# North Carolina
# Kingfish
# Fishery Management Plan

## Information Update

By

North Carolina Department of Environmental Quality

Division of Marine Fisheries
3441 Arendell Street
Post Office Box 769
Morehead City, N.C. 28557

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|---|---|
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## 1.0 ACKNOWLEDGMENTS

The 2015 North Carolina Kingfish Fishery Management Plan (FMP) Information Update was developed under the direction of the North Carolina Marine Fisheries Commission (NCMFC). The North Carolina Department of Environment and Natural Resources' (DENR) Division of Marine Fisheries (NCDMF) prepared the Information Update.

Marine Fisheries Commission

Sammy Corbett, Chair
Mark Gorges
Chuck Laughridge
Keith Rhodes
Janet Rose
Joe Shute
Rick Smith
Mike Wicker
Alison Willis

Plan Development Team

Kevin Brown – Co-lead
Andrew Cathey
Anne Deaton
Beth Egbert – Co-lead
John Hadley
Casey Knight
Laura Lee
Stephanie McInerny
Lee Paramore
Tom Wadsworth
Jason Walker
Katy West
Garland Yopp

## 2.0 FISHERIES MANAGEMENT PLAN, AMENDMENTS, AND UPDATES

Table 2.1 The Marine Fisheries Commission selected management strategies, objectives followed, and required actions in the 2007 Kingfish Fishery Management Plan.

| MANAGEMENT STRATEGY | OBJECTIVES | OUTCOME |
|---|---|---|
| 1. Maintain a long-term sustainable harvest of kingfishes on the North Carolina Coast. | 1 and 2 | Accomplished; Establish management triggers based on the biology of kingfishes, to ensure the long-term sustainability for the kingfishes stock in North Carolina using proclamation authority to enact management action if management triggers warrant. |

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ADA – Aquaculture Development Act

APAIS – Access Point Angler Intercept Survey

ASMA – Albemarle Sound Management Area

BDTRT – Bottlenose Dolphin Take Reduction Team

BRD – Bycatch Reduction Device

CAMA – Coastal Area Management Act

CHPP – Coastal Habitat Protection Plan

CHTS – Coastal Household Telephone Survey

CORMP – Coastal Ocean Research and Monitoring Program

CP – Conservation Plan

CPUE – Catch-per-unit-effort

CPI – Consumer Price Index

CRFL – Coastal Recreational Fishing License

DO – Dissolved oxygen

DDT – Dichlorodiphenyltrichloroethane

DEHNR – North Carolina Department of Environment Health and Natural Resources

DENR – North Carolina Department of Environment and Natural Resources

DSP – Distinct Population Segment

EIS – Environmental Impact Statement

EPA – United States Environmental Protection Agency

*F* – Fishing mortality

ESA – Endangered Species Act

FMP – Fishery Management Plan

FR – United States Office of the Federal Register

FRA – Fisheries Reform Act

FRG – Fisheries Research Grant

FSC – Federal species of concern

G.S. – General Statute

GSAFDF – Gulf and South Atlantic Fisheries Development Foundation

GSI – Gonadosomatic Index

HCP – Habitat Conservation Plan

HQW – High Quality Waters

IWW – Intracoastal Waterway

ITP – Incidental Take Permit

lb – Pounds

m – Meters

*M* – Natural Mortality

MAFMC – Mid-Atlantic Fishery Management Council

MBTA – Migratory Bird Treaty Act

mg/l – milligrams per liter

MGNRA – Mainland Gill Net Restricted Area

mm – Millimeters

MMPA – Marine Mammal Protection Act

MRFSS – Marine Recreational Fisheries Statistical Survey

MRIP – Marine Recreational Information Program

MSC – Moratorium Steering Committee

NCAC – North Carolina Administrative Code

NCCR – National Coastal Condition Reports

NCCRC – North Carolina Coastal Resources Commission

NCDACS – North Carolina Department of Agriculture and Consumer Services

NCDCM – North Carolina Division of Coastal Management

NCDMF – North Carolina Division of Marine Fisheries

NCDWQ – North Carolina Division of Water Quality

NCDWR – North Carolina Division of Water Resources

NCEMC – North Carolina Environmental Management Commission

NCMFC – North Carolina Marine Fisheries Commission

NCTTP – North Carolina Trip Ticket Program

NCWRC – North Carolina Wildlife Resources Commission

NLCD – National Land Cover Data

NMFS – National Marine Fisheries Service

NNCESS – Northern North Carolina Estuarine System Stock

NOAA – National Oceanic and Atmospheric Administration

NPDES – National Pollutant Discharge Elimination

NSW – Nutrient Sensitive Waters

ORW – Outstanding Resource Waters

PAH – Polycyclic aromatic hydrocarbons

PCB – Polychlorinated biphenyls

ppt – Parts per thousand

PSGNRA – Pamlico Sound Gill Net Restricted Area

PSE – Proportional Standard Error

PSS – Pamlico Sound Survey

RCGL – Recreational Commercial Gear License

RDD – Random Digit Dialing

SAV – Submerged Aquatic Vegetation

SAB – South Atlantic Bight

SAFMC – South Atlantic Fishery Management Council

SCAR – Scientific Council on Amphibians and Reptiles

SCDNR – South Carolina Department of Natural Resources

SCFL – Standard Commercial Fishing License

SEAMAP – Southeast Area Monitoring and Assessment Program

SGNRA – Shallow Water Gill Net Restricted Area

SHA – Strategic Habitat Area

SL – Standard length

SNCESS – Southern North Carolina Estuarine System Stock

SSB – Spawning Stock Biomass

STAC – Sea Turtle Advisory Committee

STSSN – Sea Turtle Stranding and Salvage Network

TBT – Tributyltin

TED – Turtle Excluder Device

TL – Total length

USACE – United States Army Corp of Engineers

USFWS – United States Fish and Wildlife Service

WS – Water supply

YOY – Young-of-the-year

## 4.0 EXECUTIVE SUMMARY

Three species of kingfishes occur in North Carolina: southern kingfish (*Menticirrhus americanus*), Gulf kingfish (*M. littoralis*), and northern kingfish (*M. saxatilis).* These species help support significant recreational and commercial fisheries. Southern kingfish is the most abundant kingfish species in the South Atlantic Bight (SAB) and therefore, was chosen as the indicator species for this assemblage. All three species are short-lived, demersal fish that inhabit nearshore ocean and estuarine habitats.

The North Carolina Kingfish Fishery Management Plan (FMP) was developed and approved by the North Carolina Marine Fisheries Commission (NCMFC) in November of 2007. The goal of the 2007 Kingfish FMP is to determine the status of the stock and ensure the long-term sustainability of the stock of kingfishes in North Carolina. The plan objectives include: 1) develop an objective management program that provides conservation of the resource and sustainable harvest in the fishery; 2) ensure that the spawning stock is of sufficient capacity to prevent recruitment overfishing; 3) address socio-economic concerns of all user groups; 4) restore, improve, and protect critical habitats that affect growth, survival, and reproduction of the North Carolina stock of kingfishes; 5) evaluate, enhance, and initiate studies to increase our understanding of the biology of kingfishes and population dynamics in North Carolina; and 6) promote public awareness regarding the status and management of the North Carolina stock of kingfishes.

This document is an Information Update to the 2007 Kingfish FMP. An Information Update only incorporates changes in factual and background data that do not alter management strategies or management measures contained in the prior FMP and does not introduce or address new management issues not previously included in the FMP. An Information Update refreshes the FMP with the most current statistics, trends, research, etc. available at the time the Information Update is developed.

The 2007 Kingfish FMP selected the use of trend analysis and management triggers as the preferred management strategy to monitor the viability of the stock of kingfishes in North Carolina (NCDMF 2007). A second management strategy promotes work to enhance public information and education. As a review of the 2007 Kingfish FMP, best available data and techniques used for the trend analysis and management triggers were refined and modified to better assess population trends as part of this FMP Information Update (Appendix 1, Evaluations of Management Triggers for Kingfish). Changes to management triggers better inform management and do not alter the basic concept of trigger management set forth in the original 2007 FMP. Management triggers set forth in this plan will continue to be the management strategy used for maintaining the long-term sustainable harvest in the kingfish fishery. A coast-wide stock assessment is a long-term research need that will have to be addressed before any estimation of biological reference points related to sustainable harvest can be determined.

The trend analysis and management triggers will be updated annually and results will be presented to the NCMFC as part of the annual FMP Update. For reference, the 2015 annual update including data through 2014 can be found on the NCDMF website at http://portal.ncdenr.org/web/mf/fmps-under-development.

The trend analysis incorporates management triggers to alert managers to the potential need for management action based on stock conditions. The activation of any two management triggers two years in a row (regardless of category) warrants further data evaluation and potential management action. The NCMFC will be alerted by the NCDMF should this criterion be met. No triggers were activated in either 2013 or 2014. The current stock status is “viable” based on positive trends in the management triggers used as a tool to determine sustainable harvest. The inability to conduct a peer reviewed stock assessment resulted in the designation of an “unknown” stock status in the 2007 Kingfish FMP. While the current plan lists kingfish in North Carolina as “viable”, a coast-wide stock assessment is a high research priority that needs to be addressed before biological reference points relative to overfished and overfishing can be determined.

Research recommendations were updated by the NCDMF to address deficiencies in the current data. These recommendations will increase our understanding of the life history and stock structure of kingfishes in North Carolina and the Atlantic Coast.

## 5.0 INTRODUCTION

## 5.1 RECOMMENDED MANAGEMENT PROGRAM

### 5.1.1 Management Authority

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

All authority for management of North Carolina's fishery for kingfishes is vested in the state of North Carolina. Management of the fishery includes all activities associated with the use, maintenance, and improvement of populations of kingfishes and their habitats in coastal areas, including research, development, regulation, enhancement, and enforcement. North Carolina's jurisdiction over kingfishes is limited to estuarine and ocean waters, located within three miles of the states coastline, and are included under rules set by the North Carolina Marine Fisheries Commission (NCMFC). The North Carolina Department of Environment and Natural Resources (DENR) is the agency directed by North Carolina General Statute (G.S.) 113-182.1 to prepare Fishery Management Plans (FMPs) for all commercially or recreationally significant species or fisheries that comprise State marine or estuarine resources. These plans must be approved and adopted by the NCMFC.

Many different state laws provide the necessary authority for fishery management in North Carolina. General authority for stewardship of the marine and estuarine resources by the DENR is provided in G.S. 113-131. The North Carolina Division of Marine Fisheries (NCDMF) is the branch of the DENR that carries out this responsibility. General Statute 113-136 provides enforcement authority for NCDMF Marine Patrol officers. General Statute 113-181 authorizes research and statistical programs. The NCMFC is charged to "manage, restore, develop, cultivate, conserve, protect, and regulate the marine and estuarine resources of the State of North Carolina" (G.S. 143B-289.51). The NCMFC can regulate fishing times, areas, fishing gear, seasons, size limits, and quantities of fish harvested and possessed (G.S. 113-182 and 143B-289.52). General Statute 143B-289.52 allows the NCMFC to delegate authority to implement its regulations for fisheries "which may be affected by variable conditions" to the Director of NCDMF by issuing public notices called "proclamations". Thus, North Carolina has a very powerful and flexible legal basis for coastal fisheries management. The General Assembly has retained for itself the authority to establish commercial fishing licenses and permit fees greater than $100. It has delegated to the NCMFC authority to establish permits for various fishing activities.

The Fisheries Reform Act of 1997 (FRA) establishes a process for preparation of coastal FMPs in North Carolina (G.S. 113-182.1.). The FRA has been amended several times. 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:

- Contain necessary information pertaining to the fishery or fisheries, including management goals and objectives, status of relevant fish stocks, stock assessments for multiyear species, fishery habitat and water quality considerations consistent with

Coastal Habitat Protection Plans adopted pursuant to G.S. 143B-279.8, social and economic impact of the fishery to the State, and user conflicts.

- Recommend management actions pertaining to the fishery or fisheries.
- Include conservation and management measures that will provide the greatest overall benefit to the State, particularly with respect to food production, recreational opportunities, and the protection of marine ecosystems, and that will produce a sustainable harvest.
- Specify a time period, not to exceed two years from the date of the adoption of the plan, to end overfishing. This subdivision shall not apply if the Fisheries Director determines that the biology of the fish, environmental conditions, or lack of sufficient data make implementing the requirements of this subdivision incompatible with professional standards for fisheries management.
- Specify a time period, not to exceed 10 years from the date of the adoption of the plan, for achieving a sustainable harvest. This subdivision shall not apply if the Fisheries Director determines that the biology of the fish, environmental conditions, or lack of sufficient data make implementing the requirements of this subdivision incompatible with professional standards for fisheries management.
- 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 that the biology of the fish, environmental conditions, or lack of sufficient data make implementing the requirements of this subdivision incompatible with professional standards for fisheries management." (G.S. 113-182.1)

Sustainable harvest is defined in the FRA (§ 113-129) 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 (SSB) of the fishery is below the level that is adequate 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 (G.S. 113-129).

### 5.1.2 Goal and Objectives

As an Information Update, the goal and objectives are the same as the 2007 Kingfish Fishery Management Plan (NCDMF 2007). The goal is to determine the status of the stock and ensure the long-term sustainability for the stock of kingfishes in North Carolina.

Objectives:

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

### 5.1.3 Definition of Management Unit and Unit Stock

The management unit for the North Carolina Kingfish FMP includes the three species of kingfishes (southern, Gulf, and northern), their habitat, and the fisheries that harvest these species in all coastal fishing waters of North Carolina. Southern kingfish, being the most abundant kingfish in the South Atlantic Bight (SAB), is designated as the indicator species for this assemblage.

The management unit identified in this plan does not encompass the entire unit stock range for any of the three species of kingfishes inhabiting North Carolina. This is the primary reason that a quantified state-specific stock assessment could not be conducted and further why a regional stock assessment approach is recommended as the most appropriate mechanism for determining the stock status and the long-term viability of this stock (NCDMF 2007).

### 5.1.4 Sustainable Harvest

Sustainable harvest in the North Carolina fishery for kingfishes is defined as the amount of harvest that can be taken without reducing the SSB below a level necessary to ensure adequate reproduction. Reference points for sustainable harvest (overfishing/overfished) cannot be determined due to deficiencies in data needed for a regional stock assessment. Sustainable harvest in North Carolina is based on monitoring trends in abundance and fishing mortality (i.e., Relative *F*) for southern kingfish.

### 5.1.5 Management Strategy

The management strategy for kingfishes in North Carolina is to 1) maintain a sustainable harvest of kingfishes over the long-term, and 2) promote public education. The first strategy is accomplished by evaluating annual trends in population abundance and relative fishing mortality. Management triggers were established in the 2007 Kingfish FMP (to monitor potential causes for concern in the North Carolina kingfish stock (NCDMF 2007). As a review of the 2007 Kingfish FMP, best available data and techniques used for the trend analysis and management triggers were refined and modified to better assess population trends as part of this FMP Information Update (Appendix 1, Evaluations of Management Triggers for Kingfish). The analysis is updated annually and all trends relative to management triggers are provided annually as part of the annual FMP update provided to the NCMFC in August of each year. The FMP updates can be found on the NCDMF website (http://portal.ncdenr.org/web/mf/fmps-under-development). The second strategy will be accomplished by the NCDMF working to enhance public information and education.

### 5.1.6 Research Needs

#### <u>5.1.6.1 Management Related Research Needs</u>

- Conduct a coast-wide stock assessment of southern kingfish along the Atlantic Coast including estimation of biological reference points for sustainable harvest. (HIGH)
- Validate young-of-the-year (YOY) and adult indices used in trend analysis. (HIGH)
- Develop a fisheries-independent survey in the ocean for juvenile and adult kingfishes. (HIGH)
- Collect observer data from commercial fishing operations to estimate at-sea species composition of the catch, discard rates, and lengths. (HIGH)

- Improve recreational data collection, particularly the species composition of discards, discard rates and associated biological data. (HIGH)
- Improve dependent commercial data collection of more sample sizes for life history information. (MEDIUM)
- Evaluate and potentially expand the NCDMF fishery-independent gill-net survey to provide data on species composition, abundance trends, and population age structure by including additional areas of North Carolina's estuarine and nearshore ocean waters. (MEDIUM)
- Continue bycatch reduction device (BRD) studies in the shrimp trawl fishery to decrease bycatch. (MEDIUM)
- Determine stock structure using genetics of kingfishes along North Carolina and the Atlantic Coast. (LOW)

#### **5.1.6.2 Biological Research Needs**

- Develop tagging study to estimate natural and fishing mortality, to investigate stock structure, and to understand movement patterns. (HIGH)
- Collect histological data to develop maturity schedule with priority to southern kingfish. (HIGH)
- Conduct an age validation study with priority to southern kingfish. (HIGH)
- Conduct study to estimate fecundity with priority to southern kingfish. (MEDIUM)
- Conduct study to identify spawning areas with priority for southern kingfish. (MEDIUM)
- Sample inlets and river plumes to determine the importance of these areas for kingfishes and other estuarine-dependent species. (LOW)
- Determine the effects of beach nourishment on kingfishes and their prey. (LOW).
- Conduct a study to investigate how tidal stages and time of day influence feeding in kingfishes. (LOW)

#### **5.1.6.3 Social and Economic Research Needs**

- Increase the sample size of surveyed participants in the commercial kingfish fishery to better determine specific business characteristics and the economics of working in the fishery. (LOW)
- Update information on the participants in the recreational kingfish fishery. (LOW)

#### **5.1.6.4 Status of 2007 Kingfish Fishery Management Plan Coastal Habitat Protection Plan Recommendations**

The 2007 Kingfish FMP included habitat and water quality as principal issues citing the maintenance and improvement of suitable estuarine and marine habitat and water quality as important factors in maintaining sustainable stocks of kingfishes (NCDMF 2007). Many of the action items outlined in the 2007 Kingfish FMP Principal Issues and Management Options section have been implemented or are substantially underway and/or were also components of the CHPP implementation plan. They include:

Habitat

- NCCRC has revised dock rules to require review by resource agencies for GP dock applications located over SAV, shell bottom, or Primary Nursery Areas, and where water depth is less than 2 ft. mean water level to avoid boating related impacts.

- NCDMF is in the process of identifying and delineating SHAs that will enhance protection of southern, Gulf, and northern kingfishes.
- Wetland buffers along coastal streams and rivers have been used to enhance wetlands and improve water quality.
- Although North Carolina legislation has been passed to allow terminal groins to be built in coastal North Carolina, the NCDMF has been in talks with applicants to minimize the adverse impacts to fisheries. In addition, the North Carolina Division of Coastal Management (NCDCM) has created standards for beach nourishment projects. These standards include sediment size and moratorium periods to minimize impacts.
- Coast-wide imagery of SAV was taken in 2007/2008 and has been mapped.
- Identification and designation of strategic SAV areas is underway through the SHA process.
- Additional bottom disturbing gear restrictions have been implemented through the bay scallop and oyster fishery management plans to avoid damage to SAV and oysters.
- DENR staff has been cooperating to develop permit conditions for marsh sills to minimize the impacts of vertical shoreline stabilization methods.
- Loss of additional riparian wetlands has been minimized through the permitting process, land acquisition, and land use planning.

Water Quality

- Neuse and Tar-Pamlico nutrient sensitive waters (NSW) nutrient reduction measures have successfully reduced nutrient loading by more than their 30% reduction goals for point source dischargers and agriculture.
- North Caroline Division of Water Resources (NCDWR) revised coastal storm water rules that limit impervious surface and run-off in coastal areas.
- Wetland buffers along coastal streams and rivers have been used to enhance wetlands and improve water quality.

## 5.2 GENERAL PROBLEM STATEMENT

### 5.2.1 Update to Management Framework for North Carolina Kingfish Stock

The 2007 Kingfish FMP implemented a management strategy for maintaining a long-term sustainable harvest in the kingfish fishery (NCDMF 2007). The strategy included developing and monitoring management triggers to evaluate stock conditions annually. Management triggers were based on biological indicators, dependent catch-per-unit-effort (CPUE), and independent surveys indices. These triggers inform management on the potential need for regulatory changes. Based on the 2007 Kingfish FMP, consideration for a management change occurs if one or more triggers are activated in a single year. Triggers are to be updated and evaluated annually.

This document is an Information Update to the 2007 Kingfish FMP. An Information Update only incorporates changes in factual and background data that do not alter management strategies or management measures contained in the prior FMP and does not introduce or address new management issues not previously included in the FMP. An Information Update refreshes the FMP with the most current statistics, trends, research, etc. available at the time the Information Update is developed.

In the review of the 2007 Kingfish FMP, NCDMF gathered available data on kingfishes through 2013 and determined that data were still insufficient to move forward with a traditional stock assessment. In lieu of a stock assessment, NCDMF further evaluated and refined the management triggers established in the 2007 Kingfish FMP. Any refinement of existing triggers was based on using best available and most current data and analytical techniques to better inform management. The updated management triggers and analyses results are provided in Appendix 1, Evaluation of Management Triggers for Kingfish. No management triggers were activated in 2013. The NCMFC reviewed the results of the management trigger modifications and analyses results at their May 2015 business meeting and voted to proceed with the review of the 2007 Kingfish FMP in the form of an Information Update. The changes and updates to the management triggers provided in Appendix 1, Evaluation of Management Triggers for Kingfish, do not alter the basic strategic concept of the trigger management set forth by the 2007 FMP.

Another management strategy discussed but not adopted in the 2007 Kingfish FMP involved the possibility for regional (multi-state) management and stock assessment for kingfishes. After the 2007 FMP was finalized, regional management was considered. In 2008, the Atlantic States Marine Fisheries Commission (ASMFC) South Atlantic Board met and reviewed data on kingfishes and charged a newly formed Southern Kingfish Technical Committee with two tasks 1) developing a prioritized list of research and data needs and 2) conducting a trend analysis of data from the Southeast Area Monitoring and Assessment Program (SEAMAP). This was completed in September of 2008 and the technical committee reported no major concerns with the kingfish stocks and provided a list of data/research needs. More recently, in May of 2014, the ASMFC South Atlantic Board was presented with an update on the trends and research priorities and subsequently decided not to pursue any further action on the management of kingfishes. As a result, Kingfish management in North Carolina continues to fall solely within the framework of the state FMP process.

## 5.3 EXISTING PLANS, STATUTES, AND RULES

### 5.3.1 Plans

There are no existing federal fishery management plans along the U.S. Atlantic coast for kingfishes (NCDMF 2007). North Carolina and Georgia are currently the only states with a management plan for kingfishes.

### 5.3.2 Statutes

In 2007, the FMP for the kingfish stock in the waters of North Carolina was finalized. All management authority for North Carolina's kingfish fishery is vested in the State of North Carolina. Statutes that have been or could be applied to the kingfish fishery include:

- G.S. 113-168.1. General provisions governing licenses and endorsements
- 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 registrations
- G.S. 113-174.1. License required; general provisions governing licenses
- G.S. 113-174.2. Coastal Recreational Fishing License
- G.S. 113-182. Regulation of fishing and fisheries
- G.S. 113-182.1. Fishery Management Plans
- G.S. 113-183. Unlawful possession, transport, and sale of fish

- G.S. 113-185. Fishing near ocean piers; trash or scrap fishing
- G.S. 113.221.1. Proclamations; emergency review
- G.S. 113-268. Injuring, destroying, stealing, or stealing from nets, seines, buoys, pots, etc.

### 5.3.3 Marine Fisheries Commission Rules

The following rules adopted by the NCMFC affect management of the kingfishes in North Carolina. The version of the rules shown below is taken from North Carolina Marine Fisheries Commission Rules effective May 1, 2015. The following rules are codified in Title 15A (Environment and Natural Resources) Chapter 03 (Marine Fisheries) of the North Carolina Administrative Code (15A NCAC 03):

- 15A NCAC 03J .0101 FIXED OR STATIONARY NETS
- 15A NCAC 03J .0103 GILL NETS, SEINES, IDENTIFICATION, RESTRICTIONS
- 15A NCAC 03J .0202 ATLANTIC OCEAN
- 15A NCAC 03J .0402 FISHING GEAR RESTRICTIONS
- 15A NCAC 03M .0102 UNMARKETABLE FINFISH
- 15A NCAC 03M .0103 MINIMUM SIZE LIMITS
- 15A NCAC 03M .0518 KINGFISH (SEA MULLET)

The details of these rules as well as information regarding North Carolina's current commercial and recreational fishery regulations are available on the NCDMF website (http://portal.ncdenr.org/web/mf/rules-and-regulations).

### 5.3.4 Kingfish Rules and Regulations Outside North Carolina

South Carolina has a 50 per person, daily fish bag limit for an aggregate of kingfishes, spot, and croaker.

### 5.3.5 Federal Regulations

Pursuant to Title 33 U.S. Code Section 3, the U.S. Army Corps of Engineers (USACE) has adopted regulations, which restrict access to, and activities within certain areas of coastal and inland fishing waters. Federal Rules codified at 33 CFR 334.410 through 334.450 designate prohibited and restricted military areas, including locations within North Carolina coastal fishing waters, and specify activities allowed in these areas.

Gill nets are prohibited in federal waters from the North Carolina/South Carolina border to New Smyrna Beach, Florida in response to an entanglement and mortality of a northern right whale (*Eubalaena glacialis*). A closure was enacted first on February 15, 2006 through March 31, 2006 and listed in the U.S. Office of the Federal Registry (FR 2006a). A permanent closure in these waters was enacted on June 25, 2007 (FR 2007). As of 2015, the waters are closed from 15 November through 15 April, using the Federal Registry Notice (FR 2006b). Maps of the closure area are available on Atlantic Large Whale Take Reduction Plan found at: http://www.greateratlantic.fisheries.noaa.gov/protected/whaletrp/docs/Updated%20Docs%2082514/northeast_trap_pot___dec_2014.pdf.

# 6.0 STATUS OF THE STOCK

## 6.1 GENERAL LIFE HISTORY

### 6.1.1 Background

Three species of kingfishes occur in North Carolina: southern (*Menticirrhus americanus*), Gulf (*M. littoralis*), and northern kingfishes (*M. saxatilis*). Kingfish refers to a single species while kingfishes refers to multiple species. Kingfishes are demersal members of the drum family (*Sciaenidae*). Southern kingfish is the most abundant kingfish species in the SAB and Gulf of Mexico (Irwin 1970; Dahlberg 1972; Crowe 1984; Smith and Wenner 1985; Harding and Chittenden 1987) with a range extending from Cape May, New Jersey southward to Buenos Aires, Argentina (Fischer 1978). Northern kingfish is the most abundant kingfish species in the Mid-Atlantic Bight (Hildebrand and Schroeder 1928; Schaefer 1965; Ralph 1982) with a range extending from the Gulf of Maine into the Gulf of Mexico (Fischer 1978). Gulf kingfish is the most abundant kingfish species in the surf zone south of Cape Hatteras, North Carolina, and has a range extending from Virginia (Welsh and Breder 1923; Irwin 1970) to Rio Grande, Brazil (Fischer 1978). Past reports had listed a fourth species, *M. focaliger*, but the species was determined to be southern kingfish (Irwin 1970). The kingfishes have several regional names including sea mullet, king whiting, king croaker, sea mink, roundhead, hard head, whiting, hake, Carolina whiting, and Virginia mullet (Welsh and Breder 1923).

The three Atlantic species are morphologically and meristically similar, causing difficulty in species identification. A rough key is outlined in Section 6.1.4.4 Adults (Figures 6.10, 6.11 and 6.12) and a more detailed key is given in Carpenter (2002).

Since all three species are harvested in North Carolina, the FMP will include discussions on the three species (if data are available). However, the focus of the management plan will be on southern kingfish due to its greater abundance relative to the other two kingfish species and a larger amount of data and published research. Gulf and northern kingfishes are included as an initial effort to describe information on life history, biology, and fishery importance in North Carolina's waters.

Length is reported as total length (TL) unless otherwise noted.

### 6.1.2 Physio-chemical Tolerances and Preferences

#### 6.1.2.1 Temperature

Kingfishes are temperate fishes generally found in waters warmer than 10.0°C. Southern kingfish have been collected in waters with temperatures ranging from 8.0°C (Bearden 1963) to 37.3°C (Irwin 1970). Larval and postlarval southern kingfish are found in warmer temperature waters (12.0–37.3°C) than adults (Crowe 1984). Since kingfish spawn during the early spring to early fall, it would be unlikely to find larval and postlarval kingfish in cold water (<10.0°C). As temperatures cool southern kingfish move to deeper, warmer water or migrate south (Bearden 1963).

Northern kingfish occur in water temperatures of 7.8 to 35.8°C (Irwin 1970). The greatest concentration of northern kingfish occurs in temperatures between 24.0 and 26.0°C (Ralph 1982).

Gulf kingfish have been collected in water temperatures ranging from 10.8 to 31.0°C (Irwin 1970). Few studies have reported the temperature tolerances of Gulf kingfish.

#### 6.1.2.2 Salinity

Kingfishes are euryhaline and inhabit waters that range from nearly fresh (2.0 part per thousand; ppt), to hypersaline (36.6 ppt), depending on the species (Bearden 1963; Irwin 1970; Crowe 1984). Southern kingfish have been observed in ocean waters as well as estuarine waters with salinities as low as 2.0 ppt. Mean length increases with salinity indicating inshore waters act as a nursery area for juveniles and sub-adult southern kingfish (Crowe 1984). Most southern kingfish are found in salinities greater than 20.0 ppt (Bearden 1963; Irwin 1970).

In North Carolina, Gulf and northern kingfishes are more common in the surf zone than southern kingfish (Ross and Lancaster 2002). Northern kingfish have been collected in waters with salinities as low as 8.0 ppt, but are most common in waters with salinities greater than 16.0 ppt (Irwin 1970). Younger northern kingfish are associated with lower salinity waters while adults are associated with higher salinity waters indicating the importance of estuaries as nursery habitats (Ralph 1982). Gulf kingfish are almost exclusively oceanic but have been found in estuarine waters with salinities as low as 17.9 ppt (Irwin 1970).

#### 6.1.2.3 Food/Feeding

The kingfishes are demersal feeders that use a single chin barbel to detect epibenthic or benthic prey (Viosca 1959; Irwin 1970; Chao and Musick 1977; Rodrigues and Vieira 2010). Southern kingfish consume decapod crustaceans, polychaetes, amphipods, mysids, pelecypod siphon tips, and mole crabs (Hildebrand and Cable 1934; Viosca 1959; Irwin 1970; McMichael and Ross 1987; Rodrigues and Vieira 2010; Anderson and Comyns 2013; SEAMAP 2013). Northern kingfish switch from feeding on copepods, mysids, crabs, and amphipods as juveniles to mole crabs, amphipods, hermit crabs, polychaetes, and small fishes as adults (Irwin 1970; Chao and Musick 1977; McMichael and Ross 1987; Anderson and Comyns 2013). Dietary analyses of Gulf kingfish found crustaceans, polychaetes, amphipods, molluscs, fishes, and pelecypod siphon tips (Viosca 1959; Irwin 1970; McMichael and Ross 1987; Palmeira and Monteiro-Neto 2010; Rodrigues and Vieira 2010; Anderson and Comyns 2013).

An ontogenetic shift in the diet of kingfishes has been attributed to atrophication of the swimbladder (Bearden 1963; Irwin 1970; Delancey 1984; McMichael and Ross 1987; Anderson and Comyns 2013). The swimbladder of southern and northern kingfishes begins to atrophy at approximately 3.9 inches TL (100 mm; Irwin 1970; Ross et al. 1987). As the swimbladder atrophies, the diet shifts from epibenthic or planktonic prey to more benthic items such as pelecypod siphon tips, polychaetes, and mole crabs (Bearden 1963; Irwin 1970; Delancey 1984; McMichael and Ross 1987; Anderson and Comyns 2013).

Tidal stage as well as day versus night feeding may have an influence on the diets of kingfishes. Delancey (1984) observed tidal variation in the diet of Gulf kingfish. Ross et al. (1987) found a significant difference between day and night diets, but did not observe a difference in the tidal stage. More detailed studies need to be conducted to understand how tidal stage and time of day influence feeding in kingfishes.

### 6.1.3 Reproductive Biology

#### 6.1.3.1 Size at Maturity

Length and sex at maturity varies for each kingfish species. Southern kingfish mature sexually at a total length of approximately 5.3 inches (135 mm) for males and 7.6 inches (192 mm) for females (Smith and Wenner 1985). Most southern kingfish females are mature at 8.3 inches (212 mm) in North Carolina (n = 2,076; Figure 6.1). The length at maturity ($L_{50}$) was defined as the point at which 50% of the fish are mature using logistic regression and maturity was estimated based on macroscopic descriptions from Smith and Wenner (1985).

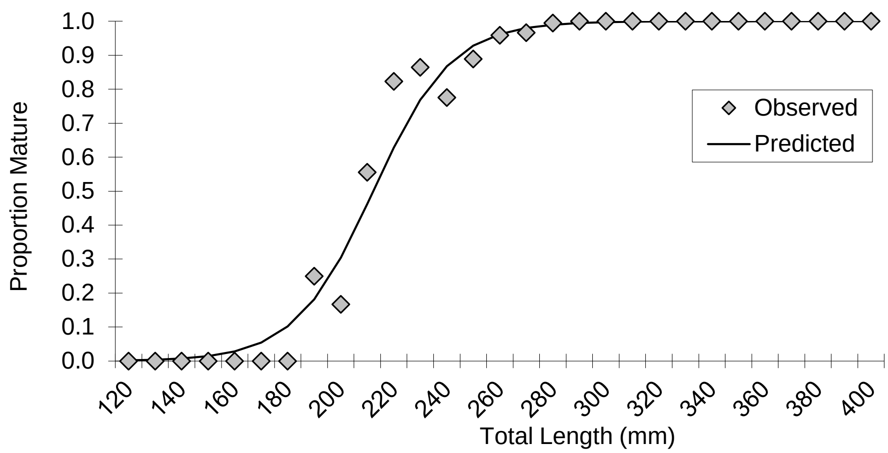


Figure 6.1 The percent of southern kingfish females mature by size, 1997–2013, n = 2,076 (Source: NCDMF, unpublished data).

Male kingfishes mature at a smaller size than the females. The smallest mature male southern kingfish was 3.9 inches (99 mm; SCDNR unpublished data) and the smallest mature female was 7.1 inches (180 mm; Smith and Wenner 1985). In North Carolina, the smallest mature female southern kingfish was 4.8 inches (122 mm).

Gulf kingfish females begin to mature at 7.4 inches (183 mm) and with an $L_{50}$ of 8.5 inches (215 mm; Figure 6.2). The females are all mature by 11.8 inches (300 mm; n = 426).

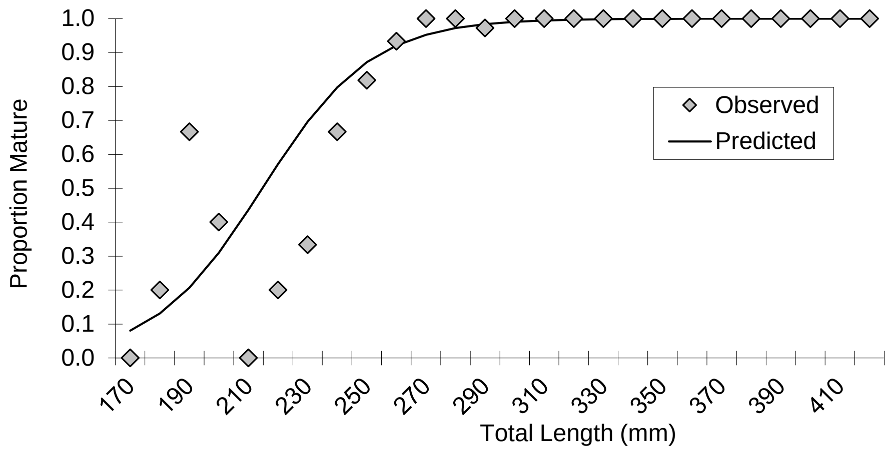


Figure 6.2 The percent of Gulf kingfish females mature by size, 1997–2013, n = 426 (Source: NCDMF, unpublished data).

Northern kingfish females began to mature at 7.9 inches (202 mm) with an $L_{50}$ of 9.5 inches (241 mm) in NC (n = 273; Figure 6.3). Northern kingfish are 100% mature at 13.0 inches (330 mm).

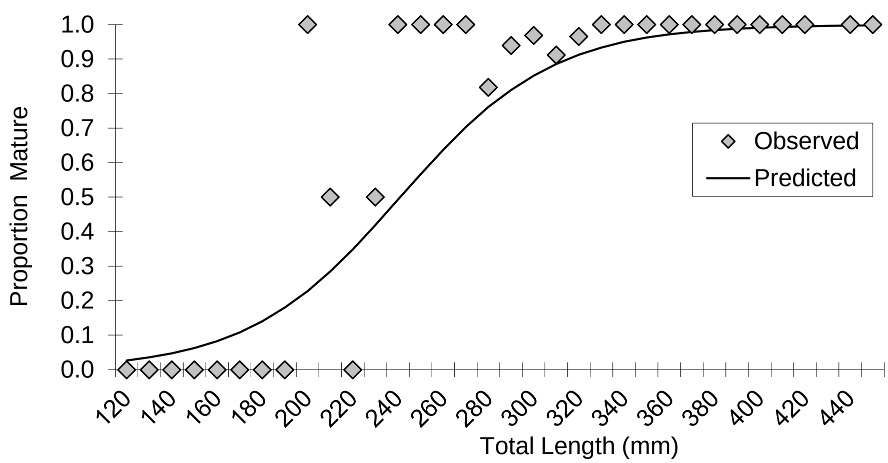


Figure 6.3 The percent of northern kingfish females mature by size, 1997–2013, n = 273 (Source: NCDMF, unpublished data).

## **6.1.3.2 Age at Maturity**

Kingfishes begin to mature during their second summer (Hildebrand and Cable 1934; Schaefer 1965; Smith and Wenner 1985). Individuals of all three species begin to mature at age 0 and most individuals are mature by age one with Gulf kingfish females having the smallest proportion mature at 87% at age one (Figure 6.4). All kingfishes are mature by age three. The NCDMF assigned the birth date of kingfishes as May 1 because it corresponds with annulus formation on the otolith and peak spawning season for southern and Gulf kingfishes.

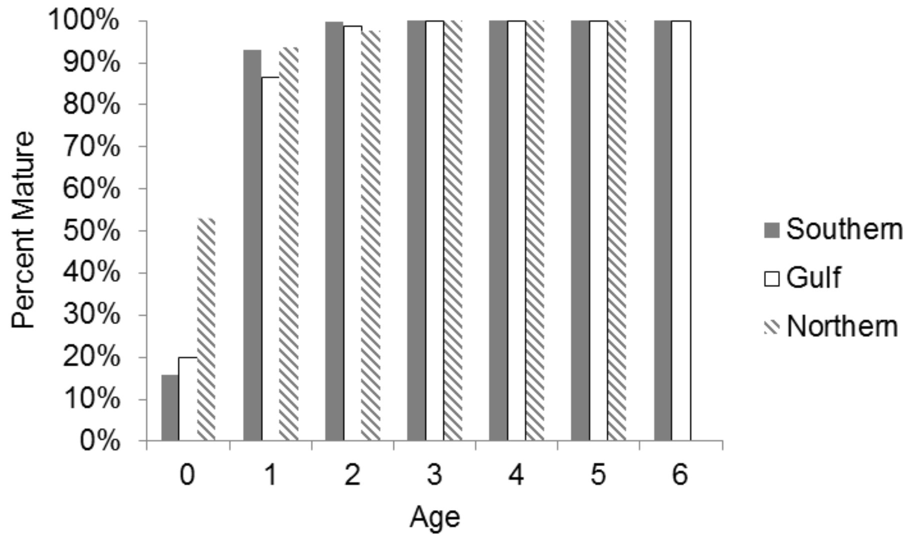


Figure 6.4 The percent mature at age for female southern, Gulf, and northern kingfishes, 1997–2013 (Source: NCDMF, unpublished data).

#### **6.1.3.3 Sex ratio**

The sexually dimorphic growth rates among kingfishes cause changes in sex ratio depending on the length of the fish (Figure 6.5). Female kingfishes grow faster and to larger sizes than males. The ratio of southern kingfish females to males begins to increase after 10.2 inches (260 mm). Nearly all southern kingfish are females by 13.4 inches (340 mm). Gulf kingfish are 100% female by 15.0 inches (380 mm). The proportion of northern kingfish females was greater than 50% for all lengths and had an increasing trend in percent of females as length increased for sizes greater than 10.2 inches (260 mm).

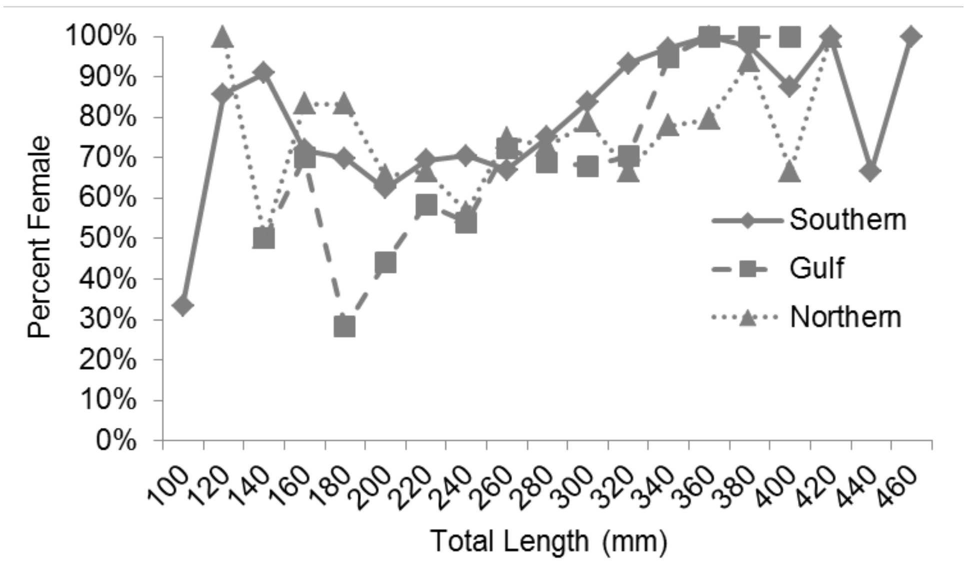


Figure 6.5 The percentage of female southern, Gulf, and northern kingfishes, 1997–2013 (Source: NCDMF, unpublished data).

A study of the shrimp trawl fishery found that most of the southern kingfish (79%) landed were female (Smith and Wenner 1985). A separate ageing study by NCDMF found that 64% of all southern kingfish caught by trawl were female (Table 6.1). In Smith and Wenner (1985), only the fish retained by the fishermen (>7.5 inches; >190 mm) were included in the ratio, while in the NCDMF ageing study all fish caught were included. Gulf kingfish had similar proportions of males and females from gill nets (54%) and long haul seines (47%), while beach seines and hook-and-line tended to harvest more females. The overall percentage for Gulf kingfish was 69% female (Table 6.1). The NCDMF found 73% of the northern kingfish to be female (Table 6.1). The bias in the NCDMF data could be due to the size selective nature of commercial gears, which tend to harvest larger individuals. The ratios were similar among gill nets and beach seines.

Table 6.1 The proportion female by gear for the southern, Gulf, and northern kingfishes, 1997–2013. Sample sizes are listed in parentheses (Source: NCDMF, unpublished data).

| Species | Pound Net | Gillnet | Beach Seine | Long Haul Seine | Hook & Line | Trawl | Grand Total[1] |
|---|---|---|---|---|---|---|---|
| Southern | 0.91 | 0.83 | 0.95 | 0.70 | 0.78 | 0.64 | 0.79 |
| | (44) | (2,651) | (39) | (326) | (386) | (601) | (4,047) |
| Gulf | | 0.54 | 0.68 | 0.47 | 0.78 | | 0.69 |
| | - | (228) | (65) | (34) | (490) | - | (817) |
| Northern | | 0.75 | 0.71 | 0.63 | 0.79 | 0.69 | 0.73 |
| | - | (455) | (59) | (30) | (73) | (160) | (777) |

[1] For gears with less than 10 fish, the proportion was not listed but was included in the grand total for species composition.

#### <u>6.1.3.4 Fecundity</u>

Based on evidence of multiple oocyte maturation stages and post-ovulatory follicles, southern kingfish are iteroparous, heterochronal spawners exhibiting indeterminate fecundity (McDowell and Robillard 2013; Clardy et al. 2014). Iteroparous spawners are those fish that spawn multiple times over a lifetime, and heterochronal spawners spawn more than once during a season. Fish with indeterminate fecundity are those in which multiple stages of oocytes are found in the ovary during the spawning season. Batch fecundity in southern kingfish was estimated to be between 22,589 oocytes for an 8.7 inches (222 mm) female to 152,109 oocytes for a 12.8 inches (324 mm) female (McDowell and Robillard 2013).

#### 6.1.3.5 Spawning Location

Spawning locations for kingfishes are unknown in North Carolina. Anecdotal evidence suggests spawning occurs on the bottom in the nearshore ocean and possibly in estuarine waters (Ralph 1982). Ripe kingfishes and kingfish eggs have been collected in nearshore ocean and estuarine waters from early spring to September (Hildebrand and Cable 1934; Bearden 1963; Hoese 1965; Smith and Wenner 1985; Bourne and Govoni 1988).

#### 6.1.3.6 Gonadosomatic Index and Spawning Period

Based on the presence of juveniles in surf zone seine surveys, the spawning season of kingfishes occurs from April through October (Welsh and Breder 1923; Hildebrand and Schroeder 1928; Bearden 1963; Schaefer 1965; Smith and Wenner 1985). Southern and northern kingfishes spawn earlier than Gulf kingfish based on peak juvenile abundance in the surf zone (Irwin 1970; Modde 1980; McMichael and Ross 1987).

Spawning seasonality for southern kingfish has been estimated by the NCDMF to be from March to September using macroscopic determination of female gonadal development as well as gonadosomatic index (GSI; Figure 6.6). The GSI value is the percent of gonad weight (grams) divided by the sum of total weight minus gonad weight (% gonad weight / [total weight-gonad weight]; Clardy et al. 2014). The GSI is a technique used to standardize gonad weight for fish of all sizes to enable quantitative investigations of spawning seasonality. The stages were based on macroscopic descriptions from Smith and Wenner (1985).

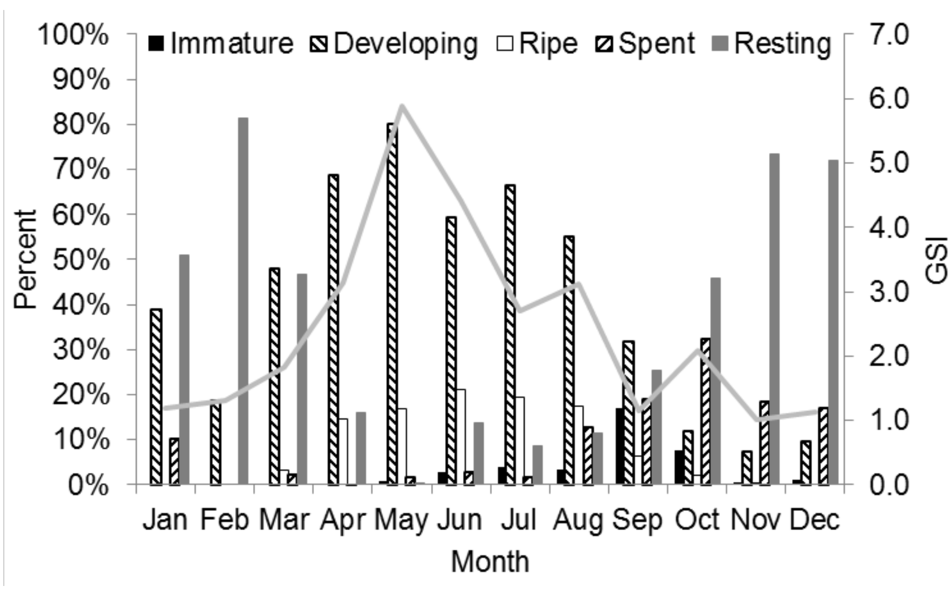


Figure 6.6 The percent of southern kingfish females in the five stages of reproductive development (n = 2,076) and gonadosomatic index (GSI) by month, 1997–2013 (Source: NCDMF, unpublished data).

The spawning season for Gulf kingfish begins in May and extends through September based on length frequency data from seine studies (Bearden 1963; Modde 1980; McMichael and Ross 1987). The NCDMF ageing study, which collects kingfish from a variety of fishery-dependent and fishery-independent surveys, found ripe fish from May to October and developing fish from March to October (Figure 6.7). The GSI values are highest in late spring and early summer and decrease monthly until November when fish are either resting or immature.

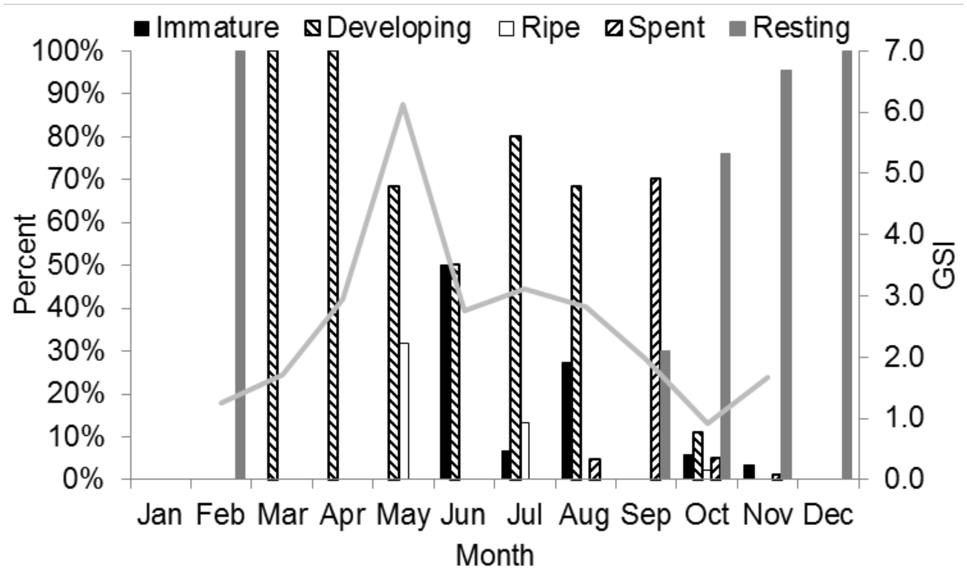


Figure 6.7 The percent of Gulf kingfish females in the five stages of reproductive development (n = 426) and gonadosomatic index (GSI) by month, 1997–2013 (Source: NCDMF, unpublished data).

The spawning season for northern kingfish extends from late June through August (Welsh and Breder 1923; Schaefer 1965; Miller et al. 2002). The NCDMF has collected northern kingfish in the ripe condition in April through August and developing fish from March through October (Figure 6.8). There was one fish in developing condition collected in December. The GSI values indicated peak spawning occurs in the early summer and then drops dramatically in late summer (after June).

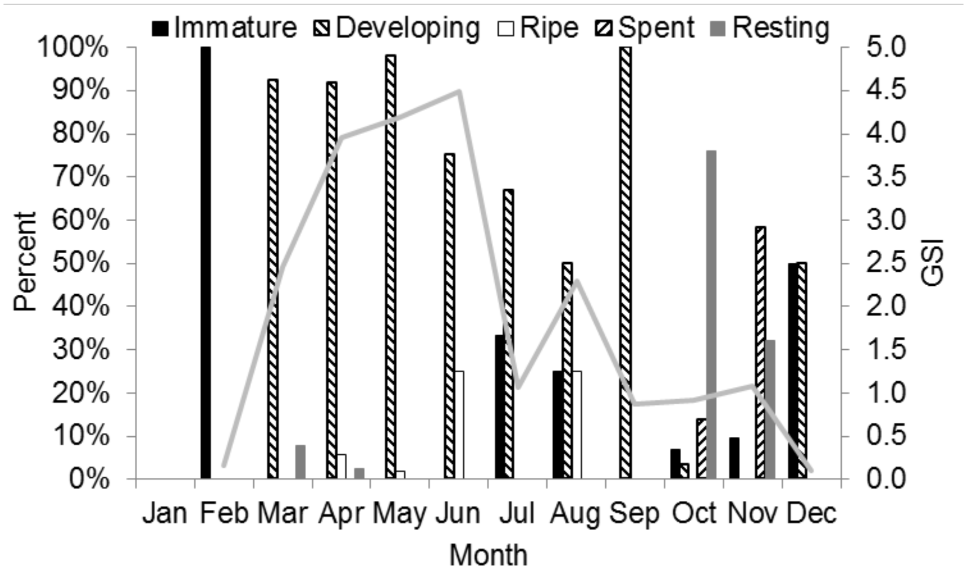


Figure 6.8 The percent of northern kingfish females in the five stages of reproductive development (n = 273) and gonadosomatic index (GSI) by month, 1997–2013 (Source: NCDMF, unpublished data).

### 6.1.4 Age, Growth, and Development

Only general descriptions are used for eggs, larvae, and juveniles since past studies may have confused the three species (Fahay 1983; Ditty et al. 2006).

#### **<u>6.1.4.1 Eggs</u>**

The eggs are pelagic and buoyant with many oil globules (1–18) and a diameter of 0.7–0.9 mm TL. Incubation lasts 46–50 hours at 20 to 21°C (Welsh and Breder 1923).

#### **<u>6.1.4.2 Larval Stage</u>**

The larvae are 2.0 to 2.5 mm TL at hatching. Early larvae have three vertical bands of chromatophores on the tail posterior to the vent and melanophores in the anterior-dorsal finfold. At 3.7 mm, the head is large and deep and melanophores form along the ventral surface of the abdomen in rows. At 8.0 to 10.0 mm TL, all fins are present and the upper jaw projects beyond the lower jaw (Lippson and Moran 1974; Able and Fahay 1998; Figure 6.9). Body and fins are covered partially or wholly with melanophores (Able and Fahay 1998). Pigmentation patterns occur at different sizes in juveniles collected from the Gulf of Mexico and juveniles from the Atlantic Coast (Ditty et al. 2006). The caudal fin is asymmetrically elongate (Welsh and Breder 1923).

#### **<u>6.1.4.3 Juveniles</u>**

At 18 to 20 mm TL, a small knob begins to form the single chin barbel (Figure 6.9). The tail becomes more pointed asymmetrically (Lippson and Moran 1974). The spinous dorsal fin is distinct from the soft dorsal fin. The soft dorsal fin is about twice the length of the anal fin and body pigmentation is dusky to dark (Able and Fahay 1998). Juveniles begin to display adult characteristics by 100 mm.

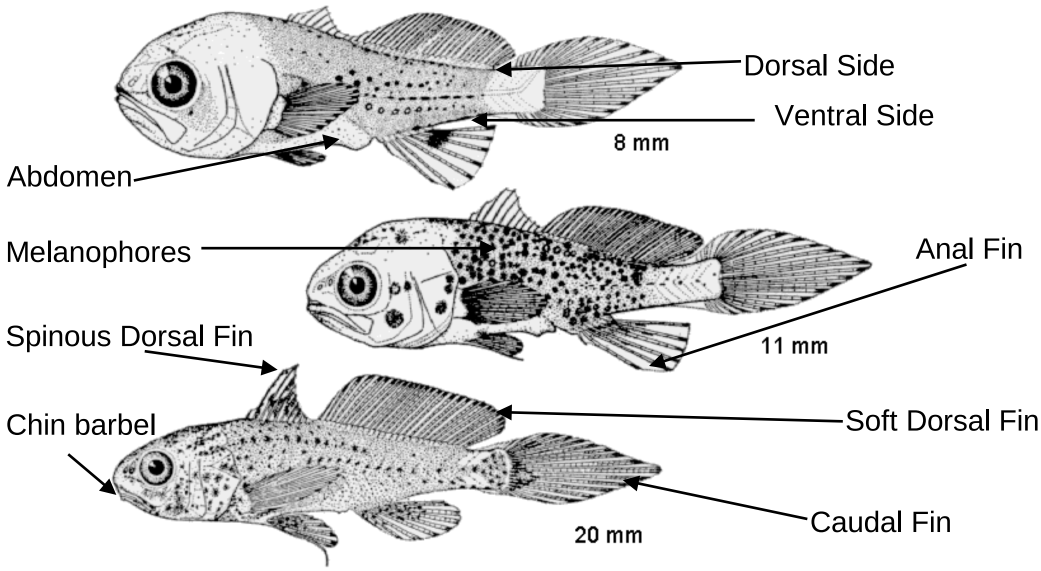


Figure 6.9 Larval and juvenile southern kingfish with a key to morphological characters.

**6.1.4.4 Adults**

Adult kingfishes are an elongate fusiform fish with a single chin barbel and an S-shaped caudal fin. The spinous dorsal fin contains 10 to11 rays and the soft dorsal fin contains 19 to 27 rays. The anal fin has one spine with six to nine soft rays (Carpenter 2002).

Southern kingfish colors are variable and range from silvery to a blotchy gray with seven to eight faint oblique bars. The inner side of the gill cover is often black (Carpenter 2002). The pectoral fin extends beyond the tip of the pelvic fin (Figure 6.10).

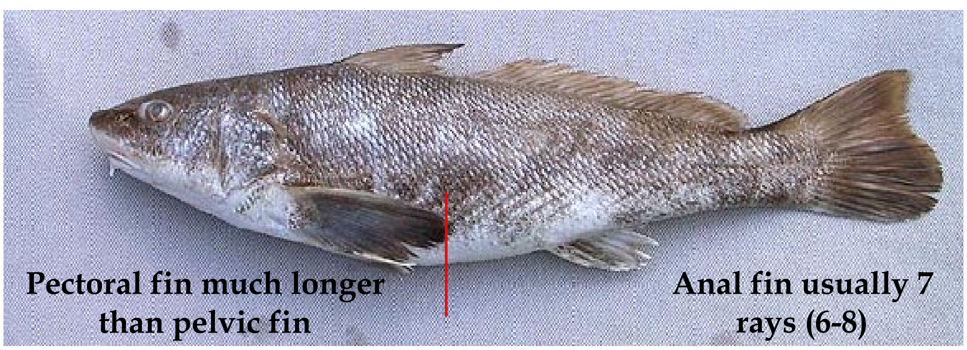


Figure 6.10 Adult southern kingfish with a key to morphological characters.

Gulf kingfish are silvery in color with black etching on the upper lobe of the caudal fin with reduced scales on the pelvic (breast) plate. The inner side of the gill cover is dusky (Carpenter 2002). The pectoral fin does not extend beyond the tip of the pelvic fin (Figure 6.11). The anal fin has six to eight soft rays.

