chestnut and Davis 1975; NCDMF 2004). While important at the turn of the century, the commercial striped bass fishery has remained at low levels for the last 50 years (Chestnut and Davis 1975; NCDMF 2004). With the establishment of the CSMA commercial quota in 1994, the CSMA landing average of 24,844 pounds accounts for 13% of North Carolina internal striped bass landings (Atlantic Ocean omitted). Striped bass landings for the CSMA (historic and current) are much lower than the Albemarle/Roanoke fishery (NCDMF 2004).

Due to the anthropogenic effects (water quality degradation, upstream flow restrictions due to dams, etc.) on early life stages of striped bass in the three watersheds of the CSMA, the CSMA stocks may not have the same abundance potential as the Albemarle/Roanoke stock and certainly not the same level of production potential as in earlier periods when water quality and flow was unimpaired. A possible reference approach may be to compare catch rates between these systems and “recovered” systems, adjusting the desired catch rate level for the differing abundance potential. This adjustment factor could be based on a suite of environmental, habitat degradation, and ecological parameters. Improvements in existing surveys and initiating new surveys should be considered to provide a quality baseline to assess management goals. Consistent striped bass surveys in the CSMA would be another approach to assess the management goals in relation to a recent or current baseline.

Geographically, within the historic range of Atlantic coast striped bass, the Roanoke River and Albemarle Sound can be viewed as a transitional zone of northern and southern striped bass migratory behaviors and differences in life history or stock productivity may also be present. While mostly an estuarine population, some Roanoke adults do contribute to the coastal ocean migratory stock (Richards and Rago 1999; Rulifson and Dadswell 1995). Although tagging studies have shown a few exceptions, it has long been thought that few striped bass hatched in rivers south of Cape Hatteras (including the CSMA) take part in the annual north-south coastal ocean migration (Bigelow and Schroeder 1953). If striped bass populations within a river are subdivided into “contingents” based on their migratory behavior (Secor 1999), those of southern populations tend to be largely estuarine or riverine. The lack of coastal ocean migratory contingents south of Cape Hatteras may be a function of temperature influenced by both latitude and the convergence of the cold Labrador Current and warm Gulf Stream off Cape Hatteras, NC. In genetic assays of striped bass from South Carolina coastal rivers, Bulak et al. (2004) found highly significant allele frequency differences among seven coastal rivers examined. Conversely, in more northern parts of their range (New Jersey, Maine), striped bass may spend many months in smaller non-natal estuaries with negligible spawning habitat, some even moving into freshwater during the spawning period thus precluding their successful spawning elsewhere (Grothues et al. 2007). In North Carolina, striped bass of Roanoke River origin do stray into the CSMA, particularly the adjacent Tar/Pamlico River.

Quantity and variability of river flows are very important considerations for successful striped bass spawning. The Roanoke River has the largest freshwater discharge of any river in

North Carolina. The Roanoke further benefits from Federal Energy Regulatory Commission (FERC) relicensing requirements to adhere as closely as possible to recommended striped bass spawning flows (graduated dam releases ranging from 13,700 to 4,000 cubic feet per second (cfs) from April 1 to June 15 with no hydropower peaking). Thus, the Roanoke River has substantial spring spawning flows that are relatively stable. In the CSMA, Tar River spring discharge on the spawning grounds near Rocky Mount at times may reach 1,000 cfs, but usually is much less and occasionally drops so low that a motorboat cannot be safely launched at the Battle Park boat ramp. The Tar River is largely unregulated (few reservoirs) with flows that vary widely during the spring. The Neuse River is similar to the Tar River, although there is a relatively small amount of water storage capacity at Falls Lake that can be utilized through coordination with the U.S. Army Corps of Engineers (USACE). Desired spring spawning discharges are 600-1000 cfs as measured at the United States Geological Survey (USGS) gauge at Clayton, but the ability to provide these flows is highly rainfall dependent and rarely can be maintained through the spawning season. The Cape Fear River is substantially larger than the Tar or Neuse rivers and the USACE manages releases from Jordan Reservoir to provide a minimum discharge of 600+ cfs measured at the Lillington USGS gage. Overriding the influence of flow at present in the Cape Fear River is the presence of the three USACE lock and dams located downstream of Fayetteville. Locking schedules are implemented each spring allowing passage of some, but not all, migrating striped bass and American shad (*Alosa sapidissima)*. Construction of a rock arch ramp to improve fish passage at the lowermost lock and dam is scheduled for completion in time for the 2012 spring spawning run. Improved fish passage, along with the striped bass harvest moratorium implemented in the Cape Fear in 2008, may facilitate expansion of this component of the CSMA stocks, although the relatively small size of the Cape Fear estuary could become limiting.

Water quality likely exerts influence on North Carolina striped bass populations, particularly during the summer in the lower rivers and estuaries. The Roanoke River is susceptible to striped bass kills following large and abrupt reductions in discharge from the dams when the downriver backswamps are flooded, allowing rapid drainage of low dissolved oxygen (DO) swamp water into the main river channel. The presence of thermal refuge, in the form of blackwater tributaries or main stem channel groundwater upwelling, may be critical for striped bass survival of hypoxic summer conditions (Hess et al. 1999), especially for the relatively constrained riverine/estuarine CSMA stocks.

ONGOING, PLANNED, AND NEEDED RESEARCH

The annual North Carolina Inter-Jurisdictional Cooperative Work Plan between the USFWS, NCDMF and NCWRC in the fall of 2009 outlined new stocking strategies for striped bass in the Tar, Neuse and Cape Fear rivers beginning with the 2010 production year. The NCWRC hatchery space and resources necessary to produce phase I fingerlings for the CSMA annually was shifted toward the production of phase II striped bass. This change would allow the stocking of phase II striped bass (target 100,000) in all three major rivers in the CSMA annually, effectively replacing the previous approach of rotating phase II fish stockings among systems every two years.

Genetics-based research is also being planned in 2010 to determine if stocking fish of endemic Cape Fear parentage can increase contribution of phase II fish to populations in the Cape Fear River. If results suggest that using river-specific broodstock (as opposed to Roanoke River parentage) is responsible for an increase in spawning stock abundance, then expansion of this practice to the Neuse and Tar rivers should be considered. Fin clip samples will be genetically evaluated to determine the contribution of stocked fish to the spawning stocks of the individual CSMA systems.

The NCDMF and NCWRC independent surveys are continuing and include collection of basic biological data such as size, sex, and age. Standard methods for striped bass age determination will be incorporated for future assessments.

A mark-recapture study and fishery-independent sampling program is scheduled to start in the winter of 2011 to provide data needed to assess the striped bass population size in the Cape Fear River and its tributaries including residency patterns, population size, and discard mortality. Striped bass will be tagged with PIT and Floy internal anchor tags by NCDMF and NCWRC staff using electrofishing, gill nets, and hook and line gear. The anchor tags will enable recreational and commercial fishermen in areas outside the study area to report recaptured individuals. The PIT tags will be used to estimate the population size of striped bass based on the electrofishing surveys by the DMF and WRC. Finally an estimate of discard mortality will be calculated for the recreational fishing sector by comparing recapture rates of the hook and line released striped bass with striped bass that were electrofished.

Maturation schedules of striped bass in the coastal rivers of the CSMA remain unknown, yet comparisons to the A/R striped stock maturation schedule determined by Olsen and Rulifson (1992) are often made. An update on the maturation schedule of the A/R stock is underway and a similar study on the CSMA is warranted.

The ASMFC was directed under the federal Striped Bass Conservation Act (1984) to develop a management plan which would address all Atlantic Ocean striped bass populations from South Carolina/North Carolina border northward (A/R stocks). Improvements to the migratory striped bass stocks became priority to local, state and federal fisheries managers as well as stakeholders. The A/R stock rebuilding process did not happen without the appropriate resources and research. Funding was provided and data gaps were filled which helped facilitate stock recovery. While significant advances were made to fill CSMA data gaps identified within the 2004 FMP, many critical data limitations remain requiring significant resources to accomplish. Dedicated personnel and funding will be required to start and accomplish the critical data needs indentified. In order to quantitatively assess the CSMA striped bass populations, critical data and research needs for the CSMA include (H=High, M=Medium, and L=Lower priority):

<u>Life History</u>

- Determine system of origin of fish on the spawning grounds (H)
- Acquire life history information: maturity, fecundity, size and weight at age, egg and larval survival (short term research projects) (H)
- Conduct a mark-recapture study utilizing conventional tags and telemetry approaches (expanded program) (H)
- Determine if suitable striped bass spawning conditions exist in the Tar/Pamlico, Neuse, and Cape Fear river (M)
- Conduct egg abundance and egg viability studies (M)
- Determine contribution of stocked fish to spawning stock (M)
- Determine extent of spawning grounds (L)

<u>Fishery Dependent Surveys - Recreational and Commercial</u>

- Improve discard estimates and discard biological characteristics from commercial fisheries (trip level observer coverage) (M)
- Obtain biological characteristics such as length, weight, age, and sex of recreational harvest (expanded creel surveys) (M)
- Obtain biological characteristics such as length, weight, age, and sex of commercial harvest (increased sampling, age structure collection) (M)

- Improve discard estimates and discard biological characteristics from recreational fisheries (creel survey) (L)
- Conduct delayed mortality studies for recreational and commercial gear (short term research projects) (L)

Fisheries Independent Surveys

- Conduct independent surveys that adequately capture all life stages of striped bass (H)
- Conduct a short term study to determine vulnerability-at-length for survey gears (L)

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Table 1. Commercial landings in pounds for the Neuse, Pamlico/Pungo, and Cape Fear rivers for 1994 – 2009.

Year	Cape Fear	Neuse	Pamlico/Pungo	Total
1994	480	8,288	866	9,634
1995	264	3,950	2,439	6,653
1996	4,139	6,965	4,230	15,334
1997	2,187	5,344	4,450	11,981
1998	501	5,537	7,514	13,551
1999	1,001	6,094	10,452	17,546
2000	567	4,808	16,749	22,123
2001	0	6,943	8,934	15,877
2002	173	4,121	8,205	12,499
2003	68	5,777	7,387	13,233
2004	2,364	7,820	14,197	24,381
2005	2,721	5,173	11,258	19,151
2006	1,057	7,090	5,402	13,548
2007	1,601	6,731	9,295	17,627
2008	831	4,828	3,718	9,377
2009	0	8,285	14,892	23,177

Table 2. Total electrofishing time in hours with number of sample days in parenthesis for striped bass by sample station and year in the Neuse River, 1994–2009.

	Sample year															
Sample Station	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Raleigh (Milburnie Dam)					0.7 (1)	0.3 (1)	1.0 (2)		2.0 (2)	10.0 (7)	3.6 (5)	8.7 (8)	5.3 (7)	8.9 (9)	5.3 (6)	4.9 (5)
Raleigh (Poole Road)							1.0 (1)			4.1 (4)						
Clayton								0.8 (1)		5.0 (5)	1.8 (2)				10.1 (4)	4.7 (2)
Wilsons Mills							2.3 (3)	2.3 (3)	2.0 (2)		0.7 (2)					
Smithfield						2.8 (2)	4.5 (5)	3.3 (5)	4.0 (4)		0.6 (1)					
Richardson's Bridge						2.3 (2)	1.3 (1)	1.5 (1)	1.0 (1)	4.5 (5)	2.4 (2)					
Goldsboro (upstream Quaker Neck Dam)			4.5 (6)	5.3 (7)	4.3 (6)	3.7 (5)	5.3 (7)	5.3 (7)	6.0 (7)	6.5 (7)	2.3 (4)	14.5 (8)	5.6 (5)	10.4 (9)	7.9 (8)	6.8 (6)
Goldsboro (downstream Quaker Neck Dam)	7.3 (5)	4.9 (2)	5.8 (6)	7.0 (7)	6.0 (6)	4.8 (5)	5.0 (7)	4.5 (7)	4.8 (5)	1.0 (2)						
Seven Springs		2.7 (1)	4.5 (6)	4.5 (6)	3.0 (4)											
Kinston		2.4 (3)	4.5 (6)	4.5 (6)	3.0 (4)											
Total[a]	7.3 (5)	10.0 (6)	19.3 (12)	21.3 (13)	17.0 (11)	13.9 (11)	20.4 (17)	17.7 (15)	19.8 (14)	31.2 (21)	11.3 (11)	23.2 (8)	10.9 (7)	19.3 (10)	23.3 (13)	16.4 (9)

[a] Because multiple stations were sampled in one day, the total number of sample days may not equal the sum of sample days by station.

Table 3. Total electrofishing time in hours with number of sample days in parenthesis for striped bass by sample station and year in the Tar River, 1996–2009.

	Sample year													
Sample Station	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Station 1 (Battle Park in Rocky Mount to Bourne Farms access area)	3.6 (4)	8 (5)	5.5 (3)	3.2 (3)	3.0 (2)	4.0 (3)	2.8 (2)	2.8 (2)	3.0 (2)	6.9 (6)	1.5 (1)	1.8 (1)	2.8 (2)	1.0 (1)
Station 2 (Bourne Farms access area to NCWRC access area at Tarboro)	5.9 (4)	10.3 (6)	13.2 (6)	6.7 (3)	4.6 (3)	0.9 (1)	4.5 (3)	2.0 (2)	3.0 (2)	5.0 (3)	2.8 (2)	4.8 (3)	3.7 (3)	1.3 (1)
Station 3 (NCWRC access area at Tarboro to City of Tarboro access area	12.6 (4)	10.5 (7)	8.6 (7)	1.6 (2)	3.9 (4)	2.0 (1)	4.0 (2)	1.8 (2)	3.0 (3)	5.7 (4)	5.6 (4)	4.8 (4)	5.3 (5)	4.3 (4)
Total[a]	22.1 (8)	28.8 (16)	27.3 (13)	11.5 (8)	11.5 (9)	6.9 (5)	11.3 (7)	6.6 (6)	9.0 (7)	17.6 (13)	9.9 (7)	11.4 (8)	11.8 (10)	6.6 (6)

[a] Because multiple stations were sampled in one day, the total number of sample days may not equal the sum of sample days by station.

Table 4. Total electrofishing time in hours with number of sample days in parenthesis for striped bass by sample station and year in the Cape Fear River, 2003–2009.

	Sample year						
Sample Station	2003	2004	2005	2006	2007	2008	2009
Lock and Dam 1 - Riegelwood	*	*	7.0 (8)	6.0 (7)	9.2 (11)	8.0 (10)	3.9 (7)
Lock and Dam 2 - Elizabethtown	*	*	7.0 (8)	6.0 (7)	9.0 (11)	7.0 (10)	4.0 (7)
Lock and Dam 3 - Duart	*	*	6.0 (7)	6.0 (7)	9.1 (11)	7.0 (10)	4.5 (7)
Totals	17.4 (11)*	8.0 (15)*	20.0 (23)	18.0 (21)	27.3 (33)	22.0 (30)	12.4 (21)

* = Sampling effort was pooled in 2003 and 2004 and included sampling at the 3 lock and dams plus 3 additional sites on the Cape Fear River (Alligator Creek, Brunswick River and mainstem at RM 63.

Table 5. Neuse River NCWRC striped bass spawning grounds survey catch at age, total catch, effort in hours fished, and CPUE in catch per hour.

	Year															
Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
2	1	0	0	3	2	0	1	0	3	0	0	2	4	4	4	6
3	16	36	48	27	69	52	75	10	32	46	8	26	33	72	28	133
4	8	78	40	32	39	89	69	25	9	127	7	25	9	45	38	106
5	22	51	67	27	40	77	101	51	15	132	27	26	5	30	47	88
6	37	27	41	26	27	36	63	44	11	43	26	19	4	7	18	28
7	22	17	14	18	20	20	25	21	17	21	12	10	1	3	3	8
8	11	11	11	8	13	16	16	4	12	23	6	12	0	4	1	0
9	3	1	5	1	5	1	5	0	3	7	2	4	0	3	0	0
10	0	0	0	1	3	1	1	0	0	4	1	0	2	4	2	1
11	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Total	120	221	226	143	219	292	357	155	102	403	90	125	58	172	141	373
Effort (H)	7.3	11.0	19.3	21.3	17.0	13.8	20.2	17.5	20.0	31.2	14.4	23.2	12.0	19.3	23.3	16.4
CPUE	16.3	20.1	11.7	6.7	12.9	21.2	17.6	8.8	5.1	12.9	6.2	5.4	4.8	8.9	6.0	22.7

Table 6. Tar/Pamlico River NCWRC striped bass spawning grounds survey catch at age, total catch, effort in hours fished, and CPUE in catch per hour.

	Year													
Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	10	11	0	0	1	4	5	0	15	26	46	9	1
3	234	492	526	19	25	47	35	50	51	1097	378	27	421	17
4	247	506	272	98	60	28	28	23	60	127	89	93	55	132
5	23	171	168	314	186	97	68	25	69	58	16	95	10	173
6	15	67	57	91	158	129	86	27	39	48	11	38	6	18
7	6	15	19	27	79	19	79	34	32	17	5	11	1	1
8	5	6	6	6	33	3	49	35	42	33	2	1	0	0
9	1	4	1	2	3	2	15	8	10	11	1	0	0	0
10	3	4	1	4	0	0	5	4	11	6	1	2	0	1
11	0	0	0	0	2	0	0	0	1	2	0	0	0	0
12	0	0	0	0	1	0	0	0	1	0	0	1	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	1
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total	535	1275	1061	561	547	326	369	211	316	1414	529	314	502	345
Effort (H)	27.4	28.8	25.4	14.1	11.5	6.9	11.3	6.6	9.0	17.6	9.8	11.4	11.8	6.5
CPUE	19.5	44.3	41.9	39.8	47.5	47.3	32.6	31.8	35.1	80.2	53.9	27.6	42.5	52.8

Table 7. Cape Fear River NCWRC striped bass spawning grounds survey catch at age, total catch, effort in hours fished, and CPUE in catch per hour.

	Year						
Age	2003	2004	2005	2006	2007	2008	2009
1	0	0	21	1	56	0	19
2	0	2	1	2	9	13	0
3	3	4	7	2	14	41	9
4	8	5	9	3	18	17	17
5	3	13	13	2	15	9	27
6	2	22	24	2	7	6	12
7	4	22	17	0	2	4	11
8	1	10	13	0	4	1	5
9	1	2	1	0	0	0	0
Total	22	80	106	12	125	91	100
Effort (H)	7.3	5.9	21.0	18.0	27.3	22.3	11.9
CPUE	3.0	21.0	5.0	0.7	4.6	4.1	8.4

Table 8. Neuse River NCDMF Program 915 survey striped bass catch-at-age and total catch. Note: effort is constant from 2004 to 2009.

	Year						
Age	2003	2004	2005	2006	2007	2008	2009
1	4	2	2	0	0	5	5
2	8	11	6	95	16	14	10
3	49	41	72	118	51	98	33
4	49	24	31	34	55	52	38
5	55	34	37	12	40	13	41
6	29	23	23	3	11	5	10
7	5	8	10	1	3	1	3
8	3	4	9	2	1	2	2
9	1	1	3	1	0	1	0
10	0	0	5	0	0	0	0
11	0	0	1	1	0	0	0
12	0	0	1	0	0	0	0
13	0	0	0	0	0	1	0
Total	204	150	200	267	177	193	142
CPUE	0.9	0.7	0.9	1.2	0.8	0.9	0.6

*2003 sampling began in July.

Table 9. Tar/Pamlico River NCDMF Program 915 survey striped bass catch-at-age and total catch. Note: effort is constant from 2004 to 2009.

	Year						
Age	2003	2004	2005	2006	2007	2008	2009
1	3	20	6	9	8	5	1
2	8	37	8	42	88	15	21
3	78	58	212	216	51	158	36
4	31	20	110	82	37	52	56
5	20	23	36	12	37	6	59
6	9	14	11	3	16	2	8
7	4	4	3	1	2	0	1
8	4	5	3	2	1	0	0
9	1	2	3	1	0	0	0
10	0	1	2	1	0	1	0
Total	158	184	395	368	241	239	182
CPUE	0.7	0.8	1.8	1.7	1.1	1.1	0.8

*2003 sampling began in July.

Table 10. Estimated slope (total mortality, Z), y-intercept, F, SE of Z, and 90% confidence interval around Z for Neuse River cohort catch curves for 1989–2003 cohorts, calculated from the NCWRC spawning grounds survey.

Cohort	Z	Intercept	SE (Z)	PSE	Fishing Mortality	90% con. Inv. Lower	90% con. Inv. Upper	Exploitation Rate	Sample Size
1989*	0.70	4.86	0.35	49	0.55	0.42	0.99	42.4%	77
1990*	0.63	4.58	0.28	45	0.48	0.40	0.87	38.3%	133
1991	0.57	4.12	0.44	76	0.42	0.28	0.87	34.6%	228
1992	0.18	1.39	0.25	138	0.03	0.00	0.36	2.9%	168
1993	0.48	2.84	0.66	139	0.33	0.09	0.86	27.9%	193
1994	0.81	5.86	0.12	14	0.66	0.72	0.89	48.2%	247
1995	0.68	4.95	0.29	42	0.53	0.45	0.92	41.3%	76
1996	0.59	3.60	0.41	70	0.44	0.31	0.87	35.4%	218
1997	0.31	1.85	0.42	134	0.16	0.03	0.59	14.8%	186
1998	1.14	7.25	0.24	21	0.99	0.92	1.37	63.0%	193
1999	0.80	4.62	0.02	3	0.65	0.78	0.82	47.9%	211
2000	0.49	1.80	0.56	116	0.34	0.07	0.90	28.6%	90
2001	0.65	2.61	0.27	42	0.50	0.43	0.87	39.4%	48
2002*	0.58	3.30	0.10	17	0.43	0.49	0.67	35.0%	91
2003*	-	-	-	-	-	-	-	-	-
Mean	0.61	3.72	0.33	72	0.46	0.37	0.85	34.9%	169

* = incomplete cohorts.

- = insufficient data to calculate Z.

Table 11. Estimated slope (Z), fishing mortality, SE, and 90% confidence interval for Neuse River annual catch curve, calculated from the NCWRC spawning grounds survey.

Year	Z	Intercept	SE (Z)	PSE	Fishing Mortality	90% con. Inv. Lower	90% con. Inv. Upper	Exploitation Rate
1994	0.82	6.73	0.28	34	0.67	0.59	1.06	49.0%
1995	0.50	3.98	0.06	12	0.35	0.46	0.55	29.6%
1996	0.65	4.51	0.20	30	0.50	0.51	0.80	39.4%
1997	0.32	1.85	0.27	85	0.17	0.12	0.52	15.4%
1998	0.43	2.84	0.29	68	0.28	0.26	0.60	24.2%
1999	0.48	3.88	0.18	38	0.33	0.34	0.61	28.0%
2000	0.74	5.43	0.21	28	0.59	0.59	0.89	44.5%
2001	0.84	5.62	0.54	64	0.69	0.40	1.28	49.7%
2002	0.23	0.83	0.58	253	0.08	-0.13	0.59	7.6%
2003	0.65	4.48	0.32	49	0.50	0.44	0.87	39.5%
2004	0.53	3.47	0.27	50	0.38	0.31	0.75	31.5%
2005	0.29	1.27	0.34	118	0.14	0.08	0.50	12.8%
2006	0.69	2.80	0.38	56	0.54	0.38	1.01	41.8%
2007	0.48	2.49	0.61	126	0.33	0.13	0.84	28.4%
2008	1.15	6.10	0.25	22	1.00	0.92	1.39	63.3%
2009	0.70	4.57	0.48	69	0.55	0.34	1.05	42.0%
Mean	0.59	3.80	0.33	69	0.44	0.36	0.83	34.2%

Table 12. Estimated slope (total mortality, Z), y-intercept, F, SE of Z, and 90% confidence interval around Z for Neuse River cohort catch curves for 2000–2003 cohorts, calculated from the NCDMF Program 915.

Cohort	Z	Intercept	SE (Z)	PSE	Fishing Mortality	90% con. Inv. Lower	90% con. Inv. Upper	Exploitation Rate	Sample Size
2000	0.78	6.46	0.72	93	0.63	0.25	1.31	46.5%	119
2001	0.50	5.25	0.24	49	0.35	0.30	0.70	29.5%	105
2002*	0.79	6.85	0.54	68	0.64	0.40	1.19	47.5%	170
2003*	0.88	7.36	0.33	38	0.73	0.60	1.15	51.6%	193
Mean	0.64	5.85	0.48	71	0.49	0.27	1.00	38.0%	112

* = incomplete cohorts.

Table 13. Estimated slope (Z), fishing mortality, SE, and 90% confidence interval for Neuse River annual catch curve, calculated from the NCDMF Program 915.

Year	Z	Intercept	SE (Z)	PSE	Fishing Mortality	90% con. Inv. Lower	90% con. Inv. Upper	Exploitation Rate
2003	1.00	9.08	0.37	37	0.85	0.70	1.30	57.3%
2004	0.43	5.22	0.43	99	0.28	0.14	0.72	24.5%
2005	0.41	5.40	0.36	87	0.26	0.20	0.62	23.1%
2006	1.18	8.29	0.08	7	1.03	1.11	1.24	64.2%
2007	1.03	8.43	0.40	39	0.88	0.70	1.36	58.5%
2008	1.01	7.74	0.21	21	0.86	0.83	1.18	57.5%
2009	1.24	9.84	0.12	10	1.09	1.12	1.35	66.3%
Mean	0.88	7.71	0.29	46	0.73	0.66	1.10	49.0%

Table 14. Estimated mortality and confidence intervals for Tar/Pamlico River striped bass from cohort catch curves, calculated from the NCWRC spawning grounds survey.

Cohort	Z	Intercept	SE (Z)	PSE	Fishing Mortality	90% con. Inv. Lower	90% con. Inv. Upper	Exploitation Rate	Sample Size
1992	0.34	3.35	0.44	130	0.19	0.02	0.67	17.5%	541
1993	0.57	5.08	0.75	131	0.42	0.11	1.04	34.5%	1,101
1994	0.43	4.50	0.57	133	0.28	0.10	0.76	24.2%	1,292
1995	0.50	4.94	0.84	166	0.35	0.02	0.99	29.8%	1,080
1996	0.67	6.18	0.57	85	0.52	0.25	1.09	40.7%	361
1997	0.36	3.63	0.15	41	0.21	0.24	0.49	19.2%	216
1998	0.33	2.79	0.60	178	0.18	-0.10	0.77	16.9%	158
1999	1.36	8.92	0.26	19	1.21	1.11	1.60	70.0%	183
2000	0.69	4.57	0.28	41	0.54	0.45	0.92	41.6%	194
2001	0.38	3.15	0.90	233	0.23	-0.47	1.24	20.9%	238
2002*	1.45	8.48	0.78	54	1.30	0.71	2.20	72.8%	1,288
2003*	1.02	6.23	1.17	115	0.87	-0.09	2.13	58.0%	514
Mean	0.56	4.71	0.54	116	0.41	0.17	0.96	31.5%	536

* = incomplete cohorts.

Table 15. Estimated mortality and associated confidence intervals for Tar/Pamlico River striped bass from annual catch curves, calculated from the NCWRC spawning grounds survey. Results from 2009 were not calculated due to insufficient data.

Year	Z	Intercept	SE (Z)	PSE	Fishing Mortality	90% con. Inv. Lower	90% con. Inv. Upper	Exploitation Rate
1996	0.91	5.13	0.69	75	0.76	0.41	1.42	53.4%
1997	0.87	6.02	0.52	60	0.72	0.49	1.26	51.5%
1998	0.90	6.00	0.29	32	0.75	0.66	1.13	52.7%
1999	1.31	9.70	0.11	8	1.16	1.21	1.41	68.6%
2000	0.98	8.28	0.75	76	0.83	0.37	1.60	56.5%
2001	1.88	14.20	0.03	2	1.73	1.86	1.90	82.3%
2002	0.74	6.86	0.44	60	0.59	0.41	1.06	44.3%
2003	0.26	2.80	0.61	235	0.11	-0.15	0.67	10.3%
2004	0.37	3.89	0.39	106	0.22	0.11	0.64	19.8%
2005	0.61	4.90	0.67	109	0.46	0.16	1.06	37.0%
2006	1.07	6.53	0.47	44	0.92	0.76	1.39	60.3%
2007	0.73	5.37	0.46	62	0.58	0.30	1.17	44.1%
2008	1.45	7.57	0.56	38	1.30	0.92	1.97	72.6%
2009	-	-	-	-	-	-	-	-
Mean	0.93	6.71	0.46	70	0.78	0.58	1.28	50.3%

- = insufficient data to calculate Z.

Table 16. Estimated mortality and 90% confidence intervals for Tar/Pamlico River striped bass from cohort catch curves, calculated from the NCDMF Program 915.

Cohort	Z	Intercept	SE (Z)	PSE	Fishing Mortality	90% con. Inv. Lower	90% con. Inv. Upper	Exploitation Rate	Sample Size
2000	0.88	6.99	0.84	96	0.73	0.30	1.49	51.6%	140
2001	0.96	8.10	1.05	109	0.81	-0.03	1.95	55.4%	204
2002*	0.87	7.94	0.07	8	0.72	0.80	0.93	51.3%	375
2003*	1.15	8.41	0.79	69	1.00	0.49	1.80	63.1%	296
Mean	0.92	7.55	0.94	103	0.77	0.14	1.72	53.5%	172

* = incomplete cohorts.

Table 17. Estimated mortality and associated 90% confidence intervals for Tar/Pamlico River striped bass from annual catch curves, calculated from the NCDMF Program 915 survey.

Year	Z	Intercept	SE (Z)	PSE	Fishing Mortality	90% con. Inv. Lower	90% con. Inv. Upper	Exploitation Rate
2003	0.64	6.12	0.21	33	0.49	0.49	0.78	38.5%
2004	0.50	5.37	0.37	75	0.35	0.24	0.75	29.2%
2005	0.80	7.56	0.54	68	0.65	0.46	1.13	47.6%
2006	1.43	9.83	0.28	20	1.28	1.20	1.67	72.3%
2007	0.37	5.16	0.22	60	0.22	0.21	0.53	19.6%
2008	1.61	10.05	0.40	25	1.46	1.23	1.99	76.7%
2009	-	-	-	-	-	-	-	-
Mean	0.89	7.35	0.34	47	0.74	0.64	1.14	47.3%

- = insufficient data to calculate Z.

Table 18. Average striped bass cohort total mortality (Z) and fishing mortality (F) from the NCWRC spawning grounds survey for the Neuse and Tar rivers. The Carmichael and Waters report were averages of the 1991–1995 cohorts (Neuse River) and 1993–1995 cohorts (Tar River).

	Z		F	
Report	Neuse	Tar	Neuse	Tar
Carmichael and Waters original estimates	0.99	1.17	0.84	1.02
Current report with Carmichael and Waters time period	0.54	0.50	0.39	0.35
Current report with full time period	0.61	0.56	0.46	0.56

Table 19. Average striped bass annual total mortality (Z) and fishing mortality (F) from the NCWRC electrofishing survey for the Neuse and Tar rivers. The Carmichael and Waters report were averages of the years 1994–2001 (Neuse River) and 1997–2001 (Tar River).

	Z		F	
Report	Neuse	Tar	Neuse	Tar
Carmichael and Waters original estimates	0.86	1.30	0.71	1.15
Current report with Carmichael and Waters time period	0.60	1.19	0.45	1.04
Current report with full time period	0.59	0.93	0.41	0.44

Table 20. Length frequencies (TL inch) from the commercial gill net fishery of the Neuse River, 1997-2009,

Length	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
18	1	0	0	0	0	0	0	0	0	2	1	1	5
19	1	0	0	0	1	1	1	0	3	7	1	4	19
20	2	1	0	0	0	1	2	7	6	7	7	8	41
21	0	2	0	0	2	5	10	11	10	8	13	17	78
22	0	3	1	4	2	4	13	11	21	14	8	16	97
23	0	1	3	2	5	0	16	11	22	13	4	12	89
24	0	0	0	4	11	2	9	12	12	4	2	6	62
25	0	0	0	0	2	2	2	6	8	0	0	2	22
26	0	0	0	0	3	1	1	2	9	1	0	2	19
27	0	0	0	1	4	0	0	1	3	0	0	1	10
28	0	0	0	0	1	1	0	2	3	0	0	0	7
29	0	0	0	0	0	0	2	0	2	0	0	0	4
30	0	0	1	1	0	1	3	2	1	0	0	1	10
31	0	0	0	0	0	0	0	1	0	0	0	0	1
32	0	0	0	0	0	0	2	2	0	0	1	0	5
33	0	0	0	0	0	0	3	0	0	0	0	0	3
34	0	0	0	0	0	0	3	1	0	0	0	0	4
35	0	0	0	0	0	0	1	1	1	0	0	0	3
36	0	0	0	0	0	1	1	0	0	0	0	0	2
37	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	1	0	1
41	0	1	0	0	0	0	0	0	0	0	0	0	1
42	0	0	0	0	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0	1	0	1
Total	4	8	5	12	31	19	69	70	101	56	39	70	484

Table 21. Length frequencies (TL inch) from the commercial gill net frequencies from the Pamlico River, 1995-2009.

Length	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
7	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
10	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	1	0	0	3	0	0	0	4
18	2	5	1	6	3	0	0	0	0	0	0	19	0	12	1	49
19	2	23	4	6	9	2	0	2	5	3	1	32	6	4	5	104
20	3	35	18	5	22	10	1	3	35	16	6	14	22	2	21	213
21	5	14	18	19	38	19	16	12	50	30	22	11	30	9	36	329
22	9	3	14	21	55	40	33	14	26	26	41	12	36	9	23	362
23	17	0	9	8	37	30	38	23	16	22	44	7	11	8	10	280
24	6	0	2	7	14	12	24	15	9	6	7	5	3	4	2	116
25	4	0	0	0	3	11	4	8	8	5	2	4	1	1	0	51
26	1	2	0	0	1	0	0	3	2	3	1	1	0	3	0	17
27	0	1	0	1	0	1	0	4	0	3	1	2	1	0	0	14
28	0	0	1	0	0	0	0	5	1	2	0	4	0	0	0	13
29	1	0	0	0	0	0	0	0	2	2	0	2	0	0	0	7
30	0	0	1	2	0	0	0	0	2	0	0	0	0	0	1	6
31	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	4
32	0	0	0	0	0	0	0	1	0	2	0	0	1	0	0	4
33	0	0	0	0	0	1	0	0	0	3	1	1	0	0	0	6
34	0	0	0	0	0	0	0	1	0	2	0	1	0	0	0	4
35	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
36	0	0	0	0	0	0	0	0	2	2	1	0	0	0	0	5
37	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	2
38	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	2
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
41	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	3
Total	50	84	68	75	186	126	116	92	162	131	127	119	111	54	99	1,600

Table 22. Length frequencies (TL inch) from the commercial gill net fishery observer program in the Neuse River, 2004-2009.

Length	2004	2005	2006	2008	2009	Total
18	1	2	0	0	1	4
19	1	1	0	1	1	4
20	1	0	0	3	1	5
21	0	6	1	5	1	13
22	5	1	2	13	2	23
23	7	4	0	3	2	16
24	1	3	0	1	0	5
25	4	3	0	0	1	8
26	1	1	0	0	0	2
27	0	0	0	0	0	0
28	0	0	0	0	0	0
29	1	1	0	0	0	2
30	1	0	0	0	0	1
31	1	0	0	0	0	1
32	1	0	0	0	0	1
33	2	0	0	0	0	2
34	0	0	0	0	0	0
35	1	0	0	0	0	1
36	0	0	0	0	0	0
37	1	0	0	0	0	1
Total	29	22	3	26	9	89

Table 23. Length frequencies (TL inch) from the commercial gill net fishery observer program in the Pamlico River, 2004-2006.

Length	2004	2005	2006	Total
14	3	0	0	3
15	0	2	0	2
16	0	5	1	6
17	0	1	2	3
18	0	0	2	2
19	2	11	30	43
20	5	10	24	39
21	12	18	10	40
22	11	37	10	58
23	2	9	3	14
24	2	9	5	16
25	0	2	0	2
26	0	2	4	6
27	1	0	0	1
28	0	2	0	2
29	0	0	1	1
30	0	0	0	0
31	1	0	0	1
32	0	2	0	2
33	0	1	0	1
34	0	0	0	0
35	0	0	0	0
36	0	1	0	1
37	0	0	0	0
38	0	0	0	0
39	0	0	0	0
40	0	0	1	1
Total	39	112	93	244

Table 24. Recreational harvest in numbers and pounds estimated by the NCDMF creel survey for the Neuse and Pamlico rivers, 2004-2008.

	Neuse River		Pamlico River	
Year	Numbers	Pounds	Numbers	Pounds
2004	3,985	14,845	2,157	8,114
2005	1,717	6,874	2,192	8,426
2006	1,246	4,081	1,237	3,275
2007	2,618	7,115	982	3,681
2008	405	1,510	443	1,502

Table 25. Length frequencies (TL inch) from the NCDMF creel survey for the Neuse River recreational fishery, 2004-2008.

Length	2004	2005	2006	2007	2008	Total
16	0	0	0	0	0	0
17	1	0	0	0	0	1
18	3	5	0	2	0	10
19	19	7	11	14	4	55
20	28	16	7	19	2	72
21	25	14	8	16	3	66
22	16	13	4	5	1	39
23	13	3	5	2	0	23
24	18	8	3	2	0	31
25	14	6	3	2	0	25
26	6	6	0	2	1	15
27	1	3	1	1	0	6
28	6	2	1	0	0	9
29	1	0	0	0	0	1
30	1	2	0	0	0	3
31	0	1	0	0	0	1
32	0	0	0	0	0	0
Total	152	86	43	65	11	357

Table 26. Length frequencies (TL inch) from the NCDMF creel survey for the Pamlico River recreational fishery, 2004-2008.

Length	2004	2005	2006	2007	2008	Total
16	0	6	0	0	0	6
17	0	1	2	1	0	4
18	8	5	2	3	3	21
19	34	33	9	11	7	94
20	72	48	29	11	9	169
21	68	30	18	11	9	136
22	40	42	9	8	7	106
23	29	32	9	12	2	84
24	9	31	7	4	2	53
25	4	6	2	1	0	13
26	3	4	1	0	0	8
27	2	2	0	0	0	4
28	7	2	0	0	0	9
29	1	4	0	0	0	5
30	1	2	1	2	0	6
31	0	0	0	0	0	0
32	1	1	0	0	0	2
Total	279	249	89	64	39	720

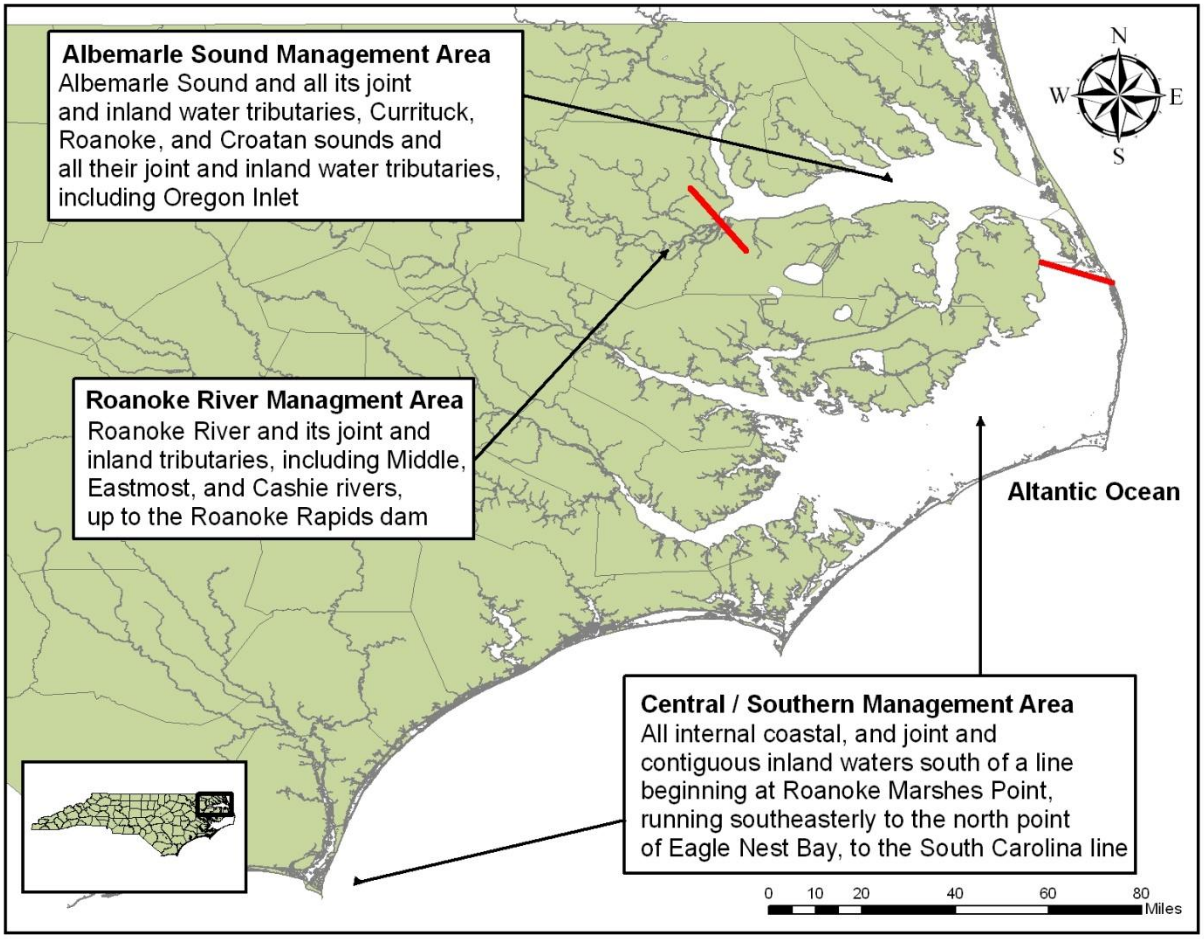

Figure 1. Map of NC striped bass management areas.

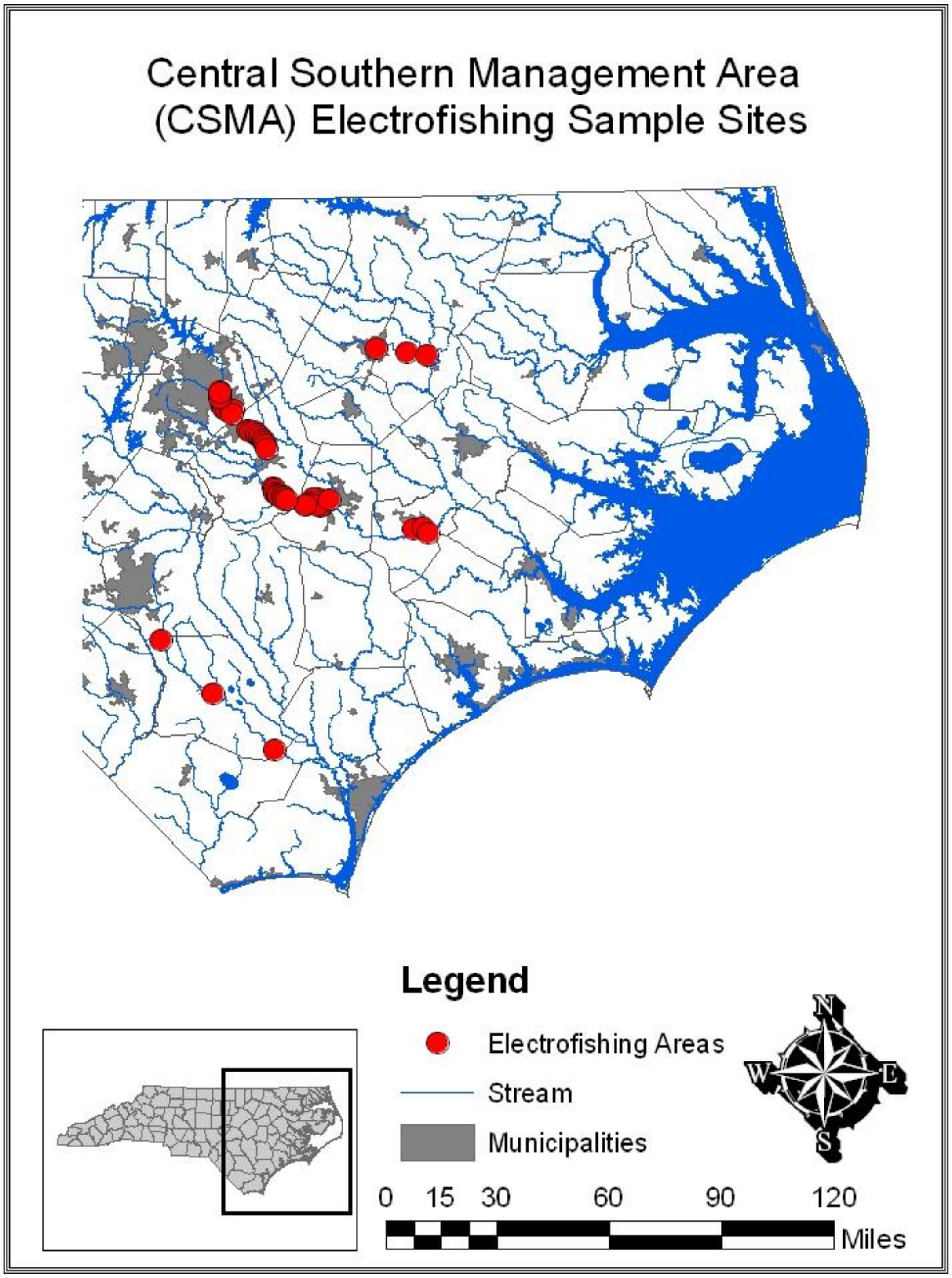

Figure 2. The NCWRC spawning grounds electrofishing areas for the CSMA.

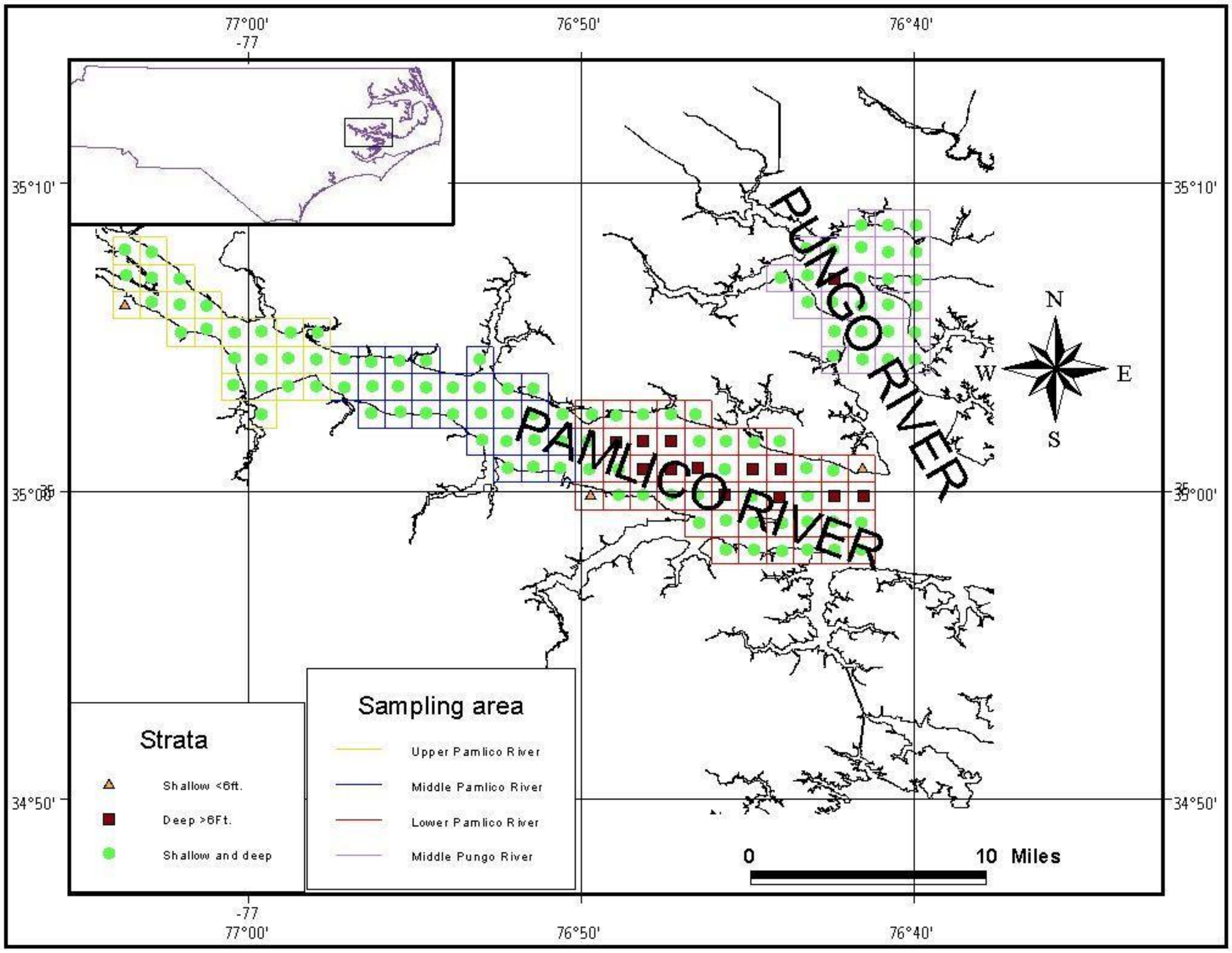

Figure 3. Program 915 sampling area and strata in the Pamlico and Pungo rivers.

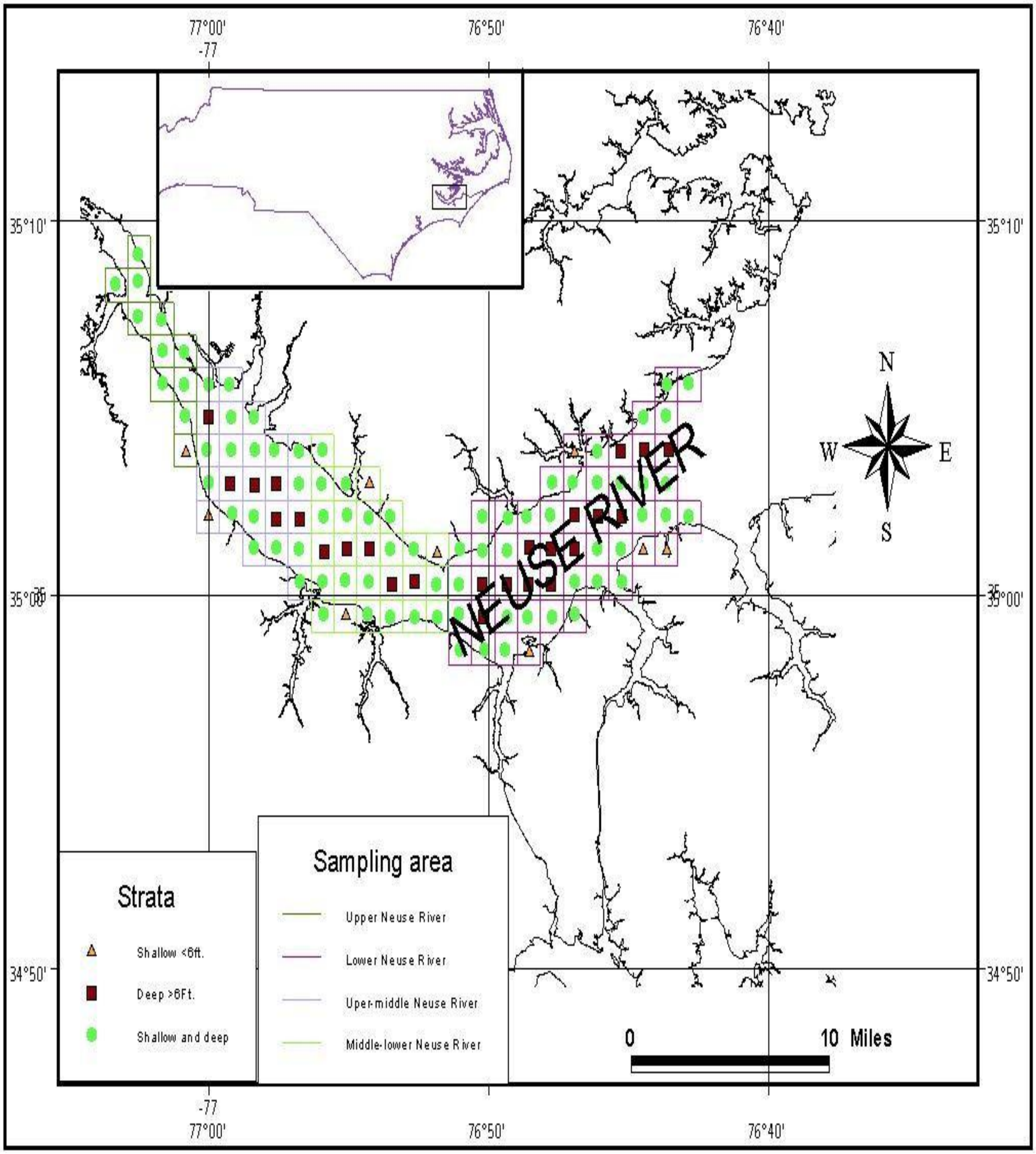

Figure 4. Program 915 sampling area and strata in the Neuse River.

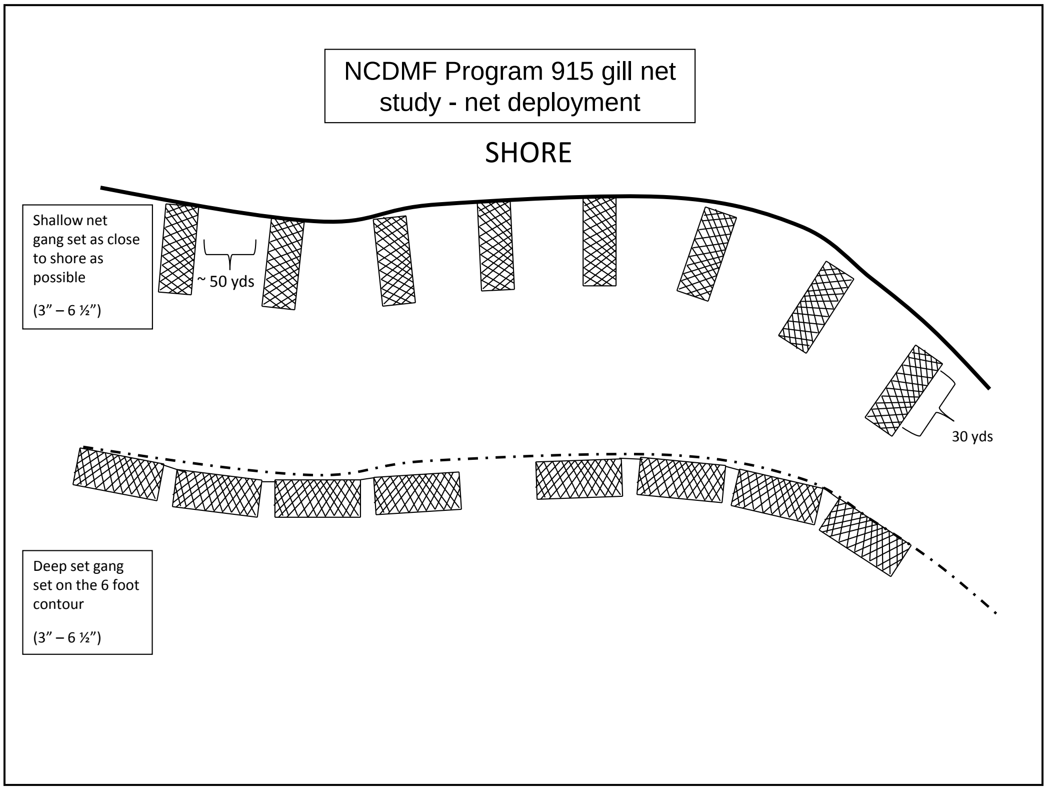

Figure 5. The North Carolina Division of Marine Fisheries (NCDMF) Program 915 survey net deployment.

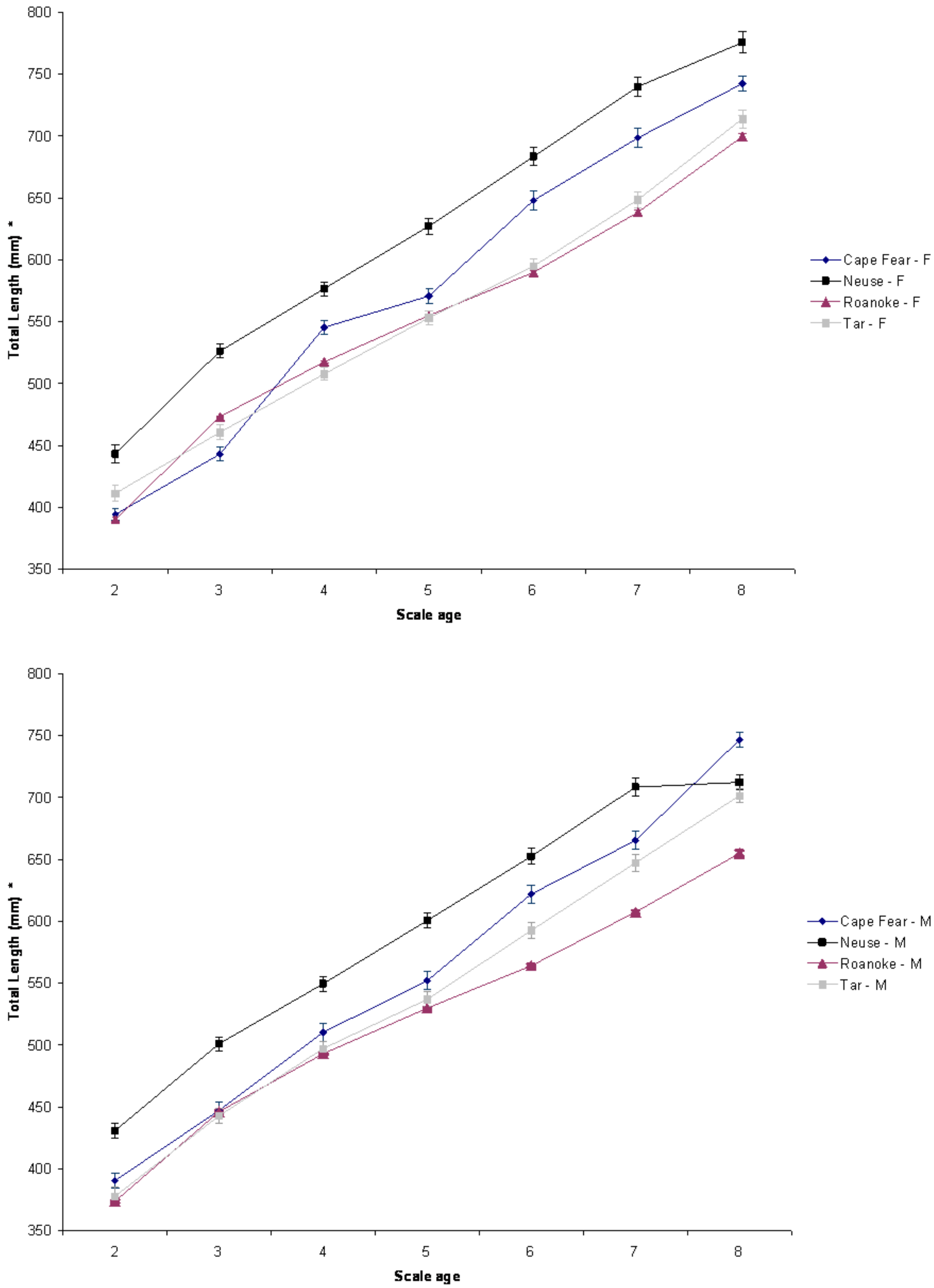

Figure 6. Mean length-at-age for female and male striped bass with scale age estimates between age 2 and age 8 for the Cape Fear, Neuse, Roanoke and Tar rivers for their respective stock assessment time series. Error bars are 1 SE.