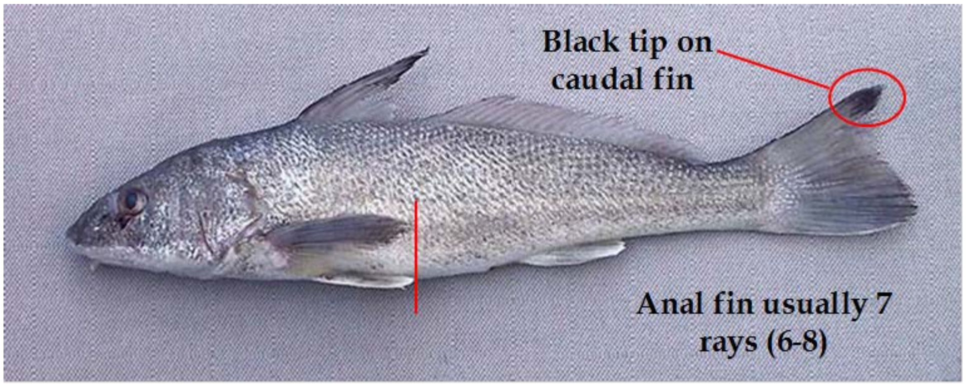


Figure 6.11 Adult Gulf kingfish with a key to morphological characters.

Northern kingfish have a large dorsal spine that extends approximately half way down the second (soft) dorsal fin, five to six oblique bars on both sides, and a longitudinal stripe beginning behind the pectoral fin that continues into the caudal fin (Figure 6.12). The second and third bars on the side form a V-shape under the spinous dorsal fin. The inner side of the gill cover is dusky (Carpenter 2002). The pectoral fin does not extend beyond the tip of the pelvic fin (Figure 6.12). The anal fin has seven to nine soft rays.

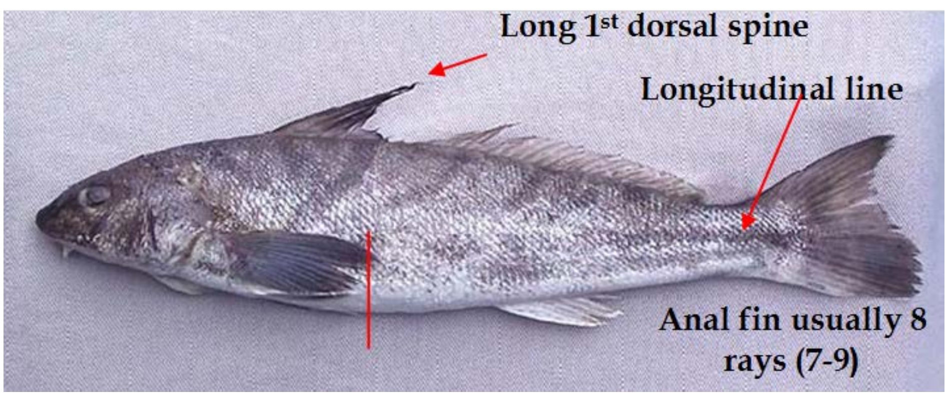


Figure 6.12 Adult northern kingfish with a key to morphological characters.

**6.1.4.5 Age and Growth**

Juvenile growth rates have been estimated using length frequencies. Kingfishes have rapid growth as juveniles. Growth has been documented to be as much as 2 mm/day (Miller et al. 2002). After the first winter, the growth rate decreases (Schaefer 1965; Smith and Wenner 1985).

Adult growth rates have been estimated using length frequency, scale aging, and otolith aging. An age and growth study conducted by the NCDMF estimated length at age using otolith-based ages. Von Bertalanffy growth curves were developed for males and females of each kingfish species because kingfishes exhibit a sexually dimorphic growth rate with female growth rates increasing after age one and ultimately attaining a larger maximum size than males (Tables 6.2, 6.3).

Table 6.2 Predicted length (mm) at age estimated by von Bertalanffy growth curves for the Atlantic Coast kingfishes captured in North Carolina waters, 1997–2013 (Source: NCDMF, unpublished data).

| | Southern | | | | Gulf | | | | Northern | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | Male | | Female | | Male | | Female | | Male | | Female | |
| | (mm) | (inches) | (mm) | (inches) | (mm) | (inches) | (mm) | (inches) | (mm) | (inches) | (mm) | (inches) |
| 1 | 204 | 8.0 | 196 | 7.7 | 202 | 8.0 | 192 | 7.6 | 222 | 8.7 | 219 | 8.6 |
| 2 | 239 | 9.4 | 265 | 10.4 | 267 | 10.5 | 305 | 12.0 | 306 | 12.0 | 306 | 12.0 |
| 3 | 265 | 10.4 | 303 | 11.9 | 301 | 11.9 | 342 | 13.5 | 324 | 12.8 | 341 | 13.4 |
| 4 | 284 | 11.2 | 324 | 12.8 | 318 | 12.5 | 354 | 13.9 | 328 | 12.9 | 356 | 14.0 |
| 5 | 298 | 11.7 | 335 | 13.2 | 327 | 12.9 | 358 | 14.1 | 329 | 13.0 | 362 | 14.3 |
| 6 | 308 | 12.1 | 342 | 13.5 | 332 | 13.1 | 359 | 14.1 | 329 | 13.0 | 364 | 14.3 |
| 7 | 315 | 12.4 | 345 | 13.6 | 334 | 13.1 | 360 | 14.2 | 329 | 13.0 | 365 | 14.4 |
| 8 | 321 | 12.6 | 347 | 13.7 | 335 | 13.2 | 360 | 14.2 | 329 | 13.0 | 366 | 14.4 |

Table 6.3 Estimated parameter values of the von Bertalanffy age-length model fit to kingfish data, 1997–2013 (Source: NCDMF, unpublished data).

| Species | Sex | n | $L_\infty$(mm) | $L_\infty$(inches) | $t_0$ | K |
|---|---|---|---|---|---|---|
| Southern | Male | 712 | 329 | 13.0 | -1.54 | 0.36 |
| Southern | Female | 2,449 | 354 | 13.9 | -0.46 | 0.56 |
| Gulf | Male | 225 | 335 | 13.2 | -0.37 | 0.66 |
| Gulf | Female | 448 | 359 | 14.1 | 0.37 | 1.16 |
| Northern | Male | 184 | 328 | 12.9 | 0.23 | 1.52 |
| Northern | Female | 535 | 367 | 14.4 | -0.12 | 0.82 |

#### 6.1.4.6 Length-Weight Relationship

A separate length-weight relationship was developed for each species and sex to compare with those developed from other studies (Table 6.4). Data from the NCDMF ageing study produces similar growth relationships as in other studies for southern kingfish (Smith and Wenner 1985; Harding and Chittenden 1987) and northern kingfish (Schaefer 1965; Wilk et al 1978). Northern and southern kingfish had similar growth rates with Gulf kingfish having the lowest growth rate. Among the three kingfish species, the male southern kingfish has the greatest growth coefficient (3.27), which indicates that southern kingfish males weigh more per unit length than northern and Gulf kingfish males (Table 6.4). Female southern and northern kingfishes had higher growth coefficients than female Gulf kingfishes. The weights for the kingfishes in the analysis were in grams and length in millimeters.

Table 6.4 Published length-weight*relationships for the three Atlantic Coast kingfish species.

| Species | n | Sex | Equation | Reference |
|---|---|---|---|---|
| Southern Kingfish | 2,170 | Female | log W = -5.28 + 3.13 log TL | Smith and Wenner 1985 |
| Southern Kingfish | 1,462 | Male | log W = -5.42 + 3.19 log TL | Smith and Wenner 1985 |
| Southern Kingfish | 1,697 | Female | log W = -5.94 + 3.39 log TL | Harding and Chittenden 1987 |
| Southern Kingfish | 1,448 | Male | log W = -5.94 + 3.40 log TL | Harding and Chittenden 1987 |
| Southern Kingfish | 3,007 | Female | log W = -5.31 + 3.14 log TL | NCDMF, unpublished data |
| Southern Kingfish | 813 | Male | log W = -5.64 + 3.27 log TL | NCDMF, unpublished data |
| Northern Kingfish | 275 | Female | log W = -5.04 + 3.03 log TL | Schaefer 1965 |
| Northern Kingfish | 216 | Male | log W = -5.39 + 3.16 log TL | Schaefer 1965 |
| Northern Kingfish | 110 | Combined | log W = -5.20 + 3.11 log TL | Wilk et al 1978; c.f. Ralph 1982 |
| Northern Kingfish | 531 | Female | log W = -5.36 + 3.14 log TL | NCDMF, unpublished data |
| Northern Kingfish | 189 | Male | log W = -5.24 + 3.09 log TL | NCDMF, unpublished data |
| Gulf Kingfish | 413 | Female | log W = -4.76 + 2.92 log TL | NCDMF, unpublished data |
| Gulf Kingfish | 219 | Male | log W = -4.48 + 2.80 log TL | NCDMF, unpublished data |

*The variables length (mm TL) and weight (g) were log-transformed to linearize the data.

#### 6.1.4.7 Maximum Size and Maximum Age

The International Gamefish Association records world record sizes for kingfishes caught recreationally. The current world record sizes are 18.0, 19.0, and 18.3 inches (457, 483, and 464 mm) for southern, Gulf, and northern kingfishes, respectively (http://wrec.igfa.org/). Harding and Chittenden (1987) reported a maximum size of 16.5 inches (419 mm) for southern kingfish in the Gulf of Mexico. The fish was aged using length frequency analysis and estimated to be four years old. The maximum size for southern kingfish recorded in the ageing study by the NCDMF was 17.7 inches (448 mm) and aged at four years old (Table 6.5). The maximum observed length for a southern kingfish in all NCDMF sampling was a 18.8 inches (478 mm) fish captured in a commercial beach seine (no aging sample was collected).

The maximum observed age of southern kingfish (using otoliths) from the NCDMF ageing study was a 13.3 inch (338 mm) male aged at nine years old collected from the Atlantic Ocean independent gill net study (Table 6.5). The oldest age class for females in the study was six years old and ranged from 12.2 to 14.3 inches (309–372 mm; n = 5).

The maximum age for Gulf kingfish males and females was seven (12.4–13.1 inches or 314–332 mm; n = 3) and six (11.2–12.6 inches or 285–320 mm, n = 2), respectively. The largest Gulf kingfish collected in the NCDMF ageing study was a female at 12.4 inches (435 mm) aged at three years old.

Northern kingfish were aged to a maximum of six years old for males (12.8 inches or 324 mm) and five years old for females (14.3–15.2 inches or 362–386 mm, n = 3). The largest northern kingfish aged by NCDMF was a 17.9 inches (454 mm) female at three years old.

Table 6.5 Average length at age and size range (mm) for North Carolina male and female southern, Gulf, and northern kingfishes, 1997–2013 (Source: NCDMF, unpublished data).

| Species | Age | n | Mean | Size range | | Age | n | Mean | Size range |
|---|---|---|---|---|---|---|---|---|---|
| Southern Kingfish | | | | | | | | | |
| Males | 0 | 5 | 196 | 165–224 | Female | 0 | 53 | 200 | 121–330 |
| | 1 | 148 | 237 | 134–134 | | 1 | 758 | 265 | 122–393 |
| | 2 | 190 | 270 | 217–342 | | 2 | 971 | 303 | 205–403 |
| | 3 | 170 | 284 | 239–342 | | 3 | 491 | 324 | 235–399 |
| | 4 | 115 | 293 | 255–332 | | 4 | 152 | 342 | 230–448 |
| | 5 | 57 | 301 | 226–403 | | 5 | 19 | 354 | 276–410 |
| | 6 | 21 | 313 | 281–440 | | 6 | 5 | 344 | 309–372 |
| | 7 | 5 | 322 | 309–333 | | 7 | 0 | - | - |
| | 8 | 0 | - | - | | 8 | 0 | - | - |
| | 9 | 1 | 338 | - | | 9 | 0 | - | - |
| Gulf Kingfish | | | | | | | | | |
| Males | 0 | 33 | 204 | 166–237 | Female | 0 | 36 | 221 | 167–354 |
| | 1 | 55 | 266 | 211–335 | | 1 | 243 | 301 | 224–369 |
| | 2 | 41 | 297 | 242–329 | | 2 | 105 | 340 | 222–415 |
| | 3 | 48 | 317 | 217–372 | | 3 | 52 | 378 | 293–435 |
| | 4 | 32 | 322 | 290–357 | | 4 | 8 | 390 | 350–412 |
| | 5 | 11 | 339 | 312–366 | | 5 | 2 | 406 | 399–413 |
| | 6 | 2 | 348 | 341–355 | | 6 | 2 | 303 | 285–320 |
| | 7 | 3 | 325 | 314–332 | | 7 | 0 | - | - |
| Northern Kingfish | | | | | | | | | |
| Males | 0 | 20 | 239 | 197–288 | Female | 0 | 58 | 233 | 141–336 |
| | 1 | 51 | 309 | 232–377 | | 1 | 196 | 311 | 192–405 |
| | 2 | 81 | 322 | 263–421 | | 2 | 222 | 332 | 265–429 |
| | 3 | 22 | 340 | 256–428 | | 3 | 45 | 357 | 271–454 |
| | 4 | 4 | 332 | 310–343 | | 4 | 11 | 353 | 291–403 |
| | 5 | 5 | 320 | 281–393 | | 5 | 3 | 373 | 362–386 |
| | 6 | 1 | 324 | 324 | | 6 | 0 | - | - |

### 6.1.5 Movements and Migrations

In the surf zone, juvenile kingfishes are regarded as spring/summer residents (Tagatz and Dudley 1961; Bearden 1963; Dahlberg 1972; Modde 1980; Modde and Ross 1981; McMichael and Ross 1987). Abundance of juvenile southern and northern kingfishes (<150 mm) in the surf zone peaks during May throughout the SAB and Gulf of Mexico which is slightly before the peak abundance of juvenile Gulf kingfish (Irwin 1970; Modde 1980; Modde and Ross 1981; McMichael and Ross 1987). The difference in peak abundances of the kingfishes has been explained by interspecies resource partitioning or by varying temperature tolerances (Ross et al. 1987). Adult kingfishes (>150 mm) are most common at depths less than 26 m (Ralph 1982; Crowe 1984; Harding and Chittenden 1987), but have been reported in the ocean as deep as 99 m (Bearden 1963).

#### <u>6.1.5.1 Larval Transport and Migration</u>

Little is known about the spawning of kingfishes, and therefore, the mechanisms that transport larvae are poorly understood. The eggs of kingfishes are buoyant. Buoyant eggs and larvae of other species are transported into estuaries by wind driven currents, Ekman transport, and advection pushing the buoyant eggs and larvae toward shore (Lawler et al. 1988). The spawning of kingfishes likely takes place in the nearshore ocean (Hoese 1965) with some kingfishes spawning in estuarine waters (Bourne and Govoni 1988). These nearshore and estuarine spawned kingfishes need to be retained within the nursery habitat for protection and food resources. Mechanisms to transport southern and northern kingfishes into estuaries and retention of kingfishes in the surf zone need to be studied to better understand the recruitment dynamics of kingfishes.

#### 6.1.5.2 Young-of-the-Year and Juvenile Movement

Young-of-the-year (YOY) tend to be found in shallower water than adults are, but it varies among species. Northern kingfish juveniles used the surf zone in New Jersey and began to egress as the fish grew (Miller et al. 2002). A North Carolina study found Gulf kingfish to exhibit site fidelity in which Gulf kingfish remained in an area throughout summer (Ross and Lancaster 2002). As waters cool, YOY migrate from the surf zone to deeper water (Bearden 1963; Schaefer 1965; Miller et al. 2002).

#### 6.1.5.3 Adult Movement and Migrations

Offshore trawl surveys observed that adult abundance is lowest in summer and peaks in the winter (Hoese 1965; Anderson 1968; Smith and Wenner 1985). A gradual increase in the abundance of kingfishes occurs with decreasing latitude during the winter along the Atlantic coast (Anderson 1968; Smith and Wenner 1985). The increase in abundance during the winter has been hypothesized to represent a southerly migration of kingfishes (Smith and Wenner 1985).

#### 6.1.5.4 Tagging Studies

A tagging study was conducted in southeastern North Carolina to determine migration patterns of adult kingfishes off North Carolina, but the study had very few tag returns limiting the conclusions of the study (Beresoff and Schoolfield 2002).

## 6.2 PRESENT STOCK STATUS

The 2007 Kingfish FMP implemented the framework for the current management strategy. An update to the management framework is provided in Section 5.2.1, Updating Management Framework of North Carolina Kingfish Stock. For this Information Update, the trend analysis and management criteria were reviewed and refined based on using the most current information and techniques. A detailed summary of refinements made to management triggers is provided in Appendix 1, Evaluation of Management Triggers for Kingfish. Current management triggers are based on fishery independent indices of abundance (YOY, adult, and proportion of catch greater than size at $L_{50}$) and a relative fishing mortality ($F$) index. A formal quantitative stock assessment for kingfish is not available; therefore, no determination can be made relative to an overfishing and overfished status. Prior attempts at a stock assessment during the 2007 FMP process were not successful, primarily due to limited data. From these prior attempts, all reviewers noted a lack of migration (mixing) data to determine the movement patterns of kingfishes along North Carolina and the entire Atlantic coast. In this Information Update, after thorough evaluation of available data, the NCDMF determined data were still insufficient to perform a traditional quantitative stock assessment. A regional (multi-state) stock assessment approach is likely needed to best determine the stock status for kingfish along the Atlantic coast including North Carolina.

The 2014 stock status for kingfishes in North Carolina is viable. The stock status is based on an annual evaluation of trends in various fishery-independent abundance indices and relative fishing mortality (*F*). The trend analysis incorporates management triggers to alert NCDMF to the potential need for management action based on stock conditions. The activation of any two management triggers (regardless of trigger category) two years in a row warrants further data evaluation and potential management action. The analysis is updated annually and all trends relative to management triggers are provided annually as part of the annual FMP update provided to the NCMFC in August of each year. The FMP updates provides an update of data annually and can be found on the NCDMF website (http://portal.ncdenr.org/web/mf/fmps-under-development). No management triggers were activated in either 2013 or 2014.

# 7.0 STATUS OF THE FISHERIES

## 7.1 COMMERCIAL FISHERY

Landings reported in the following commercial sections will be reported for all three species as a single unit. Commercial fishermen rarely differentiate the kingfishes since all three species occur in the same general areas. Southern kingfish are the most common of the three species in North Carolina.

The gears that harvest the majority of the landed kingfishes are fish trawls, gill nets, and shrimp trawls. Historically, the fish trawl fishery landed the majority of landings from 1950 to 1979. The targeted gill net fishery for kingfishes became the dominant gear in 1981 and has since remained the dominant gear for commercial harvest of kingfishes in North Carolina.

### 7.1.1 Collection of Commercial Statistics

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

### 7.1.2 Annual Landings and Value

Kingfishes are commercially important to the state of North Carolina due to the high quality of their flesh. Landings began increasing during the early 1900s reaching a peak in 1954 at 1.9 million lb (Figure 7.1). Landings declined after 1954 and fell to a low of 123,896 lb in 1976. Landings rebounded in the 1980s and 1990s when the price per pound was also increasing. Values peaked in 1997 and 2010 at $864,030 and $958,377, respectively. After 1993, landings have been variable from year to year averaging over 600,000 lb per year. These fluctuations may be due to changes in environmental conditions (i.e. water temperatures and salinities that prevail in nursery areas; Section 6.1 General Life History), fishing pressures, population size, and/or gear restrictions.

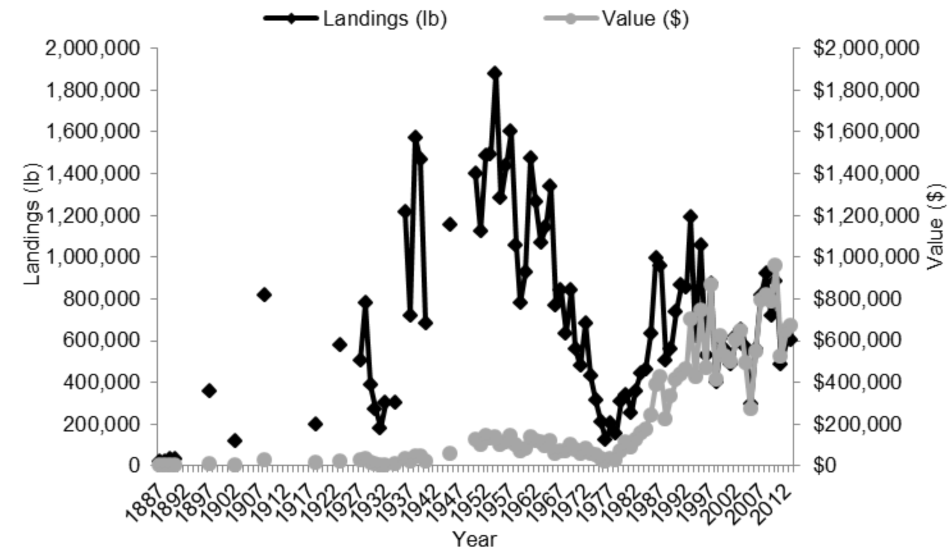


Figure 7.1 North Carolina commercial landings (lb) and dock side value ($) of kingfishes, 1887–2013 (Source: NMFS/NCDMF, unpublished data). Prior to 1950 data were not reported in every year.

### 7.1.3 Landings by Season

Landings of kingfishes and effort in the fishery are seasonal with peak landings and effort occurring in the spring and fall. Peak landings occurred in April (22%) and November (22%) between 1994 and 2013 (Figure 7.2). Effort, represented by the number of trips, peaked in April (16%) and October (16%). Peaks in landings that occur in April and November coincide with seasonal movements of kingfishes along the Atlantic coast (Smith and Wenner 1985).

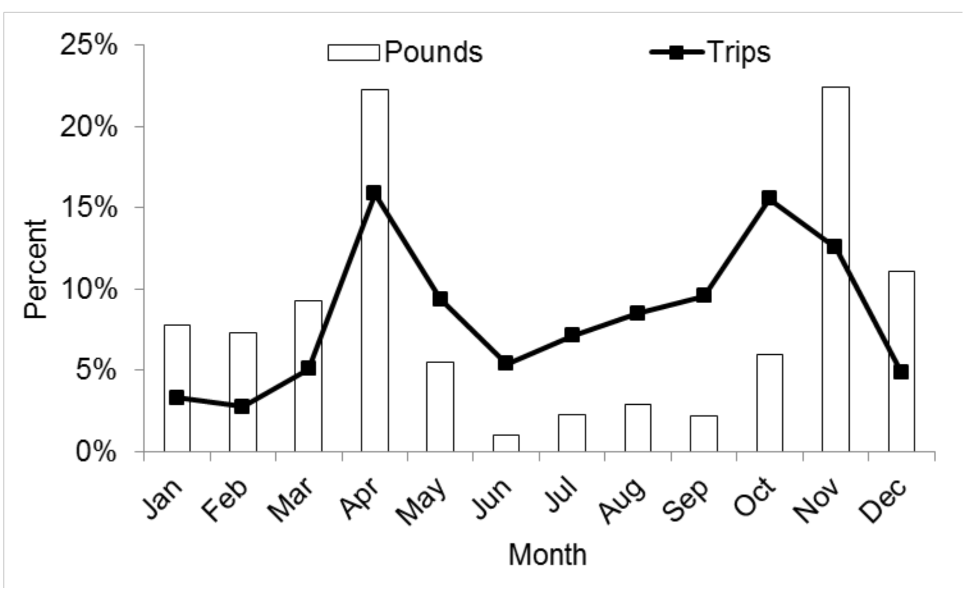


Figure 7.2 Percent of total landings and trips for kingfishes in North Carolina by month, 1994–2013 (Source: NCDMF, unpublished data).

### 7.1.4 Landings by County

The top five counties with landings of kingfishes between 1962 and 2013 (in descending order) were Carteret, Onslow, Dare, New Hanover, and Brunswick (Figure 7.3). Over time, Carteret County has consistently been the highest harvester of kingfishes averaging about 40% of the landings since 1962 but over the past 10 years, their proportion of landings has dropped to about 15% of the total landings per year. Landings by county are not available in 1967, 1969, and 1970.

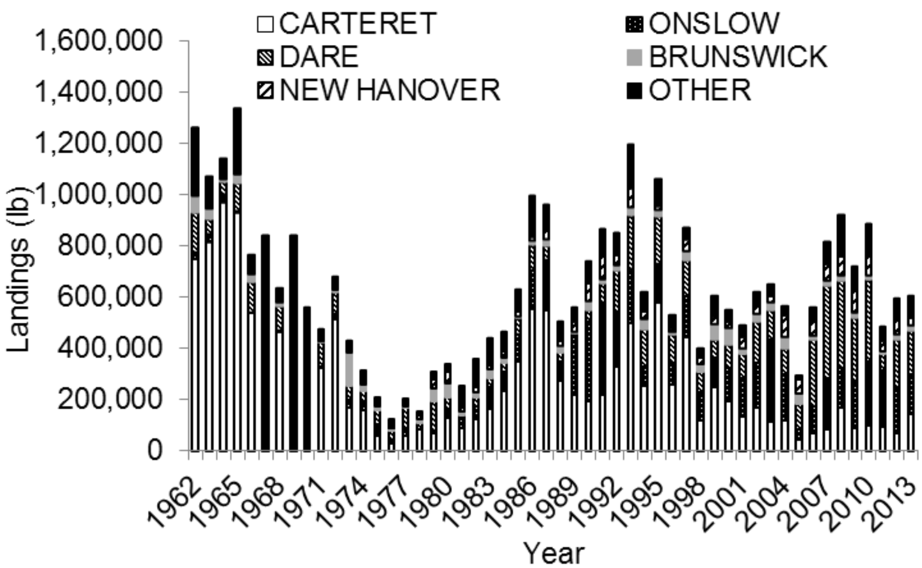


Figure 7.3 North Carolina landings of kingfishes by county of landing, 1962–2013 (Source: NCDMF, unpublished data). Landings by county are not available in 1967, 1969, and 1970.

### 7.1.5 Landings by Waterbody

The majority of kingfishes from 1962 to 2013 were harvested from the ocean (83%) and, to a lesser extent, Pamlico (10%) and Core (4%) sounds (Figure 7.4). Landings from other waterbodies only represented 3% of the total kingfishes landed. Since the inception of the NCTTP, these numbers changed little from historical percentages.

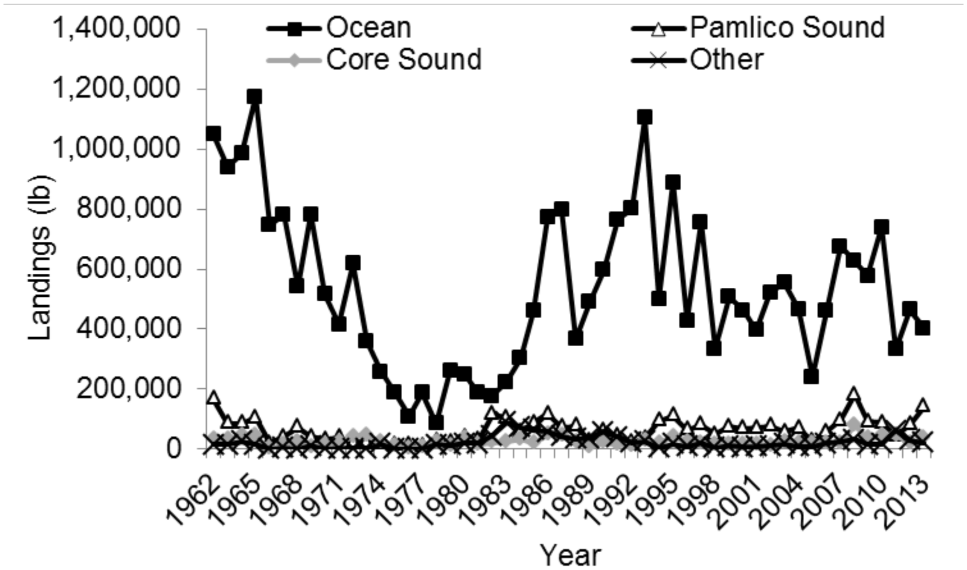


Figure 7.4 North Carolina landings of kingfishes by waterbody, 1962–2013 (Source: NCDMF, unpublished data).

### 7.1.6 Landings by Gear

Since 1962, fish trawls (flounder trawl and flynet), gill nets, shrimp trawls, and seines (long haul and beach seines) were the primary gears used to harvest kingfishes (Table 7.1; Figure 7.5). Over time, the major harvest gear has shifted from fish trawls to gill nets. Between 1962 and 2013, gill nets represented 45% of the total kingfish landings; followed by fish trawls (25%), shrimp trawls (15%), and seines (9%). Since the start of the NCTTP (1994–2013), the gill net fishery has dominated the landings (70%) while shrimp trawls make up around 19% of the landings (Figure 7.6). Regulations on fish trawls instituted in 1993 and a ban on flynets south of Cape Hatteras in 1996 has greatly contributed to the decline in fish trawl landings. Commercial hook-and-line landings of kingfishes are very sparse and only make up 0.04% of the total landings since 1994.

Table 7.1 North Carolina commercial landings of kingfishes (lb) by gear, 1962–2013 (Source: NMFS/NCTTP, unpublished data).

| Year | Gill Net | Fish Trawl | Shrimp Trawl | Trawl* | Seines | Others | Total |
|---|---|---|---|---|---|---|---|
| 1962 | 222,400 | | | 877,500 | 151,900 | 10,500 | 1,262,300 |
| 1963 | 202,300 | | | 729,300 | 134,700 | 5,000 | 1,071,300 |
| 1964 | 157,400 | 729,500 | 120,400 | | 134,000 | | 1,141,300 |
| 1965 | 163,800 | 912,500 | 124,700 | | 136,000 | | 1,337,000 |
| 1966 | 11,400 | 553,200 | 93,900 | | 105,100 | 3,000 | 766,600 |
| 1967 | 95,600 | 591,600 | 83,700 | | 60,400 | 8,000 | 839,300 |
| 1968 | 3,600 | 411,400 | 106,100 | | 107,600 | 6,700 | 635,400 |
| 1969 | 93,300 | 532,000 | 69,900 | | 137,600 | 9,900 | 842,700 |
| 1970 | 127,200 | 198,300 | 56,000 | | 173,000 | 8,500 | 563,000 |
| 1971 | 87,800 | 256,500 | 51,200 | | 79,800 | 2,900 | 478,200 |
| 1972 | 164,812 | 287,979 | 114,950 | | 91,232 | 24,075 | 683,048 |
| 1973 | 57,565 | 191,901 | 90,999 | | 83,876 | 4,306 | 428,647 |
| 1974 | 64,918 | 136,641 | 70,755 | | 39,898 | 2,372 | 314,584 |
| 1975 | 11,743 | 111,067 | 48,596 | | 38,887 | 2,237 | 212,530 |
| 1976 | 1,906 | 68,459 | 31,068 | | 20,242 | 2,221 | 123,896 |
| 1977 | 9,972 | 124,426 | 56,540 | | 12,601 | 1,064 | 204,603 |
| 1978 | 25,126 | 41,574 | 38,286 | | 43,898 | 5,070 | 153,954 |
| 1979 | 17,855 | 183,348 | 83,755 | | 19,268 | 6,277 | 310,503 |
| 1980 | 62,165 | 77,081 | 139,103 | | 54,842 | 9,414 | 342,605 |
| 1981 | 130,831 | 49,787 | 43,026 | | 27,809 | 3,198 | 254,651 |
| 1982 | 80,927 | 74,573 | 133,508 | | 54,692 | 17,352 | 361,052 |
| 1983 | 129,925 | 78,781 | 158,945 | | 63,522 | 10,708 | 441,881 |
| 1984 | 175,815 | 109,917 | 114,745 | | 56,804 | 7,070 | 464,351 |
| 1985 | 225,199 | 199,811 | 160,075 | | 42,567 | 4,788 | 632,440 |
| 1986 | 387,691 | 349,175 | 162,440 | | 88,327 | 5,757 | 993,390 |
| 1987 | 536,566 | 167,130 | 137,750 | | 110,333 | 8,149 | 959,928 |
| 1988 | 208,958 | 144,644 | 75,218 | | 72,033 | 3,096 | 503,949 |
| 1989 | 351,193 | 138,338 | 54,143 | | 17,608 | 1,142 | 562,424 |
| 1990 | 451,023 | 115,625 | 117,732 | | 50,355 | 3,877 | 738,612 |
| 1991 | 622,381 | 121,753 | 73,913 | | 44,147 | 2,457 | 864,651 |
| 1992 | 606,721 | 192,143 | 38,006 | | 12,519 | 2,319 | 851,708 |
| 1993 | 534,047 | 490,679 | 80,652 | | 86,398 | 2,448 | 1,194,224 |
| 1994 | 265,730 | 204,606 | 94,668 | | 51,264 | 4,572 | 620,841 |
| 1995 | 643,322 | 102,694 | 243,210 | | 65,966 | 3,593 | 1,058,785 |
| 1996 | 219,150 | 46,363 | 203,158 | | 57,062 | 2,528 | 528,260 |
| 1997 | 484,872 | 109,552 | 229,096 | | 46,050 | 3,318 | 872,888 |
| 1998 | 263,834 | 17,295 | 80,470 | | 34,393 | 3,321 | 399,313 |
| 1999 | 339,097 | 7,146 | 237,542 | | 20,907 | 2,774 | 607,465 |
| 2000 | 335,063 | 11,702 | 156,961 | | 45,806 | 2,409 | 551,940 |
| 2001 | 384,821 | 17,024 | 47,564 | | 37,224 | 3,109 | 489,743 |
| 2002 | 468,308 | 9,239 | 115,078 | | 25,189 | 1,922 | 619,737 |
| 2003 | 532,742 | 3,785 | 68,093 | | 39,175 | 8,841 | 652,636 |
| 2004 | 408,870 | 4,515 | 109,009 | | 43,372 | 1,893 | 567,659 |
| 2005 | 241,553 | 8,346 | 14,658 | | 30,921 | 785 | 296,263 |
| 2006 | 464,774 | 10,530 | 46,236 | | 34,519 | 3,382 | 559,440 |
| 2007 | 635,739 | 23,566 | 132,033 | | 25,119 | 1,131 | 817,588 |
| 2008 | 594,360 | 55,064 | 216,551 | | 46,202 | 8,943 | 921,120 |
| 2009 | 583,484 | 21,129 | 87,123 | | 27,045 | 3,143 | 721,924 |
| 2010 | 726,654 | 28,945 | 79,589 | | 50,367 | 1,286 | 886,841 |
| 2011 | 429,271 | 276 | 23,692 | | 32,239 | 1,376 | 486,853 |
| 2012 | 505,595 | 3,411 | 57,368 | | 28,115 | 1,760 | 596,249 |
| 2013 | 436,397 | *** | 144,643 | | 19,696 | 2,450 | 603,186 |

*Trawl fisheries were not distinguished between shrimp and fish trawls in 1962 and 1963.
*** indicates confidential data; confidential landings were added to the “Other” column.

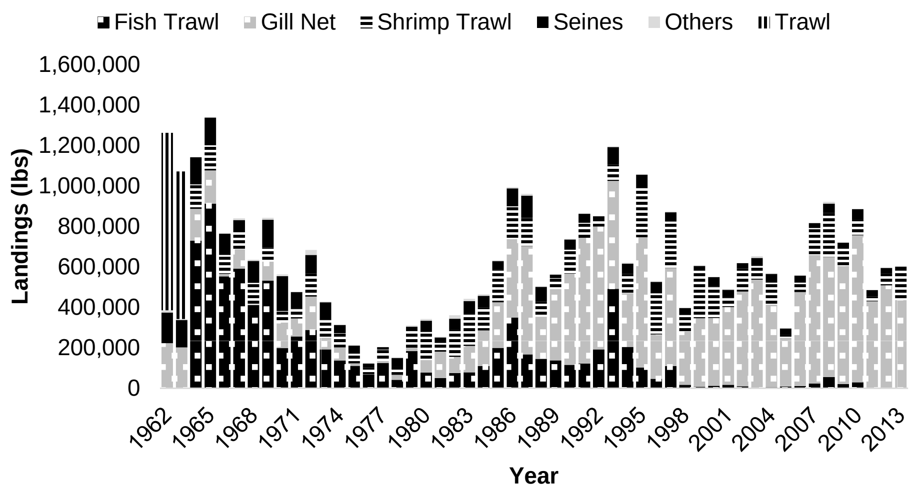


Figure 7.5 North Carolina landings of kingfishes (lb) by gear, 1962–2013 (Source: NCDMF, unpublished data). The trawl fisheries were not distinguished between shrimp and fish trawls in 1962 and 1963.

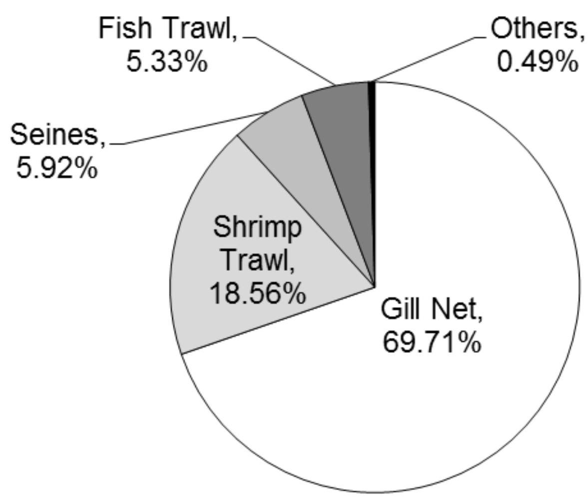


Figure 7.6 Percent of North Carolina kingfish landings by gear, 1994–2013 (Source: NCDMF, unpublished data).

### 7.1.6.1 Gill Net Fishery

Most kingfishes are captured in the small mesh (<5 inches) ocean gill net fishery, but a few are taken incidentally in the large mesh (≥5 inches) estuarine gill net fishery. Primary species harvested in the ocean with small mesh gear include Atlantic croaker, bluefish, kingfishes, spot, and weakfish. Most of the fish are captured with stretched mesh sizes between 2½ to 3 inches. Gill nets dominated the commercial landings of kingfishes from 1994 to 2013 accounting for 70% of the total landings and 63% of the total trips landing kingfishes. Landings from the gill net fishery have fluctuated widely over time with an overall increase from 1998 to 2010 when landings peaked at almost 727,000 lb. Landings between 2011 and 2013 dropped to an average of around 457,000 lb per year (Table 7.1; Figure 7.7). The number of trips landing kingfishes has shown a declining trend since 1994 but increased sharply in 2012 and 2013 (Figure 7.7).

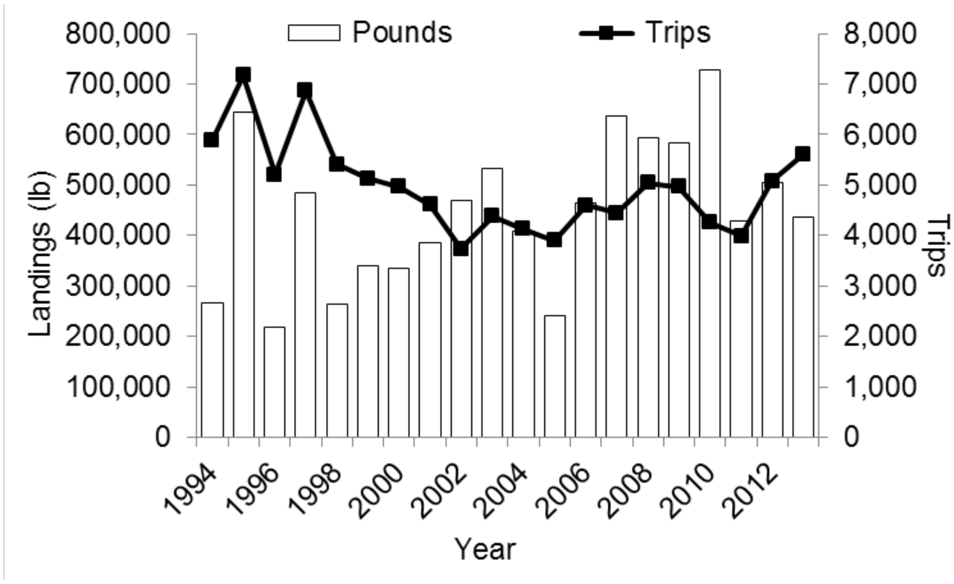


Figure 7.7 North Carolina commercial landings (lb) and trips for kingfishes from the commercial gill net fishery, 1994–2013 (Source: NCTTP, unpublished data).

The vast majority of the gill net harvest of kingfishes occurred in the ocean with most of the catch occurring in April and November as the fish were intercepted during their seasonal migration offshore (Figure 7.8). The three counties with the highest percentage of gill net landings between 1994 and 2013 were Onslow (32%), Dare (30%), and Carteret (14%) counties.

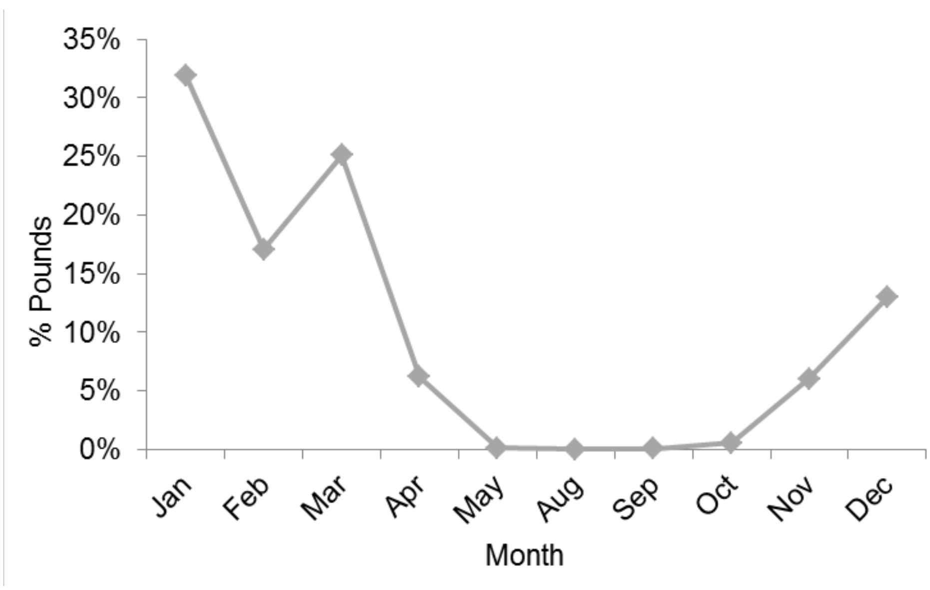


Figure 7.8 Percent of commercial gill net landings of kingfishes in North Carolina by month, 1994–2013 (Source: NCTTP, unpublished data).

Landings were categorized into 50-lb bins based on the weight of kingfishes landed for each trip (Bin >0 = Trips with 1-49 lb, Bin 50 = Trips with 50–99 lb, etc., Bin ≥1000 = Trips with 1000 lb or more). The percentage of pounds and trips was then pooled across the years from 1994 to 2013 for each bin (Figure 7.9). The trips that had the highest percent landings were trips that landed over 1,000 lb or greater per trip. These trips accounted for 31% of the total harvest but just 2% of the total gill net trips taken. Trips that landed less than 50 lb made up 76% of the total gill net trips but only landed 6% of the harvest (Figure 7.9).

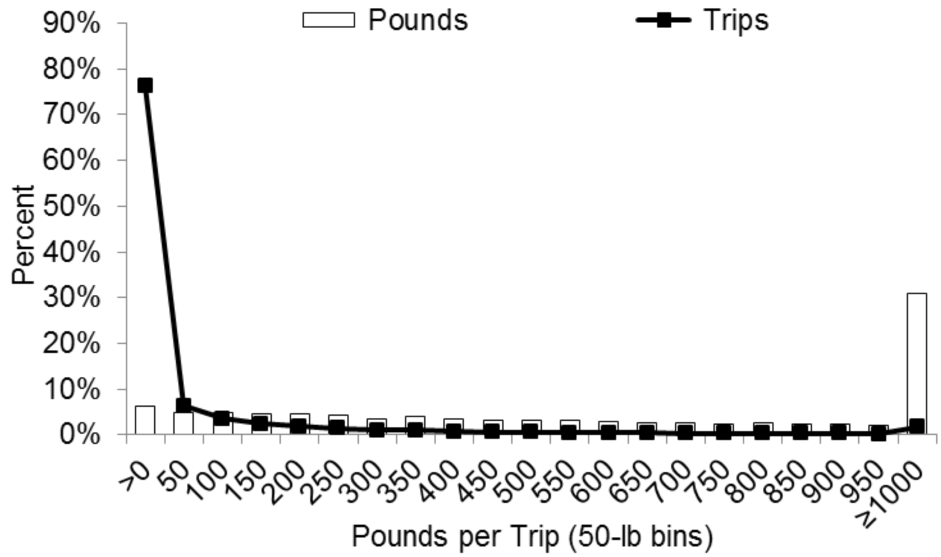


Figure 7.9 North Carolina landings (lb) and trips of kingfishes from the commercial gill net fishery in bins showing pounds per trip, 1994–2013 (50-lb increments; Source: NCTTP, unpublished data).

NCDMF fish house sampling programs 434 and 444 provided length information for southern kingfish landed by ocean gill nets. Data from the ocean gill net fishery have been available since 1983; however, data from the estuarine gill net fishery were not available until 1992. From 1983 to 2013, the lengths of southern kingfish landed by commercial gill nets in the ocean ranged from 7.1 inches (180 mm) to 18.9 inches TL (480 mm) with a median of 11.8 inches TL (300 mm; Figure 7.10). From 2003 to 2013, there was a slight contraction of size classes in southern kingfish landed in the ocean by commercial gill nets (Figure 7.10).

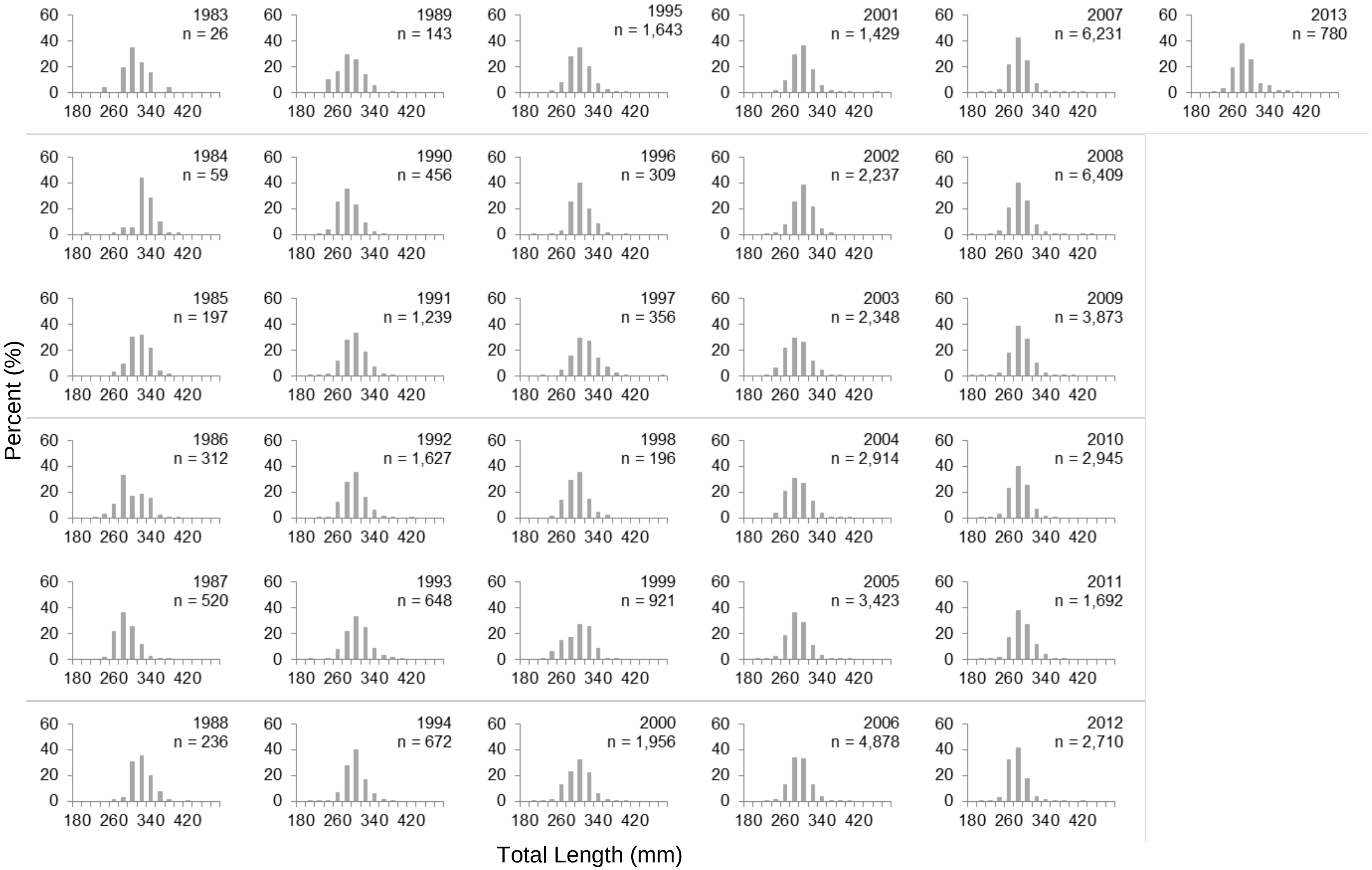


Figure 7.10 Length distributions for kingfishes sampled from the commercial ocean gill net fishery, 1983–2013 (Source: NCDMF, unpublished data). Years with sample sizes less than 25 are not included.

NCDMF fish house sampling programs 460 and 461 provide length information for southern kingfish landed by estuarine gill nets. From 1998 to 2013, the lengths for southern kingfish landed by commercial gill nets in the estuary ranged from 7.9 inches (200 mm) to 17.3 inches TL (440 mm) with a median of 11.8 inches TL (300 mm; Figure 7.11). From 1998 to 2003, the commercial southern kingfish estuarine gill net fishery also experienced a slight contraction of size classes.

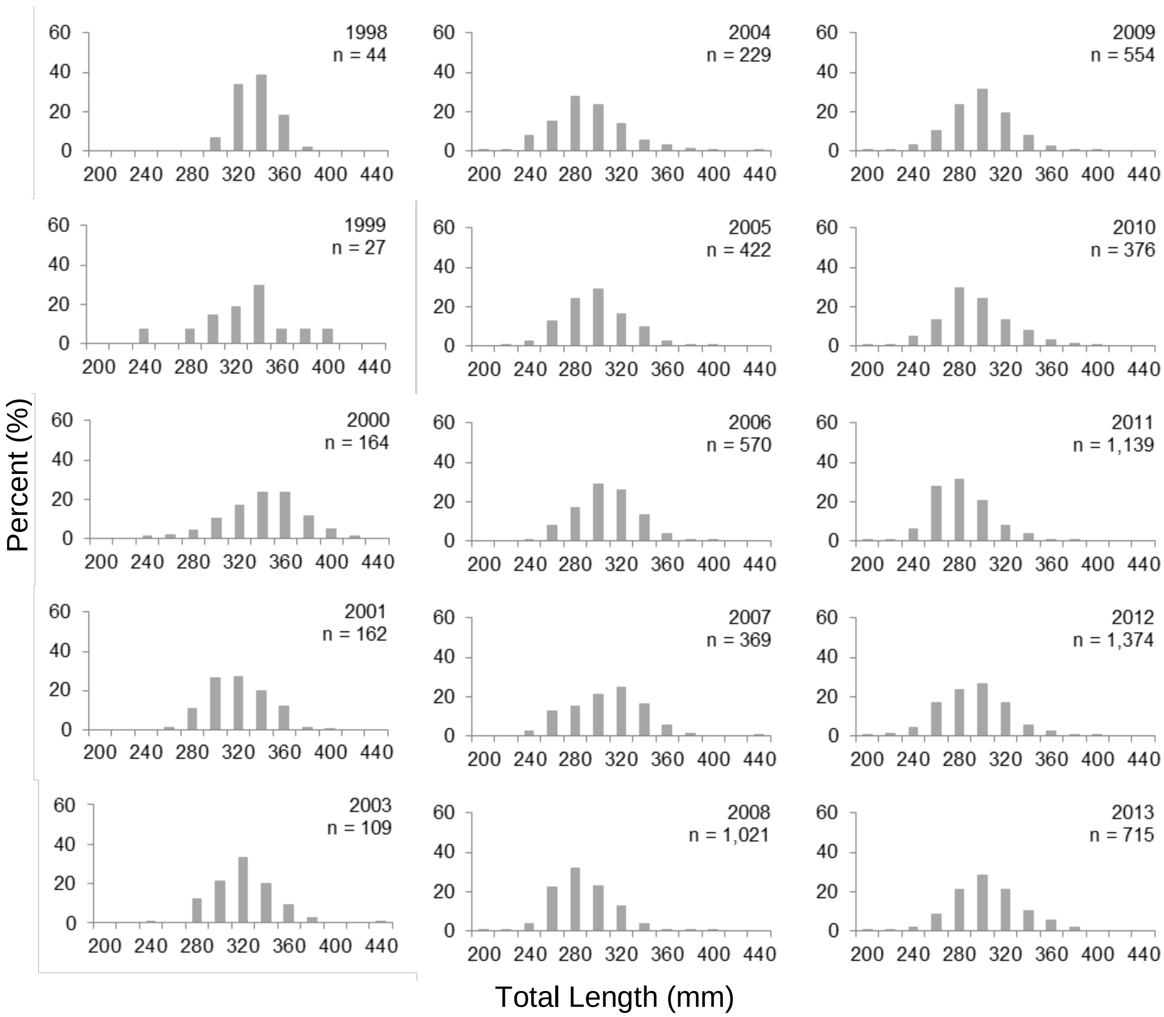


Figure 7.11 Length distributions for kingfishes sampled from the commercial estuarine gill net fishery, 1998–2013 (Source: NCDMF, unpublished data). Years with sample sizes less than 25 are not included.

### <u>7.1.6.2 Shrimp Trawl Fishery</u>

The gear and effort used to catch shrimp depends on the target species and area fished. Conventional two-seam otter trawls are used for pink and brown shrimp in the spring and summer. White shrimp are harvested with four-seam and tongue trawls during the fall. Large Pamlico Sound vessels stay out four or five days and typically tow from one to three hours, often working day and night. Smaller vessels make daily trips and employ shorter tow times. In the Core Sound area, the fishery occurs mainly at night, with trips typically lasting one night. In the southern area, fishing is conducted in the ocean and estuarine waters. Day-trips are common and most activity occurs during daylight hours.

Historically, the shrimp trawl fishery has been a significant contributor to landings of kingfishes in North Carolina. Since 1994, shrimp trawls have accounted for 19% of the total landings of kingfishes and 25% of the total trips landing kingfishes. Annual shrimp trawl landings of kingfishes have fluctuated greatly since 1994 (Figure 7.12), likely caused by the availability of kingfishes in a given year, the amount of effort in the spring fisheries for pink shrimp (*Farfantepenaeus duorarum*) and brown shrimp (*F. aztecus*) and the fall/winter fishery for white shrimp (*Litopenaeus setiferus*), and/or regulation changes. The banning of flynets south of Cape Hatteras in March 1996 (15A NCAC 03J .0202(4)) caused some fishermen to modify shrimp trawls in order to target finfish south of Cape Hatteras. This targeting of finfish by shrimp trawls led to higher landings of kingfishes in 1996 and 1997 and resulted in the NCMFC passing the fifty-fifty rule for shrimp and finfish that was implemented in December 1997 (15A NCAC 03J .0202(5); see Section 5.1.1, Management Authority). High ocean catches of kingfishes in 1999 coincided with a strong white shrimp in the fall of that year. Shrimp trawl landings of kingfishes from 1994 to 2013 by waterbody indicate that 63% of the fish were harvested from the Atlantic Ocean while 32% were harvested from the Pamlico Sound. Small amounts of kingfishes were landed from Core Sound (1%) and other estuarine waterbodies.

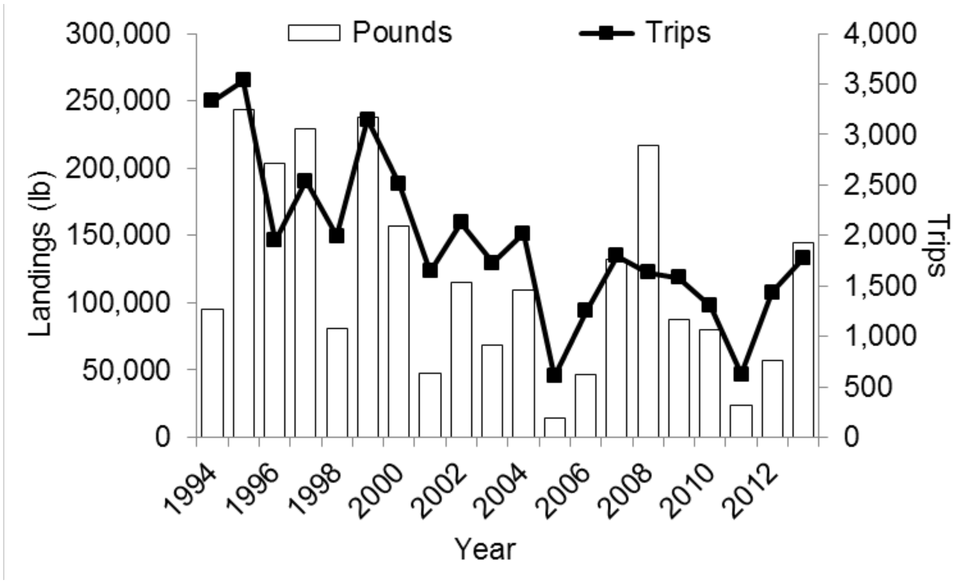


Figure 7.12 North Carolina landings (lb) and trips with kingfishes from the commercial shrimp trawl fishery, 1994–2013 (Source: NCTTP, unpublished data).

The shrimp trawl fishery in the ocean had the highest landings of kingfishes while fishing for white shrimp in the fall and winter months. Catches of kingfishes were low in the Pamlico Sound until the brown and pink shrimp fisheries started in June. Pamlico Sound shrimp trawl landings peaked in August and gradually decreased as the estuarine shrimp fishery subsided (Figure 7.13).

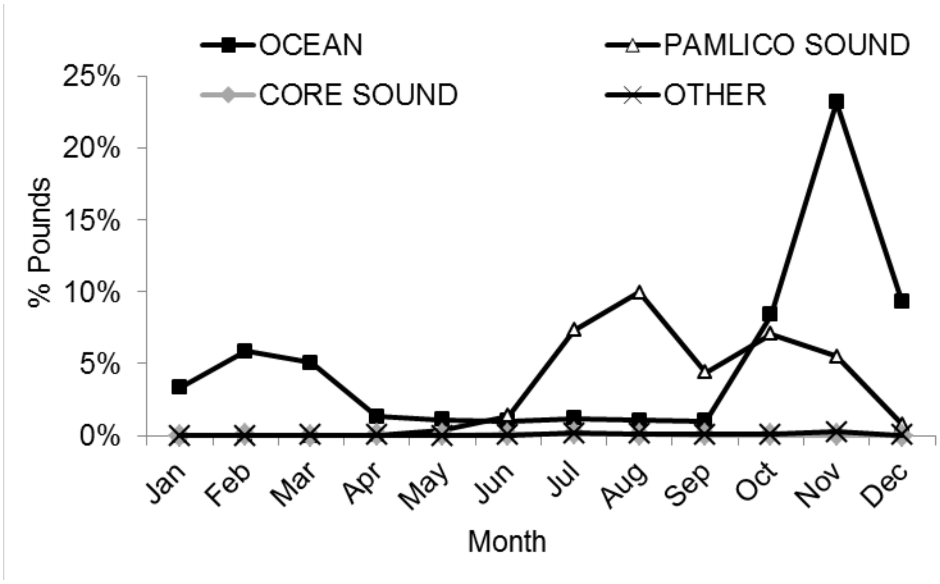


Figure 7.13 Percent of kingfishes in commercial shrimp trawl from North Carolina by month and waterbody, 1994–2013 (Source: NCTTP, unpublished data).

Most (75%) of the shrimp trawl trips with landings of kingfishes caught less than 50 lb of kingfishes accounting for only 17% of the total kingfishes landed in shrimp trawl fisheries. A large portion of the landings between 1994 and 2013 came from trips harvesting greater than 1,000 lb of kingfishes. These trips with large catches of kingfishes made up nearly 30% of the total landings for this time period (Figure 7.14). Many of these were from Carteret County during 1996 and 1997 when shrimp trawls were used to target finfish by some boats that were circumventing flynet rules for the Atlantic Ocean (Figure 7.15). The majority of kingfishes caught in shrimp trawls are landed in Carteret County followed by Onslow and Pamlico counties.

NCDMF does not target the shrimp trawl fishery for finfish sampling; therefore, a length distribution over time for kingfish caught in shrimp trawls is not available.

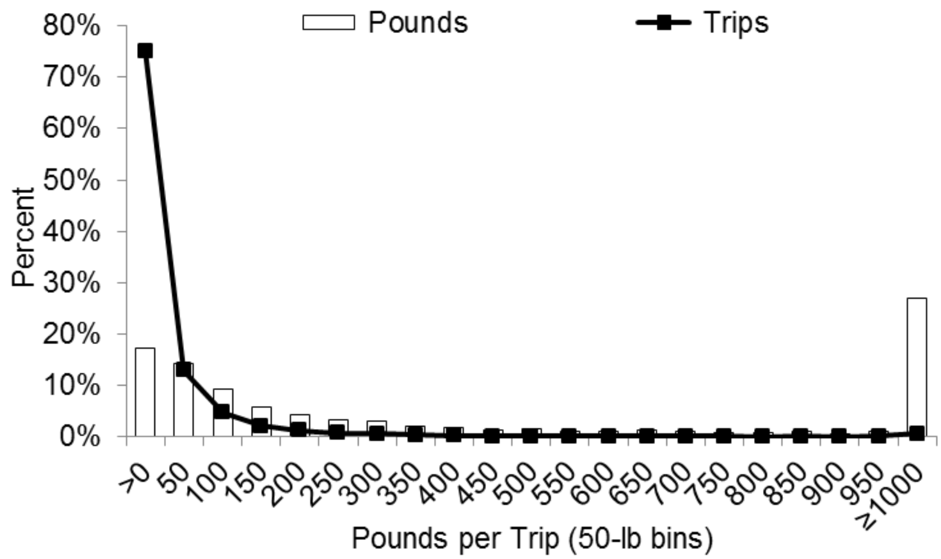


Figure 7.14 North Carolina landings (lb) and trips of kingfishes from the commercial shrimp trawl fishery in bins showing pounds per trip, 1994–2013 (50-lb increments; Source: NCTTP, unpublished data).

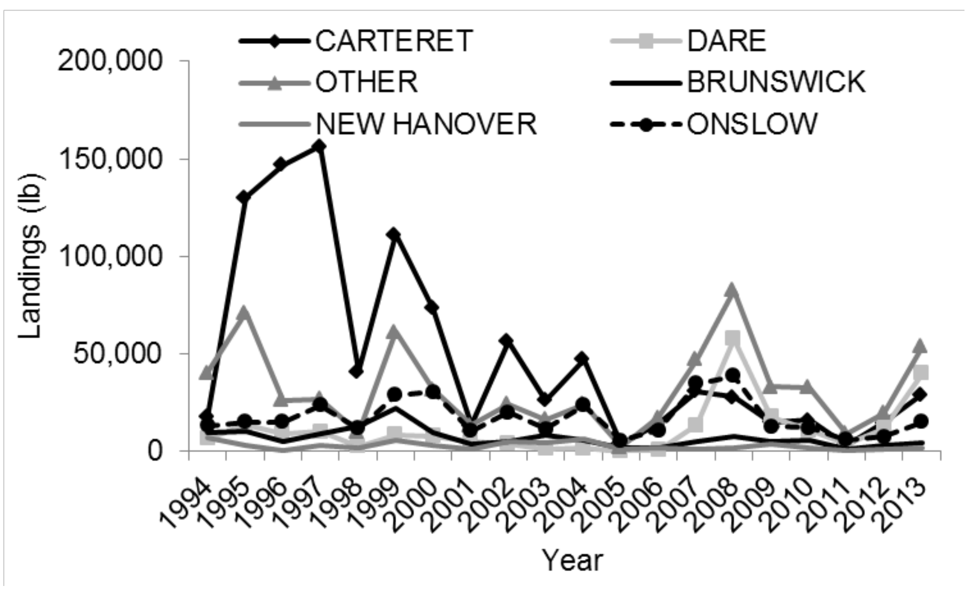


Figure 7.15 North Carolina commercial shrimp trawl landings of kingfishes by county, 1994–2013 (Source: NCTTP, unpublished data).

### 7.1.6.3 Fish Trawl Fishery

Fish trawls (composed of flounder trawls and flynets) were the dominant gear used to harvest kingfishes prior to 1980 (Table 7.1; Figure 7.5). The flynet fishery occurs in the ocean by trawlers fishing for weakfish, Atlantic croaker, bluefish, butterfish and kingfishes. Kingfish landings have been low since 1996, a decrease that directly corresponds to the area closures to flynet gears south of Hatteras. This fishery predominately takes place from October through April in waters less than 36 m (118 ft.) from Oregon Inlet to Cape Hatteras. The flounder trawl fishery targets summer flounder and black sea bass in ocean waters typically from November to April. Kingfish landings from fish trawls declined after 1993 due to area closures in the flynet fishery to protect weakfish leading to a shift towards gill nets and shrimp trawls (Figure 7.16). Flynets were banned west of Cape Lookout in 1993 (Proclamation FF-6-93). In 1995, the flynet fishery was also banned south of Cape Hatteras with the exception of the first three weeks of January, February, and March (Proclamation FF-18-94 and FF-31-94). After 1995, the flynet fishery was banned south of Cape Hatteras via proclamation (Proclamation FF-22-95) and then by rule in March 1996 (15A NCAC 03J .0202(4)).

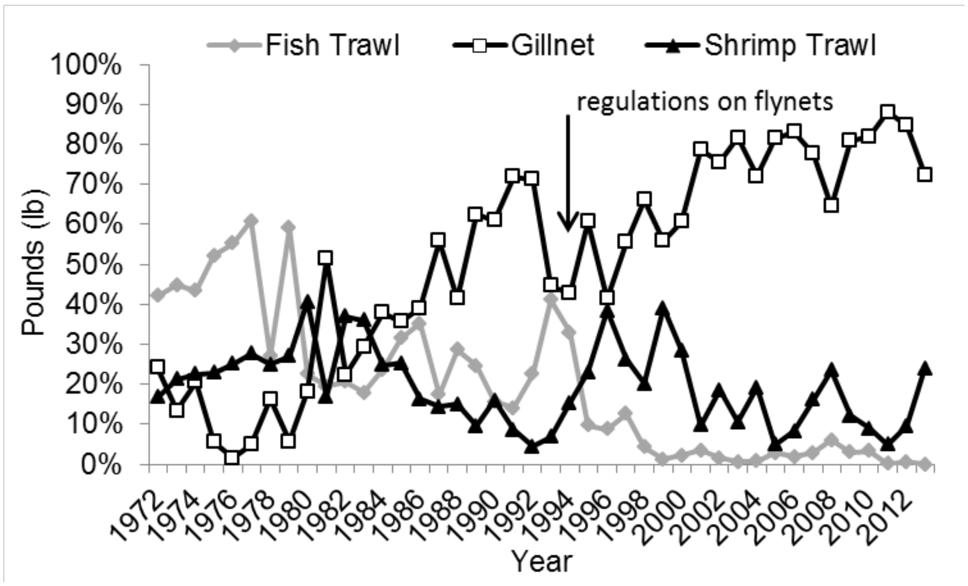


Figure 7.16 Percent of kingfishes in North Carolina from the three dominant gears, 1972–2013 (Source: NCTTP, unpublished data).

Landings of kingfishes in fish trawls decreased from 204,606 lb in 1994 to zero in 2013 (Table 7.1; Figure 7.17). The decreased ability of the trawlers to pass through Oregon Inlet to land fish in North Carolina could explain the zero landings in 2013. Since 1996, landings from this gear have been less than 50,000 lb with the exception of 1997 and 2008. In many years since 1994, landings from fish trawls have not exceeded 10,000 lb. The winter months (December–March) accounted for 87% of the harvest of kingfishes from fish trawls (Figure 7.18) as this gear generally targets fish in the ocean that have moved out of the sounds or are migrating southward during the winter.

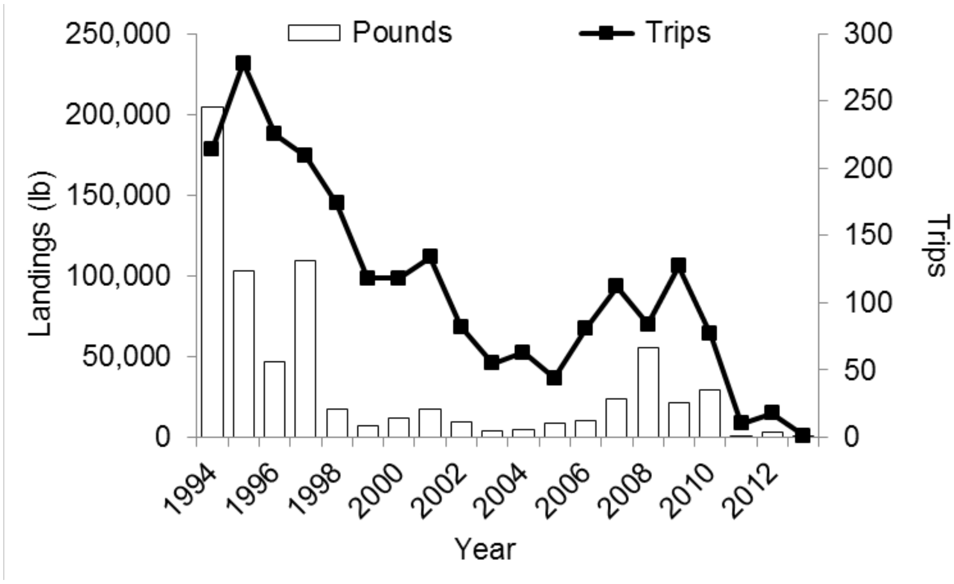


Figure 7.17 North Carolina landings (lb) and trips for kingfishes from the fish trawl fishery, 1994–2013 (Source: NCTTP, unpublished data).

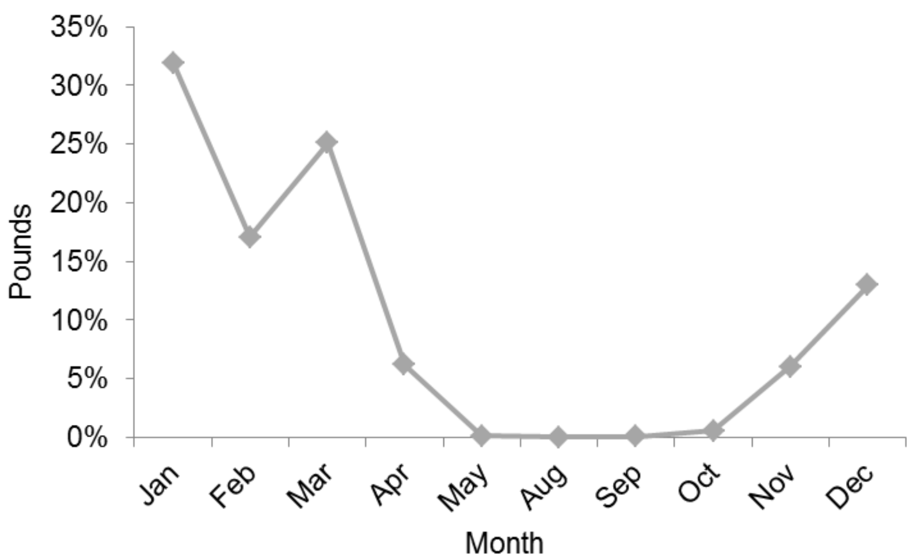


Figure 7.18 Percent of fish trawl landings of kingfishes in North Carolina by month, 1994–2013 (Source: NCTTP, unpublished data).

Between 1994 and 1997, 84% of the harvest of kingfishes from fish trawls was reported in Carteret County, followed by Dare County with 7%. Since 1997, the proportion of landings in Dare County has increased to 78% while landings of kingfishes in Carteret County were only 15% of the total. This shift coincides with regulations banning flynets south of Cape Hatteras (Figure 7.19). From 1994 to 2013, fish trawl trips harvesting greater than 1,000 lb of kingfishes accounted for only 5% of the trips that landed kingfish but accounted for 64% of the total landings (Figure 7.20). This can be attributed to five years in the time series (1994, 1995, 1997, 2008, and 2010) in which more than 50% of the annual landings came from trips with greater than 1,000 lb.

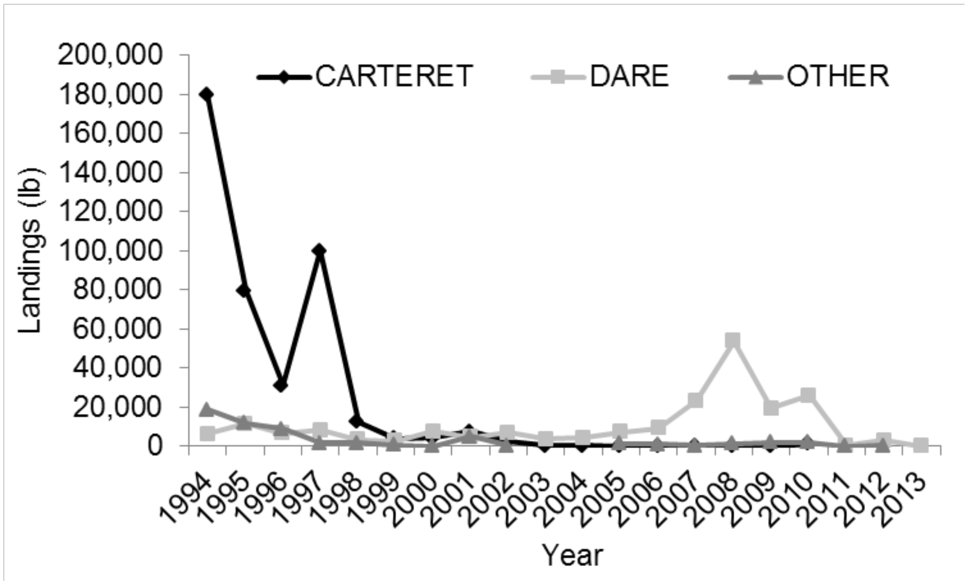


Figure 7.19 Fish trawl landings of kingfishes in North Carolina by county, 1994–2013 (Source: NCTTP, unpublished data).

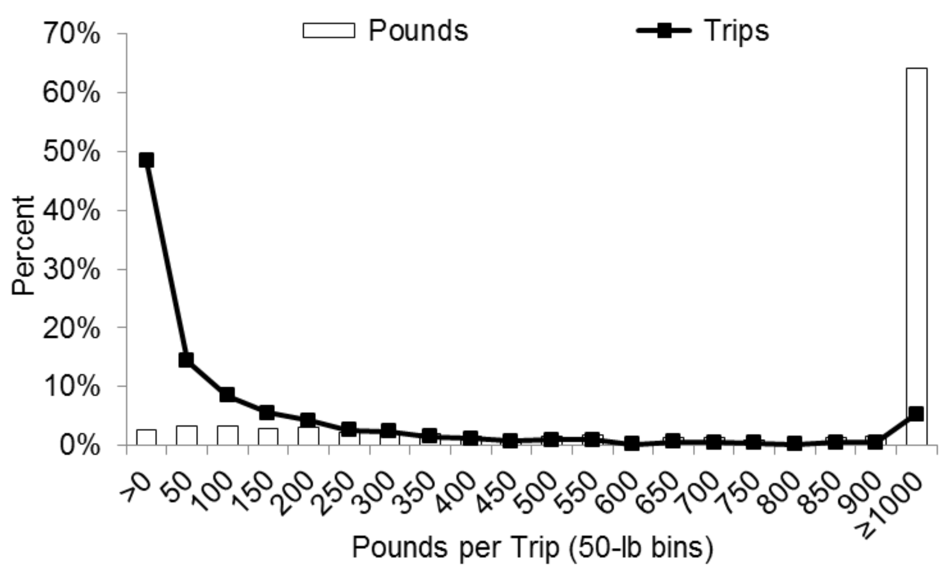


Figure 7.20 North Carolina landings (lb) and trips of kingfishes from the fish trawl fishery in bins showing pounds per trip, 1994–2013 (50-lb increments; Source: NCTTP, unpublished data).

NCDMF fish house sampling programs 433 and 443 provided length information for southern kingfish landed by fish trawls. Samples from trips using fish trawls have been available since 1983. From 1983 to 2013, the length frequency distribution of fish trawl landed southern kingfish ranged from 7.1 inches (180 mm) to 17.3 inches TL (440 mm) with a median of 11.0 inches TL (280 mm; Figure 7.21). The length distributions of southern kingfish landed by fish trawls have fluctuated slightly over the time series (Figure 7.21).

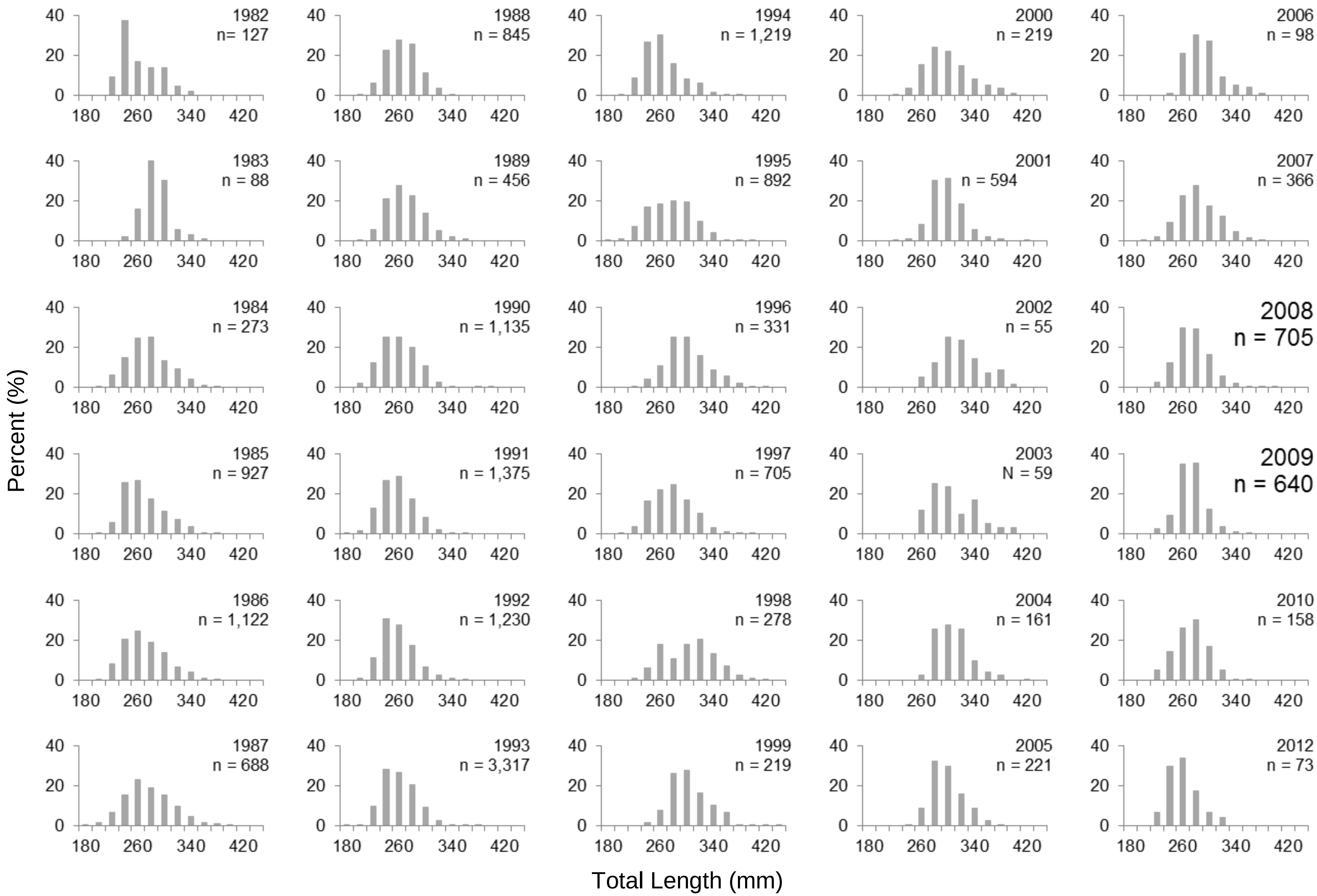


Figure 7.21 Length distributions for kingfishes from commercial fish trawl fishery, 1982–2013 (Source: NCDMF, unpublished data). Years with sample sizes less than 25 are not included.

#### 7.1.6.4 Seine Fishery

Seines (beach seines and long haul seines) have accounted for 6% of the total landings of kingfishes between 1994 and 2013 (Table 7.1; Figure 7.6). Landings of kingfishes in the seine fisheries showed a steep decline from 1994 to 1999 before somewhat leveling off through 2013. Trips landing kingfishes have been on an overall decline since 1994 (Figure 7.22).

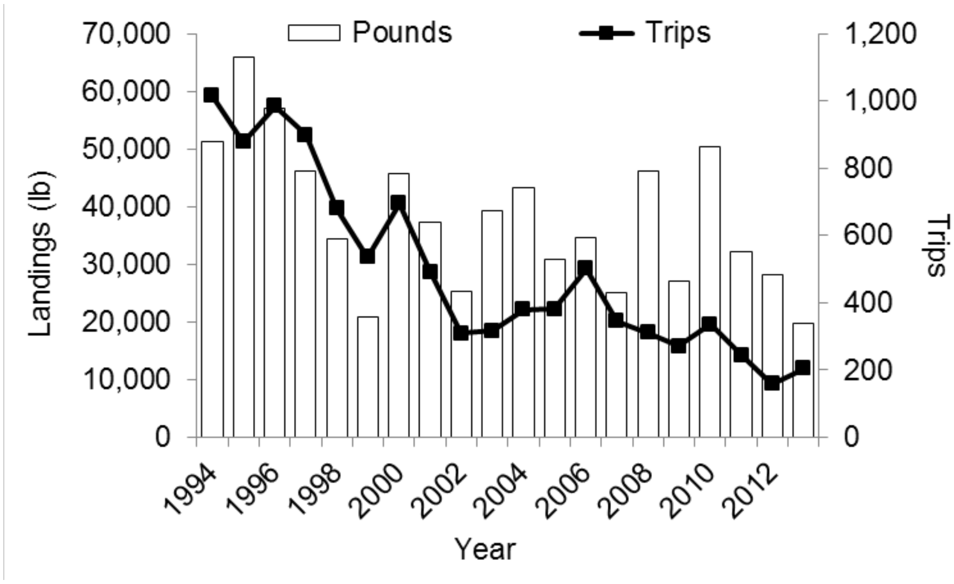


Figure 7.22 North Carolina landings (lb) and trips for kingfishes from the seine fishery, 1994–2013 (Source: NCTTP, unpublished data).

The North Carolina long haul seine fishery operates primarily in Core and Pamlico sounds, with most of the activity occurring in northern and southern Pamlico Sound (Wright 2012). The fishery is prosecuted using a seine net (usually between 1,000 and 1,500 yards) that is stretched and pulled between two boats for a distance before the boats come together and close a circle with the net. As the net is hauled, the fish are forced into the bunt section, where they are removed. The long haul seine fishery harvests fish between April and November. It is a multi-species fishery with target species consisting of Atlantic croaker, spot, weakfish, and occasionally bluefish and spotted seatrout. Kingfishes are landed incidentally to the target species.

The beach seine fishery operates in ocean waters along the beach in the northern coastal counties of North Carolina. Target species include Atlantic croaker, bluefish, butterfish, spot, weakfish, striped mullet, and striped bass (during a limited season). The beach seine fishery involves deploying and hauling a seine toward the shore to intercept nearshore migrating fish populations. Beach seines are set perpendicular to shore using dories (small boats) launched from the beach (Atlantic Ocean) and then hauled back to the beach with 4-wheel drive trucks. Beach seines are also referred to as “stop” nets defined as stationary nets not intended to gill fish, are used to impede the movement of schooling fish so that they can be harvested with the seine. The fishery presently operates primarily along the northeastern North Carolina coast, from the North Carolina/Virginia border to Cape Hatteras.

The beach seine may consist of a wash net, bunt, and wing. The most common beach seine is a “hybrid net”, constructed of monofilament-nylon net (wash net and wings) and a multifilament-nylon bunt, but some beach seiners use nets that are constructed of monofilament-nylon throughout (wash net, wing, and bunt). Small mesh beach seines range in length from 600 to

1,500 ft. but are restricted to a total length of 1,000 ft. from May 1 to October 31, North Carolina/Virginia border to Cape Lookout, North Carolina (BNDTRP, Final Rule, April 26, 2006, FR, Vol 71, No. 80).

Kingfishes are landed in long haul seines from April through December; whereas, most of the beach seine catch occurs in April and May with a smaller seasonal peak in October and November (Figure 7.23). The majority of trips (85%) using seines landed >150 lb of kingfishes (Figure 7.24). These trips only accounted for 36% of the total landings of kingfishes in the seine fishery from 1994 to 2013.

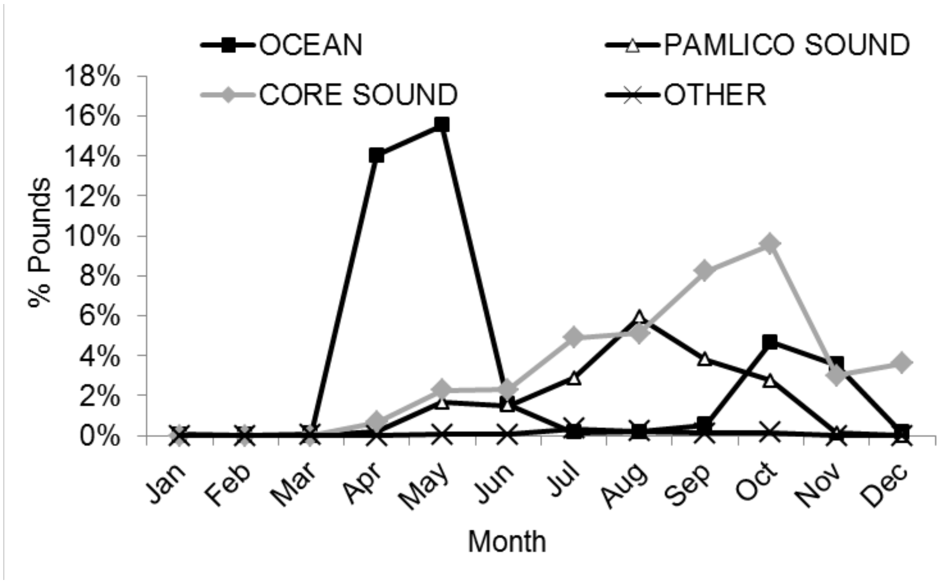


Figure 7.23 Percent of kingfishes in seines from North Carolina by month and waterbody, 1994–2013 (Source: NCTTP, unpublished data).

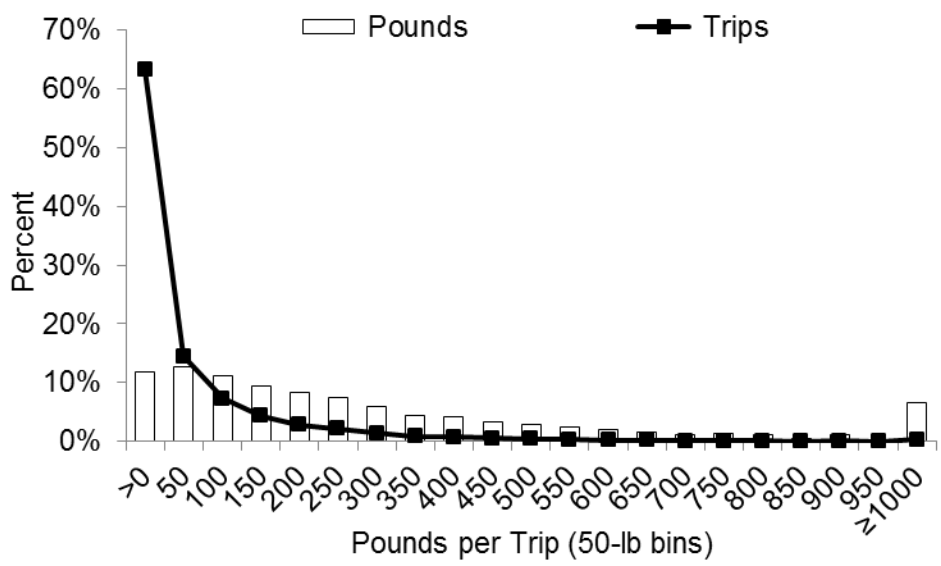


Figure 7.24 North Carolina landings (lb) and trips of kingfishes from the seine fishery in bins showing pounds per trip, 1994–2013 (50-lb increments; Source: NCTTP, unpublished data).

NCDMF fish house sampling programs 457, 437, and 447 provide length information for southern kingfish landed by long haul seines. Samples from trips using long haul seines have been available since 1979. From 1979 to 2013, the length distribution of southern kingfish landed in the commercial long haul seine fishery ranged from 4.7 inches (120 mm) to 18.1 inches TL (460 mm) with a median of 10.2 inches TL (260 mm). The length distributions of southern kingfish landed by commercial long haul seines fluctuated with a slight shift towards larger size classes since the early 2000s (Figure 7.25).

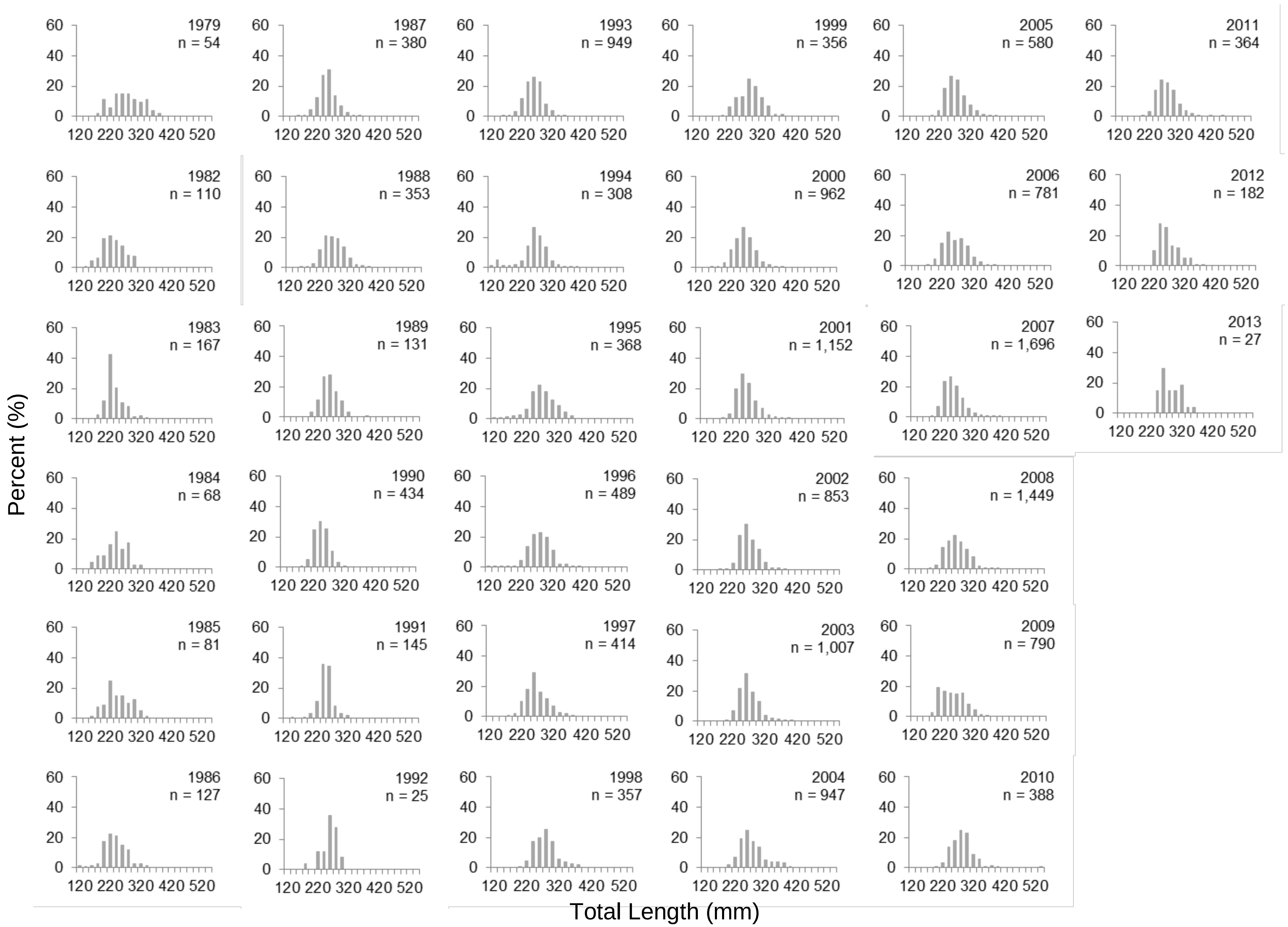


Figure 7.25 Length distributions for kingfishes from commercial long haul fishery, 1979–2013 (Source: NCDMF, unpublished data). Years with sample sizes less than 25 are not included.

NCDMF fish house sampling programs 435 and 445 provide length information for southern kingfish landed by beach seines. Samples from trips using beach seines have only been available since 1997. From 1997 to 2013, lengths of commercial beach seine landing southern kingfish ranged from 7.8 inches (200 mm) to 18.9 inches TL (480 mm) with a median of 11.8 inches TL (300 mm; Figure 7.26). During this time series, the length distributions of southern kingfish landed by commercial beach seines have had little variation (Figure 7.26).

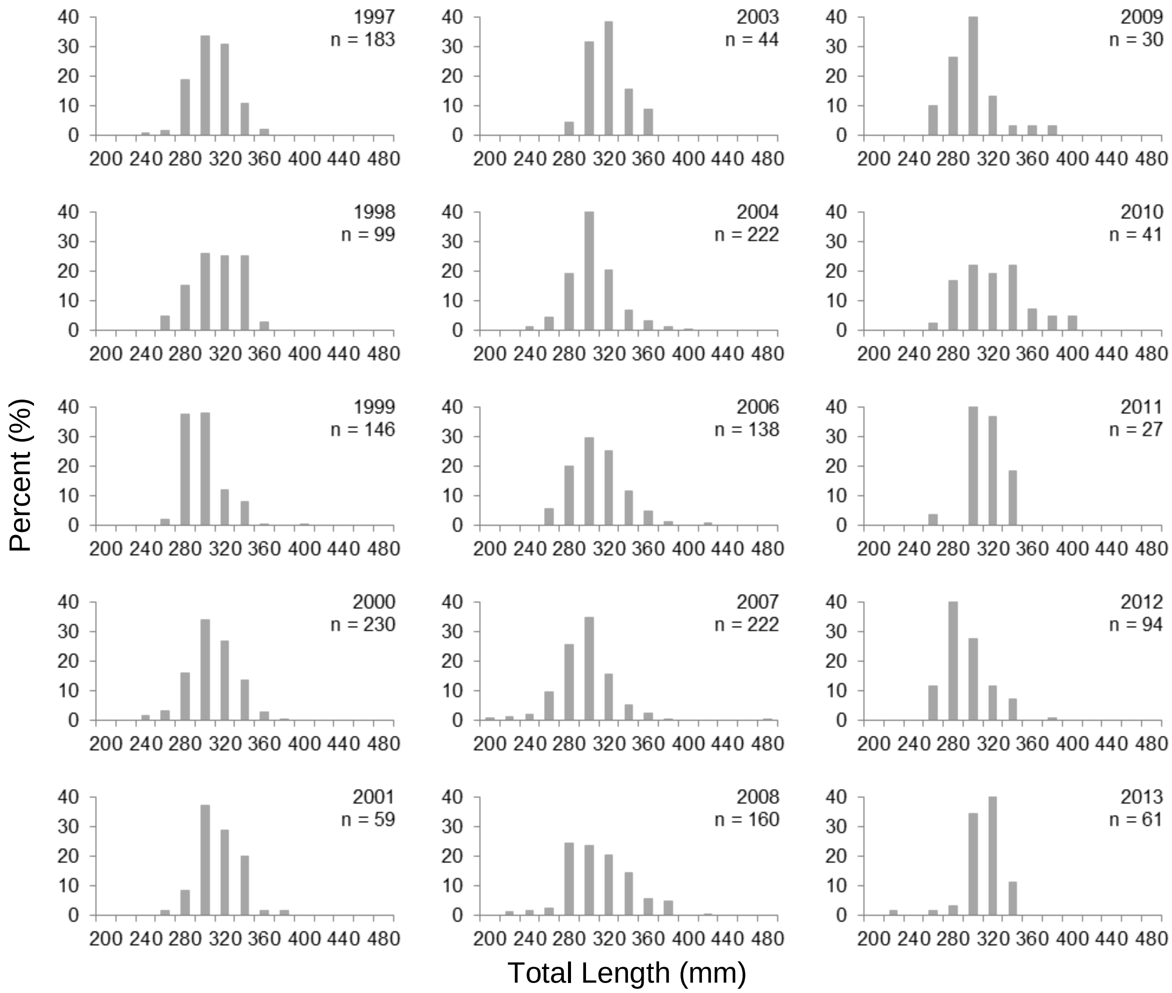


Figure 7.26 Length distributions for kingfishes from commercial beach seine fishery, 1997–2013 (Source: NCDMF, unpublished data). Years with sample sizes less than 25 are not included.

#### <u>7.1.6.5 Other gears</u>

Other commercial gears (gears other than gill nets, fish trawls, shrimp trawls, and seines) fished in North Carolina accounted for an average of less than 1% of the total landings of kingfishes. Hook-and-line landings of kingfishes made up 0.04% of the total landings between 1994 and 2013.

### 7.1.7 Bycatch Associated with Commercial Catches

Fishery managers continually face the issue of bycatch and discards in fisheries throughout the world (Gray 2002). Discards affect fishery yields and fishery managers' ability to accurately assess fishery stocks (Fennessy 1994; Hall 1999). The NCMFC 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" (ASMFC 1994). Bycatch can be divided into two components: incidental catch and discarded catch. Incidental catch refers to retained or marketable catch of non-targeted species, while discarded catch (unmarketable bycatch) is that portion of the catch returned to the sea because of regulatory, economic, or personal considerations. For the remainder of this section these two bycatch components are referred to as marketable and unmarketable bycatch.

While it is becoming increasingly apparent to scientists, natural resource managers, and much of the general public that bycatch is an important issue that must be addressed, characterizing the nature and extent of bycatch has proven extremely difficult. These difficulties are generally attributed to inadequate monitoring of many pertinent characteristics including actual bycatch levels, effort of the directed fishery, distribution of the bycatch species, and the mortality rate of the discarded species. The problem is exacerbated by the patchy distribution of effort and finfish in both time and space. The amount of bycatch in a particular trip is usually skewed, with many tows having some bycatch and very few tows with high bycatch. Additionally, available effort data are often inadequate. Although research indicates that tow duration is often a significant factor when estimating bycatch losses (Alverson et al. 1994; Murawski 1996), the NCDMF and most other agencies typically record effort data by trip without any accompanying information on tow duration or the number of tows made during a trip. Mortality of bycatch captured in commercial gear varies by species, in addition to tow time, water temperature, fishing location, and gear configuration.

To explore marketable bycatch in the gears landing kingfishes, only trips reporting one gear and landing at least 1 lb of kingfish were selected. These trips were used to determine which finfish species were typically landed in each gear type as well as how kingfish ranked among the other finfish species in regards to the percent of landings from 1994 to 2013 (Table 7.2). Up to three gears can be reported to NCTTP for each trip. Using only single gear trips eliminates the chance that a different gear other than the first gear recorded on the trip ticket was the actual gear contributing to the finfish landings. For trips landing kingfish, 99.2% of the landings were reported on single gear trips.

Table 7.2 Percent of total commercial landings by species for select gears from single gear trips landing at least 1 lb of kingfish, 1994–2013 (Source: NCTTP, unpublished data).

| Species | Beach Seine | Crab Pot | Crab Trawl | Flynet | Gill Net | Long Haul Seine | Shrimp Trawl |
|---|---|---|---|---|---|---|---|
| Atlantic Croaker | 3% | 2% | 6% | 88% | 12% | 3% | 18% |
| Spot | 30% | 17% | 5% | 0% | 13% | 58% | 11% |
| Weakfish | 15% | 7% | 1% | 5% | 18% | 17% | 4% |
| Kingfishes | 5% | 28% | 15% | 1% | 15% | 3% | 50% |
| Flounders | 0% | 10% | 70% | 0% | 4% | 0% | 11% |
| Bluefish | 11% | 11% | 0% | 2% | 11% | 2% | 0% |
| Menhaden Bait | 4% | 1% | 0% | 1% | 5% | 8% | 0% |
| Mackerel, Spanish | 1% | 0% | 0% | 0% | 7% | 0% | 0% |
| Dogfish, Spiny | 0% | 0% | 0% | 0% | 3% | 0% | 0% |
| Mullets, Jumping | 14% | 1% | 0% | 0% | 1% | 0% | 0% |
| Bait | 2% | 0% | 0% | 1% | 1% | 1% | 0% |
| Butterfish | 1% | 0% | 0% | 1% | 2% | 1% | 4% |
| Other Species | 15% | 24% | 2% | 1% | 9% | 8% | 6% |
| Average | 3% | 3% | 0% | 0% | 4% | 2% | 1% |

## 7.1.7.1 Shrimp Trawl Bycatch

### 7.1.7.1.1 Marketable Bycatch

From 1994 to 2013, an average of 303,503 lb of finfish were landed annually by shrimp trawls. Kingfishes are the most common finfish species landed with shrimp trawls, accounting for 50% of the total finfish landed (Table 7.2). Although most kingfishes captured are incidental to shrimp trawling, a directed fishery using shrimp trawls occurred in the Atlantic Ocean in 1996 and 1997. In 1996, 34% of the kingfishes landed by shrimp trawls were from trips that had no shrimp landings (Table 7.3). This number increased to 54% in 1997 (NCDMF 2007).

Table 7.3 Comparison of kingfish landings from shrimp trawls with and without shrimp landings, 1994–2013 (Source: NCTTP, unpublished data).

| Year | Total reported kingfish landings from shrimp trawls | Kingfish landings from shrimp trawls with no reported shrimp landings | Percent difference |
|---|---|---|---|
| 1994 | 94,477 | 1,233 | 1.3% |
| 1995 | 243,084 | 16,505 | 6.8% |
| 1996 | 202,326 | 69,373 | 34.3% |
| 1997 | 229,079 | 123,931 | 54.1% |
| 1998 | 80,470 | 1,627 | 2.0% |
| 1999 | 237,427 | 6,353 | 2.7% |
| 2000 | 156,870 | 2,170 | 1.4% |
| 2001 | 47,542 | 128 | 0.3% |
| 2002 | 114,416 | 711 | 0.6% |
| 2003 | 68,088 | 229 | 0.3% |
| 2004 | 108,825 | 1,296 | 1.2% |
| 2005 | 14,642 | 243 | 1.7% |
| 2006 | 46,152 | 464 | 1.0% |
| 2007 | 131,266 | 1,950 | 1.5% |
| 2008 | 216,421 | 4,475 | 2.1% |
| 2009 | 87,032 | 479 | 0.6% |
| 2010 | 79,588 | 838 | 1.1% |
| 2011 | 23,692 | 160 | 0.7% |
| 2012 | 57,368 | 742 | 1.3% |
| 2013 | 144,527 | 562 | 0.4% |
| Total | 2,383,293 | 233,467 | 9.8% |
| Average | 119,165 | 11,673 | 5.8% |

#### 7.1.7.1.2 Unmarketable Bycatch

Although a long-term characterization study of bycatch in the shrimp trawl fishery has not been conducted for North Carolina waters, preliminary investigations were conducted in 1995 (Diamond-Tissue 1999) and 1999 (Johnson 2003). Two Federal Research Grants (FRGs) were funded by North Carolina Sea Grant to compare bycatch rates between day and night fishing in the southern portion of the state (Taylor and Donello 2000; Ingraham 2003). Two more recent studies were conducted in 2008 (Brown 2009) and 2009 (Brown 2010a), and an additional study, currently underway, began in 2012, to characterize the commercial shrimp trawl fishery in North Carolina (Brown unpublished).

Diamond-Tissue's (1999) characterization study examined 52 tows conducted over 15 trips. Sampled boats had one or two nets, and all nets contained the required TED (Turtle Excluder Device) and BRD. Ninety-two different species, including 66 species of finfish, 10 species of crabs, and 13 other invertebrates were identified. Number and weight for each waterbody provided data for the top ten species. These top ten species accounted for between 85% and 95% of the total catch by number and weight in each waterbody. Kingfishes were not part of the top ten species in any waterbody.

Johnson (2003) quantified the catch of shrimp trawlers working in Core Sound (n = 46 tows) and the Neuse River (n = 8 tows) during the summers of 1999 and 2000. Three species of finfish—

spot (48%), Atlantic croaker (13%), and pinfish (12%)—accounted for 73% of the finfish bycatch from Core Sound. In the Neuse River, Atlantic croaker (44%) and spot (33%) accounted for 77% of the finfish bycatch. No kingfishes were observed in either area.

Taylor and Donello (2000) examined shrimp trawl catches from estuarine waters in the southern portion of the state (New River to Ocean Isle Beach Bridge, North Carolina) from May through November, with the exception of zero tows in July. Catches from fifty-four 45-minute tows were examined. Data were only provided for species whose combined catch weight exceeded four kilograms. No data were reported for kingfishes, so if captured, the combined total weight was less than four kilograms.

Ingraham (2003) examined ocean (0–3 miles) shrimp trawl catches from Topsail Inlet to Little River Inlet, North Carolina. Catches from 40 tows (20 daytime and 20 nighttime) collected during May–June and September–December were analyzed. Kingfishes were the eighth most abundant category, accounting for <2% of the total catch weight. Kingfish catches were significantly higher in December than any other month and nighttime catch rates were significantly higher than daytime catch rates (0.14 lb/minute night and 0.04 lb/minute daytime).

Brown's (2009) characterization study in 2008 examined 314 tows conducted over 143 trips in the nearshore (<3 miles) commercial shrimp trawl fishery off North Carolina. Two different net types were observed: double seamed nets and tongue nets. All observed vessels were double rigged or quad rigged. There were more than 100 different species observed throughout the study. Kingfish species accounted for <2% of the observed species catch by weight.

Brown's (2010b) characterization study in 2009 examined 191 tows conducted over 66 trips in the inshore commercial shrimp trawl fishery in North Carolina. Three different net types were observed: double seamed, four seamed, and tongue nets. Single rigged, double rigged, and quad rigged vessels were observed. There were 69 species observed throughout the study in all net types. Kingfish species accounted for <1% of all of the observed species catch by weight.

Brown's (unpublished) 2012 to 2015 study is a three-year statewide characterization of the commercial shrimp trawl fishery in North Carolina. Preliminary data indicate similar amounts of kingfish bycatch as previous studies (Brown 2009; Brown 2010a).

The NMFS, along with the Gulf and South Atlantic Fisheries Development Foundation (GSAFDF), began a cooperative bycatch research program in 1992. Beginning in February 1992 and continuing until December 1996, observers were placed aboard cooperating vessels to characterize bycatch and to test BRDs during normal commercial shrimp trawling (Nance 1998). More than 150 taxa have been identified from shrimp trawl catches in the South Atlantic and the average overall catch rate was 62 lb per hour. Finfish comprised 51% of the catch by weight, shrimp 18%, non-crustacean invertebrates 18%, and 13% were non-commercial shrimp crustaceans. Seasonal distribution of finfish bycatch in the South Atlantic indicates that the highest percentage by weight occurred in the summer but by number, the highest was in the spring.

Numerous gear evaluation studies have been conducted in North Carolina waters (McKenna and Monaghan 1993; Coale et al. 1994; Murray et al. 1995; McKenna et al. 1996; Brown 2010b). However, these data should not be used for characterization analysis of the shrimp trawl fishery since these studies were often conducted during times of low shrimp catch rates. Therefore, the bycatch data are not representative of typical shrimp trawl trips. For example, the fish to shrimp ratio for gear studies conducted in 1994 (McKenna et al. 1996) was 5.5 to 1.0, while characterization studies conducted in 1995 by Diamond-Tissue (1999) calculated the fish to shrimp ratio to be 1.6 to 1.0. Although these data should not be used for characterization analysis, catches provide information on presence or absence and size of species.

Gear testing was conducted on a commercial trawler in Pamlico Sound in 1991 (McKenna and Monaghan 1993). Data were collected from forty-one 90-minute tows during May (n = 6), August (n = 18), and September (n = 17). Kingfishes comprised 2.0% of the total finfish catch and averaged 3 lb per tow. May catches accounted for the highest average catch per tow (5 lb) and represented 4.5% of the total finfish catch. August and September had the same percent contribution of kingfishes to total finfish (1%). On average, a total of 4 lb of kingfishes was captured per tow in August and 3 lb in September.

Gear testing in 1994 was conducted in Pamlico, Croatan, and Core sounds and the Newport, New, and Cape Fear rivers (McKenna et al. 1996). Work in the Pamlico Sound complex (Pamlico and Croatan sounds) was performed aboard commercial and state vessels. All work in the other areas was conducted aboard commercial trawlers. New River had the highest overall CPUE of kingfishes (2 lb/tow), followed by the Cape Fear River (1 lb/tow) and Pamlico Sound (1 lb/tow; Table 7.4). Overall, kingfishes were observed in 24% of the sampled catches. The Cape Fear River had the highest percentage (62%) of kingfishes, while Core Sound and the Newport River had the lowest (2%).

Table 7.4 Kingfish data for control nets from gear testing conducted in North Carolina in 1994 (Source: McKenna et al. 1996).

| Area | Number of tows | lb Finfish | lb Kingfish | Percent kingfish | Kingfish CPUE (lb/tow) | Percentage of tows Without kingfish | Percentage of tows With kingfish |
|---|---|---|---|---|---|---|---|
| Cape Fear River | 32 | 2,033 | 19 | 1% | 1 | 38% | 62% |
| New River | 115 | 8,551 | 160 | 2% | 2 | 51% | 49% |
| Core Sound | 165 | 3,772 | 0 | <1% | 0 | 98% | 2% |
| Newport River | 60 | 137 | 0 | <1% | 0 | 98% | 2% |
| Pamlico Sound | 129 | 16,690 | 71 | <1% | 1 | 69% | 31% |
| Croatan Sound | 43 | 2,576 | 1 | <1% | <1 | 90% | 10% |
| Total | 544 | 33,759 | 252 | <1% | <1 | 76% | 24% |

Brown (2010b) conducted independent gear testing of five experimental otter trawls in the Neuse River and Pamlico Sound, North Carolina aboard the R/V Carolina Coast. Kingfish species accounted for less than 1% of the catch by weight in all net types.

The length frequency of kingfishes captured during gear testing in 1994 is shown in Figure 7.27 and is overlapped with the length frequency of kingfishes captured during the NCDMF Pamlico Sound Survey (PSS) from 1987 through 2005 (NCDMF 2007). The PSS is a fishery-independent survey conducted in June and September of each year. This survey uses two 30-foot mongoose trawls with a 1½-inch stretched mesh tailbag, which is the minimum required mesh size for shrimp trawls. The distribution of fish lengths in both studies was similar even though sample sizes were much higher in the PSS. The similarity of the lengths reflects the selectivity to the gears. Since the gear configuration of the PSS has not changed over time, this comparison was not updated with data after 2005.

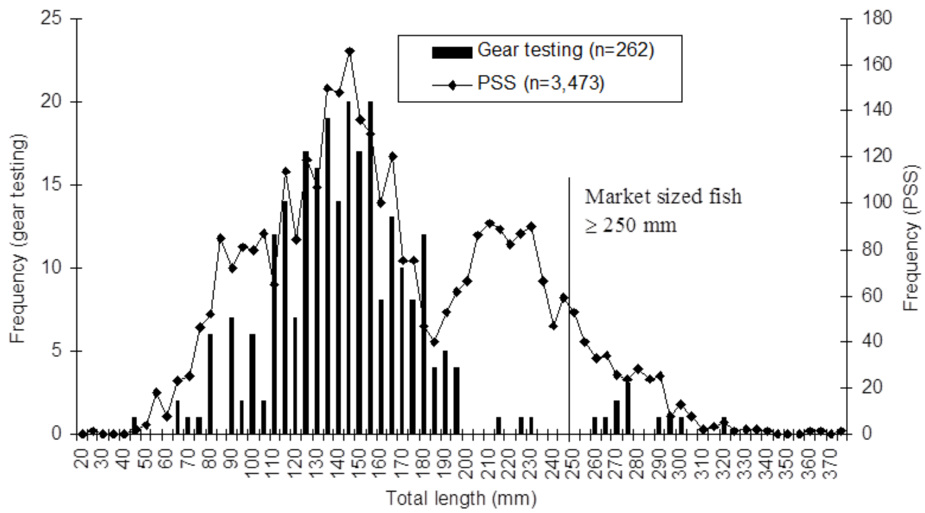


Figure 7.27 Length (mm) frequency distribution of kingfishes captured during gear testing in Pamlico Sound (1994) and the NCDMF Pamlico Sound Survey, 1987–2005 (Source: NCDMF 2007).

#### 7.1.7.1.3 Implications

Kingfishes are the most common finfish species landed by shrimp trawls by weight. However, in observer studies in the field, they represented a much lower percentage of total finfish captured (landed and discards). Most of the kingfishes observed would be marketable bycatch based on the observed lengths and conversations with fish house dealers. The contradiction between documented NCTTP landings and observer studies may indicate that most other finfish bycatch species may not be marketable sizes, but is most likely due to small sample sizes of observed data exacerbated by the limited spatial and temporal coverage. The limited data available on discarded bycatch indicate that the bycatch of these species is highly variable. Various management measures have been implemented by the NCMFC to address bycatch in the shrimp trawl fishery including: trip limits, BRDs, area closures, time restrictions, and phasing out of otter trawls in the New River. Fishery-dependent information on the number and size of kingfishes in this fishery needs to be collected across a broad range of waterbodies and seasons.

The effect of shrimp trawl bycatch on kingfish stocks is unknown; however, a reduction of fishing mortality on unmarketable juvenile finfish stocks might result in more individuals recruiting into the spawning stock therein increasing the number of fish recruiting into recreational and commercial fisheries.

### 7.1.7.2 Flynet Bycatch

#### 7.1.7.2.1 Marketable Bycatch

From 1994 to 2013, Atlantic croaker and weakfish were the top two species (by weight) harvested in flynets from trips where kingfishes were also captured. Atlantic croaker made up 88% of the flynet landings from trips landing at least 1 lb of kingfish between 1994 and 2013 (Table 7.2). Both effort and species composition of flynet trips capturing kingfishes has changed between the periods of 1994 to 1997 and 1998 to 2013. This change was attributed to regulations that eliminated flynets fishing south of Cape Hatteras. Average landings of Atlantic croaker from 1998 to 2013 decreased 22% compared to the 1994 to 1997, and the average number of trips decreased 52% during the same time. Other species indicated similar trends in effort and catch rates. The average number of trips that caught kingfishes dropped from 127 trips to 53 trips per year.

#### 7.1.7.2.2 Unmarketable Bycatch

All estimations of unmarketable fish landings were based on NCDMF fish house sampling of the catches and these estimated landings have changed little since 1997. The flynet fishery has an unmarketable fish component that accounted for between 4% and 23% of the total flynet landings from 2000 to 2012 (Burns 2004; Batsavage 2007; Batsavage et al. 2012). Unmarketable fish landings were dominated by Atlantic croaker, weakfish, Atlantic menhaden, and spot. Atlantic croaker made up between 52% and 84% of the unmarketable fish sampled. Kingfishes represented from <1% to 2% of the unmarketable fish landings between 2000 and 2012.

#### 7.1.7.2.3 Implications

The contribution of flynets to kingfish landings has decreased to the point where this gear only contributed <1% to total landings in 2012. There were near zero landings of kingfish from flynets in 2013. When the contribution of flynet landings in recent years is compared to percentage of kingfish in flynets in 1994 (32%), the effect of the flynet ban south of Cape Hatteras is apparent. This decrease in effort and landings may have had a positive impact on kingfish populations; however, the impact may have been offset by increased catches in the gill net fishery.

### 7.1.7.3 Seine Bycatch

#### 7.1.7.3.1 Marketable Bycatch

The long haul seine represented only 4% of the total kingfish landings from 1994 to 2013. Kingfish landings in this gear are typically incidental representing 3% of the total landings from trips reporting long haul seines and at least 1 lb of kingfish (Table 7.2). The most common species caught in long haul seines were spot (58%), weakfish (17%), and Atlantic menhaden (8%).

The dominant species taken in the beach seine fishery included spot (30.0%), weakfish (15%), striped mullet (14%), and bluefish (11%; Table 7.2). Kingfish made up 5% of the total landings of all species caught with beach seines from trips that also caught at least 1 lb of kingfish. The type of species caught in this gear is opportunistic and depends on the seasonal presence of migratory fish (Bowman and Tork 1998). For kingfish, the beach seine only represents 2% of the total landings from 1994 to 2013.