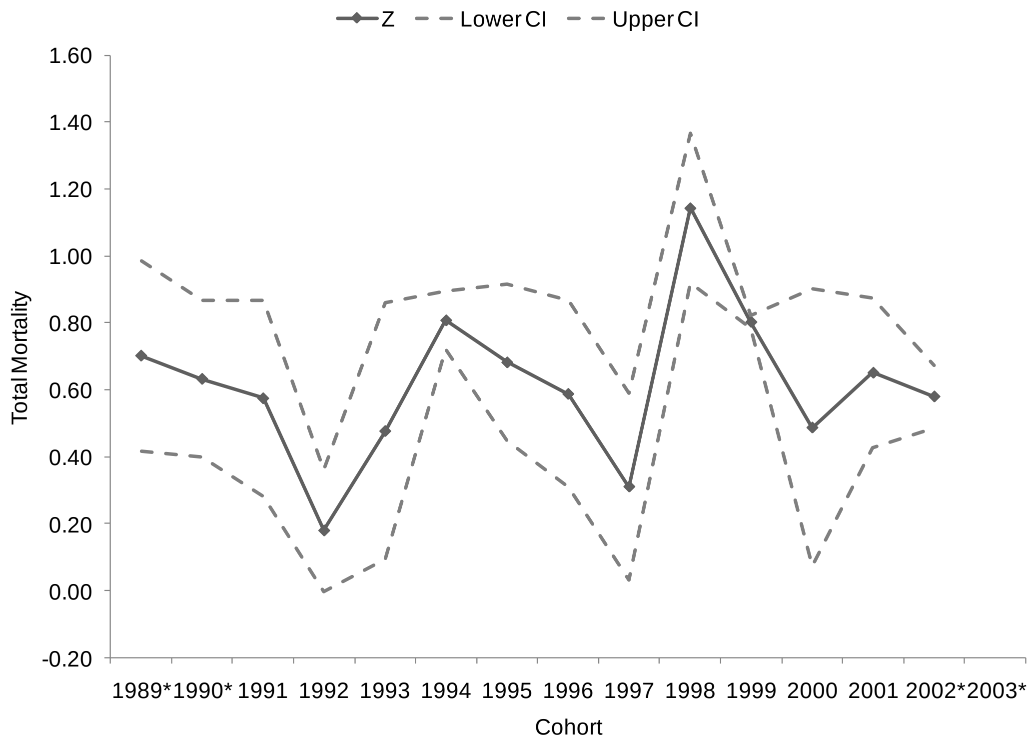

Figure 7. Total mortality (Z) estimated by cohort catch curve, 1989–2003 cohorts in Neuse River, calculated from the NCWRC spawning grounds survey.
* Denotes incomplete cohort

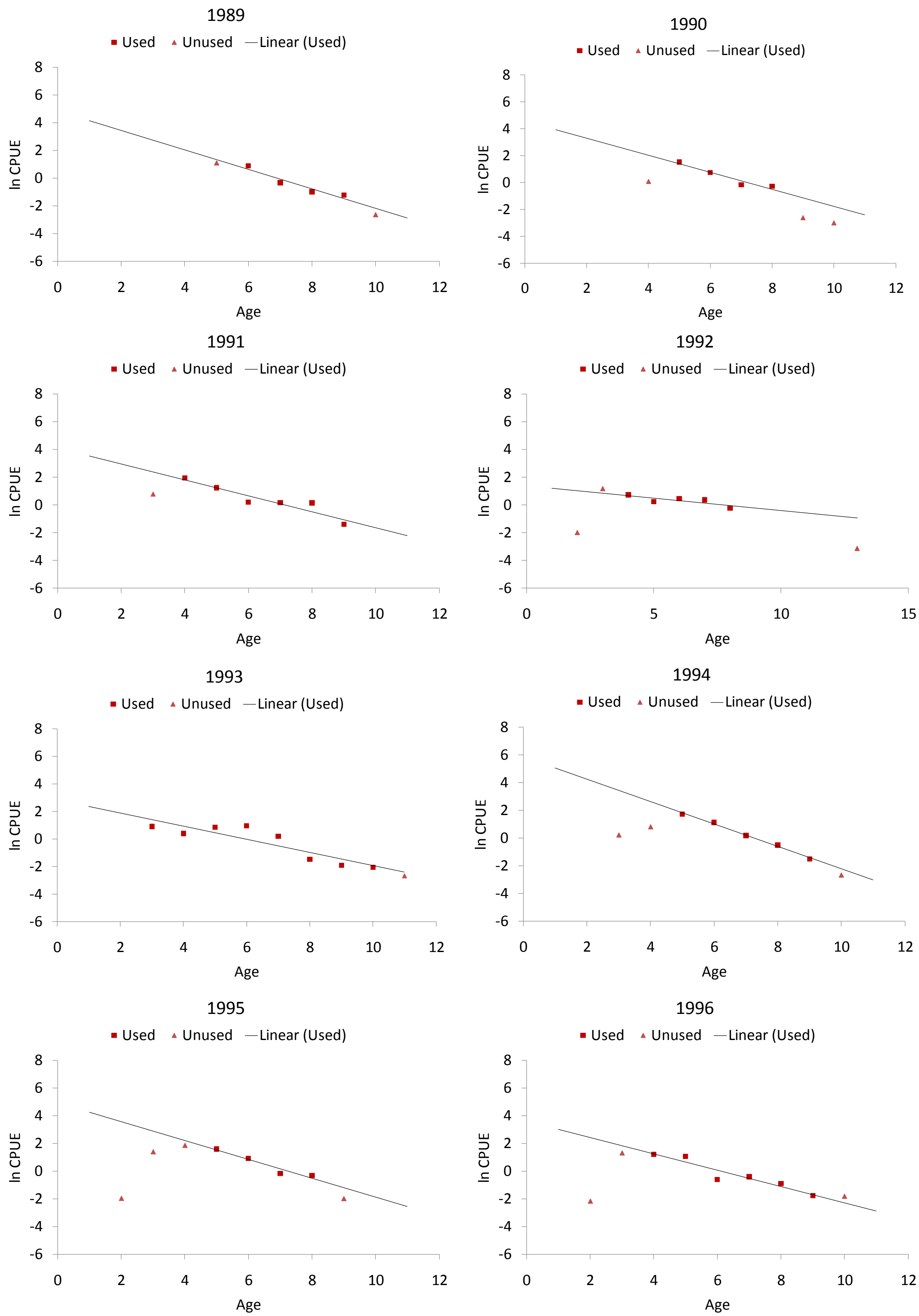

Figure 8. Observed and predicted ln(CPUE) for the Neuse River cohort catch curves for the 1989–2003 cohorts, calculated from the NCWRC spawning grounds survey.

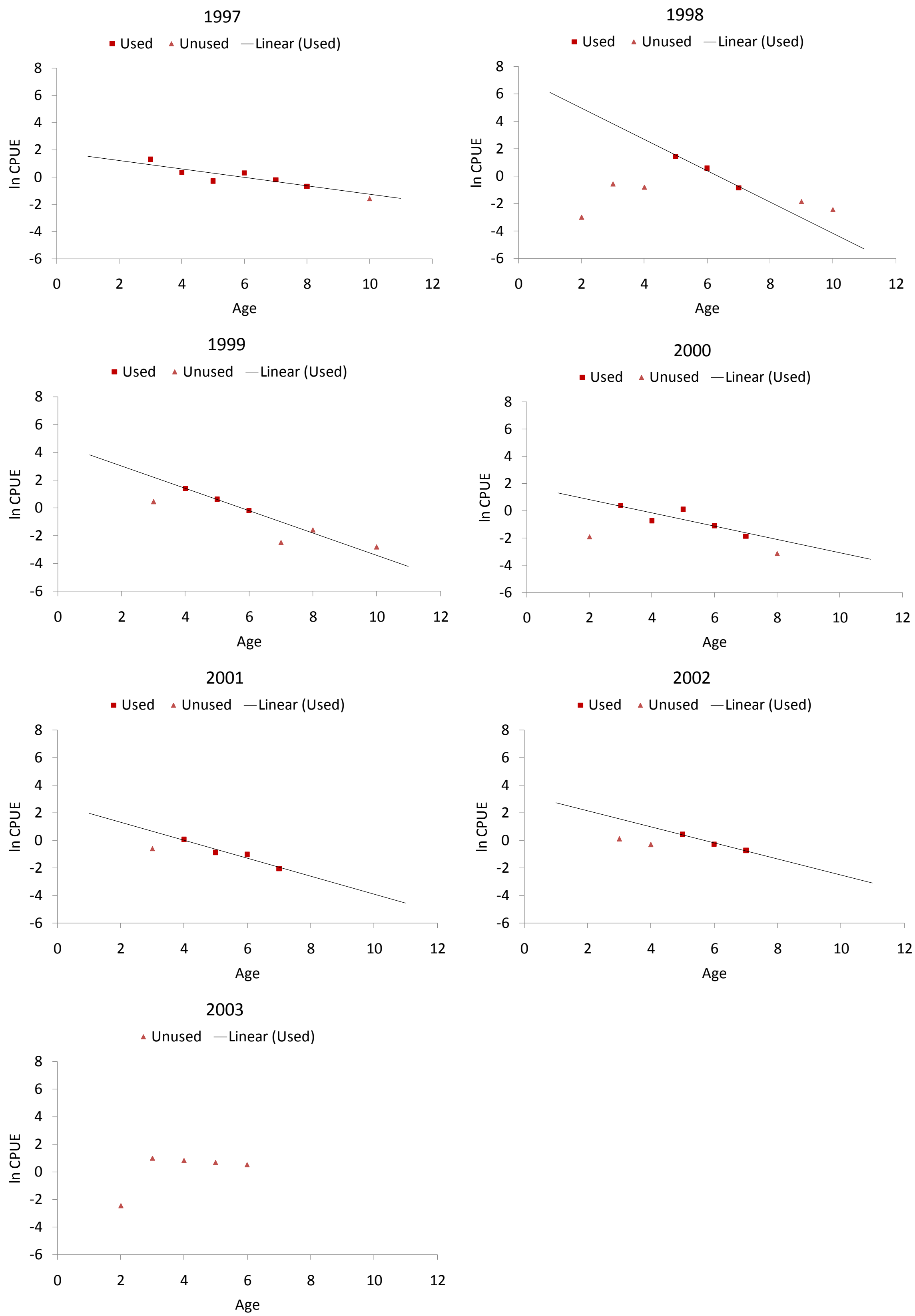

Figure 8. Continued.

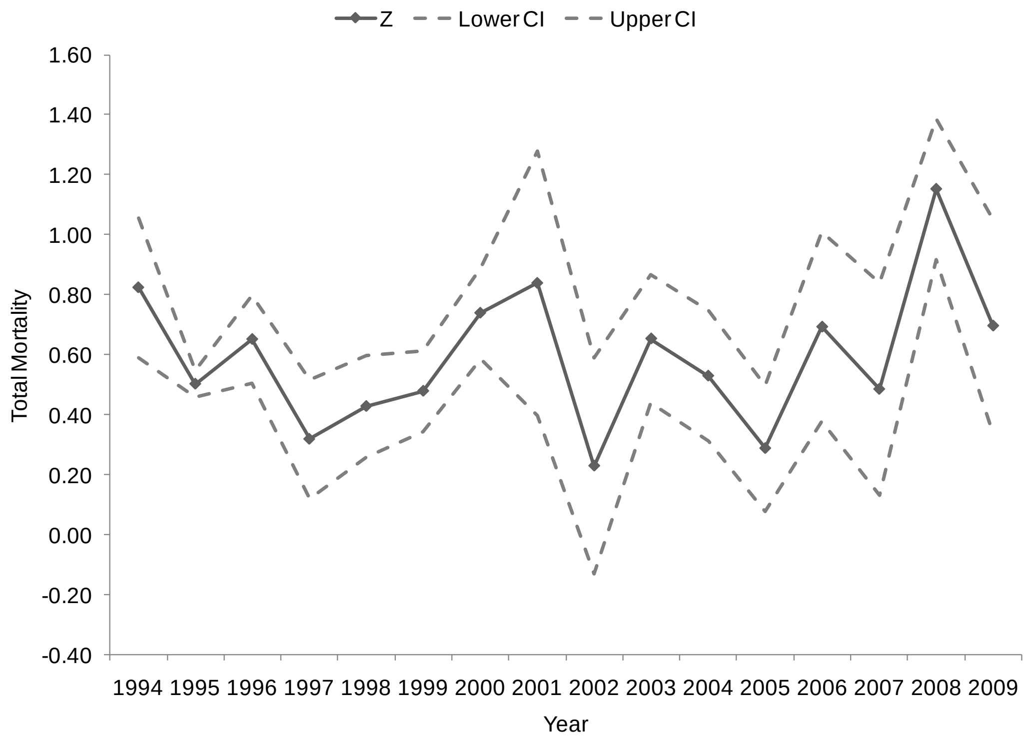

Figure 9. Estimated Z and 90% Confidence Interval, Neuse River annual catch curve, 1994–2009, calculated from the NCWRC spawning grounds survey

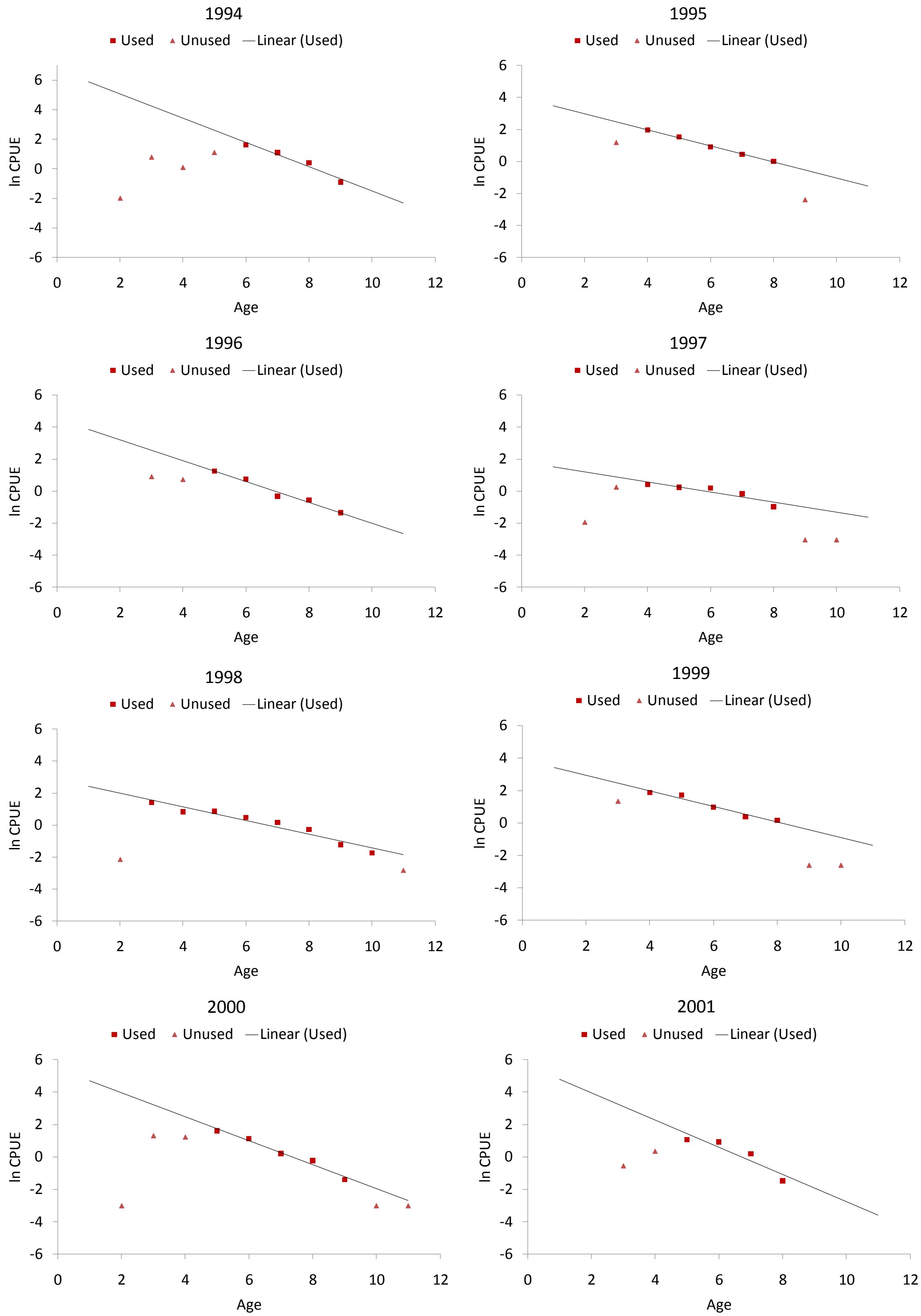

Figure 10. Observed and predicted ln(CPUE), annual Neuse River catch curves from the NCWRC spawning grounds survey, 1994–2009.

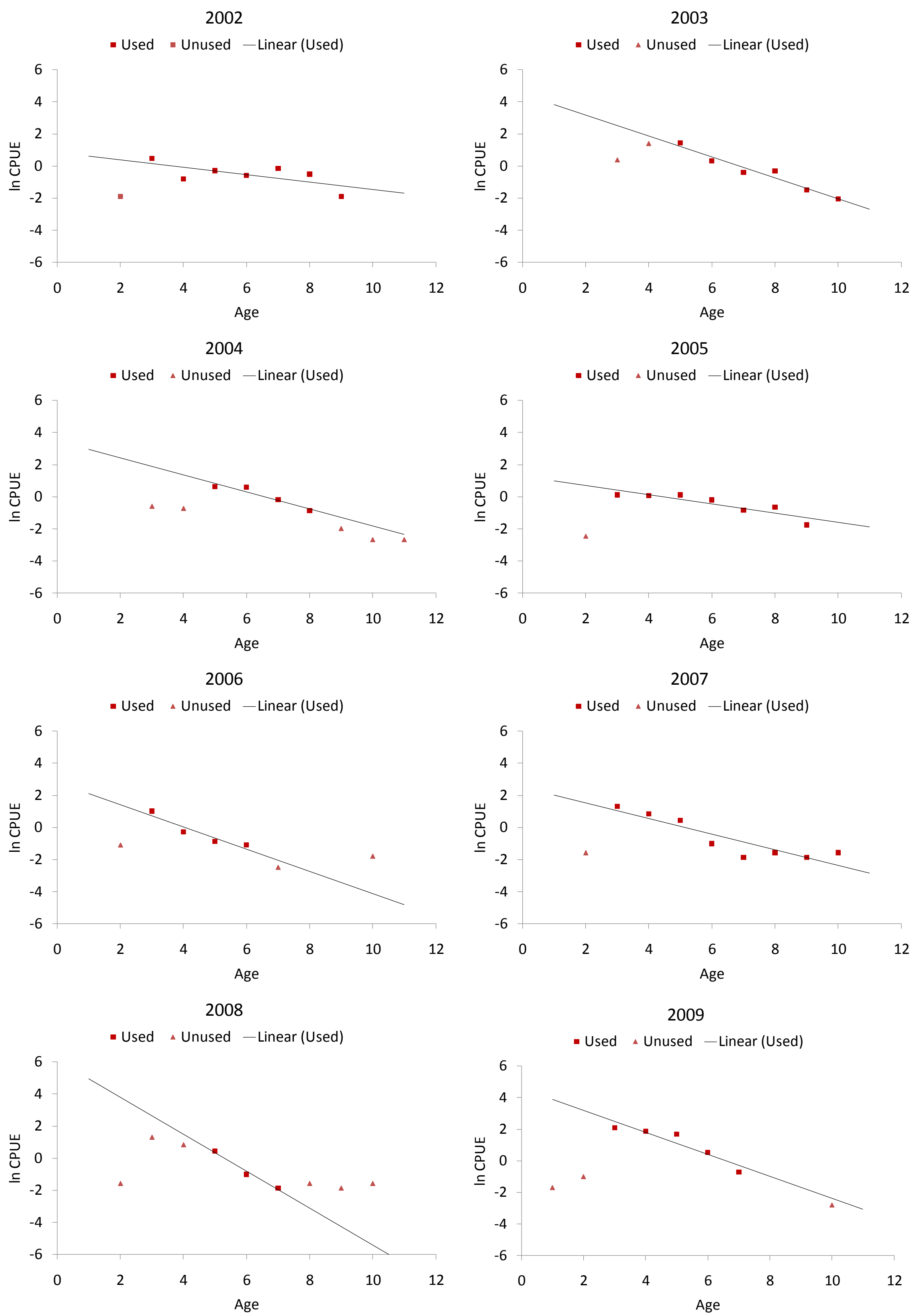

Figure 10. Continued, 2002–2009.

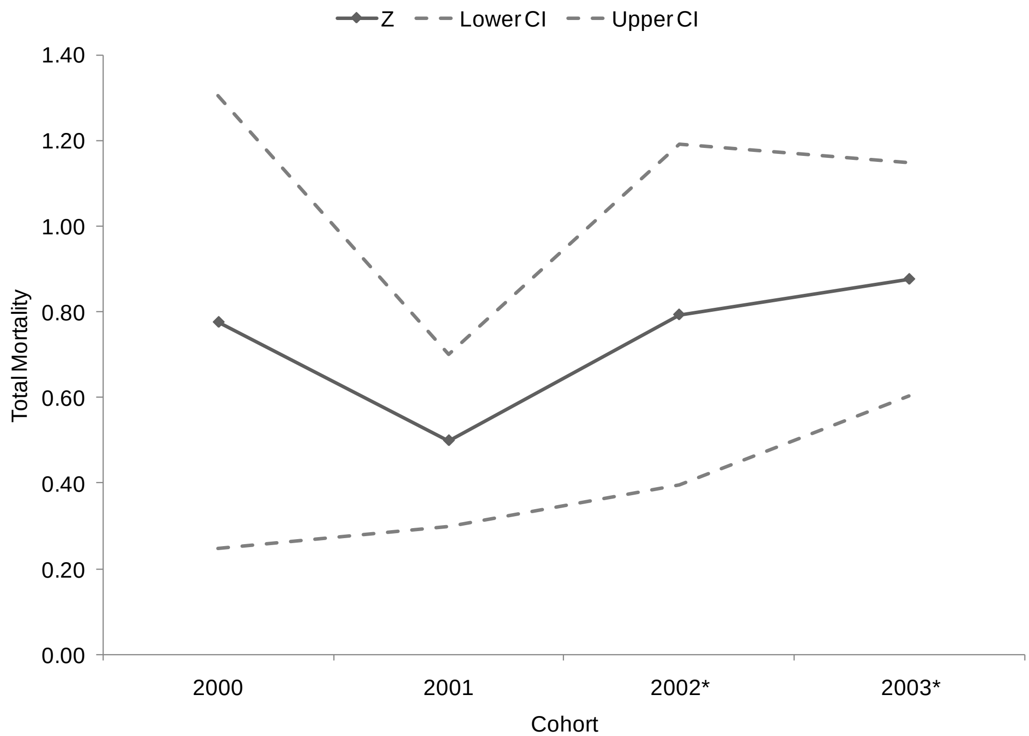

Figure 11. Total mortality (Z) estimated by cohort catch curve, 2000–2003 cohorts in Neuse River, calculated from the NCDMF Program 915 survey.
* Denotes incomplete cohort

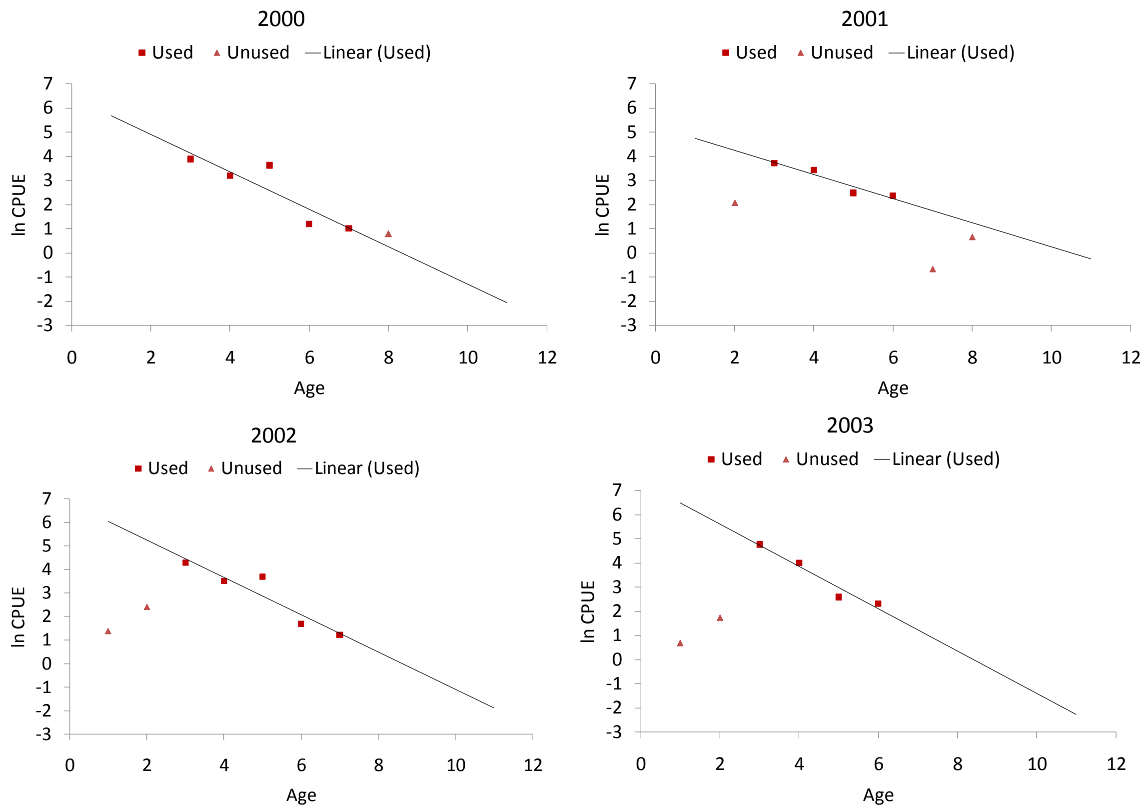

Figure 12. Observed and estimated ln(CPUE) for the Neuse River cohort catch curves for the 2000–2003 cohorts, calculated from the NCDMF Program 915 survey.

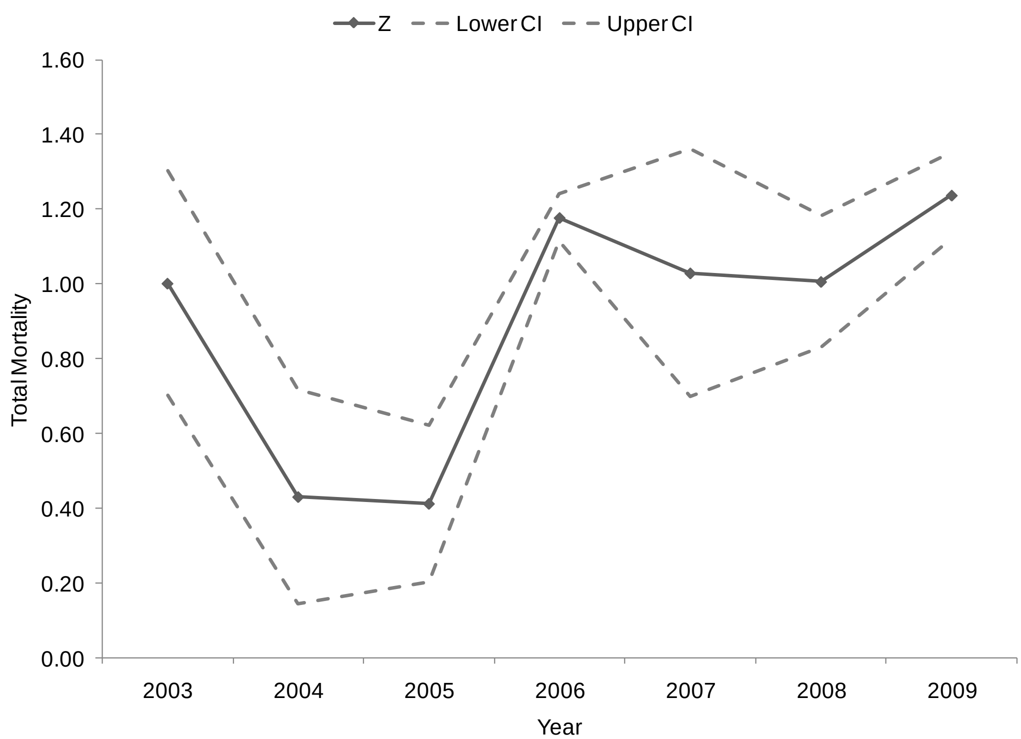

Figure 13. Estimated Z and 90% Confidence Interval, Neuse River annual catch curve, 2003–2009, calculated from the NCDMF Program 915 survey.

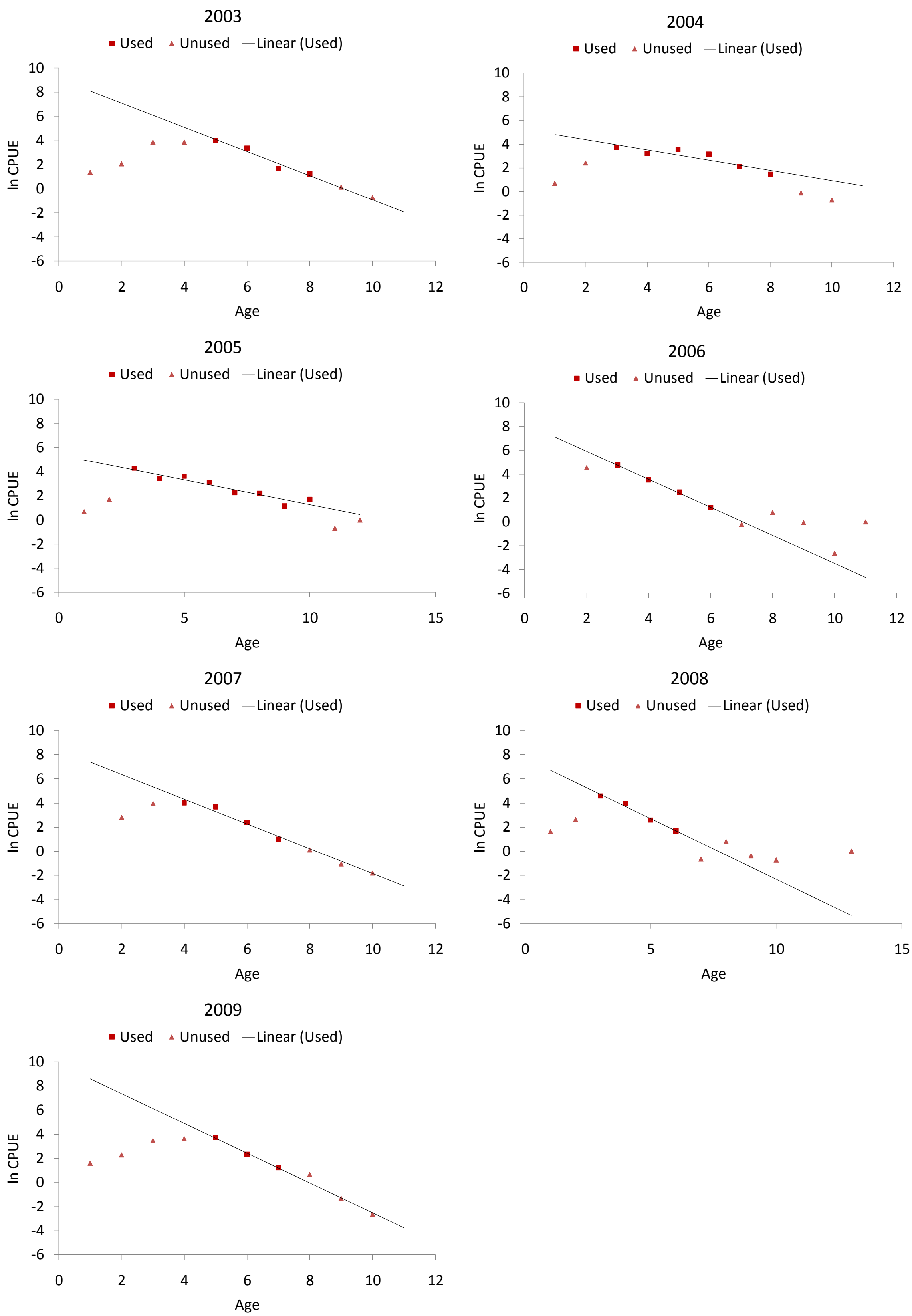

Figure 14. Observed and estimated ln(CPUE), annual Neuse River catch curves from the NCDMF Program 915 survey, 2003–2009.

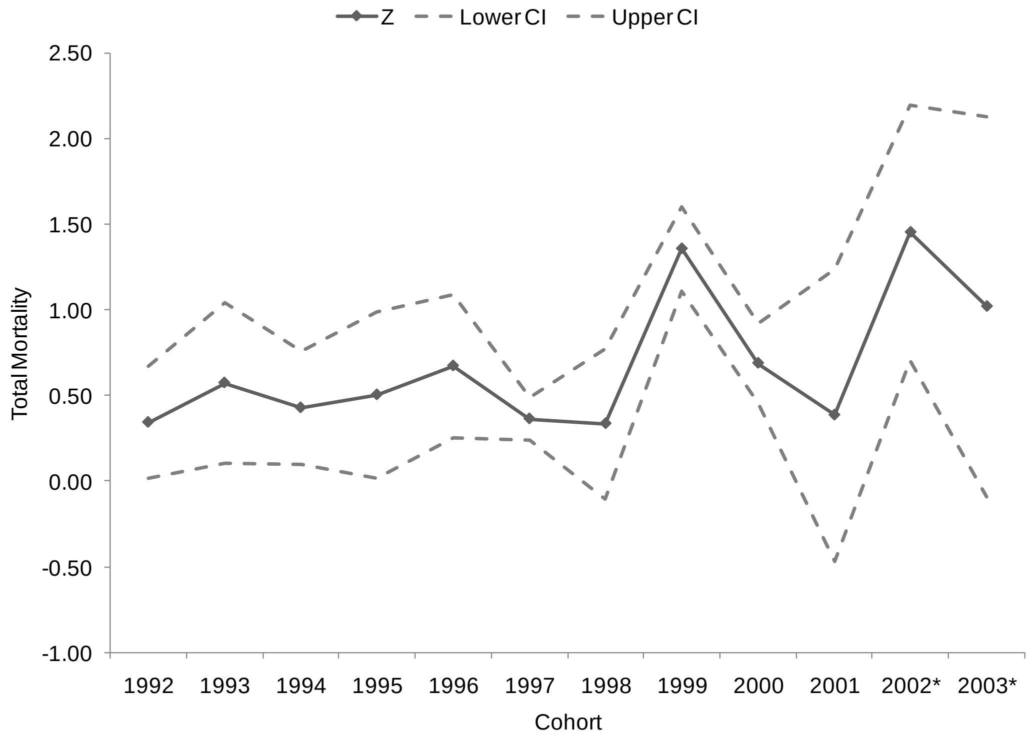

Figure 15. Tar/Pamlico River cohort catch curve estimated total mortality and confidence intervals for cohorts 1992–2003, calculated using the NCWRC spawning grounds survey.
* Denotes incomplete cohort

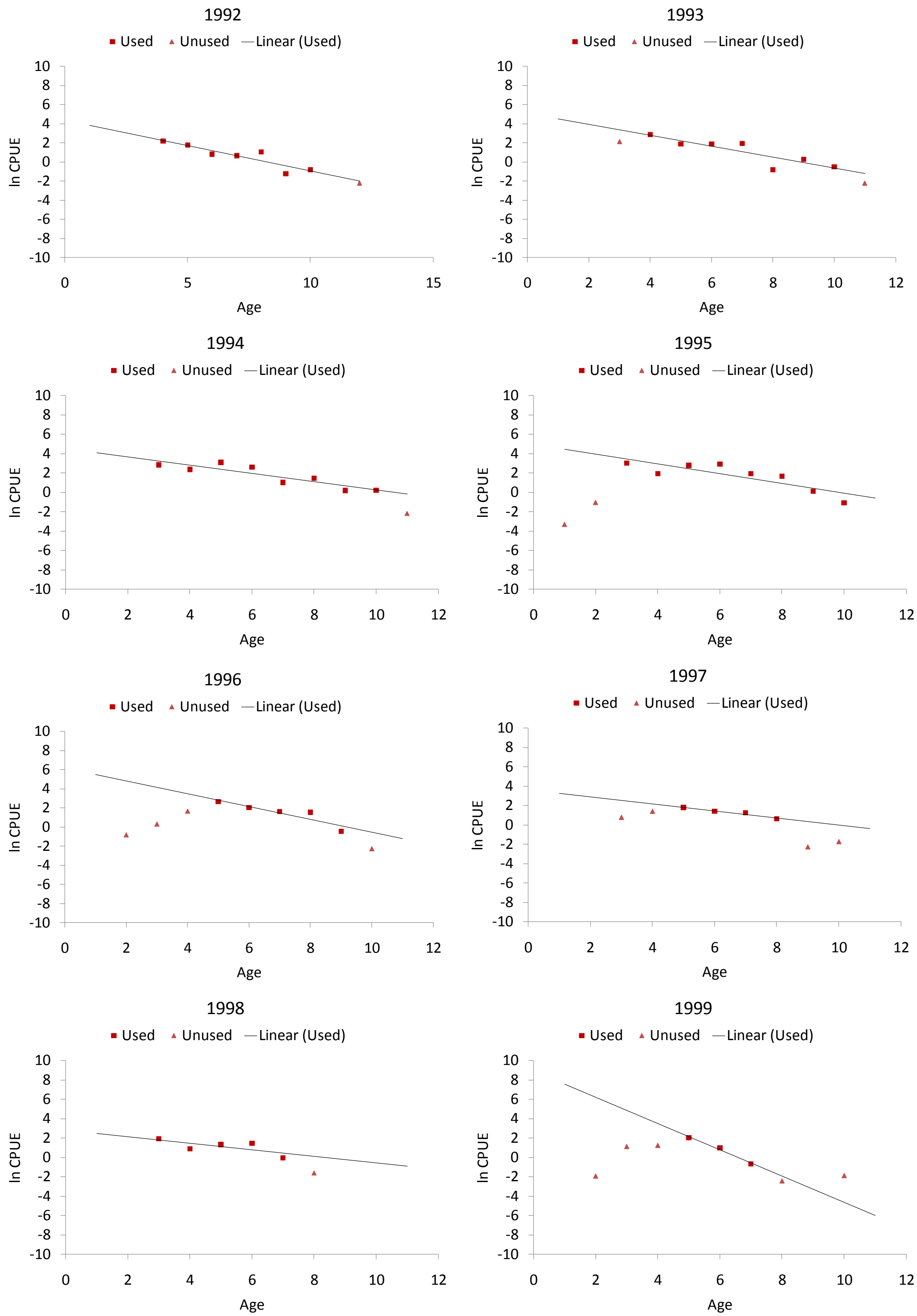

Figure 16. Observed and estimated ln(CPUE), Tar/Pamlico rivers cohort catch curves for the 1992–2003 cohorts, calculated using the NCWRC spawning grounds survey.

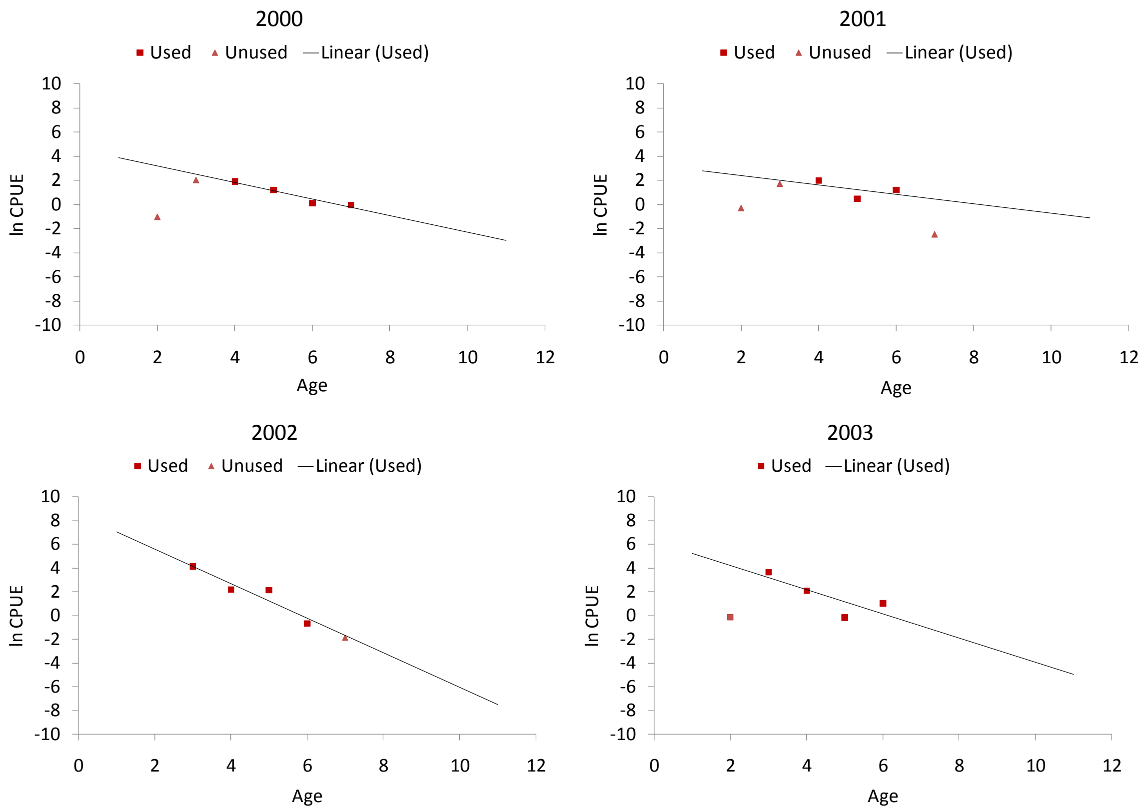

Figure 16. Continued.

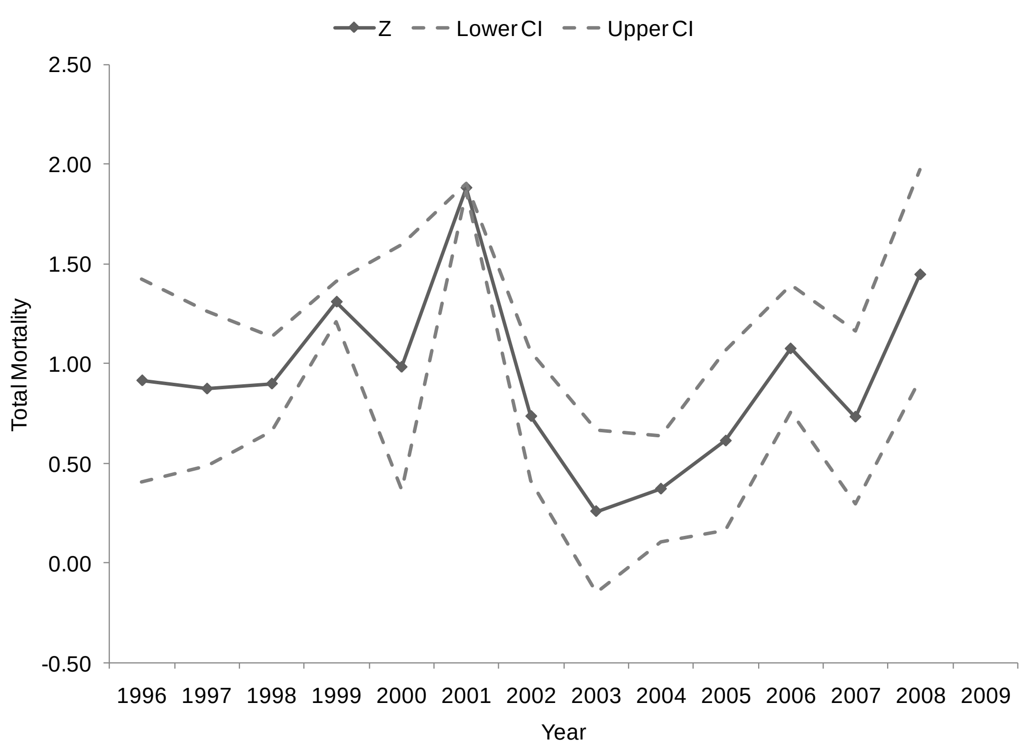

Figure 17. Tar/Pamlico River annual catch curve estimated total mortality and 90% confidence intervals from 1996–2008, calculated using the NCWRC spawning grounds survey.

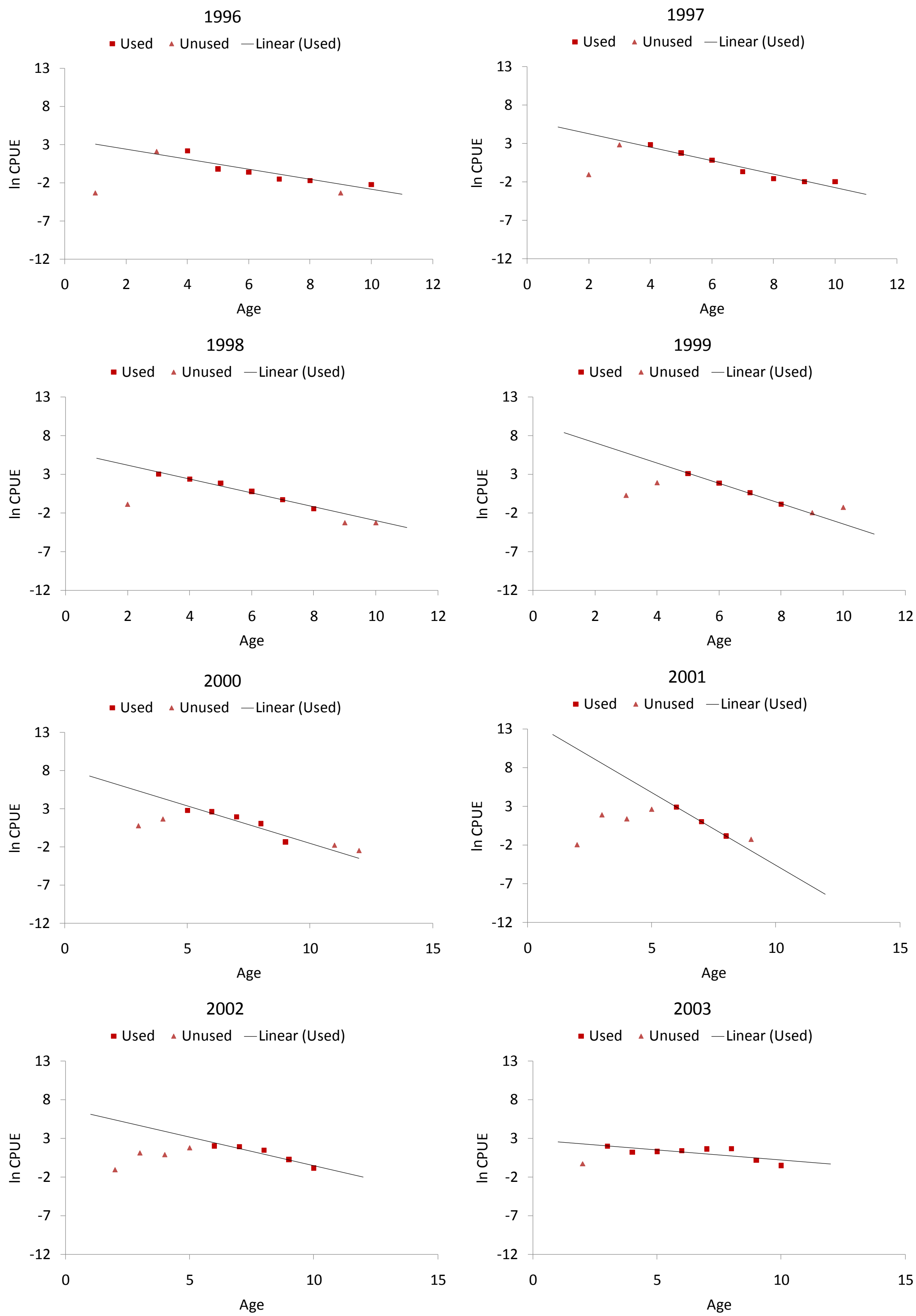

Figure 18. Observed and estimated ln(CPUE) from Tar/Pamlico River annual catch curves for the years 1996–2009, calculated from the NCWRC spawning grounds survey.

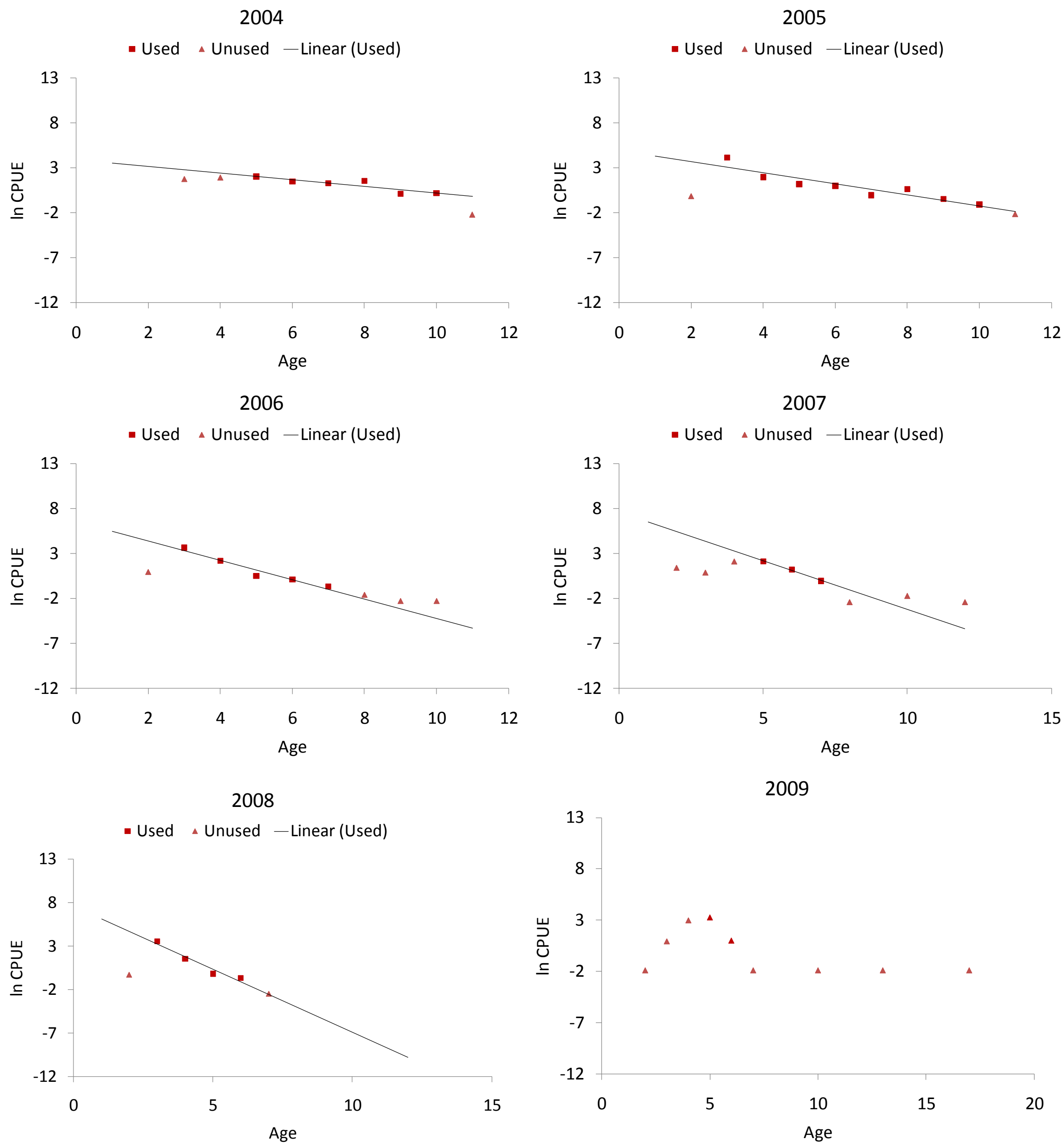

Figure 18. Continued.

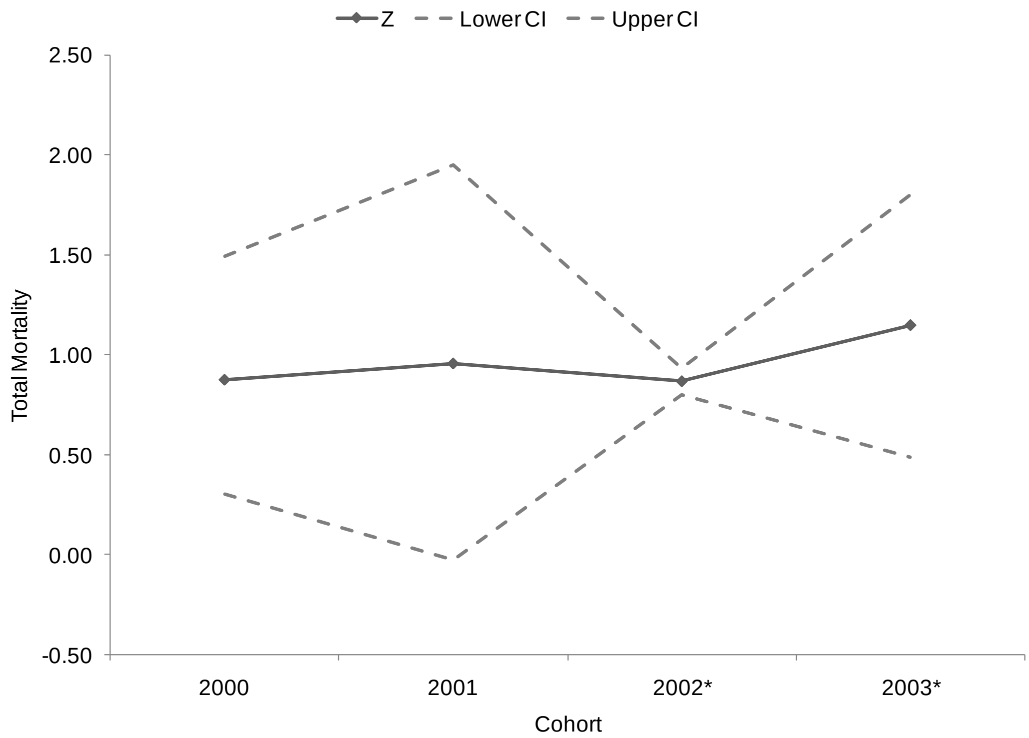

Figure 19. Tar/Pamlico River cohort catch curve estimated total mortality and 90% confidence intervals for cohorts 2000–2003, calculated using the NCDMF Program 915 survey. * Denotes incomplete cohort

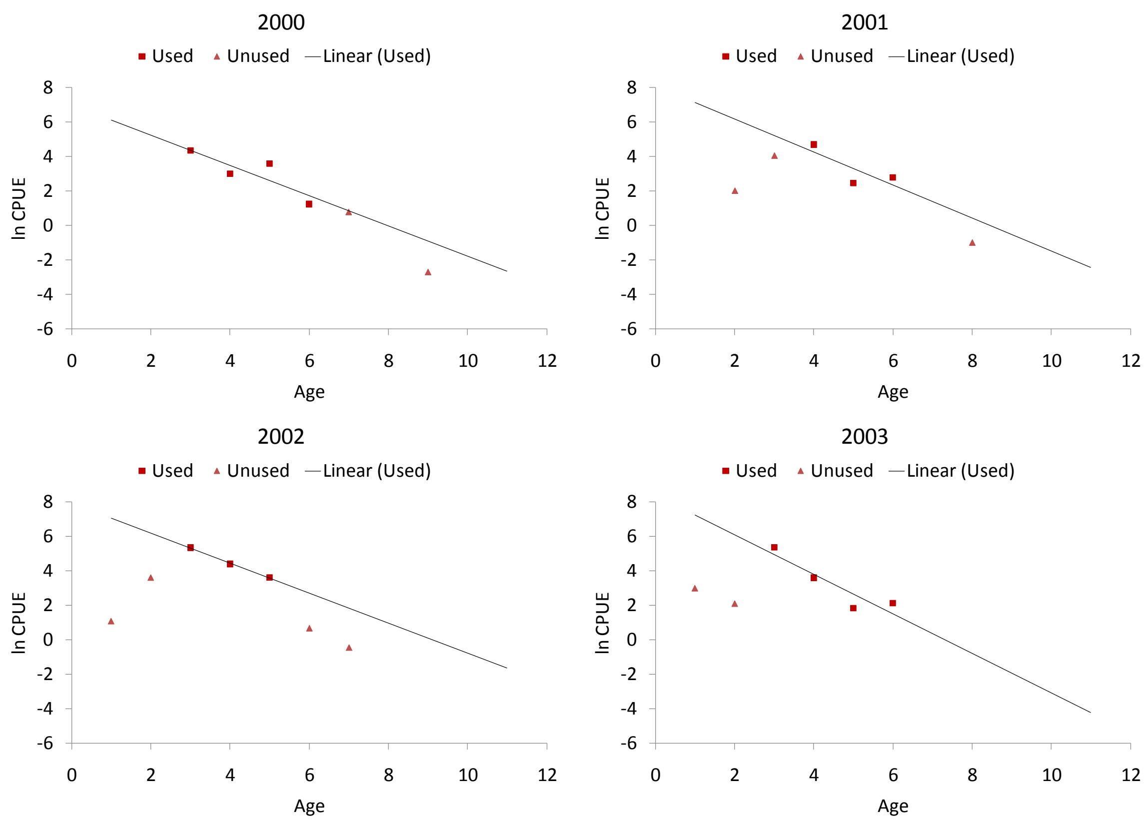

Figure 20. Observed and estimated ln(CPUE), Tar/Pamlico River cohort catch curves for the 2000–2003 cohorts, calculated using the NCDMF Program 915 survey.

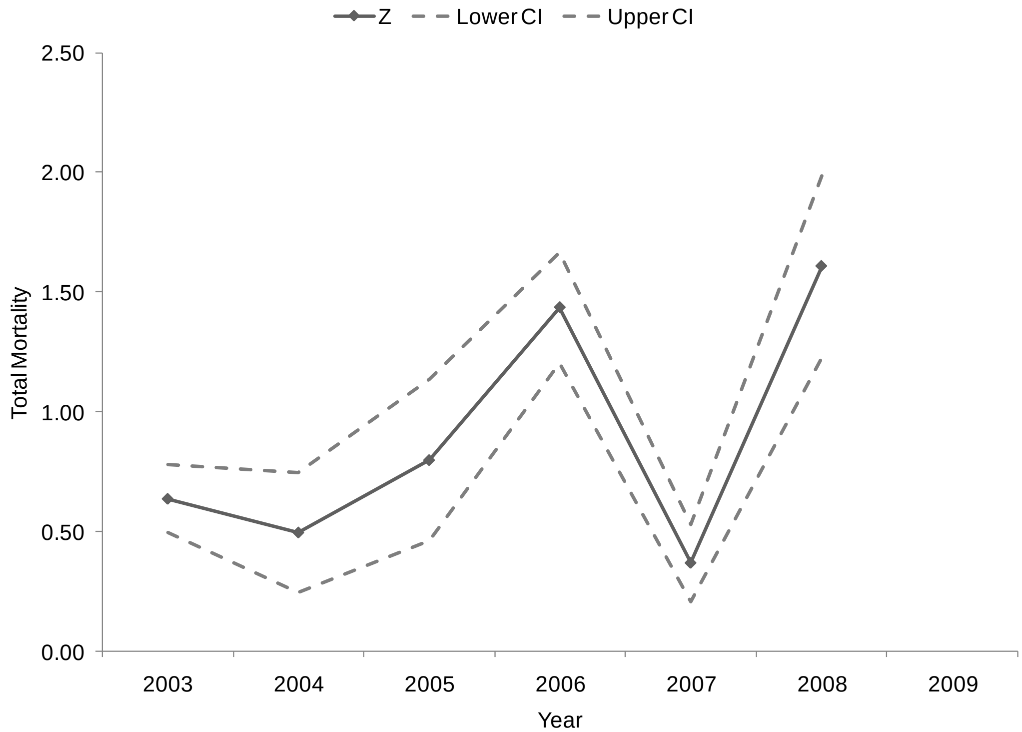

Figure 21. Tar/Pamlico River annual catch curve estimated total mortality and 90% confidence intervals from 2003–2009, calculated using the NCDMF Program 915 survey.

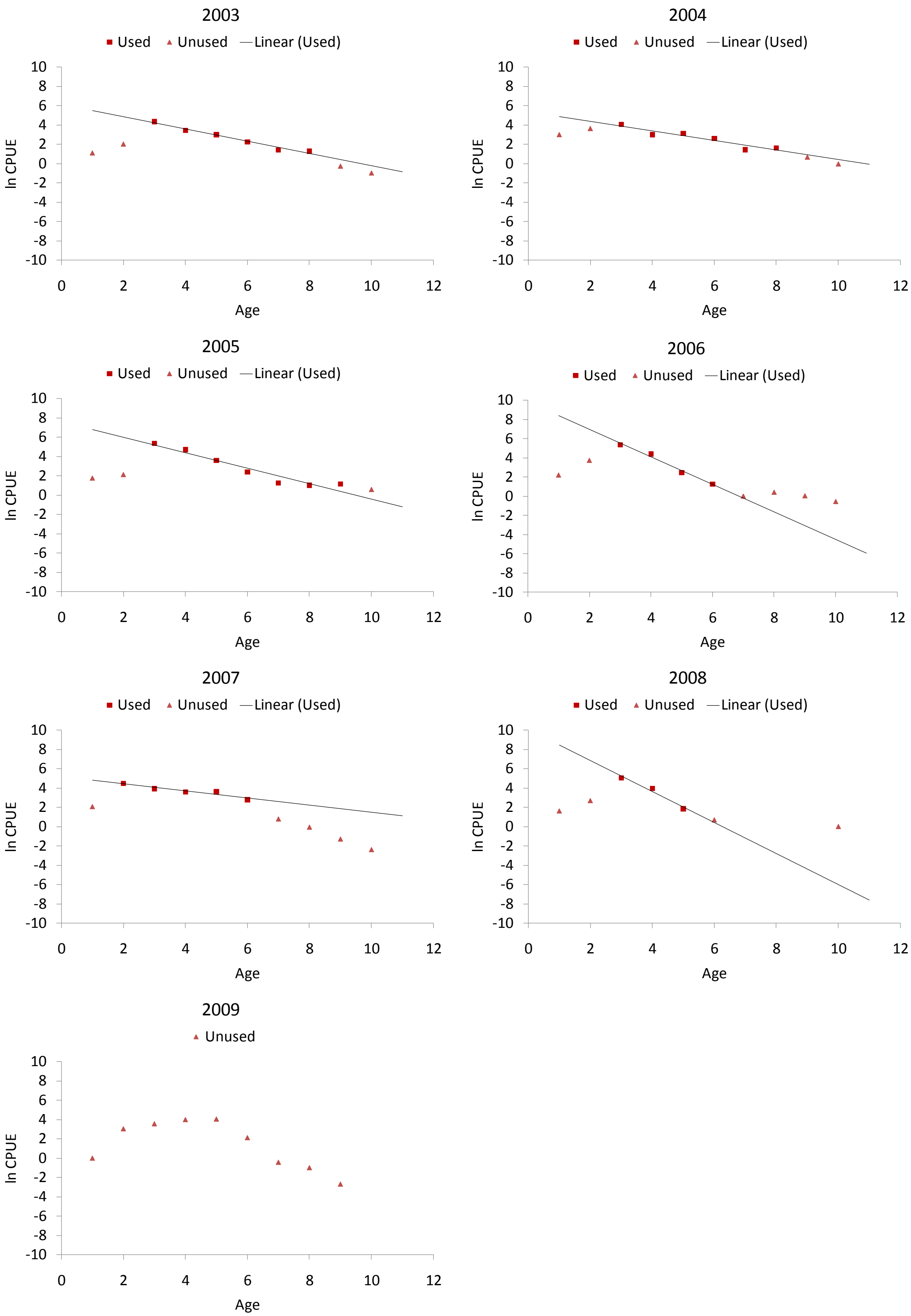

Figure 22. Observed and estimated ln(CPUE) from Tar/Pamlico River annual catch curves for the years 2003–2009, calculated from the NCDMF Program 915 survey.

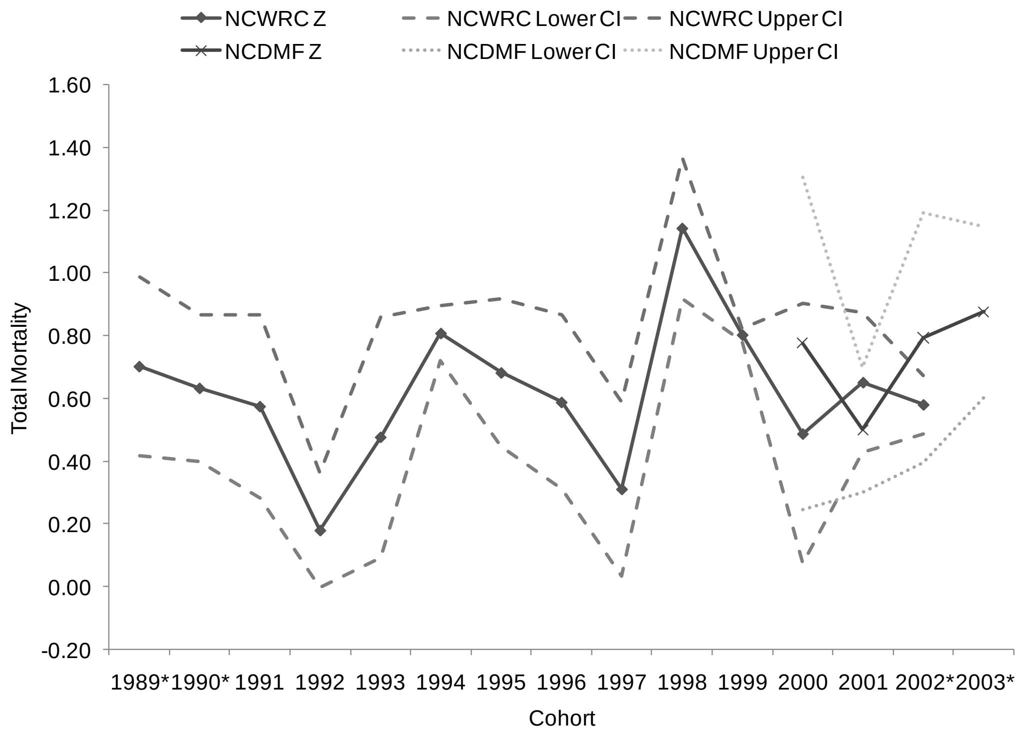

Figure 23. Comparison of the NCWRC spawning grounds survey (labeled NCWRC) and the NCDMF Program 915 survey (labeled NCDMF) estimates of cohort Z and 90% confidence intervals for the Neuse River.
* Denotes incomplete cohort

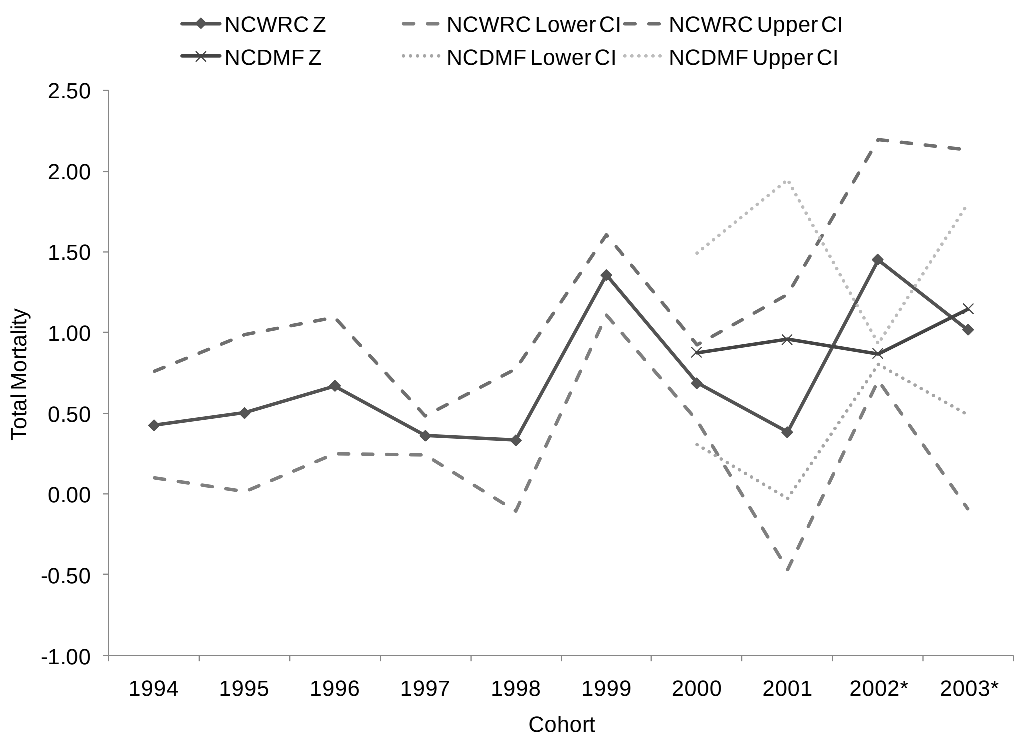

Figure 24. Comparison of the NCWRC spawning grounds survey (labeled NCWRC) and the NCDMF Program 915 survey (labeled NCDMF) estimates of cohort Z and 90% confidence intervals for the Tar/Pamlico River.
* Denotes incomplete cohort

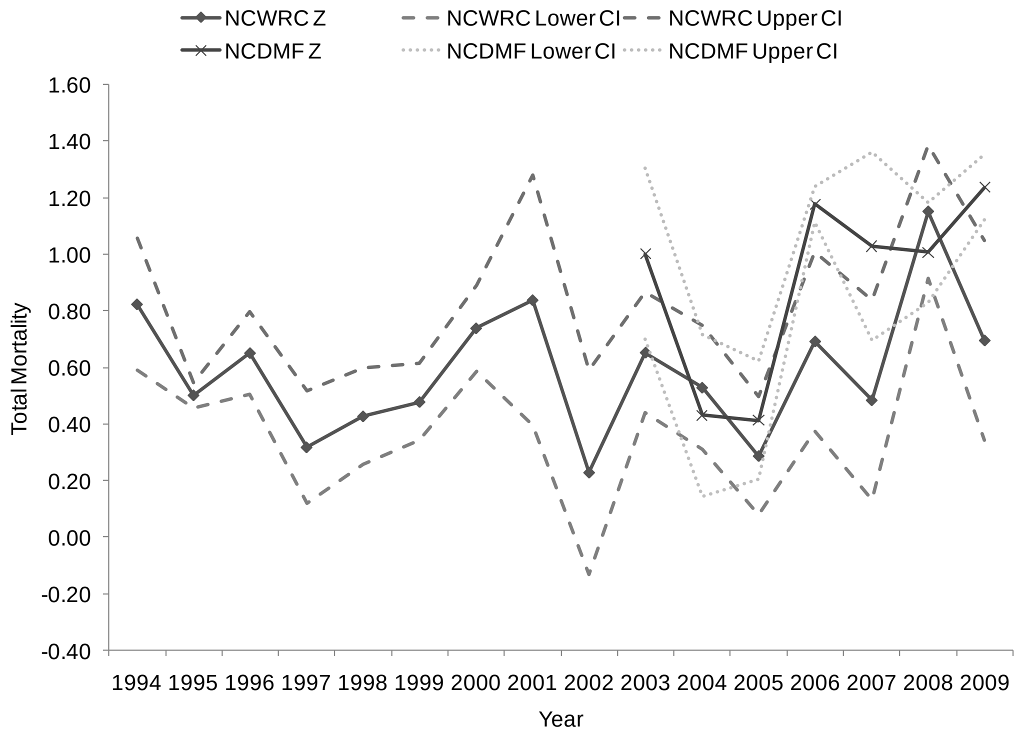

Figure 25. Comparison of the NCWRC spawning grounds survey (labeled NCWRC) and the NCDMF Program 915 survey (labeled NCDMF) estimates of annual Z and 90% confidence intervals for the Neuse River.

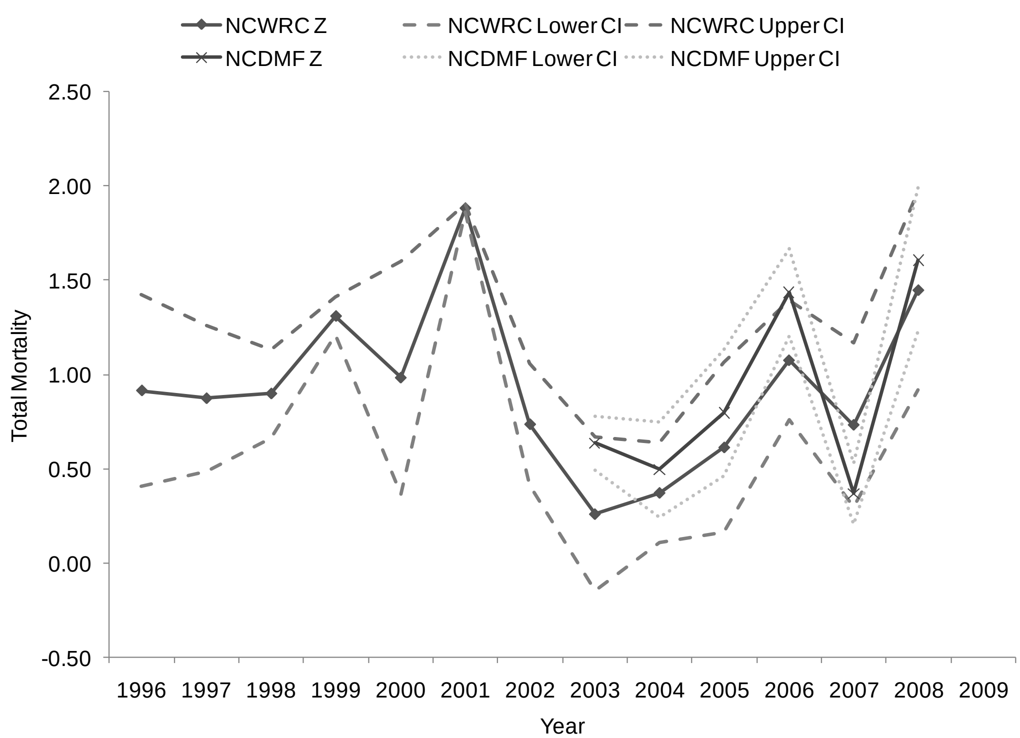

Figure 26. Comparison of the NCWRC spawning grounds survey (labeled NCWRC) and the NCDMF Program 915 survey (labeled NCDMF) estimates of annual Z and 90% confidence intervals for the Tar/Pamlico River.

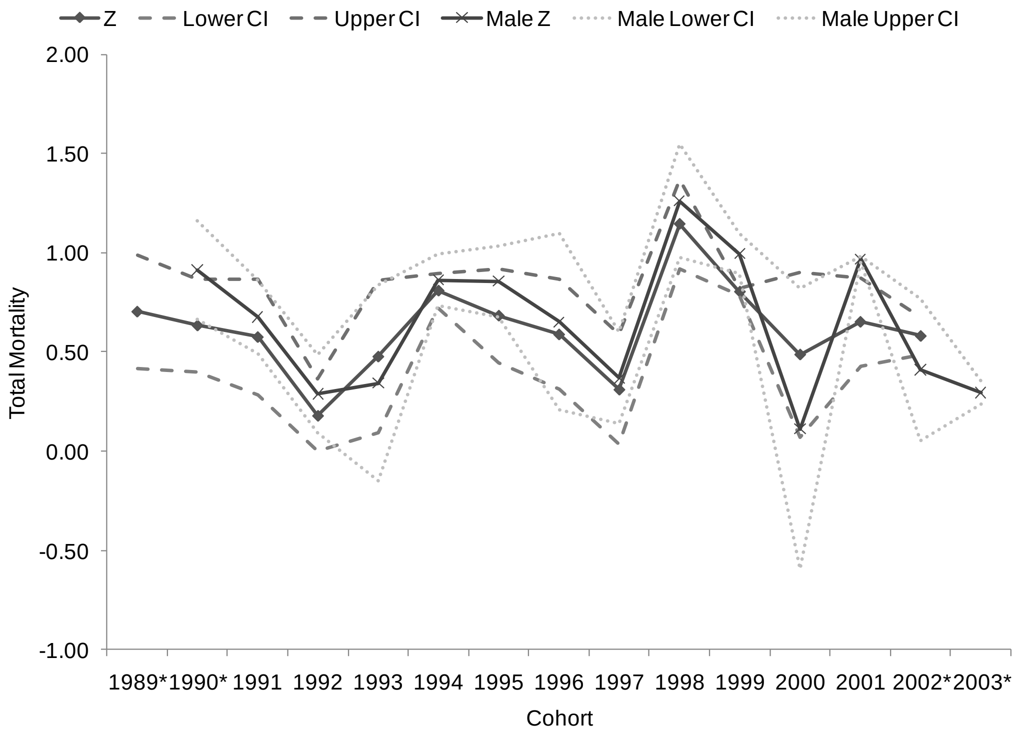

Figure 27. Comparison of the NCWRC spawning grounds survey estimates of cohort Z and 90% confidence intervals for sexes combined (Z) and males only (Zmale) for the Neuse River.
* Denotes incomplete cohort

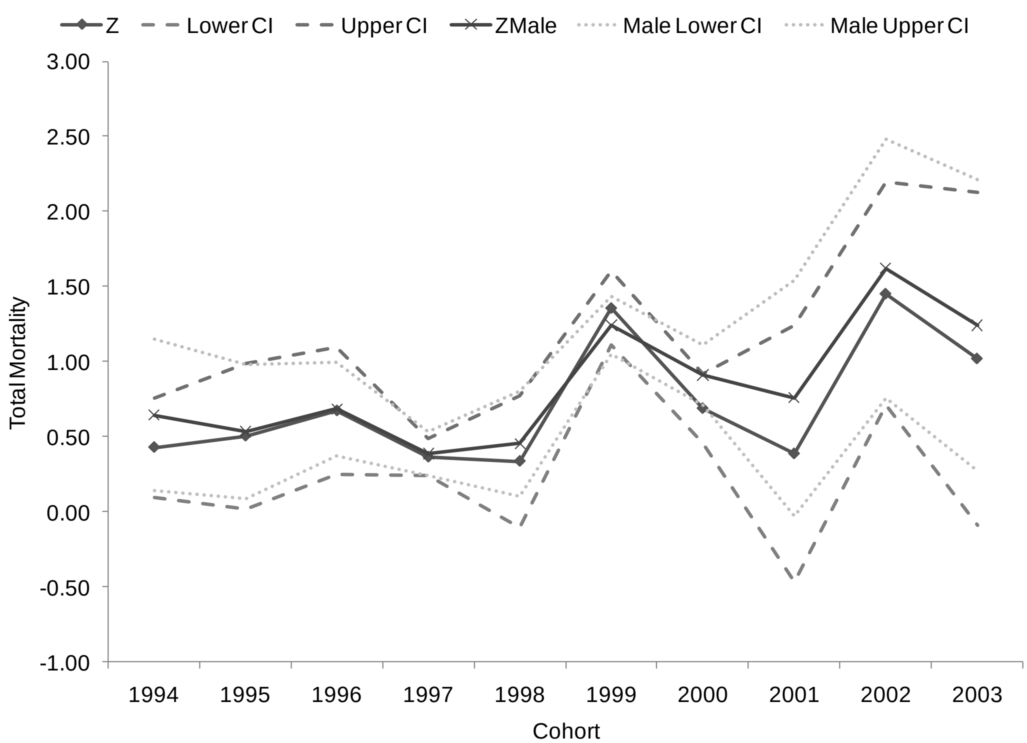

Figure 28. Comparison of the NCWRC spawning grounds survey estimates of annual Z and 90% confidence intervals for sexes combined (Z) and males only (Zmale) for the Neuse River.

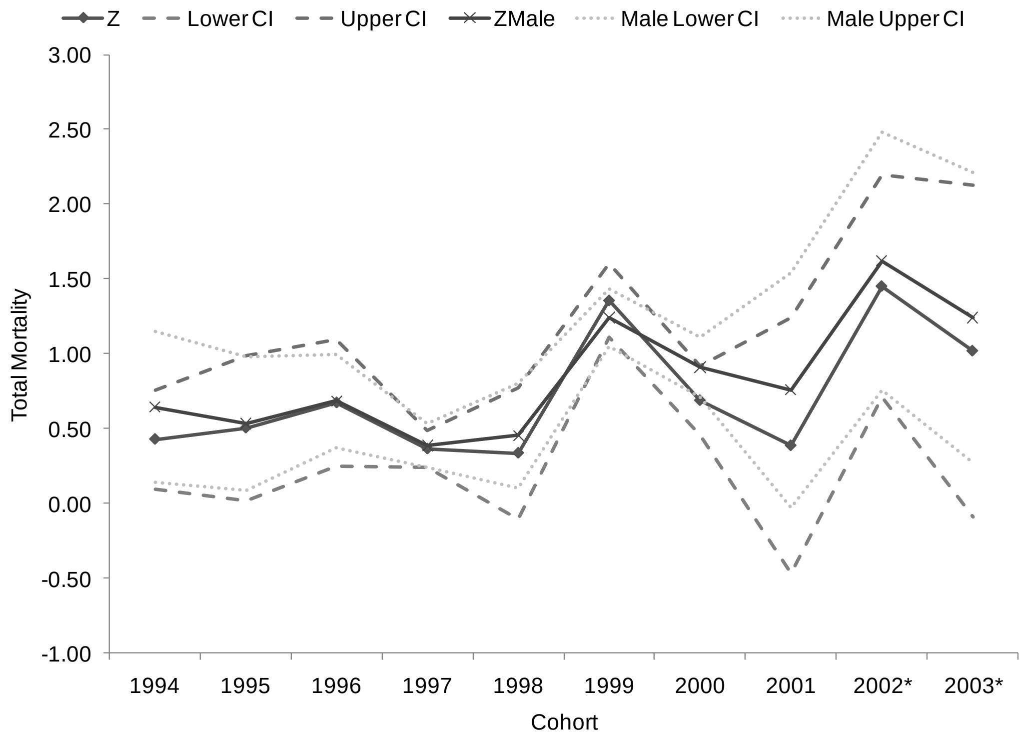

Figure 29. Comparison of the NCWRC spawning grounds survey estimates of cohort Z and 90% confidence intervals for sexes combined (Z) and males only (Zmale) for the Tar River. * Denotes incomplete cohort

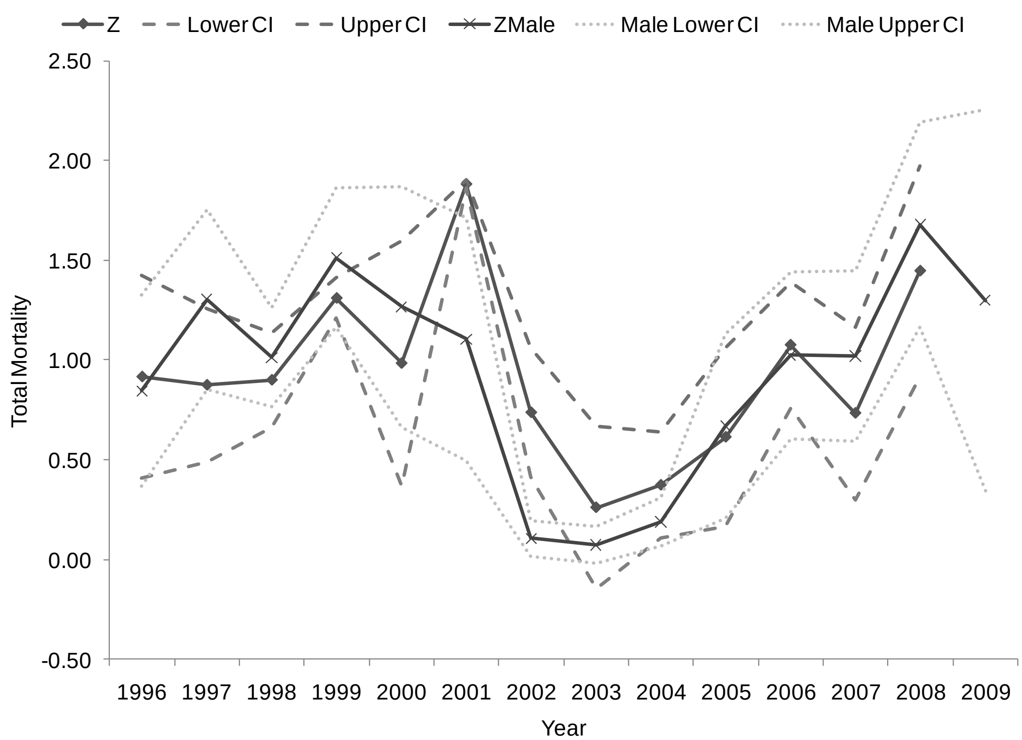

Figure 30. Comparison of the NCWRC spawning grounds survey estimates of annual Z and 90% confidence intervals for sexes combined (Z) and males only (Zmale) for the Tar River.

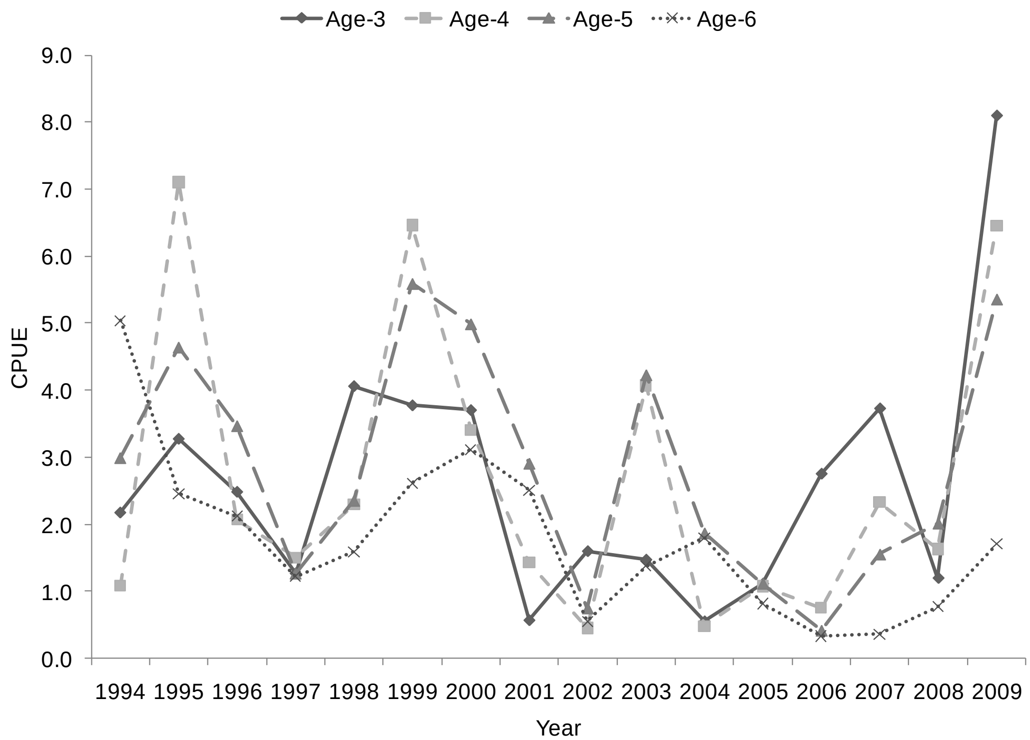

Figure 31. The CPUE at age for ages 3 through 6 for the Neuse River NCWRC spawning grounds survey, 1994–2009.

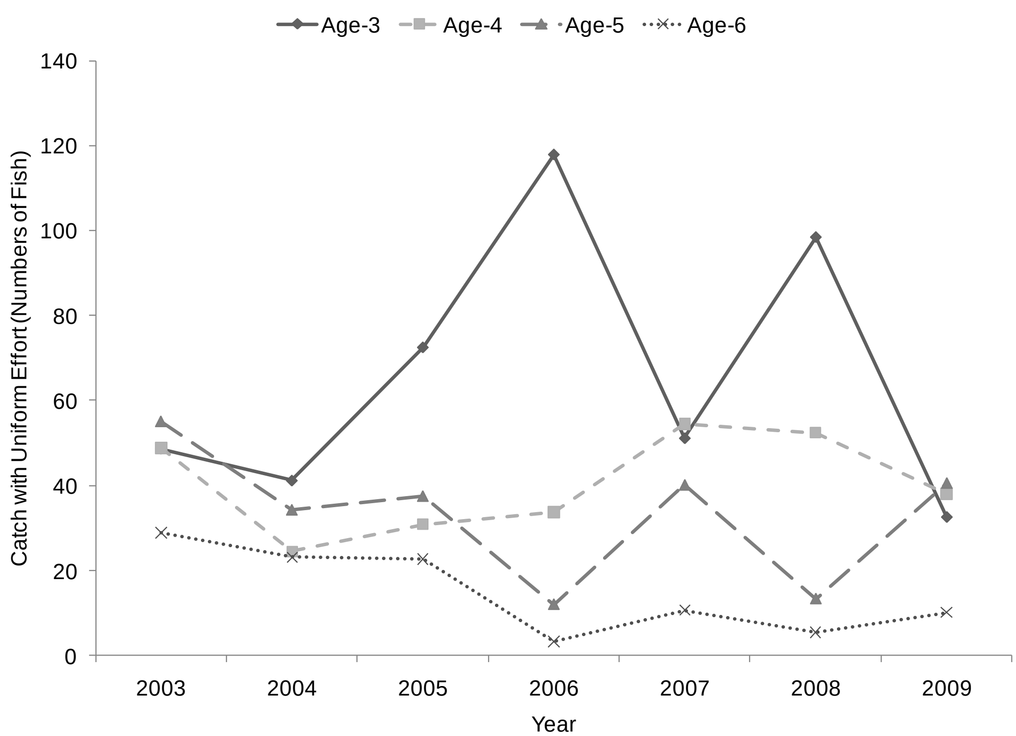

Figure 32. The catch for uniform effort at age for ages 3 through 6 for the Neuse River NCDMF Program 915 survey, 2003–2009.

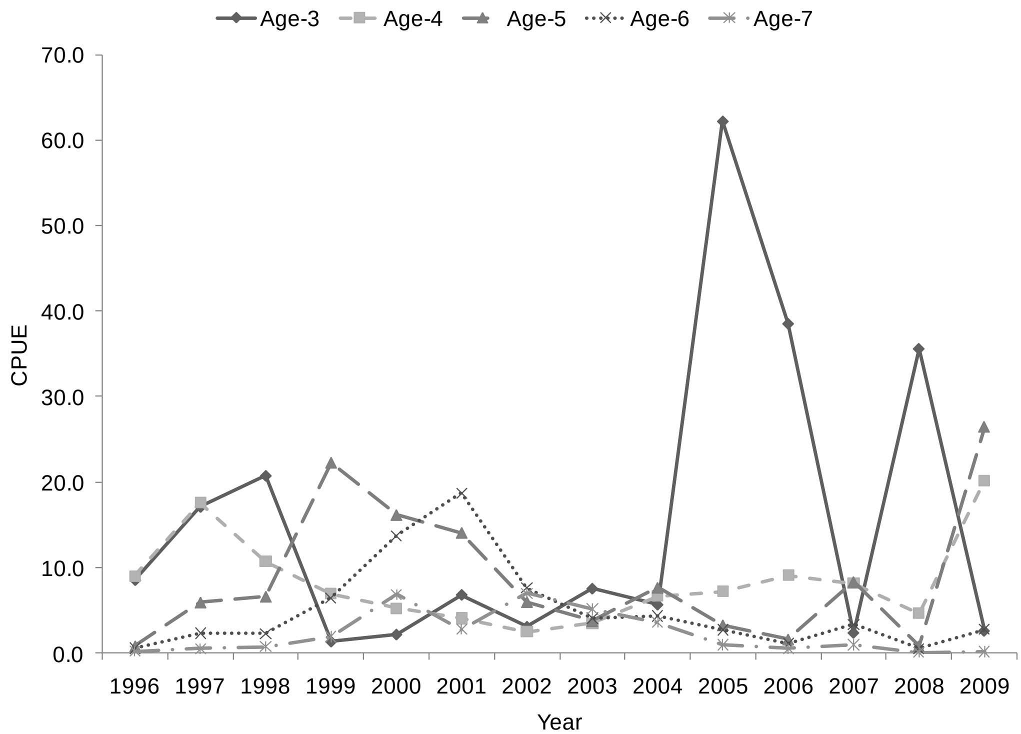

Figure 33. The CPUE at age for ages 3 through 7 for the Tar River NCWRC spawning grounds survey, 1996–2009.

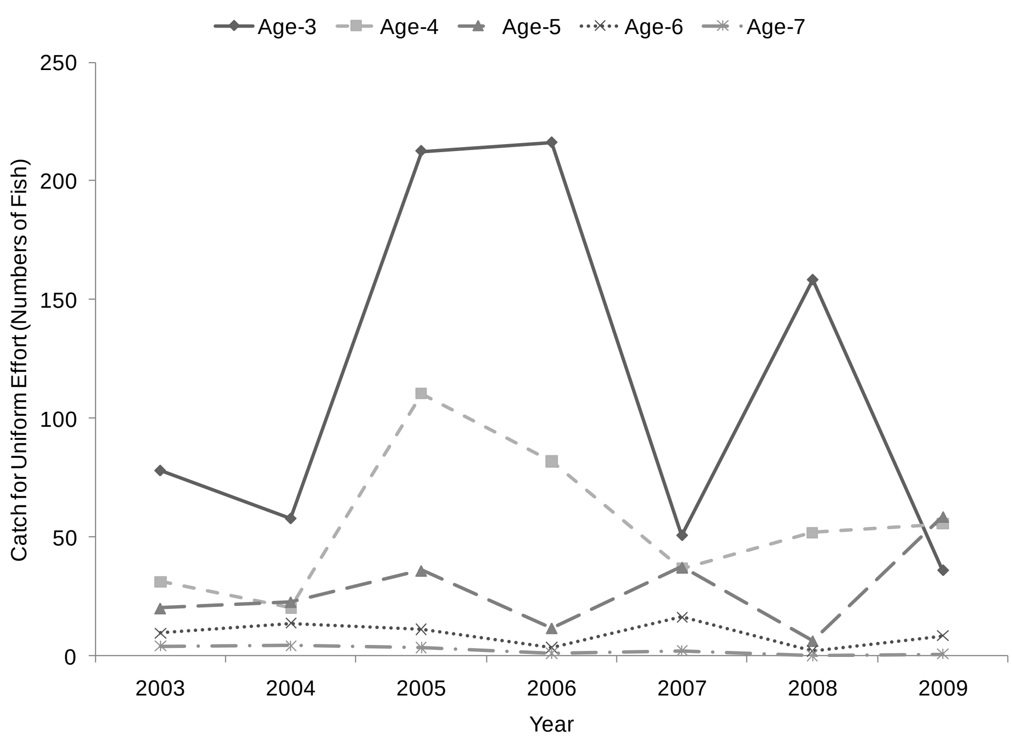

Figure 34. The catch for uniform effort at age for ages 3 through 7 for the Pamlico River NCDMF Program 915 survey, 2003-2009.

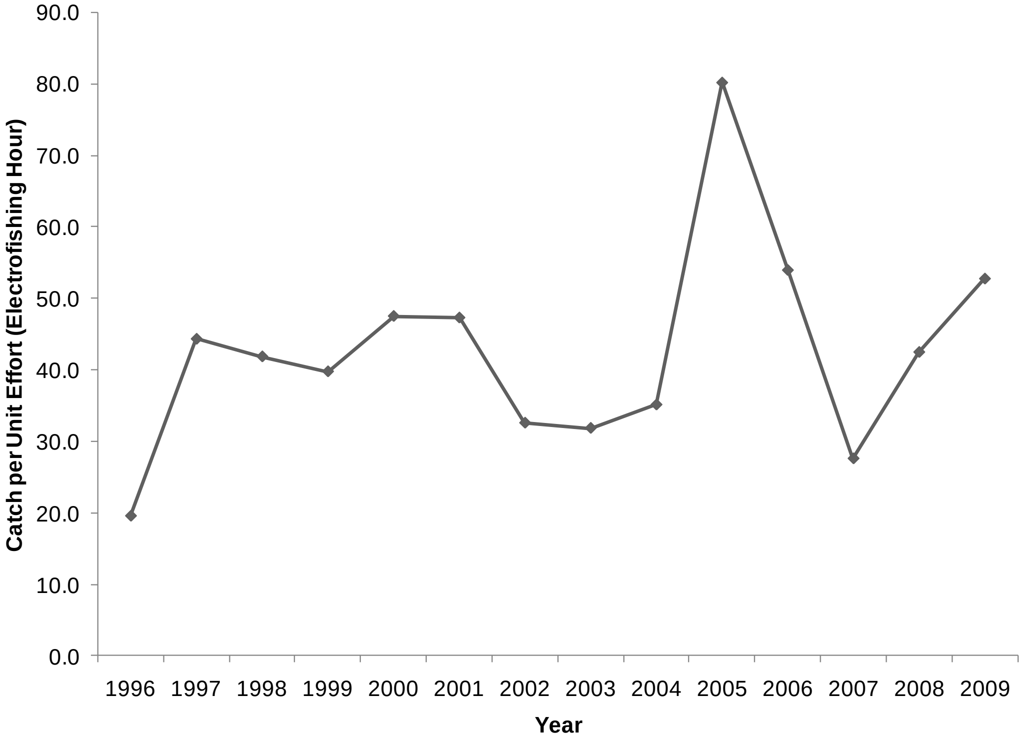

Figure 35. Annual CPUE for the Tar River from the NCWRC electrofishing survey, 1996-2009.

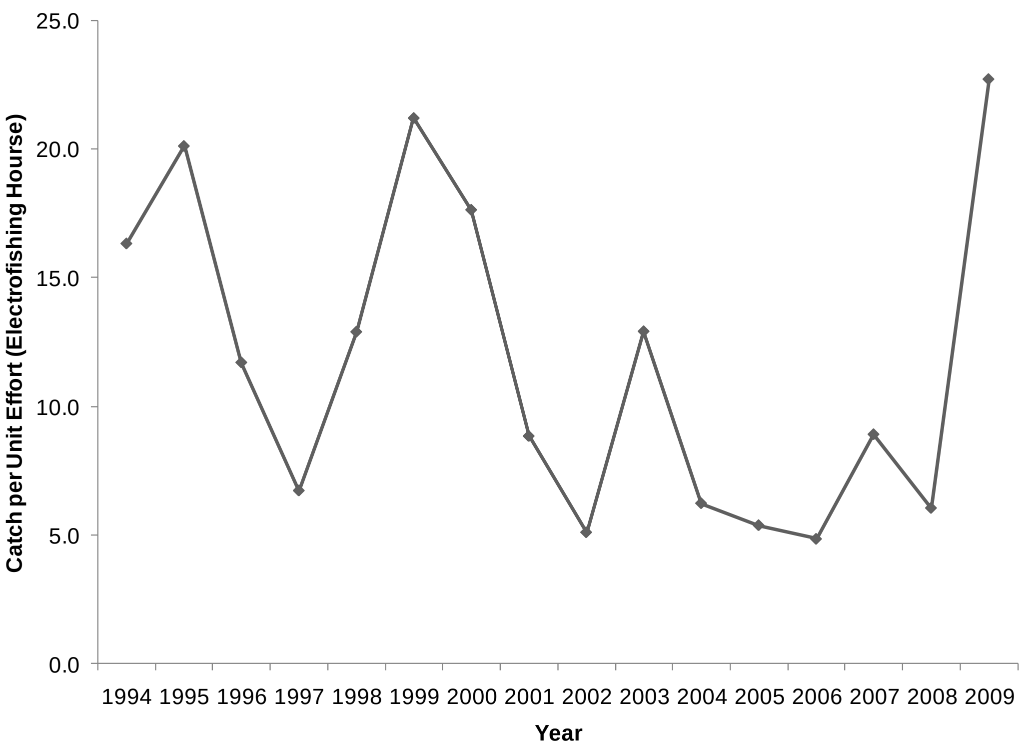

Figure 36. Annual CPUE for the Neuse River from the NCWRC electrofishing survey, 1994-2009.

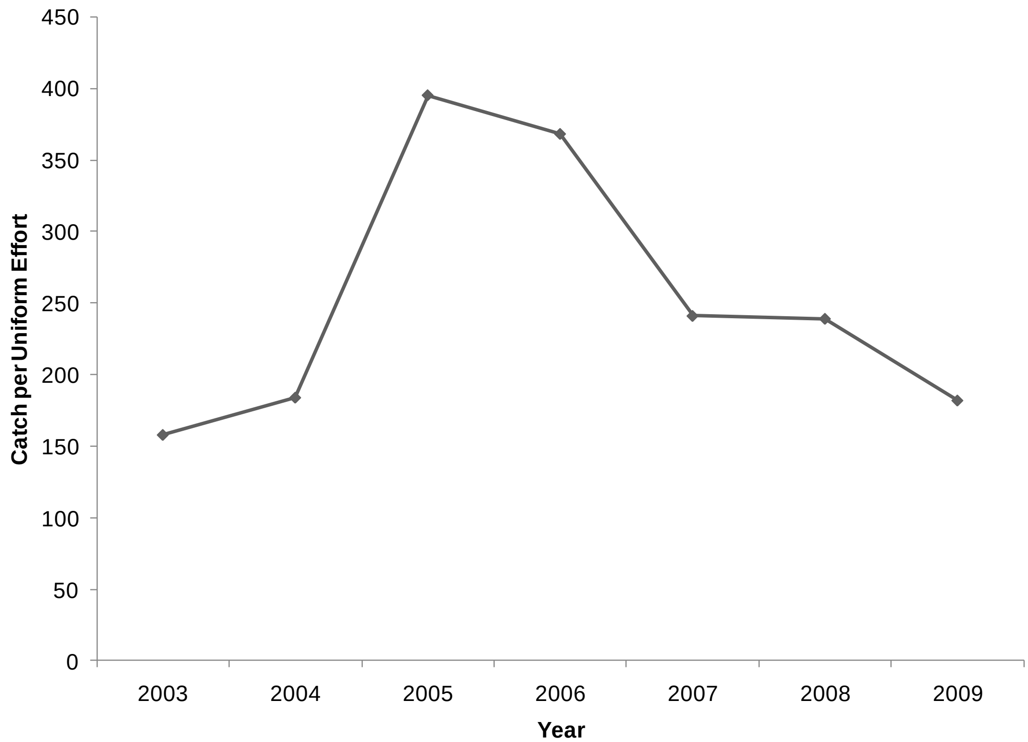

Figure 37. Annual CPUE for the Pamlico River from the NCDMF Program 915, 2003-2009.

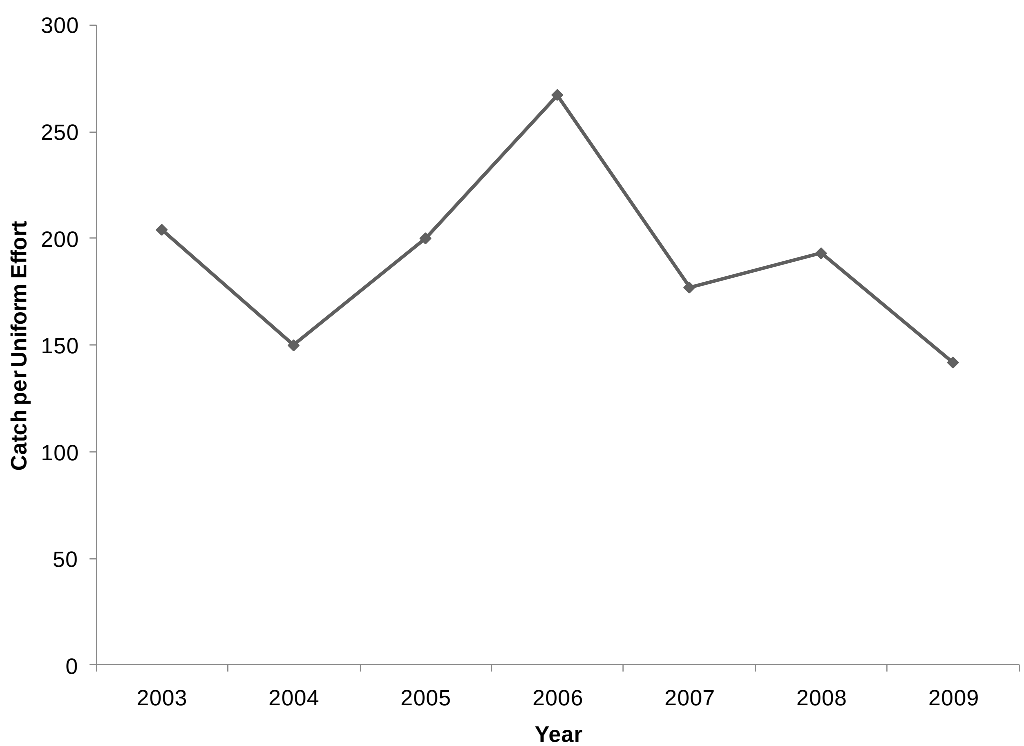

Figure 38. Annual CPUE for the Neuse River from the NCDMF Program 915, 2003-2009.

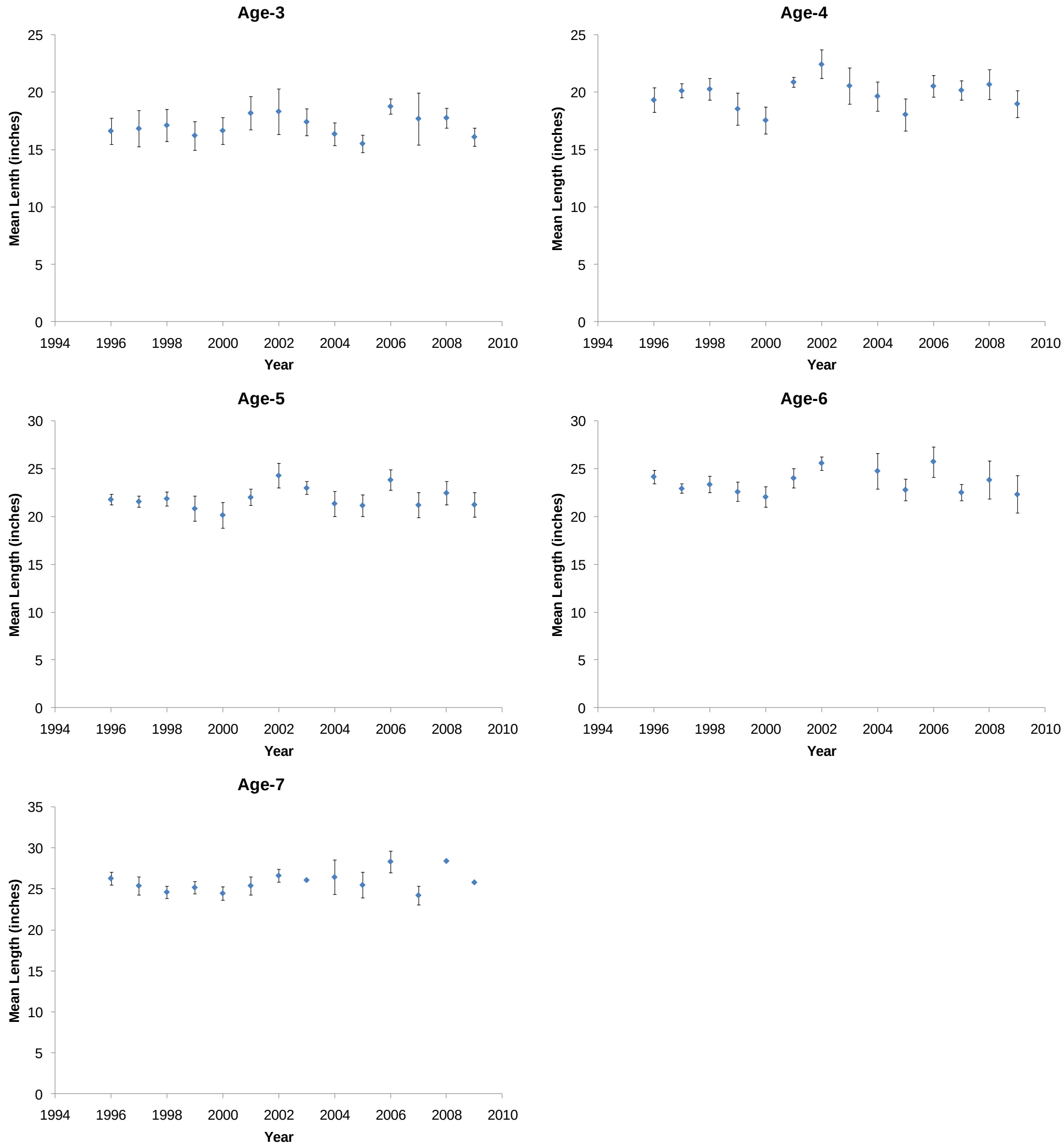

Figure 39. Mean length and standard deviation for ages 3 through 7 for the Tar/Pamlico River NCWRC spawning grounds survey, 1996–2009. Male and female striped bass are combined.

14.8 CENTRAL/SOUTHERN MANAGEMENT AREA (CSMA) STRIPED BASS MANAGEMENT MEASURES, JULY 2007

Central/Southern Management Area (CSMA) Striped Bass Management Measures, July 2007

Issue

The 2004 Estuarine Striped Bass FMP was approved by the Marine Fisheries Commission (MFC) in May 2004 and by the Wildlife Resource Commission (WRC) in July 2004. The FMP specified a number of specific management actions but also allowed for additional data collection in the CSMA prior to determining measures to deal with reducing mortality in the recreational fishery and discards in the commercial large mesh gill net fishery. New data has been acquired and management actions can now be determined. The reduction of mortality in the recreational fishery and from commercial discards are the only issues that are being reconsidered at this time, with other issues having been debated, resolved and approved, by both the MFC and the WRC in the 2004 FMP.

Current Authority

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)
3H .0103 Proclamation Authority of Fisheries Director
3J .0103 Gill Nets, Seines, Identification, Restrictions
3M .0202 Striped Bass Season, Size and Harvest Limit Internal Coastal Waters
3Q .0107 Special Rules, Joint Waters
3Q .0108 Management Plans for Striped Bass in Joint Waters
3Q .0109 Implementation of Striped Bass Management Plans

North Carolina Wildlife Resources Commission Rules
North Carolina Fisheries Rules for Inland Waters (15A NCAC)
10C .0301 Inland Game Fishes Designated
10C .0302 Manner of Taking Inland Game Fishes
10C .0305 Open Seasons Bag and Size Limits

General Background

Data limitations for the CSMA prevented the development of a quantitative assessment of stock abundance, and therefore biological reference targets were based on exploitation rates. The FMP recommended an F target rate of .22 (removal rate of ~20% per year) and a spawning stock biomass (SSB) of no less than 400,000 pounds. While the SSB cannot be determined, exploitation rates on both the Neuse and Tar River stocks were presented in the 2004 FMP based on WRC electrofishing survey data collected from the spawning grounds. From this catch curve analysis, fishing mortality rates in the Neuse and Tar rivers were estimated at F=.84 (53%) and F=1.02 (60%), respectively. To reach F threshold (F=.40) annual mortality would need to be reduced by an estimated 42% on the Neuse and 49% on the Tar. To reach F target (F=0.22) reductions of annual mortality of 61% (Neuse) and 66% (Tar) were needed. The amended FRA allows rebuilding of a stock over a ten-year timeframe so these levels of reductions would be very precautionary. NCWRC biologists have updated the catch curve analysis through 2006 and find that both the Tar and Neuse River stocks are still considered overfished with overfishing taking place. Stock status of the Cape Fear River stock was not determined but is currently at a low level. Current measures are not preventing overfishing and are not expected to provide stock improvement. Total mortality must be reduced substantially to stop overfishing.

The CSMA commercial fishery operates on a 25,000 pound annual quota and minimum size of 18 inches. The fishery has operated as a low harvest level fishery (5 to 10 fish per trip), using set seasons and daily landing limits. In the CSMA recreational fishery in coastal and joint waters the season is open year round with a 3 fish limit per person per day and an 18 inch minimum size. Inland waters require the same measures with the addition of a slot limit (22-27 inch not allowed) during May and April upstream of the Grimesland Bridge on the Tar and Hwy 55 Bridge in Lenoir County on the Neuse.

The following issues and actions for the CSMA are part of the 2004 FMP and are not being reconsidered at this time:

- Commercial Total Allowable Catch (TAC) remains at 25,000 pounds.
- Hybrid striped bass and striped bass by rule are not differentiated (both count toward quotas, creels, etc.).
- Striped bass harvest seasons only in months (October – April) in which cool water temperatures (<70°F) occur and/or only in certain portions if rivers and sounds deemed necessary.
- CSMA boundary line shared with the ASMA remains at status quo.
- Continuing the Phase II striped bass stocking program (all fish OTC marked, portion marked with external tags), with two systems in the C/S Management Area (Tar-Pamlico, Neuse and Cape Fear rivers) being stocked annually, with a goal of 100,000 fish per system.
- Continuing the Phase I striped bass stocking program (all fish OTC marked), with a goal of 100,000 fish per year, per system in the C/S Management Area (Tar, Neuse, and Cape Fear/Northeast Cape Fear rivers) annually.
- Recommendations concerning habitat and water quality.

Recreational measures and actions to reduce discard in the commercial large mesh gill net fishery are the only holdover issues that will be addressed in this paper.

Commercial Fishery

Background

The FMP estimated the dead striped bass discard in the CSMA is approximately 94,000 pounds. The FMP discusses commercial fishery gill net restrictions that have been enacted over the last several years, as a result of the Red Drum FMP and endangered species interactions. Large areas of the Pamlico Sound are closed to gill netting from August 15 – December 15, and other areas have strict permitting and gear restrictions. Attendance is required of gill nets within the upper rivers and within 200 yards of shore in lower river portions. Both dependent and independent DMF gill net data from Pamlico Sound indicates minimal catch rates of striped bass. These rates along with the existing gill net restrictions in Pamlico Sound indicate the gill net fisheries in the Sound are not responsible for significant striped bass bycatch. The 2004 FMP management options focused on reducing striped bass interactions in the rivers. The 2004 FMP preferred management measure is to require 'tie downs' in large mesh gill nets to reduce striped bass bycatch and states the following action:

Rivers - Increase the commercial possession limit to 10 fish per day per commercial fishing operation holder in the rivers during the open striped bass season. Require that gill nets in the shad and flounder fisheries operating in the Pamlico, Pungo and Neuse river areas (west of 76° 30' W long.) be tied down after the striped bass quota is reached and the season closed.