#### 7.1.7.3.2 Unmarketable Bycatch

Significant portions of long haul catches are sold as unmarketable fish (bait). Between 2003 and 2011, 26% to 59% by weight of landed catch by long hauls was unmarketable fish (Potthoff 2004; Fitzpatrick 2007; Wright 2012). The dominant species in the unmarketable fish category landings each year were Atlantic croaker, spot, Atlantic menhaden, and pinfish accounting for nearly 90% of the unmarketable fish total by weight and number from 2003 to 2011, with the exception of 2009 which had a large percentage of bluefish (16%). Kingfishes constituted only a trace amount of the long haul unmarketable fishery ranging from 0% to 2%. The NCDMF sampled the unmarketable fish component from 365 long haul catches between 2003 and 2011. The mean weight of kingfishes per catch ranged from 0.1 to 0.2 lb. No kingfish were observed in 2003, 2010, and 2011.

The amount of unmarketable fish (bait) in the beach seine fishery is minimal, with most or all of the unmarketable catch discarded while on the beach. When bait fishes were encountered, it was primarily composed of Atlantic menhaden, but sometimes included, small bluefish, spot, and/or striped mullet. Species discarded on the beach were most often skates and rays, along with some regulatory discards including small weakfish, spotted seatrout, and/or red drum or hickory shad that cannot be landed out of season (January 1–April 15). Of all the beach seine catches sampled from 1994 to 2004 (n = 58), only one unmarketable kingfish was encountered. NCDMF sampled the unmarketable fish component of 20 beach seine catches and the mean weight of kingfish was only <1% of the total catch weight (NCDMF 2007).

#### 7.1.7.3.3 Implications

Commercial landings of kingfishes in long haul seines and beach seines were less than 5% of the total kingfish landings from 1994 to 2013. Unmarketable fish landings of kingfishes were negligible in both fisheries with the majority of the fish landed sold as food fish. Anytime a fishery lands a large percentage of unmarketable fish relative to the total catch, there is a reason for fishery managers to be concerned. However, concerning kingfishes, the amount of small unmarketable fish was so few that it would have little impact on the health of these stocks.

### 7.1.7.4 Gill Net Bycatch

#### 7.1.7.4.1 Marketable Bycatch

Kingfishes harvested in gill nets were primarily captured in ocean waters from 1994 to 2013. The gill net fishery averaged 2,900,747 lb of marketable catch per year from trips landing at least 1 lb of kingfish. Weakfish (18%) had the highest landings on these trips followed by kingfishes (15%), spot (13%), Atlantic croaker (12%), and bluefish (11%; Table 7.2). Most of the trips in the gill net fishery that harvested kingfishes were multi-species trips with the top five species contributing in similar amounts to the total landings.

#### 7.1.7.4.2 Unmarketable Bycatch

Essentially all kingfish taken in this fishery were marketable (Collier 2012). The amount of unmarketable finfish landed by gill nets is negligible due to the size selectivity of this gear. Species of interest are targeted preventing an abundance of undersized and unmarketable fish (Batsavage 2004a; Batsavage 2004b; Burns 2007; White 2012).

#### 7.1.7.4.3 Implications

Currently, the dominant commercial gear capturing kingfishes is small mesh gill nets. Kingfishes were not the sole targeted species in most trips but rather one of the targeted species in a multi-species fishery. Landings associated with kingfishes were most often Atlantic croaker, bluefish, spot, weakfish, and Spanish mackerel. Management measures directed towards any one of these species in the gill net fishery would certainly affect kingfishes. Most kingfishes landed in the gill net fishery were sold. NCDMF data indicated insignificant amounts of kingfishes were discarded in the gill net fishery. This was because the fishers generally used nets that selected for marketable fish.

#### 7.1.7.5 Crab Trawl Bycatch

The crab trawl fishery has received a large amount of attention due to the bycatch of finfish (mainly southern flounder) and sub-legal crabs, but few trawlers that target blue crabs in North Carolina's internal coastal waters.

##### 7.1.7.5.1 Marketable Bycatch

From 1994 to 2013, the average finfish landings from crab trawls (hard and peeler) was 48,104 lb per year. The main finfish species landed on trips with at least 1 lb of kingfish was southern flounder accounting for 70% of the total (Table 7.2). Kingfish landings accounted for 15% of total finfish landings from this gear and averaged 1,178 lb per year. Atlantic croaker and spot were the only other species caught in more than 5% of trips using crab trawls.

##### 7.1.7.5.2 Unmarketable Bycatch

McKenna and Camp (1992) assessed the finfish bycatch of the crab trawl fishery in the Pamlico River. During this study, 15 trips were made during March through June aboard commercial crab trawlers. The mean number of tows made during a trip was 3.3 and ranged from one to five tows. Tow times ranged from one to four hours and averaged 2.87 hours per tow. An average trip consisted of 9.46 hours of towing. No kingfishes were captured in 50 tows.

Two gear studies conducted to determine the feasibility of reducing crab trawl bycatch through the alteration of the tailbag mesh size provided some limited data on kingfish bycatch (McKenna and Clark 1993; Lupton 1996). McKenna and Clark (1993) tested the effects of different tailbag mesh sizes on reducing bycatch in the crab trawl fishery. This study was performed by the NCDMF between November 1991 and November 1992. The testing was conducted in the Pamlico, Pungo, and Neuse rivers during the fall and winter and in Adam's Creek during the summer using three, four, and 4½-inch (stretched mesh) tailbags. Seventy-one tows were conducted aboard a research vessel towing two nets at a time, the control net with a 3-inch tailbag and the test net with either a 4-inch tailbag (31 tows) or 4½-inch tailbag (40 tows). Tow times were one hour at night during the winter and spring and 30 minutes during the day in the summer. During this study, a total of 587 lb of finfish were captured of which 0.5 lb (0.1%) were kingfishes.

Lupton (1996) conducted another study between June 1995 and May 1996 on different tailbag mesh sizes for crab trawls. Two hundred twenty tows were conducted during the day in Bay River aboard a research vessel towing two 30-foot nets, the control net with a 3-inch tailbag and the test net with either a 4-inch tailbag (110 tows) or 4½-inch (110 tows) tailbag. Tow times were one hour during the winter and spring and 30 minutes in the summer. Eight hundred and sixty-eight pound of finfish were captured of which 9 lb were kingfishes. Kingfishes comprised 1% of the finfish catch and averaged <1 lb per tow.

##### 7.1.7.5.3 Implications

NCTTP data and studies assessing kingfish bycatch (incidental and discarded) in the crab trawl fishery revealed minimal and insignificant catches of kingfishes. Even though, kingfish made up over 15% of the finfish catch from crab trawl trips landing at least 1 lb of kingfish, the average annual landings were less than 1,500 lb per year. Considering these data, the bycatch of kingfishes, both marketable and unmarketable, does not appear to be a significant issue in the crab trawl fishery.

#### 7.1.7.6 Crab Pot Bycatch

Issues related to finfish bycatch in crab pots are twofold: 1) the composition, quantity, and fate of the marketable and unmarketable discarded bycatch in actively fished pots; and 2) the composition, quantity, and fate of finfish bycatch in “ghost pots”. The NCTTP was used to determine marketable bycatch in crab pots and various North Carolina FRG studies were used to assess the unmarketable bycatch of kingfishes.

Ghost crab pots are defined as those pots that, either through abandonment or loss (float lines cut by boats, storm events, etc.) are left to continue to catch crabs and finfish. Concern stemmed from the significant increase in the numbers of crab pots, the long life of vinyl coated pots, and the pot’s ability to continue to trap crabs and finfish. While data exist on the fate and quantity of blue crabs in ghost pots, little information is available on finfish bycatch since dead fish are quickly consumed by blue crabs, leaving only bones and fins (Guillory 1993; NCDMF unpublished data).

##### 7.1.7.6.1 Marketable Bycatch

From 1994 to 2013, the average annual landings of the marketable portion of the incidental finfish bycatch from crab pots (hard and peeler) was 115,908 lb. Kingfishes were the most common finfish species landed in this gear with 28% of the finfish landings coming from single gear trips that landed at least 1 lb of kingfish (Table 7.2). Annual landings of kingfishes from crab pots averaged 275 lb. Other finfish commonly caught in crab pots include spot (17%), flounders (10%), and bluefish (11%).

##### 7.1.7.6.2 Unmarketable Bycatch

Four crab pot fishermen kept records of bycatch in their hard and peeler pots from March through October 1999 in the Neuse River (Doxey 2000). Hard crab pot data were collected from 283 trips during which 149,649 hard crab pots were fished. Peeler pot data were collected from 11 trips taken in May during which 1,950 peeler pots were fished. Seventeen finfish species were observed in the hard crab pots and nine different finfish in peeler pots. No kingfishes were observed in any of the pots examined.

Thorpe et al. (2004) reported hard crab pot bycatch data (May–December 2003) from Core Sound (28 trips) and Brunswick County (28 trips). The number of pots fished per trip ranged from 68 to 84, with average soak times of 2½ and 2¾ days, respectively. A total of 19 finfish species were observed. No kingfishes were captured.

##### 7.1.7.6.3 Implications

Crab pots (hard and peeler) did not appear to be a source of significant bycatch for kingfishes. Through the NCTTP and various studies assessing the bycatch in hard crab and peeler pot fisheries, very few kingfishes were observed. Specifically, commercial kingfish landings in crab pots were less than 300 lb per year representing only 5% of the total finfish catch in crab pots. Overall, kingfish bycatch does not appear to be a significant problem in the crab pot fisheries.

## 7.2 RECREATIONAL FISHERY

Kingfishes are highly sought after recreational fishes along the Atlantic coast. They are generally caught by anglers with bottom fishing rigs using natural baits such as sand fleas, bloodworms, or shrimp. North Carolina has four surveys that collect or collected data on the recreational finfish harvest: 1) the Marine Recreational Information Program (MRIP), 2) the Central and Southern Management Area (CSMA) creel survey, 3) the Recreational Commercial Gear License (RCGL) survey, and 4) the Coastal Recreational Fishing License (CRFL) recreational cast net and seine use survey.

The MRIP is the primary survey used to collect data on angler catches from the ocean and estuarine waters from the Virginia border south to the South Carolina border, excluding the Albemarle Sound. The CSMA creel survey, which began in 2004, is primarily used to collect data on angler catch and effort of anadromous striped bass in the Neuse, Pamlico, and Pungo rivers; however, the CSMA survey also collects harvest data on all finfish species reported by anglers. The RCGL survey was conducted from 2002 to 2008 to collect data from recreational fishermen who are allowed to harvest recreational limits of finfish while using commercial gear if they possess a RCGL. The CRFL recreational cast net and seine use survey began in November 2010 and is a monthly mail survey conducted to determine participation and effort of CRFL holders in recreational cast net and seine use.

No kingfish landings have been reported in the CSMA creel survey. The CRFL cast net and seine use survey just began in late 2010 so the data are still considered preliminary. Therefore, this section will focus on the data from recreational fishing of kingfishes derived from the MRIP survey and the RGCL survey.

### 7.2.1 Recreational Fishing Data Collection

The MRIP provides the primary data used to estimate the impact of marine recreational fishing on marine resources in North Carolina. The MRIP evolved from the Marine Recreational Fisheries Statistics Survey (MRFSS), which was initiated in 1981 by the NMFS to gather information from the recreational fishing community and to provide estimates of catch and effort at a regional level (NRC 2006). The NCDMF began conducting the dockside survey in 1987 and by 1989, had increased sample sizes significantly in order to provide better regional estimates and estimates useable at the state level. In 2011, the NMFS began using a new method to calculate estimates that are more accurate by weighting estimates based on high or low catch rates at high-activity versus low-activity sites (NMFS 2012). This new method was used to recalculate previous estimates dating back to 2004. Estimates prior to 2004 used in this section have been calibrated using a calibration factor calculated using the “ratio of means” procedure (Cochran 1977).

The MRIP consists of two components: the Access-Point Angler Intercept Survey (APAIS) and the Coastal Household Telephone Survey (CHTS). The CHTS uses a random digit dialing (RDD) telephone survey approach to collect marine recreational fishing effort information from residential households located in coastal counties. APAIS, an onsite intercept survey conducted at fishing access-sites, is used for collection of individual catch and discard data for calculation of catch rate at the species level. Recreational port agents collect intercept data from January through December (in two-month waves) by interviewing anglers completing fishing trips in one of four fishing modes (man-made structures, beaches and shorelines, private/rental vessels, and for-hire vessels). Man-made structures include piers, jetties, or bridges and for-hire vessels include charter vessels and head boats. Data derived from the telephone survey are used to estimate the number of recreational fishing trips (effort) for each stratum. The intercept data are used to estimate catch per trip for each species encountered. The estimated number of angler trips is multiplied by the estimated average catch-per-trip to calculate an estimate of total catch of each species for each survey stratum.

Another source of recreational landings of kingfishes came from the RCGL survey that the NCDMF conducted between 2002 and 2008 with the purpose of obtaining catch and effort estimates for the RCGL user group. The RCGL allows people to use a limited amount of commercial gear for personal use. The survey questionnaires were distributed monthly to 30% of the RCGL population from each county and requested data such as waterbodies commonly fished, types and amounts of gear used, number and weight of individual species kept, and number of individual species discarded at sea. Demographic information obtained at the time the licenses were sold was used to examine if the returned surveys were representative of the RCGL population and to ensure the samples taken could be used to generalize about the total RCGL population. Additionally, the survey responses for total catch and number of trips were examined for possible outliers using standard statistical methods. Monthly effort and catch reported by the survey respondents were extrapolated to the total RCGL population.

### 7.2.2 Marine Recreational Information Program

Recreational harvest of all kingfishes fluctuated with a slight upward trend (Figure 7.28). During the period from 1989 to 2013, the kingfish recreational harvest has equaled, on average, 43.5% of the commercial catch with an average of 297,037 lb landed by anglers. During the same time period, recreational landings of kingfish fluctuated from a minimum of 98,240 lb (17.5% of commercial catch) in 1989 to a maximum of 527,877 lb (93.1%) in 2004.

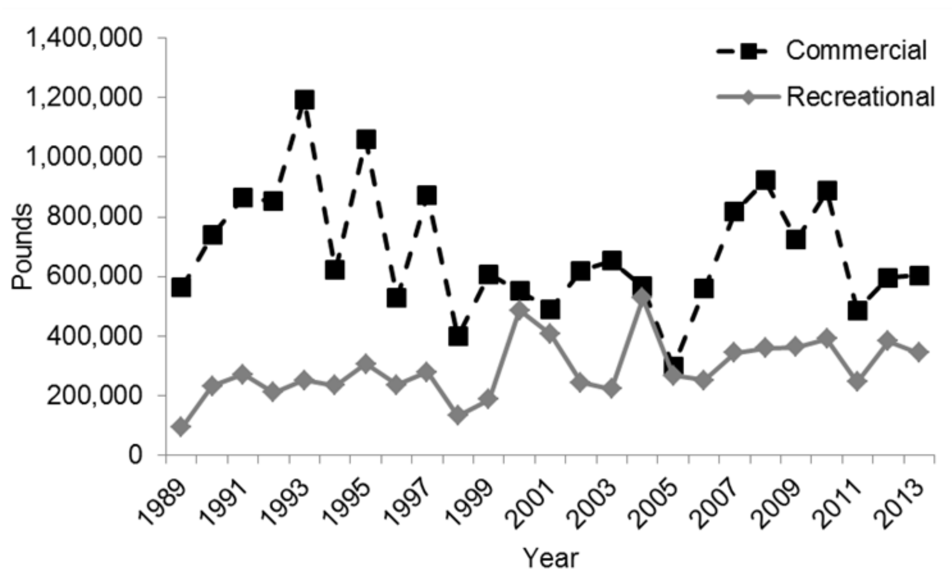


Figure 7.28 Recreational and commercial Landings for North Carolina for all kingfishes in North Carolina, 1989–2013 (Source: MRIP).

The NCDMF awards citations for hook-and-line caught kingfish that weigh 1.5 lb or greater. While fluctuating, the number of citations issued since 1991 has shown a generally increasing trend (Figure 7.29).

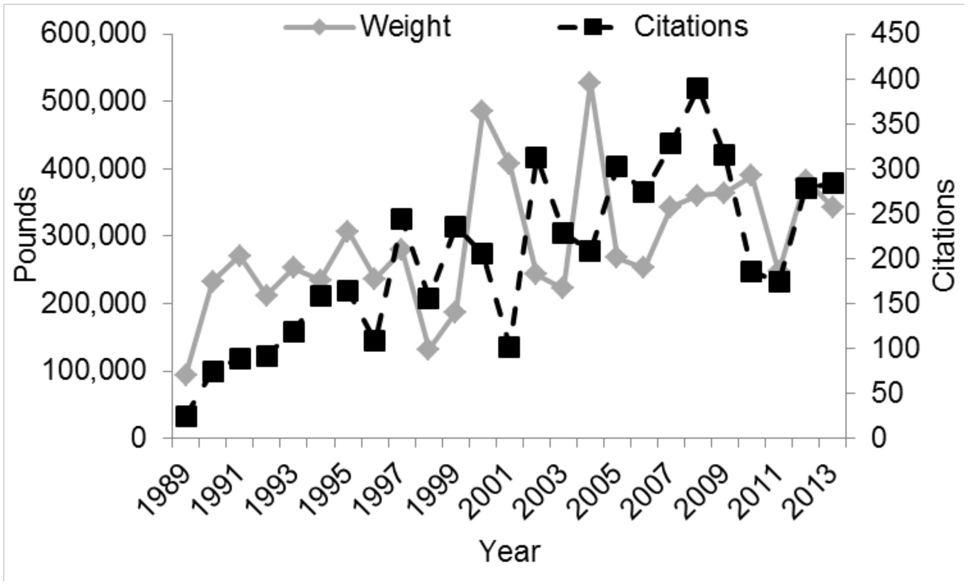


Figure 7.29 North Carolina recreational kingfish landings, 1989–2013 (Source: MRIP) and citations, 1991–2013 (Source: NC Saltwater Fishing Tournament).

Unlike the NCTTP, the MRIP survey collects kingfish data at the species level. However, there is potential for misidentification since kingfish species are morphologically and meristically similar, and fish may become discolored or fins can become broken and tattered in the field. By number, southern kingfish accounted for 63.1% of the fish harvested while Gulf kingfish constituted 19.5%, and northern kingfish the remaining 17.4% (Figure 7.30). Species composition is variable among years in ocean and estuarine waters (Figures 7.31 and 7.32). Southern kingfish were the most common species in both ocean and estuarine waters. Northern kingfish were the next most common in estuarine waters, while Gulf kingfish were the next most common in ocean waters. The length of all kingfishes measured in the MRIP survey from 1989 to 2013 combined ranged from 3.9 inches (100 mm) to 18.9 inches TL (480 mm) with a modal peak at 11.0 inches TL (280 mm; Figure 7.33).

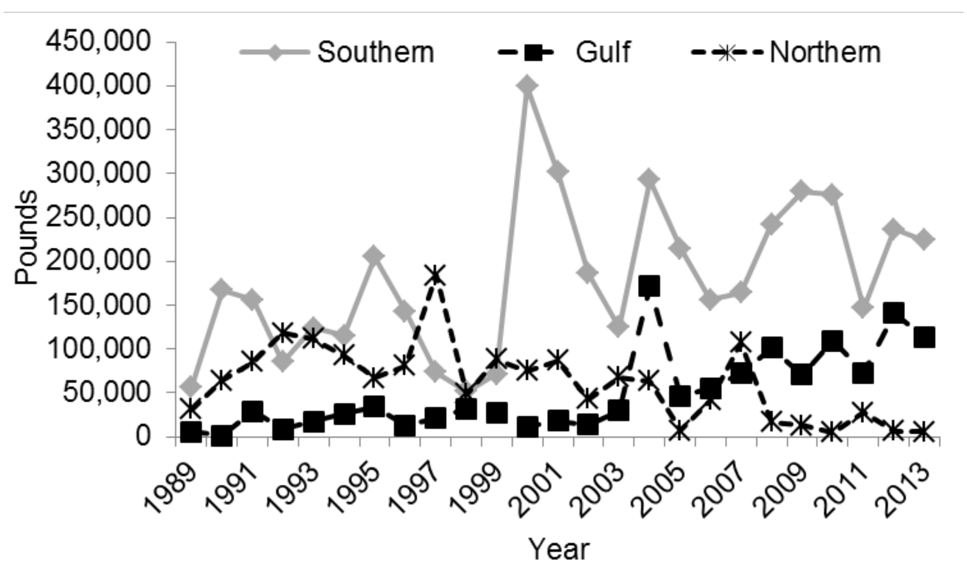


Figure 7.30 North Carolina recreational harvest (pounds) of the three kingfish species, 1989–2013 (Source: MRIP).

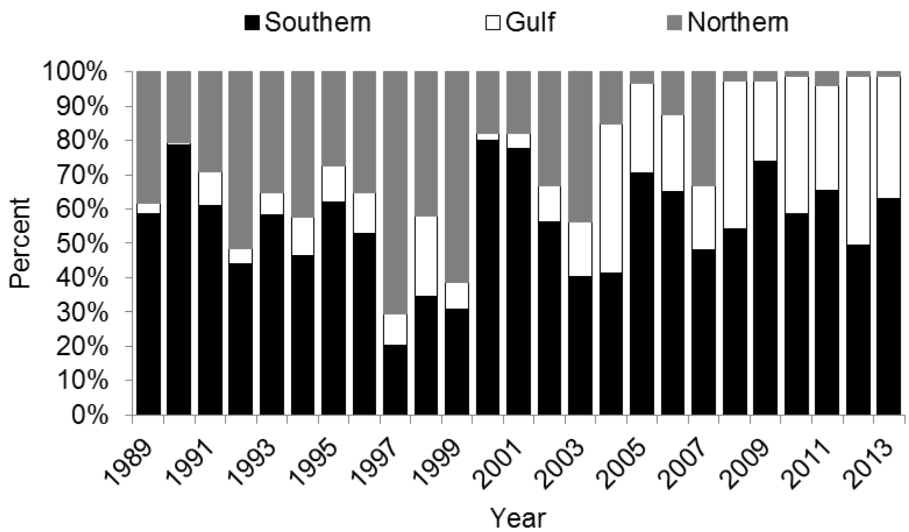


Figure 7.31 Species composition of coastal ocean captured kingfishes, 1989–2013 (Source: MRIP).

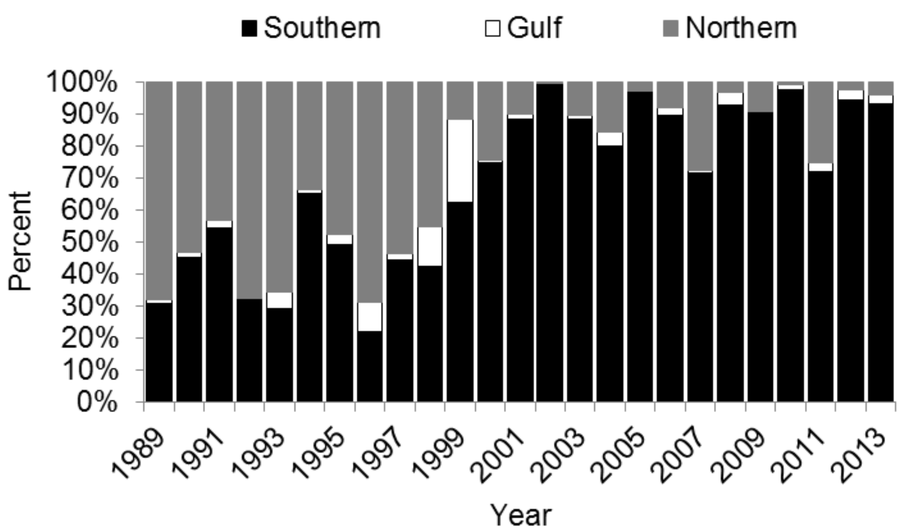


Figure 7.32 Species composition of kingfishes captured in estuarine waters of North Carolina, 1989–2013 (Source: MRIP).

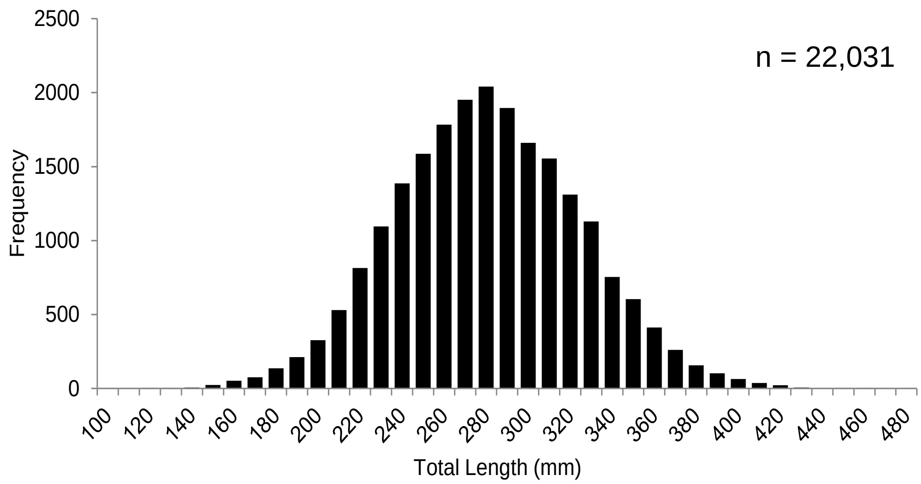


Figure 7.33 North Carolina total length frequency of all kingfishes sampled from the recreational fishery, 1989–2013 (Source: MRIP).

Estimates of angler CPUE in North Carolina were calculated by analyzing areas and modes that consistently contributed to the kingfishes harvested from 1989 to 2013. Estimates of catch and fishing trips were calculated by areas including: the ocean less than three miles from shore (state waters), ocean beyond 3 miles from shore (federal waters), and inland waters (sounds and rivers). Data indicate that most kingfishes are caught by anglers fishing in the ocean, within 3 miles from shore, from either beaches or man-made structures. Therefore, the CPUE presented values are based on the number of kingfishes harvested per angler per fishing trips in near shore ocean waters from beaches or man-made structures. From 1989 to 2013, the MRIP CPUE data have fluctuated showing a decreasing trend from 1990 to 1999 (Figure 7.34). However, the data show an increasing trend since 2005.

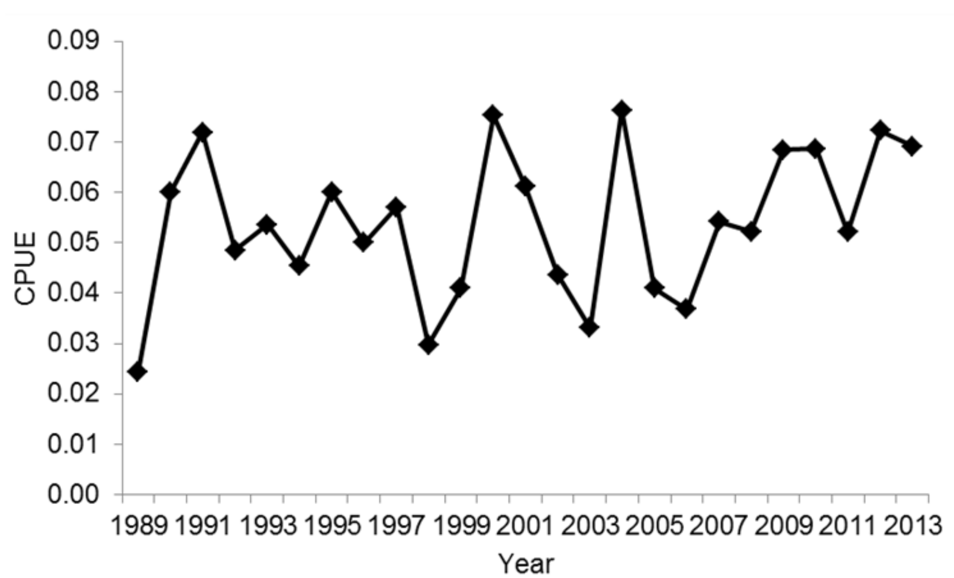


Figure 7.34 North Carolina Kingfish catch-per-unit-effort (CPUE), 1989–2013 (Source: MRIP).

### 7.2.2.1 Southern Kingfish

From 1989 to 2013 recreational harvest of southern kingfish has fluctuated averaging 179,777 lb, and ranged from 51,994 lb in 1998 to 399,354 lb in 2000 (Table 7.5). During the same time series, average lengths of southern kingfish ranged from 9.7 inches TL (264 mm) in 1990 to 11.8 inches TL (300 mm) in 2004, and mean weights ranged from 0.4 lb in 1994 to 0.7 lb in 1997, 2000, 2003, and 2004.

Table 7.5 North Carolina southern kingfish recreational harvest, 1989–2013 (Source: MRIP).

| Year | Harvest Number | PSE | Weight (lb) | PSE | Average Length (inches) | Average Weight (lb) | Live Releases |
|---|---|---|---|---|---|---|---|
| 1989 | 99,233 | 20 | 57,247 | 23 | 10.2 | 0.6 | 33,279 |
| 1990 | 371,955 | 27 | 166,990 | 26 | 9.7 | 0.5 | 189,723 |
| 1991 | 345,332 | 24 | 156,084 | 22 | 9.9 | 0.5 | 61,139 |
| 1992 | 162,455 | 23 | 85,204 | 25 | 10.3 | 0.5 | 16,508 |
| 1993 | 281,986 | 27 | 123,834 | 21 | 9.9 | 0.4 | 10,453 |
| 1994 | 239,724 | 17 | 115,505 | 18 | 10.4 | 0.5 | 2,178 |
| 1995 | 348,695 | 22 | 205,270 | 22 | 11.1 | 0.6 | 20,060 |
| 1996 | 233,066 | 38 | 142,957 | 42 | 11.4 | 0.6 | 18,203 |
| 1997 | 111,730 | 22 | 73,969 | 21 | 11.2 | 0.7 | 4,077 |
| 1998 | 82,718 | 20 | 51,994 | 19 | 11.5 | 0.6 | 342 |
| 1999 | 129,677 | 34 | 71,231 | 33 | 11.4 | 0.6 | 0 |
| 2000 | 582,842 | 26 | 399,354 | 28 | 11.6 | 0.7 | 861 |
| 2001 | 566,428 | 31 | 301,779 | 29 | 11.0 | 0.5 | 4,488 |
| 2002 | 298,389 | 38 | 186,414 | 37 | 11.5 | 0.6 | 0 |
| 2003 | 180,748 | 21 | 124,827 | 22 | 11.5 | 0.7 | 0 |
| 2004 | 414,986 | 21 | 292,739 | 21 | 11.8 | 0.7 | 0 |
| 2005 | 375,736 | 24 | 214,297 | 23 | 11.2 | 0.6 | 617 |
| 2006 | 287,519 | 19 | 155,893 | 18 | 11.1 | 0.5 | 21,615 |
| 2007 | 293,083 | 21 | 163,947 | 19 | 11.0 | 0.6 | 14,546 |
| 2008 | 432,782 | 20 | 242,437 | 20 | 10.9 | 0.6 | 4,095 |
| 2009 | 514,867 | 28 | 279,512 | 30 | 10.9 | 0.5 | 719 |
| 2010 | 462,931 | 15 | 275,848 | 16 | 11.1 | 0.6 | 0 |
| 2011 | 281,253 | 18 | 146,662 | 19 | 10.9 | 0.5 | 1,088 |
| 2012 | 397,750 | 16 | 236,425 | 18 | 11.1 | 0.6 | 2,070 |
| 2013 | 455,837 | 20 | 223,995 | 20 | 10.5 | 0.5 | 252 |

The majority (76%) of southern kingfish captured from 1989 to 2013 in North Carolina waters were by anglers fishing in ocean waters (Figure 7.35). Of the ocean caught kingfish, over half were caught from man-made structures (52%) with the other half being caught from beaches (29%) or private/rental vessels (19%). Of the 24% of southern kingfish captured from estuarine waters in North Carolina during the same time period, the vast majority were captured from anglers fishing from private/rental vessels (94%).

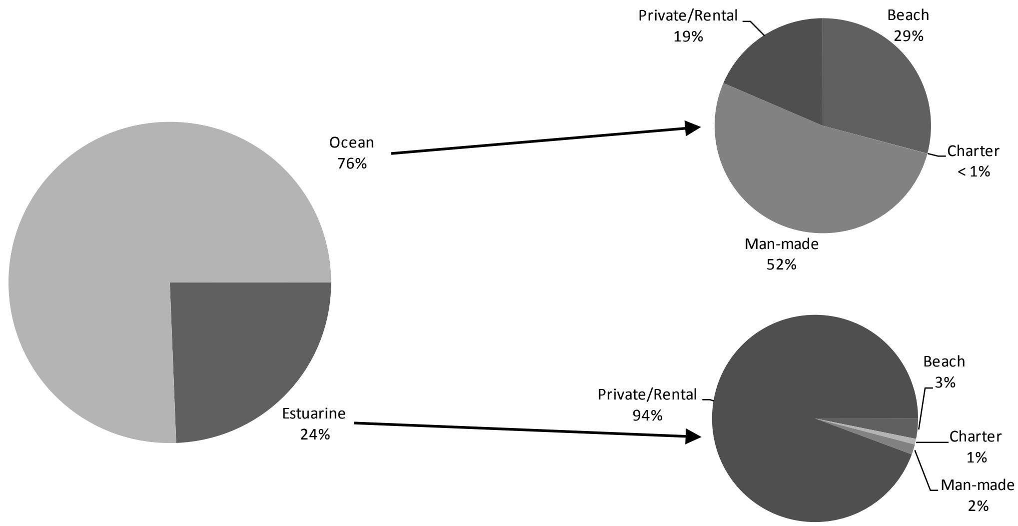


Figure 7.35 Southern kingfish landings (lb) by area and mode, 1989–2013 (Source: MRIP).

From 1989 to 2013, coast-wide average harvest of southern kingfish were variable (Table 7.6). With the exception of South Carolina and Georgia, catches tended to show a decreasing trend with increasing latitude. East Florida had the highest harvest rate accounting for 30%, followed by South Carolina (25%), Georgia (22%), North Carolina (17%), and Virginia (6%).

Table 7.6 Southern kingfish recreational harvest by state, 1989–2013 (Source: MRIP).

| State | Average Harvest Number | Average PSE | Average Weight (lb) | Average PSE | Percent | Average Length (inches) |
|---|---|---|---|---|---|---|
| East Florida | 563,821 | 26 | 326,894 | 25 | 30 | 11.3 |
| South Carolina | 483,396 | 26 | 245,333 | 26 | 25 | 10.5 |
| Georgia | 425,797 | 20 | 240,171 | 21 | 22 | 11.0 |
| North Carolina | 318,069 | 24 | 179,777 | 24 | 17 | 10.9 |
| Virginia | 111,259 | 33 | 68,271 | 45 | 6 | 10.4 |

Southern kingfish caught in estuarine and ocean waters from 1989 to 2013 were measured by recreational port agents, and unweighted length frequency distributions were developed based on these measurements. Southern kingfish sampled from the recreational ocean fishery ranged in length from 3.9 inches (100 mm) to 18.9 inches TL (480 mm) with a modal peak at 11.0 inches TL (280 mm; Figure 7.36). A total of 9,458 ocean landed southern kingfish were measured during the time series.

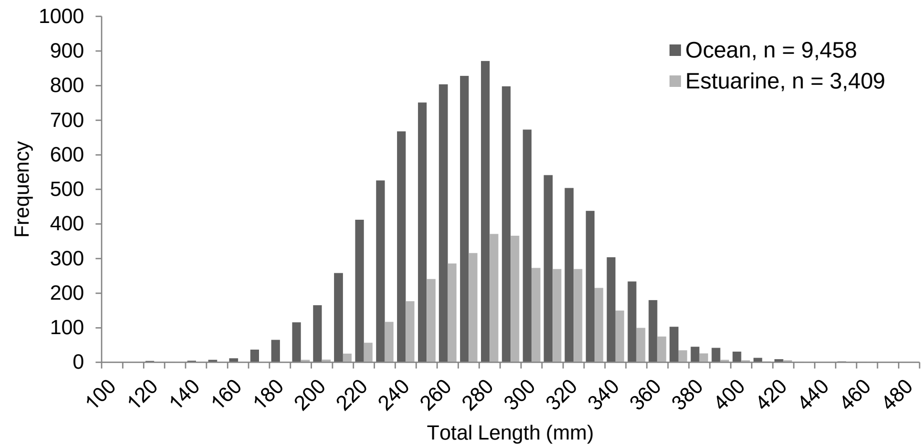


Figure 7.36 Unweighted length frequencies of North Carolina ocean and estuarine caught southern kingfish, 1989–2013 (Source: MRIP).

Southern kingfish that were captured in the estuarine waters of North Carolina over the same time period showed a similar length frequency distribution with lengths ranging from 6.3 inches (160 mm) to 18.9 inches TL (480 mm) with a modal peak of 11.0 inches TL (280 mm; Figure 7.36). A total of 3,409 fish were measured during the time series.

Catch-by-wave data were examined from 1989 to 2013 (Figure 7.37). Southern kingfish catches indicated a consistent pattern with peak harvests in the fall (Wave 6, Nov–Dec) followed by the spring (Wave 3, May–Jun). The lowest harvest occurred during the summer (Wave 4, Jul–Aug).

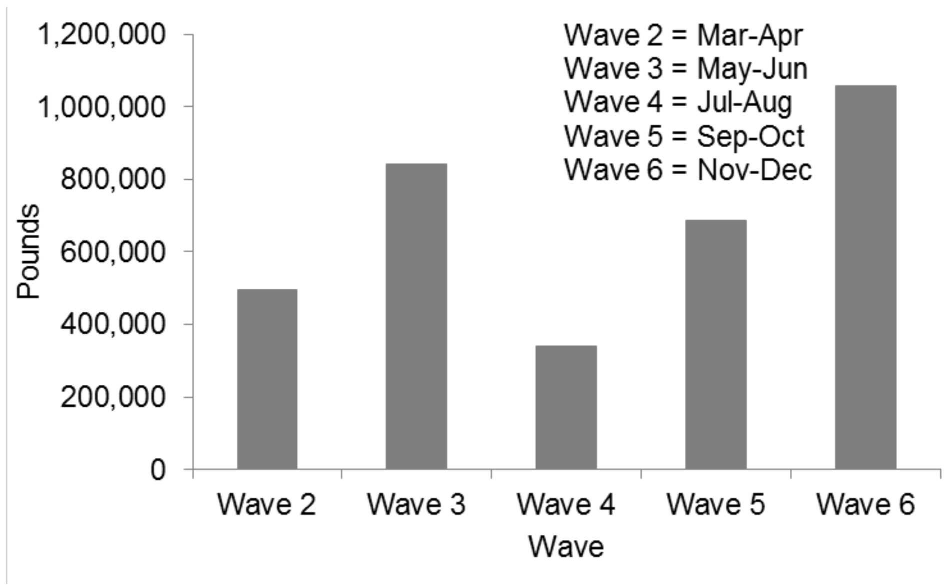


Figure 7.37 North Carolina harvest of southern kingfish (lb) by wave, 1989–2013 (Source: MRIP).

### 7.2.2.2 Gulf Kingfish

From 1989 to 2013, there has been an increasing trend in recreational landings for Gulf kingfish. During this time series, recreational harvest of Gulf kingfish averaged 49,737 lb ranging from 1,471 lb in 1990 to 171,660 lb in 2004 (Table 7.7; Figure 7.30). From 2004 to 2013, harvest has consistently stayed above the time series average.

Table 7.7 North Carolina Gulf kingfish recreational harvest, 1989–2013 (Source: MRIP).

| Year | Harvest Number | PSE | Weight (lb) | PSE | Average Length (inches) | Average Weight (lb) | Live Releases |
|---|---|---|---|---|---|---|---|
| 1989 | 7,877 | 57 | 5,842 | 65 | 11.2 | 0.7 | 0 |
| 1990 | 3,309 | 89 | 1,471 | 84 | 9.9 | 0.4 | 7,864 |
| 1991 | 58,883 | 26 | 29,083 | 30 | 9.6 | 0.5 | 32,975 |
| 1992 | 17,505 | 38 | 8,523 | 45 | 10.4 | 0.5 | 5,893 |
| 1993 | 33,720 | 35 | 17,511 | 40 | 10.5 | 0.5 | 10,406 |
| 1994 | 59,572 | 38 | 26,167 | 45 | 9.9 | 0.4 | 0 |
| 1995 | 62,571 | 82 | 34,455 | 98 | 10.4 | 0.5 | 17,240 |
| 1996 | 50,833 | 33 | 13,210 | 73 | 10.3 | 0.3 | 37,048 |
| 1997 | 43,182 | 40 | 21,318 | 49 | 9.3 | 0.5 | 13,386 |
| 1998 | 48,967 | 64 | 31,743 | 81 | 10.6 | 0.6 | 26,554 |
| 1999 | 38,320 | 51 | 27,063 | 79 | 9.8 | 0.7 | 15,610 |
| 2000 | 17,695 | 54 | 11,511 | 63 | 10.6 | 0.6 | 0 |
| 2001 | 35,119 | 37 | 18,179 | 41 | 10.6 | 0.5 | 0 |
| 2002 | 34,325 | 42 | 14,172 | 49 | 9.9 | 0.4 | 0 |
| 2003 | 54,194 | 34 | 29,643 | 40 | 10.4 | 0.5 | 0 |
| 2004 | 265,671 | 29 | 171,660 | 34 | 11.2 | 0.6 | 4,141 |
| 2005 | 83,461 | 37 | 46,048 | 39 | 10.4 | 0.6 | 256 |
| 2006 | 81,631 | 60 | 55,301 | 66 | 11.5 | 0.7 | 0 |
| 2007 | 90,511 | 32 | 71,902 | 33 | 11.8 | 0.8 | 0 |
| 2008 | 198,064 | 17 | 101,343 | 18 | 10.3 | 0.5 | 0 |
| 2009 | 131,665 | 28 | 70,800 | 29 | 10.0 | 0.5 | 0 |
| 2010 | 192,399 | 17 | 109,235 | 19 | 10.8 | 0.6 | 0 |
| 2011 | 102,475 | 24 | 72,694 | 27 | 11.7 | 0.7 | 0 |
| 2012 | 263,307 | 14 | 140,580 | 16 | 10.5 | 0.5 | 157 |
| 2013 | 214,853 | 22 | 113,964 | 22 | 10.4 | 0.5 | 0 |

From 1989 to 2013, average lengths of Gulf kingfish ranged from 9.3 inches (236 mm) in 1997 to 11.8 inches TL (300 mm) in 2007 and average weights ranged from 0.3 lb in 1996 to 0.8 lb in 2007 (Table 7.7).

Data from the MRIP survey indicates the vast majority (96%) of Gulf kingfish are captured in the ocean (Figure 7.38). Furthermore, the majority of ocean captured Gulf kingfish were captured by anglers fishing from beaches (48%) or man-made structures (47%). Of the small portion of Gulf kingfish captured from estuarine waters, most of those fish were caught by anglers fishing from private/rental vessels (94%).

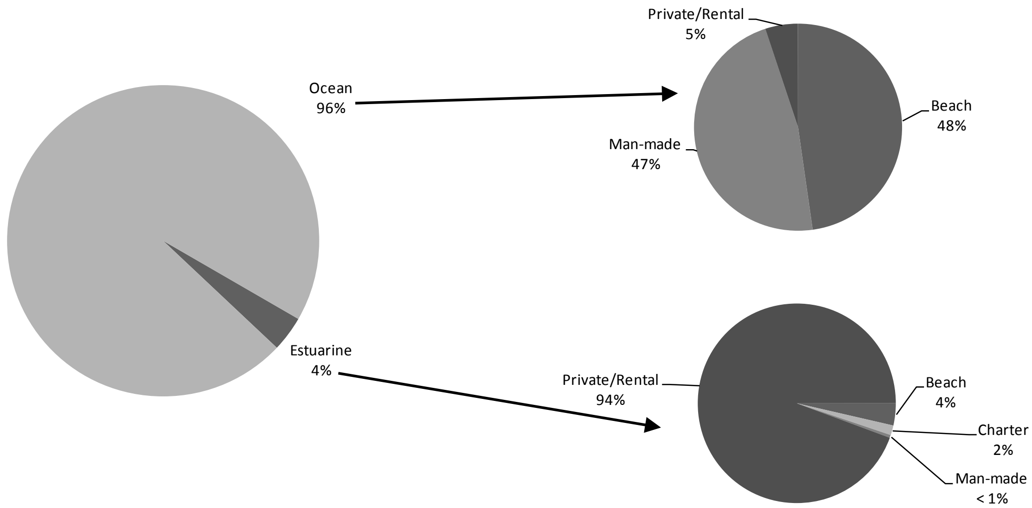


Figure 7.38 North Carolina Gulf kingfish landings (lb) by area and by mode, 1989–2013 (Source: MRIP).

According to the MRIP survey, North Carolina and Florida are the two states that harvest the greatest number of Gulf kingfish (Table 7.8). Other Atlantic coast states may harvest Gulf kingfish, but the data are only a small portion of the coast-wide harvest (<2%).

Table 7.8 Gulf kingfish recreational harvest by state, 1989–2013 (Source: MRIP).

| State | Average Harvest Number | Average PSE | Average Weight (lb) | Average PSE | Percent | Average Length (inches) |
|---|---|---|---|---|---|---|
| East Florida | 388,332 | 36 | 269,449 | 35 | 82.0 | 12.0 |
| North Carolina | 85,400 | 29 | 48,444 | 32 | 18.0 | 10.5 |

The lengths of Gulf kingfish landed by anglers from the ocean ranged from 4.3 inches (110 mm) to 18.9 inches TL (480 mm) with a single modal peak at 10.6 inches TL (270 mm; Figure 7.39). Since Gulf kingfish are found almost exclusively in the surf zone, shore based anglers catch very few fish in estuarine waters. From 1989 to 2013, recreational port agents in the intercept survey measured only 128 Gulf kingfish from estuarine waters therefore the length frequency distribution is not shown.

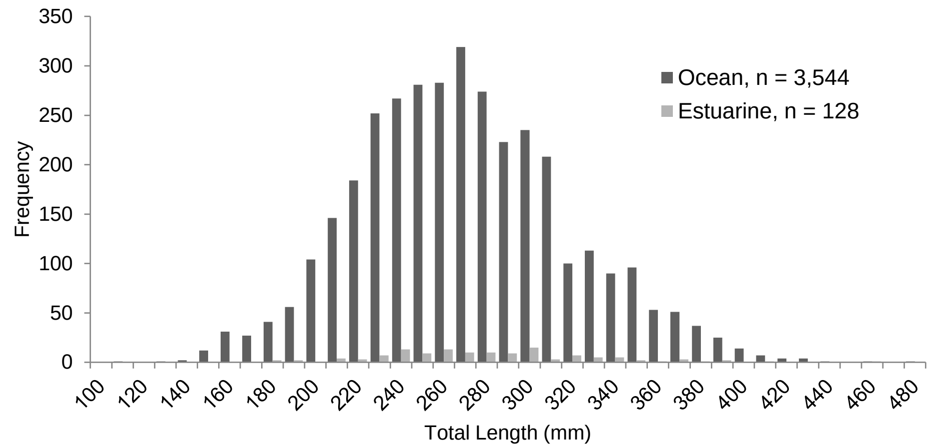


Figure 7.39 Unweighted length frequencies of North Carolina ocean and estuarine caught Gulf kingfish, 1989–2013 (Source: MRIP).

The catch-by-wave indicates that Gulf kingfish are harvested during all sampling regimes with the greatest harvest occurring during wave 5 (Sep–Oct) while wave 2 (Mar–Apr) had the lowest harvest rate (Figure 7.40).

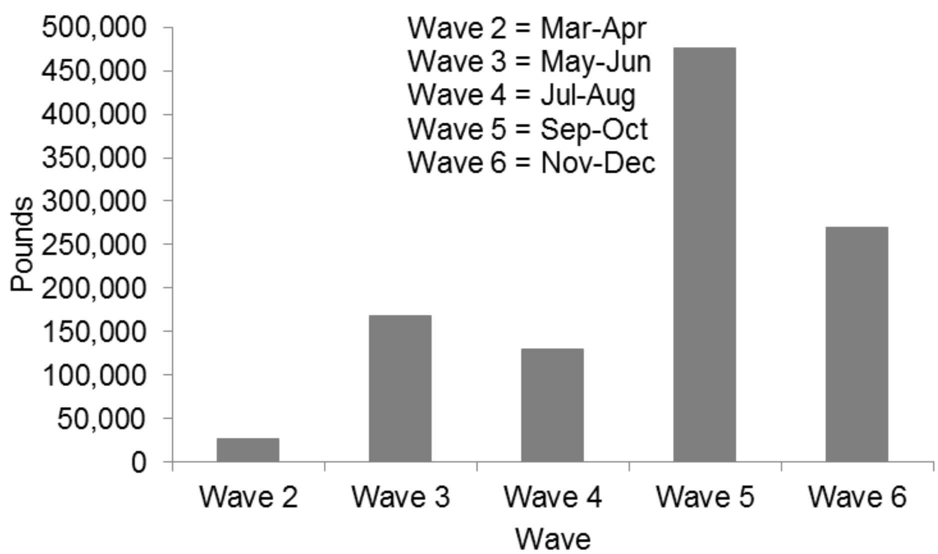


Figure 7.40 North Carolina Gulf kingfish catch by wave, 1989–2013 (Source: MRIP).

#### 7.2.2.3 Northern Kingfish

From 1989 to 2013, recreational harvest of northern kingfish has fluctuated exhibiting a decreasing trend in later years with an average of 61,577 lb, ranging from 4,823 lb in 2010 to 183,983 lb in 1997 (Table 7.6). With the exception of 2007 (107,282 lb), northern kingfish recreational harvest from 2006 to 2013 has been well below the time series average (Table 7.9). From 1989 to 2013, the average lengths of retained fish ranged from 9.4 inches TL (239 mm) in 1989 to 12.6 inches TL (320 mm) in 2011, and average weights ranged from 0.4 lb in 1990 to 0.8 lb in 2011 (Table 7.9).

Table 7.9 North Carolina northern kingfish recreational harvest and releases, 1989–2013 (MRIP).

| Year | Harvest Number | PSE | Weight (lb) | PSE | Average Length (inches) | Average Weight (lb) | Live Releases |
|---|---|---|---|---|---|---|---|
| 1989 | 65,626 | 24 | 30,980 | 30 | 9.4 | 0.5 | 10,207 |
| 1990 | 136,676 | 27 | 63,992 | 29 | 10.5 | 0.4 | 9,636 |
| 1991 | 147,046 | 22 | 85,556 | 24 | 10.6 | 0.6 | 8,240 |
| 1992 | 162,483 | 24 | 118,372 | 26 | 11.7 | 0.7 | 18,565 |
| 1993 | 153,312 | 22 | 111,687 | 24 | 11.3 | 0.7 | 10,541 |
| 1994 | 157,749 | 21 | 92,865 | 23 | 11.3 | 0.6 | 622 |
| 1995 | 120,722 | 23 | 67,110 | 25 | 10.8 | 0.5 | 13,041 |
| 1996 | 140,136 | 24 | 80,907 | 27 | 11.3 | 0.6 | 1,620 |
| 1997 | 265,270 | 32 | 183,983 | 36 | 11.7 | 0.7 | 2,052 |
| 1998 | 76,551 | 30 | 48,659 | 34 | 11.3 | 0.6 | 0 |
| 1999 | 147,229 | 32 | 88,494 | 37 | 10.8 | 0.6 | 1,115 |
| 2000 | 104,901 | 23 | 75,144 | 26 | 12.0 | 0.7 | 0 |
| 2001 | 130,393 | 27 | 86,967 | 31 | 11.6 | 0.6 | 0 |
| 2002 | 70,846 | 32 | 42,903 | 35 | 11.6 | 0.6 | 0 |
| 2003 | 101,856 | 25 | 68,145 | 28 | 11.7 | 0.6 | 195 |
| 2004 | 119,057 | 23 | 63,478 | 23 | 10.8 | 0.5 | 3,806 |
| 2005 | 13,282 | 31 | 7,344 | 31 | 11.0 | 0.6 | 1,117 |
| 2006 | 57,083 | 30 | 41,374 | 31 | 11.8 | 0.7 | 1,733 |
| 2007 | 172,447 | 25 | 107,282 | 25 | 11.4 | 0.6 | 23,770 |
| 2008 | 31,239 | 48 | 16,625 | 46 | 10.1 | 0.5 | 0 |
| 2009 | 25,069 | 50 | 13,280 | 48 | 11.0 | 0.5 | 0 |
| 2010 | 8,053 | 31 | 4,823 | 35 | 11.2 | 0.6 | 0 |
| 2011 | 35,412 | 35 | 27,531 | 41 | 12.6 | 0.8 | 2,168 |
| 2012 | 10,683 | 36 | 6,421 | 38 | 11.7 | 0.6 | 0 |
| 2013 | 10,565 | 31 | 5,495 | 34 | 11.2 | 0.5 | 0 |

Northern kingfish were captured mainly in ocean waters (87.0%; Figure 7.41). Ocean captured northern kingfish were caught by anglers fishing from man-made structures (39.0%), beaches (34.0%), and private/rental vessels (27.0%). Of the estuarine captured northern kingfish, the vast majority were caught by anglers fishing from private/rental vessels (94.0%).

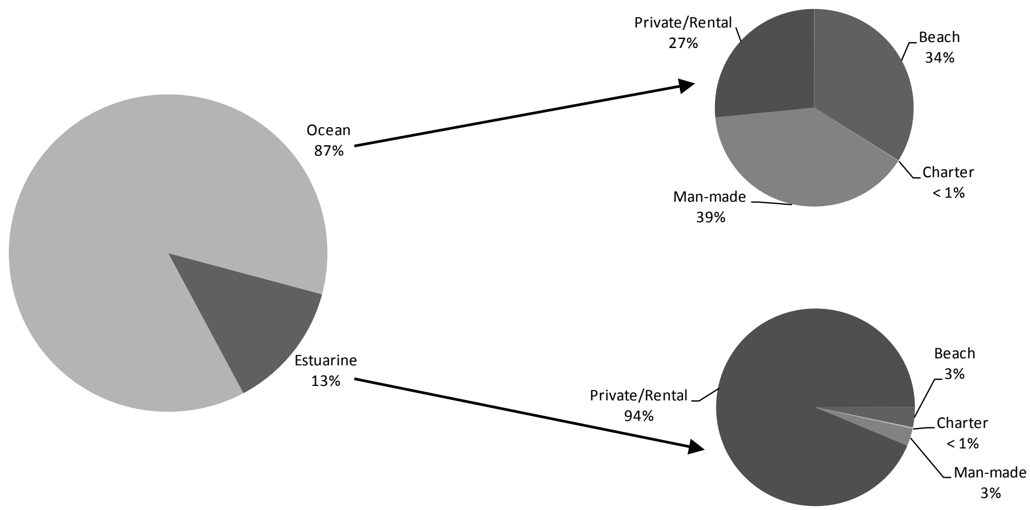


Figure 7.41 North Carolina northern kingfish landings (lb) by area and mode, 1989–2013 (Source: MRIP).

Along the Atlantic coast, northern kingfish harvest was concentrated in three states: New Jersey, Virginia, and North Carolina. North Carolina had the most harvest by weight of northern kingfish accounting for 39.5% of the harvest, followed by Virginia (30.9%), and New Jersey (29.7%; Table 7.10).

Table 7.10 North Carolina recreational northern kingfish harvest, 1989–2013 (Source: MRIP).

| State | Average Harvest Number | Average PSE | Average Weight (lb) | Average PSE | Percent | Average Length (inches) |
|---|---|---|---|---|---|---|
| North Carolina | 98,547 | 29 | 61,577 | 31 | 39.5 | 11.2 |
| Virginia | 77,032 | 46 | 42,480 | 45 | 30.9 | 10.6 |
| New Jersey | 74,028 | 45 | 48,984 | 44 | 29.7 | 11.8 |

From 1989 to 2013, 5,492 northern kingfish were measured and recorded by port agents and used to generate length frequencies distributions for the ocean and estuarine fisheries (Figure 7.42). The unweighted length distribution for ocean captured northern kingfish contained lengths that ranged from 3.9 inches (100 mm) to 17.7 inches TL (450 mm) with bi-modal peaks at the 11.0 inches (280 mm) and 12.2 inches TL (310 mm). The unweighted length distribution for estuarine captured northern kingfish contained lengths that ranged from 6.3 inches (160 mm) to 17.3 inches TL (440 mm) with tri-modal peaks at the 11.8 inches (300 mm), 13.0 inches (330 mm), and 14.2 inches (360 mm) TL. The distribution of the estuarine caught northern kingfish is centered more towards larger fish. This may be a function of the size of fish in the estuary or it may be due to the smaller sample size.

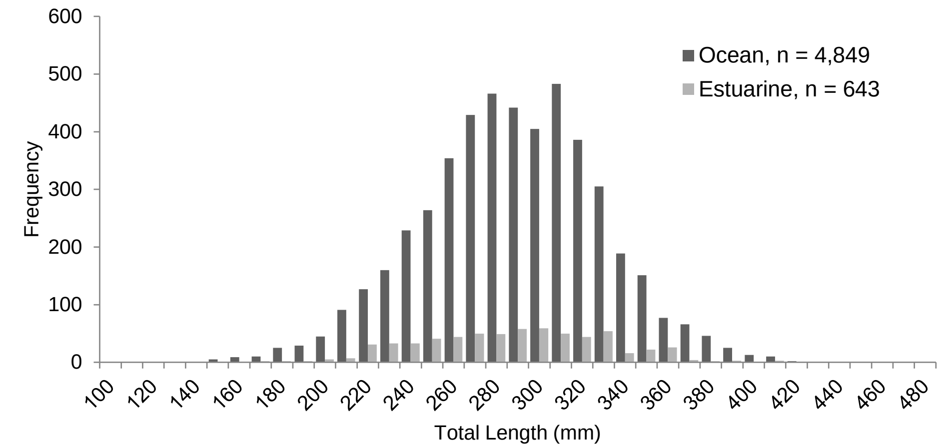


Figure 7.42 Unweighted length frequencies of North Carolina ocean and estuarine caught northern kingfish, 1989–2013 (Source: MRIP).

Catch-by-wave data for northern kingfish indicate most fish are caught in Wave 3 (May–Jun) followed by Wave 2 (Mar–Apr). The fewest number of fish were harvested during the summer (Wave 4, Jul–Aug; Figure 7.43).