Pamlico Sound - The commercial possession limit would remain at five fish in the Pamlico Sound. Striped bass will be limited to 50% by weight of the total catch, not to exceed five fish per day per fishing operation. Gill nets with a mesh length of 6 inches (stretched mesh) and greater would be prohibited during the striped bass season.

This option is intended to shorten the "directed" striped bass harvest season and impose the tie down provisions to reduce striped bass bycatch after the season closes. This option will be most effective if the tie down provisions essentially eliminate striped bass interactions. Requiring the 50% weight provisions and prohibiting large mesh gill nets in Pamlico Sound will eliminate any directed fishery.

The FMP also directed for the remaining portions of the CSMA to continue commercial striped bass seasons, opening and closing through proclamation and operating under the TAC. This option is intended to allow bycatch of striped bass from gill net fisheries. As data are collected more restrictive measures will be implemented as needed.

The DMF at the time was testing the effectiveness of various tie-down and setting configurations in reducing striped bass bycatch. The results of these studies are now available and provide additional information to evaluate methods to reduce large mesh gill net interactions with striped bass.

DMF Studies on Large Mesh Striped Bass Bycatch (Effects of Gill Net Tie-downs and Distance From Shore on Striped Bass Bycatch in the Spring Shad and Fall Flounder Fisheries**)**

Spring Shad Fishery Methods

Study Site/Personnel

This study was conducted in the Pamlico, Pungo, and Neuse Rivers from March - April 2004, with a total of 19 gill net samples collected. Sampling areas were selected where the target species (shad/striped bass) are commonly caught by gill nets. Sampling locations and fishing days were changed as needed to benefit from fish abundance and sampling conditions. Samples were obtained in a manner that closely mirrored commercial fishing practices and were conducted by Division personnel from the Pamlico District Office.

Description of Net Deployment, Tie-down & Float Gill Nets

Three control nets (float nets) and 3 test nets (2½, 3, and 4 foot tie-down heights) were organized into three pairs of nets, with all nets tied end to end. Control and test nets were set parallel to shore, with approximately half of the samples collected in shallow water (<6 feet) and half of the samples collected in deep water (>6 feet). Shallow water nets were set at an average distance from shore of 390 yards and in a mean water depth of five feet. Deep water nets were set at an average distance from shore of 580 yards and in a mean water depth of 10 feet. In addition to the pairs of control and test nets, an additional float net was set perpendicular and as close to the shoreline as possible. All nets were set to minimize differences in physical influences (i.e. bottom contours and distance from channels). Nets were set in the afternoon and checked in the morning with a target soak time of 12 to 18 hours.

Control nets were float nets without tie-downs (100 yards long by 12 feet, 30 meshes deep, for 400 square yards). Buoys (23 ounces of buoyancy) were hung on the float line every 5 yards. Float line consisted of ¼ inch hollow braided polypropylene, and the weighted lead line was 20 pounds per 600 feet.

Tests nets were sink nets (100 yards by 8 feet, 20 meshes deep, for 240 square yards) with a tie-down placed every 5 yards. Buoys (3 ounces of buoyancy) were hung on the float line every 5 yards. Float line consisted of ¼ inch hollow braided polypropylene and weighted lead line was 30 pounds per 600 feet. The perpendicular test net was a float net without tie-downs (50 yards long by 8 feet, 20 meshes deep, for 120 square yards). Buoys (23 ounces of buoyancy) were hung on the float line every 5 yards. Float line consisted ¼ inch hollow braided polypropylene, and the weighted lead line was 20 pounds per 600 feet.

Control/Test nets: All nets were constructed of number 104 (0.33 mm) diameter monofilament webbing hung on a 1 to 2 ratio with 5½ inch stretched mesh. Each net was inspected for damage upon retrieval, with net damage maintained below 10% of the total surface area.

Processing of Field Samples

The total number of each target species (striped bass and shad), the length measured to the nearest millimeter (FL), and condition of fish were recorded (alive, dead, or spoiled). A group weight was recorded to the nearest 0.1 kg for each target species. Environmental conditions such as temperature (ºC), salinity (ppt), dissolved oxygen (DO), and weather parameters were also recorded. For the purpose of this paper only the numbers (CPUE) of striped bass and shad captured are presented.

Statistical Analysis

For comparison purposes catch rates were converted to the number of fish/100 yards of net/set. This accounted for the differences in net length of the perpendicular net (50 yards) and nets set parallel to shore (100 yards). When comparing the paired nets (controls vs. tie-downs) means were tested using a paired T-Test. ANOVA was used comparing mean capture rates of the shore net versus mean capture rates of all other nets. All data were analyzed using SAS software version 8.0 (Cary, NC).

<u>*Spring Shad Fishery Results*</u>

Striped Bass CPUE

Shallow net sets (Figure 1): ANOVA showed that there was an effect of the type of net used on the catch rate of striped bass in shallow water ($p<0.001$). Pairwise mean comparisons showed there was a significant difference in the CPUE of the perpendicular shore net when compared to all other nets used (all p-values <0.01). On average, the catch ratio of the perpendicular shore net vs. control float nets was 5:1. There was no statistical difference in the CPUE when comparing the tie-downs and the corresponding controls; however tie-downs set in shallow water failed to capture striped bass demonstrating a reduction in catch of 100%.

Deep net sets (Figure 2): ANOVA showed that there was an effect of the type of net used on the catch rate of striped bass in deep water ($p<0.001$). Pairwise mean comparisons showed there was a significant difference in the CPUE of the perpendicular shore net when compared to all other nets used (all p-values <0.002). Mean CPUE ratios when comparing the perpendicular shore net to other test nets were approximately 9:1 (shore net vs. controls) and 46:1 (shore net vs. tie-downs). There were statistical differences in the CPUE when comparing the 2½’ and 4’ tie-downs to the corresponding controls ($p=0.03$). No statistical difference in catch was found when comparing the 3’ tie-down and its corresponding control. Virtually no striped bass were captured in any control or test nets set in deep water.

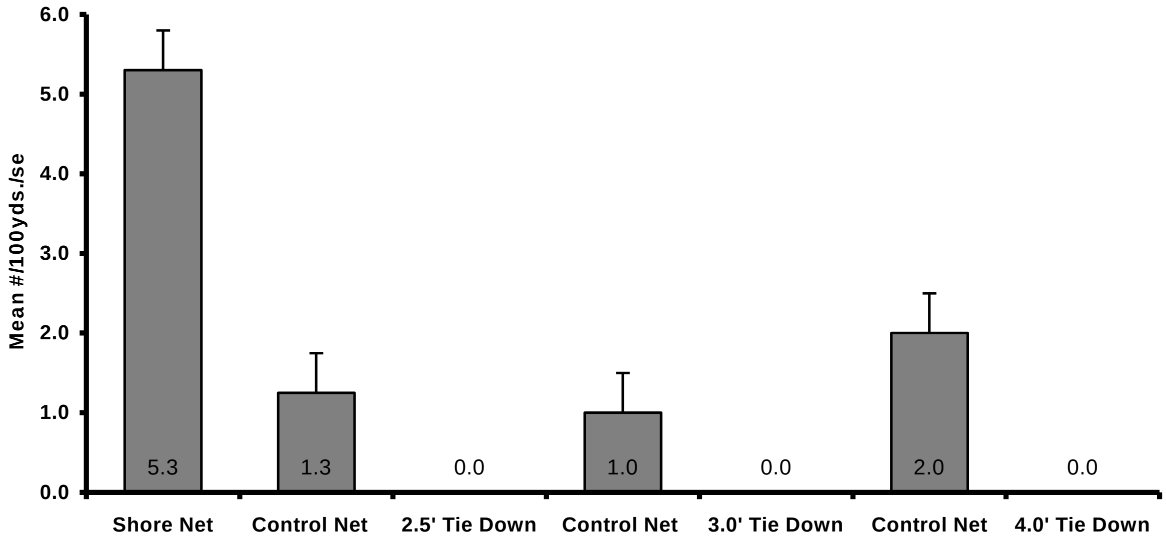

Figure 1. Striped bass CPUE for shallow water sets. A total of eight shallow water samples were collected that captured 84 striped bass.

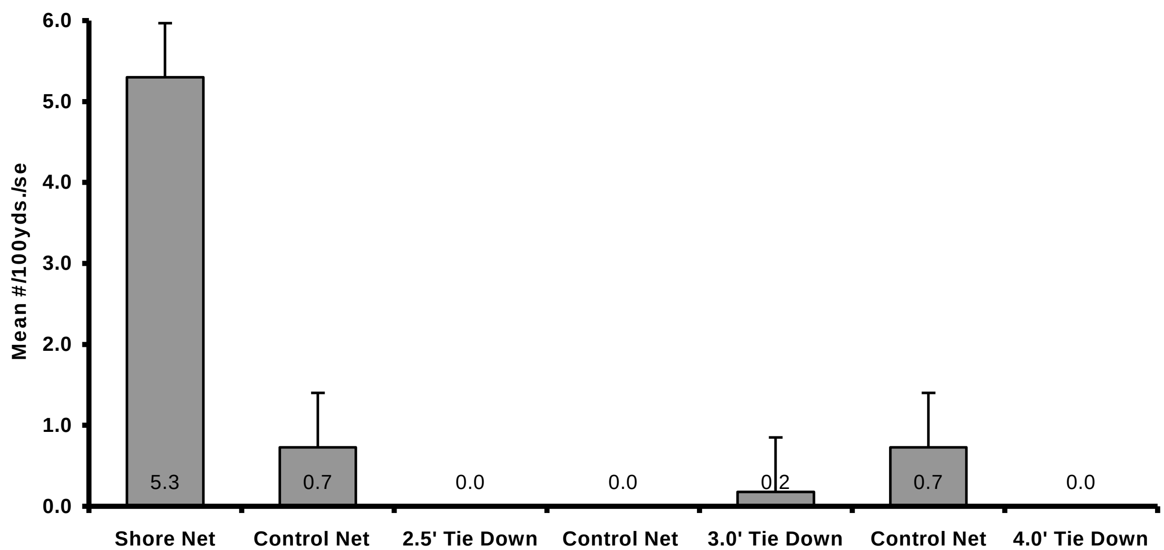

Figure 2. Striped bass CPUE for deep water sets. A total of eleven samples were collected that captured 68 striped bass.

Shad CPUE

Shallow net sets (Figure 3): ANOVA showed that there was no treatment effect of net type on the catch rate of shad in shallow water (p=0.64). All nets yielded low CPUE that indicates this species does not utilize shallow water near shore habitat. Two and a half and 3' tie-downs had similar catch rates when compared to the corresponding control nets, in contrast the 4’ tie-down demonstrated a 74% reduction in catch. CPUE ratios for paired test nets were approximately 1:1, 1:1, and 3:1 for the 2½’, 3’, and 4’ tie-downs vs. their corresponding controls, respectively. On average, the CPUE ratios when comparing the perpendicular shore net to other test nets were approximately 1:2 (controls) and 1:1 (tie-downs).

Deep net sets (Figure 4): ANOVA showed that there was an effect of net type on the catch rate of shad in deep water (p=0.01). However, pairwise comparisons yielded no significant difference in the CPUE of the perpendicular shore net when compared to all other nets used (all p<0.02). On average, catch ratios when comparing the perpendicular shore net vs. other test nets were approximately 1:5 (controls) and 1:1 (tie-downs). There was a significant difference in CPUE when comparing the 2½’ tie-down and the corresponding control (p=0.02), this comparison yielded a 96% reduction in catch and a catch ratio of 24:1 (control vs. tie-down). Although not significantly different, catch ratios for the other paired test nets were approximately 3:1 and 4:1 for the 3’ and 4’ tie-downs vs. their corresponding controls, respectively.

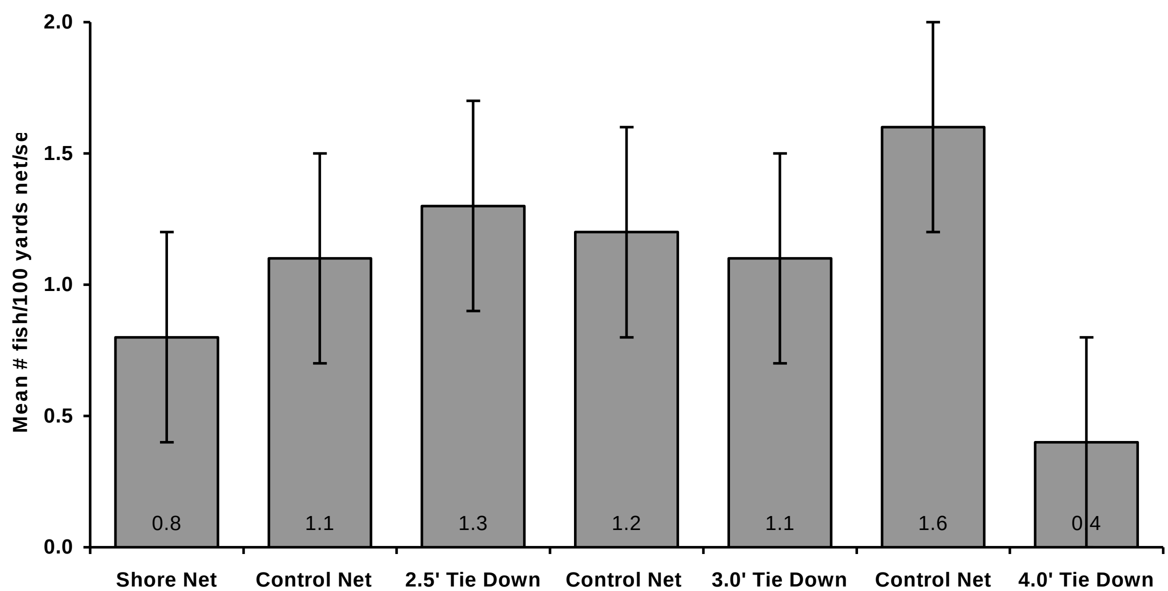

Figure 3. Shad CPUE for shallow water sets. A total of eight samples were collected that captured 74 shad.

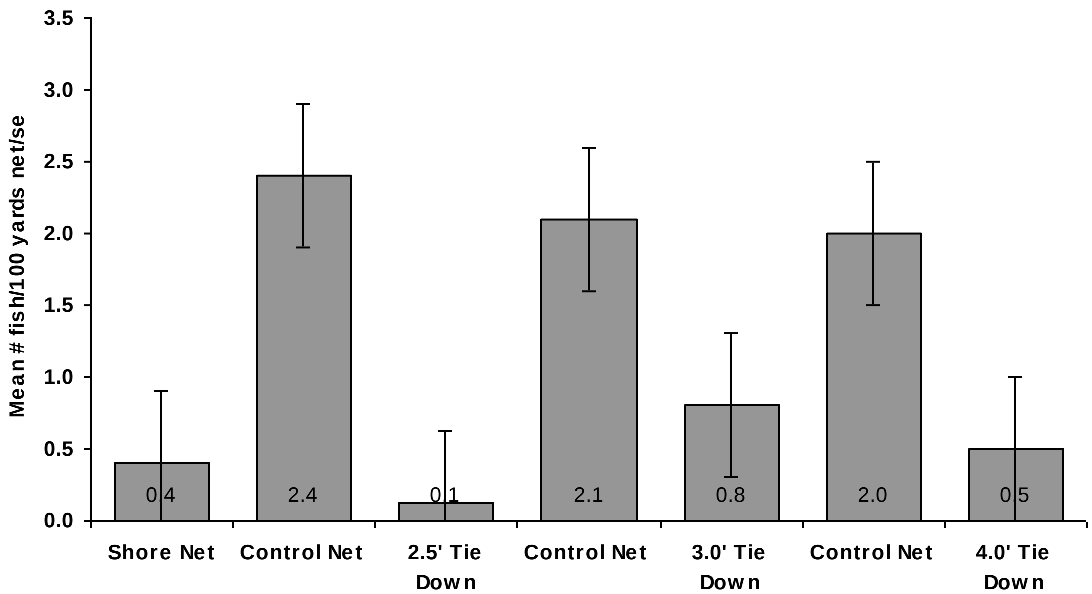

Figure 4. Shad CPUE for deep water sets. A total of eleven samples were collected that captured 89 shad.

In summary, independent sampling of the spring shad fishery indicated:

- Distance from shore is a significant factor in striped bass catch rates.
- Tie-downs decrease the amount of striped bass captured. During this study a total of only two striped bass were captured in tie-downs or 1% of the total striped bass catch.
- Tie-downs decrease the amount of shad captured in deep water sets. On average, tie-downs decreased shad CPUE 80% when compared to controls.

Fall Flounder Fishery Methods

Study Site/Personnel

This study was conducted in the Pamlico, Pungo and Neuse Rivers from August through October 2004, with a total of 22 gill net samples collected. Sampling areas were selected where the target species (flounder/striped bass) are commonly caught by gill nets. Sampling locations and fishing days were changed as needed to benefit from fish abundance and sampling conditions. Samples were collected by Pamlico District Division personnel in a manner that closely mirrored commercial fishing practices.

Description of Net Deployment, Tie-down & Float Gill Nets

Two separate pairs of nets consisting of two control nets (float nets) and two test nets (3 foot tie-down height) were utilized. The float and tie-down in each pair were set end-to-end and parallel to the shoreline. One pair was set at a distance from shore of 50 yards, and the other pair set at a depth of 6 feet. In addition to the paired control and test nets, an additional float net was set perpendicular and as close to the shore as possible. All nets were set to minimize differences in physical influences (i.e. bottom contours and distance from channels), and eliminate interactions between nets. Nets were set in the afternoon and checked in the morning with a target soak time of 12 to 18 hours.

Net Construction and Processing of Field Samples

Net Construction and Processing of Field Samples was identical to the methods described in the spring shad fishery, with the exception that all nets tied down in the fall flounder fishery were tied down to a height of three feet.

Statistical Analysis

For comparison purposes catch rates were converted to the number of fish/100 yards of net/set. This accounted for the differences in net length of the perpendicular shore net (50 yards) and nets set parallel to shore (100 yards). ANOVA was used to test the effect of treatment (type of net) on the catch rates of both flounder and striped bass, as well as test all pair wise comparisons between the perpendicular shore net and all other test nets. When comparing the paired nets (controls vs. tie-downs) means were tested using a paired T-Test. All data were analyzed using SAS software version 8.0.

Fall Flounder Fishery Results

Striped Bass CPUE

ANOVA demonstrated there was an effect of net type on the catch rates of striped bass ($p<0.001$)(Figure 5). Pairwise mean comparisons showed there was a significant difference in the CPUE of the perpendicular shore net when compared to all other nets used (all p-values <0.01). Mean CPUE ratios when comparing the perpendicular shore net to other test nets were approximately 3:1, 7:1, 7:1, and 40:1, for the control at 50 yards, tie-down at 50 yards, control at 6 feet, and tie-down at 6 feet, respectively. There was no statistical difference in mean catch rates of either tie-down type when compared to the corresponding control net. CPUE ratios for paired test nets were approximately 2:1 and 6:1 for control nets when compared to the corresponding tie-downs set at 50 yards and in 6 feet of water, respectively.

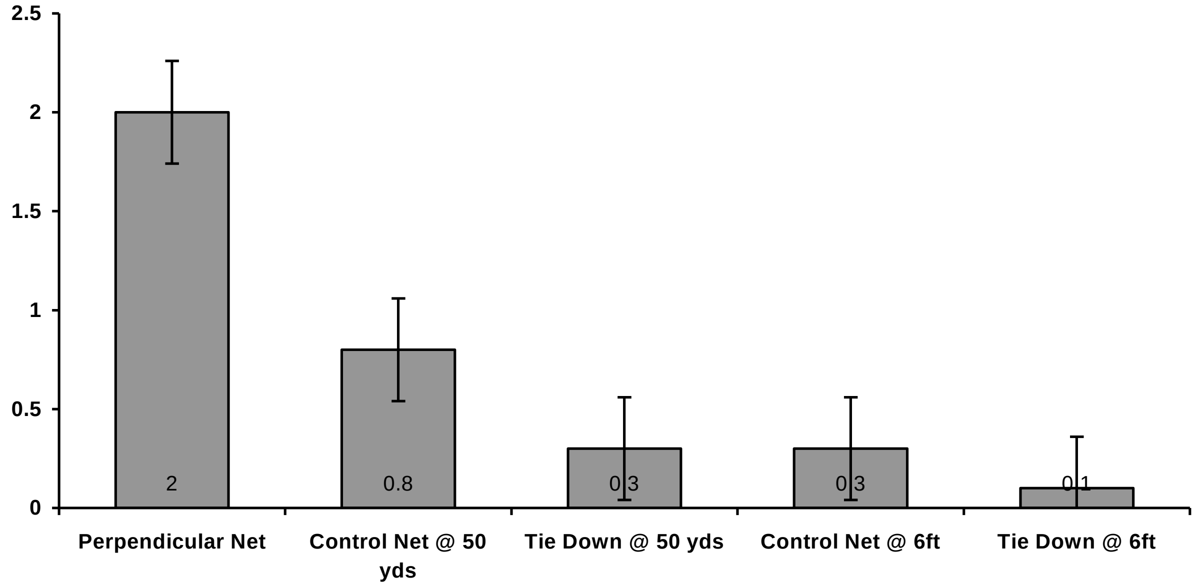

Figure 5. Striped bass CPUE for all nets. Twenty-two sets were sampled that captured 53 striped bass.

Southern Flounder

There was no effect of net type on the catch rates of flounder (p=0.61). Pairwise mean comparisons showed no significant difference in the CPUE of the perpendicular shore net when compared to all other nets used (all p-values =1.0)(Figure 6). Mean CPUE ratios when comparing the perpendicular shore net to other test nets were approximately 1:2, 1:2, 1:1, and 1:1 for the control at 50 yards, tie-down at 50 yards, control at 6 feet, and tie-down at 6 feet, respectively. There was no statistical difference in mean catch rates of either tie-down type when compared to the corresponding control net; however catch rate with respect to the 3' tie-down and corresponding control were virtually equal. In contrast, there was a 26% decrease in catch when comparing the control net vs. the tie-down set in 6 feet of water.

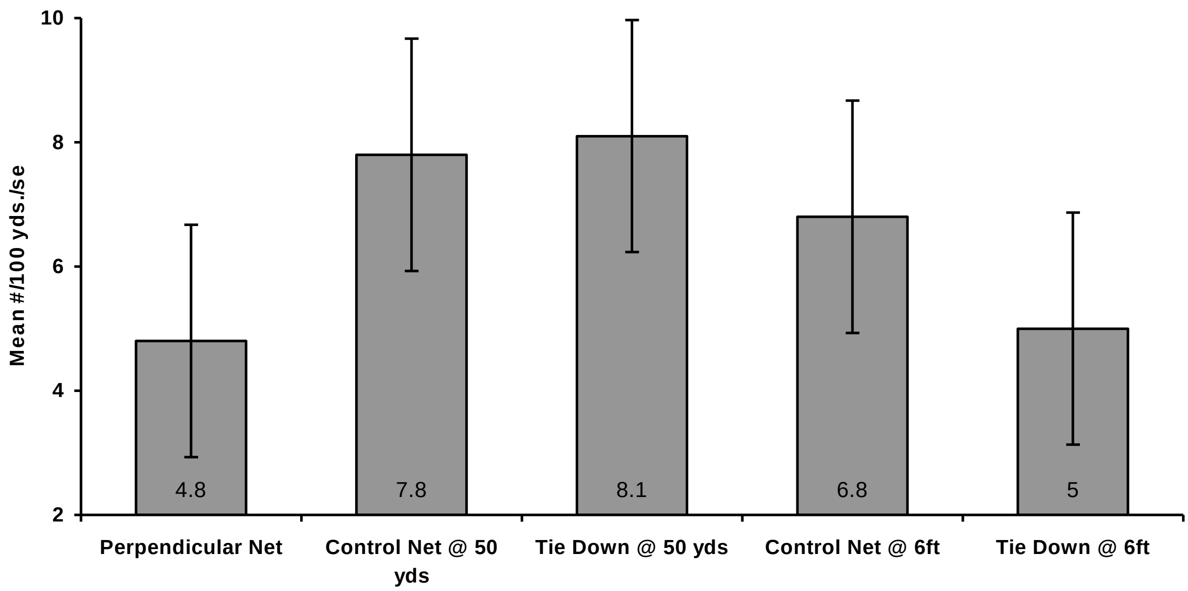

Figure 6. Flounder CPUE for all nets. Twenty-two sets were sampled that captured 663 flounder.

In summary, independent sampling of the fall flounder fishery indicated:

- Distance from shore is a significant factor in striped bass catch rates.
- Tie-downs decreased the amount of striped bass captured. When comparing the shore net vs. tie-downs set at a DFS of 50 yards and a depth of six feet striped bass catch rates were reduced 85% and 97%, respectively.
- Tie-downs do not decrease flounder catch rates at a distance from shore of 50 yards. Tie-downs demonstrated a 4% increase in catch rate when compared to the control.
- Tie-downs decreased flounder catch rates at a water depth of 6 feet. Tie-downs demonstrated a 26% reduction in catch when compared to the control. In addition, there was a 38% reduction in catch when comparing the tie-down set at 50 yards to the tie-down set at 6 feet.

Fisheries Resource Grant (FRG) Studies on Large Mesh Striped Bass Bycatch

Project No. 04-FEG-03 titled "Effects of gill net tie-downs on fish and bycatch rates associated with American Shad and flounder fisheries in southeastern North Carolina" was conducted in the Cape Fear River and compared finfish catch rates in tie-down nets versus control nets. All nets tested were of a sink net variety with statements made of "It would be expected that catch rates would be significantly different between sinking tie-down gillnets and float gill nets given the latter fishes much larger portion of the water column as well as a different part of the water column" and "significantly higher catch rates of American shad were observed in the float gillnets and a restriction on these gillnets would have a deleterious impact on the target species".

Flounder Fishery
Five tie-down nets heights 18, 24, 36, 48 and 60 inches and six control nets were utilized. All nets were 5-6 inch stretched mesh and 100 yards long. From May – September 2004, eight

monthly trips were scheduled resulting in a total of 40 trips and 548 gillnet sets. Results showed that flounder catch rates were unaffected by the type of net used, with similar catch rates in gill nets with and without tie-downs.

Shad Fishery
Five tie-down nets heights 18, 24, 36, 48 and 60 inches and eight control nets were utilized. All nets were 5-6 inch stretched mesh and 100 yards long. From January – April 2005, ten monthly trips were scheduled resulting in a total of 40 trips. Although this study yielded no statistical differences in shad and striped bass catch rates with respect to gill nets with and without tie-downs, results showed that tie-down decreased shad and striped bass catch rates by 31% and 47%, respectively.

Project No. 99-FEG-34 titled "Migratory bycatch in submerged v/s floating shad gill nets" conducted in the Albemarle Sound compared catch rates in floating nets versus nets submerged three feet below the surface. All nets consisted of 5½ inch stretched mesh. Total yardage of net fished was not specified, with nets fished during the 2000 shad season and for a total of 89 days between January 1 – April 15. Results demonstrated float nets captured 1,087 striped bass of which 853 (78%) were captured alive. Submerged gill net captured 734 striped bass of which 619 (84%) were captured alive. This study showed submerged gill net reduced striped bass bycatch by 33% and increased survivability by 27%, with striped bass mortality low in both types of net.

Project No. 01-FEG-15 titled "Catch comparison of three gill net designs in the N.C. flounder gill net fishery" was conducted in Core Sound, Jarretts Bay, and North River, all located in Carteret County. This study compared catch rates of flounder and bycatch with respect to three shallow water test nets, two float nets and one sink net. All nets consisted of 6 inch stretched mesh. Total yards of net fished was not specified, with nets fished during the 2000 shad season and for a total of 89 days between January 1 – April 15. Two-hundred yards of each net was sampled and a total of 72 trips were taken. Results demonstrated on average that sink net flounder catch rates were 14% higher than flounder catch rates in float nets (486 lbs vs. 418 lbs). Although no striped bass were sampled the sink net accounted for only 14% of the total finfish bycatch.

<u>Commercial Large Mesh Gill Net Management Options and Impacts</u>

A Status quo
- \+ No rule changes
- \+ Striped bass bycatch reduced due to southern flounder FMP regulations implemented in 2006 (5½ mesh and 14 inch size limit).
- \- Continued over-harvesting a overfished stock
- \- Not permitted by the FRA requirement
- \- Deviation from the 2004 Striped Bass FMP

B Three foot tie-down regulation only
- \+ Reduction in striped bass bycatch in nets set in water greater than three feet deep.
- \- No reduction in striped bass bycatch when nets are relocated to water depths

equal to or less than three feet.
- Financial cost of gear modification

C Six foot depth restriction only
+ Reduction in striped bass bycatch up to 85%
+ No financial cost of gear modifications
- Unrestricted net height can fish the entire water column

D Minimum Distance From Shore Regulation (MDFSR) of 50 yards
+ Reduction in striped bass bycatch up to 60%
+ No reduction in shad landings
+ No cost for gear modifications
+ No reduction in flounder landings during most of the year
- Possible loss of flounder landings during anoxic conditions
- Possible effect on landings in other fisheries
- Allows for entire water column to be fished

E MDFSR of 50 yards + 3' tie-down regulation from closure of striped bass season to December 31st
+ Reduction in striped bass bycatch up to 85%
+ No reduction in flounder landings during most of the year
+ Minimal reduction in shad landings (striped bass season 5 fish/day)
- Possible loss of flounder landings during anoxic conditions
- Financial cost of gear modifications
- Major reduction in shad landings (striped bass season 10 fish/day)

The projected loss in the shad fishery for a striped bass season of 5 fish per day would be 13% or ~5,500 lbs valued at $3,800. The projected loss with a striped bass season of 10 fish per day (using an average reduction in season time span of 50%) would increase the projected loss to 36% in landings or ~15,200 lbs at $11,000.

F MDFSR of 50 yards + 3' tie-down regulation from closure of striped bass season to December 31st, with the exception that RCGL holders can set large mesh net within 50 yards of shore if attended at all times.
+ Reduction in striped bass bycatch up to 85%
+ No reduction in flounder landings during most of the year
+ Minimal reduction in shad landings (striped bass season 5 fish/day)
+ Minimize impact to RCGL holders (minimal contributors)
- Possible loss of flounder landings during anoxic conditions
- Financial cost of gear modifications
- Major reduction in shad landings (striped bass season 10 fish/day)

G In conjunction with the MDFSR of 50 yards + 3' tie-down regulation, impose a seasonal 6' depth restriction
+ Virtual elimination of striped bass bycatch up to 95% when float nets prohibited
- Reduction in shad landings

- Reduction in flounder landings up to 38%
- Financial cost of gear modifications

In addition to negative economic impacts mentioned in options E-G, test results show this option may reduce flounder catch rates up to 38%. Since 2000 the average total river flounder landings is 301,907 lbs valued at $476,459. A 38% annual loss would average 118,000 lbs valued at $186,000. Again, during warmer months (i.e. July and August) commercial fisherman follow flounder that have left the deeper anoxic water into shallow near shore environment. This fact would certainly increase the projected 38% loss to the flounder fishery if this option were to be implemented year round.

For additional information concerning prior evaluations of commercial management options for the CSMA refer to Section 10.4.3 in the 2004 FMP.

Recreational Fishery

Survey Overviews

Hook and Line Background and Sampling Methods

Coastal striped bass (*Morone saxatilis*) populations support a popular and economically important recreational fishery in North Carolina. Recreational harvest data were lacking in the Central/Southern Management Area (CSMA) where the stock was listed as overfished in 2003. The 2004 North Carolina Estuarine Striped Bass Fishery Management Plan addressed this issue by calling for assessments of the fishery in the CSMA. A comprehensive creel survey was initiated in January 2004 to quantify the recreational component of striped bass harvests in the major portion of the CSMA. The Cape Fear River was not included. Therefore, the area covered by the study is labeled Central Management Area (CMA) and the Cape Fear River system is labeled SMA (Southern Management Area). The CMA survey has continued uninterrupted and is currently in the fourth year (2007) (Murauskas and Mumford 2006).

The survey area included the Neuse, Tar/Pamlico, and Pungo rivers (Figure 7). A non-uniform probability stratified access-point survey was used for site selections as well as effort and catch estimation. Returning fishing parties were interviewed to obtain information regarding the trip, catch, and socioeconomic attributes of striped bass anglers. Survey results were expanded to estimate total striped bass catch and effort in the CMA. Demographic parameters were reported as a percentage of total observations. Mean trip expenditures were reported and expanded by total effort to determine an estimated value of the striped bass fishery in the CMA.

Other creel surveys in the CSMA have been conducted recently by NCWRC personnel. Recreational fishing metrics in the Neuse/Trent River (2002/03; Rundle et. al. 2004), Tar/Pamlico (2004/05; Homan et. al. 2006), and Cape Fear (2003/04; Ashley and Rachels 2005) rivers were all analyzed in a similar manner to the aforementioned survey. Aside from sampling intensity and assignment of probabilities, the methodology used in the NCWRC creel surveys for determining catch, effort and harvest estimates was identical to the current 4-year CSMA creel survey. However, data from the comprehensive creel survey in the CSMA provides greater precision (overall total catch PSEs ~ 15,Table 1) and a longer time series for more adequate analysis. For this reason, the CSMA creel survey will be used in the analysis of regulations and their potential impacts.

Table 1. Overview of CSMA striped bass creel survey, estimated trips, harvest, and total catch 2004-2006. Proportional standard error in parentheses.

Year	Trips	Harvest	Total Catch
2004	10,448 (9)	6,013 (18)	19,292 (15)
2005	7,380 (11)	3,521 (18)	17,697 (15)
2006	6,057 (10)	2,481 (23)	17,376 (15)

Creel Survey Results

In 2004, an estimated 10,448 striped bass trips totaling over 53,983 angling hours occurred in the current CSMA survey area. Estimated striped bass catch was 19,292 fish, comprised of 13,280 discards and 6,012 harvested fish (22,281 pounds). In 2005, an estimated 7,380 striped bass trips totaling over 34,338 angling hours occurred in the CMA. Estimated striped bass catch was 17,697 fish, comprised of 14,176 discards and 3,521 harvested fish (13,600 pounds). In 2006, an estimated 6,057 striped bass trips totaling over 30,889 angling hours occurred in the CMA. Estimated striped bass catch was 17,376 fish, comprised of 14,895 discards and 2,481 harvested fish (7,352 pounds). In order to determine agency jurisdiction, the distribution of unexpanded striped bass catch is shown in Table 2. The majority of the striped bass came from the inland waters under WRC management authority. The expanded annual estimates (average) of the survey are shown by river and month in Table 3 and Table 4. Results from the most recent NCWRC creel surveys (Neuse, Tar/Pamlico, and Cape Fear rivers) are referenced in Table 5.

Table 2. Unexpanded distribution of CMA striped bass catch by waterbody classification, 2004-2006.

		Disposition							
		Discard (legal fish)		Discard (over bag limit)		Discard (under size limit)		Kept	
	WaterbodyClass	Number	Percent	Number	Percent	Number	Percent	Number	Percent
2004	Coastal	17	10.12	.		349	30.78	84	20.39
2004	Joint	40	23.81	1	50.00	139	12.26	114	27.67
2004	Inland	111	66.07	1	50.00	646	56.97	214	51.94
	All	168	100.00	2	100.00	1134	100.00	412	100.00
2005	Coastal	17	9.94	9	56.25	232	10.29	62	16.53
2005	Joint	16	9.36	.		208	9.23	61	16.27
2005	Inland	138	80.70	7	43.75	1814	80.48	252	67.20
	All	171	100.00	16	100.00	2254	100.00	375	100.00
2006	Coastal	46	32.39		0.00	207	24.61	40	21.74
2006	Joint	30	21.13		0.00	108	12.84	37	20.11
2006	Inland	66	46.48	4	100.00	526	62.54	107	58.15
	All	142	100.00	4	100.00	841	100.00	184	100.00

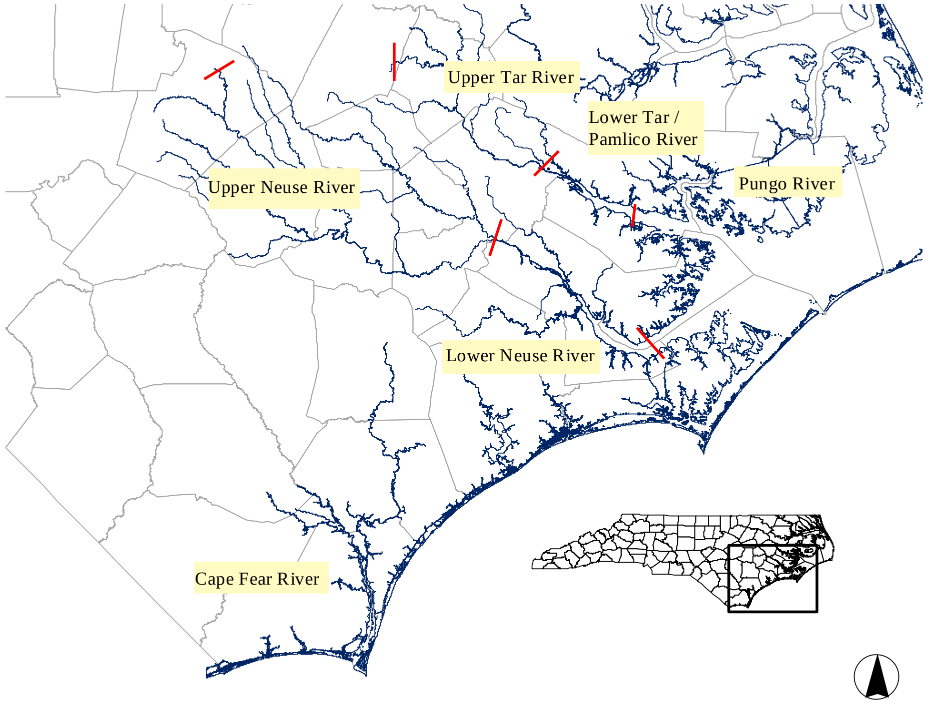

Figure 7. CSMA recreational sampling areas, 2004-2006.

Table 3. Average estimated effort, harvest, and discard for striped bass in the CMA by zone and month, 2004-2006.

	Striped Bass Effort		Harvest		Discard			
Month	Trips	Angler-h	Number	Pounds	Legal-sized	Over-creel	Sub-legal	Total Catch
January	923	4,546	503	2,073	47	161	1,177	1,888
February	730	3,505	300	1,203	44	246	653	1,243
March	848	4,534	232	1,185	31	297	390	949
April	429	2,209	125	395	16	223	271	635
May	646	3,010	145	489	123	556	514	1,338
June	772	3,199	323	1,355	104	376	484	1,287
July	538	2,267	280	1,066	200	766	513	1,759
August	346	1,659	211	499	24	376	358	969
September	217	1,087	105	336	108	106	375	694
October	788	4,909	841	2,466	32	336	1,773	2,982
November	866	4,002	382	1,185	108	441	1,733	2,664
December	859	4,811	558	2,159	65	379	711	1,714
Total	7,962	39,737	4,005	14,411	902	4,262	8,953	18,122

Table 4. Average estimated effort, harvest, and discard for striped bass in the CMA by zone and month, 2004-2006.

		Striped Bass Effort		Harvest		Discard			
Zone	Month	Trips	Angler-h	Number	Pounds	Legal-sized	Over-creel	Sub-legal	Total Catch
Lower Neuse River	January	588	2,897	174	745	26	120	369	689
	February	435	2,173	156	639	4	154	46	360
	March	476	2,542	152	834	25	29	88	295
	April	244	1,397	4	25	12	86	106	208
	May	457	2,307	63	165	123	408	292	885
	June	572	2,476	224	1,026	98	311	178	811
	July	404	1,845	220	871	91	720	322	1,353
	August	224	1,017	61	219	3	329	225	618
	September	122	766	58	186	107	57	250	473
	October	520	3,201	508	1,349	7	72	1,210	1,797
	November	533	2,259	203	586	85	261	1,118	1,666
	December	412	2,194	416	1,600	36	66	445	963
	Total	4,987	25,074	2,241	8,245	617	2,613	4,647	10,118
Lower Tar/ Upper Pamlico River	January	204	1,163	71	337	15	39	761	886
	February	205	950	99	390	38	73	565	775
	March	284	1,531	45	201	5	266	296	613
	April	127	599	55	141	4	22	154	235
	May	111	326	22	98	0	10	150	182
	June	45	112	20	74	6	45	86	156
	July	51	106	4	16	62	10	112	188
	August	58	183	65	25	18	6	85	174
	September	64	157	1	9	0	9	57	67
	October	151	803	109	392	0	134	289	533
	November	222	1,157	34	111	12	41	509	597
	December	179	880	13	48	2	208	138	361
	Total	1,701	7,968	540	1,842	162	863	3,201	4,766
Pungo River	January	132	487	257	990	6	2	47	313
	February	90	381	44	174	3	19	42	108
	March	88	461	34	150	0	2	6	42
	April	58	212	66	229	0	114	12	192
	May	78	377	60	226	0	139	72	270
	June	156	611	79	255	0	20	221	320
	July	83	316	55	178	47	36	79	217
	August	64	459	85	256	3	41	47	176
	September	30	164	46	141	1	40	69	155
	October	117	905	223	726	25	130	274	652
	November	111	586	145	488	11	139	107	401
	December	268	1,737	129	511	27	105	129	390
	Total	1,274	6,695	1,225	4,324	123	786	1,104	3,238

Table 5. Striped bass information obtained from recreational creel surveys conducted by NCWRC in the CSMA by survey and month. Standard error in parentheses.

Survey	Month	Number of trips	Effort (angler-h)	Catch (number)	Harvest (number)	Harvest (pounds)
Neuse/Trent River creel survey July 1st 2002 – June 30th 2003	July	11	2,611 (917)	812 (586)	275 (226)	1,070
	August	8	1,281 (579)	231 (160)	120 (98)	467
	September	3	256 (182)	89 (54)	71 (51)	276
	October	6	1,208 (724)	1,341 (795)	662 (401)	2,577
	November	20	3,033 (1,346)	2,229 (1,121)	862 (471)	3,355
	December	20	4,174 (1,052)	1,282 (541)	366 (184)	1,424
	January	12	3,384 (993)	2,273 (1,128)	1,426 (661)	5,550
	February	16	2,107 (1,444)	364 (364)	255 (255)	992
	March	19	2,249 (1,006)	164 (142)	91 (91)	354
	April	12	2,171 (971)	534 (233)	411 (207)	1,600
	May	8	22,878 (19,998)	5,660 (5,053)	5,103 (5,042)	19,861
	June	5	1,052 (684)	82 (52)	33 (33)	128
	Total	140	46,407 (20,249)	15,062 (5,438)	9,675 (5,144)	37,656
Tar/Pamlico River creel survey July 1st 2004 – June 30th 2005	July	1	96 (96)	215 (107)	0 (0)	0
	August	3	155 (78)	198 (198)	0 (0)	0
	September	1	53 (53)	568 (525)	0 (0)	0
	October	3	203 (184)	95 (90)	0 (0)	0
	November	8	930 (475)	779 (392)	0 (0)	0
	December	13	1,544 (812)	1,855 (1,064)	12 (12)	58
	January	27	4,448 (2,370)	1,494 (693)	59 (47)	286
	February	22	4,162 (1,706)	8,022 (5,780)	20 (20)	97
	March	8	590 (226)	1,067 (602)	65 (40)	315
	April	9	918 (524)	2,647 (1,563)	32 (24)	155
	May	4	728 (351)	171 (143)	0 (0)	0
	June	3	275 (180)	65 (49)	0 (0)	0
	Total	102	14,100 (3,153)	17,177 (6,191)	188 (70)	911
Cape Fear River creel survey July 1st 2003 – June 30th 2004	July	0	0 (0)	0 (0)	0 (0)	0
	August	0	0 (0)	0 (0)	0 (0)	0
	September	2	596 (183)	32 (15)	0 (0)	0
	October	4	859 (288)	255 (71)	0 (0)	0
	November	6	737 (255)	216 (72)	0 (0)	0
	December	5	1,010 (289)	307 (85)	0 (0)	0
	January	2	1,152 (443)	418 (150)	29 (15)	77
	February	4	594 (243)	108 (44)	36 (15)	95
	March	3	600 (278)	256 (63)	30 (14)	79
	April	1	228 (105)	99 (35)	29 (13)	77
	May	2	211 (82)	121 (33)	0 (0)	0
	June	1	27 (12)	222 (75)	31 (17)	82
	Total	30	6,013 (784)	2,038 (234)	155 (33)	410

Recreational Commercial Gear License Background and Sampling Methods.

North Carolina has long allowed the recreational use of commercial fishing gears in its coastal waters. To use commercial type gear for recreational purposes, an individual may possess either a Standard Commercial Fishing License (SCFL), Retired Standard Commercial Fishing License (RSCFL), or a Recreational Commercial Gear License (RCGL). The RCGL is a non-transferable license that expires one year from the date of purchase. An individual holding a RCGL is allowed to use limited amounts of specified commercial gear to catch seafood for personal consumption or recreational purposes. The catch from RCGL activities may not be sold. RCGL holders must comply with recreational size and bag limits. The NCDMF initiated a monthly survey of RCGL holders in March of 2002 to collect harvest and effort information.

Harvest and effort information is not available from SCFL and RSCFL holders who harvest striped bass but do not sell their catch during the commercial striped bass season.

The Monthly RCGL Survey is a mail-based survey that distributes questionnaires to 30% of all RCGL holders each month. The questionnaires request information about the waterbodies commonly fished, types and amounts of gear used, aggregate number and weight of individual species kept, and number of individual species discarded at sea. Each monthly sample of RCGL holders is expanded to estimate the total monthly catch and effort. Areas corresponding to the NCDMF Fishery Management boundary lines (Figure 8) are typically used for summarizing estimates.

Figure 8. Area delineation for typical RCGL reporting.

RCGL Survey Results

Annual statewide harvest of striped bass by RCGL holders ranged from 3,058 lb to 10,199 lb during the period 2002 through 2005 (Table 6). The CSMA accounted for 47% of the total statewide RCGL striped bass harvest during this period. On average, during the period 2002 through 2005, the annual harvest of striped bass from the CSMA is 674 striped bass (3,100 lb).

Table 6. Annual effort and catch estimates of striped bass by RCGL holders within the CSMA during the period, 2002 through 2005.

Year	Trips	Harvest (number)	Harvest (pound)	Discard (number)
2002	2,041	829	3,882	1,181
2003	1,319	821	4,253	571
2004	642	606	2,302	600
2005	1,066	442	1,962	408
Total	5,068	2,698	12,399	2,760
Average	1,267	674	3,100	690

RCGL holders indicated gill nets (both small and large mesh) as the only gears having interaction with striped bass. The total harvest from 2002 through 2005 indicate that large mesh gill nets account for the majority of striped bass catches, respectively contributing 63% by number and 71% by weight (Table 7).

Table 7. RCGL harvest and discard by gill net type (2002-2005).

	Harvest				Discard	
Gear	Number	Percent	Pound	Percent	Number	Percent
Large Mesh Gill Nets	1,700	63.0	8,777	70.8	1,466	53.1
Small Mesh Gill Nets	998	37.0	3,623	29.2	1,295	46.9
Total	2,698		12,399		2,760	

Within the CSMA, the Pamlico and Neuse rivers comprised, on average for the period 2002 through 2006, 87% of the striped bass harvest by number and 90% by weight (Table 8).

Table 8. RCGL harvest and discard by area within the CSMA, 2002 through 2005.

	Trips		Harvest				Discard	
Area	Number	Percent	Number	Percent	Pound	Percent	Number	Percent
Carteret County	8	0.2	17	0.6	117	0.9	0	0.0
Neuse River	1,611	31.8	770	28.5	4,066	32.8	1,250	45.3
Pamlico River	2,500	49.3	1,573	58.3	7,087	57.2	1,451	52.6
Pamlico Sound	565	11.2	263	9.8	844	6.8	52	1.9
Southern Area	218	4.3	75	2.8	287	2.3	0	0.0
White Oak to New River	165	3.3	0	0.0	0	0.0	8	0.3
All	5,068		2,698		12,399		2,760	

CSMA Recreational Measures for the Neuse and Tar rivers

There are several regulatory measures that can be considered in the management of the recreational striped bass fishery in the CMA. These include quotas, restricted entry, seasonal or area closures, bag limits, minimum size, or a combination of these measures. This document focuses only on those regulations relating to seasonal, bag and size restrictions.

Seasonal Closures (Hook and Line) ***mandated by the FMP***

Seasonal closures are intended to reduce harvest to improve the likelihood of reaching mortality reduction targets. The North Carolina Estuarine Striped Bass Fishery Management Plan (FMP) stipulates "*a striped bass harvest seasons in months (October – April) in which cool water temperatures (<70°F) occur and/or only in certain portions if rivers and sounds deemed necessary.*" A summer closure (May through September), or 7 month season of the recreational hook and line striped bass fishery would result in a 27% reduction (pounds) in harvest from this sector, or a 3% reduction to overall striped bass mortality in the CSMA from all fishing combined. The majority of the harvest and subsequent reduction would likely occur in the lower Neuse River (Table 4). It should be noted that since hook and line fishing would still be allowed, the level of reduction would be lessened by the discard mortality associated with catch and release practices. The FMP specified the lack of hook and line mortality rates for the CSMA as a research need.

Analysis and data collection by the NCWRC from 2003 – 2004 suggested that the Cape Fear striped bass fishery was diminished and requires additional restrictive measures for stock restoration (Ashley and Rachels 2005). Due to the nature of the Cape Fear River Basin, it has been suggested that regulations for this system remain separate from the CMA (Fritz Rhode (NCDMF) and Keith Ashley (NCWRC), personal communication). The management option of a zero harvest, no open season has been suggested. A complete closure of the recreational hook and line striped bass fishery in the Cape Fear system would result in a 100% (assuming compliance) reduction in the Cape Fear striped bass fishery.

Seasonal Closures (RCGL) ***mandated by the FMP***

A May through September seasonal closure, based on landing estimates from 2002 through 2005, would reduce the number of striped bass harvested by RCGL by 38% and weight by 40% and number of discard by 43% (**Table 9**).

Table 9. Monthly effort, harvest, and discard estimates of striped bass harvested by RCGL holders within the CSMA during the period, 2002 through 2005.

	Trips		Harvest				Discard	
Month	Number	Percent	Number	Percent	Pound	Percent	Number	Percent
January	39	0.8	23	0.8	154	1.2	0	0.0
February	90	1.8	69	2.6	223	1.8	0	0.0
March	1,282	25.3	337	12.5	1,729	13.9	547	19.8
April	151	3.0	119	4.4	577	4.7	27	1.0
May	371	7.3	300	11.1	1,789	14.4	244	8.8
June	965	19.0	349	12.9	1,671	13.5	448	16.2
July	567	11.2	217	8.0	1,058	8.5	353	12.8
August	243	4.8	52	1.9	165	1.3	35	1.3
September	103	2.0	119	4.4	281	2.3	99	3.6
October	610	12.0	306	11.3	1,520	12.3	489	17.7
November	370	7.3	457	16.9	1,496	12.1	407	14.7
December	278	5.5	351	13.0	1,736	14.0	112	4.1
All	5,068	100.0	2,698	100.0	12,399	100.0	2,760	100.0

Bag Limits (Hook and Line)

Bag limits along with size limits are among the most commonly used management tools for reducing or maintaining fishing mortality at specific levels. Since 1991 the bag limit in the CSMA waters has been three (3) fish per person per day.

Based on results from the CMA creel survey, a majority of successful anglers harvest one fish per trip (Table 10). Average striped bass catch per unit effort has remained less than 0.5 fish per trip since the inception of the program. Reductions in bag limits would have to be significant to reduce overall harvest.

Table 10. Frequency distribution of striped bass harvest per CMA angling trip. The "<1" fish per trip category occurs because harvest for each trip is divided by the total number of contributors on the trip.

	Neuse River		Tar/Pamlico rivers		Pungo River	
Fish per Angler (Harvest)	Percent	Cumulative Percent	Percent	Cumulative Percent	Percent	Cumulative Percent
<1	27.3	27.3	28.3	28.3	38.4	38.4
1	38.2	65.5	43.5	71.8	43.0	81.4
2	16.4	81.9	10.9	82.7	11.6	93.0
3	16.4	98.3	15.2	97.9	5.8	98.8
4	0.0	98.3	0.0	97.9	0.0	98.8
5	0.0	98.3	2.2	100.0	1.2	100.0
6	1.8	100.0				

Bag limit analysis using a mean catch replacement method (assigning catch values equal to proposed bag limits then re-calculating catch estimates) indicate that a two (2) fish bag limit, on average, would reduce harvest 13% in the recreational sector, or a 2% reduction to overall striped bass mortality in the CMA from all fishing combined. A one (1) fish bag limit, on average, would reduce harvest 34% in the recreational sector, or a 3% reduction to overall striped bass mortality in the CMA from all fishing combined.

Bag Limits (RCGL)

The catch per trip estimate for striped bass for RCGL trips is low with a very small percentage of RCGL holders landing numbers of striped bass in excess of the current three-fish bag limit (Table 11). Reassignment of average catch per trip estimates for 2002-2005 was made in a fashion similar to the method previously discussed for hook-and-line. Because fishing behavior and selectivity varies between large mesh and small mesh gill nets, bag limit are evaluated for each net type. Given a two-fish bag limit, RCGL large mesh gill net striped bass harvest would have been reduced by 7% (by number) and 7% (by weight) (Table 12) while a one-fish bag limit would respectively reduce harvest 17% and 21% by number and weight (Table 13). RCGL small mesh landings would have been reduced 30% by number and 25% by weight with a two-fish bag limit (Table 14). A one-fish bag limit would have reduced the number of striped bass harvested with RCGL small mesh gill nets by number 49% and weight by 51% (Table 15).

Table 11. Frequency distribution of striped bass catch per RCGL trip. The "<1" fish per trip category occurs because RCGL catches are reported on a monthly basis where the total reported catch for each species is divided by the total number of trips reported.

	Harvest		Discard		Total Catch	
Fish per Trip	Trips	Percent	Trips	Percent	Trips	Percent
<1	85	64.4	99	75.0	55	41.7
1	28	21.2	16	12.1	40	30.3
2	8	6.1	6	4.5	13	9.8
3	6	4.5	5	3.8	11	8.3
4	1	0.8	2	1.5	4	3.0
5	2	1.5	2	1.5	2	1.5
6	1	0.8		0.0	2	1.5
7	1	0.8		0.0	1	0.8
8		0.0	1	0.8	1	0.8
9		0.0		0.0		0.0
10		0.0	1	0.8	1	0.8
11		0.0		0.0	1	0.8
12		0.0		0.0	1	0.8

Table 12. Monthly and overall differences between observed large mesh gill net catches and projected catches with a two-fish bag limit for RCGL catch, 2002 through 2005.

	Number Harvest			Pounds Harvest			Number Discard		
Month	Observed	Two Fish	% Diff	Observed	Two Fish	% Diff	Observed	Two Fish	% Diff
January	6	6	0.0	37	37	0.0	0	0	-
February	37	29	-22.1	160	127	-20.7	0	8	-
March	311	295	-5.4	1,616	1,515	-6.2	400	417	4.2
April	63	56	-10.2	346	315	-8.9	19	26	33.4
May	117	99	-15.0	787	656	-16.6	70	87	25.0
June	297	297	0.0	1,381	1,381	0.0	384	384	0.0
July	139	139	0.0	753	753	0.0	201	201	0.0
August	19	19	0.0	101	101	0.0	35	35	0.0
September	34	34	0.0	196	196	0.0	39	39	0.0
October	212	203	-4.5	1,063	1,016	-4.5	79	89	11.9
November	176	158	-10.1	842	799	-5.0	125	143	14.2
December	288	247	-14.1	1,494	1,290	-13.6	112	153	36.2
All	1,700	1,583	-6.9	8,777	8,188	-6.7	1,466	1,583	8.0

Table 13. Monthly and overall differences between observed large mesh gill net catches and projected catches with a one-fish bag limit for RCGL catch, 2002 through 2005.

	Number Harvest			Pounds Harvest			Number Discard		
Month	Observed	One Fish	% Diff	Observed	One Fish	% Diff	Observed	One Fish	% Diff
January	6	6	0.0	37	37	0.0	0	0	-
February	37	21	-44.2	160	94	-41.3	0	17	-
March	311	278	-10.8	1,616	1,415	-12.5	400	434	8.4
April	63	50	-20.3	346	284	-17.9	19	32	66.7
May	117	73	-37.4	787	460	-41.5	70	113	62.5
June	297	287	-3.4	1,381	1,125	-18.5	384	394	2.6
July	139	139	0.0	753	753	0.0	201	201	0.0
August	19	19	0.0	101	101	0.0	35	35	0.0
September	34	34	0.0	196	196	0.0	39	39	0.0
October	212	184	-13.2	1,063	873	-17.9	79	107	35.2
November	176	142	-19.2	842	750	-10.9	125	159	26.9
December	288	172	-40.3	1,494	874	-41.5	112	228	103.1
All	1,700	1,406	-17.3	8,777	6,963	-20.7	1,466	1,760	20.1

Table 14. Monthly and overall differences between observed small mesh gill net catches and projected catches with a two-fish bag limit for RCGL catch, 2002 through 2005.

	Number Harvest			Pounds Harvest			Number Discard		
Month	Observed	Two Fish	% Diff	Observed	Two Fish	% Diff	Observed	Two Fish	% Diff
January	17	17	0.0	117	117	0.0	0	0	-
February	31	31	0.0	63	63	0.0	0	0	-
March	25	25	0.0	113	113	0.0	146	146	0.0
April	56	56	0.0	231	231	0.0	8	8	0.0
May	183	78	-57.1	1,002	453	-54.8	174	279	60.0
June	52	52	0.0	290	290	0.0	64	64	0.0
July	78	78	0.0	305	305	0.0	152	152	0.0
August	33	33	0.0	64	64	0.0	0	0	-
September	85	34	-60.0	85	0	-100.0	59	110	85.7
October	94	94	0.0	457	457	0.0	409	409	0.0
November	281	138	-50.9	655	391	-40.2	281	424	50.9
December	62	62	0.0	242	242	0.0	0	0	-
All	998	699	-29.9	3,623	2,725	-24.8	1,295	1,593	23.1

Table 15. Monthly and overall differences between observed small mesh gill net catches and projected catches with a one-fish bag limit for RCGL catch, 2002 through 2005.