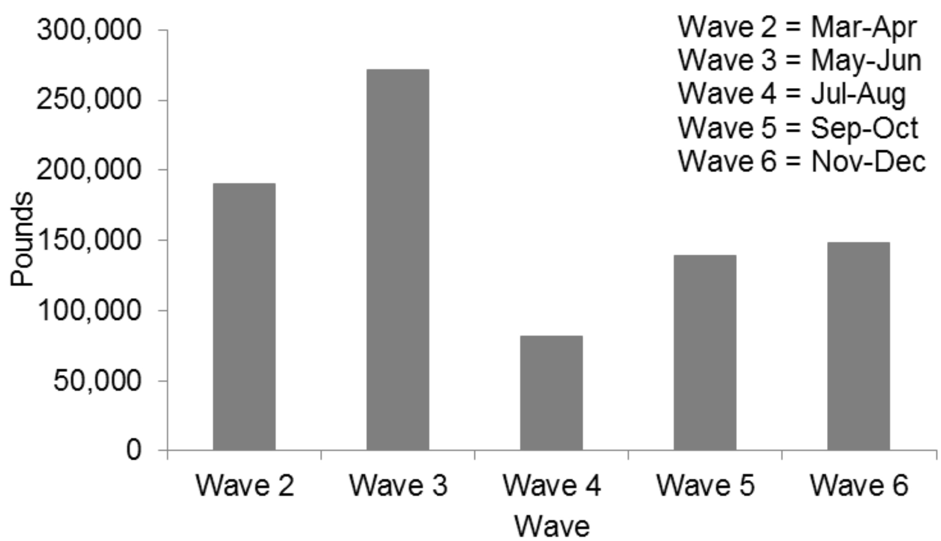


Figure 7.43 North Carolina northern kingfish harvest by wave, 1989–2013 (Source: MRIP).

### 7.2.3 Recreational Commercial Gear License

The RCGL survey data do not distinguish kingfish landings by species. Landings and trips using the RCGL were reported for years 2004 through 2006. All reported kingfish RCGL landings using this license came from gill nets; 82% of which were from small mesh gill nets (>5 inch stretched mesh; Table 7.11). In total, 953 lb of kingfish were by RCGL holders between 2004 and 2006.

Table 7.11 Number of trips, number of harvested and discarded kingfishes, and pounds of kingfish harvested by Recreational Commercial Gear License (RCGL) holders (Source: NCDMF, unpublished).

| Year | Gear | Number of Trips | Number of Kingfish Harvested | Pounds of Kingfish Harvested | Number of Kingfish Discards |
|---|---|---|---|---|---|
| 2004 | Small Mesh Gill Nets | 55 | 185 | 318 | 19 |
| 2005 | Large Mesh Gill Nets | 57 | 142 | 118 | 0 |
| 2005 | Small Mesh Gill Nets | 109 | 205 | 175 | 0 |
| 2006 | Large Mesh Gill Nets | 15 | 22 | 44 | 29 |
| 2006 | Small Mesh Gill Nets | 208 | 351 | 298 | 72 |

# 8.0 PROTECTED SPECIES

## 8.1 BACKGROUND

Protected species is a broad term that encompasses a host of species 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). Protected species in FMPs are generally discussed in relation to fisheries being prosecuted for the FMP species and specifically whether these fisheries have an incidental take of protected species. The protected species discussion 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 incidental takes in the kingfish fisheries.

## 8.2 PROTECTED SPECIES LEGISLATION

### 8.2.1 Federal Endangered Species Act

The ESA was enacted in 1973, "to provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved, (and) to provide a program for the conservation of such endangered species and threatened species" (ESA 2012). The ESA is a comprehensive act with eighteen sections that cover many aspects of endangered species protection and management.

The ESA defines a species as threatened when it is likely to become an endangered species within the near future. An endangered species is defined as any species that is in danger of extinction throughout all or a significant part of its range. A take, as defined by the ESA, is to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct (ESA 2012). Candidate species are those 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. Intentional take permits are intended for scientific purposes or to enhance the propagation or survival of the affected species (ESA Section 10(a)(1)(A)). Incidental take permits (ITP) are for activities that are otherwise lawful but are expected to incidentally take a listed species (ESA Section 10(a)(1)(B)). The latter must be accompanied by a Conservation Plan (CP), often referred to as a Habitat Conservation Plan (HCP) that outlines ways to reduce and minimize the impacts of potential takes. 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 takes that are authorized, the permit includes reporting requirements, and often includes other conditions that must be met (tagging, handling guidelines, data analyses, conservation plans, etc.).

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; and 2) and each federal agency must consult with the Secretary [in practice NMFS or U.S. Fish and Wildlife Service (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 affect 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. Fisheries such as the shrimp fishery that have federal compliance measures operate under a Section 7 agreement (NMFS 2014).

### 8.2.2 Marine Mammal Protection Act

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 incidental takes to commercial fishing and other non-fishing 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 are fisheries with frequent incidental mortality or serious injury; Category II are fisheries where occasional incidental mortality or serious injury; and Category III are fisheries with a remote likelihood of/no known incidental mortality or serious injury. 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 requirements. According to the 2014 List of Fisheries (LOF) created by NOAA, several North Carolina fisheries are listed as Category II (occasional mortality or serious injury). These fisheries include: North Carolina inshore gill net fishery, North Carolina long haul seine fishery, Mid-Atlantic haul/beach seine fishery, Mid-Atlantic mid-water trawl, Mid-Atlantic bottom trawl, Southeastern U.S., Atlantic, Gulf of Mexico shrimp trawl, North Carolina roe mullet stop net fishery, and the Atlantic blue crab trap/pot fishery (Federal Register 2014).

### 8.2.3 Migratory Bird Treaty Act

The original 1918 statute for the protection of migratory birds was implemented by the 1916 Convention between the U.S. and Great Britain (for Canada). 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 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.

### 8.2.4 North Carolina Endangered Species Act

Listing of protected species from a state perspective lies with the NCWRC (NC 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 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 North Carolina 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. The North Carolina 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 that are so rare or the natural communities that are so significant that they merit special consideration as land-use decisions are made.

Species that appear on the 2014 Natural Heritage Program List of the Rare Animal Species of North Carolina that may interact with gill nets, fish trawls, shrimp trawls, skimmer trawls, and channel nets are listed as endangered (E), threatened (T),special concern (SC) or significantly rare (SR). These species include the loggerhead sea turtle (T), leatherback sea turtle (E), hawksbill sea turtle (E), Kemp's Ridley sea turtle (E), Green sea turtle (T), diamondback terrapin (SC), shortnose sturgeon (E), Atlantic sturgeon (SC), brown pelican (SR), and double-crested cormorant (SR).

## 8.3 SPECIES

The following protected species may be found in the same waters used by the North Carolina kingfishes fisheries. Many are listed under the ESA as endangered or threatened, while others are protected under the MMPA or MBTA. Although these species may be found in the general geographic area where the kingfish fishery occurs, the fishery may not affect them. Some species may inhabit areas other than those in which the fishery is prosecuted or may migrate through the area at times when effort is reduced in the fishery.

Most of the species listed as endangered or threatened fall under federal jurisdiction either with the NMFS or with the USFWS. The following is a list of some of the Endangered (E), Threatened (T), or Federal Species of Concern (FSC) or otherwise protected species that may occur in estuarine and ocean waters of North Carolina:

Fish

- Smalltooth sawfish (*Pristis pectinata*) E
- Shortnose sturgeon (*Acipenser brevirostrum*) E
- Atlantic sturgeon (*Acipenser oxyrinchus*) 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/E
- Northern diamondback terrapin (*Malaclemys terrapin terrapin*) FSC in Dare, Pamlico, and Carteret counties in North Carolina

Mammals

- West Indian manatee (*Trichechus manatus)* E
- Fin whale (*Balaenoptera physalus*) E
- Humpback whale (*Megaptera novaeangliae*) E
- North Atlantic right whale (*Eubalaena glacialis*) E
- Sperm whale (*Physeter catodon*) E
- Sei whale (Balaenoptera borealis) E

Birds

- Double-crested cormorant (*Phalacrocorax auritus*)
- Common loon (*Gavia imner*)
- Ruddy duck (*Oxyura jamaicensis*)
- Red breasted merganser (*Mergus serrator*)
- Brown pelican (*Pelecanus occidentalis*)
- Lesser scaup duck (*Aythya affinis*)
- Hooded merganser (*Lophodytes cucullatus*)
- Great black-backed gull (*Larus marinus*)
- Bufflehead (*Bucephala albeola*)
- Surf scoter (*Melanitta perspicillata*)

- Herring gull (*Larus argentatus*)
- American black duck (*Anas rubripes*)
- Red throated loon (*Gavia stellata*)
- Pied-billed grebe (*Podilymbus podiceps*)

### 8.3.1 Protected Species Interactions in the Kingfish Fishery

Of the federal and state protected species listed above, bottlenose dolphins, sea turtles, diamondback terrapins, Atlantic sturgeon, North Atlantic right whale and several migratory bird species may interact with the kingfish fishery. The dominant gears for the harvest of kingfish in North Carolina waters are gill nets, fish trawls, shrimp trawls, hook-and-line, and seines. An in depth description of these fisheries may be found in the Section 7, Status of the Fisheries. Most research and documentation of protected species interactions for gears landing kingfish have focused on the set gill net fishery and the shrimp trawl fishery.

### 8.3.2 Bottlenose Dolphin

The bottlenose dolphin (*Tursiops truncatus*) inhabits temperate and tropical waters throughout the world. According to the 2013 U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessment, nine bottlenose dolphin stocks have been identified in the nearshore waters of the Western North Atlantic (Waring et al. 2009). Two of these stocks are found in North Carolina estuaries and are identified as the Northern North Carolina Estuarine System Stock (NNCESS) and the Southern North Carolina Estuarine System Stock (SNCESS). Bottlenose dolphins have been observed throughout the year in North Carolina estuarine waters, but will migrate offshore when water temperatures fall below 10$^{o}$C.

From 2003 to 2007, 64 dolphins of the NNCESS were found stranded or entangled in fishing gear within the area extending from Beaufort to the North Carolina/Virginia border. This stock interacts with three known fisheries (blue crab trap/pot fishery, long haul seine fishery, and inshore gill net fishery). It is unknown how many of these were due to interactions with these fisheries (Waring et al. 2009).

A marine mammal species is designated as depleted if it falls below its optimum sustainable population. The MMPA requires that a Take Reduction Team (TRT) be convened for the purpose of recommending measures for inclusion in a Take Reduction Plan (TRP) to promote recovery of a depleted stock. The Bottlenose Dolphin Take Reduction Team (BDTRT) was convened in November 2001 and is made up of fishermen, managers, scientists, and environmental group representatives. The BDTRT focused on reducing serious injuries and deaths of coastal bottlenose dolphins incidental to several east coast fisheries including: the North Carolina inshore gill net, Southeast Atlantic gill net, Southeastern U.S. shark gill net, U.S. Mid-Atlantic coastal gill net, Atlantic blue crab trap/pot, Mid-Atlantic haul/beach seine, North Carolina long haul seine, North Carolina roe mullet stop net, and Virginia pound net. In April 2006, NMFS published a final rule implementing the BNDTRP effective May 26, 2006 that can be found here: http://www.nmfs.noaa.gov/pr/pdfs/fr/fr73-77531.pdf (FR Doc. 06-3909 Filed 4-25-06).

In 2013, the BDTRT recommended that anchored small mesh gill nets in the ocean off North Carolina must be set at least 100 yards from shore year round to prevent exceeding the stocks' Potential Biological Removal (PBR) thresholds. The BDTRT also recommended exempting the ocean waters from Cape Lookout to Bogue Inlet and from Carolina Beach

Inlet to the South Carolina state line from this provision. The NCDMF implemented these measures on September 15, 2013.

In November 2013, a dead bottlenose dolphin was found entangled in a stop net located in the exempted area from Cape Lookout to Bogue Inlet. There was also a substantial increase of small mesh gill net fishing in this area at the time of the entanglement. The BDTRT recommended modifications to minimum mesh sizes for stop nets, as well as to remove the areas exempt from the 100-yard shoreline setbacks. The NCDMF removed the areas exempt from the 100-yard shoreline setbacks on June 1, 2014 and implemented the mesh size changes for stop nets on October 1, 2014.

### 8.3.3 Shortnose Sturgeon

Documented reports of shortnose sturgeon in North Carolina are limited to two areas: western Albemarle Sound (1881 and 1998) and the Cape Fear River (1987, Ross et al. 1988; 1990-1992, Moser and Ross 1995; and 2012, NCDMF, Unpublished Data). Although these two areas likely harbor Distinct Population Segments (DPS), the Cape Fear River population may number less than 50 fish, and there has been only one adult male captured from the Albemarle region. Historical reports from the 19th century indicate that shortnose sturgeon inhabited the Pamlico and Neuse rivers, but obstructions and poor water quality may have eliminated shortnose sturgeon from these rivers since then (Moser et al. 1998, cited by SSSRT 2010). Occasional identification of shortnose sturgeon may actually be misidentified juvenile Atlantic sturgeon. No shortnose sturgeon has been documented from Albemarle Sound since 1998 (Moser et al. 1998, cited by SSSRT 2010).

### 8.3.4 Atlantic Sturgeon

The Atlantic sturgeon is an anadromous species found in Atlantic coastal waters of the United States, and major river basins from Labrador (Churchill River, George River, and Ungava Bay), to Port Canaveral and Hutchinson Island, Florida (Van den Avyle 1984). Atlantic sturgeon is a mobile, long-lived species that uses a wide variety of habitats. Atlantic sturgeon require freshwater habitats to reproduce and for development of early life stages, in addition to hard bottom substrate for spawning (Vladykov and Greeley 1963; Huff 1975; Smith 1985). Coastal migrations and frequent movements between the estuarine and upstream riverine habitats are characteristic of this species (ASMFC 1998). Juvenile and adult Atlantic sturgeon frequently congregate in upper estuarine habitats around the saltwater interface, and may travel upstream and downstream throughout the summer and fall, and during late winter and spring spawning periods. Historically, Atlantic sturgeon was abundant in most North Carolina coastal rivers and estuaries with most occurring in the Roanoke River/Albemarle Sound system and in the Cape Fear River (Kahnle et al. 1998; see Greene et al. 2009 for more information on Atlantic sturgeon).

Several studies have documented interactions with Atlantic sturgeon in set gill nets in North Carolina waters. Some of these studies focused on sturgeon specifically while others focused on comparing traditional and alternative methods of fishing or constructing gill nets and their effect on bycatch. White and Armstrong (2000) studied the survival of Atlantic sturgeon in flounder gill nets in Albemarle Sound. Williams (2000) documented bycatch of Atlantic sturgeon in the fall shallow water striped mullet gill net fishery in Albemarle Sound. Rose (2000, 2001, 2004) documented the bycatch of Atlantic sturgeon in the shad gill net fishery in Albemarle Sound. Thorpe et al. (2001) and Thorpe and Beresoff (2005) documented bycatch of Atlantic sturgeon in southern area of the state in the flounder gill net fishery, and Hassell (2007) documented bycatch of Atlantic sturgeon in the flounder gill net fishery in the Pamlico River.

### 8.3.5 Sea Turtles

Sea turtles are air-breathing reptiles with streamlined bodies and large flippers that inhabit tropical, subtropical, and temperate ocean waters throughout the world. Of the seven species of sea turtle worldwide, five occur in North Carolina. They include the Kemp's Ridley sea turtle (*Lepidochelys kempii*), hawksbill sea turtle (*Eretmochelys imbricata*), leatherback sea turtle (*Dermochelys coriacea*), green sea turtle (*Chelonia mydas*), and the loggerhead sea turtle (*Caretta caretta*). Although sea turtles live most of their lives in the ocean, adult females must return to land to lay their eggs on sandy beaches. They often migrate long distances between foraging grounds and nesting beaches. Kemp's Ridley, green, and loggerhead sea turtles are known to move into North Carolina coastal waters as large juveniles to forage on crustaceans, mollusks, or grasses (Snover 2002, cited by STAC 2006). The loggerhead and green sea turtles are federally listed as threatened, while the others are listed as endangered.

The geographic distribution of loggerhead sea turtles includes the subtropical and tropical waters, continental shelves and estuaries along the margins of the Atlantic, Pacific, and Indian oceans. Loggerhead sea turtles are rare or absent far from mainland shores. In the Western Hemisphere, their range extends as far north as Newfoundland and as far south as Argentina. Green sea turtles have a global distribution in tropical and subtropical waters. In U.S. Atlantic waters, green sea turtles occur around the Virgin Islands and Puerto Rico and from Texas to Massachusetts. Leatherback sea turtles occupy the open seas, although they are occasionally seen in coastal waters. Leatherbacks prefer warmer waters; however, they frequently appear in New England waters north to Newfoundland during the summer months. Hawksbill sea turtles are typically a tropical species, found throughout the Caribbean. They are commonly observed in the Florida Keys, Bahamas, and the southwestern Gulf of Mexico. Hawksbill stragglers have been reported as far north as Massachusetts and as far south as northern Argentina. This species is infrequently found in shallow coastal estuarine systems. Kemp's Ridley sea turtles occur most frequently in the Gulf of Mexico, but they also occur along the Atlantic coast as far north as Long Island, New York and Cape Cod, Massachusetts.

As water temperatures begin to rise during the spring months, sea turtles migrate northward along the coast and into estuarine waters (Shoop and Kenney 1992; Thompson and Huang 1993; Musick et al. 1994; Witzell and Azarovitz 1996; Braun-McNeill and Epperly 2004; Mansfield et al. 2009). When waters begin cooling during the fall, many sea turtles migrate southward out of the temperate latitudes to warmer waters. Others move offshore to warm waters in or near the Gulf Stream (McClellan and Read 2007; Mansfield et al. 2009). In 1988, researchers with the NMFS Laboratory in Beaufort, NC began monitoring the distribution of sea turtles in North Carolina estuarine and nearshore waters, employing three complementary methods to assess turtle distributions: aerial surveys, public sightings, and mark-recapture studies (Epperly et al. 1995a and 1995b). This research identified a distinct seasonal pattern of sea turtle distribution in the estuarine and nearshore ocean waters of North Carolina. In April, as coastal waters begin to warm, sea turtles enter North Carolina's estuaries. During summer months, sea turtles may be found from the Albemarle Sound to the Cape Fear River and as far west as the Neuse River estuary. The greatest densities of sea turtles occur in Core Sound and along the eastern shore of Pamlico Sound. In the fall, sea turtles leave the estuaries as water temperatures cool and are rarely seen inside the barrier islands from January to March.  Sea turtles are observed in offshore ocean waters throughout the year.

Females of all five species of sea turtles lay clutches of eggs in nests on coastal beaches. The adults aggregate offshore of the nesting beaches during the spring to mate.  After mating, females move onshore to lay eggs.  Up to seven clutches may be laid during a single nesting season.  After an incubation period of two months, the hatchlings dig to the surface and move toward the ocean.  The young swim offshore and spend their early life in offshore waters.  After several years at sea, most species enter the coastal waters and move into bays, river mouths, and estuaries where they spend their juvenile life.

Hawksbill turtles have been reported off the coast of North Carolina during the months of June, July, October, and November.  This species of turtle prefers shallow coastal water with depths usually less than 66 feet.  Preferred habitat includes coral reefs, rocky bottoms, reefs, and coastal lagoons.  Adult hawksbills primary food source is sponges, but they also eat sea urchins, algae, barnacles, mollusks, jellyfish, and fish.  Hawksbills exhibit a wide tolerance for nesting substrate type and nests are typically placed under vegetation. Nesting occurs principally in Puerto Rico and the U.S. Virgin Islands but does occur in the southeast coast of Florida and the Florida Keys.  The largest threat to the hawksbill is the loss of coral reef habitat.  The extent to which hawksbills are killed or debilitated after becoming entangled in marine debris has not been quantified, but it is believed to be a serious and growing problem.  Hawksbills (predominantly juveniles) have been reported entangled in gill nets, fishing line, and synthetic rope.  Hawksbills are incidentally taken by several commercial and recreational fisheries.  Fisheries known or suspected to incidentally capture hawksbills include those using trawls, gill nets, traps, driftnets, hooks, beach seines, spear guns, and nooses (NMFS/USFWS 1993b).  There were no strandings reported of hawksbill sea turtles in North Carolina between 1986 and 2000, but there have been ten between 2001 and 2013 (NCWRC/NMFS Sea Turtle Stranding and Salvage Network (STSSN), unpublished data).

The leatherback sea turtle is the largest turtle in the world and has a worldwide distribution in tropical and temperate waters.  This species is found off the coast of North Carolina from April to October with occasional sightings into the winter.  The main prey species of leatherbacks are jellyfish and tunicates and occur almost exclusively in ocean waters (Epperly et al. 1995b).  There is one record of a NC nesting site at Cape Lookout in 1966 (Lee and Socci 1989), and an additional nesting site was reported near Cape Hatteras in 2000.  Leatherbacks become entangled often in long lines, fish trap, buoy anchor lines, and other ropes and cables (NMFS/USFWS 1992).  Between 1986 and 2006 there have been 220 reported leatherback strandings in North Carolina with an additional 30 reported leatherback strandings from 2007 to 2013 (NCWRC/NMFS STSSN, unpublished data).

The Kemp’s Ridley sea turtle occurs primarily in the Gulf of Mexico, but they also occur along the Atlantic coast as far north as New England.  Juveniles occur year-round within the sounds, bays, and coastal waters of North Carolina.  Adult Kemp’s Ridley turtles are primarily a bottom feeder, feeding on crabs, shrimp, sea urchins, starfish, jellyfish, clams, snails, and squid.  Incidental take by shrimp trawls has been identified as the largest source of mortality with between 500 and 5,000 killed annually (NMFS/USFWS 1993a).  In North Carolina, 10.0% of the sea turtle strandings between 1986 and 2006 were Kemp’s Ridley (NCWRC/NMFS STSSN; 1990–2000).  There have been 754 strandings from 2007 through 2013, which represents 18.9% of the total sea turtle strandings (NCWRC/NMFS STSSN, unpublished data).

The green sea turtle has a global distribution in tropical and subtropical waters. In U.S. Atlantic waters, it occurs around the Virgin Islands and Puerto Rico and from Texas to Massachusetts. Green turtles are sighted in oceanic waters and within the sounds of North Carolina during the period from May through October. Due to their food preference for submerged aquatic vegetation, adult green turtles are normally found in lagoons, bays, and tidal inlets. No major nesting sites are located along the U.S. coastline however, limited annual nesting occurs in Florida from April to July. Green turtle nests in North Carolina have steadily increased from 0 to 3 per year before 2008 to 16-40 nests from 2008 to 2014 (NCWRC Sea Turtle Nest Monitoring System, unpublished data). In 1992, NMFS finalized regulations to require the use of Turtle Excluder Devices (TEDs) in shrimp trawl fisheries. A significant threat to the green turtle continues to be fishing gear, primarily gill nets, but also trawls, traps and pots, and dredges. Green sea turtles have been recovered entangled in trap lines with the trap in tow (NMFS/USFWS 1991a). Strandings have drastically increased since 2007. From 1986-2006, green turtles accounted for 12.4% of the sea turtle strandings in North Carolina and from 2007 to 2013, they made up 44.7% of total strandings (NCWRC/NMFS STSSN, unpublished data).

The loggerhead sea turtle has a subtropical (and occasionally tropical) distribution, including continental shelves and estuaries along the margins of the Atlantic, Pacific, and Indian oceans. It is rare or absent far from mainland shores. The loggerhead turtle is the most common sea turtle in North Carolina (STAC 2006) and is present throughout the year, with peak densities occurring from June to September. The loggerhead turtle diet includes algae, seaweeds, horseshoe crabs, barnacles, various shellfish, sponges, jellyfish, squid, urchins, and fish. Nesting occurs along the U.S. Atlantic coast from New Jersey to Florida, however, the majority of nesting activity occurs from South Carolina to Florida. In North Carolina, nesting activity has been reported from April to September. The highest nesting densities are reported south of Cape Lookout. Loggerhead turtle nests in North Carolina have steadily increased from less than 100 per year in the 1980s and 1990s to as many as 1,304 nests in 2013; a total of 1,261 loggerhead turtle nests were reported in 2013 (NCWRC STNNS, unpublished data).

The primary threat to loggerhead turtle populations worldwide is incidental capture in fishing gear, primarily in long lines and gill nets, but also in trawls, traps and pots, and dredges. While the impact of the crab pot fishery on loggerhead populations has not been quantified, this species may be particularly vulnerable since they feed on species caught in traps and on organisms growing on the traps, trap lines, and floats (NMFS/USFWS 1991b). Strandings have decreased since 2007. From 1998-2006, loggerhead turtles accounted for 65.6% of the sea turtle strandings in North Carolina and from 2007 to 2014, they made up 32.6% of total strandings (NCWRC/NMFS STSSN, unpublished data). Several studies have documented interactions with sea turtles in set gill nets in North Carolina waters. Some of these studies focused on sea turtles specifically while others focused on comparing traditional and alternative methods of fishing or constructing gill nets and their effect on bycatch. Thorpe et al. (2001), Thorpe and Beresoff (2005), and Kimel et al. (2008) documented bycatch of green, Kemp's Ridley, and loggerhead sea turtles in the southern area of the state in several gill net fisheries and Montgomery (2001, 2002) documented the bycatch of green and loggerhead sea turtles in the Core Sound area. Research has also been done in the trawl fishery to reduce interactions with turtles.

### 8.3.6 Diamondback Terrapins

Diamondback terrapins are found throughout North Carolina's high salinity coastal marshes. This species is listed federally as a species of concern (FSC) in Dare, Pamlico, and Carteret counties in North Carolina, although it affords them no legal protection. The diamondback terrapin is listed as a “Special Concern” species by the NCWRC, making it protected under state regulations. The NCWRC Scientific Council on Amphibians and Reptiles (SCAR) is currently evaluating changing the listing of the diamond back terrapin to “Threatened” (SCAR 2011).

In a South Carolina study, terrapins were captured in salinities ranging from 4.3 to 22 ppt, with most captures in 10.1 to 15.0 ppt (Bishop 1983). Preferred habitats are the waters immediately adjacent to the marsh, small creeks, and mosquito control ditches. Terrapins are a long-lived species, probably surviving in excess of forty years. Females mature in seven to nine years, and fecundity is relatively low (Hildebrand 1932).

Populations of diamondback terrapins have declined throughout their range from Cape Cod, Massachusetts to southern Texas (Palmer and Cordes 1988; Seigel and Gibbons 1995). Possible reasons for this decline are: (1) degradation and loss of habitat (Grant 1997), (2) mortality on roads (Wood 1995), (3) raccoon predation (Seigel 1980), and (4) incidental drowning in trawls, nets, and crab pots (Bishop 1983 and Wood 1995). Blue crab pots may account for more adult diamondback terrapin mortalities than any other single factor (Bishop 1983).

Several studies have documented interactions with diamondback terrapins in set gill nets in North Carolina waters. These studies focused on comparing traditional and alternative methods of fishing or constructing gill nets and their effect on bycatch. Thorpe et al. (2001) and Thorpe and Beresoff (2005) documented the bycatch of diamondback terrapins in the southern area of the state in several gill net fisheries, Montgomery (2001, 2002) documented the bycatch of diamondback terrapins in the Core Sound area, and Evans (2001) documented the bycatch of diamondback terrapins in the Ocracoke area of Pamlico Sound.

Various studies in New Jersey (Wood 1995), Maryland (Roosenburg et al. 1997), North Carolina [Grant 1997; Crowder et al. 2002; NCWRC unpublished; Tom Henson (NCWRC), pers. comm.], and South Carolina (Bishop 1983) have documented diamondback terrapin bycatch and mortality in crab pots. In South Carolina, few captured terrapins were drowned when crab pots were checked daily, and estimated capture mortality amounted to 10% (Bishop 1983). However, in a North Carolina study, Crowder et al. (2002) noted that terrapins can hold their breath for a maximum of 5 hours, and during the summer only 45 minutes. Of the 12 terrapins captured in the North Carolina study, 58% were dead (24–48 hour soak time; Crowder et al. 2002). Bishop (1983) noted that the occurrence of ghost pots is perhaps far more detrimental to terrapin populations than actively fished pots. Some observations suggest that once a terrapin is captured others may be attracted, particularly males to a female during the spring mating season.

Population size influences catchability. Estimates of capture rates and population size by Roosenburg et al. (1997) suggest that 15–78% of a local population may be captured annually. However, not all coastal areas contain suitable terrapin habitat as outlined by Palmer and Cordes (1988). Male terrapins do not grow as large (shell depth and length) as females, and may remain vulnerable to entrapment throughout their life. Female terrapins become too large to enter crab pots by the time they reach age eight (Roosenburg et al. 1997). However, small terrapins of either sex are vulnerable to capture.

Limiting factors affecting the catchability of terrapins in crab pots are:

(1) abundance of terrapins,

(2) terrapin size (depth of shell),
(3) vertical height of the crab pot funnel,
(4) distance of the crab pot from shore, and
(5) season.

### 8.3.7 Birds

Several species of diving ducks and seabirds are incidentally caught in gill nets, leading to mortalities. 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). A few studies have been conducted on seabird bycatch in the American shad gill net fishery (Rose 2000, 2001, 2004). These nets primarily caught diving birds such as loons, cormorants, and grebes. These studies took place over an entire fishing season, generally lasting more than 100 days. These nets had mesh sizes of 5.5 inches stretch mesh, and are larger than that used to catch kingfishes. Floating nets caught more birds than sinking nets overall (111 versus 61) and the most common bird caught in these nets was the red-throated loon (42% of the overall total).

Other studies have documented interactions with migratory birds in gill nets in North Carolina waters. These studies focused on comparing traditional and alternative methods of fishing or constructing gill nets and their effect on bycatch. Thorpe et al. (2001) and Thorpe and Beresoff (2005) documented bycatch of birds in the southern area of the state in several gill net fisheries. Montgomery (2001) documented the bycatch of cormorants and loons in the Core Sound area. Evans (2001) documented the bycatch of a loon in the Ocracoke area, and Darna (2000, 2002) documented the bycatch of cormorants, loons, and merganser's in the Neuse River area of Pamlico Sound.

## 8.4 NORTH CAROLINA DIVISION OF MARINE FISHERIES 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 (NCMFC 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 (NCMFC Rule – 15A NCAC 03I.0107). In 1989, an addition was made to the MRFSS program (now MRIP) to include a sea turtle sightings query on the survey form. The NCDMF Observer Program began in 1999 in the Fisheries Management section 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 of protected species bycatch. The data collected is used for fisheries management decisions, stock assessments, and conservation efforts for protected species. Currently, the Observer Program primarily focuses on large and small mesh gill nets but data are also being collected in the recreational hook and line fishery. Data collected from observer trips include date, location, unit, time, season, gill net description (net length, number of net shots, mesh size, presence/absence of tie downs, vertical mesh height, and hanging 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 and sturgeon interaction information includes species, condition, tag numbers, and final disposition. All interactions involving protected species are documented. All observers are required to adhere to these data collection parameters.

To maintain the gill net flounder fishery, the NCDMF applied for and received an Incidental Take Permit (ITP #1259) under Section 10 of the ESA in 2000 (Gearhart 2001). The ITP authorized protected species interactions, allowing the fishery to operate under certain restrictions. The ITP contained a comprehensive Conservation Plan designed to reduce sea turtle interactions by establishing an authorized threshold of sea turtle takes, and intensive monitoring by fisheries observers, while allowing traditional gill net fisheries to be prosecuted. Observations in 2000 identified the deep water region of Pamlico Sound as the primary source for sea turtle interactions and subsequent mortality leading NMFS to establish a permanent rule for the 2001 fishing season that closed all potential fishing grounds utilized by the deep water large mesh gill net fisheries. In 2001, NCDMF applied for and received another ITP (# 1348) that implemented further restrictions by establishing prohibited fishing corridors and restricted areas throughout Pamlico Sound, known as the Pamlico Sound Gill Net Restricted Area (PSGNRA). NMFS then closed the rest of Pamlico Sound to gill nets annually from September 1 through December 15 with mesh sizes larger than 4.25 inch stretched mesh on September 27, 2001.

In 2003, NCDMF applied for and received a three-year ITP (#1398). This ITP contained a Habitat Conservation Plan (HCP), which implemented an intensive sea turtle observer and characterization program throughout the PSGNRA from September through December. These restricted areas remained unchanged and were monitored annually from September 1 through December 15 of each year. Observed levels of sea turtle interactions in the southern flounder gill net fishery remained below thresholds that were established by the ITP from 2002 through 2004 (Gearhart 2003; Price 2004; Price 2005).

The Sea Turtle Advisory Committee (STAC) was formed in 2003 by the NCMFC in response to continuing problems with protected species interactions in fisheries throughout the North Carolina coast. Their objective was to develop solutions for the reduction of sea turtle interactions in commercial (i.e., gill net, pound net) and recreational (i.e., hook and line) fishing gear, while maintaining economically viable fisheries throughout the estuarine waters of North Carolina. The STAC was comprised of stakeholders concerned with the bycatch of protected species in commercial and recreational fisheries. Stakeholders included recreational and commercial anglers and the scientific community representing state and federal agencies, academia, and an environmental organization. The committee summarized its findings in a report, which included a background summary about federal and state management, sea turtle natural history, sea turtle strandings, and characterization of North Carolina estuarine fisheries. The document concluded with identification of problems, development of solutions, and recommendations for the reduction of commercial and recreational fishery interactions with sea turtles, while maintaining North Carolina fisheries (STAC 2006).

Over a three-year effort, the STAC identified four inshore gears of primary concern with relation to sea turtle incidental catch throughout North Carolina. These gears were gill nets, pound nets, shrimp trawls, and recreational hook and line. Other gears were identified as gears of other concern, and many gears were identified as no concern (STAC 2006).

Recommendations were provided to the NCMFC following completion of this report, and many of the recommended actions are currently in place. Throughout the STAC process, the recommendation to implement observer coverage for multiple fisheries of either primary or other concern was made in order to gather information where it is limited. The STAC also supported continued efforts for gear modification and testing with the objective of reducing sea turtle interactions.

STAC Recommendations for Gill Nets (>5-inch stretch mesh; STAC 2006):

1) Establish mandatory observer coverage of all large mesh (≥5-inch stretch mesh) gill nets throughout all estuarine waters. The level of coverage should have a minimum goal of 2% of the total effort by area. Coverage should increase (~10%) in areas when/where sea turtle interactions are occurring.
2) Provide education on sea turtle resuscitation to fishermen. Support outreach programs that encourage reporting sea turtles and compliance with regulations.
3) Implement state seasonal/area closures in identified problem areas.
4) Support continued efforts for gear modification and testing with the objective of reducing sea turtle interactions.

In 2005, NCDMF applied for and received a six-year ITP (# 1528) with a few changes to the PSGNRA management area including the establishment of a state closure on top of the federal closure, redirection of observer coverage, and the elimination of the permit requirements along the mainland side of Pamlico Sound (Price 2006). Management of the PSGNRA under this ITP has been consistent and has provided continued protection of sea turtles while allowing a shallow water gill net fishery to operate along the Outer Banks and mainland side of Pamlico Sound.

In addition to the gill net fishery observations in the PSGNRA since 2000, the NCDMF also obtained commercial gill net fishery observations outside of the PSGNRA since 2004 in order to characterize effort, catch, finfish bycatch, and protected species interactions (Brown and Price 2005; Price 2007; Price 2009). The NCDMF has conducted both inshore and nearshore shrimp trawl observations (Brown 2009, 2010b), and has obtained a limited number of pound net observations (Price 2007).

In the fall of 2010, the NCMFC reestablished the STAC to address sea turtle bycatch. The duties of the reestablished STAC include but are not limited to: reviewing observer reports, devising means for fishermen to report sea turtle interactions, assisting with fishermen education, determining measures to reduce the incidental take of sea turtles, monitor Observer Program issues, and review all future ITP provisions and take calculations prior to formal application to NMFS. The STAC provided recommendations and guidance to the NCMFC and NCDMF in addressing the protection of sea turtles in North Carolina.

In August 2010, NCDMF applied for a three year ITP under Section 10 of the ESA for the incidental take of sea turtles. After many revisions and two public comment periods, the NCDMF received a ten year Sea Turtle ITP (#16230) on September 11, 2013. This ITP authorized the implementation of adaptive management measures to protect threatened and endangered sea turtles and other ESA listed species, while allowing estuarine gill net fisheries prosecuted by commercial license holders to fish in the internal coastal (estuarine) waters of North Carolina.

The Conservation Plan includes managing inshore gill net fisheries by dividing estuarine waters into six management units (A, B, C, D1, D2, E; Figure 8.1). Each of the management units is monitored seasonally and by fishery. This permit applies only to the areas defined as follows:

Management Unit A: encompasses all estuarine waters north of 35° 46.30’ N to the North Carolina/Virginia state line. This includes all of Albemarle, Currituck, Croatan, and

Roanoke sounds as well as the contributing river systems in this area. Most of this area is currently defined as the Albemarle Sound Management Area (ASMA).

Management Unit B: encompasses all estuarine waters south of 35° 46.30’N, east of 76° 30.00’W, and north of 34° 48.27’N. This Management Unit includes all of Pamlico Sound and the northern portion of Core Sound.

1) Shallow Water Gill Net Restricted Area (SGNRA) 1

   The area from Wainwright Island to Ocracoke Inlet bound by the following points: Beginning at a point on Core Banks at 34° 58.7963’N - 76° 10.0013’W, running northwesterly to Marker # 2CS at the mouth of Wainwright Channel at 35° 00.2780’N - 76° 12.1682’W, then running northeasterly to Marker “HL” at 35° 01.5665’N - 76° 11.4277’W, then running northeasterly to Marker #1 at 35°09.7058’N - 76° 04.7528’W, then running southeasterly to a point at Beacon Island at 35°05.9352’N - 76° 02.7408’W, then running south to a point on the northeast corner of Portsmouth Island at 35° 03.7014’N - 76° 02.2595’W, then running southwesterly along the shore of Core Banks to the point of beginning.

2) SGNRA 2

   The area from Ocracoke Inlet to Hatteras Inlet bound by the following points: Beginning at a point near Marker #7 at the mouth of Silver Lake at 35° 06.9091’N - 75° 59.3882’W, running north to Marker # 11 near Big Foot Slough Entrance at 35° 08.7890’N - 76° 00.3606’W, then running northeasterly to a point at 35° 13.4489’N’N - 75° 47.5531’W, then running south to a point northwest of the Ocracoke/Hatteras Ferry terminal on the Ocracoke side at 35° 11.5985’N - 75°47.0768’W, then southwesterly along the shore to a point of beginning.

3) SGNRA 3

   The area from Hatteras to Avon Channel bound by the following points: The area from Hatteras to Avon Channel bound by the following points: Beginning at a point near Marker “HR” at 35° 13.3152’N – 75° 41.6694’W, running northwest near Marker “42 RC” at Hatteras Channel at 35° 16.7617’N – 75° 44.2341’W, then running easterly to a point off Marker #2 at Cape Channel at 35° 19.0380’N – 75° 36.2993’W, then running northeasterly near Marker #1 at the Avon Channel Entrance at 35° 22.8212’N – 75° 33.5984’W, then running southeasterly near Marker #6 on Avon Channel at 35° 20.8224’N - 75° 31.5708’W, then running easterly near Marker #8 at 35° 20.9412’N – 75° 30.9058’W, then running to a point on shore at 35° 20.9562’N - 75° 30.8472’W, then following the shoreline in a southerly and westerly direction to the point of beginning.

4) SGNRA 4

   The area from Avon Channel to Rodanthe bound by the following points: Beginning at a point near Marker #1 at the Avon Channel Entrance at 35° 22.8212’N - 75° 33.5984’W, then running northerly to a Point on Gull Island at 35° 28.4495’N - 75° 31.3247’W, then running north near Marker “ICC” at 35° 35.9891’N – 75° 31.2419’W, then running northwesterly to a point at 35° 41.0000’N – 75° 33.8397’N – 75° 29.3271’W, then following the shoreline in a southerly direction to a point on shore near Avon Harbor at 35° 20.9562’N - 75° 30.8472’W, then running westerly near Marker #8 at 35° 20.9412’N - 75° 30.9058’W, then running westerly near Marker #6 on Avon Channel at 35° 20.8224’N - 75° 31.5708’W, then running northwesterly to the point of beginning.

5) Mainland Gill Net Restricted Area (MGNRA)
   The area on the mainland side of Pamlico Sound, from the shoreline of Dare, Hyde, Pamlico and Carteret counties out to 200 yards between 76° 30'W and 75° 42'W.

6) Core Sound Gill Net Restricted Area (CGNRA)
   All Internal Coastal waters south of latitude 35° 00.00'N and north of latitude 34° 48.27'N which runs approximately from the Club House on Core Banks westerly to a point on the shore at Davis near Marker "1".

Management Unit C: includes the Pamlico, Pungo, and Neuse river drainages west of 76° 30.00'W.

Management Unit D: divided into two areas, D-1 and D-2, to allow the NCDMF to effectively address areas of high sea turtle abundance or "hot spots".

Management Unit D-1: encompasses all estuarine waters south of 34° 48.27'N and east of a line running from 34° 40.6750'N – 76° 37.00'W to 34° 42.48'N – 76° 37.00"W then to the head of Turner Creek, and northerly up the western shoreline of the North River. Management Unit D-1 includes Southern Core Sound, Back Sound, and North River.

Management Unit D-2: encompasses all estuarine waters west of a line running from 34° 40.6750'N – 76° 37.00'W to 34° 42.48'N – 76° 37.00"W, then to the head of Turner Creek, and northerly up the western shoreline of the North River; and east of the NC Hwy 58 Bridge. Management Unit D-2 includes Newport River (including the Atlantic Intracoastal Waterway and Harlowe Creek up to the NC Hwy 101 Bridge) and Bogue Sound.

Management Unit E: encompasses all estuarine waters south and west of the Hwy 58 Bridge to the North Carolina/South Carolina state line. This includes the Atlantic Intracoastal Waterway (ICW) and adjacent sounds and the New, Cape Fear, Lockwood Folly, White Oak, and Shallotte rivers.

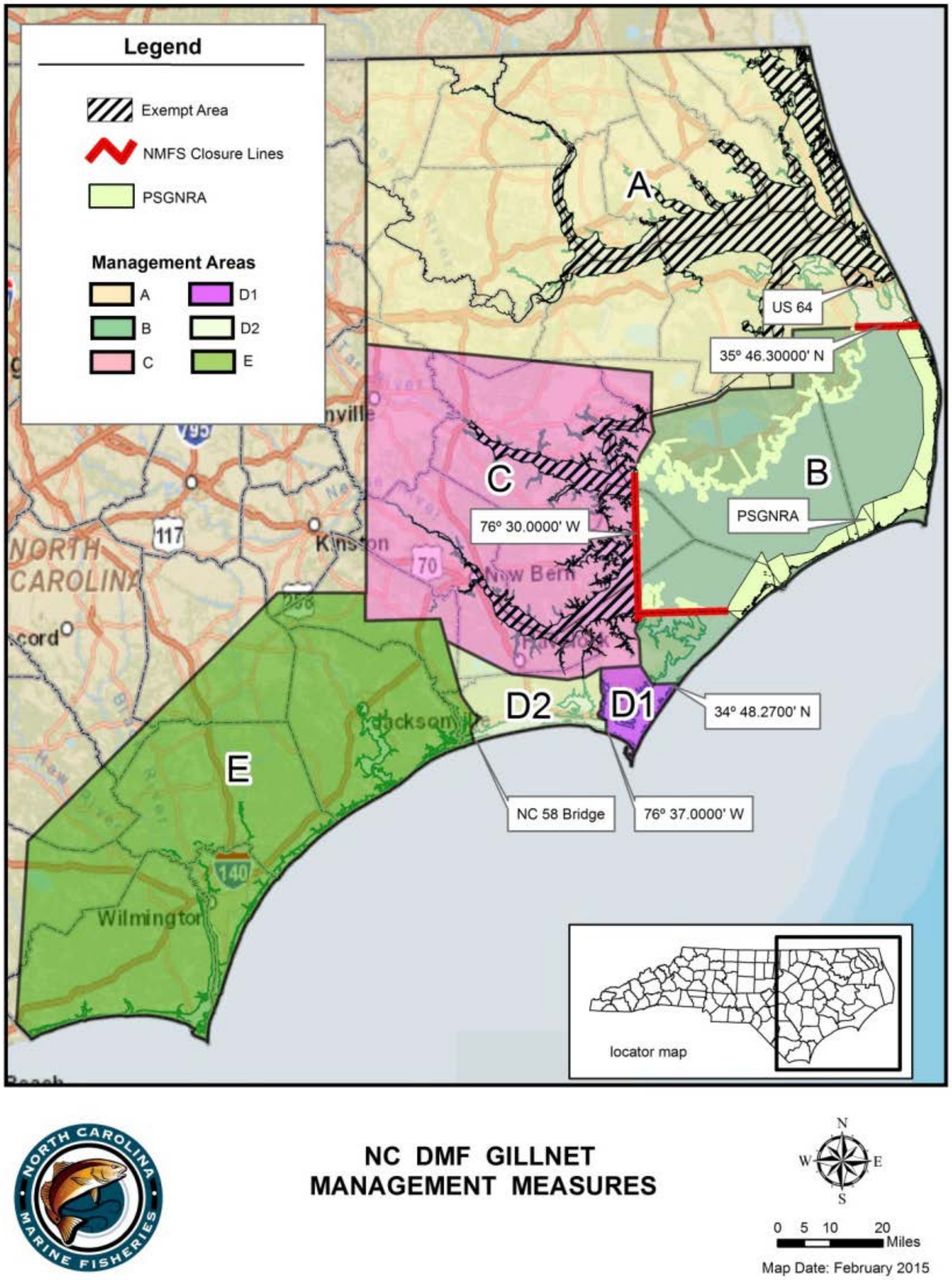


Figure 8.1 Map of Sea Turtle Management Units for North Carolina's estuarine waters in Incidental Take Permit #16230.

In the latter part of 2010, NCDMF reallocated funds to establish the Protected Resources Section within the division and obtained funding to support a statewide at-sea observer program for the estuarine gill net fishery. The new Protected Resources Section is the lead for division 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.

Marine mammal stranding response along the central North Carolina coast, 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 coordinator was hired and stranding personnel have responded to numerous marine mammal strandings. The North Carolina stranding response is divided into four areas: 1) University of North Carolina-Wilmington – personnel respond to all strandings in the southern part of the state up to and including Camp Lejeune; 2) NCDMF – personnel respond to strandings from Hammocks Beach State Park to Cape Lookout National Seashore and in Albemarle and Pamlico sounds; 3) Cape Hatteras National Seashore – personnel respond to strandings in Cape Hatteras National Seashore, and 4) DENR – personnel respond to strandings from Cape Hatteras north to the Virginia border. Stranding personnel conduct outreach by giving public seminars at marine mammal meetings, local museums, universities, and classrooms. Stranding personnel disseminate results and tissue samples from stranded animals to collaborating researchers and agencies.

On February 6, 2012, NMFS issued a final determination to list the Carolina DPS of Atlantic sturgeon as an endangered species under the ESA with a rule effective date of April 6, 2012 (77 FR 5914, 6 February 2012). In June 2012, NCDMF applied for a ten year ITP under Section 10 of the ESA for the incidental take of Atlantic sturgeon in inshore estuarine waters for the large and small mesh anchored gill net fisheries. In July 2014, NCDMF received ITP # 18102 for the incidental take of Atlantic sturgeon in inshore estuarine waters for the large and small mesh anchored gill net fisheries (NMFS 2014). The Conservation Plan prepared by NCDMF describes measures designed to monitor, minimize, and mitigate the incidental take of ESA-listed Atlantic sturgeon. The Conservation Plan includes managing inshore gill net fisheries by dividing estuarine waters into seven management units (A1, A2, A3, B, C, D, E; Figure 8.2). Each of the management units is monitored seasonally and by fishery. This permit only applies to the areas defined as follows:

Management Unit A is divided into three subunits—A-1, A-2, and A-3—to allow NCDMF to effectively address subunits where proactive management actions may be taken at a finer scale.

Management Subunit A-1 will encompass Albemarle Sound as well as contributing river systems in the unit not crossing a line 36° 4.30'N -75° 47.64'W east to a point 36° 2.50'N -75° 44.27'W in Currituck Sound or 35° 57.22'N -75° 48.26'W east to a point 35° 56.11'N -75°43.60'W in Croatan Sound and 36° 58.36'N -75° 40.07'W west to a point 35° 56.11'N -75°43.60'W in Roanoke Sound.

Management Subunit A-2 will encompass Currituck Sound north of a line beginning at 36° 4.30'N -75° 47.64' east to a point at 36° 2.50'N -75° 44.27'W as well as the contributing river systems in this unit.

Management Subunit A-3 will encompass Croatan Sound waters south from a point at 35° 57.22'N -75° 48.26'W east to a point 35° 56.11'N -75°43.60'W and Roanoke Sound waters south from a point 36° 58.36'N -75° 40.07'W west to a point 35° 56.11'N -75°43.60'W south to 35° 46.30’N.

Management Unit B will encompass all estuarine waters South of 35° 46.30’N, east of 76° 30.00’W and north of 34° 48.27’N. This management unit will include all of Pamlico Sound and the northern portion of Core Sound.

Management Unit C will include the Pamlico, Pungo, Bay, and Neuse river drainages west of 76° 30.00’W.

Management Unit D will encompass all estuarine waters south of 34° 48.27’N and west of a line running from 34° 40.6750’N – 76° 37.00’W to 34° 42.48’N – 76° 37.00”W to the NC Hwy 58 bridge. Management unit D includes southern Core Sound, Back and Bogue sounds, and North, and Newport rivers (including the Atlantic Intracoastal Waterway and Harlowe Creek up to the NC Hwy 101 Bridge).

Management Unit E will encompass all estuarine waters south and west of the NC Hwy 58 Bridge to the North Carolina/South Carolina state line. This includes the Atlantic Intracoastal Waterway (IWW) and adjacent sounds, and the White Oak, New, Cape Fear, Lockwood Folly, and Shallotte rivers.

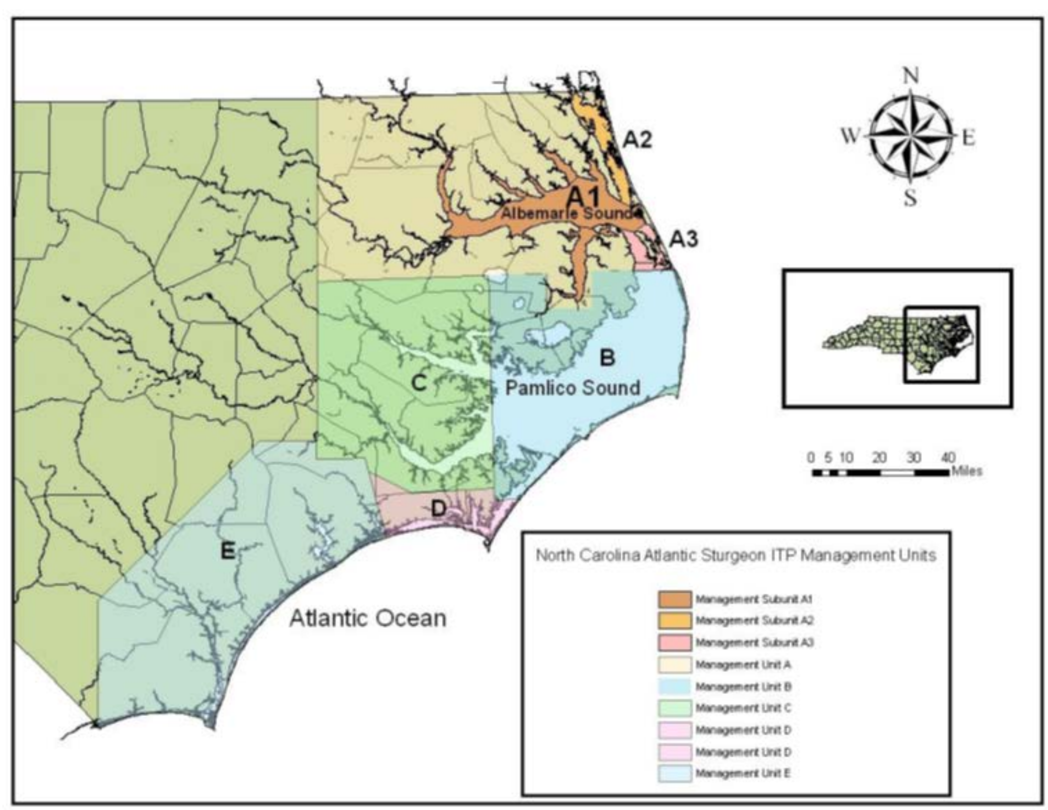


Figure 8.2. Atlantic Sturgeon Management Units for North Carolina’s estuarine waters in Incidental Take Permit #18102.

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 continuation of many economically important fisheries. In addition to the previously mentioned ITPs, 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 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). The NCDMF will continue to be proactive in developing ways to minimize impacts to protected species within North Carolina waters.

# 9.0 PRIVATE CULTURE, AQUACULTURE, AND STOCK ENHANCEMENT

## 9.1 PRIVATE CULTURE

There is currently no NCDMF program to administer private culture of kingfishes. There are no known historical records of private culture having been conducted in the State of North Carolina, nor are there any known plans to privately culture kingfishes in the future.

## 9.2 AQUACULTURE

In North Carolina, aquaculture is currently defined under the Aquaculture Development Act (ADA) (G.S. Chapter 106 Article 63) as the propagation and rearing of aquatic species in controlled or selected environments, including but not limited to, ocean ranching (G.S. 106-758(1)). The North Carolina Department of Agriculture and Consumer Services (NCDACS), NCWRC, and NCDMF all share the responsibilities in permitting aquaculture facilities and operations. Determining the jurisdiction for these facilities is based on the species of fish, where it is found in its natural settings (e.g. marine, estuarine, or freshwater), and the location of the facility (e.g. inland or coastal).

The ADA considers aquaculture a form of agriculture and thus designates NCDACS the lead state agency in matters pertaining to aquaculture (G.S. 106-759). The ADA gives the NCDACS and the Board of Agriculture the responsibility for registration and licensing of freshwater aquaculture facilities. In addition, the Act states NCDACS authority shall not include authority of the wild fishery resource managed under the authority of the NCWRC (G.S 106-761). Outside of the ADA, the General Assembly also gives the NCMFC jurisdiction over shellfish aquaculture (G.S. 113-201), as well as the conservation of marine and estuarine resources including the regulation of aquaculture facilities, which cultivate or rear marine and estuarine resources (G.S. 113-132).

### 9.2.1 North Carolina Department of Agriculture and Consumer Services and Board of Agriculture Authority

The ADA assigns NCDACS the power and duties to:

- provide aquaculturalists with information and assistance in obtaining permits related to aquaculture activities;
- promote investment in aquaculture facilities in order to expand production and processing capacity; and
- work with appropriate State and Federal agencies to review, develop and implement policies and procedures to facilitate aquacultural development (G.S. 106-759).

The ADA also gives NCDACS the authority to regulate the production and sale of commercially raised freshwater fish and freshwater crustacean species. Rules have been developed by the Board of Agriculture to register facilities for the production and sale of freshwater aquaculturally raised species, and set standards under which the commercially reared species may be transported, possessed, bought, and sold. The NCDACS and the Board of Agriculture authority are limited to commercially reared fish and do not include authority over the wild fishery resource that is managed under authority of the NCWRC (G.S. 106-761(a)).

The NCDACS, with the authorization of the Board of Agriculture, can issue two types of licenses and one permit to aquaculturists: 1) Aquaculture Propagation and Production Facility License; 2) Commercial Catchout Facility License; and 3) Holding Pond/Tank Permit.

The Aquaculture Propagation and Production Facility License is valid for five years for the operation of fish hatcheries and production facilities for the approved species only. The Commercial Catchout Facilities License allows the facility to only be stocked with species from hatcheries and production facilities, approved by the Department of Agriculture and only for the species listed in G.S. 106-761(b) to prevent the introduction of diseases, and is valid for five years. The catchout facility owner or operator is only authorized to sell fish taken by fishermen directly from the pond and must provide receipts of the sales. The angler may sell no fish taken from the catchout facility and there are no angler license requirements for anglers fishing in the licensed commercial catchout facilities. The Holding Pond/Tank Permit is for all facilities holding live food or bait species for sale. This permit is valid for two years for the approved species. Possession of either an Aquaculture Propagation and Production Facility License or a Commercial Catchout Facility License will serve in lieu of a Holding Pond/Tank Permit for possession both on and off their facilities premises.

### 9.2.2 North Carolina Wildlife Resources Commission Authority

The ADA provides a list of preapproved species that can be propagated and produced with a NCDACS Aquaculture License (G.S. 106-761(b)). The NCWRC can only place restrictions on the listed species when there is a disease concern. All other species are prohibited from propagation and production unless the applicant for the permit first obtains written permission from the NCWRC. In the past, the NCWRC has issued written authorization for species that spend any portion of their life in freshwater even though they may spend a majority of their life in estuarine or marine waters. NCWRC has no implementing rules for § 106-761, rather obtaining "letters of authorization" for culture of aquatic species not approved in the legislation is done by policy and the process steps may be found on the NCWRC website. To facilitate the review of such requests, NCWRC has an application and additional information available at: http://www.ncwildlife.org/Licensing/OtherLicensesPermits/AuthorizationtoCultureNonApprovedFishSpecies.aspx.

### 9.2.3 Division of Marine Fisheries and the Marine Fisheries Commission Authority

General Statue 113-132 states "the Marine Fisheries Commission (NCMFC) has jurisdiction over the conservation of marine and estuarine resources (G.S. 113-132). Except as may be otherwise provided by law, it has jurisdiction over all activities connected with the conservation and regulation of marine and estuarine resources, including the regulation of aquaculture facilities as defined in G.S. 106-758 which cultivate or rear marine and estuarine resources." Implementing NCMFC rules deal with issuance of the aquaculture operation and collection permits (15A NCAC 03O .0503).

The NCDMF has regulatory authority over aquaculture through an Aquaculture Operation Permit. In order to operate an aquaculture facility that deals with estuarine or marine species the facility must obtain a permit from the NCDMF director (15A NCAC 03O .0501). If the applicant is collecting wild fish for the aquaculture facility, the NCDMF has regulatory authority over how the fish are collected.

## 9.3 STOCK ENHANCEMENT

Currently, there is no program or plan for stock enhancement of kingfishes in North Carolina.

# 10.0 SOCIOECONOMIC STATUS OF THE KINGFISH FISHERY

## 10.1 ECONOMIC ASPECTS OF THE COMMERCIAL FISHERY

### 10.1.1 Ex-vessel Value and Price

Landings and ex-vessel value data for kingfishes are evaluated from 1972 to 2013. The NCTTP began in 1994 when it was mandated that all commercial landings sold to a licensed seafood dealer be reported to the NCDMF. Prior to 1994, landings were recorded through a NCDMF/NMFS survey program where landings were provided by seafood dealers. Reporting the ex-vessel price of seafood is voluntary, with multiple seafood dealers throughout the state regularly provide price data.

When examining data over several years, it can be useful from an economic perspective to tie the ex-vessel value of annual landings to an established baseline year to control for the effects of inflation. Changes in ex-vessel values from year to year can be more clearly understood after removing the influence of changing dollar values over time. To do so, nominal ex-vessel values and prices (the amount paid dockside to the fisherman) are adjusted by the U.S. Consumer Price Index (CPI) to the value of a U.S. dollar in 1972 in an attempt to remove the effects of inflation. For this reason, nominal and inflation adjusted ex-vessel values and prices are provided (Figures 10.1, 10.2; Table 10.1).

The nominal value (the value that is not adjusted for inflation) of North Carolina landings of kingfishes per year has generally shown an increasing trend between1972 and 2013 (Figure 10.1; Table 10.1). The lowest nominal value was observed in 1976, at $20,173, followed by an increasing trend through the 1980s and mid-1990s. Nominal ex-vessel value peaked in 2010 at $958,377, before falling to $668,480 in 2013. When adjusted for inflation, the highest ex-vessel value was observed in 1997, with the inflation-adjusted value falling thereafter but showing no-long term trend.

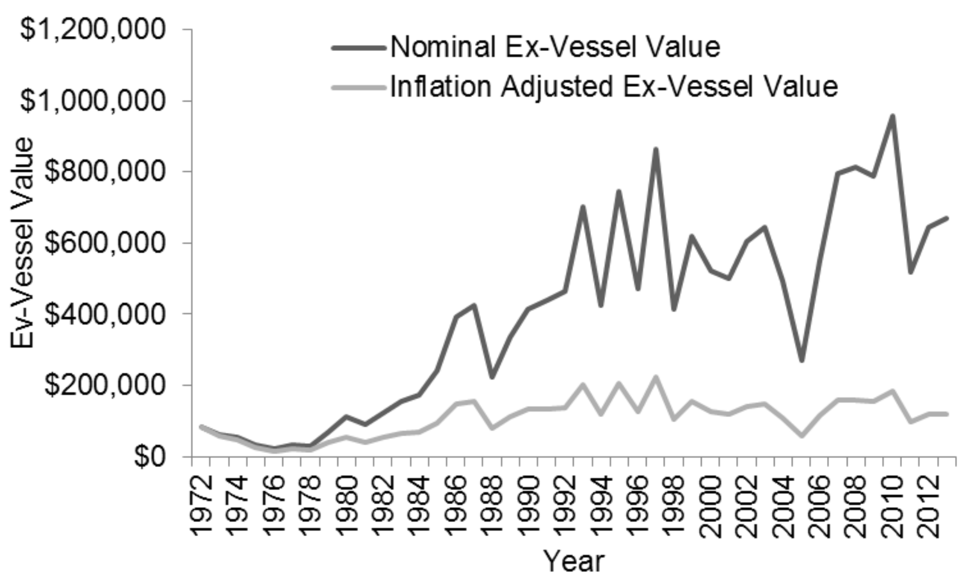


Figure 10.1 Ex-vessel value of landings of kingfishes in North Carolina, 1972–2013 (Source: NCTTP, unpublished data).

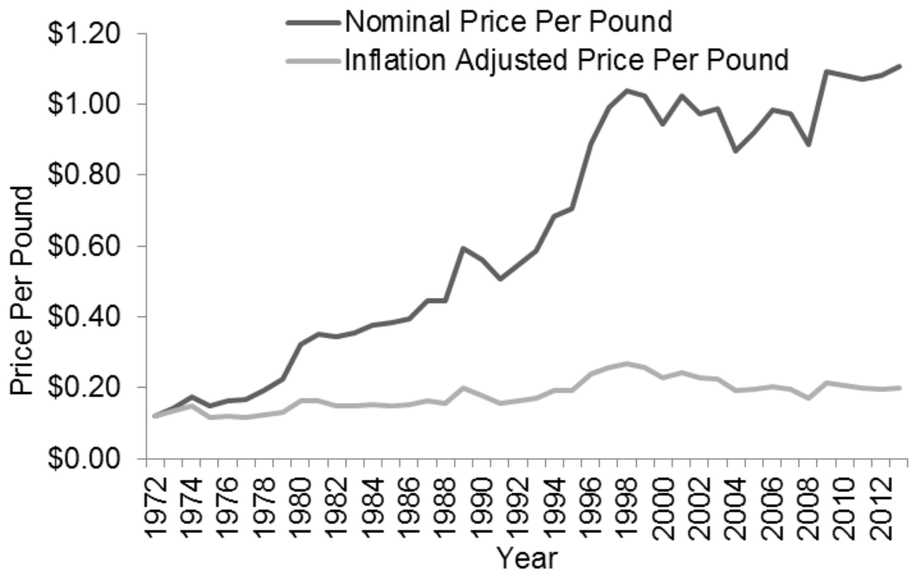


Figure 10.2 Annual average nominal and inflation-adjusted ex-vessel price per pound for kingfishes landed in North Carolina, 1972–2013 (Source: NCTTP, unpublished data).

Table 10.1 Annual commercial landings, nominal ex-vessel value, inflation adjusted ex-vessel value, nominal price per pound, and inflation-adjusted price per pound of kingfishes landed in North Carolina, 1972–2013 (Source: NCTTP, unpublished data).

| Year | Pounds Landed | Nominal Ex-Vessel Value | Inflation Adjusted Ex-Vessel Value | Nominal Price Per Pound | Inflation Adjusted Price Per Pound |
|---|---|---|---|---|---|
| 1972 | 683,048 | $82,740 | $82,740 | $0.12 | $0.12 |
| 1973 | 428,647 | $60,556 | $57,010 | $0.14 | $0.13 |
| 1974 | 314,584 | $54,445 | $46,162 | $0.17 | $0.15 |
| 1975 | 212,530 | $31,635 | $24,579 | $0.15 | $0.12 |
| 1976 | 123,896 | $20,173 | $14,820 | $0.16 | $0.12 |
| 1977 | 204,603 | $33,926 | $23,401 | $0.17 | $0.11 |
| 1978 | 153,954 | $29,534 | $18,934 | $0.19 | $0.12 |
| 1979 | 310,503 | $69,580 | $40,061 | $0.22 | $0.13 |
| 1980 | 342,605 | $110,436 | $56,022 | $0.32 | $0.16 |
| 1981 | 254,651 | $89,396 | $41,108 | $0.35 | $0.16 |
| 1982 | 361,052 | $123,817 | $53,633 | $0.34 | $0.15 |
| 1983 | 441,881 | $155,857 | $65,410 | $0.35 | $0.15 |
| 1984 | 464,351 | $174,597 | $70,242 | $0.38 | $0.15 |
| 1985 | 632,440 | $241,653 | $93,876 | $0.38 | $0.15 |
| 1986 | 993,390 | $391,492 | $149,310 | $0.39 | $0.15 |
| 1987 | 959,928 | $426,366 | $156,885 | $0.44 | $0.16 |
| 1988 | 503,949 | $223,357 | $78,921 | $0.44 | $0.16 |
| 1989 | 562,424 | $334,358 | $112,711 | $0.59 | $0.20 |
| 1990 | 738,612 | $412,824 | $132,028 | $0.56 | $0.18 |
| 1991 | 864,651 | $439,283 | $134,817 | $0.51 | $0.16 |
| 1992 | 851,708 | $464,525 | $138,397 | $0.55 | $0.16 |
| 1993 | 1,194,224 | $701,314 | $202,871 | $0.59 | $0.17 |
| 1994 | 620,841 | $424,307 | $119,676 | $0.68 | $0.19 |
| 1995 | 1,058,785 | $746,603 | $204,777 | $0.71 | $0.19 |
| 1996 | 528,260 | $470,545 | $125,359 | $0.89 | $0.24 |
| 1997 | 872,888 | $864,030 | $225,025 | $0.99 | $0.26 |
| 1998 | 399,313 | $414,315 | $106,248 | $1.04 | $0.27 |
| 1999 | 607,465 | $621,078 | $155,829 | $1.02 | $0.26 |
| 2000 | 551,940 | $520,965 | $126,460 | $0.94 | $0.23 |
| 2001 | 489,743 | $501,999 | $118,484 | $1.03 | $0.24 |
| 2002 | 619,737 | $603,854 | $140,306 | $0.97 | $0.23 |
| 2003 | 652,636 | $644,920 | $146,509 | $0.99 | $0.22 |
| 2004 | 567,659 | $492,452 | $108,970 | $0.87 | $0.19 |
| 2005 | 296,263 | $271,731 | $58,158 | $0.92 | $0.20 |
| 2006 | 559,440 | $550,566 | $114,155 | $0.98 | $0.20 |
| 2007 | 817,588 | $795,412 | $160,355 | $0.97 | $0.20 |
| 2008 | 921,120 | $815,149 | $158,257 | $0.88 | $0.17 |
| 2009 | 721,924 | $789,000 | $153,727 | $1.09 | $0.21 |
| 2010 | 886,841 | $958,377 | $183,715 | $1.08 | $0.21 |
| 2011 | 486,853 | $520,413 | $96,707 | $1.07 | $0.20 |
| 2012 | 596,249 | $645,607 | $117,539 | $1.08 | $0.20 |
| 2013 | 603,186 | $668,480 | $119,947 | $1.11 | $0.20 |

The nominal price per pound for kingfishes showed an overall steady increase from the early 1970s through the late 1990s, regardless of the number of fish landed (Figure 10.2); however, in the late 1990s and mid-2000s there was a slight downward trend. At the time, many North Carolina fishermen attributed this trend to competition from a developing Florida fishery. Nominal prices rose again in the late 2000s and peaked in 2013 at $1.11 per pound. When adjusted for inflation, the price per pound exhibited an increasing trend from the 1970s through the mid-1990s, with a peak in 1998. Since then, inflation adjusted prices have gone slightly downward but remain relatively stable.

### 10.1.2 Gear and Price

From 1994 to 2013, gill nets accounted for the highest ex-vessel value among the gears used to catch kingfish (Table 10.2). On average, 71% of the total dockside value for landings of kingfishes was caught using gill nets. Fish trawls accounted for a large portion of kingfish landings early in the time series, but dropped off substantially after 1997. Shrimp trawls had the second highest landings value in most years followed by seines and “other” gears.

Table 10.2 Landings, nominal ex-vessel value, and average nominal price per pounds for kingfishes by gear, 1994–2013 (Source: NCTTP, unpublished data).

| | Fish Trawl | | | Gill Net | | | Seines | | | Shrimp Trawl | | | Other | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Pounds | Ex-Vessel Value | Price per Pound | Pounds | Ex-Vessel Value | Price per Pound | Pounds | Ex-Vessel Value | Price per Pound | Pounds | Ex-Vessel Value | Price per Pound | Pounds | Ex-Vessel Value | Price per Pound |
| 1994 | 204,606 | $109,027 | $0.53 | 265,730 | $199,867 | $0.75 | 51,264 | $39,340 | $0.77 | 94,668 | $72,588 | $0.77 | 4,572 | $3,485 | $0.76 |
| 1995 | 102,694 | $78,656 | $0.77 | 643,322 | $449,404 | $0.70 | 65,966 | $46,127 | $0.70 | 243,210 | $169,891 | $0.70 | 3,593 | $2,526 | $0.70 |
| 1996 | 46,363 | $31,403 | $0.68 | 219,150 | $212,090 | $0.97 | 57,062 | $55,306 | $0.97 | 203,158 | $169,298 | $0.83 | 2,528 | $2,448 | $0.97 |
| 1997 | 109,552 | $95,912 | $0.88 | 484,872 | $489,979 | $1.01 | 46,050 | $46,819 | $1.02 | 229,096 | $227,967 | $1.00 | 3,318 | $3,353 | $1.01 |
| 1998 | 17,295 | $15,332 | $0.89 | 263,834 | $275,771 | $1.05 | 34,393 | $35,894 | $1.04 | 80,470 | $83,847 | $1.04 | 3,321 | $3,472 | $1.05 |
| 1999 | 7,146 | $6,119 | $0.86 | 339,097 | $347,236 | $1.02 | 20,907 | $21,543 | $1.03 | 237,542 | $243,323 | $1.02 | 2,774 | $2,857 | $1.03 |
| 2000 | 11,702 | $9,904 | $0.85 | 335,063 | $317,127 | $0.95 | 45,806 | $43,385 | $0.95 | 156,961 | $148,268 | $0.94 | 2,409 | $2,281 | $0.95 |
| 2001 | 17,024 | $21,607 | $1.27 | 384,821 | $391,051 | $1.02 | 37,224 | $37,795 | $1.02 | 47,564 | $48,389 | $1.02 | 3,109 | $3,157 | $1.02 |
| 2002 | 9,239 | $9,808 | $1.06 | 468,308 | $455,662 | $0.97 | 25,189 | $24,506 | $0.97 | 115,078 | $112,008 | $0.97 | 1,922 | $1,870 | $0.97 |
| 2003 | 3,785 | $4,053 | $1.07 | 532,742 | $526,194 | $0.99 | 39,175 | $38,690 | $0.99 | 68,093 | $67,251 | $0.99 | 8,841 | $8,731 | $0.99 |
| 2004 | 4,515 | $3,872 | $0.86 | 408,870 | $355,044 | $0.87 | 43,372 | $37,665 | $0.87 | 109,009 | $94,228 | $0.86 | 1,893 | $1,643 | $0.87 |
| 2005 | 8,346 | $8,027 | $0.96 | 241,553 | $221,261 | $0.92 | 30,921 | $28,302 | $0.92 | 14,658 | $13,424 | $0.92 | 785 | $718 | $0.92 |
| 2006 | 10,530 | $10,337 | $0.98 | 464,774 | $457,427 | $0.98 | 34,519 | $33,973 | $0.98 | 46,236 | $45,501 | $0.98 | 3,382 | $3,328 | $0.98 |
| 2007 | 23,566 | $22,544 | $0.96 | 635,739 | $618,822 | $0.97 | 25,119 | $24,445 | $0.97 | 132,033 | $128,501 | $0.97 | 1,131 | $1,101 | $0.97 |
| 2008 | 55,064 | $47,129 | $0.86 | 594,360 | $527,036 | $0.89 | 46,202 | $41,075 | $0.89 | 216,551 | $191,983 | $0.89 | 8,943 | $7,927 | $0.89 |
| 2009 | 21,129 | $23,125 | $1.09 | 583,484 | $637,740 | $1.09 | 27,045 | $29,570 | $1.09 | 87,123 | $95,127 | $1.09 | 3,143 | $3,438 | $1.09 |
| 2010 | 28,945 | $29,456 | $1.02 | 726,654 | $786,589 | $1.08 | 50,367 | $54,630 | $1.08 | 79,589 | $86,307 | $1.08 | 1,286 | $1,394 | $1.08 |
| 2011 | 276 | $295 | $1.07 | 429,271 | $458,932 | $1.07 | 32,239 | $34,489 | $1.07 | 23,692 | $25,231 | $1.06 | 1,376 | $1,466 | $1.07 |
| 2012 | 3,411 | $3,704 | $1.09 | 505,595 | $547,470 | $1.08 | 28,115 | $30,524 | $1.09 | 57,368 | $62,015 | $1.08 | 1,760 | $1,893 | $1.08 |
| 2013 | * | * | * | 436,397 | $483,910 | $1.11 | 19,696 | $21,798 | $1.11 | 144,643 | $159,979 | $1.11 | 2,441 | $2,784 | $1.14 |

### 10.1.3 Waterbodies

Since the start of the NCTTP in 1994, the majority of the ex-vessel value of commercial landings of kingfishes has occurred in ocean waters, averaging 80% of the total ex-vessel value for all waters in the state (Figure 10.3; Table 10.3). This was generally followed by landings from the Pamlico Sound, Core Sound, and "other" waterbodies combined. In 2013, ocean waters dropped to their lowest level as a percent of total kingfish landings value, while landings in Pamlico Sound and Core Sound accounted for a greater percentage of the total landings value.

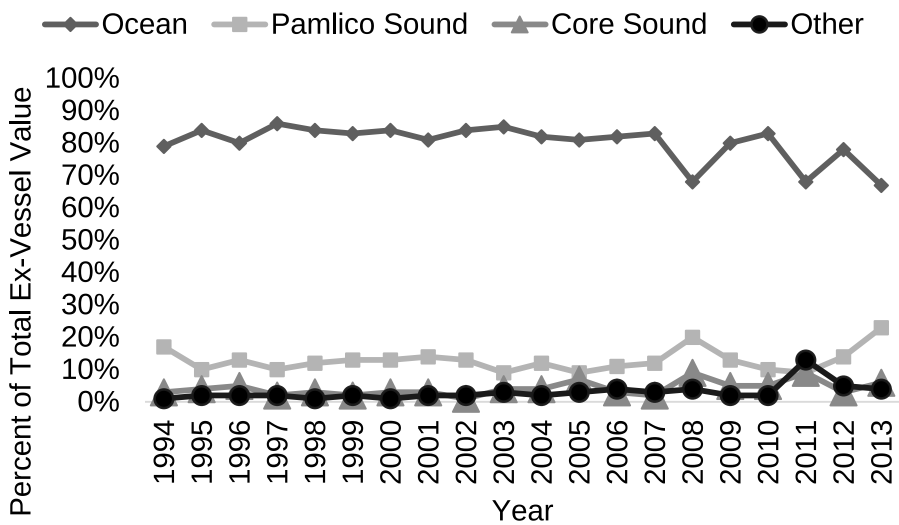


Figure 10.3 Percent of total annual commercial kingfish harvest value by waterbody, 1994–2013 (Source: NCTTP, unpublished data).

Table 10.3 Nominal ex-vessel value of commercial landings of kingfishes by waterbody, 1994–2013 (Source: NCTTP, unpublished data).

| | Ocean | | Pamlico Sound | | Core Sound | | Other | | All Water Bodies |
|---|---|---|---|---|---|---|---|---|---|
| Year | Ex-Vessel Value | Percent of Total Value | Ex-Vessel Value | Percent of Total Value | Ex-Vessel Value | Percent of Total Value | Ex-Vessel Value | Percent of Total Value | Total Ex-Vessel Value |
| 1994 | $333,619 | 79% | $72,447 | 17% | $14,434 | 3% | $3,807 | 1% | $424,307 |
| 1995 | $627,664 | 84% | $77,730 | 10% | $29,000 | 4% | $12,209 | 2% | $746,603 |
| 1996 | $374,964 | 80% | $62,688 | 13% | $23,808 | 5% | $9,085 | 2% | $470,545 |
| 1997 | $745,454 | 86% | $82,084 | 10% | $17,300 | 2% | $19,192 | 2% | $864,030 |
| 1998 | $346,229 | 84% | $50,519 | 12% | $12,660 | 3% | $4,907 | 1% | $414,315 |
| 1999 | $517,714 | 83% | $77,722 | 13% | $14,006 | 2% | $11,636 | 2% | $621,078 |
| 2000 | $436,000 | 84% | $65,246 | 13% | $13,195 | 3% | $6,524 | 1% | $520,965 |
| 2001 | $407,493 | 81% | $72,230 | 14% | $13,843 | 3% | $8,432 | 2% | $501,999 |
| 2002 | $508,803 | 84% | $75,802 | 13% | $8,634 | 1% | $10,615 | 2% | $603,854 |
| 2003 | $547,525 | 85% | $57,245 | 9% | $23,725 | 4% | $16,425 | 3% | $644,920 |
| 2004 | $406,112 | 82% | $61,019 | 12% | $17,282 | 4% | $8,040 | 2% | $492,452 |
| 2005 | $221,307 | 81% | $23,916 | 9% | $18,489 | 7% | $8,019 | 3% | $271,731 |
| 2006 | $453,727 | 82% | $57,824 | 11% | $18,933 | 3% | $20,082 | 4% | $550,566 |
| 2007 | $657,410 | 83% | $94,712 | 12% | $17,196 | 2% | $26,093 | 3% | $795,412 |
| 2008 | $555,097 | 68% | $160,441 | 20% | $70,392 | 9% | $29,219 | 4% | $815,149 |
| 2009 | $632,745 | 80% | $99,968 | 13% | $38,807 | 5% | $17,481 | 2% | $789,000 |
| 2010 | $798,588 | 83% | $94,537 | 10% | $46,794 | 5% | $18,458 | 2% | $958,377 |
| 2011 | $355,569 | 68% | $48,932 | 9% | $48,537 | 9% | $67,374 | 13% | $520,413 |
| 2012 | $503,700 | 78% | $88,991 | 14% | $20,968 | 3% | $31,949 | 5% | $645,607 |
| 2013 | $447,481 | 67% | $156,791 | 23% | $39,213 | 6% | $24,995 | 4% | $668,480 |
| Average | - | 80% | - | 13% | - | 4% | - | 3% | - |

### 10.1.4 Participants and Effort

Commercial fishermen in North Carolina often rely on multiple species to generate revenue at different times of the year and participate in several fisheries. When examining the total ex-vessel value of commercial landings from commercial participants reporting landings of kingfishes, it is clear that participants in the fishery for kingfishes often rely more on other species for fishing revenue. In 2013, participants in the commercial fishery for kingfishes reported seafood landings that were valued at $33.25 million, with brown shrimp and white shrimp accounting for the largest portion of the harvest value (16% for both species), followed by hard blue crab (15%), flounders (12%), croaker (5%), Spanish mackerel (3%), striped mullet (3%), oysters (2%), and finally kingfishes (2%). While there is a directed commercial fishery for kingfishes, when examining all trips where kingfishes were landed, kingfishes most often made up less than 5% of the total ex-vessel value of the trip. This reflects the notation that kingfishes are often unintended species rather than the target of these fishing trips (Table 10.4). A similar trend is also reflected in Table 10.5, where the majority of commercial participants report landings of kingfishes worth less than $100 each year.

Table 10.4 Number of commercial trips landing kingfishes sorted by percent of total trip ex-vessel value attributable to kingfishes, 1994–2013 (Source: NCTTP, unpublished data).

| Percent of total trip value | Year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
| <5% | 7,316 | 8,346 | 5,844 | 6,595 | 5,528 | 6,072 | 5,527 | 4,074 | 3,680 | 3,792 | 4,271 |
| 5%-9.9% | 1,151 | 1,172 | 955 | 1,211 | 989 | 926 | 924 | 685 | 553 | 603 | 562 |
| 10%-24.9% | 1,195 | 1,128 | 853 | 1,231 | 939 | 827 | 889 | 741 | 595 | 751 | 605 |
| 25%-49.9% | 622 | 670 | 559 | 830 | 478 | 531 | 445 | 527 | 418 | 477 | 426 |
| 50%-74.9% | 362 | 528 | 367 | 497 | 327 | 438 | 246 | 432 | 371 | 311 | 294 |
| 75%-99.9% | 377 | 598 | 276 | 573 | 435 | 565 | 533 | 685 | 767 | 758 | 578 |
| 100% | 65 | 54 | 54 | 84 | 72 | 87 | 148 | 116 | 127 | 102 | 117 |
| Total trips | 11,088 | 12,496 | 8,908 | 11,021 | 8,768 | 9,446 | 8,712 | 7,260 | 6,511 | 6,794 | 6,853 |

| Percent of total trip value | Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | Average |
| <5% | 3,268 | 4,084 | 4,334 | 4,690 | 4,535 | 3,720 | 3,230 | 4,094 | 5,565 | 4,928 |
| 5%-9.9% | 452 | 606 | 473 | 549 | 581 | 497 | 383 | 542 | 648 | 723 |
| 10%-24.9% | 459 | 663 | 544 | 485 | 593 | 464 | 313 | 655 | 605 | 727 |
| 25%-49.9% | 294 | 432 | 316 | 340 | 374 | 311 | 214 | 435 | 422 | 456 |
| 50%-74.9% | 206 | 313 | 348 | 292 | 278 | 234 | 201 | 390 | 345 | 339 |
| 75%-99.9% | 315 | 465 | 801 | 733 | 695 | 700 | 616 | 588 | 448 | 575 |
| 100% | 130 | 84 | 115 | 164 | 174 | 234 | 87 | 156 | 106 | 114 |
| Total trips | 5,124 | 6,647 | 6,931 | 7,253 | 7,230 | 6,160 | 5,044 | 6,860 | 8,139 | 7,862 |

Table 10.5 Number of participants in the commercial fishery for kingfishes in North Carolina sorted by ex-vessel value of landings, 1994–2013 (Source: NCTTP, unpublished data).

| | Year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
| Under $100 | 508 | 538 | 503 | 504 | 449 | 458 | 451 | 385 | 370 | 344 | 407 |
| % of total | 61% | 57% | 61% | 58% | 60% | 58% | 60% | 58% | 56% | 55% | 61% |
| $100-$500 | 170 | 168 | 165 | 166 | 166 | 140 | 139 | 137 | 136 | 139 | 119 |
| % of total | 20% | 18% | 20% | 19% | 22% | 18% | 19% | 21% | 21% | 22% | 18% |
| $501-$1,000 | 69 | 83 | 58 | 63 | 47 | 48 | 45 | 40 | 50 | 49 | 52 |
| % of total | 8% | 9% | 7% | 7% | 6% | 6% | 6% | 6% | 8% | 8% | 8% |
| $1,001-$2,000 | 38 | 55 | 53 | 46 | 40 | 65 | 54 | 36 | 39 | 32 | 38 |
| % of total | 5% | 6% | 6% | 5% | 5% | 8% | 7% | 5% | 6% | 5% | 6% |
| $2,001-$5,000 | 34 | 58 | 36 | 54 | 26 | 41 | 34 | 42 | 38 | 27 | 23 |
| % of total | 4% | 6% | 4% | 6% | 3% | 5% | 5% | 6% | 6% | 4% | 3% |
| $5,001-$10,000 | 8 | 23 | 8 | 23 | 9 | 21 | 19 | 13 | 17 | 16 | 12 |
| % of total | 1% | 2% | 1% | 3% | 1% | 3% | 3% | 2% | 3% | 3% | 2% |
| More than $10,000 | 3 | 12 | 7 | 15 | 8 | 10 | 8 | 9 | 13 | 13 | 14 |
| % of total | 0% | 1% | 1% | 2% | 1% | 1% | 1% | 1% | 2% | 2% | 2% |
| Total | 830 | 937 | 830 | 871 | 745 | 783 | 750 | 662 | 663 | 620 | 665 |

| | Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | Average |
| Under $100 | 414 | 424 | 396 | 467 | 478 | 376 | 411 | 429 | 444 | 438 |
| % of total | 72% | 65% | 60% | 61% | 64% | 58% | 68% | 63% | 60% | 61% |
| $100-$500 | 90 | 111 | 114 | 117 | 118 | 122 | 93 | 115 | 128 | 133 |
| % of total | 16% | 17% | 17% | 15% | 16% | 19% | 15% | 17% | 17% | 18% |
| $501-$1,000 | 19 | 47 | 52 | 57 | 48 | 47 | 36 | 53 | 48 | 51 |
| % of total | 3% | 7% | 8% | 8% | 6% | 7% | 6% | 8% | 6% | 7% |
| $1,001-$2,000 | 17 | 25 | 34 | 41 | 36 | 32 | 19 | 28 | 50 | 39 |
| % of total | 3% | 4% | 5% | 5% | 5% | 5% | 3% | 4% | 7% | 5% |
| $2,001-$5,000 | 24 | 18 | 25 | 30 | 32 | 27 | 20 | 24 | 40 | 33 |
| % of total | 4% | 3% | 4% | 4% | 4% | 4% | 3% | 4% | 5% | 4% |
| $5,001-$10,000 | 5 | 12 | 21 | 22 | 18 | 24 | 15 | 13 | 19 | 16 |
| % of total | 1% | 2% | 3% | 3% | 2% | 4% | 2% | 2% | 3% | 2% |
| More than $10,000 | 7 | 16 | 20 | 26 | 21 | 25 | 13 | 16 | 13 | 13 |
| % of total | 1% | 2% | 3% | 3% | 3% | 4% | 2% | 2% | 2% | 2% |
| Total | 576 | 653 | 662 | 760 | 751 | 653 | 607 | 678 | 742 | 722 |

The number of participants in the fishery for kingfishes has varied while the number of seafood dealers has remained relatively steady from 1994 to 2013 (Figure 10.4). The number of commercial participants tended to drop from the mid-1990s to the mid-2000s. This was followed by a rise in participant counts until 2008. Participation fell again for several years before recovering towards the end of the time series, with 742 commercial fishermen reporting landings of kingfishes in 2013. Despite the directed fishery for kingfishes, many of the participants likely caught kingfishes as bycatch in other fisheries, such as the shrimp fishery, indicating that other fisheries heavily influence the total number of participants reporting landings of kingfishes from year to year.

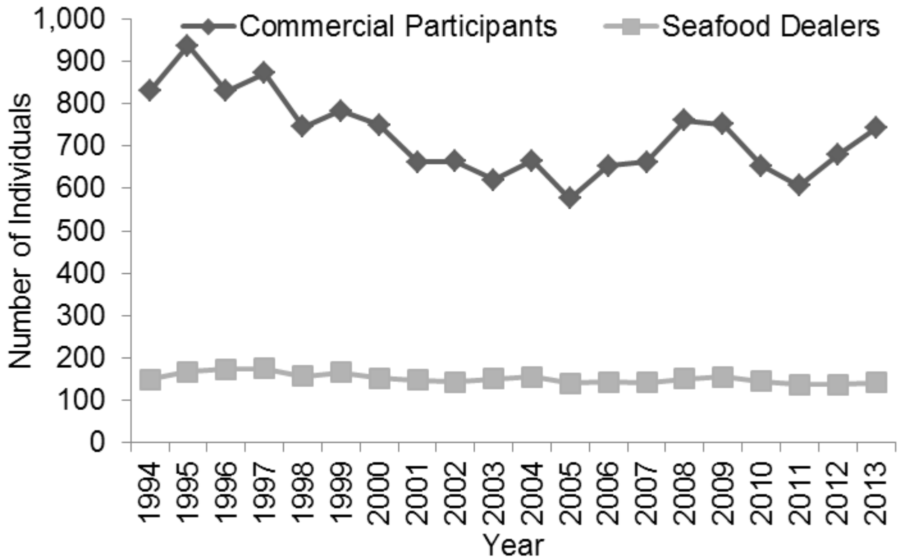


Figure 10.4 Number of commercial participants and seafood dealers reporting landings of kingfishes in North Carolina, 1994–2013 (Source: NCTTP, unpublished data).

Table 10.6 shows the total number of seafood dealers reporting landings of kingfishes by ex-vessel value. As mentioned, the number of dealers selling kingfishes has not changed drastically over the time series. While variable from year to year, the total percentage of dealers selling kingfishes has tended to shift more to the extreme values in the table of "Under $100" and "More than $20,000", with 2013 percentages coming in above the long-term average for both categories. Brunswick County had the largest number of dealers selling kingfishes in 2013, followed by Carteret, Dare, New Hanover, and Onslow counties (Table 10.7).

Table 10.6 Number of seafood dealers involved in the commercial fishery for kingfishes in North Carolina sorted by ex-vessel value of landings, 1994–2013 (Source: NCTTP, unpublished data).

| | Year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
| Under $100 | 47 | 65 | 78 | 73 | 62 | 61 | 58 | 64 | 52 | 55 | 54 |
| % of total | 31% | 39% | 45% | 41% | 39% | 37% | 38% | 43% | 36% | 36% | 35% |
| $100-$500 | 30 | 27 | 33 | 29 | 28 | 25 | 20 | 19 | 23 | 32 | 38 |
| % of total | 20% | 16% | 19% | 16% | 18% | 15% | 13% | 13% | 16% | 21% | 24% |
| $501-$1,000 | 11 | 15 | 6 | 12 | 16 | 11 | 17 | 7 | 6 | 13 | 12 |
| % of total | 7% | 9% | 3% | 7% | 10% | 7% | 11% | 5% | 4% | 9% | 8% |
| $1,001-$2,000 | 20 | 14 | 14 | 8 | 15 | 13 | 11 | 10 | 13 | 11 | 12 |
| % of total | 13% | 8% | 8% | 5% | 10% | 8% | 7% | 7% | 9% | 7% | 8% |
| $2,001-$5,000 | 18 | 18 | 17 | 17 | 11 | 18 | 18 | 22 | 23 | 14 | 11 |
| % of total | 12% | 11% | 10% | 10% | 7% | 11% | 12% | 15% | 16% | 9% | 7% |
| $5,001-$10,000 | 14 | 7 | 11 | 15 | 8 | 17 | 15 | 13 | 11 | 14 | 13 |
| % of total | 9% | 4% | 6% | 9% | 5% | 10% | 10% | 9% | 8% | 9% | 8% |
| $10,001-$20,000 | 7 | 12 | 11 | 6 | 11 | 16 | 6 | 7 | 6 | 4 | 11 |
| % of total | 5% | 7% | 6% | 3% | 7% | 10% | 4% | 5% | 4% | 3% | 7% |
| More than $20,000 | 3 | 10 | 4 | 16 | 6 | 6 | 7 | 6 | 9 | 8 | 5 |
| % of total | 2% | 6% | 2% | 9% | 4% | 4% | 5% | 4% | 6% | 5% | 3% |
| Total | 150 | 168 | 174 | 176 | 157 | 167 | 152 | 148 | 143 | 151 | 156 |

| | Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | Average |
| Under $100 | 66 | 65 | 58 | 62 | 67 | 54 | 66 | 67 | 64 | 62 |
| % of total | 47% | 45% | 41% | 41% | 43% | 37% | 48% | 49% | 45% | 41% |
| $100-$500 | 28 | 28 | 25 | 24 | 32 | 26 | 23 | 19 | 26 | 27 |
| % of total | 20% | 20% | 18% | 16% | 21% | 18% | 17% | 14% | 18% | 18% |
| $501-$1,000 | 8 | 8 | 11 | 12 | 5 | 13 | 9 | 7 | 8 | 10 |
| % of total | 6% | 6% | 8% | 8% | 3% | 9% | 7% | 5% | 6% | 7% |
| $1,001-$2,000 | 11 | 8 | 11 | 9 | 11 | 12 | 11 | 7 | 5 | 11 |
| % of total | 8% | 6% | 8% | 6% | 7% | 8% | 8% | 5% | 4% | 7% |
| $2,001-$5,000 | 10 | 16 | 8 | 12 | 16 | 12 | 7 | 11 | 8 | 14 |
| % of total | 7% | 11% | 6% | 8% | 10% | 8% | 5% | 8% | 6% | 9% |
| $5,001-$10,000 | 8 | 5 | 10 | 8 | 5 | 6 | 8 | 6 | 13 | 10 |
| % of total | 6% | 3% | 7% | 5% | 3% | 4% | 6% | 4% | 9% | 7% |
| $10,001-$20,000 | 7 | 7 | 9 | 13 | 9 | 8 | 6 | 10 | 3 | 8 |
| % of total | 5% | 5% | 6% | 9% | 6% | 6% | 4% | 7% | 2% | 6% |
| More than $20,000 | 2 | 6 | 10 | 11 | 11 | 14 | 8 | 10 | 15 | 8 |
| % of total | 1% | 4% | 7% | 7% | 7% | 10% | 6% | 7% | 11% | 6% |
| Total | 140 | 143 | 142 | 151 | 156 | 145 | 138 | 137 | 142 | 152 |

Table 10.7 Number of seafood dealers reporting landings of kingfishes by county in North Carolina, 1994–2013 (Source: NCTTP, unpublished data).

| | Year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| County | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
| Brunswick | 24 | 28 | 28 | 33 | 28 | 30 | 32 | 23 | 23 | 28 | 29 |
| Carteret | 25 | 28 | 26 | 32 | 30 | 32 | 27 | 24 | 27 | 25 | 27 |
| Dare | 31 | 34 | 37 | 30 | 26 | 24 | 23 | 22 | 21 | 22 | 19 |
| New Hanover | 15 | 15 | 16 | 16 | 15 | 15 | 13 | 16 | 15 | 19 | 16 |
| Onslow | 11 | 12 | 11 | 11 | 11 | 10 | 10 | 12 | 14 | 12 | 18 |
| Other | 44 | 51 | 56 | 54 | 47 | 56 | 47 | 51 | 43 | 45 | 47 |
| Total | 150 | 168 | 174 | 176 | 157 | 167 | 152 | 148 | 143 | 151 | 156 |

| | Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| County | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | Average |
| Brunswick | 22 | 20 | 23 | 23 | 31 | 26 | 26 | 29 | 31 | 27 |
| Carteret | 24 | 25 | 24 | 29 | 23 | 29 | 27 | 24 | 24 | 27 |
| Dare | 21 | 17 | 21 | 17 | 17 | 15 | 13 | 16 | 15 | 22 |
| New Hanover | 17 | 15 | 16 | 16 | 12 | 15 | 11 | 10 | 12 | 15 |
| Onslow | 12 | 16 | 14 | 17 | 18 | 16 | 15 | 14 | 13 | 13 |
| Other | 44 | 50 | 44 | 49 | 55 | 44 | 46 | 44 | 47 | 48 |
| Total | 140 | 143 | 142 | 151 | 156 | 145 | 138 | 137 | 142 | 152 |

### 10.1.5 Economic Impact of the Commercial Fishery

The expenditures and income within the commercial fishing industry and related businesses produce ripple effects as money is spent and re-spent in the state economy. Each dollar spent generates additional economic impacts by stimulating further economic activity that supports jobs, income, industry output and business sales. The estimated economic impact of commercial landings of kingfishes can be found in Table 10.8.

Table 10.8 Economic impacts associated with commercial landings of kingfishes in North Carolina, 2013.

| | | | Estimated Economic Impacts | | |
|---|---|---|---|---|---|
| Participants[1] | Trips[1] | Ex-vessel value[1] | Jobs[2,3] | Income impacts (thousands of dollars)[3] | Sales impacts (thousands of dollars)[3] |
| 742 | 8,139 | $668,480 | 57 | $1,079.2 | $2,579.9 |

[1]As reported by the NCTTP
[2]Represents average monthly number of full-time and part-time jobs over a 12-month period
[3]Economic impacts calculated using the NCDMF commercial fishing economic impact model and IMPLAN economic impact modeling software; all economic impact estimates are for the state economy of North Carolina

The presented economic impact estimates represent those of commercial seafood harvesters, dealers, processors, wholesalers, distributors, and retailers. These estimates are a product of the NCDMF economic impact model for commercial fishing which uses IMPLAN economic impact modeling software customized with data from the NCDMF as well as economic multipliers originating from the NMFS Commercial Fishing and Seafood Industry Input/Output Model (NOAA 2011). Commercial landings data from the NCTTP are used as the primary input as well as data from North Carolina commercial fishermen and seafood dealers collected during surveys that have been carried out by the NCDMF Fisheries Economics Program examining fishing business expenditures (Crosson 2007, 2009, 2010a; Hadley and Crosson 2010; Hadley and Wiegand 2014). Economic multipliers for commercial harvesters as well as seafood dealers and processors are derived from NCDMF data while multipliers for seafood wholesalers, distributors, and retailers originate from the NMFS model.

## 10.2 ECONOMIC ASPECTS OF THE RECREATIONAL FISHERY

Kingfishes are commonly caught and targeted recreational species among nearshore, pier, and beach anglers in North Carolina. Information on recreational fishing for kingfishes is collected by the NCDMF in conjunction with the MRIP. The effort estimates produced by the MRIP can be used to estimate total recreational fishing trip expenditures and economic impacts stemming from directed trips (caught and targeted) for kingfishes (Table 10.9). As with the commercial sector, these expenditures produce ripple effects as money is spent and re-spent in the state economy. This economic activity supports jobs, income, industry output and business sales in the state.

Table 10.9 Economic impacts associated with directed recreational fishing trips for kingfishes, 2013.

| | | | Estimated Economic Impacts | |
|---|---|---|---|---|
| Trips[1] | Trip expenditures (thousands of dollars)[2] | Jobs[3,4] | Income Impacts (thousands of dollars)[4] | Sales Impacts (thousands of dollars)[4] |
| 301,091 | $18,337.1 | 269 | $8,159.40 | $21,633.60 |

[1]Trip estimates as reported by the MRIP
[2]Expenditures estimated using the NCDMF economic impact model for coastal recreational fishing.
[3]Represents average monthly number of full-time and part-time jobs over a 12-month period
[4]Economic impacts calculated using the NCDMF economic impact model for coastal recreational fishing and IMPLAN economic impact modeling software.

Estimates of the economic impacts occurring from recreational fishing trips for kingfishes are conducted using the NCDMF economic impact model for coastal recreational fishing and IMPLAN software. The NCDMF economic impact model combines effort data by mode (charter boat, private/rental boat, beach/bank, and man-made structures) with inflation adjusted angler expenditures per trip by expenditure category. These expenditures are derived from information collected from recreational anglers in North Carolina during surveys that have been carried out by the NCDMF Fisheries Economics Program and for North Carolina Sea Grant to provide estimated total coastal recreational fishing trip expenditures (Dumas et al. 2009; Crosson 2010; Hadley 2012).

Determining the economic impact of recreational fishing for a specific species involves a level of uncertainty given that multiple species are often targeted and caught on a recreational fishing trip. The nature of the MRIP trip data that must be used to provide the inputs to examine economic impacts of coastal recreational fishing makes it difficult to distinguish the percentage of expenditures that should be dedicated to a single species. As such, the presented economic impacts are a conservatively high estimate of the trip impacts that can be attributed solely to kingfishes, since other desirable species are at times targeted or caught by those fishing recreationally for kingfishes. If other desirable species are caught or targeted on a fishing trip, such as southern flounder or spot, some portion of the angler's expense for the trip would likely be dedicated towards these species as well.

Due to the nature of the effort data that is used, an analysis cannot be performed at this time that removes the impact of other species from directed trips for kingfishes. Therefore, all trip expenses occurring on directed trips for kingfishes are fully dedicated to this group of species. Of the directed recreational trips included in this analysis, 62% of the trips list kingfishes as a primary or secondary target, with the remaining 38% of trips indicating catching or harvesting kingfishes but not listing the species as the primary or secondary target.

Conversely, the economic impacts presented may represent a conservatively low estimate for the recreational fishery for kingfishes, as this analysis solely examines impacts derived from recreational fishing trip expenditures (gas, groceries, bait, etc.). The analyzed expenditures do not include those that are made on durable goods related to recreational fishing such as rods, reels, boats, or towing vehicles. While some durable goods are purchased with the intention of being used in the fishery for kingfishes, these durable goods often have a usable lifespan of several years and may be utilized in multiple other fisheries as well as in other activities (recreational boating, waterfowl hunting, transportation, etc.). General information on durable goods expenditures for coastal recreational fishing in North Carolina do exist, but data are not available that would allow an analysis to devote these expenditures specifically to the recreational fishery for kingfishes.

## 10.3 SOCIAL ASPECTS OF THE FISHERY

### 10.3.1 Commercial Fishery

The NCDMF Fisheries Economics Program has been conducting in-depth socioeconomic surveys of commercial fishermen since 1999 that gather information on fishing business characteristics, expenditures, and general perceptions about community reliance on commercial fishing, fisheries management, and conflict. The surveys are conducted in five different regions of the state. These survey responses can be used to provide insight into the social importance of specific species from a commercial fishing perspective. The current dataset has a relatively small number of survey responses from commercial fishermen that identify themselves as participants in the fishery for kingfishes (n = 22)[1].

#### <u>10.3.1.1 Demographics and fishing characteristics of commercial fishermen</u>

Table 10.10 shows the demographic and fishing characteristics of the 22 commercial fishermen that identified themselves as participants in the fishery for kingfishes. Nearly all were Caucasian males, with an average age of 50 years and had 30 years of commercial fishing experience. Most had at least a high school education and over a third had some college education. On average, commercial fishing accounted for the 80% of their personal income and the majority of survey respondents (64%) reported that fishing accounted for all of their personal income.

[1] Surveys utilized in this analysis consist of those conducted with commercial fishermen who use the waters of Core Sound (last surveyed in 2007), the Albemarle and Pamlico sounds (last surveyed in 2014), and the Atlantic Ocean (last surveyed in 2009).

Table 10.10 Demographic and fishing characteristics of survey respondents participating in the commercial fishery for kingfishes (Source: NCDMF Fisheries Economics Program, unpublished data).

| | Number | Percent |
|---|---|---|
| Gender | | |
| Male | 22 | 100% |
| Race | | |
| Caucasian | 21 | 95% |
| African American | 1 | 5% |
| Education | | |
| Less than high school | 2 | 9% |
| High school graduate | 12 | 55% |
| Some college | 7 | 32% |
| College graduate | 1 | 5% |
| Age | | |
| Average | 50 | |
| Minimum | 34 | |
| Maximum | 66 | |
| Years fishing | | |
| Average | 30 | |
| Minimum | 5 | |
| Maximum | 50 | |

| | | Number | Percent |
|---|---|---|---|
| Marital Status | | | |
| | Married | 18 | 82% |
| | Divorced | 3 | 14% |
| | Separated | 1 | 5% |
| Household Size | | | |
| | 1 | 2 | 10% |
| | 2 | 9 | 43% |
| | 3 | 4 | 19% |
| | 4 | 4 | 19% |
| | 5 | 1 | 5% |
| | >5 | 1 | 5% |
| Fishing status | | | |
| | Full Time | 17 | 77% |
| | Part Time | 5 | 23% |
| % of personal income from fishing | | | |
| | Average | | 80% |
| | Minimum | | 15% |
| | Maximum | | 100% |

#### 10.3.1.2 Historical Importance and Community Reliance on Commercial Fishing

North Carolina coastal communities have historically been strongly dependent on the commercial fishing and tourism industries. A historical overview of the commercial fishery for kingfishes can be found in Section 7.0, Status of the Fisheries. The NCDMF socioeconomic surveys collect information from commercial fishermen on their opinion as to how historically important commercial fishing is to their community and how important commercial fishing is currently to their community's local economy. On a scale of one to ten in regards to particular survey questions, with one being "not at all" and ten being "extremely", the average rating across all kingfish fishermen interviewed was 9.9 in regards to commercial fishing being historically important to their community. On the same scale, the statement "commercial fishing is important economically in my current community" generated a slightly lower average response of 8.2. Table 10.11 shows the communities that were most often cited by survey respondents.

Table 10.11 Communities of survey respondents participating in the commercial fishery for kingfishes (Source: NCDMF Fisheries Economics Program, unpublished data).

| Community | Number of Respondents |
|---|---|
| Hatteras, NC | 6 |
| Frisco, NC | 2 |
| Sneads Ferry, NC | 2 |
| Kitty Hawk, NC | 1 |
| Nags Head, NC | 1 |
| Accomac, VA | 1 |
| Hubert, NC | 1 |
| Wanchese, NC | 1 |
| Hampstead, NC | 1 |
| Stumpy Point, NC | 1 |
| Southport, NC | 1 |
| Beaufort, NC | 1 |
| Atlantic, NC | 1 |
| Otway, NC | 1 |
| Harkers Island, NC | 1 |

#### 10.3.1.3 Perceived Conflicts

Commercial fishermen were asked about conflicts or negative experiences occurring in the previous year with other commercial fishermen, recreational fishermen, state regulations, and federal regulations. The majority of survey participants involved in the fishery kingfishes (64%) did not indicate any conflicts or negative experiences within the survey categories (Figure 10.5). The most common conflict reported was with recreational fishermen (27%), followed by federal regulations (23%), state regulations (23%), and other commercial fishermen (14%). Several fishermen reported more than one type of conflict; therefore, the reported percentages do not add up to 100%.

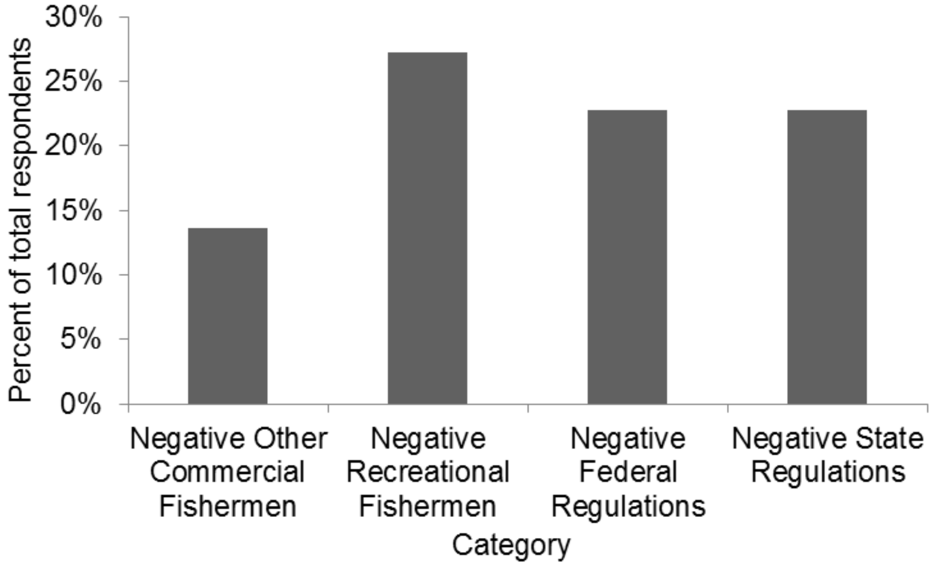


Figure 10.5 Reported conflicts of survey respondents participating in the commercial fishery for kingfishes (Source: NCDMF Fisheries Economics Program, unpublished data).

#### 10.3.1.4 Perception of Important Issues

Commercial participants involved in the fishery for kingfishes interviewed by the NCDMF were asked to rate how important certain issues were in relation to their fishing business. The most important issue to these fishermen was the price of fuel. This was followed by coastal development, low prices for seafood, anticipating future business conditions, and losing working waterfronts. Of least concern were trip limits, overfishing, quotas, size limits, and state regulations (Table 10.12). The lack of concern over the previously stated issues is intuitive, as there are few regulations on kingfishes compared to other species found in coastal North Carolina.

Table 10.12 Fishing business related issues considered most important to survey respondents participating in the commercial fishery for kingfishes (Source: NCDMF Fisheries Economics Program, unpublished data).

| Ranking | Issue |
|---|---|
| 1 | Price of fuel |
| 2 | Coastal development |
| 3 | Low prices for seafood |
| 4 | Anticipating future business conditions |
| 5 | Losing working waterfronts |
| 6 | Competition from imported seafood |
| 7 | Gear restrictions |
| 8 | Federal regulations |
| 9 | Weather |
| 10 | Rules and proclamations |
| 11 | Closed season |
| 12 | State regulations |
| 13 | Size limits |
| 14 | Quotas |
| 15 | Overfishing |
| 16 | Trip limits |

### 10.3.2 Recreational Fishery

The NCDMF Fisheries Economics Program conducted a socioeconomic survey of CRFL holders in 2009 (Crosson 2010b). This survey collected information on fishing trip expenditures, fishing behavior, and general perceptions on fisheries management, issues effecting saltwater fishing, and conflict. These survey responses can be used to provide insight into the demographics and perceptions of recreational anglers on a species-specific basis. Of the 608 anglers that were surveyed, a total of 285 identified themselves as participants in the fishery for kingfishes.

#### 10.3.2.1 Demographic and Fishing Characteristics of Recreational Anglers

Table 10.13 shows the demographic and fishing characteristics of the 285 CRFL holders that identified themselves as participants in the fishery for kingfishes. Nearly all were Caucasian males, with an average age of 49 years and 30 years of recreational fishing experience. Almost all had at least a high school education (94%) and two thirds had at least some college education. Surveyed anglers most commonly had an annual household income between $50,001 and $75,000.

Table 10.13 Demographic and fishing characteristics of survey respondents participating in the recreational fishery for kingfishes (Source: NCDMF Fisheries Economics Program, unpublished data).

| | Number | Percent |
|---|---|---|
| Gender | | |
| Male | 258 | 92% |
| Female | 23 | 8% |
| Marital Status | | |
| Currently married | 232 | 83% |
| Never married | 30 | 11% |
| Divorced | 12 | 4% |
| Separated | 4 | 1% |
| Widowed | 3 | 1% |
| Race | | |
| Caucasian | 258 | 93% |
| African American | 11 | 4% |
| Native American | 6 | 2% |
| Latino | 2 | 1% |
| Age | | |
| Average | 49 | |
| Minimum | 19 | |
| Maximum | 73 | |
| Years fishing | | |
| Average | 30 | |
| Minimum | 2 | |
| Maximum | 60 | |

| | Number | Percent |
|---|---|---|
| Number of people in household | | |
| 1 | 24 | 9% |
| 2 | 137 | 49% |
| 3 | 48 | 17% |
| 4 | 54 | 19% |
| 5 | 11 | 4% |
| > 5 | 5 | 2% |
| Household income | | |
| Less than $15,000 | 6 | 2% |
| $15,001-$30,000 | 21 | 8% |
| $30,001-$50,000 | 49 | 18% |
| $50,001-$75,000 | 58 | 21% |
| $75,001-$100,000 | 49 | 18% |
| More than $100,000 | 40 | 14% |
| Prefer not to answer | 55 | 20% |
| Education | | |
| Less than high school | 18 | 6% |
| High school graduate | 78 | 28% |
| Some college | 90 | 32% |
| College graduate | 71 | 25% |
| Graduate degree | 25 | 9% |

#### 10.3.2.2 Common Target Species

Surveyed CRFL holders were asked to list the species that they targeted when recreational fishing. Table 10.14 shows the top 10 most commonly targeted species of surveyed kingfish anglers. Flounder were the most commonly mentioned species (92%), followed closely by spot (91%), spotted sea trout (81%), Atlantic croaker (81%), bluefish (78%), and red drum (72%).

Table 10.14 Top 10 most common other target species of survey respondents participating in the recreational fishery for kingfishes (Source: NCDMF Fisheries Economics Program, unpublished data).

| Species | Percent of respondents |
|---|---|
| Flounder | 92% |
| Spot | 91% |
| Spotted sea trout | 81% |
| Atlantic croaker | 81% |
| Bluefish | 78% |
| Red drum | 72% |
| Black drum | 68% |
| Pompano | 60% |
| Gray trout | 57% |
| Striped bass | 49% |

#### 10.3.2.3 Perceived Conflicts

Recreational anglers were asked about conflicts or negative experiences occurring in the previous year with other recreational fishermen, commercial fishermen, state regulations, and federal regulations. Most anglers did not report any conflicts or negative experiences within the surveyed categories. The most common conflict reported was with commercial fishermen (14%) followed by other recreational fishermen (9%), state regulations (3%), and federal regulations (1%; Figure 10.6).

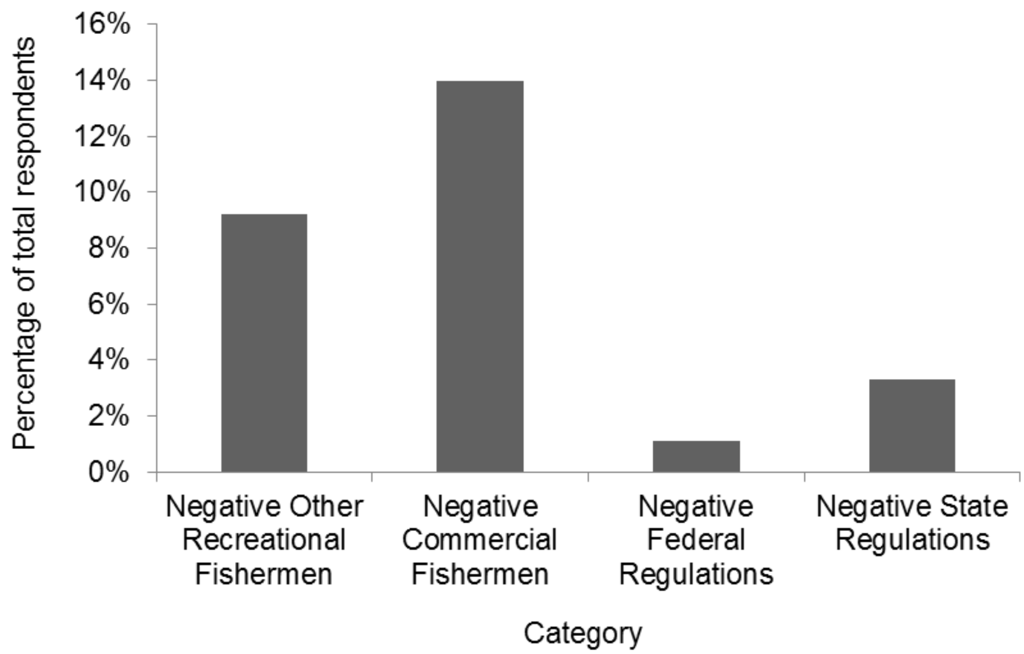


Figure 10.6 Reported conflicts of survey respondents participating in the recreational fishery for kingfishes (Source: NCDMF Fisheries Economics Program, unpublished data).

#### 10.3.2.4 Perception of Important Issues

Recreational kingfish anglers interviewed by the NCDMF were asked to rate how important certain issues were in relation to their fishing activity. The most important issue to these fishermen was water quality (Table 10.15). This was followed by keeping up with regulations, finding time to go fishing, the price of fuel, and overfishing. Of least concern was competition from other recreational fishermen, competition from commercial fishermen, bag and size limits, weather, and access to boat ramps, beaches, and piers.

Table 10.15 Fishing related issues considered most important to survey respondents participating in the recreational fishery for kingfishes (Source: NCDMF Fisheries Economics Program, unpublished data).

| Ranking | Issue |
|---|---|
| 1 | Water Quality |
| 2 | Keeping up with regulations |
| 3 | Finding time to go fishing |
| 4 | Price of fuel |
| 5 | Overfishing |
| 6 | Losing fishing piers |
| 7 | Access to boat ramps, beaches, and piers |
| 8 | Weather |
| 9 | Bag and size limits |
| 10 | Competition from commercial fishermen |
| 11 | Competition from other recreational fishermen |

# 11.0 ENVIRONMENTAL FACTORS

## 11.1 HABITAT

Kingfishes have diverse habitat preferences that shift due to season and ontogenetic stage (Section 6.1 General Life History). Kingfishes are found in most habitats defined by the North Carolina Coastal Habitat Protection Plan (CHPP) including water column, soft bottom, submerged aquatic vegetation, and hard bottom (Deaton et al. 2010). Wetlands and shell bottom habitat, although not directly connected to habitats of kingfishes, are critical to kingfishes because they provide nursery areas for prey items and are important to the health of aquatic ecosystems. Protection of each habitat type is vital to maintaining a productive coastal ecosystem, which in turn is essential for a sustainable stock of kingfishes. Much of the information below was taken from the CHPP (Deaton et al. 2010).

### 11.1.1 Water Column

The water column habitat is defined as "the water covering a submerged surface and its physical, chemical, and biological characteristics" (Deaton et al. 2010). Kingfishes make use of the water column throughout each life stage. The water column is a transport mechanism for eggs, which are buoyant due to oil globules (Welsh and Breder 1923). As described in the life history section, spawning occurs in the nearshore ocean or possibly inshore waters. Eggs are transported to the surf zone and into estuaries by prevailing wind-driven currents (Welsh and Breder 1923; Hoese 1965; Irwin 1970; Bourne and Govoni 1988). Additionally, larval behavioral responses such as directional swimming or movement in the water column further increase the chance of recruitment into estuaries, entrainment in an estuary, or recruitment to the surf zone (Boehlert and Mundy 1988; Churchill et al. 1999). Alterations of a natural system due to inlet stabilization or dredging of navigational channels will affect egg and larvae transport into estuaries (Epifanio 1988). Jetties have been shown to limit the scope of flood tide prisms (focusing flood waters to between jetties; Seabergh 1988; Blanton et al. 1999), which may reduce the numbers of eggs and larvae transported into the system, particularly for ocean-spawned fishes (Epifanio 1988; Lawler et al. 1988; Hare et al. 1999).