	Number Harvest			Pounds Harvest			Number Discard		
Month	Observed	One Fish	% Diff	Observed	One Fish	% Diff	Observed	One Fish	% Diff
January	17	8	-50.0	117	58	-50.0	0	8	-
February	31	31	0.0	63	63	0.0	0	0	-
March	25	25	0.0	113	113	0.0	146	146	0.0
April	56	48	-14.8	231	206	-10.8	8	17	100.0
May	183	44	-76.2	1,002	270	-73.0	174	314	80.0
June	52	52	0.0	290	290	0.0	64	64	0.0
July	78	60	-23.1	305	234	-23.2	152	170	12.0
August	33	33	0.0	64	64	0.0	0	0	-
September	85	17	-80.0	85	0	-100.0	59	127	114.3
October	94	68	-27.8	457	236	-48.2	409	435	6.4
November	281	82	-70.8	655	250	-61.8	281	480	70.7
December	62	38	-38.6	242	9	-96.2	0	24	-
All	998	507	-49.2	3,623	1,794	-50.5	1,295	1,786	37.9

Size Limits (Hook and Line)

Size limits are management tools often based on a species age at maturity and life history. Minimum size limits normally allow fish to spawn at least one time and therefore will contribute to the growth of the population before capture. Maximum size limits are used to protect the larger fish that produce more eggs. Minimum size limits protect smaller immature fish, while maximum size limits conserve larger females that may produce proportionally more eggs than smaller females. Protective slot limits define a size range through which fish may be not be kept. The purpose of a protective slot limit is to protect medium-sized fish so that they may grow larger and to protect a size class that may be very prolific. Studies of the A/R stock have shown 45% of age three females (22 to 24 inches TL) are sexually mature.

In 1979 the statewide minimum size limit for striped bass was 12 inches total length (TL). In 1991 the minimum recreational size limit for striped bass was raised to 18 inches TL. The NCWRC has established a protective slot limit in the upper inland portions of the Neuse and Tar/Pamlico rivers of 22 to 27 inches, with the objective of increasing the numbers of spawning females age 5-8.

From 2004 to 2006, recreational creel agents in the CMA measured 883 striped bass. Table 16 provides a length frequency distribution to evaluate potential reduction in catch by increasing the minimum size limit and/or slot restrictions. Results indicate that stronger enforcement of current regulations should reduce striped bass recreational hook and line harvest by 2% (assuming 100% compliance). If the protective slot limit (22 to 27 inches) was expanded to include joint and coastal waters, this would lead to a 30% reduction in harvest in the recreational sector, or a 3% reduction to overall striped bass mortality in the CMA from all fishing combined (Table 16).

Table 16. Length (TL) frequency distribution of observed striped bass landings in the current CMA survey area, 2004-2005. The shaded area encompasses a 22-27 inch potential protective slot restriction*.

	Lower Neuse		Lower Tar / Upper Pamlico		Pungo River		CMA (Total)	
TL inches	Number	Percent	Number	Percent	Number	Percent	Number	Percent
16”	1	0.4	2	0.9	1	0.3	4	0.5
17”	2	0.7	4	1.9	4	1.0	10	1.1
18”	36	13.0	18	8.5	45	11.5	99	11.2
19”	50	18.1	41	19.2	82	20.9	173	19.6
20”	45	16.2	43	20.2	103	26.2	191	21.6
21”	35	12.6	24	11.3	61	15.5	120	13.6
22”	22	7.9	26	12.2	46	11.7	94	10.6
23”	25	9.0	25	11.7	32	8.1	82	9.3
24”	27	9.7	8	3.8	8	2.0	43	4.9
25”	11	4.0	5	2.3	6	1.5	22	2.5
26”	9	3.2	1	0.5	3	0.8	13	1.5
27”	7	2.5	6	2.8	1	0.3	14	1.6
28”	3	1.1	5	2.3	1	0.3	9	1.0
29”	3	1.1	2	0.9	0	0.0	5	0.6
30”	1	0.4	1	0.5	0	0.0	2	0.2
31”	0	0.0	2	0.9	0	0.0	2	0.2
Total	277	100.0	213	100.0	393	100.0	883	100.0

*Slot represents 30% of all observed fish in CMA, ranging from 24% (Pungo R.) to 36% (Neuse R.).

Table 17. Measures of central tendency for lengths and weights of observed striped bass by river and year, 2004-2006.

Year	River	Length (TL, inches)				Weight (pounds)			
		Num	Min	Max	Ave	Num	Min	Max	Ave
2004	Lower Neuse River	152	16	29	21.3	152	2.1	12.1	4.2
	Upper Tar River	6	19	29	22.3	5	2.1	11.6	5.6
	Lower Tar/upper Pamlico River	84	17	31	21.1	84	2.3	10.6	4.4
	Pungo River	189	17	27	20.2	189	2.2	7.7	3.5
	Total	431	16	31	20.8	430	2.1	12.1	3.9
2005	Upper Neuse River	4	20	26	22.5	4	2.9	7.7	4.8
	Lower Neuse River	82	17	30	21.5	82	2.0	11.2	4.1
	Upper Tar River	5	16	21	19	5	2.9	4.9	3.8
	Lower Tar/ upper Pamlico River	101	16	31	21.6	101	2.0	14.8	4.6
	Pungo River	143	17	28	20.6	143	0.8	6.0	3.5
	Total	335	16	31	21.1	335	0.8	14.8	4.0
2006	Lower Neuse River	43	18	27	20.6	43	2.2	8.4	3.4
	Lower Tar/ upper Pamlico River	28	16	30	19.8	28	2.7	12.1	3.6
	Pungo River	61	16	25	20.6	61	2.1	5.3	3.4
	Total	132	16	30	20.4	132	2.1	12.1	3.5

Size Limits (RCGL)

The RCGL Survey is limited to aggregate number and weight for catches occurring during a given month and does not collect biological information such as individual fish length. To examine potential reductions for RCGL gill net, biological information collected from the commercial gill net fisheries may provide a proxy to generate a numbers at length for the RCGL gill net fisheries. A 22 to 27 inch slot limit would reduce the RCGL large mesh gill net harvest by 51% (Table 18). There were too few striped bass from observed commercial small mesh gill nets to calculate slot limit reductions.

Table 18. Number at length for the RCGL large mesh gill net fishery, 2002 through 2005. Length distributions obtained from large mesh commercial observer data (Katy West - personal communication).

Size Class	Frequency	Percent	Harvest (Number)
18	1	1.19	20
19	10	11.90	202
20	6	7.14	121
21	15	17.86	304
22	12	14.29	243
23	20	23.81	405
24	4	4.76	81
25	4	4.76	81
26	3	3.57	61
29	2	2.38	40
31	1	1.19	20
33	2	2.38	40
34	1	1.19	20
35	1	1.19	20
36	1	1.19	20
37	1	1.19	20

Recreational Summary

Hook and Line Reductions

Management measures and their potential impacts on the recreational fisheries are summarized in Table 19. Based on current survey estimates, each 10% reduction in the hook and line sector of the striped bass fishery will result in a 1.0% reduction in overall striped bass mortality in the CMA (Table 20).

Table 19. Approximate reductions (based on 3-year averages) in estimated hook and line recreational striped bass harvest (number and weight) by restriction. The Seven month season as presented in the 2004 FMP would include October 1 – April 30. The three month season below would include only the months of March, April and November.

Management strategy	Estimated harvest (number)	Estimated harvest (pounds)	Mortality reduction (recreational sector)	Mortality reduction (overall CSMA)***
Status Quo	4,005	14,411	0 %	0 %
A. Seven month season	2,941	10,666	-27 %	-2.7 %
B. Three month season	739	2,765	-82 %	-8.3 %
C. 2 fish bag	3,480	12,067	-13 %	-1.7 %
D. 1 fish bag	2,657	10,058	-34 %	-3.1 %
E. 18" size limit	3,941	14,180	-2 %	0.2 %
F. 18" + 22"-27" slot	2,789	10,037	-30 %	-3.1 %
A, C, E	2,553	8,857	-36 %	-4.0 %
A, D, E	1,954	7,432	-51 %	-5.0 %
A, C, F	1,807	6,269	-55 %	-5.8 %
A, D, F	1,383	5,261	-65 %	-6.5 %
B, C, E	649	2,423	-84 %	-8.6 %
B, D, E	491	2,265	-88 %	-8.7 %
B, C, F	459	1,715	-89 %	-9.1 %
B, D, F	347	1,603	-91 %	-9.2 %

*** Based on the total estimated harvest of 139.830 pounds including commercial landings and discards, recreational landings and discards, and RCGL landings and discards.

Table 20. Approximate impact of restrictions on striped bass hook and line recreational fishery and overall reduction of striped bass mortality in the CMA.

Estimated recreational striped bass harvest (pounds)	Reduction to recreational striped bass fishery in the CMA	Overall reduction to mortality in the CMA striped bass fishery*
0	-100 %	-10.31 %
1,441	-90 %	-9.28 %
2,882	-80 %	-8.24 %
4,323	-70 %	-7.21 %
5,764	-60 %	-6.18 %
7,206	-50 %	-5.15 %
8,647	-40 %	-4.12 %
10,088	-30 %	-3.09 %
11,529	-20 %	-2.06 %
12,970	-10 %	-1.03 %
14,411**	0 %	0.00 %

* Based on the total estimated harvest of 139.830 pounds including commercial landings and discards, recreational landings and discards, and RCGL landings and discards.
** Based on three-year average of estimated harvests from CMA striped bass creel survey including Neuse, Tar/Pamlico, and Pungo rivers.

RCGL Reductions

RCGL holders will be impacted by both recreational and commercial management strategies. Since RCGL small mesh and large mesh nets may not receive identical restrictions, reductions have been calculated separately for large mesh nets and small mesh nets and the combined impact is shown in (Table 21).

Table 21. Potential impact of management strategies on RCGL small mesh and large mesh gill net harvest based on an average of catch estimate from 2002 through 2005.

Management Strategy	Harvest (number)	Percent Reduction	Harvest (pound)	Percent Reduction	Discard (Number)	Percent Reduction	Mortality Reduction (overall)
Status Quo	675	0.0	3,100	0.0	690	0.0	0.00 %
(1) Tie-down	318	52.9	1,257	59.5	382	44.6	1.54 %
(A) May through September Closure*	415	38.4	1,858	40.1	396	42.7	1.10 %
(B) January, February, May through October, December Closure	228	66.2	950	69.4	337	51.2	1.79 %
(C) Two-fish bag limit	571	15.4	2,728	12.0	794	-15.1	0.19 %
(D) One-fish bag limit	478	29.1	2,188	29.4	887	-28.4	0.51 %
(E) 22 to 27" Slot limit	-	-	-	-	-	-	-
1, A	186	72.5	691	77.7	241	65.1	2.04 %
1, A, C	146	78.4	608	80.4	281	59.4	2.08 %
1, A, C, E	-	-	-	-	-	-	-
1, A, D	109	83.8	407	86.9	317	54.1	2.19 %
1, A, D, E	-	-	-	-	-	-	-
1, B	113	83.3	362	88.3	223	67.8	2.29 %
1, B, C	75	88.8	289	90.7	168	75.6	2.38 %
1, B, C, E	-	-	-	-	-	-	-
1, B, D	58	91.4	240	92.3	186	73.1	2.41 %
1, B, D, E	-	-	-	-	-	-	-
A, C	355	47.4	1,679	45.8	441	36.2	1.19 %
A, C, E	-	-	-	-	-	-	-
A, D	289	57.2	1,315	57.6	522	24.3	1.40 %
A, D, E	-	-	-	-	-	-	-
B, C	182	73.0	842	72.8	291	57.8	1.90 %
B, C, E	-	-	-	-	-	-	-
B, D	157	76.8	754	75.7	317	54.1	1.94 %
B, D, E	-	-	-	-	-	-	-

* Previous agreed measures to reduce striped bass mortality in the recreational sector of the CMA. May – September closure.

Each 10% reduction in the recreational commercial gear sector of the striped bass fishery will result in a 0.2% reduction in overall striped bass mortality in the CMA (Table 22).

Table 22. Approximate impact of restrictions on striped bass RCGL fishery and overall (all methods combined) striped bass fishery.

Estimated RCGL striped bass harvest (pounds)	Reduction to RCGL striped bass fishery in the CM	Overall reduction to mortality in the CMA striped bass fishery*
0	-100 %	-2.22 %
310	-90 %	-2.00 %
620	-80 %	-1.77 %
930	-70 %	-1.55 %
1,240	-60 %	-1.33 %
1,550	-50 %	-1.11 %
1,860	-40 %	-0.89 %
2,170	-30 %	-0.67 %
2,480	-20 %	-0.44 %
2,790	-10 %	-0.22 %
3,100	0 %	0.00 %

* Based on the total estimated harvest of 139,830 pounds including commercial landings and discards, recreational landings and discards, and RCGL landings and discards.
** Based on average estimate from 2002-2005 RCGL surveys in CSMA.

Combined Reductions

Management strategies by restriction and potential impact on the recreational sector of the CMA striped bass fishery (hook and line and RCGL combined) are shown in Table 23.. Each 10% reduction in the recreational sector (hook and line and RCGL combined) of the striped bass fishery will result in a 1.3% reduction in overall striped bass mortality in the CMA (Table 24).

Table 23. Approximate reductions (based on multi-year averages) in estimated recreational striped bass (hook and line and RCGL combined) harvest and discard by restriction.

Management Strategy	Estimated harvest (pounds)	Mortality reduction (recreational Sector)	Mortality reduction (overall CSMA)*
Status Quo	17,511	0.0 %	0.0 %
1. Tie-down	15,668	10.5 %	1.3 %
A. Seven month season**	12,524	28.5 %	3.6 %
B. Three month season	3,715	78.8 %	9.9 %
C. 2 fish bag	14,795	15.5 %	1.9 %
D. 1 fish bag	12,246	30.1 %	3.8 %
E. 18" size limit	17,280	1.3 %	0.2 %
F. 18" + 22"-27" slot	10,037	42.7 %	5.3 %
A, C, E	10,536	39.8 %	5.0 %
A, D, E	8,747	50.0 %	6.3 %
A, C, F	6,269	64.2 %	8.0 %
A, D, F	5,261	70.0 %	8.8 %
B, C, E	3,265	81.4 %	10.2 %
B, D, E	3,019	82.8 %	10.4 %
B, C, F	1,715	90.2 %	11.3 %
B, D, F	1,603	90.8 %	11.4 %
1, A, C, E	9,465	45.9 %	5.8 %
1, A, D, E	7,839	55.2 %	6.9 %
1, A, C, F	6,269	64.2 %	8.0 %
1, A, D, F	5,261	70.0 %	8.8 %
1, B, C, E	2,712	84.5 %	10.6 %
1, B, D, E	2,505	85.7 %	10.7 %
1, B, C, F	1,715	90.2 %	11.3 %
1, B, D, F	1,603	90.8 %	11.4 %

* Based on the total estimated harvest of 139,830 pounds including commercial landings and discards, recreational landings and discards, and RCGL landings and discards.
** FMP required measures to reduce striped bass mortality in the recreational sector of the CMA. May – September closure.

Table 24. Approximate impact of restrictions on striped bass recreational fishery (hook and line and RCGL combined) and overall (all methods combined) striped bass fishery.

Estimated RCGL striped bass harvest (pounds)	Reduction to RCGL striped bass fishery in the CM	Overall reduction to mortality in the CMA striped bass fishery*
0	-100 %	-12.52 %
1,751	-90 %	-11.27 %
3,502	-80 %	-10.02 %
5,253	-70 %	-8.77 %
7,004	-60 %	-7.51 %
8,756	-50 %	-6.26 %
10,507	-40 %	-5.01 %
12,258	-30 %	-3.76 %
14,009	-20 %	-2.50 %
15,760	-10 %	-1.25 %
17,511	-0 %	0.00 %

* Based on the total estimated harvest of 139,830 pounds including commercial landings and discards, recreational landings and discards, and RCGL landings and discards.
** Based on average estimate from 2002-2005 RCGL surveys in CSMA.

Recreational Options and Impacts for the Tar and Neuse

A. Status quo
+ No changes in rules
- Continued overharvesting of an overfished stock
- Not allowed by FRA requirement

B. Seasonal Closure during May through September **(2004 FMP Requirement)**
+ Would reduce hook and line harvest 27%
+ Would reduce RCGL harvest 40%
+ Release mortality minimized by reducing directed striped bass trips
+ Would conserve the stock for a period of time.
+ Would possibly lead to increased recruitment and increase in SSB.
- Anglers not allowed to keep striped bass during closed season.
- Potential economic impacts of season closure (trip expenditures) .
- Contribute minimally to reaching target reduction level (4%,Table 23).

C. 2 fish bag limit year round
+ Would reduce hook and line harvest 13%
+ Would reduce RCGL harvest from 12%
+ Consistent with ASMA.
+ Would possibly lead to increased recruitment and increase in SSB.
- Would potentially increase discard due to release mortality .
- Contribute minimally to reaching target reduction level (2%,Table 23).

D. 2 fish bag limit year round and seasonal closure May through September (maintaining 18” size limit)
+ Would reduce hook and line harvest 36%
+ Would reduce RCGL harvest 46%
+ Would conserve the stock for a period of time and reduce harvest.
+ Would possibly lead to increased recruitment and increase in SSB.
- Would potentially increase discard due to release mortality.
- Contribute minimally to reaching target reduction level (5%,Table 23).

E. 2 fish bag limit year round and seasonal closure May through September (maintaining 18” size limit) and tie-down requirement for large mesh RCGL nets.
+ Would reduce hook and line harvest 36%
+ Would reduce RCGL harvest 80%
+ Would conserve the stock for a period of time and reduce harvest.
+ Would possibly lead to increased recruitment and increase in SSB.
- Substantially reduce recreational RCGL striped bass fishery in CMA
- Would potentially increase discard due to release mortality.
- Contribute minimally to reaching target reduction level (6%,Table 23).

F. 2 fish bag limit year round and seasonal closure May through September (maintaining 18” size limit) and tie-down requirement for large mesh RCGL nets. Additional 22-27” slot restriction in all joint and inland waters (modification of option ‘ACF’ in Table 23).

+ Would reduce hook and line harvest ~51%
+ Would reduce RCGL harvest 80%
+ Would conserve the stock for a period of time and reduce harvest.
+ Would possibly lead to increased recruitment and increase in SSB.
+ Would provide consistency in regulation throughout inland and joint waters.
- Substantially reduce recreational RCGL striped bass fishery in CMA
- Would potentially increase discard due to release mortality.
- Contribute minimally to reaching target reduction level (8%, Table 23).

For additional information concerning previous evaluation of recreational management options for the CSMA refer to Sections 10.2.3 and 10.4.3 in the 2004 FMP.

CSMA Measures for the Cape Fear River System

The available information for the Cape Fear River confirms that significant overfishing on this population has occurred. Spring electrofishing surveys continue to document the absence of appreciable numbers of spawning striped bass, suggesting the failure of multiple year-classes. Similarly, recreational creel data from the Cape Fear River estimate that only 155 striped bass were harvested in the 12-month period between July 1, 2003 and June 30, 2004. Commercial landing from 2002-2006 have averaged 1,237 pounds. These landing are included in the 25,000 TAC.

Aggressive conservation measures are needed to rebuild the Cape Fear striped bass population. Recreational and commercial options and potential impacts include the following:

A Status quo
+ No changes in rules
- Continued overharvesting of an overfished stock
- Not allowed by FRA requirement

B Zero harvest in the recreational striped bass fishery in the Cape Fear River System (2004 FMP allows for distinct area regulations within the CSMA).
+/- Would eliminate hook and line harvest (annual harvest estimate of 155 pounds)
+/- Would eliminate RCGL harvest (annual harvest estimate of 75 pounds)
+ Would allow for stock rebuilding, including potential increases in recruitment and eventually SSB

C Zero harvest in the commercial striped bass fishery in the Cape Fear River System (2004 FMP allows for distinct area regulations within the CSMA).
+/- Would eliminate commercial gill net harvest (annual harvest estimate of 1,237 pounds)

+ Would allow for stock rebuilding, including potential increases in recruitment and eventually SSB
- Would have discard mortality from set gill nets

D Restrict commercial harvest to 50% bycatch provision, a low poundage cap (1,000 lb) for Cape Fear, a low (3 fish or less) per trip limit, and other gear deployment requirements in the Cape Fear River System.
(2004 FMP allows for distinct area regulations within the CSMA).
+ Would allow for the utilization of striped bass discards and reduce waste
+ Would minimize impact to existing multi-species commercial fisheries
+ Would allow for some stock rebuilding
- Discard utilized is a small component of the shad fishery and any commercial harvest would create inequity with the recreational sector's zero harvest

Summary Discussion and PDT Recommendations

Reduction in harvest and discards are needed in order to approach the threshold F rates established for the Neuse and Tar rivers striped bass stocks. Each fishery component, commercial and recreational will be impacted in order to meet this objective. The commercial fishery has a 25,000 pound TAC and has a substantial level of additional discard. The recreational fishery has been regulated by size and bag limits, with no restriction on total harvest. In the deliberations and development of the 2004 FMP, the magnitude of the recreational harvest was unknown. However, with the recent creel surveys one is now able to quantify the impacts of the proposed management restrictions and relate their relative contribution toward stated management objectives. Total recreational (hook and line and RCGL) striped bass mortality contributes, on average roughly 15% of total mortality in the CMA (Table 25). The estimate of the commercial sector contribution is 85%, with the unused bycatch discard being the major contributor. The North Carolina Marine Fisheries Commission adopted a policy in November 1991 directing the NCDMF to establish the goal of reducing bycatch to the absolute minimum and incorporates that goal into actions. As noted in the 2004 FMP, the discard estimate was based on the best available data (at the time) and was not to be taken as an absolute value due to several constraints in the analysis. Regardless of the absolute value, the estimates of bycatch mortality are excessive, and proper management of the CSMA striped bass fishery necessitates focusing on ways to significantly minimize discard waste.

Table 25. Contribution to overall striped bass mortality by fishery.

Fishery	Annual mortality (pounds)	Percent contribution
Commercial harvest	25,000	17.9
Commercial estimated discards*	94,370	67.5
Recreational hook and line	14,411	10.3
Recreational hook and line discards**	2,259	1.6
Recreational commercial gear	3,100	2.2
Recreational commercial gear discards***	690	0.5
Total	139,830	100.0

* From 2004 FMP
** Based on average discard estimate multiplied by an average weight of 3.8 lbs. and a mortality rate of 10%.
*** Based on the number of fish estimated discarded multiplied by an average weight of 2 lbs. and a mortality rate of 50%.

The FRA provides that state FMPs be reviewed every 5 years, and the NC Estuarine Striped Bass FMP is scheduled for review in 2008. At that time, or if the MFC and WRC feels stock status requires earlier review and action, the entire framework of management could be re-evaluated based on the best available data. At this juncture and in line with the direction of the 2004 FMP the following change in management actions are proposed by the Plan Development Team (PDT):

1) Commercial Large Mesh in River Areas, west of 76 30'Longitude-Require 3 foot tie down use in large mesh (>5 in stretch mesh) gill nets, maintain a minimum distance from shore of 50 yards for these nets, except RCGL large mesh nets may be set within 50 yards of shore if attended at all times. Restrictions would be in place after the commercial TAC is met (spring) through 31 December of each year (Commercial Option F). Estimated reduction in discard of 85%,

2) Recreational and Commercial Measure for the Cape Fear System- Implement a zero harvest for both commercial and recreational, based on the recent review of stock condition and the evidence of minimal natural reproduction.

3) Recreational Measures for the CMA- Restrict harvest to months of October-April, 2 fish bag, 18 inch TL minimum size with a slot limit of 22-27 inch in joint and inland waters (Recreational Option F). Estimated reduction in recreational harvest of ~56%.

The projected overall reduction in mortality in the CSMA is ~64% if the PDT measures are implemented. These measures were taken before the Central, Southeast, and Inland Advisory Committees (AC) for comment and recommendations.

Central/Southern Management Area (CSMA) Advisory Committees, Regional AC's, and Public Comment and Recommendations

Table 26 shows an overview of the CSMA Plan Development Team (PDT) and Advisory Committee (AC) recommendations, as well as recommendations from the Central, Southeast, and Inland AC's. The Northeast Advisory Committee will meet 19 July 2007 and a date for Finfish has yet to be scheduled.

Table 26. MFC regional advisory motions for the striped bass central southern management area (CSMA), June 2007.

FISHERY	CSMA PDT	CSMA AC	Central AC	SE AC	INLAND AC
Commercial	Per FMP	Per FMP	Per FMP	Per FMP	Per FMP
Large Mesh Commercial Discards (CMA)	Tie-downs, DFS* w/ RCGL attendance exception. (Line 76º 30’)	Tie-downs, DFS w/ RCGL attendance exception. (Line 76º 30’)	Tie-downs, DFS w/ RCGL attendance exception. Recommendation that line 76º 30’ be researched to be moved up river to minimize impacts to the flounder fishery	Tie-downs, DFS w/ RCGL attendance exception Recommendation that line 76º 30’ be researched and moved up river only if this does not significantly impact reduction in striped bass discards	Tie-downs, DFS w/ RCGL attendance exception (line 76º 30’)
Hook and Line (CMA)	Summer closure, 2 fish bag, and slot (I/J)	Summer closure only	Summer closure only	Summer closure only	Status quo
RCGL (CMA)	Summer closure, 2 fish bag & slot, and Tie-downs - DFS w/ RCGL attendance exception. (Line 76º 30’)	Summer closure and Tie-downs - DFS w/ RCGL attendance exception. (Line 76º 30’)	Summer closure and Tie-downs - DFS w/ RCGL attendance exception. (Line see above commercial discards)	Summer closure and Tie-downs - DFS w/ RCGL attendance exception. (Line see above commercial discards)	Tie-down only
Cape Fear (Commercial and Hook and Line)	No Harvest	Dam Removal	Dam Removal	No Harvest	No Harvest and Dam mitigation (bypasses)

*DFS=Minimum Distance from Shore of 50 yards. Gill net measures would be required from end of CSMA season through Dec.

MFC Regional Advisory Motions - Recommendations and Rationale

Large Mesh Gill Net Discard

The CSMA PDT objective was to maximize the reduction in striped bass discards and minimize the effects to the flounder and shad fishery. The PDT recommended that in the commercial large mesh (>5 in) gill net river areas (west of 76º 30' longitude) require 3' tie-down and maintain a Minimum Distance From Shore (MDFS) of 50 yards, except Recreational Commercial Gear License (RCGL) large mesh nets may be set within 50 yards of shore if attended at all times. Restrictions would be in place after the commercial spring striped bass TAC is met through 31 December of each year.

The CSMA AC passed the PDT recommendation without dissent. The AC also passed a motion to maintain a commercial bag limit of 5 striped bass per day. The intent of this motion was to deter the targeting of striped bass and ensure the extension of the spring shad fishery.

The Central AC agreed with the requirement of 3' tie-downs, a MDFS of 50 yards, and with the exception RCGL large mesh nets may be set within 50 yards of shore if attended at all times. They also agreed with the proposed time frame for the restrictions, starting after the commercial TAC is met through 31 December of each year. However, there was strong opposition to the proposed restriction line (76º 30'). The AC felt that the impact to the flounder fisherman in the lower portions of the rivers, due to lower catch rates 50 yards from shore, the net damage due to skates and rays, and the increased spatial conflict with crabbers warranted that the line be re-evaluated and moved up river in both the Neuse and Pamlico/Pungo systems in order to minimize impacts to the much more economically important flounder fishery. The public stated they did not encounter many striped bass in the lower portions of the rivers and thus the proposed line was unnecessarily restrictive.

The Southeast AC agreed with the same recommendations of the Central AC; however, they recommended the line should only be moved up river if the reductions in striped bass discards are relatively unaffected.

The Inland AC passed the PDT recommendation without dissent.

Additional Data Review for Large Mesh Gill Net Discard

The Division took into account the regional advisory committees concerns of the impacts of tie-down and MDFS line 76º 30' on the flounder fishery. Fishery independent and dependent data was analyzed for the distribution and abundance of striped bass in the river systems.

Program Methods

Program 915 consists of randomized sampling of one nautical mile grids. Sampling has occurred from February 15th through December 15th each year since 1999. The rivers are divided into 4 areas in the Neuse River (Upper, Upper-Middle, Lower-Middle, and Lower), 3 areas in the Pamlico River (Upper, Middle, and Lower), and 1 area for the Pungo River (Figure 9 and Figure

10). Main areas are characterized by physical properties, stratified by depth, and divided into one minute by one-minute quadrants (equivalent to one square nautical mile). Within the main areas each month sampling quadrants by strata are randomly selected.

Floating gill nets are used to sample shallow and deep strata, with each net gang consisting of 30-yard segments of 3, 3 ½, 4, 4 ½, 5, 5 ½, 6, and 6 ½ inch stretched mesh, for a total of 240 yards of nets combined. Nets are deployed parallel (deep sets) or perpendicular (shallow sets) to the shore based on the strata and common fishing techniques for the area. The catch from the gang of nets comprises a single sample. Two random samples (one shallow + one deep) are completed from each area every other week. Monthly within each system 16 sampling trips (4 trips x twice a month x 2 samples) are completed. For the analysis only April through December sets were used (months proposed regulations would be implemented).

Program 466 Observer data has been collected by the Division or through contracts with ECU from 2001-2006. Agency staff accompanied commercial gill net fisherman on both large and small mesh gill net trips. These observers record location, gear and effort characteristics, and environmental information for each trip, as well as determine the quantity, size, and disposition (alive, dead, discard, etc) of the species taken.

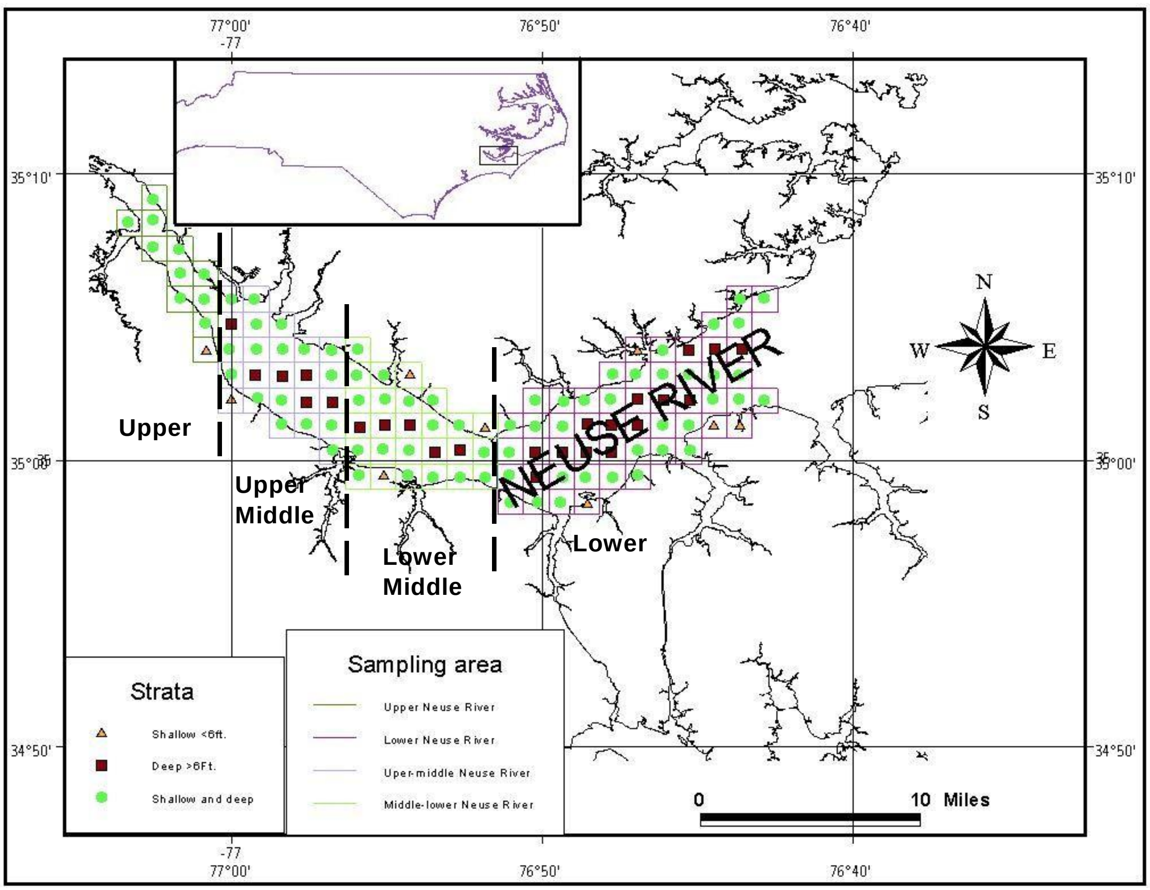

Figure 9. Program 915 sampling areas and grids for the Neuse River.

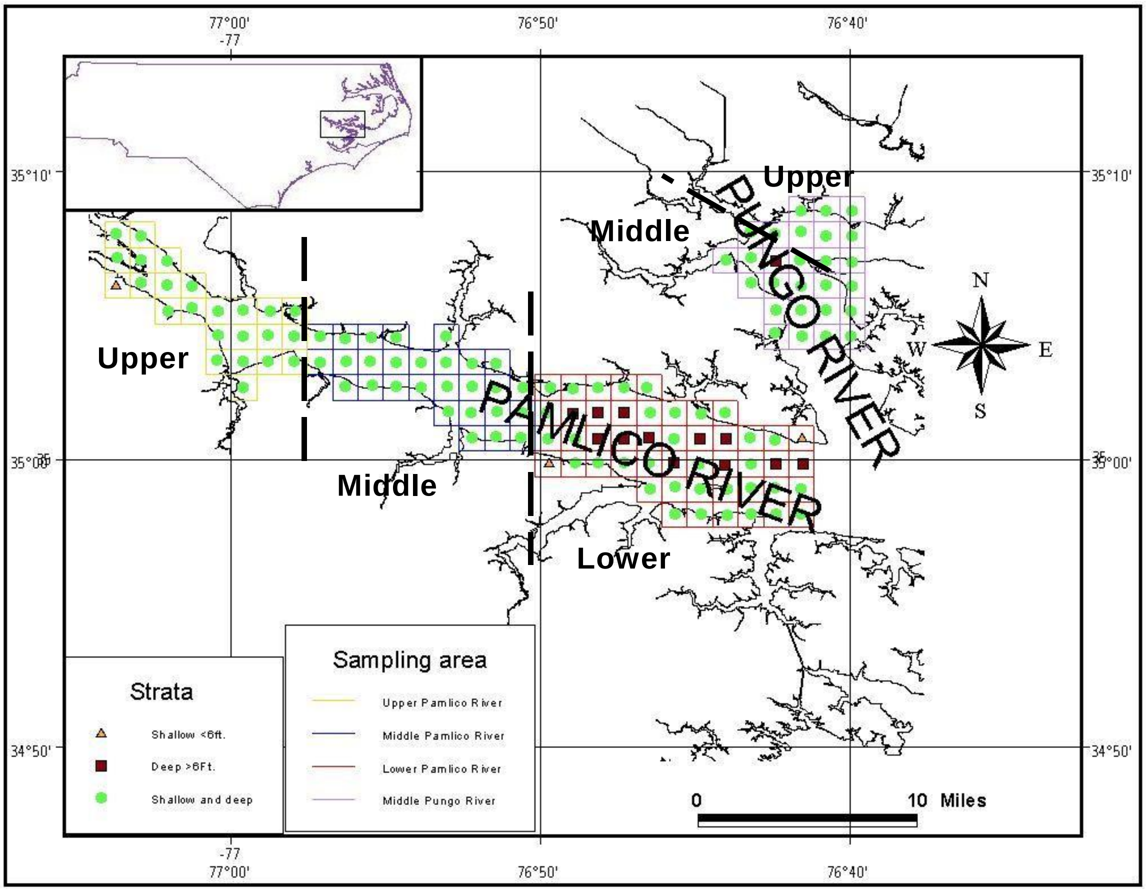

Figure 10. Program 915 sampling areas and grids for the Pamlico and Pungo rivers.

Review

Fishery independent gill net data from Program 915 IGN on the Neuse, Pamlico, and Pungo rivers demonstrated that the majority of all striped bass were captured in the upper and middle portions of the rivers. In addition, fishery dependent observer data also showed negligible striped bass catch rates in the lower portions of the Pamlico, Pungo, and Neuse rivers.

Neuse River data shows a CPUE (individuals per 240 yards) of 0.28 striped bass per sample in the lower area of the river or less than 7% of the striped bass captured (Table 27). The lower area of the Neuse that was sampled includes areas east of a line (76º48') that runs south from Minnesott Beach to Cherry Point (Figure 9). Table 27 also demonstrates that 83% of the striped bass were captured in the upper and upper middle portions of the Neuse River (Figure 9). Figure 11 shows the Neuse river striped bass CPUE distribution by grid within sampling areas and demonstrates negligible catch of striped bass within the lower portions of the rivers. Low striped bass interactions are also evident through observer data analysis (Figure 12 and Figure 13).

Table 27. Program 915 IGN Neuse River, including # of samples, # striped bass captured, and CPUE.

Neuse Areas	# of samples	# Striped bass	CPUE
Upper	222	418	1.88
Upper Middle	222	354	1.59
Lower Middle	214	87	0.41
Lower	220	62	0.28
Totals	878	921	0.95

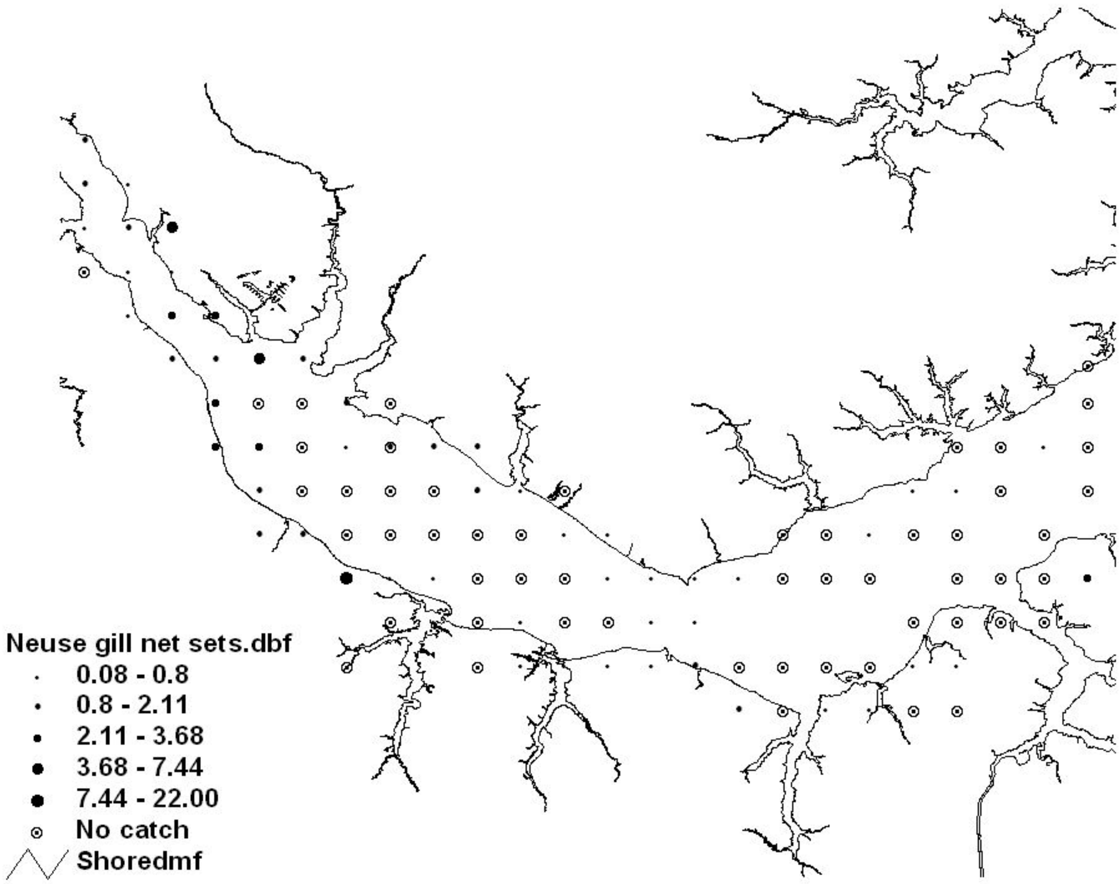

Figure 11. Program 915 IGN Neuse River striped bass CPUE distribution. All sites of striped bass capture are condensed to the lower right portion of the sampling grid, explaining why some legend points are located on land.

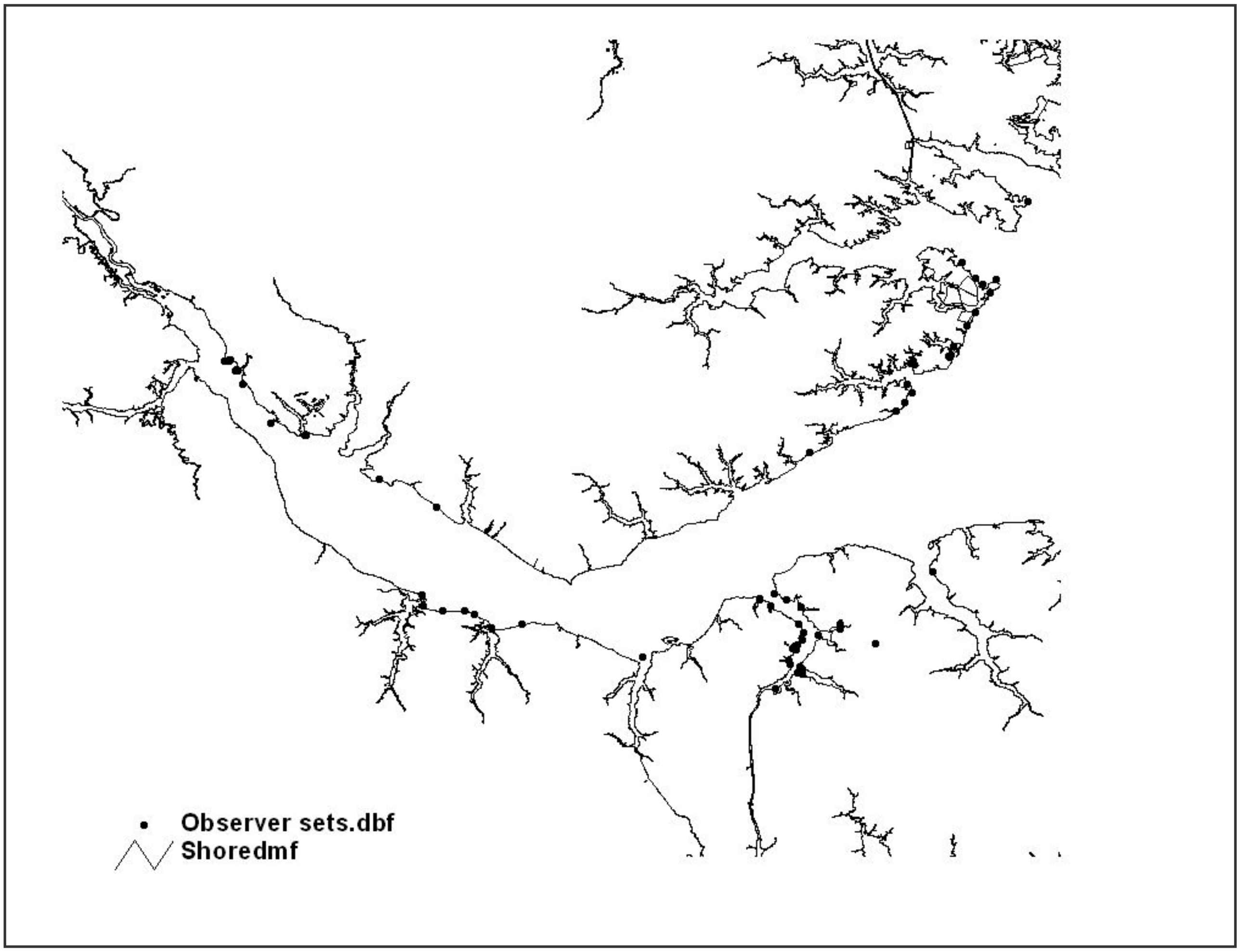

Figure 12. Program 466 observed gill net trips, Neuse River.

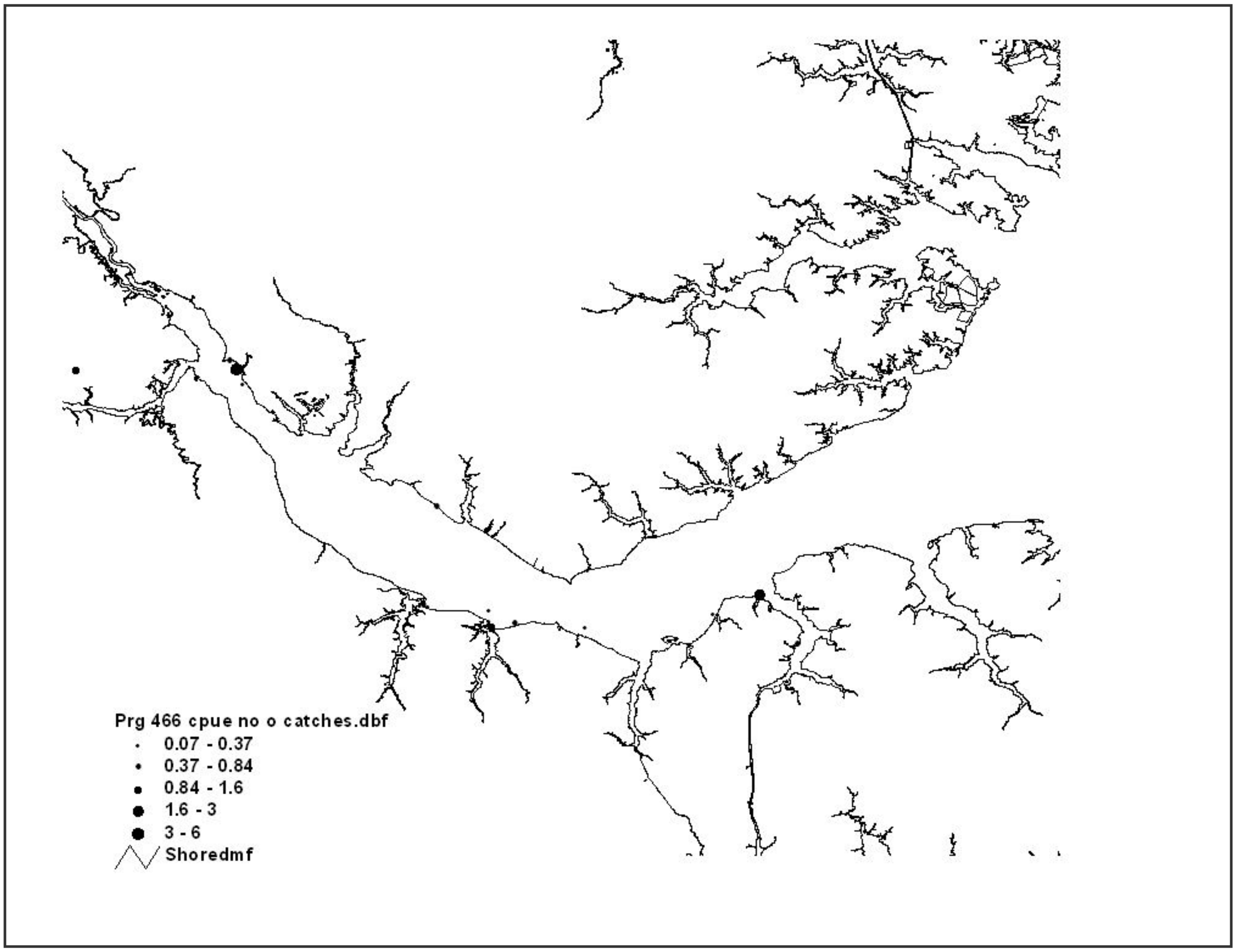

Figure 13. Program 466 observed gill net trips with striped bass CPUE, Neuse River.

Pamlico River program 915 data provides a CPUE of 0.30 striped bass per sample in the lower area of the river or less than 8% of the striped bass captured (Table 28). The lower area of the Pamlico River sampled includes areas east of a line (76º 46') that runs south from Gum Point to Fork Point (Figure 14). Table 28 also demonstrates that 67% of all striped bass were captured in the upper portions of the Pamlico River and demonstrates minimal catch of striped bass within the lower portions of the rivers. Figure 14 shows the Pamlico and Pungo Rivers CPUE distribution by grid within sampling areas. Pungo River data demonstrates a CPUE of 0.75 striped bass per sample in the middle portion of the river or 28% of all striped bass captured (Table 29). Table 29 also demonstrates that 72% of all striped bass were captured in the upper portions of the Pungo River. Low striped bass interactions are also evident through observer data analysis (Figure 15 and Figure 16).

Table 28. Program 915 IGN Pamlico River, including # of samples, # striped bass captured, and CPUE.

PamlicoArea	# of samples	# Striped bass	CPUE
Upper	254	681	2.68
Middle	250	252	1.01
Lower	245	74	0.30
Totals	749	1,007	1.34

Table 29. Program 915 IGN Pungo River, including # of samples, # striped bass captured, and CPUE.

Pungo Area	# of samples	# Striped bass	CPUE
Upper	42	81	1.93
Middle	197	148	0.75
Totals	239	229	0.95

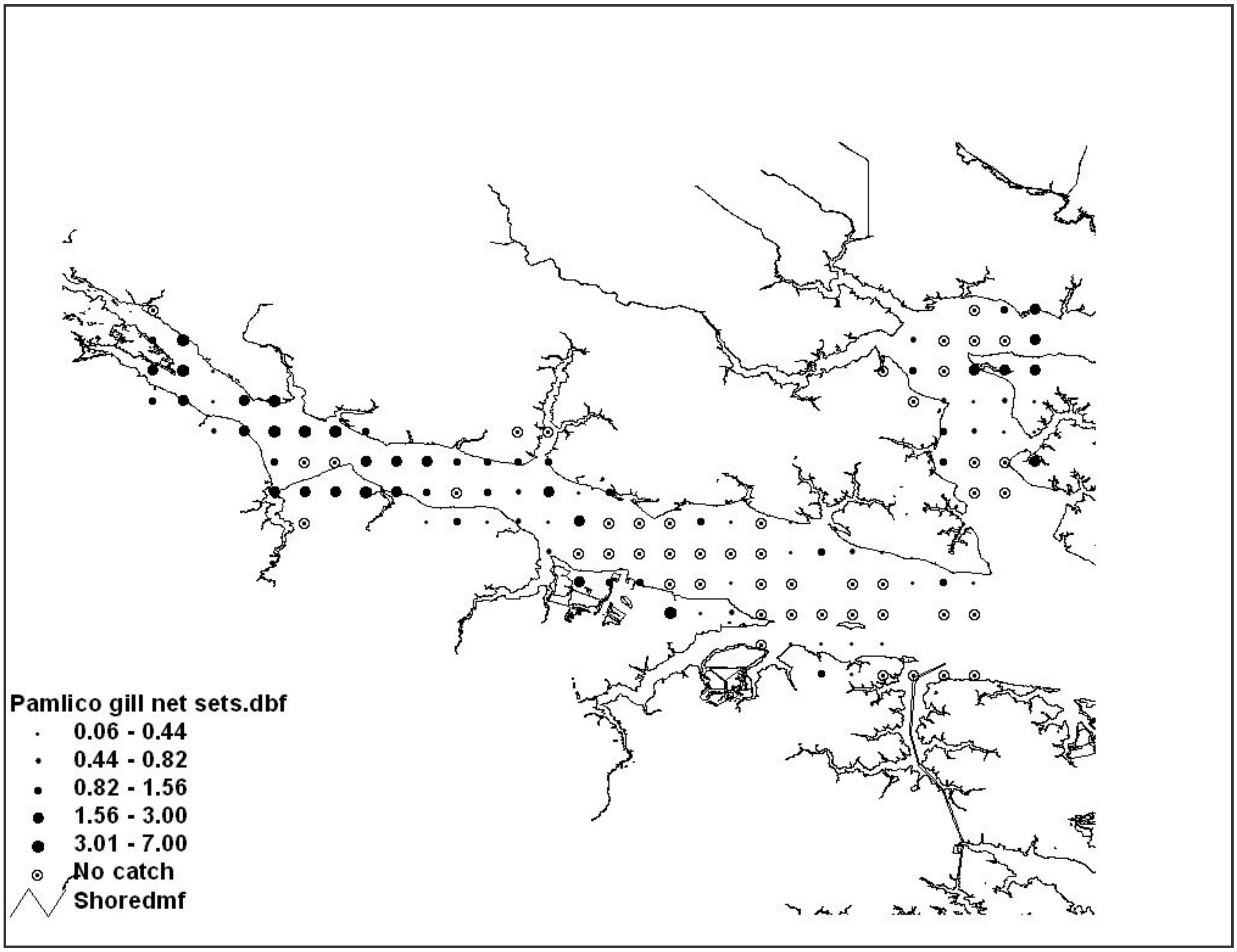

Figure 14. Program 915 IGN Pamlico and Pungo rivers striped bass CPUE distribution. All sites of striped bass capture are condensed to the lower right portion of the sampling grid, explaining why some legend points are located on land.

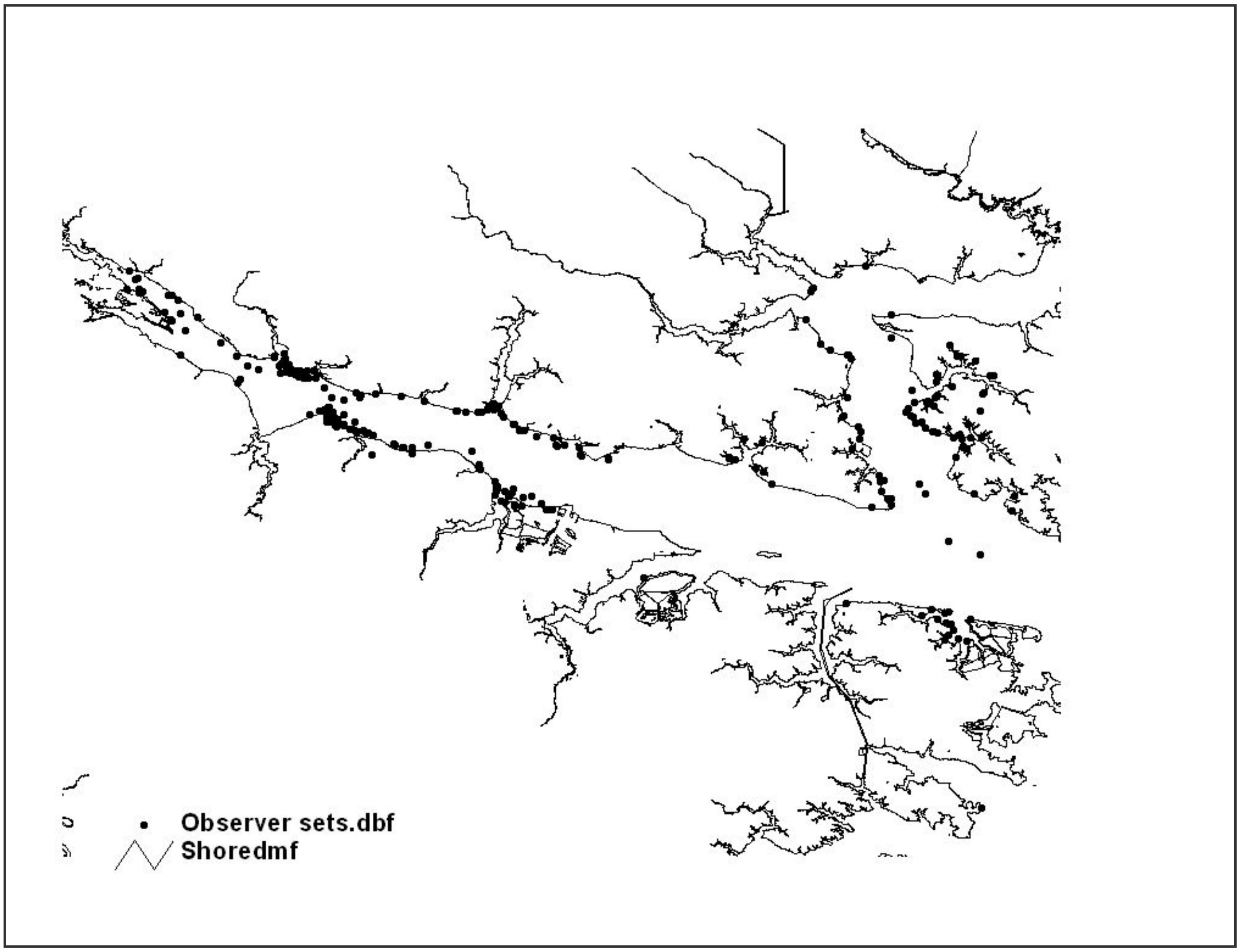

Figure 15. Program 466 observed gill net trips, Pamlico and Pungo rivers.

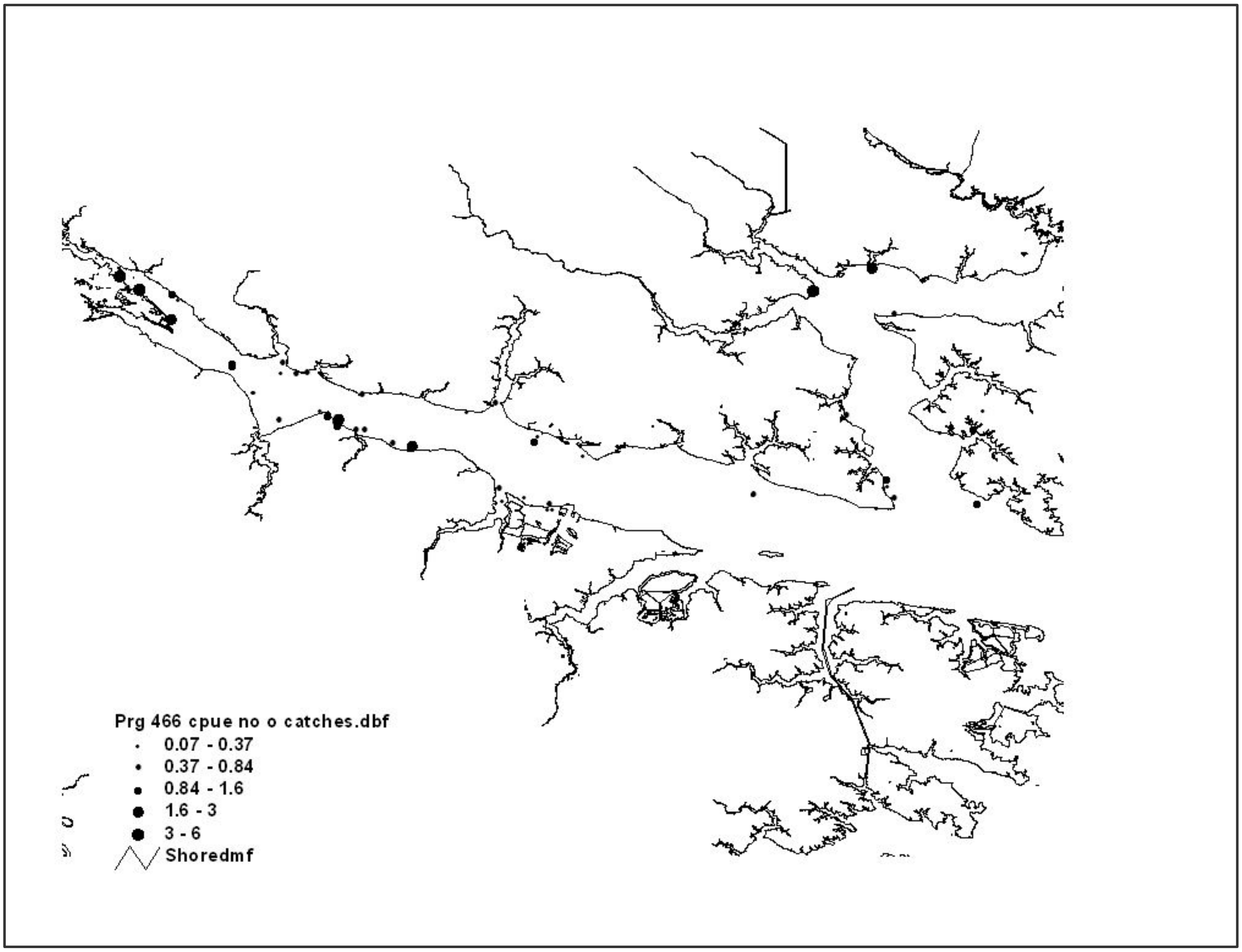

Figure 16. Program 466 observed gill net trips with striped bass CPUE., Pamlico and Pungo river s.

Cape Fear River System

The CSMA PDT objective was to maximize the likelihood of rebuilding the Cape Fear River stock. They recommended zero harvest for both the commercial and recreational fisheries. All available data from both the Division and WRC show a low abundance of adult striped bass in the Cape Fear River.

The CSMA AC rejected the PDT recommendation. The AC thought a no-harvest restriction was too severe, and water quality and dam blockages were the main reason for a declining stock not overfishing. The CSMA AC recommended dam removal. The Central AC also recommended dam removal. The Inland AC recommended no harvest and dam mitigation (fish bypasses).

The Southeast AC agreed with the PDT and recommended no-harvest. However, there was significant debate on wasteful bycatch practices in the shad fishery; high striped bass gill net mortality and discarding dead striped bass.

Additional data review for Cape Fear

Division Cape Fear River independent gill net data provides an average monthly mortality rate for striped bass from January through April, with a mean overall mortality rate of 42% (Table 30). Division sets were for a 24-hour period.

Table 30. Cape Fear River independent gill net data, striped bass survival.

MONTH	Survival			Survival		
	Alive %	Dead %	Total	Alive (n)	Dead (n)	Total
1	60.5	39.5	100	26	17	43
2	73.7	26.3	100	14	5	19
3	50	50	100	6	6	12
4	41.2	58.8	100	7	10	17
Totals	58.2	41.8	100	53	38	91

FRG - *Project No. 04-FEG-03* titled "Effects of gill net tie-downs on fish and bycatch rates associated with American Shad and flounder fisheries in southeastern North Carolina" was conducted in the Cape Fear River and compared finfish catch rates in tie-down sink nets versus control sink nets. Project data that was provided to the Division showed an average striped bass mortality of 60.9% (Table 31). The majority (60%) of the observed mortality took place in samples taken with soak times greater than 24 hours. In addition, 80% of this mortality took place in gill net samples taken within 50 yards of shore.

Table 31. FRG No. 04-FEG-03 Cape Fear River striped bass mortality (40 trips).

MONTH	Survival			Survival		
	Alive %	Dead %	Total	Alive (n)	Dead (n)	Total
1	36.4	63.6	100	4	7	11
2	100	0	100	4	0	4
3	33.4	66.6	100	10	20	30
4	37.5	62.5	100	9	15	24
Totals	39.1	60.9	100	27	42	69

Table 32 provides the annual landings of striped bass for the Cape Fear River. The fishery has contributed between 0.2 to 10.8% of the 25,000 annual CSMA commercial quota. In 2007 the quota monitoring data from permit holders indicated 232 fish harvested, with the majority (70%)of the harvest being taken in January and February.

Table 32. Cape Fear Commercial landings and total days striped bass season was open, 1998-2006.

Year	Landings (lbs)	Total Days
2007	1,303	92
2006	1,057	89
2005	2,721	118
2004	2,364	114
2003	68	111
2002	156	114
2001	129	113
2000	631	113
1999	1,631	113
1998	584	113

Recreational Measures CMA

Table 26 summarizes the recommendations from the CSMA AC and Regional ACs for the recreational fisheries in the CMA. The CSMA PDT recommended a summer closure May through September, 2 fish bag, and a slot (22-27”) in inland and joint waters. RCGL will be regulated by a combination of both the hook and line and commercial restrictions.

The CSMA AC rejected the PDT recommendation. The AC felt the hook and line restrictions were too severe given the fact that recreation mortality played such an insignificant role in striped bass overall mortality. The CSMA AC recommended a summer closure only, with the rationale that recreational summer closure combined with the large mesh gill net restrictions met the goal of a 62% reduction in overall mortality.

The Central AC and Southeast AC agreed with the same recommendations of the CSMA AC. Again their rationale was the recreational summer closure combined with the large mesh gill net restrictions met the goal in an overall reduction in striped bass mortality.

The Inland AC felt any recreational restrictions were too severe and recommended status quo for the recreational fishery.

Agency (DMF and WRC) Recommendations

Large Mesh Gill Net in the River systems

Require the use of a 3 foot tie down in large mesh (>5 in stretch mesh) gill nets, maintain a minimum distance from shore of 50 yards for these nets, except RCGL large mesh nets may be set within 50 yards of shore if attended at all times. Restrictions would be in place after the commercial TAC is met (spring) through 31 December of each year. After additional data review the agencies recommend that the originally proposed line of 76º 30’ be maintained for the tie-down restriction but the MDFS restriction be implemented further upstream of new lines as indicated below (reference Figures 17 and 18):

1) Neuse River- Minnesott Beach to Cherry Point (trawl line rule – 3J.0104b.5.D),
2) Pamlico River- Gum Point to Fork Point (designated pot area line – 3R.0107a.6.F),
3) PungoRiver- Sandy Point – Field Point.

The relocation of MDFS lines upstream will continue to minimize large mesh interactions with striped bass but avoid unintended hardships in the flounder fishery while still maintaining the required reduction of striped bass discard mortality.

Recreational CMA

Restrict harvest to months of October-April (required by approved FMP), 2 fish bag, 18 inch TL minimum size with a slot limit of 22-27 inches in joint and inland waters. To maximize the likelihood of meeting the FMP benchmarks, reductions in all components are needed. The uncertainty for each fishery component between the projected and what the actual future savings contribute to stock rebuilding requires a broader inclusive approach.

Cape Fear River system

Implement a zero harvest for both commercial and recreational, based on the review of stock condition and the evidence of minimal natural reproduction. Dam mitigation is a CHPP implementation objective and the Division is committed to pursuing that objective. However, the authority to remove the locks ultimately rests with the federal government. Setting the fishery seasons and take limits in order to rebuild a stock is a duty of the MFC and WRC, and the DMF and WRC believe a complete harvest moratorium will be necessary for this stock to ever have a reasonable chance of rebuilding. The waste from the resultant discard in the commercial fishery is acknowledged but the quantity is relatively minor. In order to have consistent measures and alleviate disparity between the recreational and commercial sectors, this waste is unavoidable for the long-term benefit of the stock.

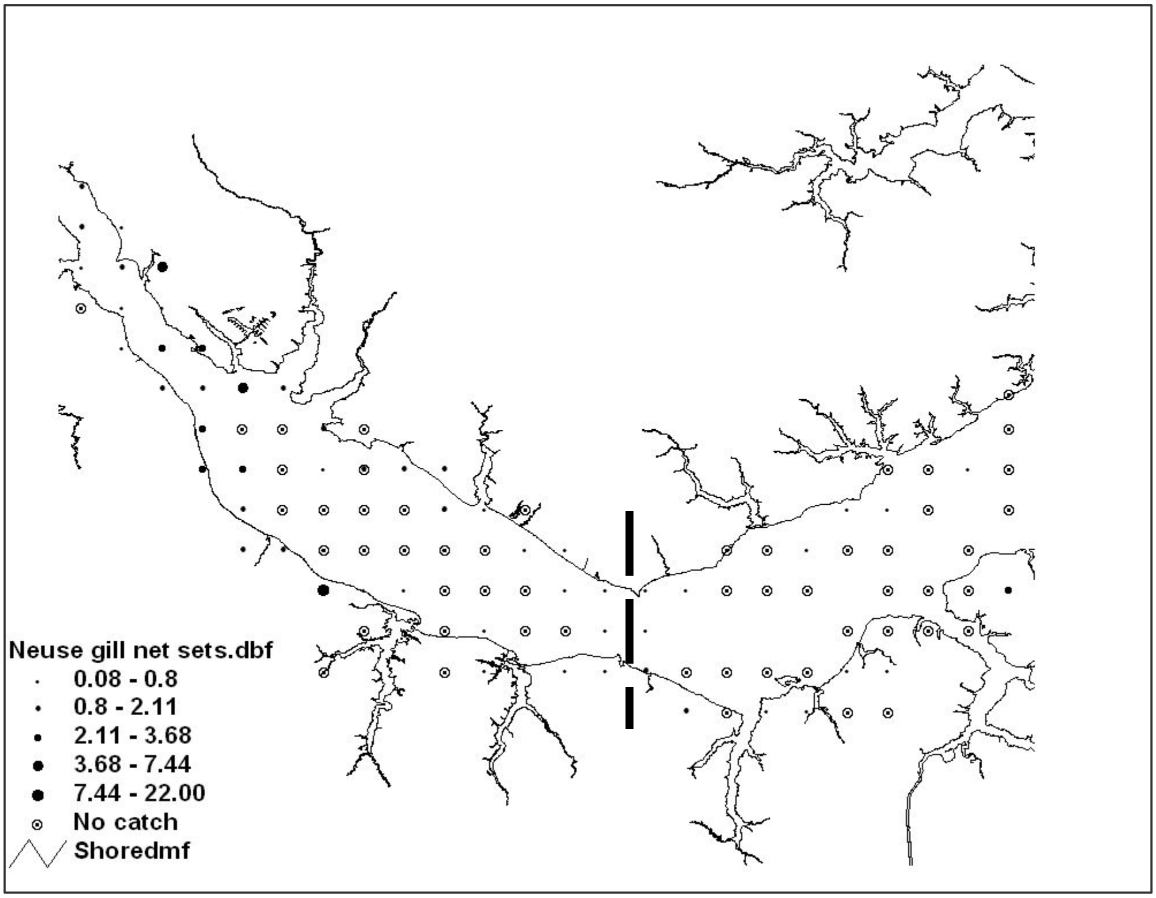

Figure 17. Distribution of 915 IGN Neuse River striped bass CPUE. All sites of striped bass capture are condensed to the lower right portion of the sampling grid, explaining why some legend points are located on land.

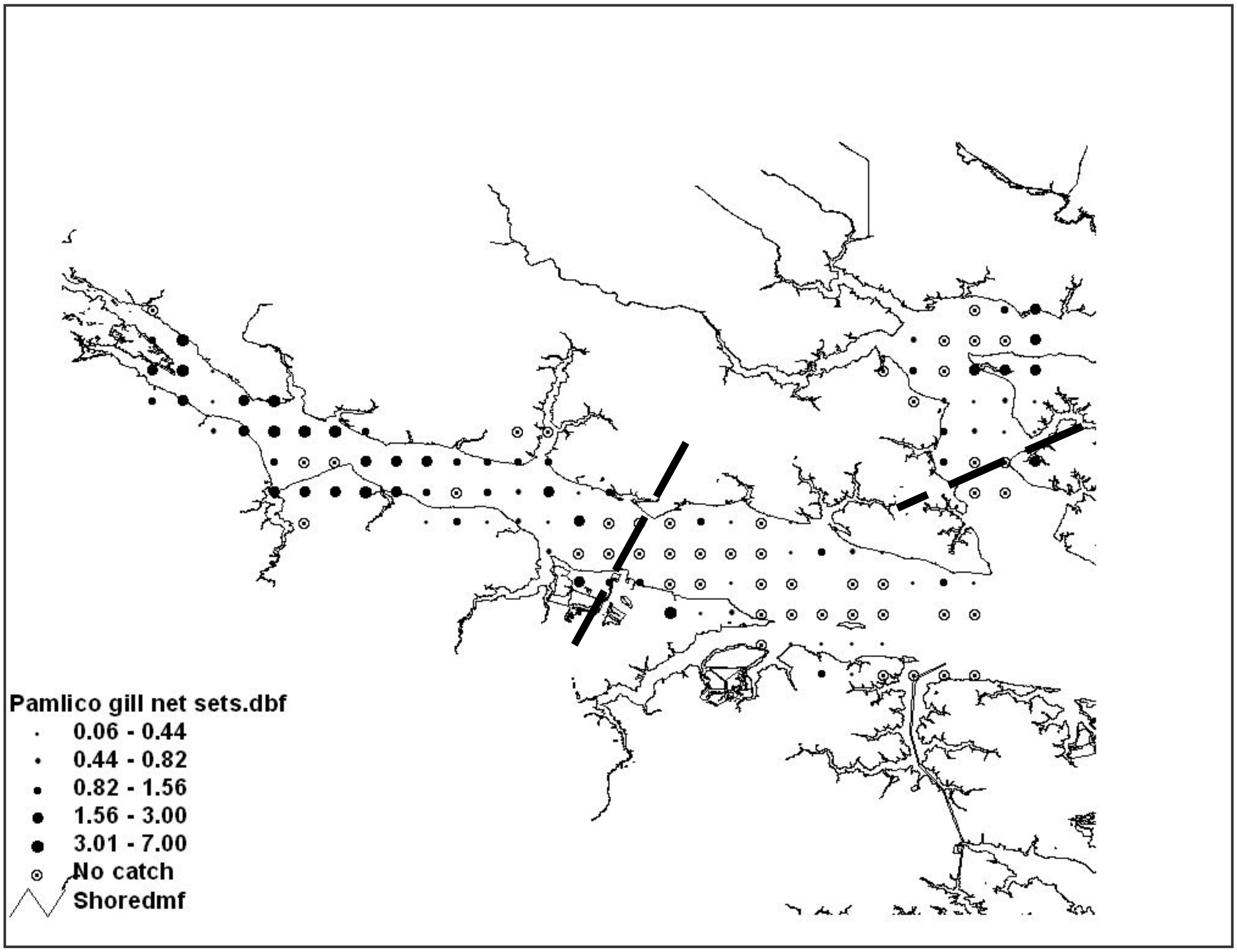

Figure 18. Distribution of 915 IGN Neuse River striped bass CPUE. All sites of striped bass capture are condensed to the lower right portion of the sampling grid, explaining why some legend points are located on land.

Proposed Rules

WRC and MFC will need to adopt rules to implement the proposed management measures. These draft rules are included in Attachment A.

Literature Referenced

Ashley, K.W.; and R.T. Rachels. 2005. Cape Fear River Basin Recreational Angler Creel Survey, 2003-2004. North Carolina Wildlife Resources Commission Division of Inland Fisheries. Raleigh, NC.

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Rundle, K.R.; Waters, C.T.; and R.D. Barwick. 2004. Neuse River Basin Sport Fishery Creel Survey, 2002-2003. North Carolina Wildlife Resources Commission Division of Inland Fisheries. Raleigh, NC.

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Unknown Author. 2000. Migratory Bird Bycatch in Submerged v/s Floating Shad Gill Nets, 99-FEG-34. Sea Grant North Carolina.

ATTACHMENT A

CSMA STRIPED BASS RULES
DRAFT ISSUE PAPER

July 12, 2007

I. ISSUE

Establish new management measures in the North Carolina Striped Bass Central Southern Management Area (CSMA). Rule changes are needed to: 1) establish an October 1 – April 30 harvest season for striped bass in the Tar/Pamlico and Neuse river basins; 2) establish a 2-fish daily creel limit (currently 3-fish per day) in the Tar/Pamlico and Neuse river basins; 3) implement a 22 to 27 inch protective slot limit in the joint waters of the Tar/Pamlico and Neuse river basins; and 4) impose zero harvest of striped bass in the Cape Fear River.

II. ORIGINATION

The joint WRC & DMF Plan Development Team (PDT) for the Estuarine Striped Bass FMP.

III. BACKGROUND

The 2004 Estuarine Striped Bass FMP was approved by the Marine Fisheries Commission (MFC) in May 2004 and by the Wildlife Resource Commission (WRC) in July 2004. The FMP specified a number of specific management actions but also allowed for additional data collection in the CSMA prior to determining measures to deal with reducing mortality in the recreational fishery and discards in the commercial large mesh gill net fishery. New data has been acquired and management actions can now be determined. The reduction of mortality in the recreational fishery and from commercial discards are the only issues that are being reconsidered at this time, with other issues having been debated, resolved and approved, by both the MFC and the WRC in the 2004 FMP.

The CSMA commercial fishery operates on a 25,000 pound annual quota and minimum size of 18 inches. The fishery has operated as a low harvest level fishery (5 to 10 fish per trip), using set seasons and daily landing limits. In the CSMA recreational fishery in coastal and joint waters the season is open year round with a 3 fish limit per person per day and an 18 inch minimum size. Inland waters require the same measures with the addition of a slot limit (22-27 inch not allowed) during May and April upstream.

IV. AUTHORITY

G.S. 113-134 MFC may adopt rules
113-182 Regulation of fishing and fisheries
113-182.1 Fishery Management Plans
113-221.1 Proclamations, emergency review
143B-289.52 MFC powers and duties

V. DISCUSSION

Assessment data collected in the Tar, Neuse and Cape Fear rivers continues to demonstrate low abundance of adult striped bass returning each spring to inland spawning areas in these systems. Fishing mortality rates established for these populations in the 2004 NC Striped Bass Fishery Management Plan continue to significantly exceed target and threshold levels for population recovery. The proposed changes would help conserve the available spawning stock, and would eliminate harvest during warm weather (greater than 70^{o}) months (May-September) when catch-and-release mortality is highest. Data on the Cape Fear River striped bass stock indicates that it is only a remnant population and that a complete elimination of directed harvest will be necessary for this stock to have a reasonable chance of rebuilding.

The WRC, MFC, and DMF will implement the agreed upon measures in their respective jurisdictions. The measures dealing with additional restrictions (seasonal tie downs, and minimum distance from shore) on large mesh gill nets will be implemented through proclamation. Rule 15A NCAC 03J.0103 grants the Director proclamation authority for gill nets and seines. The WRC is proposing modifications to 15A NCAC 10C .0305 (b) 5 to implement new measures in Inland Waters (see below). The following Section VI. describes the MFC and joint MFC/WRC rules that will be needed to implement new restrictions in joint and coastal waters.

VI. PROPOSED RULE(S)

MODIFY SUBCHAPTER 3M - FINFISH

SECTION .0200 – STRIPED BASS
15A NCAC 03M .0202 SEASONS, SIZE AND HARVEST LIMIT: INTERNAL COASTAL WATERS
15A NCAC 03M .0202 is proposed for amendment as follows

.0202 SEASON, SIZE AND HARVEST LIMIT: INTERNAL COASTAL WATERS

~~(a)~~ The Fisheries Director may, by proclamation, impose any or all the following restrictions on the taking of striped bass in a commercial fishing operation or for recreational purposes in internal coastal ~~waters:~~ waters during the period from October 1 through April 30:

(1) Specify fishing days and times, ~~season or seasons:~~
 ~~(A) for recreational purposes;~~
 ~~(B) for commercial fishing operations from October 1 through April 30,~~
(2) Specify areas,
(3) Specify ~~quantity,~~ quantity, except possession shall not exceed:
 (a) more than three fish in any one day in the Albemarle Sound Management Area as designated in 15A NCAC 03R .0201,
 (b) more than two fish in any one day in the joint and coastal fishing waters of the Central Southern Management Area as designated in 15A NCAC 03R .0201,
(4) Specify means/methods,
(5) Specify size, but the minimum size specified shall not be less than 18 inches total length,
(6) Require submission of statistical and biological data.

Fish that do not meet the minimum size limit specified by proclamation shall immediately be returned to the waters from which taken regardless of condition.

~~(b) The Fisheries Director may, by proclamation, impose any or all the following restrictions on the taking of striped bass by hook-and-line or for recreational purposes in internal coastal waters in order to comply with the management requirements incorporated in the North Carolina Estuarine Striped Bass Plan:~~

~~(1) Specify quantity, but shall not exceed possession of more than three fish in any one day, and~~
~~(2) Specify size, but the minimum size specified shall not be less than 18 inches total length.~~

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

MODIFY SUBCHAPTER 3Q – JURISDICTION OF AGENCIES
SECTION .0100 – GENERAL REGULATIONS JOINT
15A NCAC 03Q .0107 SPECIAL RULES, JOINT WATERS
15A NCAC 03Q .0107 is proposed for amendment as follows

.0107 SPECIAL RULES, 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 hybrids taken by any means which 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 during the months of May through September.
 (d) It is unlawful to possess striped bass or striped bass hybrids taken from the joint waters of the Cape Fear River.
 ~~(b)~~(e) It is unlawful to possess more than one daily creel limit of striped bass or their hybrids, in the aggregate, per person per day, regardless of the number of management areas fished, and fish possessed by the individual must be in compliance with the size and creel limits for the management area being fished.
 ~~(c)~~(f) 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 or net stakes 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. September 1, 2005; April 1, 2001; August 1, 2000.

Proposed WRC Rule text:
Title 15A 10C .0305 (b) 5
(5) In the inland fishing waters of ~~Cape Fear,~~ Neuse, Pee Dee, Pungo and Tar Pamlico rivers and their tributaries extending upstream to the first impoundment of the main course on the river or its tributaries, and Lake Mattamuskeet, the daily creel limit for striped bass and their hybrids is ~~three~~ two fish in aggregate. The ~~and the~~ minimum length limit is 18 inches~~.~~ and ~~In the Tar-Pamlico River and its tributaries upstream of the Grimesland bridge and in the Neuse River and its tributaries upstream of the NC 55 bridge in Lenoir County,~~ no striped bass or striped bass hybrids between the lengths of 22 inches and 27 inches shall be retained ~~during the period April 1 through May 31~~. In these waters, the season for taking and possessing striped bass is closed from May 1 through September 30. In the inland fishing waters of the Cape Fear River and its tributaries, the season for taking and possessing striped bass is closed year-round.

VII. RECOMMENDATION

Prepared by K West
12 July 2007

Attachment B **Central/Southern Management Area (CSMA) Small Mesh Gill Net Fishery Overview Presented to CSMA AC March 2007**
Issue

The PDT recognized the need to address the contribution of the small mesh gill net fishery to striped bass discard mortality within the CSMA. This issue paper has been created to explain current regulations, as well as provide relevant fisheries dependent and independent data.

Current Authority

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)
3H .0103 Proclamation Authority of Fisheries Director
3J .0103 Gill Nets, Seines, Identification, Restrictions
3R .0112 Attended Gill Net Areas
3O .0302 Authorized Gear (RCGL)
North Carolina Wildlife Commission Rules for Inland Waters (15A NCAC)
10C.0407 Permitted Special Devices and Open Seasons

Background

The estuarine gill net fishery in North Carolina is a year round multi-species fishery. Species targeted and mesh size used vary by season. Table 33 provides a breakdown of CSMA commercial gill net trips by season and area for 2003-2005 combined. A trip was classified based on the most predominant species in the catch by weight. The DMF trip ticket program does not provide specifics on the mesh size of the gear used, however based on the predominant species, the mesh size used on the trip can be inferred. Large mesh gill net trips constitute ~70% of all estuarine gill net trips taken in the CSMA (Table 33). This demonstrates that the small mesh is not the major component in the CSMA estuarine gill net fishery, however the small mesh fishery does contribute to total landings and discard mortality.

Based on the magnitude of the gill net fishery, in terms of amount of gear used, number of trips made, and the number of participants involved, there are management concerns, specifically:

- Negative public perception (gill net fishery perceived as a wasteful fishing practice)
- Type, quantity and disposition of species in the gill net bycatch
- Interactions with endangered species (i.e. sea turtles)
- Socioeconomic conflict between the recreational and commercial fisherman – “right to the resource”

In order to effectively manage this fishery the Division of Marine Fisheries (DMF) Director has proclamation authority for gill net and seines to specify area, season, mesh size, methods, and number and length. In addition the combination of two rules (3J .0103 and 3R.0112) help control red drum and striped bass bycatch while still allowing directed gill net fisheries for spot, mullet, bluefish, and Spanish mackerel. These rules have helped reduce the number of striped bass harvested from the Neuse and Tar River by unattended small mesh (less than 5 inch mesh) gill net since their statewide implementation in mid-1999. Evidence of the rules impact on the reduction in small mesh effort is seen in the trip ticket data. There was a 32 % reduction in the overall small mesh trips when comparing the average number to trips taken from 1994 to 1999 versus 2000-2005, with the mean number of trips declining from 8,352 to 5,680 (Table 34).

Table 33. CSMA commercial gill net trips by season and area, 2003-2005 combined. Shown is the mean number of trips per year and percent contribution to total. Shaded rows indicate species captured in large mesh gill net.

	CORE SOUND						PAMLICO AND NEUSE RIVER						PAMLICO SOUND						ALL AREAS	
	Attendance		Lifted		Combined		Attendance		Lifted		Combined		Attendance		Lifted		Combined		Total	
SPECIES	Mean	% Total	Mean	% Total	Mean	% Total	Mean	% Total	Mean	% Total	Mean	% Total	Mean	% Total	Mean	% Total	Mean	% Total	Mean	% Total
Bluefish	44	1.3	85	2.9	129	2	13	0.5	34	1.1	47	0.9	451	12	511	14	961	13	1,137	6
Catfish	1	0	27	0.9	28	0.4	14	0.6	178	5.9	192	3.5	2	0	6	0.2	8	0.1	228	1.2
Drum, Red	36	1	80	2.8	116	1.8	19	0.8	39	1.3	59	1.1	122	3.3	83	2.3	204	2.8	379	2
Flounders	2,946	85	966	33	3,912	61	2,169	89	1,077	36	3,246	60	2,507	67	1,149	33	3,656	50	10,815	57
Herring	0	0	0	0	0	0	0	0	8	0.3	8	0.1	0	0	27	0.8	27	0.4	35	0.2
Hickory Shad	0	0	35	1.2	35	0.5	0	0	151	5	151	2.8	0	0	232	6.6	232	3.2	417	2.2
Mackerel, Sp	6	0.2	4	0.1	10	0.2	12	0.5	1	0	13	0.2	336	9	11	0.3	347	4.8	370	1.9
Mullets	92	2.6	200	6.9	293	4.6	115	4.7	320	11	434	8	128	3.4	308	8.7	436	6	1,163	6.1
Perch, White	0	0	0	0	0	0	8	0.3	91	3	99	1.8	0	0	99	2.8	99	1.4	198	1
Sea Mullet	3	0.1	15	0.5	18	0.3	1	0	1	0	1	0	10	0.3	37	1	47	0.6	66	0.3
Shad	1	0	239	8.2	240	3.8	0	0	471	16	471	8.7	0	0	37	1	37	0.5	748	3.9
Spot	345	9.9	1,017	35	1,362	21	72	3	76	2.5	148	2.7	113	3	504	14	617	8.5	2,127	11
Striped Bass	0	0	75	2.6	75	1.2	0	0	375	12	375	6.9	0	0	134	3.8	134	1.8	584	3.1
Trout, Gray	5	0.1	50	1.7	55	0.9	0	0	12	0.4	12	0.2	61	1.6	205	5.8	266	3.7	333	1.7
Trout, Speckled	8	0.2	112	3.9	120	1.9	6	0.3	169	5.6	175	3.2	8	0.2	183	5.2	192	2.6	487	2.5
Total	3,487	100	2,905	100	6,392	100	2,429	100	3,001	100	5,430	100	3,738	100	3,525	100	7,264	100	19,086	100

Table 34. Total Small Mesh Trips by Area and Year

	Location			
Year	**Core Sound**	**Pamlico/Neuse River**	**Pamlico Sound**	**Total**
1994	2,267	1,400	4,421	8,088
1995	2,396	1,175	6,141	9,712
1996	2,261	1,048	3,852	7,161
1997	2,185	1,098	5,444	8,727
1998	2,091	1,031	4,913	8,035
1999	2,618	975	4,798	8,391
Total	13,818	6,727	29,569	50,114
Mean	2,303	1,121	4,928	8,352
2000	1,971	1,103	3,682	6,756
2001	1,837	875	3,342	6,054
2002	1,369	1,220	2,490	5,079
2003	1,776	814	2,701	5,291
2004	2,081	748	2,538	5,367
2005	1,413	974	3,147	5,534
Total	10,447	5,734	17,900	34,081
Mean	1,741	956	2,983	5,680

Small Mesh restrictions

Commercial Gill Net

Pamlico and Pungo rivers - attended gill net areas in 15A NCAC 3R.0112 (a) 1-4 are shown in Figure 17.

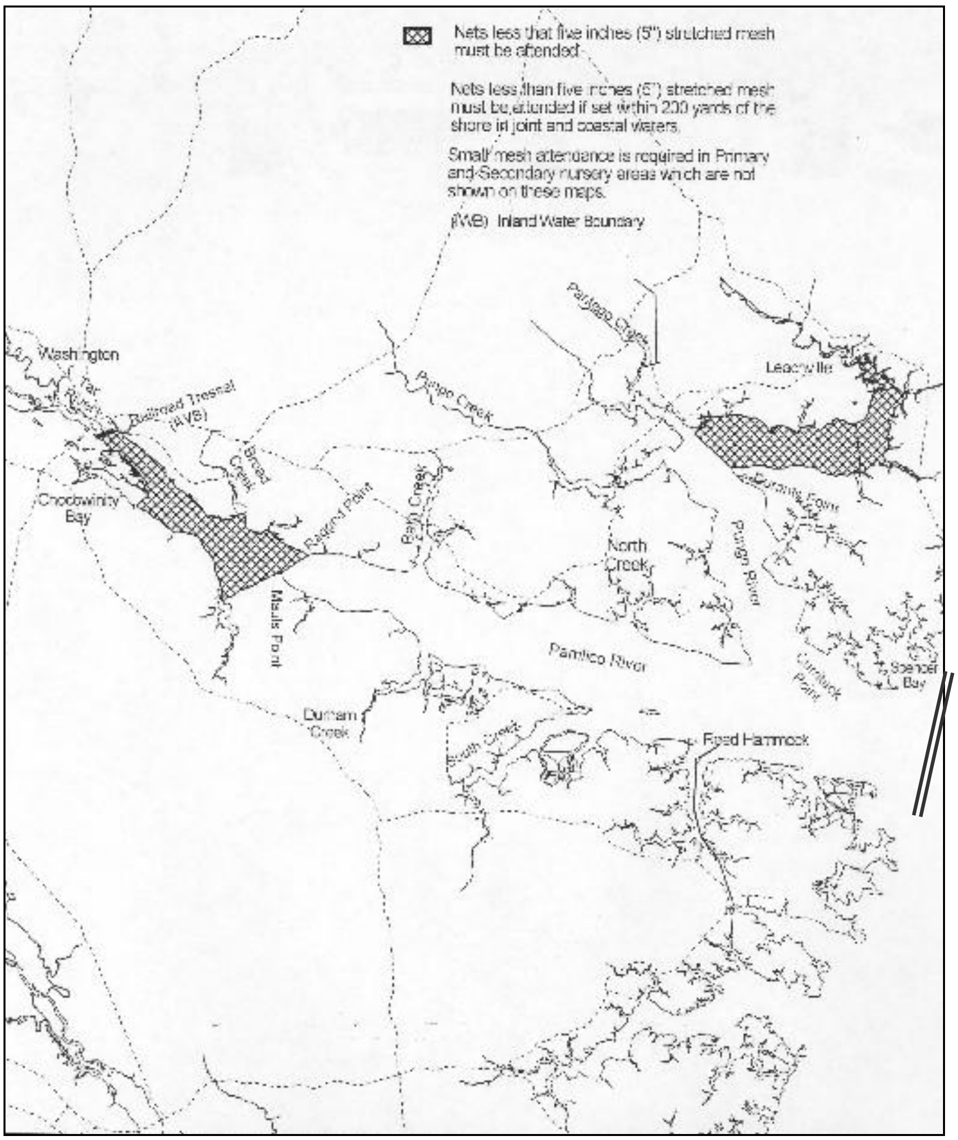

Figure 17. Pamlico and Pungo river small mesh attendance.

Small mesh gill net in grid-lined areas west of a line running from Ragged point to Mauls Point in the Pamlico River and east of a line running from the east side of Pantego Creek to Durants point in the Pungo River must be attended during all times of the year. Small mesh attendance is also required year round within 200 yards of shore in the lower portions of the Pamlico and Pungo Rivers and their tributaries down to a line running from Pamlico Point to Roos Point (Figure 17).

Neuse and Trent rivers - attended gill net areas in 15A NCAC 3R.0112 (a) 5-7 are shown in Figure 18.

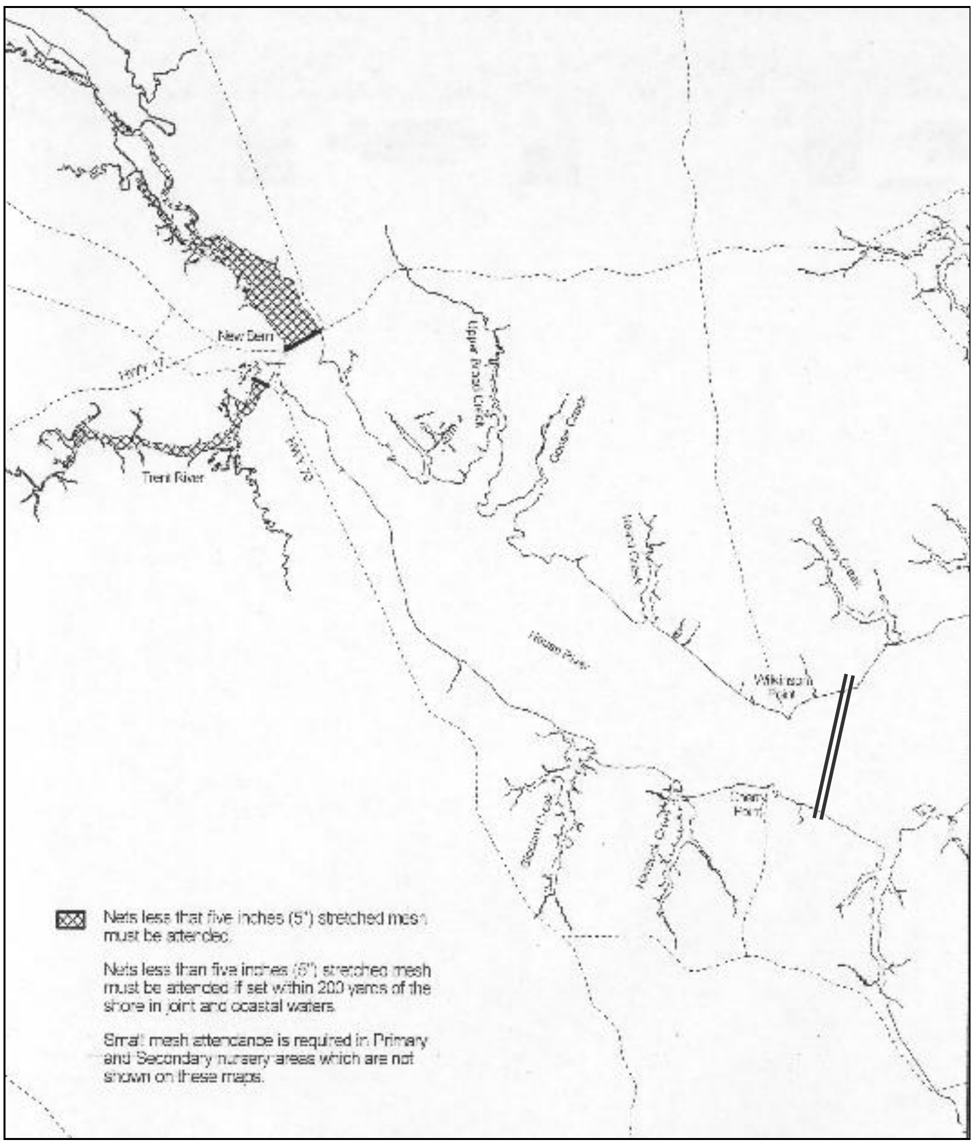

Figure 18. Neuse and Trent River small mesh attendance

Small mesh gill net in grid-lined areas northwest of the Highway 17 high-rise bridge on the Neuse River and south of Highway 17 on the Trent River must be attended during all times of the year. Small mesh attendance is also required year round within 200 yards of shore in the Neuse and Trent River down to a line running from Wilkinson Point to Cherry Point (Figure 18).

Core Sound attended gill net areas in 15A NCAC 3R.0112 (b) 3 are shown in Figure 19.

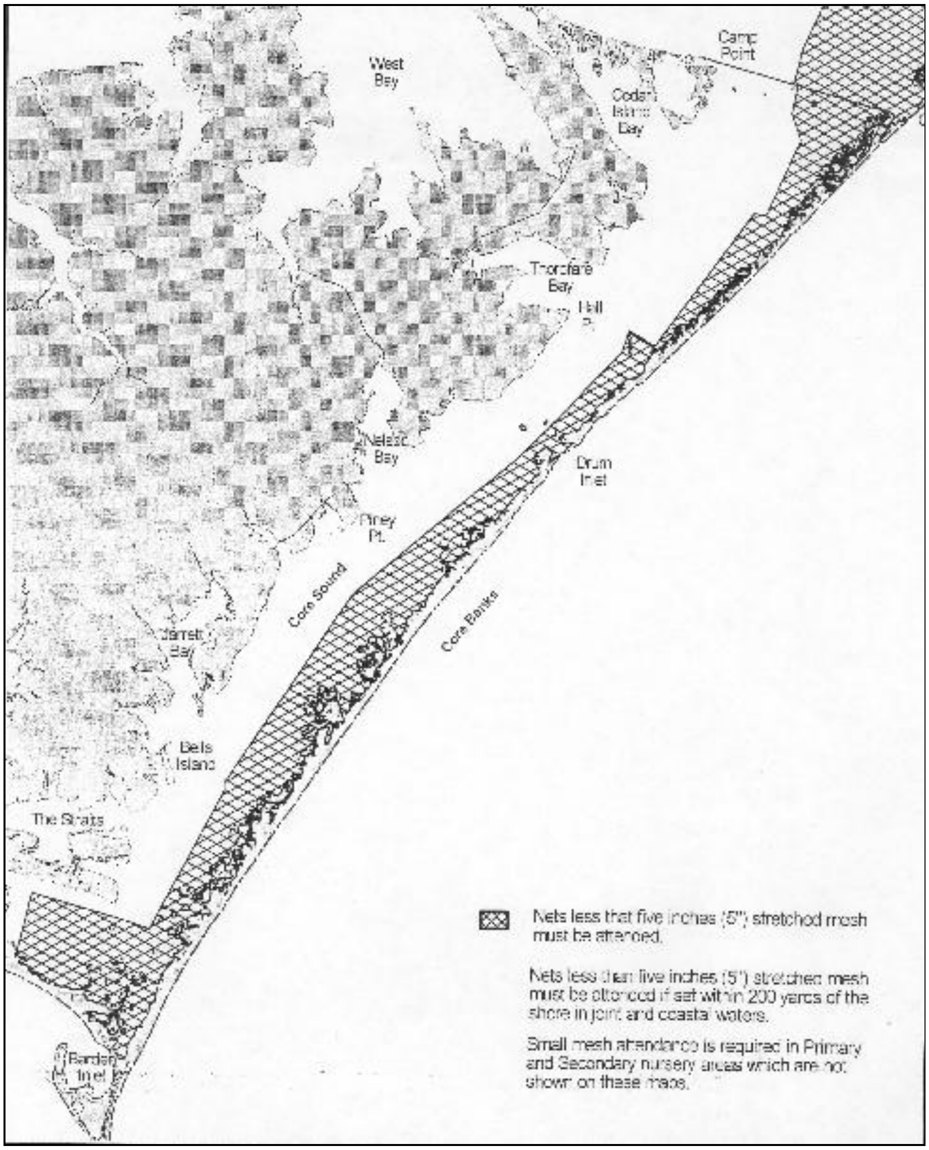

Figure 19. Core Sound small mesh attendance.

The Core Sound small mesh gill net attendance area is described as the grid-lined area starting at Wainwright Island and running south to a point off Shackleford Banks at a mean distance from shore of 1,700 yards. Small mesh attendance in this area is required May 1st through October 31st (Figure 19).

Pamlico Sound and Outer Banks attended gill net areas in 15A NCAC 3R.0112 (b) 1-2 are shown in Figure 20.

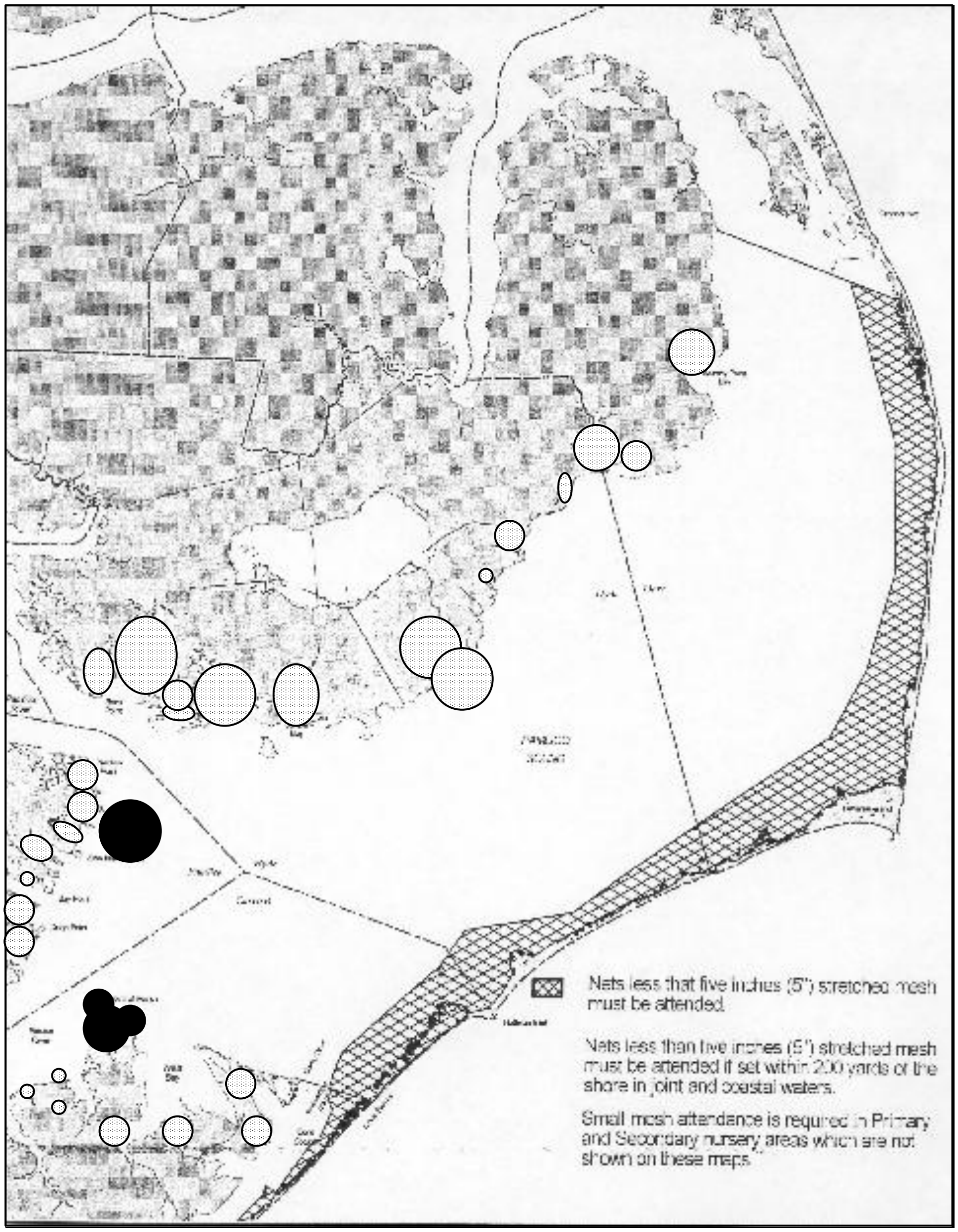

Figure 20. Pamlico Sound small mesh attendance

The Outer Banks small mesh gill net attendance area is described as a grid-lined area starting at Eagles Nest Bay running northwesterly to a point west of Pea Island then extending south to Wainwright Island at a mean distance from shore of 4,400 yards. Small mesh gill net attendance is also required in all primary and permanent secondary nursery areas highlighted with dotted rings. Military prohibited areas are highlighted with black rings. In all other waters shown in Figure 20 small mesh must be attended if set within 200 yards from shore. For all areas in Figure 20 small mesh attendance is required May 1st through October 31st, with the exception that the 200 yard attendance is not required south of Highway 12 in Carteret County during October. Small mesh gill net attendance is lifted in all areas during the cold-water months, November 1st through April 30th (Figure 20).

Recreation Commercial Gear License (RCGL) and Other Rules

The recreational users of small mesh gill nets are also under restrictions. Rule 3O.0302 stipulates that holders of a RCGL (allowed to use commercial gear but may not sale) are limited to 100 yards of small mesh (which for RCGL is defined as less than 5 ½ inch) net per person and not more that 200yards when two or more RCGL holders are onboard a vessel. All RCGL small mesh gill nets must be attended at all times. DMF surveys of RCGL fishermen have shown that on average (2003-2005) approximately 14,600 small mesh gill net trips are taken annually in the CSMA.

Rule 3J .0301 was also modified with the implementation of the Southern Flounder FMP and the rule modification eliminated the use of nets with a mesh size between 5 to 5 ½ inch in internal waters fromApril15th through December 15th. This rule took affect after the approval of the 2004 Estuarine Striped Bass FMP.

Since 2001 the WRC has not allowed the use of set nets in inland waters.

DMF Fishery Independent and Dependent Research

Gill Net Selectivity Program 462

Socioeconomic conflict between the recreational and commercial fisherman in the Neuse River led the Division to research catch rates and mortality of target species during cold-water months in which small mesh gill net attendance is lifted, November 1st through April 30th. The following data addresses concern over small mesh striped bass discards in the lower portions of the rivers and areas of the sounds in which unattended gill net is fished.

The Division conducted fisheries independent research to quantify catch rates and mortality of target species with respect to the month of capture. A total of 19 small mesh gill net samples were collected in creeks off the Neuse and Bay River during the months of October - December 2006 (Figure 21). This study utilized 3 separate gangs of net with each gang consisting of 3 nets (3½, 4, and 4½' stretched mesh, each 30 yards long by 8 feet deep). Nets were set perpendicular and as close to shore as possible. Nets were set, left unattended and then fished each preceding day with a target soak time of 24 hours. Selection of fishing days and area fished were based on weather conditions and fish abundance, with samples obtained in a manner that closely mirrored commercial fishing practices.

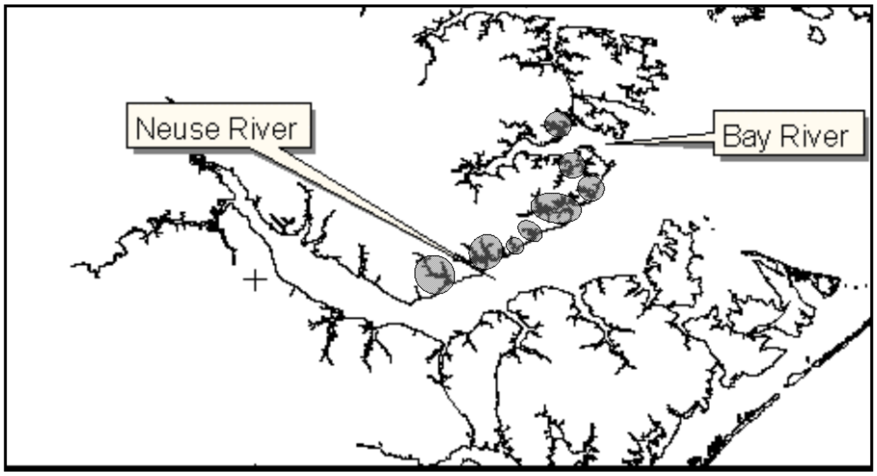

Figure 21. 462 Small Mesh Gill Net Sampling Areas.

Catch Rates of Target Species

Striped bass made up 1% of the total catch by number when examining only target species, specifically striped mullet, red drum, speckled trout and striped bass (Figure 22). Percent of the total catch for other target species was 53% striped mullet, 33% red drum, and 13% speckled trout. During the 3-month study a total of 9 striped bass were captured and when all species captured are included, striped bass consisted of 0.6% of the total catch by number. A total of 5,130 yards of small mesh gill net was set yielding a CPUE of 1.0 striped bass captured every 570 yards of small mesh net or 0.47 striped bass captured per sample day. The low striped bass catch rates indicate that during this time of year the Neuse river stock is not concentrated in the lower portions of the river.

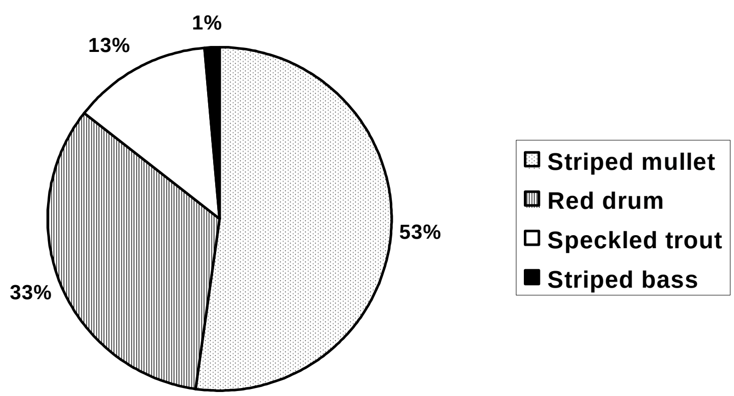

Figure 22. Target Species Percent of Total Number

Survival and Mortality of Target Species

The extremely small sample size of striped bass more than likely will not show a true representation of mortality; however, 5 of the 9 animals captured were released alive. Samples sizes of other target species captured, specifically striped mullet (n=330), red drum (n=210), and speckled trout (n=82) may be indicative of commercial small mesh gill net survival and mortality. Comparisons were made with respect to month captured, October (required attendance) versus November/December (months small mesh attendance is lifted). Speckled trout survival increased from 43% to 69% from October to November - December of 2006, an increase of 26%. Striped mullet survival decreased slightly from 92% to 84% from October to November/December of 2006, a decrease of 8%. The species that gill net attendance was intended to protect had an overall increase in survival of 27%. Red drum survival increased from 51% in October to 78% in November – December of 2006 (Figure 23). The increase in survival as the water temperature decreases has been noted in other studies as well. Striking a balance between the attendance burden placed on the fishermen and the need to increase survivability of bycatch was the intent of the MFC seasonal attendance for small mesh gill net rule.

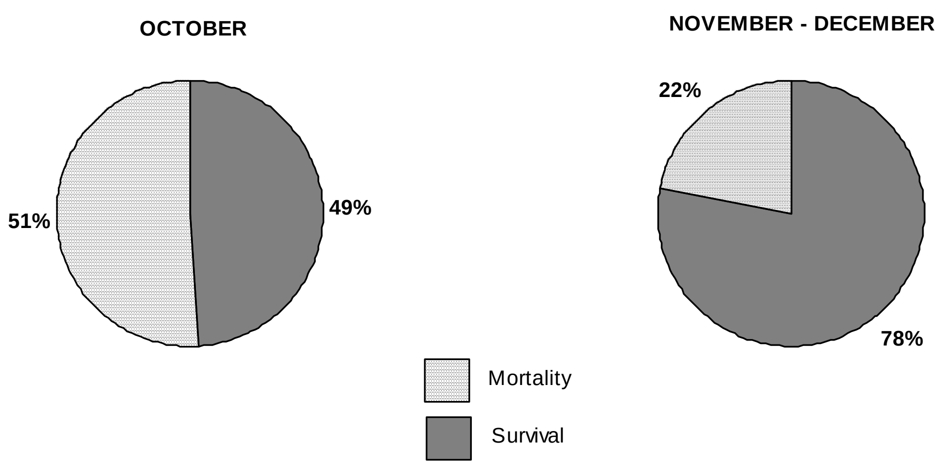

Figure 23. Red drum mortality vs. survival

Independent Gill Net Study (Program 915) and Commercial Observer Study (Program 466)

The DMF has two other sources of data that provide information on potential striped bass take from small mesh gillnets. The DMF Independent Gill Net Survey and Fishery Dependent Observer data that characterizes small mesh fishery .

IGN Program 915

This fishery independent study utilized 2 separate gangs of float net. Each gang consisted of 30-yard segments of 3, 3½, 4, 4½, 5, 5½, 6, and 6 ½ inch stretched mesh, for a total of 480 yards of nets combined. Nets were deployed parallel or perpendicular to the shore based on the strata and common fishing techniques for the area. Nets were set in the evening and fished the following morning with a target soak time of 12 hours.

Table 35 provides CPUE by area and time of year for 2004-2006 combined. Only capture rates from small mesh nets (<5 inch stretched mesh) are included. River CPUE (number per 120 yards) was highest during November and December (1.92 fish/small mesh sample). CPUE was low and steady throughout all years in the Pamlico Sound. In 771 samples collected over a three year period in the Pamlico Sound, a total of 89 striped bass were captured, yielding a CPUE of 0.12 striped bass per sample. Data yielded a 93% decrease in CPUE when comparing Pamlico Sound to the rivers (CPUE=1.41). The Neuse and Tar river striped bass stocks are found mainly in the rivers and are not concentrated in Pamlico Sound

Table 35. Striped bass small mesh CPUE (Program 915) by area and season, 2004-2006.

	Pamlico/Pungo/Neuse River			Pamlico Sound		
	CPUE	# Captured	# of Samples	CPUE	# Captured	# of Samples
Jan-April	1.01	145	144	0.15	21	143
May-Oct	1.43	781	548	0.10	55	525
Nov-Dec	1.92	186	97	0.13	13	103
Mean	1.41	1112	789	0.12	89	771

Observer Work

Table 36 describes Program 466 fishery dependent observer data for small mesh set gill nets. The DMF program utilizes ECU contracted biologists who accompany fishermen on their fishing trips. All catch (harvest and bycatch) is examined and sampled. For this program the CPUE is shown as the number of fish per 100 yards of gill net, with a yearly average CPUE of 0.03 and 0.05 striped bass captured in the sound and rivers, respectively (Table 36). Striped bass CPUE shows insignificant catch rates in both the sound and river small mesh gill net fishery, again indicating the small mesh fishery does not significantly contribute to striped bass discard mortality. When looking at all areas combined a total of 163 trips were observed, with a total of 38,275 number of finfish captured (Table 37). Striped bass During the 3-year time span a total of 39 striped bass were captured in 19 trips taken, amounting to 0.1% of the total catch by number observed in trips. This program indicated the CSMA small mesh fishery is presently not a major factor in striped bass discard mortality.

Table 36. Striped bass CPUE by area and season for commercial observer program 466, 2004-2006.

	Pamlico Sound					Pamlico/Pungo/Neuse Rivers				
	CPUE	# Captured	Total Yardage	Trips	Mean Yardage	CPUE	# Captured	Total Yardage	Trips	Mean Yardage
Jan-April	0.07	25	38,110	45	847	0.06	9	14,070	29	485
May-Oct	0.01	1	13,020	27	543	0.01	1	7,225	14	516
Nov-Dec	0.01	2	29,015	46	631	0.10	1	1,050	2	525
Combined	0.03	28	80,145	118	673	0.05	11	22,345	45	509

Table 37. Program 466 total number of trips and species captured in the CSMA observed small mesh fishery. One hundred and sixty three commercial trips were observed, 2004-2006.

Species	# of Trips Observed (n = 163)	Total Number
Atlantic menhaden	123	19,250
spot	94	5,912
bluefish	73	2,915
white perch	59	2,587
weakfish	94	1,695
hickory shad	47	1,515
kingfishes	40	652
striped mullet	54	648
gizzard shad	27	576
black drum	48	544
alewife	10	452
red drum	56	327
Atlantic croaker	45	296

spotted seatrout	60	233
butterfish	15	149
southern flounder	37	99
pigfish	10	55
striped bass	19	39
butterfishes	3	31
Spanish mackerel	7	30
blue crab	6	26
spiny dogfish	9	25
cownose ray	4	22
pinfish	10	22
Florida pompano	3	20
southern kingfish	7	16
American shad	8	14
hogchoker	7	11
common carp	3	10
sheepshead	8	10
cat sharks	3	9
horseshoe crab	7	8
longnose gar	5	6
lyre goby	1	5
summer flounder	5	5
Cormorant	5	5
Atlantic sturgeon	4	4
smooth dogfish	2	3
Atlantic stingray	2	3
channel catfish	1	3
searobins	2	3
silver perch	3	3
Other	32	37
Total	163	38,275

DMF Studies on Small Mesh Striped Bass Bycatch (FRG)

Project No. 00-FEG-08 titled “Characterization of small mesh gill net bycatch in the upper Currituck sound” was conducted to address concern of striped bass bycatch in the white perch small mesh fishery. All nets were 100 yards long, by eight feet deep, and consisted of 3.25 inch stretched mesh. Total yardage of net fished and samples taken was not specified. The spring small mesh study took place from January-April 2001. Striped bass made up 1% of the total catch, with an increased number alive related to lower water temperatures and increased oxygen content.