The water column provides an important source of food items for juvenile kingfishes, which primarily feed on epibenthic or planktonic prey such as copepods (Bearden 1963; Irwin 1970; Delancey 1984; McMichael and Ross 1987). The resuspension and retention of inorganic nutrients in the surf zone, an important nursery area for kingfishes, creates a food rich environment for larva and juveniles and supports large concentrations of fishes that use this area seasonally (Hackney et al. 1996).

Adult kingfishes are most common in high salinity waters (>18 ppt; Bearden 1963; Irwin 1970; Deaton et al. 2010). Salinity, which is an important factor in determining species distribution, is affected by rainfall, season, estuarine morphology, wind, lunar tides, and freshwater discharge (Deaton et al. 2010). Other important water quality factors determining species distribution include water temperature, dissolved oxygen (DO), flow, and pH. Kingfishes tolerate a wide range of temperatures but are generally regarded as spring and summer residents of North Carolina (Ross and Lancaster 2002). Kingfishes have been reported to migrate southward in the nearshore ocean during the fall and winter when the temperature decreases (Smith and Wenner 1985).

### 11.1.2 Soft Bottom

The soft bottom habitat is defined as “unconsolidated, unvegetated sediment that occurs in freshwater, estuarine, and marine environments” (Deaton et al. 2010). The soft bottom habitat is separated into freshwater, estuarine, and marine habitats due to differing geomorphology, salinity regime, sediment type, hydrography, and/or water depth. Estuarine sediment types include sand, peat, inorganic mud, and organic rich mud. Courser sandy sediments are concentrated along eroding or high-energy shorelines and the shallower perimeter of water bodies, while finer mud sediments are in the deeper center of water bodies (Wells 1989; Riggs 1996). Intertidal flats, ocean beaches, and inlets are dynamic soft bottom features, comprised of shifting sands. Soft bottom habitat in the estuary and ocean is highly valuable as a foraging area for kingfishes and other organisms.

All three kingfish species appear to be associated with soft bottom more than other benthic habitat types. Southern and northern kingfishes occur over sand and mud bottoms of estuarine and marine habitats (Hildebrand and Cable 1934; Bearden 1963; Irwin 1970; Dahlberg 1972; Ralph 1982; Crowe 1984; Harding and Chittenden 1987). Southern kingfish inhabit deep channels with mud bottoms (Viosca 1959) and mud bottoms in the ocean (Irwin 1970) and Pamlico Sound (J. Schoolfield, NCDMF, pers. com.). Northern kingfish are common in shallow bays as juveniles, and the adults are associated with mud bottom in the ocean as well as with hard substrate in the ocean (Irwin 1970; Miller et al. 2002). Juvenile and adult Gulf kingfish are most common in the nearshore marine habitat over a sandy bottom (Irwin 1970; Dahlberg 1972; Modde and Ross 1981). The use of distinct topographical features such as shoals, sandbars, and sloughs by kingfishes has not been described. More research is needed to confirm spawning and nursery use of soft bottom habitat by these species.

Soft bottom habitat plays a key role as a foraging area for herbivores, detritivores, invertebrate, feeding fish (including kingfishes), and larger predators because of the high concentrations of organic matter and infauna that occurs there (Peterson and Peterson 1979). The sediment type and energy regime will affect the primary and secondary productivity of the bottom, and therefore the benthic microalgae (benthic diatoms and blue-green algae), demersal zooplankton, and invertebrate prey available for kingfishes and other organisms. Primary production in bottom sediments is also derived from deposition of detrital matter from marsh vegetation, submerged grasses, and macroalgae that settles on soft bottoms (Currin et al. 1995). The soft bottom environment of the estuary supports a high diversity of benthic fauna (300 spp.; Hackney et al. 1996). Two important prey taxa for kingfishes, polychaete worms and pelecypods, inhabit the soft bottom in the estuary (Irwin 1970; McMichael and Ross 1987; Miller et al. 1996). Kingfishes will nip off pelecypod siphons and prey on mobile invertebrates that use the soft bottom such as penaeid shrimp (*Penaeus* spp., *Farfantepenaeus* spp., and *Litopenaeus* spp.) and hermit crabs (*Pagurus* spp., *Petrochirus* spp., and *Clibanarius vittatus*; Irwin 1970; McMichael and Ross 1987; Miller et al. 1996).

Two distinct areas of the marine soft bottom habitat include the surf zone (intertidal) and subtidal bottom (Deaton et al. 2010). Juvenile kingfishes of all three species use the surf zone as a nursery area. Kingfishes are summer residents of the surf zone, with Gulf kingfish generally ranking in the top five in number of individuals collected in surf zone studies (Tagatz and Dudley 1961; Cupka 1972; Ross and Lancaster 2002). Although species diversity is reduced in the marine intertidal bottom compared to the estuary and subtidal marine bottom, the habitat includes two of the more common prey species for kingfishes:

the mole crab (*Emerita talpoida*) and coquina clams (*Donax variables*, *D. parvula;* McMichael and Ross 1987; Hackney et al. 1996).

The offshore sand bottom along coastal North Carolina has a diverse benthic community comprised of polychaete worms, crustaceans, mollusks, and fishes (Posey and Ambrose 1994; Van Dolah et al. 1994). The infaunal species such as tube dwelling worms and permanent burrow dwelling worms are most impacted by beach renourishment and sand mining (Hackney et al. 1996). These soft bottom species tend to be opportunistic and recover relatively quickly after disturbances, depending on time of year, sediment compatibility, and other factors (Posey and Alphin 2001).

Kingfishes can use shallow unvegetated estuarine shoreline as a corridor to migrate within the estuary with reduced risk of predation (Peterson and Peterson 1979). Although there is little benthic structure associated with soft bottom, kingfishes can find refuge from predators by remaining on very shallow flats that are inaccessible to predators. Kingfishes are also somewhat camouflaged against the sand substrate. Adult kingfishes migrating in fall will feed on intertidal flats.

Soft bottom also plays a very important role in the ecology of estuarine ecosystems as a storage reservoir of nutrients, chemicals, and microbes. Intense biogeochemical processing and recycling establishes a filter to trap and reprocess natural and human-induced nutrients and toxic substances. These materials may pass through an estuary (Matoura and Woodward 1983), become trapped in the organic rich low salinity zone (Sigels et al. 1982; Imberger 1983), or migrate within the estuary over seasonal cycles (Uncles et al. 1988).

Estuarine soft bottom habitat may be affected by marina and dock facilities through alteration of the shoreline configuration, circulation patterns, and changes in bottom sediment characteristics (Wendt et al. 1990). Because benthic microalgae, an important component of primary production in soft bottom habitat, are light dependent, bottom sediments in dredged marinas will have reduced light availability due to the deeper water depth and shading from docking structures. Operation of a marina can also affect productivity of the soft bottom community due to introduction of heavy metals, hydrocarbons, and bacteria (Chmura and Ross 1978; Marcus and Stokes 1985; Voudrias and Smith 1986). Heavy metals and hydrocarbons are toxic to many soft bottom dwelling invertebrates and benthic feeding fish (Weis and Weis 1989). Additionally, DO may become depleted or below biotic thresholds in dredged marina basins and channels. A North Carolina study found significantly lower DO concentrations (less than 5.0 mg/l) inside some marinas compared to outside marinas (DEHNR 1990).

Fishing related impacts to soft bottom and other habitats have been reviewed and compiled in federal FMPs for managed species, and have been summarized in FMPs by the South Atlantic Fishery Management Council (SAFMC) and the Mid-Atlantic Fishery Management Council (MAFMC), as well as by the Moratorium Steering Committee (MSC 1996; Auster and Langton 1999; NCDMF 1999; Collie et al. 2000). A legislative report to the MSC (1996) compiled a list of the gears used in North Carolina waters and their probable impacts. The gears with the greatest potential for damage to soft bottom or other habitats include dredges and trawls. The extent of habitat damage from fishing gear varies greatly with the gear type, habitat complexity, and amount of gear contact.

Because of the severe bottom disturbance to structured habitat, crab dredging, hydraulic clam dredging, and clam kicking are restricted to open sand and mud bottoms, including areas frequently dredged as navigational channels. Bottom trawling is used more extensively than dredges on soft bottom habitat in both estuarine and coastal ocean waters. Dredge and trawl damage to soft bottom includes removing or damaging epifauna, reducing diversity and abundance of the benthic community, smoothing sediment features, and increasing exposure to predators (Auster and Langton 1999; Collie et al. 2000). Dredges and trawls resuspend sediment, which can clog fish gills, smother benthic prey of kingfishes, and reduce light dependent benthic productivity, which in turn affects the benthic food web (SAFMC 2009). No studies have looked at the effect of trawling on the benthic community of Pamlico or other sounds in North Carolina, which is a key food source for kingfish. Maps of areas prohibited to dredging or trawling in North Carolina waters are included in Figures 11.1, 11.2, and 11.3.

While the NCMFC rules are designed to minimize commercial fishing gear impacts to fish habitat, these restrictions primarily focus on restricting the use of highly destructive bottom disturbing gear from most structural habitats such as oyster or submerged aquatic vegetation (SAV) beds. Soft bottom habitat, because of its low structure and dynamic nature, has historically been considered the most appropriate location to use bottom-disturbing gear. Oyster dredges are restricted to subtidal waters in Pamlico Sound and deeper portions of bays and tributaries adjacent to Pamlico Sound and is prohibited in Primary Nursery Areas, Shellfish Management Areas, portions of Secondary Nursery Areas, and SAV habitat.

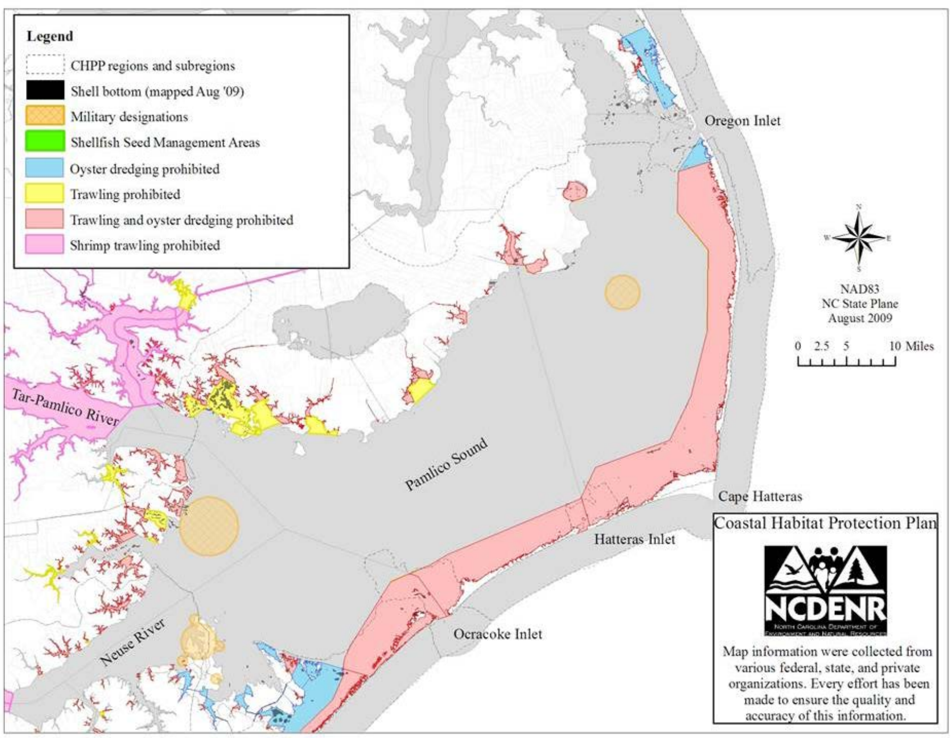


Figure 11.1 Areas prohibited to dredging or trawling in northern coastal waters of North Carolina.

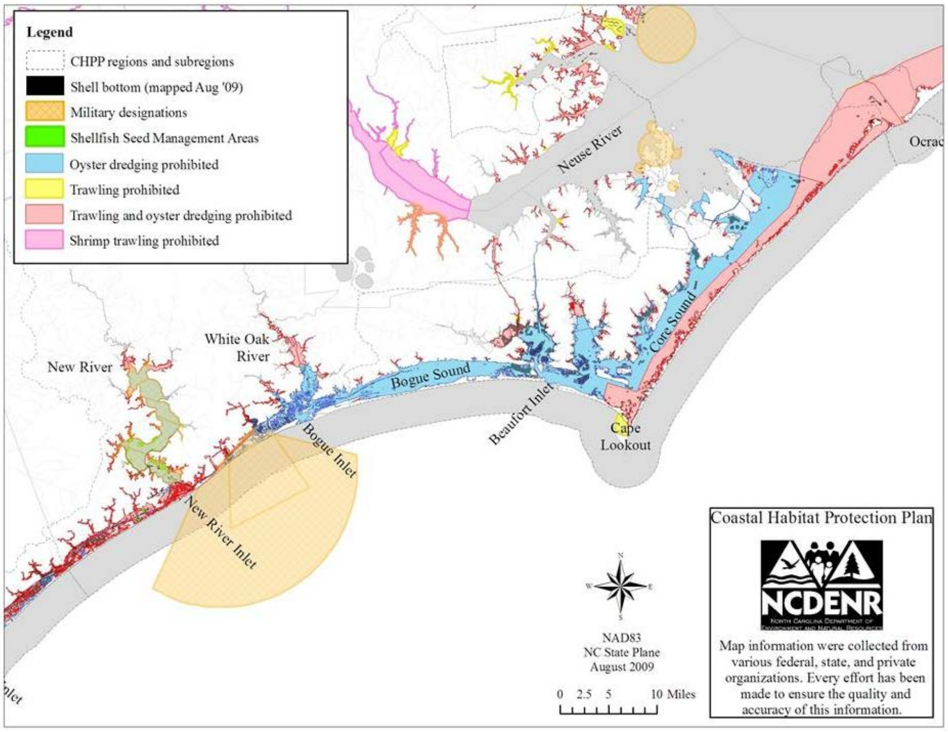


Figure 11.2 Areas prohibited to dredging or trawling in central coastal waters of North Carolina.

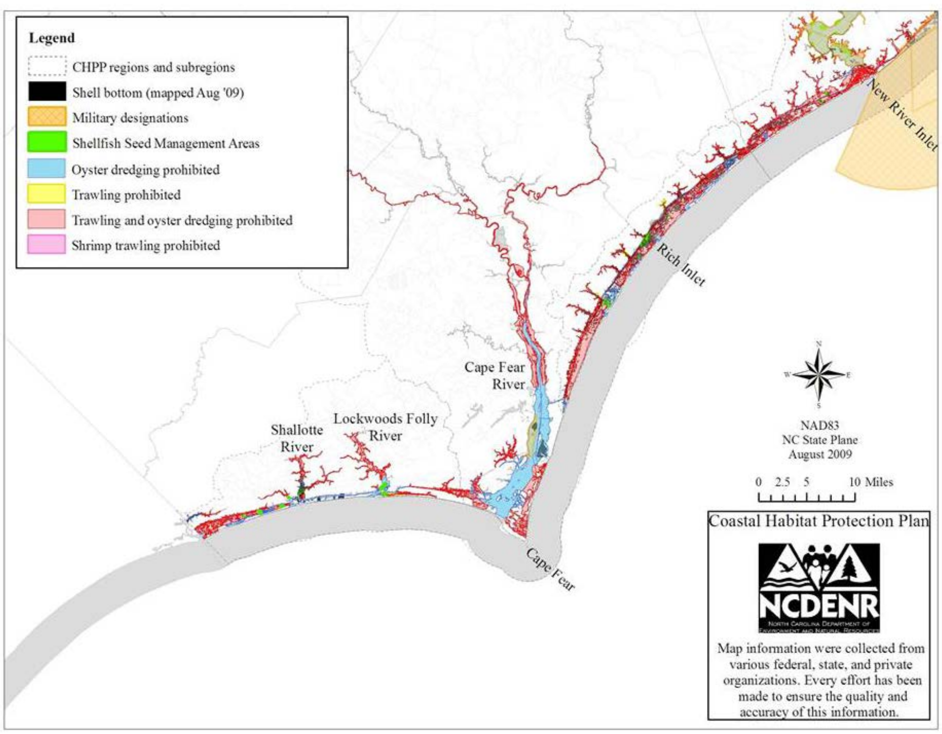


Figure 11.3 Areas prohibited to dredging or trawling in southern coastal waters of North Carolina.

Beach nourishment, and subsequent renourishment, can threaten the quality of intertidal and shallow subtidal ocean bottom habitat, which is important nursery and foraging grounds for kingfishes. When sand is placed on the intertidal beach, the existing benthos is buried, killing the prey available for kingfishes (Hackney et al. 1996). The reported recovery time of the benthic community generally ranges from one month to one year, although longer in some cases (Reilly and Bellis 1983; Van Dolah et al. 1992; Rackocinski et al. 1993; Donoghue 1999; Jutte et al. 1999; Peterson et al. 2000; Lindquist and Manning 2001; USACE 2001). Factors that affect the recovery time include compatibility of deposited material with native sand, volume, depth, and length of filler area, time of year, frequency of renourishment events, and specific site conditions. In addition to reduction in available food, beach renourishment can affect kingfishes and other fish species by altering preferred topographic features such as ebb tide deltas and nearshore muddy sloughs or reducing visibility (Deaton et al. 2010). Demersal feeding fish that feed in the surf zone, such as kingfishes and Florida pompano (*Trachinotus carolinus*), would be the most vulnerable to these effects of beach nourishment. Since Gulf and northern kingfish exhibit strong site fidelity, localized disturbances may negatively affect abundance of Gulf and northern kingfishes (Miller et al. 2002; Ross and Lancaster 2002).

In North Carolina, the effects of a Brunswick County beach nourishment project on surf fish, benthic invertebrates, and water quality were evaluated from March 2001 to May 2002 (USACE 2003). Sand from the lower Cape Fear River dredging project was placed on Bald Head Island, Caswell Beach, Oak Island, and Holden Beach. Sampling conducted before and after the project found no significant differences in fish abundance or diversity among disturbed, undisturbed, and reference sites during any season. Although not statistically significant, Gulf kingfish were less abundant at the disturbed sites than the undisturbed sites. The decline was thought to be at least partially due to the reduced availability of benthic invertebrates preferred by Gulf kingfish. However, the high mobility and schooling behavior of the dominant fish species (anchovies and sciaenids) and insufficient and uneven sampling size made statistical detection difficult.

In a beach nourishment study conducted in New Jersey, abundance of bluefish, a visual feeder, decreased while northern kingfish, a benthic feeder, appeared to increase (USACE 2001); however, no long-term trends were detected in distribution or abundance. This study concluded that the inter-annual fluctuations in surf zone fish populations were too large to accurately detect change from such a project, unless the change was completely catastrophic. In addition, the cumulative impacts when beach nourishment is conducted over a wide area may have a greater impact on kingfishes since kingfishes exhibit little movement along the intertidal zone as juveniles (Miller et al. 2002; Ross and Lancaster 2002). Adequate monitoring of the effects of beach nourishment on the soft bottom community and associated surf fish populations is increasingly important as the number of beach nourishment projects increase and should be required for all large-scale or long-term nourishment projects.

A study in New Hanover County investigated the effects of beach nourishment on the nursery function of the surf zone by comparing fish and invertebrate assemblages, density, and nutritional condition of juvenile Florida pompano and Gulf kingfish. Findings indicated that fish composition and diet differed significantly at nourished beaches compared to unnourished beaches, potentially affecting diet and growth (Lipton et al. 2010; Perillo and Lankford 2010).

The frequency and magnitude of beach nourishment on developed beaches have increased over time. From the 1960s to 2000, only nine miles of beach (3% of the ocean shoreline) had ongoing storm damage reduction projects at three municipalities: Wrightsville Beach, Carolina Beach, and Kure Beach. In 2015, practically all municipalities with oceanfront development had or were pursuing long-term beach nourishment projects (storm damage reduction projects). Exceptions include the oceanfront communities in Currituck County, Hatteras Village, and Sunset Beach (approximately 27 mi). Approximately 160 mi (50%) of oceanfront beaches are federally or state owned. Consequently, once permits for beach nourishment have been obtained by the developed oceanfront communities seeking them, a potential of 41% of North Carolina's beaches could be nourished (Table 11.1). Due to federal budget shortfalls, many of these projects are moving forward without federal funding. In addition, some portion of federally-owned land could be nourished also.

Table 11.1 Storm damage reduction projects permitted or in the planning stages.

| Beach community | Status | Federally authorized [1] |
|---|---|---|
| Duck | Preparing permit application information | N |
| Kitty Hawk | Preparing permit application information | N |
| Kill Devil Hills | Preparing permit application information | N |
| Nags Head | Completed in 2011 | N |
| Rodanthe | Completed one time emergency nourishment in 2014 | N |
| Buxton | Preparing permit application information | N |
| Bogue Banks | Carteret County Beach Commission was formed to plan and coordinate nourishment and develop a programatic EIS for all projects on Bogue Island. Sand sources primarily from different dredging projects and funded locally. | Y |
| North Topsail Beach | Project using offshore borrow areas in 2015. Excessive amount of rock was dredged onto the beach, requiring beach raking. | N |
| Surf City | Preparing permit application information | N |
| Topsail Beach | Preparing permit application information | N |
| Wrightsville Beach | Last done spring 2014 | Y |
| Carolina Beach | Last done winter 2012/2013 | Y |
| Bald Head | Receives sand regularly from Wilmington Harbor dredging | N |
| Caswell, Oak Islands | Receives sand regularly from Wilmington Harbor dredging | Y |
| Holden Beach | Last done in 2009; planning for sand and groin on east end | Y |
| Ocean Isle | Last done in 2014; planning for sand and groin on east end | Y |

[1] Federal funds are not always available for federally authorized projects.

North Carolina's ocean shorelines are primarily unhardened. However, in 2011, SB110 was passed into law amending North Carolina Coastal Resources Commission (NCCRC) rules to allow for the permitting of up to four terminal groins. These would be treated as a pilot program to determine the effectiveness of terminal groins in North Carolina. The four communities moving forward to construct a terminal groin are Bald Head Island, Ocean Isle Beach, Figure 8 Island, and Holden Beach. Carteret County and North Topsail Beach have also expressed interest. Jetties and groins, alter barrier island migration processes, and can accelerate erosion on downdrift beaches. These structures can potentially interfere with the passage of larvae and early juveniles from offshore spawning grounds into estuarine nursery areas because successful transport through the inlet occurs within a narrow zone parallel to the shoreline and are highly dependent on along-shore transport processes (Blanton et al. 1999; Churchill et al. 1999; Hare et al. 1999).

Given the increasing interest in ocean shoreline stabilization, the cumulative impacts of activities on the intertidal and subtidal communities are expected to increase. To adequately assess the direct and cumulative impacts of beach nourishment activities on fish, their habitat, and biological recovery rates, thorough monitoring must be conducted. The NCMFC adopted a beach nourishment policy in 2000 in order to guide the permitting process to fully consider fish habitat impacts (NCDMF 2007). All beach nourishment projects should adhere to the guidelines provided in that policy. The policy is a tool for the NCMFC to use, should they decide to comment on a project. In addition, regulatory agencies should incorporate guidelines to minimize long-term impacts to soft bottom habitat, benefiting kingfishes and other surf zone species.

### 11.1.3 Submerged Aquatic Vegetation

Submerged aquatic vegetation (SAV) is a fish habitat dominated by one or more species of underwater vascular plants. The NCMFC defines SAV habitat as submerged lands that:

"(i) are vegetated with one or more species of submerged aquatic vegetation including bushy pondweed or southern naiad (*Najas guadalupensis*), coontail (*Ceratophyllum demersum*), eelgrass (*Zostera marina*), horned pondweed (*Zannichellia palustris*), naiads (*Najas* spp.), redhead grass (*Potamogeton perfoliatus*), sago pondweed (*Stuckenia pectinata*, formerly *Potamogeton pectinatus*), shoalgrass (*Halodule wrightii*), slender pondweed (*Potamogeton pusillus*), water stargrass (*Heteranthera dubia*), water starwort (*Callitriche heterophylla*), waterweeds (*Elodea* spp.), widgeon grass (*Ruppia maritima*) and wild celery (*Vallisneria americana*). These areas may be identified by the presence of above-ground leaves, below-ground rhizomes, or reproductive structures associated with one or more SAV species and include the sediment within these areas; or

(ii) have been vegetated by one or more of the species identified in Sub-item (4)(i)(i) of this Rule within the past 10 annual growing seasons and that meet the average physical requirements of water depth (six feet or less), average light availability (secchi depth of one foot or more), and limited wave exposure that characterize the environment suitable for growth of SAV. The past presence of SAV may be demonstrated by aerial photography, SAV survey, map, or other documentation. An extension of the past 10 annual growing season's criteria may be considered when average environmental conditions are altered by drought, rainfall, or storm force winds." [2009 MFC rule 15A NCAC 03I .0101 (4)(i)].

High salinity SAV beds are present primarily in Pamlico, Core, and Bogue sounds (Ferguson and Wood 1994). Smaller patches of seagrass occur from New River through northern New Hanover County (Deaton et al. 2010). Seagrasses provide habitat for an array of species including kingfishes and prey of kingfishes (Ross and Noble 1990). Sampling by NCDMF in grass beds behind the Outer Banks documented southern and northern kingfish in low densities (NCDMF 1990). Over 150 other species of fish and invertebrates were found in seagrass beds in eastern Pamlico and Core sounds.

SAV enhances the ecosystem by stabilizing and trapping sediment, reducing wave energy, and cycling nutrients within the system (Thayer et al. 1984). The three-dimensional structure provides a surface for small plants and animals to attach to and provides a safe refuge and foraging area for a large number of juvenile fish and invertebrates (SAFMC 1998). Beds of SAV also produce large quantities of organic matter, which supports a complex food base for numerous fish and other organisms (Thayer et al. 1984). SAV provides a structure that enhances safe corridor between habitats, reducing predation, and providing food for kingfishes and other species (Micheli and Peterson 1999).

Along the Atlantic coast, North Carolina supports more SAV than any other state with the exception of Florida (Funderburk et al. 1991; Sargent et al. 1995). Based on aerial photography, North Carolina was estimated to have between 134,000 and 200,000 acres of SAV in 1990 (Ferguson and Wood 1994). Aerial photography underestimates SAV coverage in low salinity waters (western Albemarle-Pamlico system) where water clarity is limited. Other mapping efforts have been done using field surveys to document SAV distribution in these areas (Davis and Brinson 1990; NCDWQ 1998). The need for repeated mapping of SAV to monitor and assess distribution changes has been identified and resources were allocated toward coast-wide mapping in 2006-2008. This last coast-wide mapping delineated 137,951 acres of SAV, of which approximately half was classified as dense and half as patchy (APNEP 2012). These numbers are considered conservative since they likely underestimate SAV in western Pamlico Sound tributaries and Albemarle Sound. The high salinity grass beds from the northern Outer Banks to Bogue Inlet were remapped in 2013 using aerial photography. Researchers have developed a more accurate and feasible means to map the low salinity SAV habitat in Albemarle Sound and western Pamlico Sound tributaries and researchers at East Carolina University are currently working on mapping portions of these areas. In 2015, high salinity SAV was remapped in the southern portion of the coast, from Bogue Sound to Mason’s Inlet.

The primary factors controlling distribution of SAV are water depth, sediment composition, currents, wave energy, and light penetration through the water column (Goldsborough and Kemp 1988; Duarte 1991; Kenworthy and Haunert 1991; Dennison et al. 1993; Gallegos 1994; Moore et al. 1996; Virnstein and Morris 1996; Moore et al. 1997; Koch 2001; French and Moore 2003; Havens 2003; Kemp et al. 2004; Cho and Poirrier 2005; Biber et al. 2008). At a minimum, high salinity SAV leaves require 15–25% of incident light to survive (Dennison and Alberte 1986; Kenworthy and Haunert 1991; Bulthius 1994; Fonseca et al. 1998).

Decreases in abundance of SAV are attributed to nutrient enrichment and sediment loading (Twilley et al. 1985; Durako 1994), both of which increase the turbidity in the water column, decreasing light availability for SAV (Kenworthy and Haunert 1991). Increased sediment and nutrient loading in the water column can enter coastal waters from point source discharges, nonpoint source stormwater runoff, or resuspension of bottom sediments. Specific sources that contribute to increased sediment loading include construction activities, unpaved roads, road construction, golf courses, uncontrolled urban runoff, mining, silviculture, row crop agriculture, and livestock operations (NCDWQ 2000a). Specific sources that contribute to increased nutrient loading include agricultural and urban runoff, wastewater treatment plants, forestry activities, and atmospheric deposition. Nutrients in point source discharges are from human waste, food residues, cleaning agents, and industrial processes. The primary contributors of nutrients from nonpoint sources are fertilizer and animal wastes (NCDWQ 2000b).

Dredging, shading by docks, and trawling can also decrease SAV abundance. Dredging for navigational channels, marinas, or other infrastructure can physically damage or remove SAV, while shade from docks over grass beds can lead to gradual loss of SAV beneath the structures. Use of bottom disturbing gear, (e.g., crab and oyster dredges, shrimp trawls) can also damage SAV beds, but NCDMF regulations restrict such gears over most SAV habitat. Protection of the SAV grass beds is critical.

### 11.1.4 Hard Bottom

Hard bottom as defined by the CHPP is an "exposed area of rock or unconsolidated sediments, distinguished from surrounding unconsolidated sediments, which may or may not be characterized by live or dead biota, generally located in the ocean rather than in the estuary" (Deaton et al. 2010). Hard bottom provides habitat for kingfishes on reefs in waters less than 30 m. Anecdotal evidence supports the claim that kingfishes use hard bottom areas. Northern kingfish's Latin name, *saxatilis,* means "among the rocks" (FishBase 2015) and fishermen suggest an increase in northern kingfish catch near rocky bottom habitat. More information is needed on the use of hard bottom habitat by kingfishes.

Shallow hard bottom habitats in North Carolina state waters are threatened in some areas by beach nourishment since the added sand can be transported seaward with cross shelf currents over time, covering hard bottom structures (Thieler et al. 1995; Thieler et al. 1998; Reed and Wells 2000). As the hard bottom area decreases, the number of species and abundance decrease (Lindeman and Snyder 1999; Ojeda et al. 2001).

Other impacts to hard bottom habitats include commercial fishing, infrastructure, and water quality degradation (Deaton et al. 2010). Commercial fishing gear, mainly trawls, impacts the hard bottom habitat by breaking or detaching organisms, and causes reductions in the abundance of benthic invertebrates often consumed as prey (Watling and Norse 1998). Infrastructure for pipelines, fiber optic cable, and sonar testing (Navy) impacts hard bottom habitats by cable movement, seismic testing, geophysical mapping activities, repairs to broken cables, directional drilling, sedimentation, or a physical barrier to movement (SEAMAP 2001; Deaton et al. 2010).

### 11.1.5 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 that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (Deaton et al. 2010). Wetlands are one of the most biologically productive ecosystems (Teal 1962). The productivity is transported into the estuarine system as decayed plant matter (detritus) and microalgae growing on or between marsh plants (Peterson and Howarth 1987). While kingfishes are rarely found in shallow wetlands, common prey items such as shrimp and crabs rely on wetlands as nursery areas and foraging habitat. Wetlands also provide many ecosystem functions that benefit the waters and habitats that kingfishes use, such as trapping and filtering toxins and sediments from stormwater runoff and stabilizing the shoreline by slowing wave energy (Mitsch and Gosselink 1993).

According to the 2011 National Land Cover Data (NLCD), there were approximately 3,759,729 acres of woody and emergent herbaceous wetlands within the CHPP regions (Jin et al. 2013). This represents a 2.7% decrease in woody wetlands and an 18.9% increase in emergent herbaceous wetlands since 2001. According to National Wetland Inventory data, which consists of imagery data from 1977 to 2010, there are approximately 228,146 acres of salt/brackish marsh within the CHPP region, with the greatest acreage in the Pamlico system.

In 1993, it was estimated that approximately 66% (4.7 million acres) of North Carolina's original wetlands remain (NCDWQ 2000a). Human activities that result in wetland habitat loss include ditching, channelization, filling for agriculture and development, and shoreline stabilization (NCDWQ 2000b). Prior to the 1990s, the major impact on the wetlands was agriculture and forestry. After 1990, the threats to wetlands have shifted to dredging, filling, water control projects, and shoreline stabilization associated with development. Reducing wetland losses is critical to long-term protection of the coastal ecosystem.

## 11.2 WATER QUALITY DEGRADATION

Adequate water quality is necessary to maintain the chemical properties of the water column that are needed by kingfishes, as well as sustain the other habitats that kingfishes rely on. Human activities can alter the chemistry and flow characteristics of the water column in ways that are not optimal for growth or survival of kingfishes. For example if salinity or DO concentrations are altered beyond the known preferences of kingfishes, their distribution, or growth rates may be affected. The most common causes of water quality impairment in North Carolina's coastal river basins are excessive sediment loading and low DO (NCDWQ 2000a). Since kingfishes are demersal bottom feeders, low DO and toxin bioaccumulation are probably the greatest water quality concerns for these species. Because southern kingfish spend more time in North Carolina's estuarine waters than northern or Gulf kingfish, it is more vulnerable to estuarine water quality degradation.

Water pollution sources are classified into two categories: point and nonpoint source pollution. Point source pollution is defined as pollution from a defined point such as a pipe while nonpoint source pollution is pollution from a non-defined point of entry such as stormwater runoff. Both source types contribute to oxygen consuming wastes, excessive nutrients, increased sediment, as well as toxins, pesticides, and heavy metals. Point source dischargers (municipal and industrial wastewater treatment plants, small domestic wastewater treatment system for schools, commercial offices, residential subdivisions, and individual homes) in North Carolina must apply for and obtain a National Pollutant Discharge Elimination System (NPDES) permit from the North Carolina Division of Water Quality (NCDWQ 2000a).

Sediment and nutrients are the major pollution substances associated with nonpoint source pollution. However, bacteria, heavy metals, oil, and grease can also be carried into surface waters by runoff. Several activities are associated with nonpoint source pollution. These include land clearing, plowing, drainage ditch construction, pesticide and fertilizer use, as well as concentrated livestock operations (NCDWQ 2000a).

The NLCD within coastal draining waterbodies provides an indication of how potential pollutant sources from various land uses are changing over time. The 2015 CHPP summarizes this information in detail (Deaton et al. 2010). Agricultural lands include cropland, pastureland, animal operations, and land-based aquaculture. According to the U.S. Department of Agriculture's 2007 census, farmland in North Carolina has declined from ~9.0 to ~8.4 million acres during 2002–2012. For animal operations, the number of swine has dropped from ~10 million in 2002 to ~8 million in 2012; there has been a steady increase in poultry production (http://www.nass.usda.gov/Statistics_by_State/North_Carolina/index.asp). It is estimated that over two million acres of land have been drained and developed for agriculture and silviculture along the North Carolina coast. Within every square mile of agricultural land in coastal North Carolina, there are estimated to be more than 20 miles of field ditches, collector canals, and main canals (Heath 1975; Daniel 1978).

Ditching and drainage is also associated with residential development and infrastructure. Many roads on the Albemarle-Pamlico Peninsula were constructed atop spoil piles between canals to prevent flooding. In urban coastal areas, ditches are constructed along subdivision streets, draining to coastal waters. These drainage features often connect to headwaters, altering the natural hydrology of downstream systems. Ditching accelerates the rate that stormwater enters coastal waters and reduces the amount of pollutant filtration that occurs. Unlike agriculture and silviculture, developed land uses have been steadily increasing. Over the past 15 years (1997–2012), the percent increase in urban built-up/transportation has ranged from 28.2 to 137.7%. While there has been an overall increase in developed area since 1997, the rate of new development, based on stormwater permit data, increased sharply from 2001 to 2007, but slowed between 2007 and 2013 (Deaton et al. 2010).

Ambient water quality monitoring data are available for some estuarine waters from the NCDWQ and are summarized in the appropriate river basin plans (Lumber, Cape Fear, White Oak, Neuse, Tar-Pamlico, and Pasquotank). The NCDWQ does not monitor benthic community or sediments in estuarine areas. There is negligible sampling by the NCDWQ in the larger sounds. However, the FerryMon program is a program in which NC ferries collect water quality information in three to four transects along Ferry routes. The routes are located in southeast Pamlico Sound (Cedar Island to Ocracoke), across central Pamlico Sound (Swan Quarter to Ocracoke), across the Neuse River (Minnesott Beach to Cherry Branch), and across the Pamlico River (Aurora to Bayview). Budget and ferry status have limited data collection on some routes during certain time periods. Information collected includes temperature, salinity, DO, pH, turbidity, and chlorophyll a. Data from FerryMon have been coupled with remote sensing efforts by the United State Environmental Protection Agency (EPA) to determine suspended phytoplankton composition and concentration in the sound. Refer to the FerryMon website to view data over different time periods: http://www.ferrymon.org

An additional source of data to determine water quality in North Carolina is the National Coastal Assessment Program conducted by the EPA. Coastal monitoring data (water and sediment quality, benthos, fish tissue, etc.) are compiled regionally in National Coastal Condition Reports (NCCR) to summarize overall condition of waters in the U.S. The last report, using data from 2003 to 2006, rated the overall condition of the southeast U.S. as fair (EPA 2012). From 2000 to 2006, the percent of area in the southeast with water quality rated as good has declined and the percent of area rated as poor has increased. Refer to http://water.epa.gov/type/oceb/assessmonitor/nccr/ to view the details of this assessment.

Information is sparse or lacking for water quality trends in ocean waters where kingfishes most commonly occur. The NCDWQ does not monitor ambient water quality in nearshore ocean waters. However, since 1997, the Shellfish Sanitation Office, Division of Environmental Health (now NCDMF), has been recording *Enterococcus* bacteria levels for safe swimming along ocean beaches and some estuarine areas. A total of 240 swimming sites are tested and the results are posted on program's website (http://portal.ncdenr.org/web/mf/recreational-water-quality). Although these bacteria will not harm kingfishes, this is an indicator that other pollutants associated with upland activity, such as nutrients or toxins, may be present. Another source of ocean water quality monitoring is through the University of North Carolina at Wilmington's Coastal Ocean Research and Monitoring Program (CORMP). Continuous monitoring data on water temperature, wave height, water depth, and wind conditions are collected from piers and fixed moorings.

### 11.2.1 Nutrients

Nitrogen and phosphorus, components of fertilizers and animal and human wastes, are common nutrients that, in small quantities, are beneficial to aquatic life but can be detrimental in large quantities (Paerl 2002). In excessive amounts, nutrient loading leads to habitat degradation, toxicity, hypoxia, anoxia, algal blooms, fish kills, and loss of biodiversity. These are all signs of cultural eutrophication and water quality degradation (NCDWQ 2000a; Paerl 2002). Cultural eutrophication is the rapid process of the accumulation of nutrients and sediments caused by man (NCDWQ 2000a). Urban runoff, crop agriculture, animal operations, erosion, and industrial expansion in the coastal regions have led to the rise of nitrogen loading in our estuaries.

Recent research has shown atmospheric depositions of nitrogen (AD-N), previously considered a minor source of nitrogen input, to be a highly significant source of externally supplied nitrogen entering the estuaries (Paerl 2002). There also may be a link between acidic deposition (acid rain) and eutrophication of estuaries (Driscoll et al. 2003). Sources of both AD-N and acid rain are mostly from burning fossil fuels and by agricultural activities (Pearl 2002; Driscoll et al. 2003).

### 11.2.2 Oxygen Depletion

Survival of kingfishes and other organisms depends on an adequate supply of dissolved oxygen (DO). Anoxia (no oxygen) and hypoxia (low oxygen) occur naturally but can increase in frequency due to anthropogenic causes. Stratification of the water column, particularly in summer, due to wind, temperature, and salinity conditions prevents mixing of bottom waters with more oxygenated surface waters. Algal blooms can result in lower DO levels in the water, especially at night, due to excessive plant respiration. When these blooms die, bacteria decomposing the dead plant material remove oxygen (NCDWQ 2000b). Shallow water estuaries with less frequent flushing often develop persistent stratification and bottom-water hypoxia that can last for weeks to months (Tenore 1972). Low oxygen levels, in turn, can lead to fish kills. Anthropogenic causes of oxygen depletion are often attributed to excessive loading of nutrients from stormwater runoff, heavy rainfall, and air deposition. Low oxygen events in coastal waters of the U.S. are becoming larger and longer lasting due to increasing eutrophication (Cooper and Brush 1991; Breitberg 1992; Lenihan and Peterson 1998).

Most demersal fishes experience mortality in waters having 1–2 mg/l of DO, altered metabolism where DO levels are <4 mg/l, and impaired larval growth where DO levels are <4.7 mg/l (Miller et al. 1985; Gray et al. 2002). Some estuarine species are capable of detecting and avoiding low oxygen waters, but there are species-specific differences in tolerance thresholds (Wannamaker and Rice. 2000). There are no reported oxygen tolerances for kingfishes. Of the species studied, Atlantic croaker (*Micropogonias undulatus*), which is similar to kingfishes in habitat and diet preferences, are more sensitive to moderate hypoxia than other species, and would move to waters with slightly greater DO levels (2 mg/l vs. 1 mg/l), suggesting they would be capable of avoiding hypoxia-related mortality. The migration of benthic organisms from hypoxic or anoxic waters can result in high densities of organisms in oxygenated areas (habitat compression), increased competition, and increased predation by opportunistic predators (Eby et al. 2000).

Although mortality due to oxygen depletion does not appear to be a significant factor for kingfishes, prolonged periods of hypoxia could stress and alter the ecological successional patterns if the benthos is altered (Luettich et al. 1999). The various successional stages may influence or benefit different benthic feeders to various extents, with disturbed early successional benthic communities favoring small and juvenile benthic feeders and recovered benthic communities favoring larger adult species. Research is needed on kingfishes' tolerance levels of and behavioral responses to hypoxia and the effect of current conditions on populations.

According to the NCDWR Annual Report of Fish Kill Events, there were 13 events in 2013, with a mortality of 20,608,452 fish, and 19 events in 2014, with an estimated mortality of 2,659,000 fish (http://portal.ncdenr.org/web/wq/ess/fishkillsmain). The vast majority of the fish kills in 2013 and 2014 occurred within the Neuse and Tar-Pamlico estuaries beginning in late September and October. The lower Neuse, as well as the lower Pamlico estuary, has historically experienced adverse environmental conditions for fish populations, such as low DO, high water temperatures, and fluctuating salinities. The most common species affected by fish kills in coastal North Carolina waters is menhaden, being particularly sensitive to environmental stress from water temperature and oxygen levels, invasive pathogens, and other stress factors (http://portal.ncdenr.org/web/wq/ess/fishkillsmain).

Kingfishes have not been reported in fish kill investigations. However, the lack of a swim bladder and demersal nature of kingfishes may hinder ability of investigators to spot dead or dying kingfishes. Furthermore, since kingfishes occur on the bottom in estuaries where hypoxia and anoxia have been reported to occur, the species may be negatively affected by low oxygen events. Eby et al. (2000) estimated that up to 30–50% of the Neuse River estuary was unsuitable bottom habitat during summer due to hypoxia. Several studies have indicated that the frequency, duration, and spatial extent of low oxygen events have increased over the years due to increasing eutrophication of coastal waters from human and animal waste discharges, greater fertilizer use, loss of wetlands, and increased atmospheric nitrogen deposition (Cooper and Brush 1991; Dyer and Orth 1994; Paerl et al. 1995; Buzelli et al. 2002). More information is needed to understand the consequences on the estuarine food web and to what extent anoxia is affecting the soft bottom community. Efforts are needed to reduce anthropogenic nutrient loading, particularly in systems that have a history of hypoxia and anoxia.

### 11.2.3 Sedimentation and Turbidity

Sediment impacts on fish depend on the concentration of suspended sediment, type of sediment, and the duration of the sedimentation. These impacts can plug gills and reduce respiratory abilities (Wilber and Clarke 2001). This can lead to a reduced tolerance to disease, toxins, and turbidity as well as affect spawning and rearing habitat (NCDWQ 2000a).

Sediment loading usually results from nonpoint sources such as building and road construction. Stormwater runoff from urban areas, agriculture, silviculture, animal operations, as well as mining and removal of vegetated buffers accelerates sediment loading as well as increases turbidity in the water column (NCDWQ 2000a). Water activities such as dredging, boating and fishing with bottom disturbing gears also add to an increase in turbidity. Of all of these sources, agriculture is one of the largest contributors of sedimentation in the southeastern U.S. (SAFMC 1998).

Another source of sediment of increased turbidity in estuaries is shoreline erosion. Erosion occurs when waves and currents erode shorelines and transport sediment into the waters, causing short- and long-term changes along the coast. While shoreline erosion is a natural process, like eutrophication, it has been accelerated because of human activities.

### 11.2.4 Toxic Chemicals

Toxic chemicals that are found in the water column include heavy metals, polycyclic aromatic hydrocarbons (PAHs), petroleum hydrocarbons, polychlorinated biphenyls (PCBs), dioxins, antifoulants, chlorine, ammonia, and pesticides. Most of these chemicals come from localized point and nonpoint sources while activities contributing to heavy metal contamination include urban sprawl, dock and marina development, boating activity, dredge spoil disposal, automotive transportation, industrial shipping and industrial emissions (Wilbur and Pentony 1999). Studies have shown that fine-grained sediments act as a reservoir for heavy metals and are readily adsorbed on tiny sediment particles, particularly organic rich muds (Riggs et al. 1991). Chemicals such as dichlorodiphenyltrichloroethane (DDT), diedrin, and tributyltin (TBT) continue to contaminate sediments, even though they have been banned since 1977.

While toxins can fluctuate between the sediment and water column, concentrations of toxic chemicals tend to accumulate in sediments to several orders of greater magnitude than overlying waters (Kwon and Lee 2001). The bioavailability and transport of a toxin is affected by the physical and chemical conditions of the environment and the feeding habits and condition of aquatic organisms. Toxic chemicals can become active in soft bottom sediment or overlying waters through resuspension from natural weather events or human activities such as dredging and trawling. Resuspension of sediments with heavy metal contamination can be a problem in fine-grained areas such as sheltered creeks. Because low concentrations of heavy metals in the water column can be easily incorporated into fine-grained sediment, such as organic rich mud, toxicants levels can accumulate in the sediment and be resuspended into the water column (Riggs et al. 1991). This is of particular concern as the majority of North Carolina's soft bottom is composed of fine-grained organic sediments.

Toxins in sediments or the water column can affect benthic invertebrates by inhibiting or altering reproduction or growth or in some situations causing mortality (Weis and Weis 1989). Early life stages are most vulnerable to toxins (Funderburk et al. 1991). Food resources for benthic feeders, like kingfishes, may be limited in highly contaminated areas because macroinvertebrate diversity significantly declines with increasing sediment contamination (Weis et al. 1998; Brown et al. 2000; Dauer et al. 2000). While the survival of some aquatic organisms is affected by toxins, other organisms survive and bioaccumulate the chemicals to toxic levels, passing them along in the food chain. Multiple studies have shown clear connections between concentrations of toxins in sediments and those in benthic feeding fish and invertebrates (Kirby et al. 2001; Marburger et al. 2002). Heavy metal contamination of sediments has been documented to result in elevated trace metal concentrations in shrimp, striped mullet, oysters, and flounder (Kirby et al. 2001; Livingstone 2001). Fish can uptake metals in different ways, through the skin and gills and the wall of the digestive tract. Mzimela et al. (2003) found that the groovy mullet, *Liza dumerelii,* accumulated elevated levels of iron, aluminum, zinc, manganese, chromium, copper, and lead (in that order) from discharges into Richards Bay, South Africa. Sources of contamination were industrial discharges from fertilizer, paper pulp, and aluminum smelter production.

Toxic chemicals come from localized point sources as well as diffuse nonpoint sources. Industrial and municipal waste discharges are point sources. Nonpoint sources of toxins include urban runoff containing household and yard chemicals, roadways, marinas and docks, boating activity, runoff from agriculture and forestry, industrial emissions, spills from industrial shipping, and dredge spoil disposal (Wilbur and Pentony 1999).

The extent of sediment contamination in North Carolina coastal waters is not well known. Sediment sampling is not conducted by the NCDWQ since there are no sediment standards in the state. Sediment quality is assessed by the EPA through the National Coastal Assessment Program. From 2000 to 2006, the percent of area in the southeast with sediment quality rated as good declined to the lowest percent in 2003 and increased to 2001 levels by 2006, with the reverse trend for percentage of area with poor rating.

To better determine if contaminated sediment is a significant threat to coastal fish habitat, the distribution and concentration of heavy metals and other toxins in estuarine sediments need to be adequately assessed, as well as the condition of the benthic community, and the areas of greatest concern need to be identified. Continued minimization of point and nonpoint sources of toxic contaminants is vital for protecting not only soft bottom but also the other fish habitats.

## 11.3 HABITAT AND WATER QUALITY PROTECTION

### 11.3.1 North Carolina Marine Fisheries Commission Authority

Presently, the NCMFC has authority for the following actions with regard to marine and estuarine resources: manage, restore, develop, cultivate, conserve, protect, and regulate. Marine and estuarine resources are "All fish [including marine mammals, shellfish, and crustaceans], except inland game fish, found in the Atlantic Ocean and in coastal fishing waters; all fisheries based upon such fish; all uncultivated or undomesticated plant and animal life, other than wildlife resources, inhabiting or dependent upon coastal fishing waters; and the entire ecology supporting such fish, fisheries, and plant and animal life." (G.S. 113-129).

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

### 11.3.2 Authority of Other Agencies

The DENR has several divisions responsible for providing technical and financial assistance, planning, permitting, certification, monitoring, and regulatory activities, which affect the coastal water quality or habitat. NCDCM is responsible for development permits along the estuarine shoreline in 20 coastal counties. Wetland development activity throughout North Carolina is permitted through the USACE and the NCDWR 401-

certification program). The NCDWR has established a water quality classification and standards program for “best usage” to promote protection of unique and special pristine waters with outstanding resource values. The High Quality Waters (HQW), Outstanding Resource Waters (ORW), Nutrient Sensitive Waters (NSW), and Water Supply (WS) classifications have outlined management strategies to control point and nonpoint source pollution. Various federal and state environmental and resource agencies, including the NCDMF, evaluate projects proposed for permitting and provide comments and recommendations to the NCDCM, NCDWR, and USACE on potential habitat and resource impacts. Habitat protection relies on enforcement, the efforts of commenting agencies to evaluate impacts, and the incorporation of recommendations into permitting decisions. Habitats are also protected through the acquisition and management of natural areas as parks, refuges, reserves, or protected lands by public agencies and/or private groups.

### 11.3.3 Coastal Habitat Protection Plan

The FRA of 1997 mandated the NCDENR to prepare CHPPs (CHPPs–G.S. 143B-279.8). The legislative goal for the CHPPs is long-term enhancement of the coastal fisheries associated with coastal habitats and provides a framework for management actions to protect and restore habitats critical to North Carolina’s coastal fishery resources. There are three commissions that have regulatory jurisdiction over the coastal resources, water, and marine fishery resources including NCMFC, North Carolina Coastal Resources Commission (NCCRC), and the North Carolina Environmental Management Commission (NCEMC). The CHPP was completed in December 2004 and implementation plans for each division and the department were approved in July 2005. The plan is to be reviewed every five years. Actions taken by all three commissions pertaining to the coastal area, including rule making, are to comply, “to the maximum extent practicable” with the plans. The CHPP helps to ensure consistent actions among these three commissions as well as their supporting NCDENR agencies.

The CHPP describes and documents the use of habitats by species supporting coastal fisheries, status of these habitats, and the impacts of human activities and natural events on those habitats. Fish habitat is defined as freshwater, estuarine, and marine areas that support juvenile and adult populations of economically important fish, shellfish, and crustacean species (commercial and recreational), as well as forage species important in the food chain (Deaton et al. 2010). Fish habitat also includes land areas that are adjacent to, and periodically flooded by, riverine and coastal waters. Six fish habitats are discussed and designated based on distinctive physical properties, ecological functions, and habitat requirements for living components of the habitat: wetlands, SAV, soft bottom, shell bottom, ocean hard bottom, and water column.

The CHPP recommends that some areas of fish habitat be designated as “Strategic Habitat Areas” (SHAs). SHAs are defined as specific locations of individual fish habitat or systems of habitat that have been identified to provide critical habitat functions or that are particularly at risk due to imminent threats, vulnerability, or rarity. While all fish habitats are necessary for sustaining viable fish populations, some areas may be especially important to fish viability and productivity. Protection of these areas would therefore be a high priority (Deaton et al. 2010). The process of identifying SHAs began in 2005.

The CHPP focuses on the fish habitat and threats to the habitat. This FMP describes habitat conditions or needs for the various life stages of the kingfishes. 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.

## 11.4 STATUS OF 2007 HABITAT RECOMMENDATIONS

The 2007 Kingfish FMP included habitat and water quality as principal issues citing the maintenance and improvement of suitable estuarine and marine habitat and water quality as important factors in maintaining sustainable stocks of kingfishes (NCDMF 2007). Many of the action items outlined in the 2007 Kingfish FMP Principal Issues and Management Options section have been implemented or are substantially underway and/or were also components of the CHPP implementation plan. They include:

Habitat

- NCCRC has revised dock rules to require review by resource agencies for general-purpose dock applications located over SAV, shell bottom, or Primary Nursery Areas, and where water depth is less than 2 ft. mean water level to avoid boating related impacts.
- NCDMF is in the process of Identifying and delineating SHAs that will enhance protection of southern, Gulf, and northern kingfishes.
- Wetland buffers along coastal streams and rivers have been used to enhance wetlands and improve water quality.
- Although North Carolina legislation has been passed to allow terminal groins to be built in coastal North Carolina, the NCDMF has been in talks with applicants to minimize the adverse impacts to fisheries. In addition, the NCDCM has created standards for beach nourishment projects. These standards include sediment size and moratorium periods to minimize impacts.
- Coast-wide imagery of SAV was taken in 2007/2008 and has been mapped.
- Identification and designation of strategic SAV areas is underway through the SHA process.
- Additional bottom disturbing gear restrictions have been implemented through the bay scallop and oyster fishery management plans to avoid damage to SAV and oysters.
- DENR staff has been cooperating to develop permit conditions for marsh sills to minimize the impacts of vertical shoreline stabilization methods.
- Loss of additional riparian wetlands has been minimized through the permitting process, land acquisition, and land use planning.

Water Quality

- Neuse and Tar-Pamlico NSW nutrient reduction measures have successfully reduced nutrient loading by more than their 30% reduction goals for point source dischargers and agriculture*.*
- NCDWR revised coastal storm water rules that limit impervious surface and run-off in coastal areas.
- Wetland buffers along coastal streams and rivers have been used to enhance wetlands and improve water quality.

# 12.0 PRINCIPAL ISSUES AND MANAGEMENT OPTIONS

As an Information Update, this plan refreshes the 2007 Kingfish FMP with the most current statistics, trends, research, etc. available at the time the Information Update is developed. An Information Update is developed without the assistance of an FMP advisory committee and does not require review by regional or standing advisory committees of the NCMFC. Potential issues were solicited from the public at the beginning of the Information Update process. The public was made aware of the comment period via a news release on January 26, 2015 with a deadline for comments by February 17, 2015. There were five comments received. The comments and the NCDMF responses are listed in Appendix 2, Solicitation of Public Comment on Kingfish Issues. Most commenters requested no changes to the current management for kingfishes. One commenter requested a size limit be placed on kingfishes, another commenter suggested aquaculture as a management option, and one commenter expressed concern over predation on kingfishes by spiny dogfishes. No new issues were recommended for development in the Kingfish FMP by either the NCDMF or the NCMFC based on the public comment received.

The 2007 Kingfish FMP addressed several issues. These included habitat and water quality issues, potential issues with protected species in the kingfish fishery, and a management strategy to ensure sustainable harvest. Issue papers and management options considered for each of these issues can be reviewed in the original 2007 Kingfish FMP (NCDMF 2007). Updated information on habitat and water quality along with related research recommendations can be found in Section 11, Environmental Factors. Updated information related to protected species can be found in Section 8, Protected Species. The updated management strategy can be found in Appendix 1, Evaluation of Management Triggers for Kingfish.

## 12.1 SUMMARY OF MANAGEMENT ACTIONS

### 12.1.1 Rules

No new rules required.

### 12.1.2 Legislative Action

No legislative action required.

# 13.0 RECOMMENDED MANAGEMENT STRATEGIES AND RESEARCH RECOMMENDATIONS

## 13.1 MANAGEMENT STRATEGIES

The 2007 Kingfish FMP selected the use of trend analysis and management triggers as the preferred management strategy to monitor the viability of the kingfish stock in North Carolina (NCDMF 2007). A second management strategy promotes work to enhance public information and education. As an FMP Information Update, this plan adheres to the management strategies set forth in the original 2007 plan. As a review of the original plan, best available data and techniques used for the trend analysis and management triggers were refined and modified to better assess population trends as part of this FMP Information Update (Appendix 1, Evaluations of Management Triggers for Kingfish). Changes to management triggers are considered to better inform management and do not alter the basic concept of trigger management set forth in the original 2007 FMP. Management triggers set forth in this plan will continue to be the management strategy used for maintaining the long-term sustainable harvest in the kingfish fishery. A coast-wide stock assessment is a long-term research need that will have to be addressed before any estimation of biological reference points related to sustainable harvest can be estimated.

The trend analysis and management triggers established for this plan, as outlined in Appendix 1, Evaluations of Management Triggers for Kingfish, will be updated annually and results will be presented to the NCMFC as part of the annual FMP Update. For reference, the 2015 annual update including data through 2014 is on the NCDMF website (http://portal.ncdenr.org/web/mf/fmps-under-development), 2015 Kingfish Fishery Management Plan Update.

The trend analysis incorporates triggers to alert managers to the potential need for management action based on stock conditions. The activation of any two management triggers two years in a row (regardless of category) warrants further data evaluation and potential management action. The NCMFC will be alerted should this criterion be met.

## 13.2 SUMMARY OF RESEARCH RECOMMENDATIONS

The following research recommendations were compiled to help achieve the goal and objectives of this FMP (see Section 5.2.1, Goal and Objectives). The division reviewed and prioritized the research recommendations. The prioritization of each research recommendation is designated as a high, medium, or low priority. A low ranking does not infer a lack of importance but is either already being addressed by others or provides limited information for aiding in management decisions. A high ranking indicates there is a substantial need, which may be time sensitive in nature, to provide information to help with management decisions.