Conclusion

The data presented indicates that striped bass discard mortality in the CSMA small mesh fishery is currently minimal as little interaction with striped bass has been observed. In the development of the 2004 Estuarine Striped Bass FMP the PDT and AC discussed whether additional restrictions were needed on small mesh gill nets in the CSMA. Based on the types of information presented here, the final approved FMP only included the direction to implement tie down restrictions in the large mesh river area fishery. However, as striped bass abundance increases in the CSMA, we will need to continue to monitor the impact of the small mesh gill net fishery to insure this practice does not negate conservation efforts.

14.9 SUMMARY OF MANAGEMENT RECOMMENDATIONS AND PUBLIC COMMENT BY ISSUE

MEMO

TO: The NC Marine Fisheries Commission, NC Wildlife Resources Commission, NC Estuarine Striped Bass Plan Development Team, and NC Estuarine Striped Bass FMP Albemarle/Roanoke and Central Southern Management Area Advisory Committees (AC).

CC: Louis Daniel Ph. D., Dee Lupton, David Taylor, Michelle Duval Ph. D., Kathy Rawls, Kevin Dockendorf

FR: Charlton Godwin and Katy West

RE: Amendment I to the NC Estuarine Striped Bass FMP, Public Comment and NCMFC Standing and Regional AC's Research and Management Recommendations

DA: 17 October 2011

The following tables summarize the Advisory Committee's (AC's) and agencies' (NCDMF and NCWRC as this is a joint FMP) Management Recommendations regarding the Issues identified in the draft NC Estuarine Striped Bass FMP Amendment I. Also included are the Research and Management Recommendations from other Sections within the FMP. Also summarized is Public Comment received at six Public Meetings held in conjunction with the AC meetings.

Table 1. Issues developed through the NC Estuarine Striped Bass FMP Amendment I process, and the NCMFC's Albemarle/Roanoke and Central Southern FMP ACs and the NCDMF and NCWRC Management Recommendations on those Issues.			
ISSUE	**A/R AC RECOMMENDATION**	**CSMA AC RECOMMENDATION**	**NCDMF/NCWRC RECOMMENDATION**
Atlantic Ocean Summertime Recreational Harvest Closure	Close the Atlantic Ocean to the harvest of striped bass from the time the ASMA recreational season closes in the spring until October 1 of each year.	Status quo; allow the fishery to continue with the catch card survey May 1 through Oct 30.	Close the Atlantic Ocean to the harvest of striped bass from the time the ASMA recreational season closes in the spring until October 1 of each year.
Striped Bass Stocking in Coastal Rivers	Status quo on stocking; Target of 100,000 fish stocked annually in each of the three CSMA systems (Tar/Pamlico, Neuse, and Cape Fear), with 3,000 stocked fish tagged in each system annually.		
Require the Use of Single Barbless Hook During Striped Bass Recreational Closed Season	Status quo and continue to educate anglers on conservative angling practices for striped bass.	Status quo and educate anglers on ethical angling practices, with additional recommendation to include mortality statistics associated with various handling techniques	Status quo and continue to educate anglers on conservative angling practices for striped bass.
ASMA/CSMA and ASMA/RRMA Boundary Line Changes	Support necessary rule changes to create new boundaries.	Support necessary rule changes to create new boundaries.	Support necessary rule changes to create new boundaries.
CSMA Discards	N/A	Status quo on current management measures and does not support DFS proposal.	Status quo on current management measures and does not support DFS proposal.
Hook and Line as Commercial Gear in Estuarine Waters	Status quo; do not allow Hook and Line as a commercial gear for striped bass.	Status quo with adaptive management; do not allow Hook and Line as commercial gear for striped bass unless future restrictions on the use of gill nets necessitate alternative commercial gears.	Status quo with adaptive management; do not allow Hook and Line as commercial gear for striped bass unless future restrictions on the use of gill nets necessitate alternative commercial gears.
Management of CSMA Fisheries	N/A	Status quo on all management measures with the addition of a pound for pound payback overage in the commercial fishery and does not support the DFS proposal.	Status quo on all management measures with the addition of a pound for pound payback overage in the commercial fishery and does not support the DFS proposal.
Management of ASMA/RRMA Fisheries (was not a formal Issue Paper)	Status Quo on the current management regime.	N/A	Status Quo on the current management regime.

Table 2. Issues developed through the NC Estuarine Striped Bass FMP Amendment I process and the NCMFC standing and regional AC's Management Recommendations on those Issues.				
ISSUE	**Atlantic Ocean summertime recreational harvest closure**	**Striped bass stocking in the CSMA**	**Require single barbless hooks during summertime catch and release fisheries**	**ASMA RRMA Boundary Line Change**
Finfish AC	Status quo- continue the fishery with catch card May-Oct	Status quo-100,000 fish per year per system	Status quo and educate anglers on ethical angling practices	Support rule change for new boundary points
Inland AC	Supports the Atlantic Ocean summertime recreational harvest closure	Status quo-100,000 fish per year per system	Status quo and educate anglers on ethical angling practices, with additional recommendation to include mortality statistics associated with various handling techniques	Support rule change for new boundary points
Central AC	Status quo- continue the fishery with catch card May-Oct	Recommend stocking 150,000 fish per year per system	Status quo and educate anglers on ethical angling practices	Support rule change for new boundary points
SE AC	Supports the Atlantic Ocean summertime recreational harvest closure	Status quo-100,000 fish per year per system, PLUS evaluate cost effectiveness of current stocking program	Status quo and educate anglers on ethical angling practices, with additional recommendation to include mortality statistics associated with various handling techniques	Support rule change for new boundary points

NE AC	Status quo - continue the fishery with catch card May-Oct **<u>4 to 4 tie vote: Motion Fails</u>**	Status quo-100,000 fish per year per system	Status quo and educate anglers on ethical angling practices	Support rule change for new boundary points

Table 2. Continued

ISSUE	Discards in the CSMA	Hook and line as commercial gear	Current management measures in the CSMA	Current management measures in the ASMA/RRMA
Finfish AC	Status quo with tie down line and distance from shore (DFS) lines	Status quo with adaptive management if future restrictions require the use of alternative gear	Status quo with the addition of a commercial overage payback provision	Status quo with all current management measures
Inland AC	Status quo with tie down line and distance from shore lines	Status quo with adaptive management if future restrictions require the use of alternative gear	Status quo with the addition of a commercial overage payback provision	Status quo with all current management measures
Central AC	Status quo with tie down line and the addition of moving the DFS lines upriver to the points specified in the Cuthrell map by proclamation from June 15 to August 31, at which point the DFS lines are to be restored to the original position	Status quo with adaptive management if future restrictions require the use of alternative gear	Status quo WITHOUT the addition of a commercial overage payback provision measures (includes the recommendation from the Discards in the CSMA Issue Paper)	Status quo with all current management

SE AC	Status quo with tie down line and distance from shore lines	Status quo with adaptive management if future restrictions require the use of alternative gear	Status quo with the addition of a commercial overage payback provision	Status quo with all current management measures
NE AC	Status quo with tie down line and distance from shore lines	Status quo with adaptive management if future restrictions require the use of alternative gear	Status quo with the addition of a commercial overage AND underage payback provision	Status quo with all current management measures

RESEARCH NEEDS AND MANAGEMENT RECOMMENDATIONS FROM THE NC ESTUARINE STRIPED BASS FMP AMENDMENT I

The Habitat and Water Quality MFC AC voted at their September 12, 2011 meeting to support and implement the following Research and Management Recommendations relative to striped bass from the 2010 Coastal Habitat Protection Plan, as well as the Research and Management Recommendations identified in Section 10, Environmental Status, of the FMP:

RECOMMENDATIONS THAT SHOULD BE SUPPORTED AND IMPLEMENTED IDENTIFIED IN THE 2010 COASTAL HABITAT PROTECTION PLAN:

- There should be continued support and development of SHAs in NC.
- Once the SHAs have been designated there should be continued protection of these areas by the cooperating agencies.
- Work with WRC, DWQ, and others to implement management measures that will enhance water quality in areas used by striped bass.
- Work with American Rivers and other partners to accelerate dam removal in priority areas.
- Agencies should continue to protect NC coastal wetlands through the permit review process. Quantify the density and distribution of striped bass eggs, fry, and juveniles in coastal rivers to estimate potential losses to entrainment and impingement.
- Determine if contaminants are present in striped bass habitats and identify those that are potentially detrimental to various life history stages.
- Evaluate the effects of existing and future water withdrawals on water quality and quantity and fisheries habitat in coastal watersheds.

RECOMMENDATIONS THAT SHOULD BE SUPPORTED AND IMPLEMENTED IDENTIFIED IN SECTION 10, ENVIRONMENTAL STATUS, OF THE DRAFT NC ESTUARINE STRIPED BASS FMP AMENDMENT I:

- Identify and designate anadromous fish nursery areas and how early juvenile striped bass move and are distributed in NC estuarine waters.
- Identify minimum flow requirements in the Tar/Pamlico, Neuse, and Cape Fear rivers necessary for successful spawning, egg development, and larval transport to nursery grounds.
- Evaluate the impacts/effects of reverse osmosis plants on receiving waters and aquatic resources.
- Verify condition of identified SHAs used by striped bass.
- Investigate abundance and spawning contribution of striped bass in the NC and Virginia portions of the Blackwater, Nottoway and Meherrin rivers.
- Investigate striped bass use in the North Carolina portions of the Waccamaw River during the appropriate season.

- Continue to investigate the potential for passage of striped bass above Roanoke Rapids Dam.
- Support fish passage at Buckhorn Dam and Lock and Dam No.2 and No.3 and investigate anadromous fish utilization of the rock ladder at Lock and Dam No. 1.
- Investigate the feasibility of fish passage at and improved water flows from Rocky Mount Mill Dam and Tar River Reservoir Dam.
- Support the removal of Milburnie Dam in Raleigh.
- Support fish passage above the Yadkin chain of dams in North Carolina.
- Data on the density and distribution of striped bass eggs, fry, and juveniles in coastal rivers are needed so that potential losses to entrainment and impingement can be estimated.
- Identify effective engineering solutions to prevent entrainment and impingement of striped bass eggs, fry, and juveniles.
- NCDMF and NCWRC should work with DWQ and other agencies to determine and establish more stringent water quality standards in Anadromous Fish Spawning Areas.

OTHER RESEARCH NEEDS IDENTIFIED IN VARIOUS SECTIONS OR WITHIN ISSUES IN THE DRAFT NC ESTUARINE STRIPED BASS FMP AMENDMENT I:

Atlantic Ocean Summer Recreational Closure

- Methodology tested to accurately capture Atlantic Ocean striped bass harvest during summer months (May-October)

Striped Bass Stocking In Coastal Rivers

- Increase surveys of stocked systems to determine percent contribution of wild versus stocked fish
- Determine if fish produced from system-specific parentage will increase stocking contribution to spawning populations
- Determine factors impacting survivability of stocked fish in each system

Discard Mortality Of Striped Bass From Commercial Set Gill Nets In The CSMA

- More at-sea observations made for the gill net fishery to more accurately assess the discards from this fishery
- Explore improvements to NCDMF programs (Trip Ticket, Fish House sampling, fisherman surveys or logbooks) in order to aquire spatially and temporally accurate gill net gear parameters (e.g. yardage, mesh)
- Investigate the impacts of delayed mortality on striped bass captured in gill nets

RESEARCH NEEDS BY SECTION:

Section 6 Status Of The Stocks

Research Recommendations from the CSMA stock assessment (2010) (H- High priority, M-Medium priority, and L- Low priority).
Life History

- Determine system of origin of fish on the spawning grounds (H).
- Acquire life history information: maturity, fecundity, size and weight at age, egg and larval survival (short term research projects) (H).
- Conduct a mark-recapture study utilizing conventional tags and telemetry approaches (expanded program) (H).
- Determine if suitable striped bass spawning conditions exist in the Tar/Pamlico, Neuse, and Cape Fear rivers (M).
- Conduct egg abundance and egg viability studies (M).
- Determine contribution of stocked fish to spawning stock (M).
- Determine extent of spawning grounds (L).

Fishery Dependent Surveys - Recreational and Commercial

- Improve discard estimates and discard biological characteristics from commercial fisheries (trip level observer coverage) (M).
- Obtain biological characteristics such as length, weight, age, and sex of recreational harvest (expanded creel surveys) (M).
- Obtain biological characteristics such as length, weight, age, and sex of commercial harvest (increased sampling, age structure collection) (M).
- Improve discard estimates and discard biological characteristics from recreational fisheries (creel survey) (L).
- Conduct delayed mortality studies for recreational and commercial gear (short term research projects) (L).

Fisheries Independent Surveys

- Conduct independent surveys that adequately capture all life stages of striped bass (H).
- Conduct a short term study to determine vulnerability-at-length for survey gears (L).

SECTION 8 PROTECTED SPECIES

Request funding for state observer program:

- Provides data on interactions, fisheries characterizations, and discard information
- Allows for continued proactive management
- Expensive
- Could be difficult to achieve adequate observer coverage coast wide

Apply for ITP for impacted fisheries:

- Provides a legal means of having interactions
- Provides data on protected species and fisheries characterization
- Allows for continued proactive management
- Expensive
- Could be difficult to achieve adequate observer coverage coast wide

Continue gear development research to minimize species interactions:

- Allows fisheries to continue
- Potentially increased survival of protected species
- Potentially reduces interactions
- Potential for fisheries to close due to protected species interactions while gear is being developed

Implementation of outreach programs to inform state agencies, the public, and the commercial and recreational fishing industries about issues relating to protected species and fishery management:

- Well informed public may be able to reduce interactions
- Proactive way to address the issues
- Additional staff time to develop outreach materials

PUBLIC COMMENT RECEIVED

12 September 2011 DENR Washington Regional Office, Washington, NC

Public present: 3. One member of the public commented on striped bass.

1) Manage to end overfishing (if overfished) and require net attendance

13 September 2011 Craven County Agricultural Office, New Bern, NC

Public present: 5. One member of the public commented on striped bass.

1) He urged the MFC to allow fishermen to keep what they catch to avoid waste, manage on a quota system with possession limits and to eliminate size limits.

15 September 2011 Archdale Building Ground Floor Hearing Room Raleigh, NC

Public present: 1. No public comment on striped bass.

20 September 2011 DENR Washington Regional Office, Washington, NC

Public present: 0. No public comment on striped bass.

21 September 2011 DENR Wilmington Regional Office, Wilmington, NC

Public present: 4. Two members of the public commented on striped bass.

1) The first member of the public commented that he believed that anglers did not know about the no possession provision in the Cape Fear River and its tributaries. He recommended posting signs at area boat ramps. He works closely with the Cape Fear River Striper Foundation in order to improve habitat and water quality to help restore striped bass in the Cape Fear River. He offered to continue to work closely with the NCDMF staff towards these efforts, including possibly sources of funding for research needs of providing volunteers to assist NCDMF staff in any way needed. He stated he and his group were satisfied with the support they have gotten from the NCDMF.
2) The second person commented that he felt the current stocking program was inefficient and a waste of money. Rather than the current system of raising striped bass in ponds at hatcheries (to about 8 inches in length before release) he thought it would be better to close off an area in the wild and let them grow to bigger size.

22 September 2011 Dare County Hearing Room, Manteo, NC

Public present: 3. Two members of the public commented on striped bass.

1) Commented that he did not like the bycatch provision. It forced him to set more net than necessary just to meet the 50% weight provision. Recommended to keep the daily trip limits but do away with the bycatch provision.
2) Another member of the public commented during discussion about the Atlantic Ocean closure. The fish being harvested in the summer in the Atlantic Ocean were A/R prime spawning stock fish and needed protection. Harvest on these fish was closed in the ASMA and CSMA and should be closed in the Atlantic Ocean as well. The catch card survey was not being adhered to by anglers, therefore catch was unquantified and was not getting counted against the ASMA recreational total allowable catch, which could put us out of compliance with the ASMFC Atlantic Striped Bass FMP. Overall, it is a resource issue and she felt the A/R spawning stock that was being harvested during this time in this area was too valuable to the stock and needed protection.

14.10 RULE CHANGES REQUIRED TO IMPLEMENT MANAGEMENT STRATEGIES

ISSUE 11.4 STRIPED BASS MANAGEMENT AREA - ALBEMARLE SOUND MANAGEMENT AREA SOUTHERN BOUNDARY LINE ADJUSTMENT

15A NCAC 03J .0209 is amended with changes as published in 27:12 NCR 1156 as follows:

15A NCAC 03J .0209 ALBEMARLE SOUND/CHOWAN RIVER HERRING MANAGEMENT AREAS

(a) The Albemarle Sound Herring Management Area is defined as Albemarle Sound and all its joint water tributaries; Currituck Sound; Roanoke and Croatan sounds and all their joint water tributaries, including Oregon Inlet, north of a line beginning on the west shore at a point ~~35° 48.3693' N – 75° 43.7232' W~~ 35° 48.5015' N – 75° 44.1228' W on Roanoke Marshes Point; running southeasterly to the east shore to a point 35° 44.1710' N – 75° 31.0520' W on the north point of Eagles Nest Bay.

(b) The Chowan River Herring Management Area is defined as that area northwest of a line beginning on the west shore at a point 35° 59.9267' N – 76° 41.0313' W on Black Walnut Point; running northeasterly to the east shore to a point 36° 02.2140' N – 76° 39.3240' W on Reedy Point, to the North Carolina/Virginia state line; including the Meherrin River.

(c) ~~Effective January 1, 2001, it~~ It is unlawful to use drift gill nets in the Albemarle Sound and Chowan River river herring management areas with a mesh length less than three inches from January 1 through May 15.

History Note: *Authority G.S. 113-134; 113-182; 143B-289.52;*
Temporary Adoption Eff. May 1, 2000;
Eff. April 1, 2001;
Amended Eff. June 1, 2013; December 1, 2007.

15A NCAC 03R .0112 is amended with changes as published in 27:12 NCR 1195-1197 as follows:

15A NCAC 03R .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 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; 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~~ high-rise bridge;

(6) Trent River and its tributaries; and

(7) Within 200 yards of any shoreline in Neuse River and its tributaries east of the Highway 17 ~~highrise~~ high-rise bridge and south and west of a line beginning on Maw Point at a point 35° 09.0407' N - 76° 32.2348' W; running southeasterly near the Maw Point Shoal Marker "2" to a point 35° 08.1250' N - 76° 30.8532' W; running southeasterly near the Neuse River Entrance Marker "NR" to a point 35° 06.6212' N - 76° 28.5383' W; running southerly to a point 35° 04.4833' N - 76° 28.0000' W near Point of Marsh in Neuse River. In Core and Clubfoot creeks, the Highway 101 Bridge constitutes the attendance boundary.

(b) The attended gill net areas referenced in 15A NCAC 03J .0103(h) are delineated in the following coastal and joint fishing waters of the state south of a line beginning on Roanoke Marshes Point at a point ~~35° 48.3693' N - 75° 43.7232' W;~~ 35° 48.5015’ N - 75° 44.1228’ 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), (7), (8), (10), (11), and (12);

(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° 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 southeasterly to a point 35° 14.9386' N - 75° 42.9968' W near Beacon "35" in Rollinson Channel; running southwesterly to a point 35° 14.0377' N - 75° 45.9644' W near a "Danger" Beacon northwest of Austin Reef; 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 in the area upstream of the 76° 28.0000' W longitude line beginning at a point 35° 22.3752' N - 76° 28.0000' W near Roos Point in Pamlico River; running southeasterly to a point 35° 04.4833' N - 76° 28.0000' W near Point of Marsh in Neuse River; and

(5) Within 50 yards of any shoreline east of the 76° 28.0000' W longitude line beginning at a point 35° 22.3752' N - 76° 28.0000' W near Roos Point in Pamlico River; running southeasterly to a point 35° 04.4833' N - 76° 28.0000' W near Point of Marsh in Neuse River, except from October 1 through November 30, 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; 113-221.1; 143B-289.52;*
Eff. August 1, 2004;
Amended Eff. June 1, 2013; April 1, 2011; April 1, 2009.

15A NCAC 03R .0201 is amended with changes as published in 27:12 NCR 1197 as follows:

15A NCAC 03R .0201 STRIPED BASS MANAGEMENT AREAS

(a) The Albemarle Sound Management Area is designated as Albemarle Sound and all its joint and inland water tributaries, (except for the Roanoke, Middle, Eastmost and Cashie rivers), Currituck, Roanoke and Croatan sounds and all their joint and inland water tributaries, including Oregon Inlet, north of a line beginning at a point ~~35° 48 .3693'N - 75° 43 .7232'W~~ 35° 48.5015' N - 75° 44.1228' W on Roanoke Marshes Point, running southeasterly to a point 35° 44 .1710'N - 75° 31 .0520'W on the north point of Eagle Nest Bay.

(b) The Roanoke River Management Area is designated as Roanoke River and its joint and inland tributaries, including Middle, Eastmost and Cashie rivers, up to the Roanoke Rapids dam.

(c) The Central/Southern Management Area is designated as all ~~internal~~ internal, coastal, ~~and joint~~ joint, and contiguous inland waters south of a line beginning at a point ~~35° 48 .3693'N - 75° 43 .7232'W~~ 35° 48.5015' N - 75° 44.1228' W on Roanoke Marshes Point, running southeasterly to a point 35° 44 .1710'N - 75° 31 .0520'W on the north point of Eagle Nest Bay, to the South Carolina line.

History Note: *Authority G.S. 113-132; 113-134; 113-182; 143B-289.52;*
Eff. October 1, 2004;
Amended Eff. June 1, 2013.

ISSUE 11.5 CASHIE RIVER – CHANGE IN JOINT AND COASTAL WATERS BOUNDARY LINE

15A NCAC 03Q .0202 is amended with changes as published in 27:12 NCR 1157-1195 as follows:

15A NCAC 03Q .0202 DESCRIPTIVE BOUNDARIES FOR COASTAL-JOINT-INLAND WATERS

Descriptive boundaries for Coastal-Joint-Inland Waters referenced in 15A NCAC 03Q .0201 are as follows:

(1) Beaufort ~~County~~County:

(a) Pamlico ~~- Tar -~~ - Tar River - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 35° 32.2167' N - 77° 02.8701' W; running southwesterly along the east side of the railroad bridge to a point on the south shore 35° 32.0267' N - 77° 03.5179' W.

(i) All Manmade tributaries - All manmade tributaries within Pamlico – Tar River in Beaufort County are designated as Joint.

(b) Pungo River - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 35° 34.2702' N - 76° 30.1354' W; running northeasterly to a point on the east shore 35° 34.3192' N - 76° 30.0238' W. Joint Waters east and Coastal Waters west of a line beginning at a point on the north shore 35° 32.0974' N - 76° 29.6067' W; running southerly to a point on the south shore 35° 30.2620' N - 76° 29.3843' W.

(i) Flax Pond Bay - All waters within this waterbody are designated as Coastal.

(ii) Upper Dowry Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 31.8946' N - 76° 32.1231' W; running northeasterly to a point on the east shore 35° 31.9656' N - 76° 32.0114' W.

(iii) Lower Dowry Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 32.4188' N - 76° 35.3924' W; running northeast to a point on the east shore 35° 32.4691' N - 76° 35.2748' W.

(iv) George Best Creek - All waters within this waterbody are designated as Coastal.

(v) Toms Creek - All waters within this waterbody are designated as Coastal.

(vi) Pantego Creek – Inland Waters north and Coastal Waters south of a line beginning at a point on the north shore 35° 31.9908' N – 76° 36.6105' W; running southerly along the Breakwater to a point 35° 31.6628' N – 76° 36.9840' W; running southwesterly to a point on the south shore 35° 31.5653' N – 76° 37.3832' W.

(vii) Pungo Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 35° 29.9986' N - 76° 40.3564' W; running southerly to a point on the south shore 35° 29.8887' N - 76° 40.3262' W.

(A) Vale Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 31.0370' N - 76° 38.9044' W; running northeasterly to a point on the east shore 35° 31.0528' N - 76° 38.8536' W.

(B) Scotts Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 30.4264' N - 76° 40.1156' W; running easterly to a point on the east shore 35° 30.4264' N - 76° 39.9430' W.

(C) Smith Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 35° 30.2844' N - 76° 40.2941' W; running southerly to a point on the south shore 35° 30.1982' N - 76° 40.2621' W.

(viii) Woodstock (Little) Creek - Inland Waters south and Coastal Waters north of a line beginning at a point on the west shore 35° 30.5291' N - 76° 38.1600' W; running easterly to a point on the east shore 35° 30.4852' N - 76° 38.0278' W.

(ix) Jordan Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 35° 27.7256' N - 76° 36.2159' W; running southerly to a point 35° 27.5587' N - 76° 36.2704' W; following the eastern shore to a point 35° 27.4651' N - 76° 36.3294' W; running southerly to a point on the south shore 35° 27.3429' N - 76° 36.4498' W.

(x) Satterthwaite Creek - Inland Waters northwest and Coastal Waters southeast of a line beginning at a point on the north shore 35° 25.2994' N - 76° 35.4281' W; running southerly to a point on the south shore 35° 25.1284' N - 76° 35.4949' W.

(xi) Wright Creek - Inland Waters southwest and Coastal Waters northeast of a line beginning at a point on the west shore 35° 24.8664' N - 76° 35.4240' W; running southeasterly to a point on the east shore 35° 24.7995' N - 76° 35.3086' W.

(c) North Creek - Joint Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 25.1667' N - 76° 40.1042' W; running easterly to a point on the east shore 35° 25.0971' N - 76° 39.6340' W.

(d) St. Clair Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 25.7691' N - 76° 42.6406' W; running easterly to a point on the east shore 35° 25.7695' N - 76° 42.5967' W.

(e) Mixon Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 25.7601' N - 76° 46.5971' W; running easterly to a point 35° 25.7304' N - 76° 46.2547' W; following the southern shoreline to a point 35° 25.6878' N - 76° 46.2034' W; running southeasterly to a point 35° 25.6606' N - 76° 46.1892' W; following the southern shoreline to a point 35° 25.6267' N - 76° 46.1494' W; running southeasterly to a point on the east shore 35° 25.6166' N - 76° 46.1361' W.

(f) Bath Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 27.1685' N - 76° 49.4087' W; running northeasterly to a point on the east shore 35° 27.2371' N - 76° 49.0969' W.

(g) Duck Creek - Inland Waters northeast and Coastal Waters southwest of a line beginning at a point on the west shore 35° 27.5395' N - 76° 52.0074' W; running southerly to a point on the east shore 35° 27.4401' N - 76° 51.9827' W.

(h) Mallard Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 27.6461' N - 76° 53.6398' W; running easterly to a point on the east shore 35° 27.6425' N - 76° 53.5816' W.

(i) Upper Goose Creek - Inland Waters northeast and Coastal Waters southwest of a line beginning at a point on the west shore 35° 28.5346' N - 76° 56.0229' W; running southeasterly to a point on the east shore 35° 28.4014' N - 76° 55.8714' W.

(j) Broad Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 29.1023' N - 76° 57.3738' W; running easterly to a point on the east shore 35° 29.1059' N - 76° 57.1188' W.

(k) Herring Run (Runyan Creek) - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 32.1615' N - 77° 02.3606' W; running southeasterly to a point on the east shore 35° 32.1340' N - 77° 02.3438' W.

(l) Chocowinity Bay - Inland Waters northwest and Coastal Waters southeast of a line beginning at a point on the west shore 35° 29.4751' N - 77° 01.8507' W; running northeasterly to a point on the east shore 35° 29.8780' N - 77° 01.3169' W.

(m) Calf Tree Creek - Inland Waters south and Coastal Waters north of a line beginning at a point on the north shore 35° 29.2268' N - 77° 01.2973' W; running southeasterly to a point on the south shore 35° 29.2115' N - 77° 01.2831' W.

(n) Hills Creek - Inland Waters south and Coastal waters north of a line beginning at a point on the west shore 35° 28.5227' N - 77° 00.2664' W; running easterly to a point on the east shore 35° 28.5193' N - 77° 00.2270' W.

(o) Blounts Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 35° 26.2010' N - 76° 58.1716' W; running southerly to a point on the south shore 35° 26.1369' N - 76° 58.1671' W.

(p) Nevil Creek - Inland Waters south and Coastal Waters north of a line beginning at a point on the west shore 35° 26.1117' N - 76° 54.5233' W; running southeasterly to a point on the east shore 35° 26.0966' N - 76° 54.5045' W.

(q) Barris Creek - Inland Waters south and Coastal Waters north of a line beginning at a point on the west shore 35° 24.8423' N - 76° 49.9928' W; running easterly to a point on the east shore 35° 24.8451' N - 76° 49.9745' W.

(r) Durham Creek - Inland Waters south and Coastal Waters north of a line beginning at a point on the west shore 35° 23.7824' N - 76° 49.3016' W; running easterly to a point on the east shore 35° 23.7821' N - 76° 48.8703' W.

(s) Huddles Cut - Inland Waters south and Coastal Waters north of a line beginning at a point on the west shore 35° 22.5817' N - 76° 44.8727' W; running easterly to a point on the east shore 35° 22.5782' N - 76° 44.8594' W.

(t) Huddy Gut – All waters within this waterbody are designated as Coastal.

(u) South Creek – Inland Waters south and Coast Waters north of a line beginning at a point on the west shore 35° 18.9589' N – 76° 47.4298' W; running easterly to a point on the east shore 35° 18.9994' N – 76° 47.3007' W.

(i) Tooleys Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 20.7080' N - 76° 44.8937' W; running northeasterly to a point on the east shore 35° 20.7440' N - 76° 44.8324' W.

(ii) Drinkwater Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 20.1441' N - 76° 45.8262' W; running easterly to a point on the east shore 35° 20.1333' N - 76° 45.7530' W.

(iii) Jacobs Creek - Inland Waters northwest and Coastal Waters southeast of a line beginning at a point on the north shore 35° 20.1420' N - 76° 45.8395' W; running southwesterly to a point on the south shore 35° 20.0692' N - 76° 45.8912' W.

(iv) Jacks Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the north shore 35° 19.5455' N - 76° 47.0155' W; running southwesterly to a point on the south shore 35° 19.4986' N - 76° 47.0741' W.

(v) Whitehurst Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 35° 19.2878' N - 76° 47.4778' W; running southerly to a point on the south shore 35° 19.2295' N - 76° 47.4430' W.

(vi) Little Creek - Inland Waters south and Coastal waters north of a line beginning at a point on the west shore 35° 18.9873' N - 76° 45.9292' W; running easterly to a point on the east shore 35° 19.0209' N - 76° 45.8258' W.

(vii) Short Creek - Inland Waters southeast and Coastal Waters northwest of a line beginning at a point on the north shore 35° 20.1228' N - 76° 44.6031' W; running southwesterly to a point on the south shore 35° 20.0527' N - 76° 44.6667' W.

(viii) Long Creek - Inland Waters south and Coastal Waters north of a line beginning at a point on the west shore 35° 20.3050' N - 76° 44.3444' W; running northeasterly to a point on the east shore 35° 20.4185' N - 76° 43.8949' W.

(ix) Bond Creek - Inland Waters south and Coastal Waters north of a line beginning at a point on the west shore 35° 20.4231' N - 76° 42.0469' W; running southeasterly to a point on the east shore 35° 20.2539' N - 76 ° 41.8254' W.

(x) Muddy Creek - Inland Waters south and Coastal Waters north of a line beginning at a point on the west shore 35° 20.1523' N - 76° 41.2074' W; running northeasterly to a point on the east shore 35° 20.2413' N - 76° 41.0572' W.

(v) Davis Creek - Inland Waters south Coastal Waters north of a line beginning at a point on the west shore 35° 20.7032' N - 76° 40.3404' W; running easterly to a point on the east shore 35° 20.7112' N - 76° 40.1637' W.

(w) Strawhorn Creek - Inland Waters south and Coastal Waters north of a line beginning at a point on the west shore 35° 20.4091' N - 76° 39.0998' W; running northeasterly to a point on the east shore 35° 20.4750' N - 76° 38.8874' W.

(x) Lower Goose Creek – All waters within this waterbody are designated as Coastal.

(i) Lower Spring Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 35° 19.7932' N - 76° 37.5347' W; running southerly to a point on the south shore 35° 19.4670' N - 76° 37.4134' W.

(ii) Peterson Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the west shore 35° 18.7722' N - 76° 37.5059' W; running northeasterly to a point on the east shore 35° 18.8406' N - 76° 37.4111' W.

(iii) Snode Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 35° 18.2787' N - 76° 37.4679' W; running southwesterly to a point on the south shore 35° 18.0821' N - 76° 37.5544' W.

(iv) Campbell Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 35° 17.1203' N - 76° 37.9248' W; running southerly to a point on the south shore 35° 16.8807' N - 76° 37.9101' W.

(A) Smith Creek – All waters within this waterbody are designated as Inland.

(v) Hunting Creek - Inland Waters south and Coastal Waters north of a line beginning at a point on the west shore 35° 16.7523' N - 76° 36.8138' W; running easterly to a point on the east shore 35° 16.6779' N - 76° 36.5885' W.

(2) Bertie ~~County~~County:

(a) Albemarle Sound - All waters in this waterbody are designated as Coastal.

(i) All Manmade Tributaries – All manmade tributaries within this waterbody for Bertie County are designated as Joint.

(ii) Roanoke River - Joint Waters south and Coastal Waters north of a line beginning at a point on the west shore of the Roanoke River 35° 56.5068' N - 76° 41.8858' W; running easterly to a point on the east shore 35° 56.5324' N - 76° 41.5896' W.

(A) Sandy Run (Norfleet Gut) – Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36º 10.1119' N - 77º 17.5396' W; running northeasterly to a point on the east shore 36º 10.1172' N – 77º 17.5316' W.

(B) Quinine - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36° 09.6041' N - 77° 15.9091' W; running easterly to a point on the east shore 36° 09.6068' N - 77° 15.8912' W.

(C) Wire Gut - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36° 00.9580' N - 77° 13.0755' W; running easterly to a point on the east shore 36° 00.9542' N - 77° 13.0320' W.

(D) Apple Tree Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 36° 00.4174' N - 77° 12.3252' W; running southeasterly to a point on the south shore 36° 00.3987' N - 77° 12.3088' W.

(E) Indian Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 35° 59.0794' N - 77° 11.4926' W; running southerly to a point on the south shore 35° 59.0597' N - 77° 11.4967' W.

(F) Coniott Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 35° 56.6562' N - 77° 04.2860'

W; running southwesterly to a point on the south shore 35° 56.6397' N - 77° 04.3066' W.

(G) Conine Creek - All waters in this waterbody are designated as Joint.

(H) Old Mill Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 35° 53.9483' N - 76° 55.3921' W; running southeasterly to a point on the east shore 35° 53.9378' N - 76° 55.3710' W.

(I) Cut Cypress Creek - Inland Waters northeast and Joint Waters southwest of a line beginning at a point on the north shore 35° 51.9465' N - 76° 53.5762' W; running southeasterly to a point on the south shore 35° 51.9229' N - 76° 53.5556' W.

(J) Broad Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 35° 52.5191' N - 76° 50.4235' W; running southerly to a point on the south shore 35° 52.4262' N - 76° 50.3791' W.

(K) Thorofare - All waters within this waterbody are designated as Joint.

(iii) Cashie River - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 35° 54.7865' N - 76° 49.0521' W; running southerly to a point on the south shore 35° 54.6691' N - 76° 49.0553' W. Joint Waters south and west and Coastal Waters north and east of a line beginning at a point on the ~~north~~ west shore ~~35° 56.4598' N - 76° 43.8093' W;~~ 35° 56.2934’ N - 76° 44.1769’ W; running ~~southerly~~ easterly to a point on the north shore of an island in the mouth of the river ~~35° 56.2250' N - 76° 43.9265' W.~~ 35° 56.2250' N - 76° 43.9265' W. Joint Waters west and Coastal Waters east of a line beginning at a point on the south shore of an island in the mouth of the river 35° 56.1254' N - 76° 43.9846' W; running southerly to a point on the south shore ~~35° 56.0650' N - 76° 43.9599' W.~~35° 56.0650' N - 76° 43.9599' W.

(A) Cashoke Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 35° 56.2934' N - 76° 44.1769' W; running southwesterly to a point on the south shore 35° 56.2623' N - 76° 44.1993' W.

(B) Broad Creek - Inland Waters south and Joint Waters north of a line beginning at a point on the west shore 35° 55.0568' N - 76° 45.2632' W; running easterly to a point on the east shore 35° 55.0543' N - 76° 45.1309' W.

(C) Grinnel Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 35° 55.3147' N - 76° 44.5010'

W; running southerly to a point on the south shore 35° 55.2262' N - 76° 44.5495' W.

(iv) Middle River – All waters within this waterbody are designated Joint.

(v) Eastmost River – Joint Waters south and Coastal Waters north of a line beginning at a point on the west shore 35° 56.5024' N - 76° 42.4877' W; running westerly to a point on the east shore 35° 56.4070' N -76° 42.7647' W.

(vi) Mud Gut - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 35° 53.2880' N - 76° 45.4463' W; running southwesterly to a point on the south shore 35° 53.2527' N - 76° 45.4678' W.

(b) Black Walnut Swamp - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 35° 59.4680' N - 76° 40.9556' W; running southerly to a point on the south shore 35° 59.3946' N - 76° 40.9629' W.

(c) Salmon Creek - Inland Waters southwest and Coastal Waters northeast of a line beginning at a point on the north shore 36° 00.4648' N - 76° 42.3513' W; running southeasterly to a point on the south shore 36° 00.3373' N - 76° 42.1499' W.

(d) Chowan River - Joint Waters northwest and Coastal Waters southeast of a line beginning at a point on the west shore 36° 02.3162' N - 76° 42.4896' W; running northeasterly to a point on the east shore 36° 03.1013' N - 76° 40.8732' W.

(i) Barkers Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 14.0709' N - 76° 44.2451' W; running southerly to a point on the south shore 36° 14.0492' N - 76° 44.2456' W.

(ii) Willow Branch - Inland Waters southwest and Joint Waters northeast of a line beginning at a point on the north shore 36° 04.7206' N - 76° 43.7667' W; running southeasterly to a point on the south shore 36° 04.7138' N - 76° 43.7580' W.

(iii) Keel (Currituck) Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36° 14.1245' N - 76° 44.1961' W; running easterly to a point on the east shore 36° 14.0899' N - 76° 43.8533' W.

(3) Bladen ~~County~~County:

(a) Cape Fear River - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 34° 24.2628' N - 78° 17.6390' W; running northeasterly along the Lock and Dam # 1 to a point on the east shore 34° 24.2958' N - 78° 17.5634' W.

(i) Natmore Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 34° 24.2841' N - 78° 16.4405' W; running easterly to a point on the east shore 34° 24.2852' N - 78° 16.4039' W.

(4) Brunswick ~~County~~County:

(a) Calabash River And Tributaries - All waters within this waterbody in Brunswick County are designated as Coastal.

(b) Saucepan Creek - All waters within this waterbody are designated as Coastal.

(c) Shallotte River - Inland Waters northwest and Coastal Waters southeast of a line beginning at a point on the south shore 33° 58.3412' N - 78° 23.1948' W; running northeasterly to a point on the north shore 33° 58.3518' N - 78° 23.1816' W.

(i) Mill Dam Branch - All waters within this waterbody are designated as Coastal.

(ii) Squash Creek - All waters within this waterbody are designated as Coastal.

(iii) Mill Pond - All waters within this waterbody are designated as Coastal.

(iv) Charles Branch - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 33° 58.6276' N - 78° 21.2919' W; running easterly to a point on the east shore 33° 58.6257' N - 78° 21.2841' W.

(v) Grisset Swamp - All waters within this waterbody are designated as Coastal.

(vi) Little Shallotte River And Tributaries - All waters within this waterbody are designated as Coastal.

(d) Lockwood Folly River- Inland Waters northeast and Coastal Waters southwest of a line beginning at a point on the north shore 34° 00.6550' N - 78° 15.8134' W; running southeasterly along the south side of NC Hwy 211 bridge to a point on the south shore 34° 00.6285' N - 78° 15.7928' W.

(i) Stanberry Creek - All waters within this waterbody are designated as Coastal.

(ii) Pompeys Creek - All waters within this waterbody are designated as Coastal.

(iii) Maple Creek - All waters within this waterbody are designated as Coastal.

(iv) Rubys Creek - All waters within this waterbody are designated as Coastal.

(v) Big Doe Creek - All waters within this waterbody are designated as Coastal.

(vi) Lennons Creek - All waters within this waterbody are designated as Coastal.

(vii) Mercers Mill Pond Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 33° 57.7498' N - 78° 12.3532' W; running southeasterly to a point on the east shore 33° 57.7439' N - 78° 12.3440' W.

(e) Elizabeth River - All waters within this waterbody are designated as Coastal.

(i) Ash Creek - All waters within this waterbody are designated as Coastal.

(f) Beaverdam Creek - All waters within this waterbody are designated as Coastal.

(g) Dutchman Creek - All waters within this waterbody are designated as Coastal.

(i) Calf Gully Creek - All waters within this waterbody are designated as Coastal.

(ii) Jumpin Run - All waters within this waterbody are designated as Coastal.

(iii) Fiddlers Creek - All waters within this waterbody are designated as Coastal.

(h) Cape Fear River - Joint Waters north and Coastal Waters south of a line beginning at a point on the western side 34° 13.6953' N - 77° 57.2396' W; running southeasterly along the southern side of US 17-74-76 bridge to a point on the eastern side 34° 13.6214' N - 77° 57.0341' W.

(i) Carolina Power And Light Intake Canal - All waters within this waterbody are designated as Coastal.

(ii) Walden Creek - All waters within this waterbody are designated as Coastal.

(iii) Orton Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 34° 02.8436' N - 77° 56.7498' W; running southerly to a point on the south shore 34° 02.8221' N - 77° 56.7439' W.

(iv) Lilliput Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 34° 04.1924' N - 77° 56.5361' W; running southerly to a point on the south shore 34° 04.1487' N - 77° 56.5447' W.

(v) Sandhill Creek ~~Inland~~ - Inland Waters southwest and Coastal Waters northeast of a line beginning at a point on the north shore 34° 06.9584' N - 77° 57.0085' W; running southeasterly to a point on the south shore 34° 06.9371' N - 77° 56.9943' W.

(vi) Town Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 34° 07.7492' N - 77° 57.3445' W; running southerly to a point on the south shore 34° 07.7034' N - 77° 57.3431' W.

(vii) Mallory Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 34° 09.9868' N - 77° 58.2023' W; running southerly to a point on the south shore 34° 09.9618' N - 77° 58.2133' W.

(viii) Brunswick River - Joint Waters northwest and Coastal Waters southeast of a line beginning at a point on the south shore 34° 10.7281' N - 77° 57.7793' W; running northeasterly to a point on the north shore 34° 10.9581' N - 77° 57.6452' W.

(A) Alligator Creek - For the southernmost entrance into the Brunswick River: Inland Waters east and Joint Waters west of a line beginning at a point on the south shore 34° 13.5040' N - 77° 58.6331' W; running northwesterly to a point on the north shore 34° 13.5472' N - 77° 58.6628' W. For the northernmost entrance into the Brunswick River: Inland Waters east and Joint Waters west of a line beginning at a point on the south shore 34° 14.4300' N - 77° 59.2346' W; running northerly to a point on the north shore 34° 14.4618' N - 77° 59.2300' W.

(B) Jackeys Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the south shore 34° 11.9400' N - 77° 58.5859' W; running northerly to a point on the north shore 34° 11.9565' N - 77° 58.5859' W.

(C) Sturgeon Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 34° 14.6761' N - 77° 59.4145'

W; running southerly to a point on the south shore 34° 14.6404' N - 77° 59.4058' W.

(ix) Cartwheel Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 34° 15.7781' N - 77° 59.3852' W; running southerly to a point on the south shore 34° 15.7564' N - 77° 59.3898' W.

(x) Indian Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 34° 17.0441' N - 78° 00.3662' W; running southwesterly to a point on the south shore 34° 17.0006' N - 78° 00.3977' W.

(xi) Hood Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 34° 20.3713' N - 78° 04.7492' W; running southwesterly to a point on the south shore 34° 20.3393' N - 78° 04.7373' W.

(xii) Northwest Creek - All waters within this waterbody are designated as Inland.

(5) Camden ~~County~~County:

(a) Albemarle Sound – All waters within this waterbody are designated Coastal.

(i) All Manmade Tributaries – All waters within this waterbody are designated as Joint.

(ii) Pasquotank River – Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36° 18.0768' N - 76° 13.0979' W; running easterly along the south side of the Highway 158 Bridge to a point on the east shore 36° 18.0594' N - 76° 12.9620' W. Joint Waters west and Coastal Waters east of a line beginning at a point on the north shore 36° 11.4282' N - 76° 01.2876' W; running southwesterly to a point on the south shore 36° 08.7563' N - 76° 03.6991' W.

(A) Raymond Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36° 14.0746' N - 76° 03.3952' W; running easterly to a point on the east shore 36° 14.0711' N - 76° 03.3668' W.

(B) Portohonk Creek - Inland Waters northeast and Joint Waters southwest of a line beginning at a point on the west shore 36° 15.0519' N - 76° 05.2793' W; running southeasterly to a point on the east shore 36° 15.0391' N - 76° 05.2532' W.

(C) Areneuse Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36° 17.3133' N - 76° 08.1655' W; running southeasterly to a point on the east shore 36° 17.1328' N - 76° 07.6269' W.

(iii) North River - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 18.7703' N - 75° 58.7384' W; running southerly to a point on the south shore 36° 18.4130' N- 75° 58.7228' W. Joint Waters north and Coastal Waters south of a line beginning at a point on the west shore 36° 09.8986' N - 75° 54.6771' W; running easterly to a point on the east shore 36° 10.0108' N - 75° 52.0431' W.

(A) Wading Gut - Inland Waters south and Joint Waters north of a line beginning at a point on the west shore 36° 10.6054' N - 75° 55.9529' W; running southeasterly to a point on the east shore 36° 10.5777' N - 75° 55.8654' W.

(B) Little Broad Creek - Inland Waters south and Joint Waters north of a line beginning at a point on the west shore 36° 11.6530' N - 75° 57.2035' W; running southeasterly to a point on the east shore 36° 11.5587' N - 75° 56.9160' W.

(C) Broad Creek – Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 12.2197' N - 75° 57.2685' W; running southerly to a point on the south shore 36° 11.6766' N - 75° 57.2254' W.

(D) Hunting Creek - Inland Waters southwest and Joint Waters northeast of a line beginning at a point on the north shore 36° 15.0480' N - 75° 57.5820' W; running southeasterly to a point on the south shore 36° 14.9308' N - 75° 57.4635' W.

(E) Abel Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 15.9530' N - 75° 58.0348' W; running southerly to a point on the south shore 36° 15.8553' N - 75° 58.0842' W.

(F) Back Landing Creek - Inland Waters northwest and Joint Waters southeast of a line beginning at a point on the north shore 36° 16.4746' N - 76° 07.6377' W; running southwesterly to a point on the south shore 36° 16.2030' N - 76° 57.8897' W.

(G) Public Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 17.2462' N - 75° 58.2774' W; running southerly to a point on the south shore 36° 17.2121' N - 75° 58.2788' W.

(H) Cow Creek ~~-Inland~~ - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 17.8667' N - 75° 58.3483' W; running southerly to a point on the marsh island 36° 17.7600' N - 75° 58.3300' W; running southerly following the eastern shoreline of the island to a point 36° 17.7122' N - 75° 58.3273' W; running southwesterly to a point on the south shore 36° 17.6522' N - 75° 58.3543' W.

(I) Great Creek - Mouth: Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 18.1045' N - 75° 58.4289' W; running southerly to a point on the south shore 36° 17 9882' N - 75° 58.4458' W. On north shore of Great Creek within the fourth tributary: Inland Waters south and Joint Waters north of a line beginning at a point on the west shore 36° 18.1729' N - 75° 58.9137' W; running southeasterly to a point on the south shore 36° 18.1640' N - 75° 58.9022' W.

(J) Indiantown Creek – All waters within this waterbody are designated as Inland.

(6) Carteret ~~County~~County:

(a) Neuse River - All waters in this waterbody are designated as Coastal.

(i) Adams Creek - All waters in this waterbody are designated as Coastal.

(A) Back (Black) Creek - All waters in this waterbody are designated as Coastal.

(B) Cedar Creek - All waters in this waterbody are designated as Coastal.

(ii) Garbacon Creek - All waters in this waterbody are designated as Coastal.

(iii) South River - Inland Waters south and Coastal Waters north of a line beginning at a point on the west shore 34° 53.5068' N - 76° 31.1233' W; running northeasterly to a point on the east shore 34° 53.4494' N - 76° 31.3032' W.

(A) Big Creek - All waters in this waterbody are designated as Coastal.

(B) Southwest Creek - All waters in this waterbody are designated as Coastal.

(C) West Fork - All waters in this waterbody are designated as Inland.

(D) East Creek - All waters in this waterbody are designated as Inland.

(E) Eastman Creek - All waters in this waterbody are designated as Coastal.

(iv) Browns Creek - All waters in this waterbody are designated as Coastal.

(b) North River ~~And Tributaries -~~ All waters in this waterbody are designated as Coastal.

(i) Panter Cat Creek - All waters in this waterbody are designated as Coastal.

(ii) Cypress Creek - All waters in this waterbody are designated as Coastal.

(c) Newport River - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 34° 45.2478' N - 76° 46.4479' W; running southerly to a point on the south shore 34° 45.1840' N - 76° 46.4488' W.

(i) Core Creek - All waters in this waterbody are designated as Coastal.

(ii) Harlowe Creek - All waters in this waterbody are designated as Coastal.

(iii) Bogue Sound And Tributaries - All waters in this waterbody are designated as Coastal.

(d) White Oak River - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 34° 48.1466' N -77° 11.4711' W; running easterly to a point on the east shore 34° 48.1620' N -77° 11.4244' W.

(i) Pettiford Creek - Inland Waters east and Coastal Waters west of a line beginning at a point on the north shore 34° 42.6935' N - 77° 04.0745' W; running along the west side of the Highway 58 bridge to a point on the south shore 34° 42.6569' N - 77° 04.0786' W.

(ii) Little Hadnotts Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 34° 45.0839' N - 77° 06.5931' W; running northerly to an easterly point on the east shore 34° 45.0867' N - 77° 06.5780' W.

(iii) Hadnotts Creek - Inland Waters east and Coastal Waters west of a line beginning at a point on the north shore 34° 45.9908' N - 77° 05.7847' W; running along the west side of the Highway 58 bridge to a point on the south shore 34° 45.9738' N - 77° 05.7810' W.

(iv) Neds Creek - All waters in this waterbody are designated as Coastal.

(v) Hunters Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the northwest shore 34° 47.1205' N - 77° 09.9462' W; running southeasterly to a point on the southeast shore 34° 47.0947' N -77° 09.9160' W.

(7) Chowan ~~County~~<u>County:</u>

(a) Albemarle Sound - All waters within this waterbody in Chowan County are designated as Coastal.

(i) All Manmade Tributaries - All manmade tributaries are designated as Joint.

(ii) Yeopim River – Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 05.4526' N - 76° 27.7651' W; running southerly to a point on the south shore at Norcum Point 36° 05.1029' N - 76° 27.7120' W. Joint Waters west and Coastal Waters east of a line beginning at a point on the north shore 36° 04.7426' N - 76° 24.2536' W; running southwesterly to a point on the south shore 36° 04.1136' N - 76° 24.5365' W.

(iii) Queen Anne Creek - Inland Waters east and Coastal Waters west of a line beginning at a point on the north shore 36° 03.3757' N - 76° 36.3629' W; running southerly to a point on the south shore 36° 03.3551' N - 76° 36.3574' W.

(iv) Pembroke Creek (Pollock Swamp) - Inland Waters west and Coastal Waters east of a line beginning at a point on the west shore 36° 03.2819' N - 76° 37.0138' W; running northeasterly to a point on the east shore 36° 03.4185' N - 76° 36.6783' W.

(v) Chowan River - Joint Waters northwest and Coastal Waters southeast of a line beginning at a point on the west shore 36° 02.3162' N - 76° 42.4896' W; running northeasterly to a point on the east shore 36° 03.1013' N - 76° 40.8732' W.

(A) Rocky Hock Creek - Inland Waters east and Joint Waters west of a line beginning on the west shore at a point 36° 06.5662' N - 76° 41.3108' W; running southeasterly to a point on the east shore at 36° 06.6406' N - 76° 41.4512' W.

(B) Dillard (Indian) Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 36° 14.2234' N - 76° 41.5901' W; running southerly to a point on the south shore 36° 14.2023' N - 76° 41.5855' W.

(C) Stumpy Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 36° 16.6440' N - 76° 40.4251' W; running southerly to a point on the south shore 36° 16.6255' N - 76° 40.4196' W.

(D) Catherine (Warwick) Creek - Inland Waters northeast and Joint Waters southwest of a line beginning at a point on the west shore 36° 18.1011' N - 76° 41.1286' W; running southeasterly to a point on the east shore 36° 17.9413' N - 76° 40.8627' W.

(8) Columbus ~~County~~County:

(a) Cape Fear River – All waters within this waterbody of Columbus County are designated as Joint.

(i) Livingston Creek – Inland Waters south and Joint Waters north of a line beginning at a point on the west shore 34° 21.1518' N – 78° 12.0358' W; running easterly to a point on the east shore 34° 21.1420' N – 78° 12.0018' W.

(ii) Waymans Creek – Inland Waters southwest and Joint Waters northeast of a line beginning at a point on the west shore 34° 22.9861' N – 78° 14.5266' W; running southeasterly to a point on the east shore 34° 22.9838' N – 78° 14.5236' W.

(9) Craven ~~County~~County:

(a) Neuse River - Inland Waters west and Joint Waters east of a line at Pitch Kettle Creek beginning at a point on the north shore 35° 16.9793' N - 77° 15.5529' W; running south to a point on the south shore 35° 16.9237' N - 77° 15.5461' W. Joint Waters northwest and Coastal Waters southeast of a line beginning at a point on the east shore 35° 07.7096' N - 77° 01.6749' W; running southwesterly along the southern side of the Southern Railroad bridge to a point on the west shore 35° 07.1530' N - 77° 02.5570' W.

(i) Adams Creek - All waters in this waterbody are designated as Coastal.

(A) Back Creek – All waters in this waterbody are designated as Coastal.

(ii) Courts Creek - Inland Waters east Joint Waters west of a line beginning at a point on the north shore 34° 56.6958' N - 76° 42.7175' W; running southwesterly to a point on the south shore 34° 56.6606' N - 76° 42.7450' W.

(iii) Long Branch - Inland Waters south and Coastal Waters north of a line beginning on the west shore 34° 55.6189' N - 76° 43.8180' W; running easterly to a point on the east shore 34° 55.6175' N - 76° 43.7846' W.

(iv) Clubfoot Creek - All waters in this waterbody are designated as Coastal.

(A) Gulden Creek - All waters in this waterbody are designated as Coastal.

(B) Mitchell Creek - All waters in this waterbody are designated as Coastal.

(C) Morton Mill Pond - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 34° 51.9245' N - 76° 45.7754' W; running southerly to a point on the south shore 34° 51.7799' N - 76° 45.8184' W.

(v) Hancock Creek - Coastal Waters east and Inland Waters west of a line beginning on the north shore at 34° 56.3420' N - 76° 51.2809' W; running southerly to a point on the south shore at 34° 56.2731' N - 76° 51.3034' W.

(vi) Slocum Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore at 34° 57.1875' N - 76° 53.7648' W; running southwesterly to a point on the south shore 34° 57.1334' N - 76° 53.8069' W.

(vii) Scott Creek - Inland Waters west and Coastal Waters east of a line from a point on the north shore 35° 05.5723' N - 77° 02.0677' W; running southerly to a point on the south shore 35° 05.5316' N - 77° 02.0745' W.

(viii) Trent River – Inland Waters west and Joint Waters east of a line at Wilson Creek beginning at a point on the north shore 35° 04.05490' N - 77° 06.0987' W; running southerly to a point on the south shore 35° 04.3837' N - 77° 06.1230' W. Joint Waters west and Coastal Waters east of a line on the western side of the Highway 70 Trent River Bridge beginning at a point on the north shore 35° 06.2136' N - 77° 02.1968' W; running southerly to a point on the south shore 35° 05.9351' N - 77° 02.2645' W.

(A) Brice Creek - Inland Waters south and Joint Waters north of a line beginning at a point on the west shore 35° 04.5114' N - 77° 03.6433' W; running easterly to a point on the east shore 35° 04.5634' N - 77° 03.4469' W.

(ix) Jack Smith Creek - Inland Waters southwest and Joint Waters northeast of a line beginning on the west shore 35° 07.5482' N - 77° 03.1613' W; running southeasterly to a point on the east shore 35° 07.5320' N - 77° 03.1338' W.

(x) Bachelor Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 35° 09.0099' N - 77° 04.5858' W; running southerly to a point on the south shore 35° 08.9085' N - 77° 04.7172' W.

(xi) Dollys Gut - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 35° 13.6303' N - 77° 09.9847' W; running southerly to a point on the south shore 35° 13.5937' N - 77° 09.9778' W.

(xii) Greens Thoroughfare - Easternmost entrance: Inland Waters northwest and Joint Waters southeast of a line beginning at a point on the north shore 35° 13.7807' N - 77° 09.9224' W; running southwesterly to a point on the south shore 35° 13.7587' N - 77° 09.9728' W. Westernmost entrance: Inland Waters south and Joint Waters north of a line beginning on the west shore 35° 14.1398' N - 77° 11.5530' W; running easterly to a point on the east shore 35° 14.1481' N - 77° 11.5036' W.

(xiii) Greens Creek - Inland Waters west and Joint Waters east of a line beginning on the north shore 35° 14.1883' N - 77° 11.8862' W; running southeasterly to a point on the south shore 35° 14.1389' N - 77° 11.7535' W.

(xiv) Turkey Quarter Creek - Inland Waters south and Joint Waters north of a line beginning at a point on the west shore 35° 15.6738' N - 77° 14.6823' W; running southeasterly to a point on the east shore 35° 15.6534' N - 77° 14.6470' W.

(xv) Pitch Kettle Creek – All waters within this waterbody are designated as Inland.

(xvi) Taylors Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 35° 14.3719' N - 77° 10.8050' W; running southwesterly to a point on the south shore 35° 14.3300' N - 77° 10.8352' W.

(xvii) Pine Tree Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 35° 12.6663' N - 77° 07.4285' W; running southwesterly to a point on the south shore 35° 12.7033' N - 77° 07.3594' W. Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 35° 12.8553' N - 77° 07.8300' W; running easterly to a point on the east shore 35° 12.8372' N - 77° 07.7934' W. Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 35° 13.2012' N - 77° 08.7753' W; running southeasterly to a point on the east shore 35° 13.1714' N - 77° 08.7071' W.

(xviii) Stumpy Creek - Southern entrance: Inland Waters northwest and Joint Waters southeast of a line beginning at a point on the north shore 35° 11.5752' N - 77° 06.1866' W; running southwesterly to a point on the south shore 35° 11.5550' N - 77° 06.2411' W. Northern entrance: Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 35° 11.9377' N - 77°

06.7263' W; running southeasterly to a point on the south shore 35° 11.9169' N - 77° 06.7044' W.

(xix) Swift Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 35° 11.5972' N - 77° 06.0562' W; running easterly to a point on the east shore 35° 11.5816' N - 77° 05.9861' W.

(xx) Mill Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 35° 08.5041' N - 77° 02.3400' W; running south easterly to a point on the south shore 35° 08.4711' N - 77° 02.3176' W.

(xxi) Duck Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the north shore 35° 05.7648' N - 77° 00.5191' W; running south easterly to a point on the south shore at 35° 05.6803' N - 77° 00.4179' W.

(xxii) Northwest Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 03.5096' N - 76° 58.2604' W; running northeasterly to a point on the east shore at 35° 03.5948' N - 76° 58.0297' W.

(xxiii) Upper Broad Creek – Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 04.5050' N - 76° 56.5269' W; running easterly along the Tidelands EMC power lines to a point on the east shore at 35° 04.4705' N - 76° 56.2115' W.

(10) Currituck ~~County~~County:

(a) Albemarle Sound - All waters within Albemarle Sound in Currituck County are designated as Coastal.

(i) All Manmade Tributaries - All Manmade Tributaries to Albemarle Sound in Currituck County are designated as Joint.

(ii) North River – Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 18.7703' N - 75° 58.7384' W; running southerly to a point on the south shore 36° 18.4130' N - 75° 58.7228' W. Joint Waters north and Coastal Waters south of a line beginning on the west shore 36° 09.8986' N - 75° 54.6771' W; running easterly to a point on the east shore 36° 10.0108' N - 75° 52.0431' W.

(A) Duck Creek - Inland Waters northeast and Joint Waters southwest of a line beginning at a point on the west shore 36° 12.4056' N - 75° 54.2967' W; running southeasterly to a point on the east shore 36° 12.1865' N - 75° 54.0298' W.

(B) Barnett Creek - Inland Waters northeast and Joint Waters southwest of line beginning at a point on the north shore 36° 14.2405' N - 75° 55.0112' W; running southeasterly to a point on the south shore 36° 14.0956' N - 75° 54.9774' W.

(C) Lutz Creek - Inland Waters northeast and Joint Waters southwest of a line beginning at a point on the north shore 36° 14.7397' N - 75° 55.4914' W; running southeasterly to a point on the east shore 36° 14.4948' N - 75° 55.1989' W.

(D) Goose Pond - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36° 15.5152' N - 75° 57.0936' W; running easterly to a point on the east shore 36° 15.4016' N - 75° 56.7842' W. Also south of a line beginning at a point on the west shore 36° 16.0334' N - 75° 57.1018' W; running easterly to a point on the east shore 36° 16.0301' N - 75° 57.0629' W.

(E) Deep Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 36° 17.1576' N - 75° 56.7594' W; running southerly to a point on the south shore 36° 16.9846' N - 75° 56.6802' W.

(F) Narrow Ridges Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 36° 18.3249' N - 75° 57.8910' W; running southerly to a point on the south shore 36° 18.1388' N - 75° 57.9029' W.

(G) Bump Landing Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 36° 19.3757' N - 75° 57.9057' W; running southerly to a point on the south shore 36° 19.2496' N - 75° 57.9107' W.

(H) Taylor Bay - All waters within Taylor Bay are designated Joint.

(I) Intracoastal Waterway From Taylor Bay To Coinjock Bay - All waters within the IWW are designated Joint.

(J) Indiantown Creek – All waters within this waterbody are designated Inland.

(b) Currituck Sound - Joint Waters north and Coastal Waters south of a line beginning at a point on the west shore of Currituck Sound 36° 04.8195' N - 75° 47.4101' W; running easterly to a point on the east shore 36° 05.5739' N - 75° 44.5729' W.

(i) All Manmade Tributaries – All manmade tributaries within this waterbody are designated as Joint.

(ii) Coinjock Bay - All waters within this waterbody are designated as Joint.

(iii) Nelson (Nells) Creek - Northern entrance: Inland Waters south and Joint Waters north of a line beginning at a point on the west shore 36° 16.5806' N - 75° 52.1168' W; running northeasterly to a point on the east shore 36° 16.6410' N - 75° 51.9580' W. Southern entrance: Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 15.9816' N - 75° 51.7245' W; running southerly to a point on the south shore 36° 15.8640' N - 75° 51.6897' W.

(iv) Hog Quarter Creek - Northernmost entrance: Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 07.7400' N - 75° 48.6254' W; running southerly to a point on the south shore 36° 07.7210' N - 75° 48.6135' W. Southernmost entrance: Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 07.4118' N - 75° 48.4986' W; running southerly to a point on the south shore 36° 07.3532' N - 75° 48.5110' W.

(v) Parkers Creek – Inland Waters northwest and Joint Waters southeast of a line beginning on the west shore 36° 22.1079' N - 75° 55.5459' W; running northeasterly to a point on the east shore 36° 22.1607' N - 75° 55.4512' W. Inland Waters south and Joint Waters north of a line beginning at a point on the west shore 36° 22.3928' N - 75° 55.6970' W; running northeasterly to a point on the east shore 36° 22.4011' N – 75° 55.6782' W.

(vi) North Landing River - All waters in this waterbody are designated as Joint.

(A) Northwest River - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore of 36° 30.8374' N - 76° 04.8770' W; running southerly to a point on the south shore 36° 30.7061' N - 76° 04.8916' W.

(I) Gibbs Canal - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 32.2322' N - 76° 01.8923' W; running southerly to a point on the south shore 36° 32.1997' N - 76° 01.8937' W.

(II) Tull Creek - Inland Waters southwest and Joint Waters northeast of a line beginning at a point on the north shore 36° 30.0991' N - 76° 04.8587' W; running southeasterly to a point on the south shore 36° 29.9599' N - 76° 04.7126' W.

(B) West Landing - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36° 30.9867' N – 76° 02.5868' W; running easterly to a point on the east shore 36° 31.0045' N - 76° 02.3780' W.

(11) Dare ~~County~~County:

(a) Alligator River – Coastal Waters north and Joint Waters south of a line beginning at a point on the west shore 35° 54.2903' N - 76° 01.6818' W; running along the south side of the US 64 bridge to a point on the east shore 35° 53.6835' N - 75° 58.8578' W.

(i) Whipping Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 35° 41.3930' N - 76° 00.2481' W; running southerly to a point on the south shore 35° 41.3717' N - 76° 00.2554' W.

(ii) Swan Creek and Lake - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 35° 40.2674' N - 76° 00.7360' W; running southerly to a point on the south shore 35° 40.2420' N - 76° 00.7548' W.

(iii) Milltail Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 35° 50.5192' N - 75° 58.6134' W; running southerly to a point on the south shore 35° 50.4956' N - 75° 58.6158' W.

(iv) Laurel Bay Lake (Creek) - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 35° 52.4036' N - 75° 58.8560' W; running southerly to a point on the south shore 35° 52.3960' N - 75° 58.8528' W.

(v) East Lake - Coastal Waters west and Inland Waters east of a line beginning at a point on the north shore 35° 56.1676' N - 75° 55.2603' W; running southerly to a point on the south shore 35° 55.4727' N - 75° 55.5043' W. Joint Waters north and Inland Waters south of a line beginning at a point on the west shore 35° 58.6402' N - 75° 52.1855' W; running easterly to a point on the east shore 35° 58.5887' N - 75° 51.7080' W.

(b) Albemarle Sound - All waters in this waterbody in Dare County are designated as Coastal.

(i) All Manmade Tributaries - All manmade tributaries in Dare County for this waterbody are designated as Joint.

(ii) Kitty Hawk Bay - Joint Waters north and Coastal Waters south of a line beginning at a point on the west shore 36° 03.1967' N - 75° 44.3087' W; running easterly to a point on the east shore 36° 03.1871' N - 75° 44.2716' W. Joint Waters east and Coastal Waters west of a line beginning at a point on the north shore 36° 03.1338' N - 75° 44.2423' W; running southerly to a point on the south shore 36° 03.0919' N - 75° 44.2533' W. Joint Waters east and Coastal Waters west of a line beginning at a point on the north shore 36° 02.9960' N - 75° 44.2840' W; running southerly to a point on the south shore 36° 02.9592' N - 75° 44.2291' W. Joint Waters east and Coastal Waters west of a line beginning at a point on the north shore 36° 02.4964' N - 75° 44.2089' W; running southerly to a point on the south shore 36° 01.3270' N - 75° 43.6422' W.

(iii) Peter Mashoes Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 35° 57.2344' N - 75° 48.3087' W; running southerly to a point on the south shore 35° 56.7805' N - 75° 48.3563' W.

(iv) Tom Mann Creek - Inland Waters south and Coastal Waters north of a line beginning at a point on the west shore 35° 58.5296' N - 75° 52.8982' W; running easterly to a point on the east shore 35° 58.5175' N - 75° 53.6851' W.

(v) Collington Harbor – Joint Waters east and Coastal Waters west of a line beginning at a point on the north shore 36° 01.0828' N - 75° 43.6070' W; running southerly to a point on the south shore 36° 01.0510' N - 75° 43.6015' W.

(c) Croatan Sound - All waters in this waterbody in Dare County are designated as Coastal.

(i) All Manmade Tributaries - All waters in this waterbody are designated as Joint.

(ii) Spencer Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 35° 51.4205' N - 75° 45.0645' W; running southerly to a point on the south shore 35° 51.3876' N - 75° 45.0640' W. Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 35° 51.5597' N - 75° 45.0141' W; running southerly to a point on the south shore 35° 51.4624' N - 75° 45.0498' W. Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 35° 51.6783' N - 75° 44.9125' W; running southerly to a point on the south shore 35° 51.5693' N - 75° 45.0109' W.

(iii) Calahan Creek (Callaghan Creek) - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 35° 51.1312' N - 75° 45.1327' W; running southwesterly to a point on the south shore 35° 51.0953' N - 75° 45.1629' W.

(d) Roanoke Sound - All waters in this waterbody in Dare County are designated as Coastal.

(i) Buzzard Bay - Joint Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 59.6662' N - 75° 41.8400' W; running easterly to a point on the east shore 35° 59.4376' N - 75° 40.5770' W.

(e) Pamlico Sound - All waters in this waterbody in Dare County are designated as Coastal.

(i) Stumpy Point Bay - All waters in this waterbody are designated as Coastal.

(A) All Manmade Tributaries - All waters in this waterbody are designated as Joint.

(ii) Long Shoal River - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 38.7661' N - 75° 53.4429' W; running easterly to a point on the east shore 35° 38.7641' N - 75° 53.4159' W

(A) All Manmade Tributaries - All waters in this waterbody are designated as Joint.

(B) Pains Bay - All waters in this waterbody are designated as Coastal.

(I) Pains Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 36.4464' N - 75° 49.0420' W; running easterly to a point on the east shore 35° 36.4439' N - 75° 49.0324' W.

(C) Deep Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 37.8971' N - 75° 51.3125' W; running easterly to a point on the east shore 35° 37.8840' N - 75° 51.2928' W.

(f) Currituck Sound - Joint Waters north and Coastal Waters south of a line beginning at a point on the west shore 36° 04.8195' N - 75° 47.4101' W; running easterly to a point on the east shore 36° 05.5739' N - 75° 44.5729' W.

(i) All Manmade Tributaries – All manmade tributaries are designated as Joint.

(ii) Martin Point Creek (Jean Guite Creek) - Inland Waters south Joint Waters north of a line beginning at a point on the west shore 36° 07.6716' N - 75° 44.9656' W; running easterly to a point on the east shore 36° 07.7568' N - 75° 44.6823' W.

(12) Gates ~~County~~County:

(a) Chowan River - All waters within this waterbody for Gates County are designated as Joint.

(i) Catherine (Warwick) Creek - Inland Waters northeast and Joint Waters southwest of a line beginning at a point on the west shore 36° 18.1011' N - 76° 41.1286' W; running southeasterly to a point on the east shore 36° 17.9413' N - 76° 40.8627' W.

(ii) Bennetts Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36° 18.3499' N - 76° 42.0286' W; running northeasterly to a point on the east shore 36° 18.4057' N - 76° 41.6986' W.

(iii) Beef Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36° 20.3235' N - 76° 44.6401' W; running easterly to a point on the east shore 36° 20.3070' N - 76° 44.5797' W.

(iv) Sarem Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 36° 21.7259' N - 76° 46.4085' W; running southerly to a point on the south shore ~~36° 21.6748' N - 76° 46.4392' W~~36° 21.6748' N - 76° 46.4392' W.

(v) Shingle (Island) Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the north shore of the westernmost entrance into Chowan River 36° 21.8449' N - 76° 48.0940' W; running southeasterly to a point on the south shore 36° 21.7831' N - 76° 48.0427' W. At the easternmost entrance to the creek: Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36° 21.8469' N - 76° 47.2668' W; running northeasterly to a point on the east shore 36° 21.9062' N - 76° 47.1862' W.

(vi) Barnes Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the western shore 36° 21.8820' N - 76° 48.6419' W; running easterly to a point on the east shore 36° 21.8978' N - 76° 48.5902' W.

(vii) Spikes Creek - Inland Waters northwest and Joint Waters southeast of a line beginning at a point on the west shore 36° 22.6515' N - 76° 50.8882' W; running northeasterly to a point on the east shore 36° 22.6684' N - 76° 50.8493' W.

(viii) Buckhorn Creek (Run Off Swamp) - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36° 22.9682' N - 76° 51.9172' W; running easterly to a point on the east shore 36° 22.9614' N - 76° 51.8870' W.

(ix) Mud Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36° 23.5134' N - 76° 53.9131' W; running easterly to a point on the east shore 36° 23.5132' N - 76° 53.8815' W.

(x) Somerton Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36° 31.7177' N - 76° 54.8327' W; running easterly to a point on the east shore 36° 31.7143' N - 76° 54.7810' W.

(13) Halifax ~~County~~County:

(a) Roanoke River - Inland Waters northwest and Joint Waters southeast of a line beginning at a point on the west shore 36° 12.5264' N - 77° 23.0223' W; running northeasterly along the south side of the Highway 258 Bridge to a point on the east shore 36° 12.5674' N - 77° 22.9724' W.

(i) Kehukee Swamp – Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 05.1942' N - 77° 18.9596' W; running southwesterly to a point on the south shore 36° 05.1670' N - 77° 18.9761' W.

(ii) Clarks Canal - Inland Waters north and Joint Waters south of a line of a line beginning at a point on the west shore 36° 04.6165' N - 77° 19.5817' W; running easterly to a point on the east shore 36° 04.6215' N - 77° 19.5643' W.

(14) Hertford ~~County~~County:

(a) Chowan River – All waters within this waterbody for Hertford County are designated as Joint.

(i) Keel (Currituck) Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36° 14.1245' N - 76° 44.1961' W; running easterly to a point on the east shore 36° 14.0899' N - 76° 43.8533' W.

(ii) Swain Mill (Taylor Pond) Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 18.5808' N - 76° 43.4729' W; running southerly to a point on the south shore 36° 18.5616' N - 76° 43.4706' W.

(iii) Goose Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 19.5838' N - 76° 44.5971' W; running southerly to a point on the south shore 36° 19.5375' N - 76° 44.5925' W.

(iv) Wiccacon River - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 20.5439' N - 76° 45.4550' W; running southeasterly to a point on the south shore 36° 20.4684' N - 76° 45.3392' W.

(v) Hodges Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 21.2459' N - 76° 46.3421' W; running southerly to a point on the south shore 36° 21.1823' N - 76° 46.3243' W.

(vi) Catherine Creek - Inland Waters south and Joint Waters north of a line beginning at a point on the west shore 36° 22.9579' N - 76° 53.1994' W; running southeasterly to a point on the east shore 36° 22.9456' N - 76° 53.1742' W.

(vii) Harris (Hares) Mill Creek - All waters within this waterbody are designated as Inland.

(viii) Meherrin River - All waters within this waterbody are designated as Joint.

(A) Potecasi Creek - Inland Waters southwest and Joint Waters northeast of a line beginning at a point on the west shore 36° 26.1234' N - 76° 57.5262' W; running southeasterly to a point on the east shore 36° 26.1005' N - 76° 57.4960' W.

(B) Liverman Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36° 26.7244' N - 76° 58.2797' W; running easterly to a point on the east shore 36° 26.7086' N - 76° 58.2499' W.

(C) Vaughan's Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 28.3541' N - 77° 05.6259' W; running southerly to a point on the south shore 36° 28.3307' N - 77° 05.6369' W.

(D) Banks Creek - All waters in this waterbody are designated as Inland.

(ix) Buckhorn Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36° 31.9519' N - 76° 55.2580' W; running easterly to a point on the east shore 36° 31.9628' N - 76° 55.2429' W.

(15) Hyde ~~County~~County:

(a) Pamlico Sound - All waters within this waterbody in Hyde County are designated as Coastal.

(i) Pungo River - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 35° 34.2702' N - 76° 30.1354' W; running northeasterly to a point on the east shore 35° 34.3192' N - 76° 30.0238' W. Joint Waters east and Coastal Waters west of a line beginning at a point on the north shore 35° 32.0974' N - 76° 29.6067' W; running southerly to a point on the south shore 35° 30.2620' N - 76° 29.3843' W.

(A) Rutman Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 35° 33.1874' N - 76° 27.4090' W; running easterly to a point 35° 33.1759' N - 76° 27.2525' W; running northeasterly to a point on the east shore 35° 33.2455' N - 76° 26.9119' W.

(B) Wilkerson Creek - Inland Waters south and Joint Waters north of a line beginning at a point on the west shore 35° 33.1251' N - 76° 27.2328' W; running northerly to a point 35° 33.1553' N - 76° 27.2447' W; running easterly to a point on the east shore 35° 33.3286' N - 76° 26.2019' W.

(C) Atlantic Intracoastal Waterway From Wilkerson Creek To Alligator River At Winn Bay – All waters within this part of the ~~IWW~~ Intracoastal Waterway are designated as Joint.

(D) Horse Island Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 35° 32.1965' N - 76° 28.0462' W; running southerly to a point on the south shore 35° 32.1480' N - 76° 28.0705' W.

(E) Tarklin Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 35° 31.1553' N - 76° 28.1478' W; running ~~southesterly~~ southeasterly to a point on the south shore 35° 31.0974' N - 76° 28.0984' W.

(F) Scranton Creek – Inland Waters east and Joint Waters west of line beginning at a point on the north shore 35° 30.0080' N - 76° 26.7759' W; running southerly to a point on the south shore 35° 29.9574' N - 76° 26.7750' W.

(G) Smith Creek - Inland Waters south and Coastal Waters north of a line beginning at a point on the west shore 35° 30.2812' N - 76° 29.7546' W; running southeasterly to a point on the east shore 35° 30.1904' N - 76° 29.4657' W.

(H) Fishing Creek - Inland Waters east and Coastal Waters west of a line beginning at a point on the west shore 35° 30.2400' N - 76° 35.0143' W; running southeasterly to a point on the east shore 35° 30.0645' N - 76° 34.8211' W.

(I) Slades Creek - All waters within this waterbody are designated as Coastal.

(J) Fortescue Creek - All waters within this waterbody are designated as Coastal.

(ii) Rose Bay - All waters within this waterbody are designated as Coastal.

(A) Rose Bay Creek - All waters within this waterbody are designated as Coastal.

(B) Rose Bay Canal - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 35° 28.5607' N - 76° 19.6545' W; running southerly to a point on the south shore 35° 28.5509' N - 76° 19.6572' W. Joint Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 27.8491' W - 76° 24.2198' W; running easterly to a point on the east shore 35° 27.8404' N - 76° 24.2065' W.

(iii) Swan Quarter Bay - All waters within this waterbody are designated as Coastal.

(A) Oyster Creek - All waters within this waterbody are designated as Coastal.

(iv) Juniper Bay - All waters within this waterbody are designated as Coastal.

(A) Juniper Bay Creek - Joint Waters east and Coastal Waters west of a line beginning at a point on the north shore 35° 23.2472' N - 76° 14.8754' W; running southwesterly to a point on the south shore 35° 23.1738' N - 76° 14.9794' W.

(B) Juniper Bay Creek Canal - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 35° 23.8618' N - 76° 13.1044' W; running easterly to a point on the east shore 35° 23.8677' N - 76° 13.0888' W.

(v) Lake Mattamuskeet – All waters in this waterbody are designated as Inland.

(A) Outfall Canal - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 35° 26.6017' N - 76° 10.1715' W; running easterly to a point on the east shore 35° 26.6093' N - 76° 10.1513' W. Joint Waters north and Coastal waters south of a line beginning at a point on the west shore 35° 21.4945' N - 76° 06.5336' W; running northeasterly to a point on the east shore 35° 21.5480' N - 76° 06.4819' W.

(B) Lake Landing Canal - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 35° 28.7878' N - 76° 04.5867' W; running easterly to a point on the east shore 35° 28.7910' N - 76° 04.5726' W. Joint Waters north and Coastal ~~waters~~ Waters south of a line beginning at a point on the west 35° 25.9529' N - 76° 03.6785' W; running easterly to a point on the east shore 35° 25.9568'

N - 76° 03.6566' W. Joint Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 25.9666' N - 76° 03.5856' W; running easterly to a point on the east shore 35° 25.9819' N - 76° 03.5600' W.

(C) Waupopin Canal - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 35° 31.8413' N - 76° 01.7779' W; running southerly to a point on the south shore 35° 31.8283' N - 76° 01.7637' W. Joint Waters west and Coastal Waters east of a line beginning at a point on the west shore 35° 31.5557' N - 75° 58.8725' W; running easterly to a point on the east shore 35° 31.5648' N - 75° 58.8555' W.

(D) Rattlesnake Canal - Joint Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 26.6965' N - 76° 00.8079' W; running easterly to a point on the east shore 35° 26.7116' N - 76° 00.7749' W.

(E) All Other Manmade Tributaries To Lake Mattamuskeet – All manmade tributaries of this waterbody are designated as Inland.

(vi) Middletown Creek - All waters within this waterbody are designated as Coastal.

(vii) Long Shoal River - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 38.7661' N - 75° 53.4429' W; running easterly to a point on the east shore 35° 38.7641' N - 75° 53.4159' W.

(A) All Manmade Tributaries – All manmade tributaries of this waterbody are designated as Joint.

(B) Broad Creek - All waters within this waterbody are designated as Coastal.

(C) Flag Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the west shore 35° 37.3782' N - 75° 53.0699' W; running easterly to a point on the east shore 35° 37.3894' N - 75° 53.0593' W.

(D) Cumberland Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 35° 38.3026' N - 75° 53.3010' W; running southerly to a point on the south shore 35° 38.2692' N - 75° 53.3038' W.

(b) Alligator River - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore at Cherry Ridge Landing 35° 42.2172' N - 76° 08.4686' W; running southerly to a point on the south shore 35° 42.1327' N - 76° 08.5002' W.

Swan Creek and Lake - All waters within this waterbody are designated as Inland.

(16) Jones ~~County~~County:

(a) White Oak River – Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 34° 48.1466' N -77° 11.4711' W; running easterly to a point on the east shore 34° 48.1620' N -77° 11.4244' W.

(i) Grants Creek - All waters within this waterbody are designated as Inland.

(ii) Hunters Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the northwest shore 34° 47.1205' N -77° 09.9462' W; running southeasterly to a point on the southeast shore 34° 47.0947' N -77° 09.9160' W.

(17) Martin ~~County~~County:

(a) Roanoke River – All waters within this waterbody in Martin County are designated as Joint.

(i) Prices Gut - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 35° 57.3701' N - 77° 11.9815' W; running southerly to a point on the south shore 35° 57.3552' N - 77° 11.9796' W.

(ii) Rainbow Gut - Inland Waters south and Joint Waters north of a line beginning at a point on the west shore 35° 55.9334' N - 77° 11.3246' W; running easterly to a point on the east shore 35° 55.9275' N - 77° 11.3136' W.

(iii) Conoho Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 35° 52.5439' N - 77° 02.6673' W; running easterly to a point on the east shore 35° 52.5407' N - 77° 02.6280' W.

(iv) Sweetwater Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the west shore 35° 51.6464' N - 77° 00.5090' W; running southeasterly to a point on the east shore 35° 51.6252' N - 77° 00.4879' W.

(A) Peter Swamp – All waters within this waterbody are designated as Inland.

(v) Devils Gut - All waters in this waterbody are designated as Joint.

(A) Upper Deadwater Creek - All waters in this waterbody are designated Joint.

(B) Lower Deadwater Creek - All waters in this waterbody are designated Joint.

(C) Gardner Creek - Inland Waters south and Joint Waters north of a line beginning at a point on the west shore 35° 50.1599' N - 76° 56.0211' W; running easterly to a point on the east shore 35° 50.1633' N - 76° 55.9899' W.

(vi) Roses Creek - Inland Waters southeast and Joint Waters northwest of a line beginning at a point on the north shore 35° 50.1683' N - 76° 50.9664' W;

running southwesterly to a point on the south shore 35° 50.1363' N - 76° 56.9907' W.

(vii) Welch Creek - Inland Waters south and Joint Waters north of a line beginning at a point on the western shore 35° 51.8458' N - 76° 45.8381' W; running easterly along the shoreline and across the mouths of the three creek entrances to a point on the east shore 35° 51.8840' N - 76° 45.6207' W.

(18) New Hanover ~~County~~County:

(a) Cape Fear River - Joint Waters north and Coastal Waters south of a line beginning at a point on the western side 34° 13.6953' N - 77° 57.2396' W; running southeasterly along the southern side of US 17-74-76 bridge to a point on the eastern side 34° 13.6214' N - 77° 57.0341' W.

(i) Lords Creek - Inland Waters east and Coastal Waters west of a line beginning at a point on the north shore 34° 05.1562' N - 77° 55.3816' W; running southerly to a point on the south shore 34° 05.1303' N - 77° 55.4008' W.

(ii) Todds Creek - Inland Waters east and Coastal Waters west of a line beginning at a point on the north shore 34° 07.4791' N - 77° 55.5175' W; running southeasterly to a point on the south shore 34° 07.4578' N - 77° 55.5116' W.

(iii) Barnards Creek - Inland Waters east and Coastal Waters west of a line beginning at a point on the north shore 34° 09.4347' N - 77° 56.5969' W; running southerly to a point on the south shore 34° 09.3887' N - 77° 56.5791' W.

(iv) Greenfield Lake Outlet - Greenfield Lake Outlet Inland Waters east and Coastal Waters west of a line beginning at a point on the north shore 34° 12.7210' N - 77° 57.2058' W; running southerly to a point on the south shore 34° 12.7075' N - 77° 57.2085' W.

(v) Tommer Creek - For the southernmost entrance into the Cape Fear: Inland Waters northwest and Joint Waters southwest of a line beginning at a point on the west shore 34° 15.6397' N - 77° 58.9608' W; running northeasterly to a point on the east shore 34° 15.6589' N- 77° 58.9338' W. For the northernmost entrance into the Cape Fear: Inland Waters south and Joint Waters north of a line beginning at a point on the west shore 34° 16.6630' N - 77° 59.4699' W; running northeasterly to a point on the east shore 34° 16.6767' N - 77° 59.4506' W.

(vi) Catfish Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 34° 16.7546' N - 77° 59.3751' W ; running southeasterly to a point on the south shore 34° 16.7118' N - 77° 59.3870' W.

(vii) Northeast Cape Fear River - Inland Waters north and Joint Waters south of a line beginning at a point on the west side 34° 26.5658' N - 77° 50.0871' W;

running northeasterly along the southern side of NC 210 bridge to a point on the east side 34° 26.6065' N - 77° 49.9955' W.

(A) Smiths Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 34° 16.0366"N - 77° 56.8405' W; running southeasterly to a point on the south shore 34° 15.9919' N - 77° 56.7961' W.

(B) Ness Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 34° 17.1741' N - 77° 57.2460' W; running southeasterly to a point on the south shore 34° 17.1494' N - 77° 57.2044' W.

(C) Dock Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 34° 18.1274' N - 77° 57.3847' W; running southwesterly to a point on the south shore 34° 18.1173' N - 77° 57.3678' W.

(D) Fishing Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 34° 19.1613' N - 77° 57.2460' W; running southwesterly to a point on the south shore 34° 19.1331' N - 77° 57.2245' W.

(E) Prince George Creek - Inland Waters south and Joint Waters north of a line beginning at a point on the west shore 34° 21.8481' N - 77° 57.0066' W; running northeasterly to a point on the east shore 34° 21.8778' N - 77° 57.9755' W.

(F) Sturgeon Creek - Inland Waters south and Joint Waters north of a line beginning at a point on the west shore 34° 22.6796' N - 77° 51.6018' W; running northeasterly to a point on the east shore 34° 22.6931' N - 77° 51.5776' W.

(G) Island Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the south shore 34° 23.2509' N - 77° 47.3377' W ; running northeasterly to a point on the north shore 34° 23.3322' N - 77° 49.3208' W.

(19) Northampton ~~County~~County:

(a) Roanoke River - Inland Waters northwest and Joint Waters southeast of a line beginning at a point on the west shore 36° 12.5264' N - 77° 23.0223' W; running northeasterly along the south side of the Highway 258 Bridge to a point on the east shore 36° 12.5674' N - 77° 22.9724' W.

(i) Sandy Run (Norfleet Gut) - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36° 10.1119' N - 77° 17.5396' W; running northeasterly to a point on the east shore 36° 10.1172' N - 77° 17.5316' W.

(b) Meherrin River - All waters of Meherrin River up to the Virginia state line within Northampton County are designated as Joint.

(i) Vaughan's Creek – Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36º 28.3541' N – 77º 05.6259' W; running southerly to a point on the south shore 36 º 28.3307' N – 77º 05.6369' W.

(20) Onslow ~~County~~County:

(a) Beasleys Creek (Barlow Creek) - All waters within this waterbody are designated as Coastal.

(b) Kings Creek - All waters within this waterbody are designated as Coastal.

(c) Turkey Creek - All waters within this waterbody are designated as Coastal.

(d) Mill Creek - All waters within this waterbody are designated as Coastal.

(e) New River - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 34° 45.1654' N - 77° 26.1222' W; running easterly along the southern side of the US Hwy 17 bridge to a point on the east shore 34° 45.2007' N - 77° 25.9790' W.

(i) Wheeler Creek - All waters within this waterbody are designated as Coastal.

(ii) Everett Creek - All waters within this waterbody are designated as Coastal.

(iii) Stones Creek - All waters within this waterbody are designated as Coastal.

(iv) Muddy Creek - All waters within this waterbody are designated as Coastal.

(v) Mill Creek - All waters within this waterbody are designated as Coastal.

(vi) Lewis Creek - All waters within this waterbody are designated as Coastal.

(vii) Southwest Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 34° 40.8723' N - 77° 26.2399' W; running northeasterly to a point on the east shore 34° 40.9112' N - 77° 26.1758' W.

(viii) Brinson Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 34° 44.0945' N - 77° 26.4335' W; running southerly to a point on the south shore 34° 44.0654' N - 77° 26.4239' W.

(ix) Northeast Creek - Inland Waters northeast and Coastal Waters southwest of a line beginning at a point on the west shore 34° 44.0778' N - 77° 21.2640' W; running southeasterly along the southern side of the railroad bridge to a point on the east shore 34° 44.0446' N - 77° 21.2126' W.

(x) Wallace Creek - Inland Waters east and Coastal Waters west of a line beginning at a point on the north shore 34° 40.9604' N - 77° 21.5698' W; running southwesterly along the western side of the first bridge upstream from the mouth, to a point on the south shore 34° 40.8576' N - 77° 21.4787' W.

(xi) Codels Creek - Inland Waters east and Coastal Waters west of a line beginning at a point on the north shore 34° 38.8845' N - 77° 20.4533' W; running southerly to a point on the south shore 34° 38.8691' N - 77° 20.4515' W.

(xii) French Creek – Inland Waters east and Coastal Waters west of a line beginning at a point on the north shore 34° 38.4059' N - 77° 20.2619' W; running southerly to a point on the south shore 34° 38.2566' N - 77° 20.3233' W.

(xiii) Duck Creek - Inland Waters southwest and Coastal Waters northeast of a line beginning at a point on the north shore 34° 38.0179' N - 77° 20.5169' W; running southwesterly to a point on the south shore 34° 37.9172' N - 77° 20.6520' W.

(f) Freeman (Browns) Creek - All waters within this waterbody are designated as Coastal.

(g) Bear Creek - All waters within this waterbody are designated as Coastal.

(h) Queens Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 34° 42.1815' N - 77° 11.5690' W; running easterly to a point on the east shore 34° 42.2273' N - 77° 11.4193' W.

(i) Parrotts Swamp - All waters within this waterbody are designated as Coastal.

(i) White Oak River - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 34° 48.1466' N - 77° 11.4711' W; running northeasterly to a point on the east shore 34° 48.1620' N - 77° 11.4244' W.

(i) Stevens Creek - All waters within this waterbody are designated as Coastal.

(ii) Holland Mill (Mill Pond) Creek - All waters within this waterbody are designated as Coastal.

(iii) Webbs Creek - Inland Waters northwest and Coastal Waters southeast of a line beginning at a point on the north shore 34° 45.7559' N - 77° 10.1321' W; running southwesterly to a point on the south shore 34° 45.7404' N - 77° 10.1486' W.

(iv) Freemans Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 34° 46.9791' N - 77° 10.3935' W; running southerly to a point on the south shore 34° 46.9663' N - 77° 10.3999' W.

(v) Calebs Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 34° 48.1354' N - 77° 11.4688' W; running southeasterly to a point on the south shore 34° 48.1192' N - 77° 11.4546' W.

(vi) Grants Creek - All waters within this waterbody are designated as Inland.

(21) Pamlico ~~County~~County:

(a) Pamlico River - All waters within this waterbody are designated as Coastal.

(i) Lower Goose Creek - All waters within this waterbody are designated as Coastal.

(A) Dixons Creek - All waters within this waterbody are designated as Coastal.

(B) Patons Creek - All waters within this waterbody are designated as Coastal.

(C) Wilson Creek - All waters within this waterbody are designated as Coastal.

(D) Eastham Creek - Inland Waters east and Coastal Waters west of a line beginning at a point on the north shore 35° 17.8205' N - 76° 35.1828' W; running southerly to a point on the south shore 35° 17.6797' N - 76° 35.1840' W.

(E) Upper Spring Creek - All waters within this waterbody are designated as Coastal.

(F) Intracoastal Waterway from Upper Spring Creek To Gale Creek - All waters within this waterbody are designated as Coastal.

(G) Hunting Creek - Inland Waters south and Coastal Waters north of a line beginning at a point on the west shore 35º 16.7523' N - 76º 36.8138' W; running easterly to a point on the east shore 35º 16.6779' N - 76º 36.5885' W.

(ii) Oyster Creek - All waters within this waterbody are designated as Coastal.

(iii) Clark Creek - All waters within this waterbody are designated as Coastal.

(A) Middle Prong - All waters within this waterbody are designated as Coastal.

(B) James Creek - All waters within this waterbody are designated as Coastal.

(b) Pamlico Sound - All waters within this waterbody are designated as Coastal.

(i) Porpoise Creek - All waters within this waterbody are designated as Coastal.

(ii) Drum Creek - All waters within this waterbody are designated as Coastal.

(iii) Bay River - Inland Waters south and Coastal Waters north of a line beginning at a point on the north shore 35° 08.4601' N - 76° 45.9173' W; running southeasterly to a point on the south shore 35° 08.4436' N - 76° 45.8885' W.

(A) Gale Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 35° 13.3142' N - 76° 36.7089' W; running southwesterly to a point on the south shore 35° 13.2964' N - 76° 36.7222' W.

(B) Chadwick Creek - All waters within this waterbody are designated as Coastal.

(C) Bear Creek - All waters within this waterbody are designated as Coastal.

(D) Vandemere Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 12.0330' N - 76° 40.7460' W; running northeasterly to a point on the east shore 35° 12.0433' N - 76° 40.7235' W.

(I) Long Creek - All waters within this waterbody are designated as Coastal.

(E) Smith Creek - All waters within this waterbody are designated as Coastal.

(F) Chapel Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 10.0076' N - 76° 42.4909 ' W; running easterly to a point on the east shore 35° 10.0096' N - 76° 42.4722' W.

(G) Raccoon Creek - All waters within this waterbody are designated as Coastal.

(H) Trent Creek - Inland Waters south and Coastal Waters north of a line beginning at a point on the west shore 35° 06.2738' N - 76° 43.1071' W; running southeasterly to a point on the east shore 35° 06.2603' N - 76° 43.0741' W.

(I) Thomas Creek - Inland Waters east and Coastal Waters west of a line beginning at a point on the north shore 35° 07.2024 ' N - 76° 43.0929' W; running southerly to a point on the south shore 35° 07.1610' N - 76° 43.0947' W.

(iv) Masons Creek - All waters within this waterbody are designated as Coastal.

(v) Moore Creek - All waters within this waterbody are designated as Coastal.

(vi) Rices Creek - All waters within this waterbody are designated as Coastal.

(vii) Ball Creek - All waters within this waterbody are designated as Coastal.

(viii) Cabin Creek - All waters within this waterbody are designated as Coastal.

(ix) Riggs Creek - All waters within this waterbody are designated as Coastal.

(x) Spring Creek - All waters within this waterbody are designated as Coastal.

(xi) Long Creek - All waters within this waterbody are designated as Coastal.

(c) Neuse River - All waters within this waterbody are designated as Coastal.

(i) Swan Creek – All waters within this waterbody are designated as Coastal.

(ii) Lower Broad Creek - All waters within this waterbody are designated as Coastal.

(A) Greens Creek - All waters within this waterbody are designated as Coastal.

(B) Pittman Creek - All waters within this waterbody are designated as Coastal.

(C) Burton Creek - All waters within this waterbody are designated as Coastal.

(D) Brown Creek - All waters within this waterbody are designated as Coastal.

(I) Spice Creek - All waters within this waterbody are designated as Coastal.

(E) Gideon Creek - All waters within this waterbody are designated as Coastal.

(F) Tar Creek - All waters within this waterbody are designated as Coastal.

(G) Parris Creek - All waters within this waterbody are designated as Coastal.

(iii) Orchard Creek - All waters within this waterbody are designated as Coastal.

(iv) Pierce Creek - All waters within this waterbody are designated as Coastal.

(v) Whitaker Creek - All waters within this waterbody are designated as Coastal.

(vi) Smith Creek - Joint Waters northwest and Coastal Waters southeast of a line beginning at a point on the north shore at the Oriental Bridge 35° 01.5149' N - 76° 41.9549' W; running southwesterly to a point on the south shore 35° 01.3391' N - 76° 42.1774' W.

(vii) Greens Creek - All waters within this waterbody are designated as Joint.

(A) Kershaw Creek - All waters within this waterbody are designated as Joint.

(viii) Dawson Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 35° 00.3371' N - 76° 45.6513' W; running southerly to a point on the south shore 35° 00.1492' N - 76° 45.6202' W.

(A) Tarkiln Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 00.4124' N - 76° 45.5392' W; running easterly to a point on the east shore 35° 00.4289' N - 76° 45.4472' W.

(ix) Gatlin Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 34° 58.4165' N - 76° 47.4645' W; running easterly to a point on the east shore 34° 58.4154' N - 76° 47.4371' W.

(x) Little Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 34° 58.5175' N - 76° 49.5822' W; running southeasterly to a point on the east shore 34° 58.5086' N - 76° 49.5680' W.

(xi) Mill Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 34° 59.6024' N - 76° 51.1276' W; running easterly to a point on the east shore 34° 59.5955' N - 76° 51.0864' W.

(xii) Beard Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 00.3293' N - 76° 52.1855' W; running easterly to a point on the east shore 35° 00.3055' N - 76° 51.9012' W.

(xiii) Lower Duck Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 01.5781' N - 76° 54.1580' W; running easterly to a point on the east shore 35° 01.5566' N - 76° 54.0248' W.

(xiv) Goose Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 03.4414' N - 76° 55.1170' W; running easterly to a point on the east shore 35° 03.3567' N - 76° 54.9728' W.

(xv) Upper Broad Creek - Inland Waters north and Coastal Waters south of a line beginning at a point on the west shore 35° 04.5050' N - 76° 56.5269' W; running easterly to a point on the east shore 35° 04.4705' N - 76° 56.2115' W.

(22) Pasquotank ~~County~~County:

(a) Albemarle Sound - All waters within this waterbody in Pasquotank County are designated Coastal.

(i) All Manmade Tributaries - All manmade tributaries of Pasquotank County are designated as Joint.

(ii) Little River - Inland Waters northwest and Joint Waters southeast of a line beginning at a point on the west shore 36° 12.2950' N - 76° 17.1405' W; running northeasterly to a point on the east shore 36° 12.5237' N - 76° 16.9418' W. Joint Waters west and Coastal Waters east of a line beginning at a point on the north shore 36° 07.5322' N - 76° 10.6901' W; running southwesterly to a point on the south shore 36° 06.4199' N - 76° 11.6047' W.

(A) Symonds Creek - Inland Waters northeast and Joint Waters southwest of a line beginning at a point on the north shore 36° 10.2898' N - 76° 14.1801' W; running southeasterly to a point on the south shore 36° 10.2042' N - 76° 14.0368' W.

(iii) Big Flatty Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 09.3267' N - 76° 08.2562' W; running southerly to a point on the south shore 36° 08.9730' N - 76° 08.3175' W. Joint waters north and Coastal Waters south of a line beginning at a point on the west shore 36° 07.9621' N - 76° 07.1818' W; running easterly to a point on the east shore 36° 08.2706' N - 76° 06.2525' W.

(iv) Pasquotank River - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36° 18.0768' N - 76° 13.0979' W; running easterly along the south side of the Highway 158 Bridge to a point on the east shore 36° 18.0594' N - 76° 12.9620' W. Joint Waters west and Coastal Waters east of a line beginning on the north shore 36° 11.4282' N - 76° 01.2876' W; running southwesterly to a point on the south shore 36° 08.7563' N - 76° 03.6991' W.

(A) Little Flatty Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 11.5209' N - 76° 04.6517' W; running southerly to a point on the south shore 36° 10.9973' N - 76° 04.5149' W.

(B) New Begun Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 13.3298' N - 76° 08.2878' W; running southerly to a point on the south shore 36° 13.0286' N - 76° 08.1820' W.

(I) Paling Creek – All waters in this waterbody are designated as Inland.

(II) James Creek – All waters in this waterbody are designated as Inland.

(C) Charles Creek - Inland Waters south and Joint Waters north of a line beginning at a point on the west shore 36° 17.8090' N - 76° 13.0732' W; running easterly to a point on the east shore 36° 17.8024' N - 76° 13.0407' W.

(23) Pender ~~County~~County:

(a) Cape Fear River – All waters within this waterbody for Pender County are designated as Joint.

(i) Thorofare – For the easternmost entrance into the Black River: Inland Waters northwest and Joint Waters southeast of a line beginning at a point on the west shore 34° 22.0493' N - 78° 04.4435' W; running northeasterly to a point on the east shore 34° 22.0783' N - 78° 04.4123' W. For the westernmost entrance into the Cape Fear River: Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 34° 21.9197' N - 78° 07.0527' W; running southeasterly to a point on the south shore ~~34° 21.8618' N - 78° 06.9992' W~~ 34° 21.8618' N - 78° 06.9992' W.

(ii) Black River - Inland Waters northeast and Joint Waters southwest of a line beginning at a point on the north shore 34° 22.0783' N - 78° 04.4123' W; running southeasterly to a point on the south shore 34° 21.9950' N - 78° 04.2864' W.

(iii) Northeast Cape Fear River - Inland Waters north and Joint Waters south of a line beginning at a point on the west side 34° 26.5658' N - 77° 50.0871' W; running northeasterly along the southern side of NC 210 bridge to a point on the east side 34° 26.6065' N - 77° 49.9955' W.

(A) Cowpen Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 34° 22.1417' N - 77° 59.3357'

W; running southerly to a point on the south shore 34° 22.1298' N - 77° 59.3426' W.

(B) Long Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the west shore 34° 22.7149' N - 77° 58.2797' W; running northeasterly to a point on the east shore 34° 22.7428' N - 77° 58.2348' W.

(C) Turkey Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 34° 22.8465' N - 77° 57.4827' W; running southerly to a point on the south shore 34° 22.7895' N - 77° 57.4452' W.

(D) Old Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 34° 22.5249' N - 77° 52.1493' W; running northeasterly to a point on the east shore 34° 22.5327' N - 77° 52.1278' W.

(E) Honey Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 34° 22.8627' N - 77° 51.0887' W; running easterly to a point on the east shore 34° 22.8609' N - 77° 51.0507' W.

(F) Harrisons Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the north shore 34° 24.1859' N - 77° 48.6570' W; running southwesterly to a point on the south shore 34° 24.1387' N - 77° 48.6982' W.

(G) Island Creek - Inland Waters east and Joint Waters west of a line beginning at a point on the south shore 34° 23.2509' N - 77° 47.3377' W; running northeasterly to a point on the north shore 34° 23.3322' N - 77° 49.3208' W.

(b) Topsail Sound And Tributaries - All waters within this these waterbodies are designated as Coastal.

(c) Beasleys (Barlow) Creek - All waters within this waterbody are designated as Coastal.

(24) Perquimans ~~County~~County:

(a) Albemarle Sound – All waters within this waterbody in Perquimans County are designated as Coastal.

(i) All Manmade Tributaries – All waters within this water body are designated as Joint.

(ii) Yeopim River – Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 05.4526' N - 76° 27.7651' W; running southerly to a point on the south shore at Norcum Point 36° 05.1029' N - 76° 27.7120' W. Joint Waters west and Coastal Waters east of a line beginning at a point on the north shore 36° 04.7426' N - 76° 24.2536' W; running southwesterly to a point on the south shore 36° 04.1136' N - 76° 24.5365' W.

(A) Yeopim Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore of 36° 04.7206' N - 76° 24.8396' W; running easterly to a point on the east shore 36° 04.7426' N - 76° 24.2536' W

(iii) Perquimans River - Joint Waters west and Coastal Waters east of a line beginning at a point on the west shore 36° 05.9669' N - 76° 18.1791' W; running northeasterly to a point on the east shore 36° 06.7655' N - 76° 16.5953' W. Inland Waters southwest and Joint Waters northeast of a line beginning at a point on the west shore 36° 11.6569' N - 76° 28.0055' W; running southeasterly to a point on the east shore 36° 11.6123' N - 76° 27.9382' W.

(A) Walter's Creek - Inland Waters southwest and Joint Waters northeast of a line beginning at a point on the north shore 36° 11.1305' N - 76° 27.9185' W; running southeasterly to a point on the south shore 36° 11.0224' N - 76° 27.6626' W.

(B) Mill Pond Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36° 11.9757' N - 76° 27.5752' W; running easterly to a point on the east shore 36° 11.9766' N - 76° 27.2511' W.

(C) Suttons Creek - Inland Waters north and Joint Waters south of a line beginning at a point on the west shore 36° 10.0394' N - 76° 23.7945' W; running southeasterly to a point on the east shore 36° 09.9325' N - 76° 23.5263' W.

(D) Jackson (Cove) Creek - Inland Waters northeast and Joint Waters southwest of a line beginning at a point on the north shore 36° 08.4642' N - 76° 20.3324' W; running southeasterly to a point on the east shore 36° 08.4159' N - 76° 20.2890' W.

(E) Muddy Creek - Inland Waters northwest and Joint Waters southwest of a line beginning at a point on the north shore 36° 07.0381' N - 76° 17.1350' W; running southeasterly to a point on the east shore 36° 07.0218' N - 76° 17.1226' W.

(iv) Little River - Inland Waters northwest and Joint Waters southeast of a line beginning at a point on the west shore 36° 12.2950' N - 76° 17.1405' W; running northeasterly to a point on the east shore 36° 12.5237' N - 76° 16.9418' W. Joint Waters west and Coastal Waters east of a line beginning at a point on the north shore 36° 07.5322' N - 76° 10.6901' W; running southwesterly to a point on the south shore 36° 06.4199' N - 76° 11.6047' W.

(A) Deep Creek - Inland Waters southwest and Joint Waters northeast of a line beginning at a point on the north shore 36° 11.0945' N - 76° 16.6717' W; running southeasterly to a point on the south shore 36° 10.7510' N - 76° 16.2258' W.

(B) Davis Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 36° 12.2950' N - 76° 17.1405' W; running southerly to a point on the south shore 36° 12.2222' N - 76° 17.1153' W.

(25) Tyrrell ~~County~~County:

(a) Albemarle Sound – All waters within this waterbody in Tyrrell County are designated as Coastal.

(i) All Manmade Tributaries – All manmade tributaries within this waterbody are designated as Joint.

(ii) Banton (Maybell) Creek – Inland Waters south and Coastal Waters north of a line beginning at a point on the west shore 35º 56.0552' N - 76º 22.0664' W; running northeasterly to a point on the east shore 35º 56.1151' N - 76º 21.8760' W.

(iii) Scuppernong River – Coastal Waters northwest and Joint Waters southeast of a line beginning at a point on the northeast shore 35° 56.7196' N - 76° 18.8964' W; running southwesterly to a point on the southwest shore at 35° 56.3351' N - 76° 19.6609' W. Inland Waters south and Joint Waters north of a line beginning at a point on the west shore 35° 54.0158' N - 76° 15.4605' W; running easterly to a point on the east shore 35° 54.0406' N - 76° 15.3007' W.

(A) First Creek (Rider's Creek) - Inland Waters south and Joint Waters north of a line beginning at a point on the west shore 35° 54.0495' N - 76° 15.2842' W; running northeasterly to a point on the east shore 35° 54.0641' N - 76° 15.2554' W.

(B) Furlough Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 35° 55.6391' N - 76° 18.9797' W; running southwesterly to a point on the south shore 35° 55.6322' N - 76° 18.9907' W.

(iv) Alligator River - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore at Cherry Ridge Landing 35° 42.2172' N - 76° 08.4686' W; running southerly to a point on the south shore 35° 42.1327' N - 76° 08.5002' W. Coastal Waters north and Joint Waters south of a line running along the north side of the Highway 64 Bridge beginning at a point on the west shore 35° 54.2903' N - 76° 01.6818' W; running easterly to a point on the east shore 35° 53.6835' N - 75° 58.8578' W.

(A) Little Alligator River - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 35° 56.7640' N - 76° 01.0299' W; running southerly to a point on the south shore 35° 55.9362' N - 76° 01.2492' W.

(B) Second Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 35° 51.7616' N - 76° 03.5105' W; running southerly to a point on the south shore 35° 51.1317' N - 76° 03.8003' W.

(C) Goose Creek - Inland Waters west and Joint Waters east of a line beginning at a point on the north shore 35° 50.2658' N - 76° 03.9115' W; running southerly to a point on the south shore 35° 50.2123' N - 76° 03.9120' W.

(D) The Frying Pan - Joint Waters by connection with Alligator River.

(E) Gum Neck Landing Ditch - Inland Waters northeast and Joint Waters southwest of a line beginning at a point on the west shore 35° 41.6054' N - 76° 06.8215' W; running southeasterly to a point on the east shore 35° 41.5841' N - 76° 06.7991' W.

(26) Washington ~~County~~County:

(a) Albemarle Sound - All waters within this waterbody in Washington County are designated as Coastal.

(i) All Manmade Tributaries - All manmade tributaries of Albemarle Sound within Washington County are designated as Joint.

(ii) Mackeys (Kendrick) Creek - Inland Waters southeast and Coastal Waters northwest of a line beginning at a point on the north shore 35° 56.3806' N - 76° 36.4356' W; running southwesterly to a point on the south shore 35° 56.3122' N - 76° 36.4613' W.

(iii) Pleasant Grove Creek (Cherry Swamp) - Inland Waters south and Coastal Waters north of a line beginning at a point on the west shore 35° 56.4791' N - 76° 34.1624' W; running easterly to a point on the east shore 35° 56.5042' N - 76° 34.0319' W.

(iv) Chapel Swamp Creek - Inland Waters south and Coastal Waters north of a line beginning at a point on the west shore 35° 56.4150' N - 76° 33.3494' W; running easterly to a point on the east shore 35° 56.4122' N - 76° 33.3091' W.

(v) Bull Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 35° 56.9954' N - 76° 23.0291' W; running southerly to a point on the south shore 35° 56.9602' N - 76° 23.0282' W.

(vi) Deep Creek - Inland Waters west and Coastal Waters east of a line beginning at a point on the north shore 35° 56.1291' N - 76° 23.1179' W; running southerly to a point on the south shore 35° 56.0744' N 76° 23.1230' W.

(vii) Banton (Maybell) Creek - Inland Waters south and Coastal Waters north of a line beginning at a point on the west shore 35° 56.0552' N - 76° 22.0664' W; running northeasterly to a point on the east shore 35° 56.1151' N - 76° 21.8760' W.

(b) Roanoke River - Joint Waters south and Coastal Waters north of a line beginning at a point on the west shore of the Roanoke River 35° 56.5068' N - 76° 41.8858' W; running easterly to a point on the east shore 35° 56.5324' N - 76° 41.5896' W.

(i) Conaby Creek - Inland Waters south and Joint Waters north of a line beginning at a point on the west shore 35° 55.3779' N - 76° 42.4401' W; running easterly to a point on the east shore 35° 55.3752' N - 76° 42.3408' W.

(ii) Welch Creek – Inland Waters south and Joint Waters north of a line beginning at a point on the western shore 35º 51.8458' N - 76º 45.8381' W; running easterly along the shoreline and across the mouths of the three creek entrances to a point on the east shore 35º 51.8840' N - 76º 45.6207' W.

(c) Scuppernong River - All waters in this waterbody in Washington County are designated as Inland.

History Note: Authority G.S. 113-132; 113-134; 143B-289.52;
Eff. February 1, 1991;
Amended Eff. June 1, 2013; April 1, 2009; August 1, 2004; July 1, 1993; September 1, 1991.

ISSUE 11.7 HOOK AND LINE AS COMMERCIAL GEAR IN ESTUARINE STRIPED BASS FISHERIES

15A NCAC 03M .0201 is amended as published in 27:12 NCR 1156-1157 as follows:

15A NCAC 03M .0201 GENERAL

(a) Striped bass is defined as striped bass (Morone saxatilis) and its hybrids taken in coastal and joint fishing waters.

~~(b) Hook-and-line fishing equipment is not commercial fishing equipment in the striped bass fishery. It is unlawful to sell or purchase striped bass taken by hook-and-line. Striped bass taken legally with hook-and-line may be possessed and transported.~~

~~(c)~~(b) It is unlawful to possess striped bass imported from other states less than 18 inches long (total length).

~~(d)~~(c) It is unlawful to import, buy, sell, transport, offer to buy or sell, or possess striped bass except during any:

(1) open striped bass season established for internal coastal waters;

(2) open striped bass season established for the Atlantic Ocean; or

(3) open striped bass season of another state without possession of the following:

(A) A bill of lading as described in 15A NCAC 03I .0114; and

(B) A numbered, state-issued tag from the State of origin affixed through the mouth and gill cover. This tag must remain affixed until processed for consumption by the consumer.

~~(c)~~(d) The management ~~units and recreational fishery management~~ areas for estuarine striped bass fisheries in coastal North Carolina are designated in 15A NCAC 03R .0201.

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. March 1, 1994; September 1, 1991;
Temporary Amendment Eff. May 1, 2000;
Amended Eff. June 1, 2013; October 1, 2008; October 1, 2004; April 1, 2001.

15A NCAC 03M .0201 is amended as published in 27:12 NCR 1156-1157 as follows:

15A NCAC 03M .0202 is amended with changes as published in 27:12 NCR 1157 as follows:

15A NCAC 03M .0202 SEASON, SIZE AND HARVEST LIMIT: INTERNAL COASTAL WATERS

(a) It is unlawful to possess striped bass from the coastal fishing waters of the Cape Fear River and its tributaries.

(b) It is unlawful to possess striped bass from the Roanoke River Management Area in a commercial fishing operation.

~~(b)~~(c) The Fisheries Director may, by proclamation impose any or all the following restrictions on the taking of striped bass in a commercial fishing operation or for recreational purposes in internal coastal waters during the period from October 1 through April 30:

(1) Specify fishing days and ~~times,~~ times;

(2) Specify ~~areas,~~ areas;

(3) Specify quantity, except possession for recreational purposes shall not exceed:

(A) more than three fish in any one day in the Albemarle Sound Management Area as designated in ~~15A NCAC 03R .0201, and~~ Rule 15A NCAC 03R .0201; and

(B) more than two fish in any one day in the joint and coastal fishing waters of the Central Southern Management Area as designated in ~~15A NCAC 03R .0201.~~ Rule 15A NCAC 03R .0201;

(4) Specify ~~means/methods,~~ means and methods; and

(5) Specify size, but the minimum size specified shall not be less than 18 inches total ~~length, and~~ length.

~~(6) Require submission of statistical and biological data~~. [1]

[1] This rule was deleted at the request of the Rules Review Commission because there was adequate authority in other rules for the requirement.

Fish that do not meet the minimum size limit specified by proclamation shall immediately be returned to the waters from which taken regardless of condition.

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; November 1, 1991;
Temporary Amendment Eff. September 1, 1996;
Amended Eff. April 1, 1997;
Temporary Amendment Eff. July 1, 1999;
Amended Eff. June 1, 2013; July 1, 2008; August 1, 2000.