### 13.2.1 Management Related Research Needs

- Conduct a coast-wide stock assessment of southern kingfish along the Atlantic Coast including estimation of biological reference points for sustainable harvest. (HIGH)
- Validate YOY and adult indices used in trend analysis. (HIGH)

- Develop a fisheries-independent survey in the ocean for juvenile and adult kingfishes. (HIGH)
- Collect observer data from commercial fishing operations to estimate at-sea species composition of the catch, discard rates, and lengths. (HIGH)
- Improve recreational data collection, particularly the species composition of discards, discard rates and associated biological data. (HIGH)
- Improve dependent commercial data collection of more sample sizes for life history information. (MEDIUM)
- Evaluate and potentially expand the NCDMF fishery-independent gillnet survey to provide data on species composition, abundance trends, and population age structure by including additional areas of North Carolina's estuarine and nearshore ocean waters. (MEDIUM)
- Continue bycatch reduction device studies in the shrimp trawl fishery to decrease bycatch. (MEDIUM)
- Determine stock structure using genetics of kingfishes along North Carolina and the Atlantic Coast. (LOW)

### 13.2.2 Biological Research Needs

- Develop tagging study to estimate natural and fishing mortality, to investigate stock structure, and to understand movement patterns. (HIGH)
- Collect histological data to develop maturity schedule with priority to southern kingfish. (HIGH)
- Conduct an age validation study with priority to southern kingfish. (HIGH)
- Conduct study to estimate fecundity with priority to southern kingfish. (MEDIUM)
- Conduct study to identify spawning areas with priority for southern kingfish. (MEDIUM)
- Sample inlets and river plumes to determine the importance of these areas for kingfishes and other estuarine-dependent species. (LOW)
- Determine the effects of beach re-nourishment on kingfishes and their prey. (LOW).
- Conduct a study to investigate how tidal stages and time of day influence feeding in kingfishes. (LOW)

### 13.2.3 Social and Economic Research Needs

- Increase the sample size of surveyed participants in the commercial kingfish fishery to better determine specific business characteristics and the economics of working in the fishery. (LOW)
- Update information on the participants in the recreational kingfish fishery. (LOW)

## 13.3 REVIEW CYCLE

As provided in the Fisheries Reform Act of 1997, the Kingfish FMP will be reviewed at least every five years.

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# 15.0 APPENDICES

## 15.1 APPENDIX 1. EVALUATION OF MANAGEMENT TRIGGERS FOR KINGFISH

November 2014
Updated January 2015

Laura Lee
Ray Mroch
Will Smith

### BACKGROUND

Current management triggers for kingfish are organized into three groups: biological monitoring, fisheries-dependent catch per unit effort (CPUE), and fisheries-independent surveys. The triggers within each group are listed below:

Biological Monitoring

Mean fish length by fishery compared to last five years
Proportion of age one kingfishes greater than 50% of fish 11.0 to 11.8 inches TL

Fisheries-Dependent CPUE

Commercial < 2/3 of the mean harvest from 1999 to 2004
Recreational < 2/3 of the mean harvest from 1999 to 2004

Fisheries-Independent Surveys—Juvenile and Adult

Pamlico Sound Survey fall 2/3 below mean CPUE
Southeast Area Monitoring and Assessment Program (SEAMAP) fall 2/3 below mean CPUE

If **one** of the management triggers is "tripped" then the NCDMF will consider management action.

### EVALUATION

The first issue that needs clarification is whether the triggers apply to southern kingfish only or all kingfish species separately or combined (see Follow Up section).

It is not clear how the indicator related to mean length by fishery will be judged. It simply states that it will be compared to the average length from the previous five years, but it does not specify what constitutes a good or bad result. It will be assumed that the intention was that a decrease in average length relative to the previous five years will trip the trigger.

It is expected that the average age of a fish population decreases with increasing fishing pressure because fewer fish survive to old age (Francis and Smith 1995; Francis and Jellyman

1999). Since age is often highly correlated with length it is not unreasonable to assume that average length would decrease with decreasing biomass; however, this is not always the case (Francis and Smith 1995). Additionally, natural variations in recruitment can cause substantial variation in annual average length, even when fishing pressure is constant (Francis and Jellyman 1999). For these reasons, evaluation of average length alone may not be appropriate.

Since tracking average length is considered (incorrectly) an index of the fraction of the population that survives to relatively older ages, it might be more appropriate to identify another metric based on length frequencies that is expected to more accurately track the relative abundance of older fish. The loss of larger, presumably older fish from the population is expected to produce a signal in the tails of the length distribution rather than the center of the distribution; thus, some index that accounts for the tails of the annual length-frequency distribution is more appropriate. For example, if no fish greater than a certain size are observed for five years, that might be a management trigger. The same logic could be applied to age distributions in order to identify another trigger based on ages; however, if age samples are collected in a less random way with respect to length data collection, length data may be more accurate.

The triggers based on fisheries-dependent CPUE indices are not clear. As stated, the triggers suggest they will be tripped if the CPUE index is less than 2/3 of the average harvest from 1999 to 2004. It is assumed that the intention was that the trigger would be tripped if the CPUE index is less than 2/3 of the average CPUE index from 1999 to 2004.

Fisheries-dependent indices are associated with numerous biases. Relative indices are assumed to be proportional to stock size. In order for a fisheries-dependent index to be proportional to abundance, fishing effort must be random with respect to the distribution of the population and catchability must be constant over space and time. This is one of the benefits of fisheries-independent surveys for use as indices of abundance—they are designed to provide unbiased estimators and employ a standard methodology over time and space. Other factors affecting the proportionality of fisheries-dependent indices to stock size include changes in fishing power, gear selectivity, gear saturation and handling time, fishery regulations, gear configuration, fishermen skill, market prices, discarding, vulnerability and availability to the gear, distribution of fishing activity, seasonal and spatial patterns of stock distribution, changes in stock abundance, and environmental variables. Additionally, it is often difficult to define a standard unit of effort for fisheries-dependent data. Many agencies, including the NCDMF, do not require fishermen to report records of positive effort with zero catch; lack of these “zero catch” records in the calculation of indices can introduce further bias. Furthermore, fisheries-dependent indices are, at most, only reflective of trends in fished areas and apply only to individuals within the size range that is capable of being caught by the fishing gear. Both fisheries-dependent and fisheries-independent indices can be standardized to account for factors other than changes in abundance that affect the indices (Maunder and Punt 2004). This requires the collection of auxiliary data at the time of harvest or sampling event. Often, such data are not available for fisheries-dependent indices. Finally, fisheries-dependent indices tend to exhibit hyperstability (Harley 2001); that is, the CPUE index remains high while the population declines.

A further issue related to the recreational fishery CPUE index is the recent change in methodology that occurred in 2013 (see http://www.st.nmfs.noaa.gov/recreational-fisheries/index). Accounting for this change in the computation of the recreational fishery CPUE index will be a difficult task, if possible at all.

As mentioned above, fisheries-independent indices can be standardized to account for factors beyond abundance changes that impact the index. Other considerations for fisheries-independent survey series include length of time series, survey design, consistency in methodology, catchability and availability to the gear, sample timing and spatial coverage, and precision. The minimum length for a survey index to be considered sufficient is the average lifespan of the species. Southern kingfish live approximately nine years so the Pamlico Sound Survey index is considered of adequate length (twenty-four years). The survey is based on a sound statistical design, so survey design is not thought to be an issue. There have been some changes in methodology over time; this can be accommodated by limiting the time series to those years in which the methods have been consistent. For the Pamlico Sound Survey, this would be from 1990 forward. Sample timing is not thought to be an issue as southern kingfish have been caught in the June and September components during every year of the survey. Spatial coverage is an issue as the southern kingfish extends beyond North Carolina waters.

Catchability and availability are more difficult to assess. One way this can be evaluated is by looking at the percentage of tows in which the species does not occur ("zero" tows). Consistently high proportions of tows with zero catch can indicate that there is low catchability and/or availability. The percentage of zero tows was calculated for southern kingfish observed in the Pamlico Sound Survey for both the June and September components of the survey. In many years, the percentage of zero tows exceeds 60% for June (Table 1). The average number of zero tows per year for June is 59% and the average for September is 49%. A closer look at the data shows that there are three strata ('NR', 'PR', 'PUN') in which southern kingfish are infrequent or rare (Tables 2, 3). The calculation of an index based on these survey data could consider eliminating data collected from these strata. Alternatively, one could consider applying a zero-inflated model when constructing the index.

Precision is easily evaluated by computing the standard error associated with the annual index. A stratified-GLM approach was used to calculate standardized indices for June and September. The standard errors and proportional standard errors (PSEs) were also calculated. Most statistical texts recommend a PSE of 20% or less. The PSEs of the June and September indices are shown in Figures 1 and 2. PSE values exceed 20% in all but three years for the June index and all but one year for the September index. Elimination of the three strata suggested above may lead to improved precision.

**RECOMMENDATION** (accepted by NCDMF 1/7/2015)

Based on the evaluation, it is recommended that consideration of management action should not be based on any one trigger alone but some combination of two or more triggers. Management triggers based on average length should not be considered; instead, a trigger based on the upper tail of the length and/or age distribution should be developed. Another recommendation is to eliminate the fisheries-dependent CPUE indices as management triggers. Finally, the Pamlico Sound Survey index should be computed for June and September separately and should not include data collected in the 'NR', 'PR', or 'PUN' strata.

**JANUARY 2015 FOLLOW UP**

The Kingfish PDT met on Wednesday, January 7 to discuss several issues including the evaluation of management triggers. Upon further review of prior plan and stock assessment report text, the recommendations put forward in this document, and review of the full time series of data through 2013, the PDT during its discussion accepted this report's initial recommendations and made further refinements. Additionally, the PDT clarified that management triggers apply to southern kingfish. The PDT decided on the following management triggers (organized into three categories; see PDT minutes for 1/7/2015):

Biological Monitoring

Proportion of adults ≥ length at 50% maturity ($L_{50}$) for NCDMF Program 195 June
Proportion of adults ≥ $L_{50}$ for NCDMF Program 915
Proportion of adults ≥ $L_{50}$ for SEAMAP summer

→ If the proportion of adults ≥ $L_{50}$ falls below 2/3 of the average proportion of adults ≥ $L_{50}$ for the time series, then the trigger will be considered tripped.

Fisheries-Independent Surveys—Juvenile and Adult

NCDMF Pamlico Sound Survey September index of YOY relative abundance
SEAMAP summer index of adult relative abundance
SEAMAP fall index of YOY relative abundance

→ If a fisheries-independent survey falls below 2/3 of the average abundance for the time series (through 2013), then the trigger will be considered tripped.

Other

Relative fishing mortality rate (*F*)

→ If relative *F* rises above 66% of the average relative *F* for the time series (through 2013), the trigger will be considered tripped.

If any **two** triggers trip **two** years in a row (regardless of category), then data will be reevaluated and management action may be considered.

**DETAILS**

Peak spawning for southern kingfish occurs in April so data collected by the NCDMF during March and April were used to estimate the maturity schedule. The value for $L_{50}$ was estimated using the standard logistic maturity curve (males and females pooled) and the estimate was 210 mm total length (TL; Figure 3). Adults collected during the June component of the Program 195 survey (excluding strata NR, PR, and PUN) were considered individuals > 150 mm TL. For the July through September component of Program 915 (Pamlico Sound deep strata only), adults were defined as individuals > 190 mm TL. For the summer component of the SEAMAP (Onslow, Raleigh, and Long bays, inner—shallow—strata) survey, adults were considered individuals > 150 mm TL.

Defining cut-offs for YOY and adults for the fisheries-independent surveys varied by survey and season. For the September component of the Pamlico Sound survey (excluding strata NR, PR, and PUN), YOY were defined as individuals ≤ 190 mm TL. For the summer component of the SEAMAP (Onslow, Raleigh, and Long bays, inner—shallow—strata) survey, adults were defined as above (>150 mm TL). For the fall component of the SEAMAP (Onslow, Raleigh, and Long bays, inner—shallow—strata) survey, YOY were considered individuals ≤ 205 mm TL. The relative index derived from the Program 195 survey was calculated using a stratified general linear model (GLM) approach. The indices derived from the SEAMAP survey were computed using standard (non-stratified) GLMs.

Relative *F* is a simple method for estimating trends in *F* (Sinclair 1998). It is estimated as catch divided by a fisheries-independent index of relative abundance. Here, catch (commercial landings plus recreational harvest) was divided by the SEAMAP spring index (Onslow, Raleigh, and Long bays, inner—shallow—strata) of relative abundance.

**RESULTS**

The management triggers based on the proportions of adults ≥ $L_{50}$ are shown in Figures 4 through 6. The proportions of adults ≥ $L_{50}$ derived from the NCDMF Program 915 survey were above the trigger threshold in all years throughout the respective time series (Figure 5). The management triggers based on the fisheries-independent survey indices are shown in Figures 7 through 9. The management trigger based on relative *F* is shown in Figure 10.

In 17 of the 27 years (1987–2013), at least one trigger was tripped in each of two categories (Table 4). There were eight instances when two triggers simultaneously tripped two years in a row (regardless of category). No triggers were tripped in 2013.

**DISCUSSION AND RECOMMENDATIONS**

The management triggers adopted in the 2007 Kingfish FMP were evaluated and recommendations were put forth in this document to improve and refine those triggers. Based on the evaluation of the newly proposed management triggers, consideration of management action is not warranted at this time. The results indicated that no triggers were tripped in 2013.

On January 20, 2015, the Management Review Team (MRT) supported the recommendations of the PDT and therefore becoming the division recommendation.

At the August 2015 Marine Fisheries Commission (MFC) meeting, the commission members voted and approved the division recommended updated triggers.

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**Table 1.** Percentage of zero tows for southern kingfish occurring in the June and September components of the NCDMF Pamlico Sound Survey, 1990–2013.

| Year | June | September |
|---|---|---|
| **1990** | 79.6 | 45.1 |
| **1991** | 90.6 | 43.4 |
| **1992** | 64.2 | 59.6 |
| **1993** | 51.9 | 81.1 |
| **1994** | 69.8 | 44.9 |
| **1995** | 73.6 | 28.8 |
| **1996** | 63.5 | 81.1 |
| **1997** | 62.3 | 69.8 |
| **1998** | 88.5 | 66.7 |
| **1999** | 70.4 | 55.8 |
| **2000** | 50.9 | 47.2 |
| **2001** | 67.9 | 49.1 |
| **2002** | 71.7 | 48.1 |
| **2003** | 75.5 | 54.7 |
| **2004** | 57.4 | 43.4 |
| **2005** | 65.4 | 44.2 |
| **2006** | 42.6 | 46.3 |
| **2007** | 45.1 | 29.6 |
| **2008** | 50.0 | 44.4 |
| **2009** | 44.4 | 38.9 |
| **2010** | 24.1 | 51.9 |
| **2011** | 63.0 | 31.5 |
| **2012** | 20.4 | 46.3 |
| **2013** | 27.8 | 24.1 |

**Table 2.** Percentage of tows in which southern kingfish were present in the June component of the NCDMF Pamlico Sound Survey by strata, 1990–2013.

| Year | NR | PDE | PDW | PR | PSE | PSW | PUN |
|---|---|---|---|---|---|---|---|
| **1990** | 0 | 18 | 56 | 0 | 33 | 0 | 0 |
| **1991** | 0 | 4.5 | 13 | 0 | 29 | 33 | 0 |
| **1992** | 0 | 42 | 63 | 0 | 50 | 40 | 0 |
| **1993** | 0 | 76 | 44 | 0 | 71 | 25 | 0 |
| **1994** | 0 | 40 | 50 | 0 | 38 | 25 | 0 |
| **1995** | 0 | 36 | 29 | 0 | 43 | 25 | 0 |
| **1996** | 0 | 48 | 57 | 0 | 43 | 50 | 0 |
| **1997** | 20 | 64 | 29 | 0 | 17 | 40 | 0 |
| **1998** | 0 | 15 | 13 | 0 | 33 | 0 | 0 |
| **1999** | 0 | 26 | 30 | 0 | 57 | 80 | 0 |
| **2000** | 0 | 74 | 44 | 0 | 71 | 60 | 0 |
| **2001** | 0 | 53 | 45 | 0 | 14 | 33 | 0 |
| **2002** | 20 | 32 | 33 | 0 | 43 | 40 | 0 |
| **2003** | 0 | 30 | 36 | 0 | 50 | 0 | 0 |
| **2004** | 0 | 50 | 40 | 20 | 86 | 50 | 0 |
| **2005** | 0 | 53 | 44 | 0 | 50 | 20 | 0 |
| **2006** | 40 | 60 | 67 | 0 | 100 | 60 | 33 |
| **2007** | 0 | 78 | 44 | 20 | 83 | 60 | 33 |
| **2008** | 60 | 50 | 33 | 40 | 71 | 60 | 33 |
| **2009** | 0 | 65 | 44 | 40 | 86 | 100 | 0 |
| **2010** | 60 | 90 | 89 | 0 | 100 | 100 | 0 |
| **2011** | 20 | 60 | 22 | 0 | 43 | 40 | 0 |
| **2012** | 80 | 95 | 100 | 0 | 86 | 80 | 33 |
| **2013** | 20 | 85 | 89 | 40 | 86 | 100 | 0 |

**Table 3.** Percentage of tows in which southern kingfish were present in the September component of the NCDMF Pamlico Sound Survey by strata, 1990–2013.

| Year | NR | PDE | PDW | PR | PSE | PSW | PUN |
|---|---|---|---|---|---|---|---|
| **1990** | 0 | 70 | 60 | 0 | 86 | 100 | 0 |
| **1991** | 20 | 68 | 83 | 0 | 88 | 50 | 0 |
| **1992** | 0 | 60 | 0 | 0 | 75 | 100 | 0 |
| **1993** | 20 | 24 | 11 | 20 | 14 | 33 | 0 |
| **1994** | 0 | 79 | 57 | 20 | 83 | 50 | 0 |
| **1995** | 20 | 95 | 75 | 0 | 86 | 100 | 33 |
| **1996** | 20 | 14 | 13 | 0 | 67 | 25 | 0 |
| **1997** | 20 | 50 | 33 | 0 | 29 | 0 | 0 |
| **1998** | 20 | 39 | 33 | 0 | 63 | 33 | 0 |
| **1999** | 0 | 58 | 50 | 20 | 86 | 0 | 0 |
| **2000** | 0 | 95 | 10 | 0 | 100 | 33 | 0 |
| **2001** | 0 | 84 | 44 | 0 | 71 | 40 | 0 |
| **2002** | 0 | 95 | 44 | 0 | 29 | 50 | 33 |
| **2003** | 0 | 68 | 20 | 0 | 71 | 75 | 33 |
| **2004** | 0 | 70 | 56 | 40 | 86 | 75 | 0 |
| **2005** | 20 | 65 | 33 | 20 | 100 | 100 | 33 |
| **2006** | 0 | 65 | 56 | 40 | 71 | 80 | 0 |
| **2007** | 20 | 95 | 67 | 40 | 71 | 100 | 0 |
| **2008** | 20 | 60 | 56 | 20 | 86 | 100 | 0 |
| **2009** | 0 | 90 | 67 | 0 | 57 | 100 | 0 |
| **2010** | 0 | 45 | 67 | 40 | 71 | 60 | 33 |
| **2011** | 0 | 95 | 78 | 0 | 71 | 100 | 33 |
| **2012** | 20 | 85 | 44 | 20 | 43 | 40 | 33 |
| **2013** | 0 | 100 | 88 | 20 | 100 | 100 | 0 |

**Table 4.** Summary of management trigger organized by category. Bold values indicate values that exceed (and so would trip) the trigger.

| | **BIOLOGICAL MONITORING** | | | **FISHERIES-INDEPENDENT SURVEYS** | | | **OTHER** |
|---|---|---|---|---|---|---|---|
| | **Proportion of Adults >= L50** | | | **YOY Indices** | | **Adult Index** | **Relative *F*** |
| **Year** | Program 195 June | Program 915 | SEAMAP Summer | Program 195 September | SEAMAP Fall | SEAMAP Summer | Relative *F* |
| **1987** | 0.602 | | | **0.538** | | | |
| **1988** | 0.450 | | | **0.926** | | | |
| **1989** | **0.300** | | 0.585 | **1.31** | 10.5 | **7.63** | 17,627 |
| **1990** | 0.529 | | 0.463 | **2.35** | 9.93 | 29.1 | **92,209** |
| **1991** | 0.667 | | 0.894 | **3.45** | 9.92 | 41.7 | **31,107** |
| **1992** | 0.429 | | 0.622 | **1.37** | **5.20** | 15.7 | **25,449** |
| **1993** | 0.542 | | 0.456 | **0.106** | **4.70** | 14.2 | **59,442** |
| **1994** | 0.794 | | 0.917 | 5.07 | 11.3 | **3.10** | **137,621** |
| **1995** | 0.440 | | 0.486 | 8.60 | **2.36** | **11.1** | **49,097** |
| **1996** | 0.872 | | 0.780 | **0.208** | 9.77 | **5.44** | **30,411** |
| **1997** | 0.576 | | **0.373** | **0.452** | **4.00** | **11.0** | 20,276 |
| **1998** | 1.00 | | 0.769 | **0.207** | 10.6 | **5.65** | 9,743 |
| **1999** | 0.920 | | 0.608 | **3.79** | 22.6 | 28.0 | **24,813** |
| **2000** | 0.733 | | 0.929 | 8.21 | 8.31 | **11.6** | **83,334** |
| **2001** | 0.660 | 0.983 | **0.303** | 4.42 | **5.15** | 25.6 | 20,962 |
| **2002** | 0.704 | 0.978 | 0.882 | 6.30 | 14.2 | **11.9** | **31,765** |
| **2003** | 0.860 | 0.978 | 0.645 | 5.81 | **4.24** | 18.5 | 5,706 |
| **2004** | 0.513 | 0.963 | **0.284** | **2.98** | 13.2 | 45.0 | 5,579 |
| **2005** | 0.594 | 0.970 | 0.643 | **1.52** | 11.0 | 18.1 | 5,530 |
| **2006** | 0.541 | 0.979 | 0.423 | 20.4 | **5.55** | 23.7 | 13,604 |
| **2007** | **0.338** | 1.00 | 0.521 | 8.97 | **6.59** | **8.42** | **45,254** |
| **2008** | 0.480 | 0.987 | 0.577 | 8.79 | 9.56 | **3.99** | **41,046** |
| **2009** | 0.591 | 1.00 | 0.398 | 24.9 | **3.75** | 16.2 | **33,941** |
| **2010** | 0.508 | 0.981 | 0.786 | **1.47** | 16.9 | **11.9** | 20,169 |
| **2011** | 0.447 | 1.00 | 0.507 | 16.8 | 31.3 | 21.1 | **31,533** |
| **2012** | 0.523 | 1.00 | **0.368** | 5.02 | 9.22 | 61.9 | 8,052 |
| **2013** | 0.659 | 0.941 | 0.558 | 16.9 | 10.7 | 39.5 | 4,048 |
| **Threshold** | 0.402 | 0.654 | 0.394 | 3.97 | 6.68 | 13.1 | 22,396 |
| Total Years | 27 | 13 | 25 | 27 | 25 | 25 | 25 |
| n Exceed | 2 | 0 | 4 | 14 | 9 | 11 | 14 |

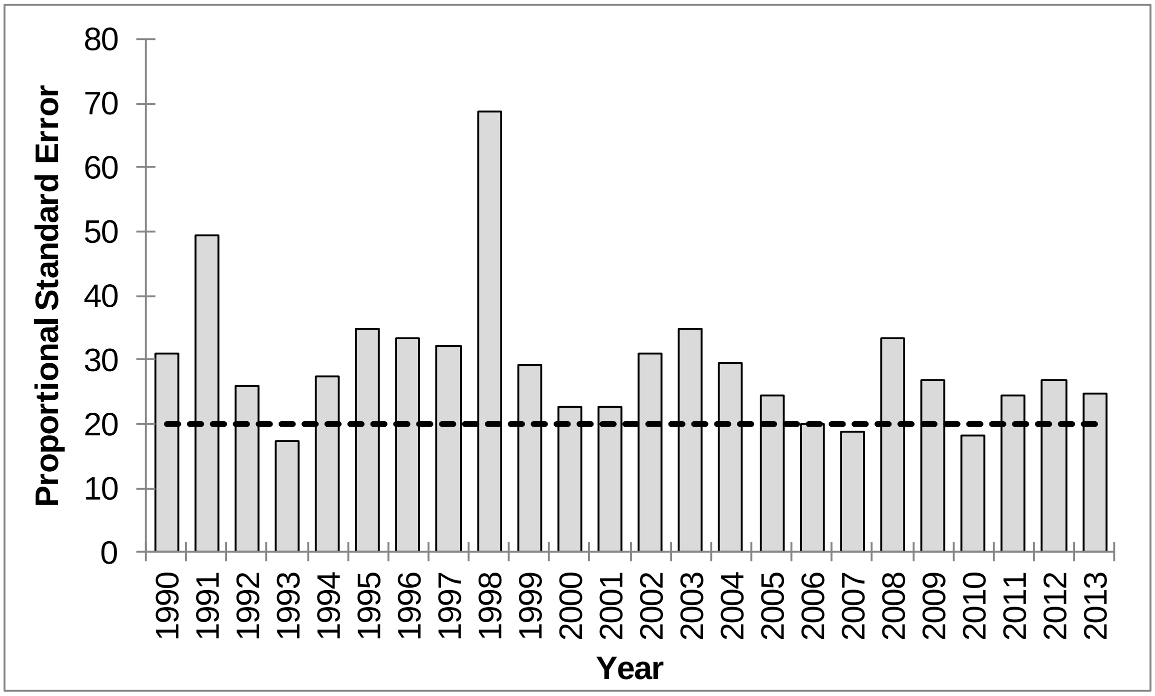


**Figure 1.** Annual PSE values associated with the GLM-standardized index of southern kingfish occurring in the June component of the Pamlico Sound Survey, 1990–2013. Dotted line represents 20% PSE.

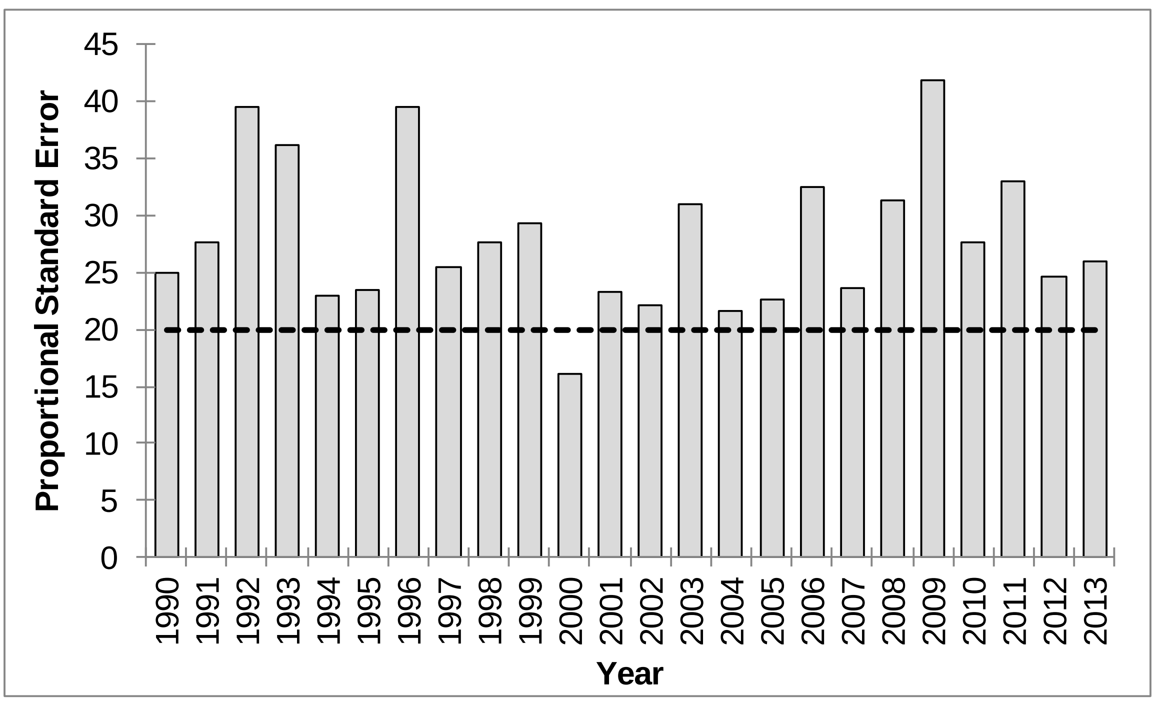


**Figure 2.** Annual PSE values associated with the GLM-standardized index of southern kingfish occurring in the September component of the Pamlico Sound Survey, 1990–2013. Dotted line represents 20% PSE.

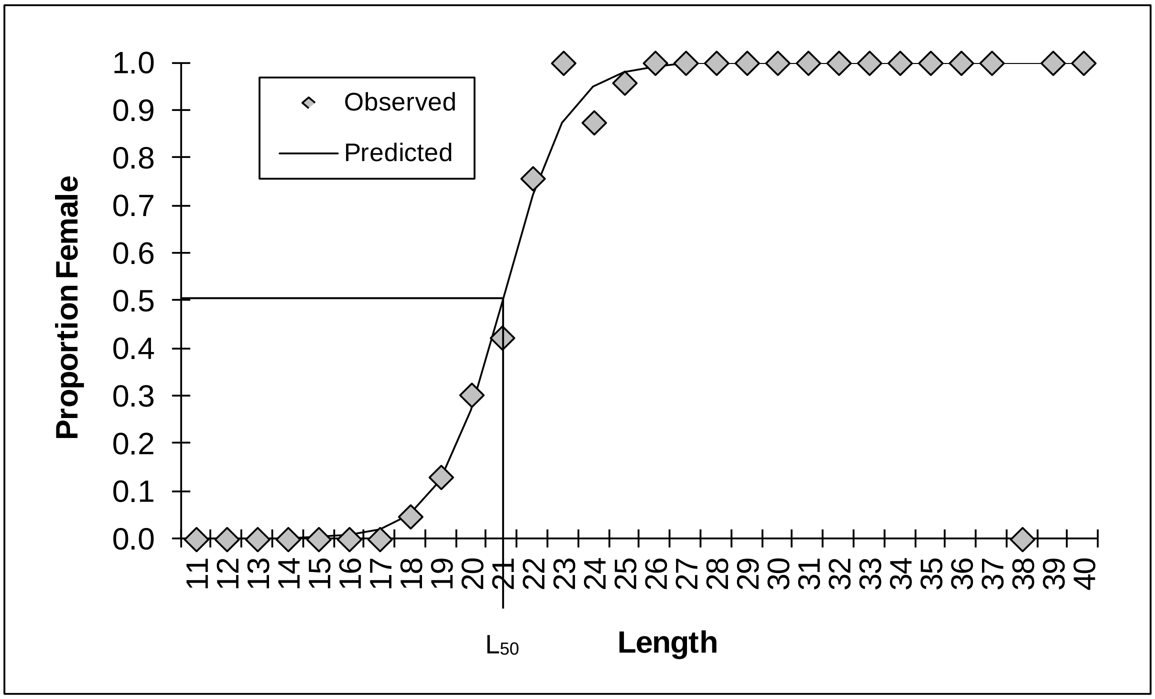


**Figure 3.** Predicted maturity schedule for male and female (pooled) southern kingfish.

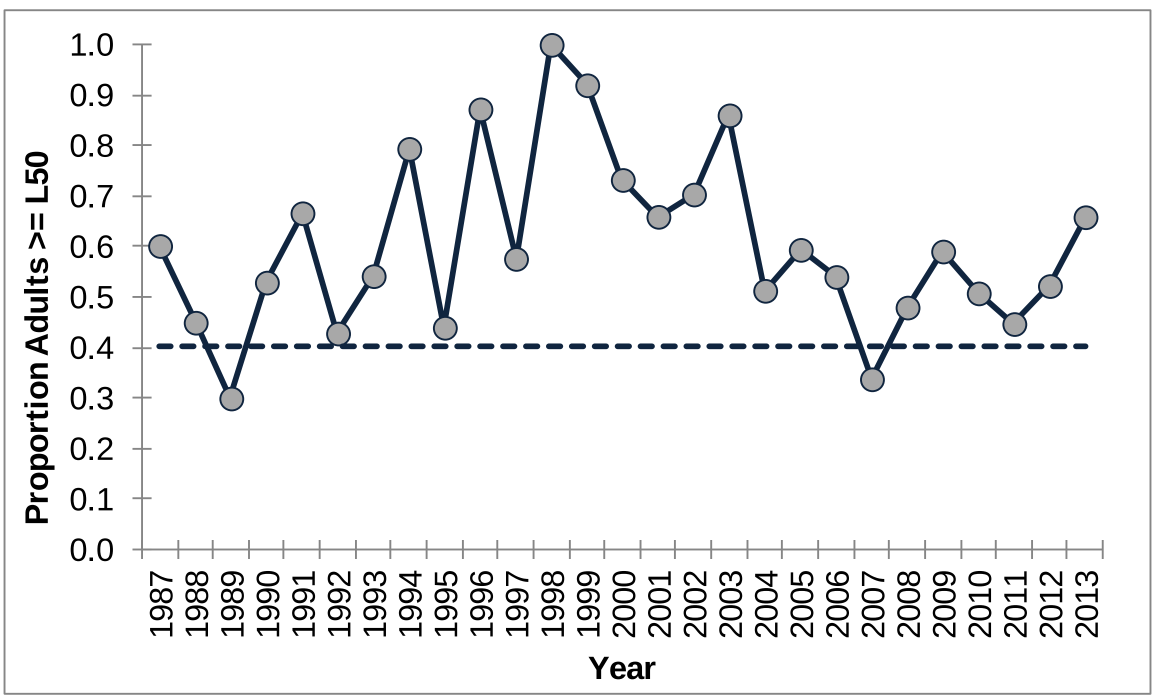


**Figure 4.** Annual proportions of adults greater than or equal to the length at 50% maturity occurring in the June component of the NCDMF Program 195 survey (excluding strata NR, PR, and PUN), 1987–2013. Dotted line represents 2/3 of the average of the time series.

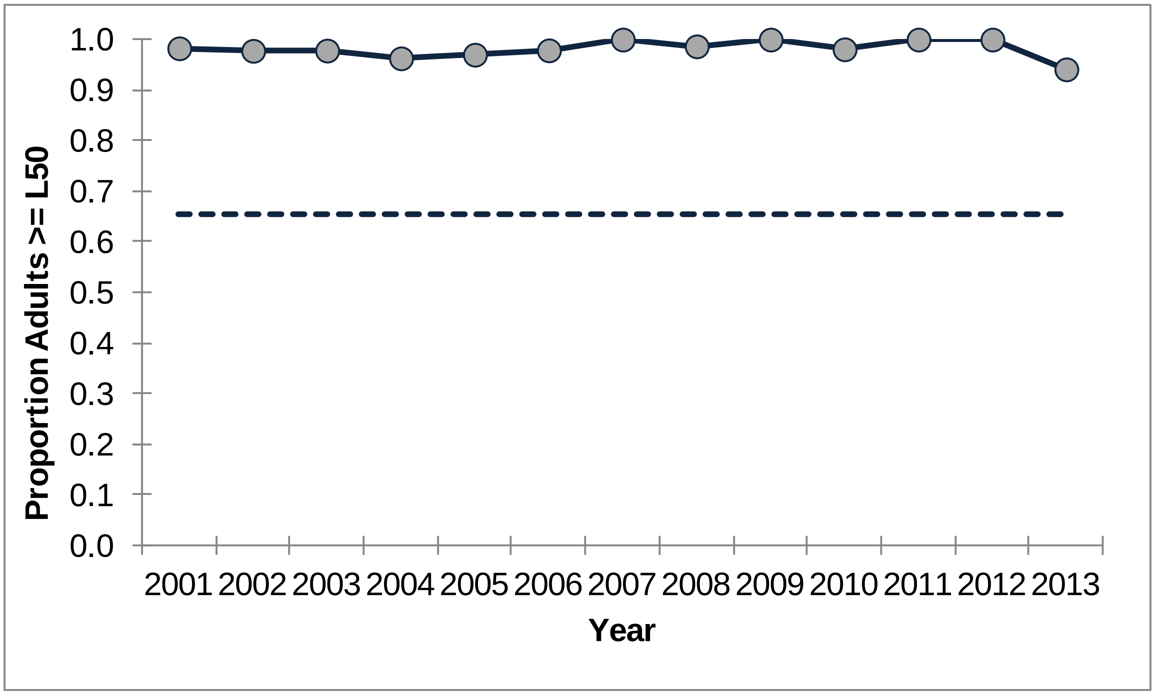


**Figure 5.** Annual proportions of adults greater than or equal to the length at 50% maturity occurring in the July–September component of the NCDMF Program 915 survey (Pamlico Sound deep strata only), 2001–2013. Dotted line represents 2/3 of the average of the time series.

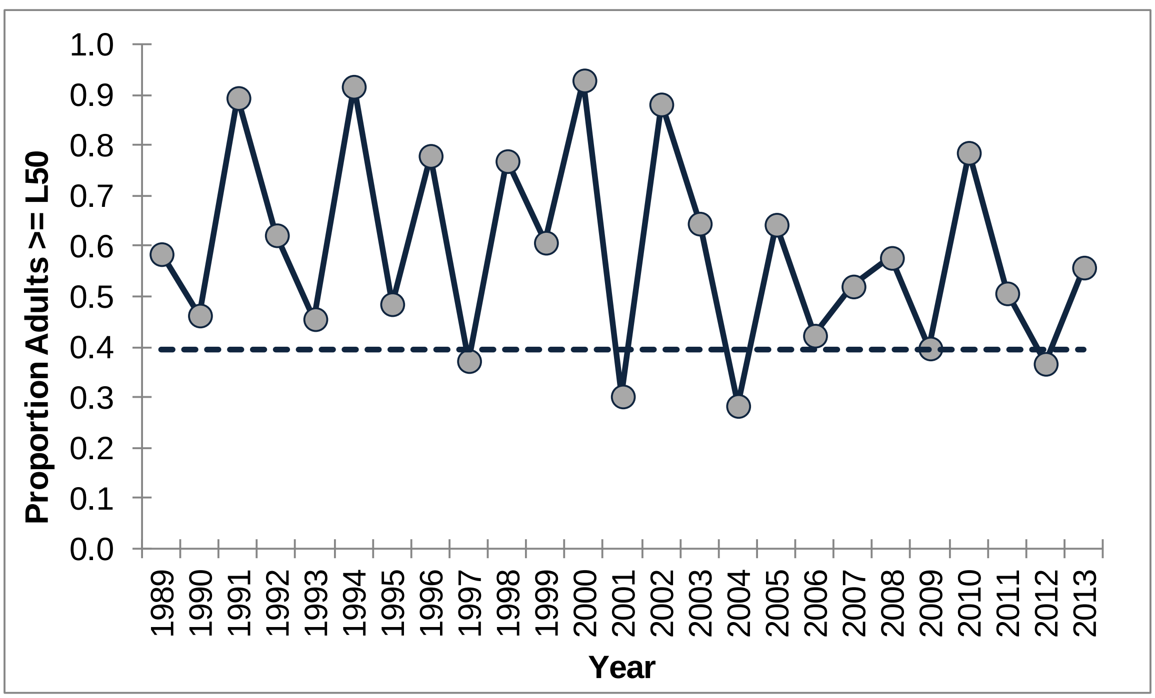


**Figure 6.** Annual proportions of adults greater than or equal to the length at 50% maturity occurring in the summer component of the SEAMAP survey (Onslow, Raleigh, and Long bays, inner—shallow—strata), 1989–2013. Dotted line represents 2/3 of the average of the time series.

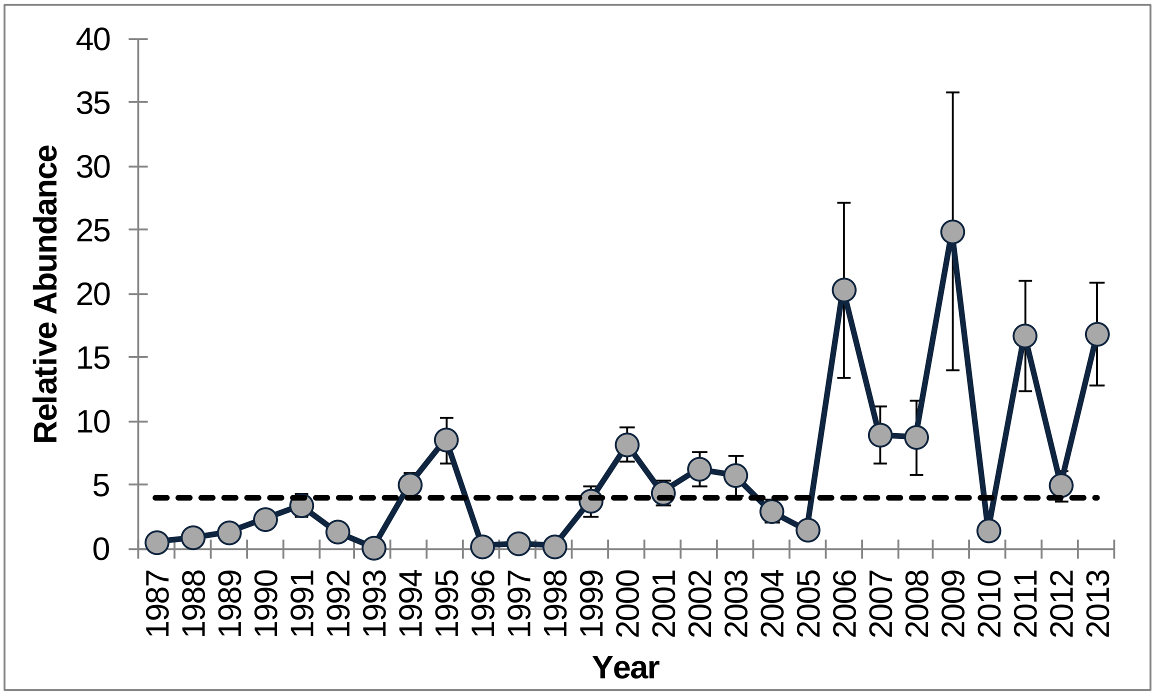


**Figure 7.** Annual index of relative YOY abundance derived from the September component of the NCDMF Program 195 survey (excluding strata NR, PR, and PUN), 1987–2013. Dotted line represents 2/3 of the average of the time series.

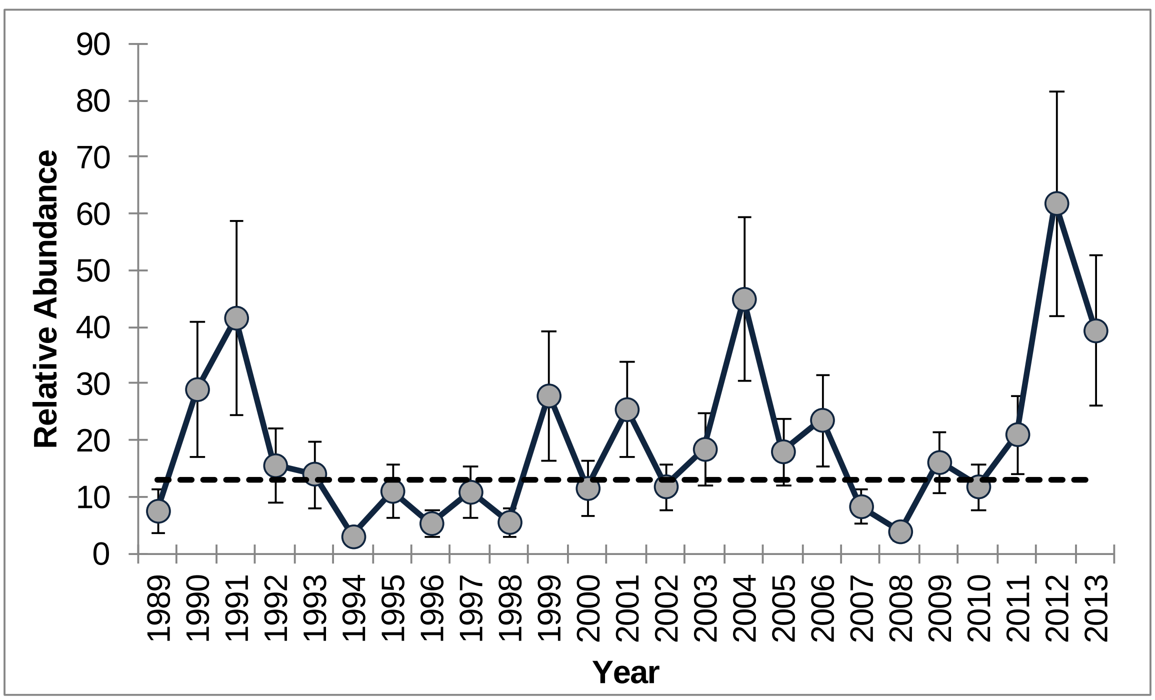


**Figure 8.** Annual index of relative adult abundance derived from the summer component of the SEAMAP survey (Onslow, Raleigh, and Long bays, inner—shallow—strata), 1989–2013. Dotted line represents 2/3 of the average of the time series.

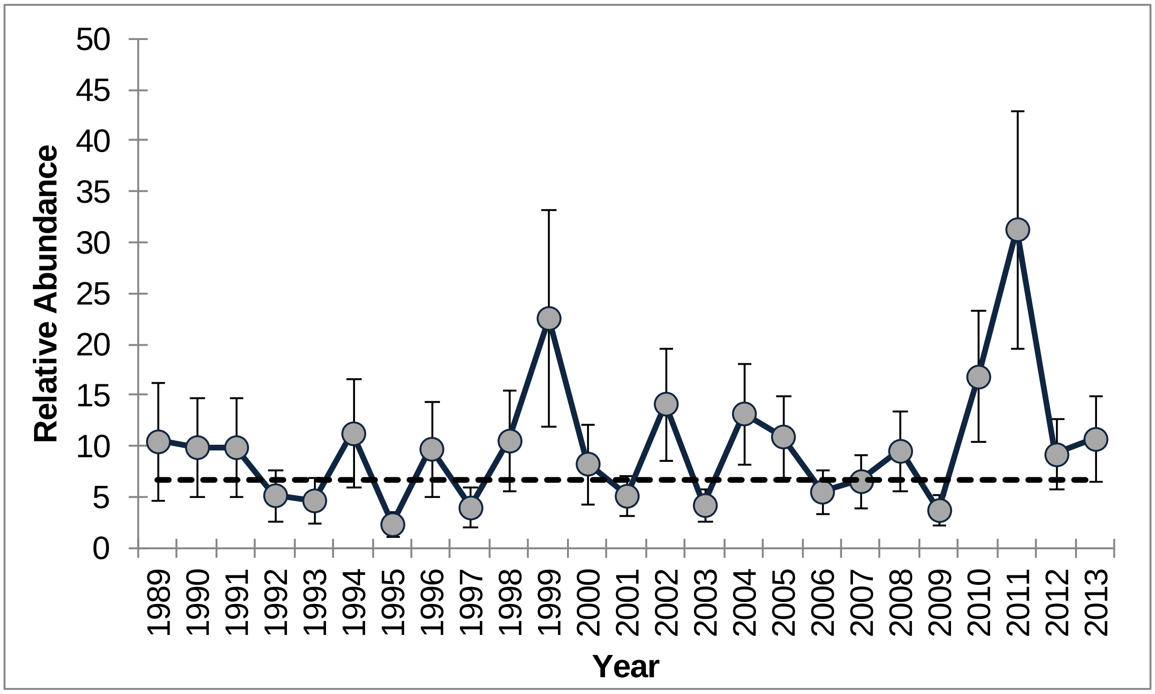


**Figure 9.** Annual index of relative YOY abundance derived from the fall component of the SEAMAP survey (Onslow, Raleigh, and Long bays, inner—shallow—strata), 1989–2013. Dotted line represents 2/3 of the average of the time series.

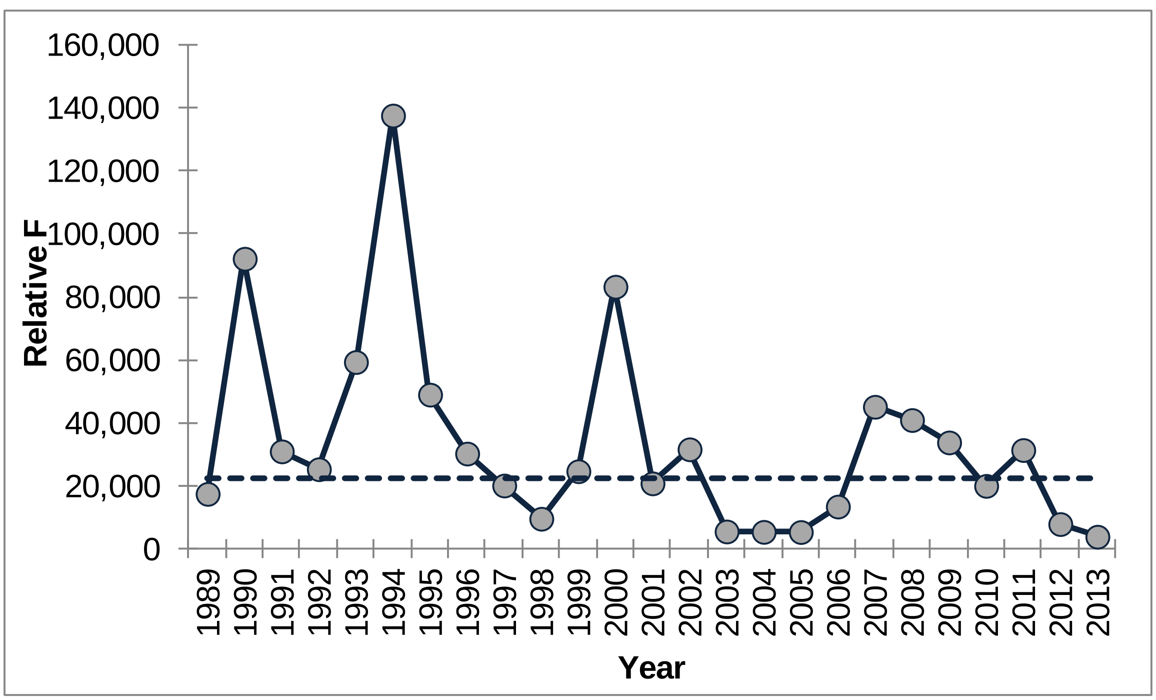


**Figure 10.** Annual estimates of relative fishing mortality rate (*F*), 1989–2013. Dotted line represents 66% of the average of the time series.

## 15.2 APPENDIX 2. SOLICITATION OF PUBLIC COMMENT ON KINGFISH ISSUES

**News Release distributed Jan. 26, 2015**

**MOREHEAD CITY** – The N.C. Division of Marine Fisheries is asking the public to submit comments on issues they would like to see addressed in an upcoming Kingfish Fishery Management Plan. State law requires the division to review each fishery management plan every five years

The division has begun a mandated review of the N.C. Kingfish Fishery Management Plan that was adopted by the N.C. Marine Fisheries Commission in 2007. The agency is soliciting public comment as part of an internal process to determine what procedural method to take in reviewing the plan.

If changes in management strategies or rules are needed, the division will pursue a plan amendment, where division staff and an advisory committee develop positions on specific issues that need to be addressed. If changes in management strategies are not required, the division will proceed with a revision, which is a more abbreviated process that involves updating data and fishery information contained in the plan.

Written comments will be accepted until February 17 and should be addressed to Beth Egbert, N.C. Division of Marine Fisheries, P.O. Box 1965, Manteo, N.C. 27954 or sent by email to Beth.Egbert@ncdenr.gov or to Kevin Brown, N.C. Division of Marine Fisheries, P.O. Box 769, Morehead City, N.C. 28557 or sent by email to Kevin.H.Brown@ncdenr.gov.

State law requires the division to prepare a fishery management plan for adoption by the Marine Fisheries Commission for all commercially and recreationally significant species or fisheries that comprise state marine and estuarine resources. These plans provide management strategies designed to ensure long-term viability of the species.

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**From the Public**

**Email received Jan. 26, 2015 from Dan Wood**

*I would like to see the state put a size limit on Kingfish (whiting). Right now thousands and thousands of small whiting are killed before they have a chance to reach eating size by netters as well as by both commercial and recreational fishermen. By putting a size limit on them they would at least reach spawning size before they can legally be taken.*
*Thanks for your consideration,*
*Dan Wood*
*Lexington, NC*
*e-mail: woodjd@lexcominc.net*
*phone: 336-239-2315*

***Division Response***

The management strategy set forth under the 2007 Kingfish Fishery Management Plan is the use of management triggers where management actions may be considered based on trends in several indices (biological and fishery independent). Indices have been updated through 2013 and based on these the Division has determined there is no need for additional regulations for kingfish at this time. A size limit would increase regulatory discards of kingfishes. Some culling occurs at sea and has been documented in the shrimp trawl fishery off South Carolina (DMF, unpublished data). Placing a nine-inch or greater size limit on kingfishes, which are bycatch in several fisheries, would result in additional regulatory discards in the shrimp trawl, long haul seine, beach seine, sciaenid pound net, winter trawl, and recreational fisheries as well as the gill net fishery. Heads of kingfishes are also used as bait in the recreational red drum fishery. Under North Carolina law, 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 (Marine Fisheries Commission Rule 15A NCAC 03M .0101).

The Division is not proposing any changes in management strategies or measures for the N.C. Kingfish Fishery Management Plan. Changes in factual and background data will be documented in the upcoming Information Update to the plan. The Marine Fisheries Commission will be advised of this at its May 2015 business meeting in New Bern. The commission is scheduled to vote on final approval of the Information Update to the fishery management plan at its November 2015 business meeting in Nags Head. Thank you for your interest in the State's fisheries.

N.C. Kingfish Fishery Management Plan 2007
http://portal.ncdenr.org/c/document_library/get_file?uuid=3882c28f-da09-4978-93ab-13ba38eb0414&groupId=38337

**Email received Jan. 26, 2015 from Frank Folb (Northern Regional AC)**

*The Sea Mullet fishery is very important to both recreational and commercial fisherfolks.*

*Sea Mullet was in the olden days what brought families to the Outer Banks to fish to help feed their families.*
*Still today it is a highly sought after fish that is of high priority to fishing piers and surf fisherman along our coast and our neighboring states above and below us.*
*Because these fish are NOT a highly sought after species on recreational boats I suggest that little or no limits for recreational fisheries as to size and creel be made.*
*If a minimum size limit is considered it should no more 9-10 inches and the creel for recreational should be no less than 50-75 fish.*

*Commercial Limits*
*In the past we have gone to historical data to see what the largest catch of a fish was and given them at least that amount for a top limit of catch for the year.*
*If I am correct that at present the fishery is viable and healthy I suggest we at least double any historical high for the beginning limit. This fishery is very important to the commercial sector in recent years and fills in a void when many other fisheries are closed. Until there is a need by research that a daily limit is needed is suggest no limit be placed on amount of catch per day or seasons open.*

*I would appreciate your reactions to my suggestions and also would include me on what your scientific committee minutes so I can follow and be involved throughout its implementation.*
*Thanks*
*Frank Folb*
*Northern Advisory Committee*
*Frank & Fran's Tackle*
*Avon, NC*

***Division Response***

The management strategy set forth under the 2007 Kingfish Fishery Management Plan is the use of management triggers where management actions may be considered based on trends in several indices (biological and fishery independent). Indices have been updated through 2013 and based on these the Division has determined there is no need for additional regulations for kingfish at this time. Currently, the only regulation for kingfishes in North Carolina relates to shrimp and crab trawls from December 1 through March 31. During this time it is unlawful to possess finfish caught incidental to shrimp and crab trawling in the Atlantic Ocean unless the weight of the combined catch of shrimp and crabs exceeds the weight of finfish; except that an additional 300 pounds of kingfish may be taken by crab or shrimp trawlers working south of Bogue Inlet [Marine Fisheries Commission Rule 15A NCAC 03J .0202 (5)].

The Division is not proposing any changes in management strategies or measures for the N.C. Kingfish Fishery Management Plan. The upcoming Information Update will contain the most recent data to characterize the fishery and species of kingfish. The Marine Fisheries Commission will be advised of this at its May 2015 business meeting in New Bern. The commission is scheduled to vote on final approval of the Information Update to the fishery management plan at its November 2015 business meeting in Nags Head. Thank you for your interest in the State's fisheries.

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**Email received Jan. 27, 2015 from Glenn Shivar**

*Hello! I have a few comments that I would like to express concerning sea mullet, aka kingfish.*

*--Are regulations really necessary? In my small part of the coast they seem larger and more numerous than I have seen and I'm 66 yrs old.*

*-- Make the creel limit generous, at least 30 / person.*

*-- Have no length requirement. Often used as bait. Big drum in the surf and for large flounder.*

*Thank You and have a Great Day - Glenn Shivar*

***Division Response***

The management strategy set forth under the 2007 Kingfish Fishery Management Plan is the use of management triggers where management actions may be considered based on trends in several indices (biological and fishery independent). Indices have been updated through 2013 and based on these the Division has determined there is no need for additional regulations for kingfish at this time. Currently, the only regulation for kingfishes in North Carolina relates to shrimp and crab trawls from December 1 through March 31. During this time it is unlawful to possess finfish caught incidental to shrimp and crab trawling in the Atlantic

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The Division is not proposing any changes in management strategies or measures for the N.C. Kingfish Fishery Management Plan. The upcoming Information Update will contain the most recent data to characterize the fishery and species of kingfish. The Marine Fisheries Commission will be advised of this at its May 2015 business meeting in New Bern. The commission is scheduled to vote on final approval of the Information Update to the fishery management plan at its November 2015 business meeting in Nags Head. Thank you for your interest in the State's fisheries.

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**Email received February 12, 2015 from Chris McCaffity**

*Public Comments Regarding Kingfish Management*

*I am Chris McCaffity. Please keep an open mind as you think about these solutions that could be applied to managing most seafood including kingfish and herring.*

*Start by deciding how many kingfish their existing habitat can support. Establish reasonable recreational/charter and consumer/commercial quotas. Allow stakeholders to decide how each sector's annual quotas will be managed with a 2/3 majority vote from participating permit/license holders. Stock kingfish in rotation with other species as needed to support desired harvest levels. Take practical steps to enhance habitat so our waters can support more marine life. Reward fishermen and consumers with higher quotas as stocks reach desired levels. Process unmarketables from cleaned seafood into aquaculture feed.*

*Hatcheries and habitat enhancement could be the perfect union of mariculture and wild-caught seafood that lives free and self-sufficient until harvested. Stocked species would thrive and produce at Optimum Yield even as we harvest more. These proven solutions would feed more people while creating more recreational opportunity and generating more revenue. It is time to focus more on enhancing our fisheries than restricting access to them.*

*Thank you for your thoughtful consideration of these positive solutions. I am happy to answer any questions. freefish7@hotmail.com*

***Division Response***

The management strategy set forth under the 2007 Kingfish FMP is the use of management triggers where management actions may be considered based on trends in several indices (biological and fishery independent). Indices have been updated through 2013 and based on these the Division has determined there is no need for additional regulations for kingfish at this time. Currently, the only regulation for kingfishes in North Carolina relates to shrimp and crab trawls from December 1 through March 31. During this time it is unlawful to possess finfish caught incidental to shrimp and crab trawling in the Atlantic Ocean unless the weight of the combined catch of shrimp and crabs exceeds the weight of finfish; except that an additional 300 pounds of kingfish may be taken by crab or shrimp trawlers working south of Bogue Inlet [15A NCAC 3J .0202 (5)].

The Division is not proposing any changes in management strategies or measures for the N.C. Kingfish Fishery Management Plan. The upcoming Information Update will contain the most recent data to characterize the fishery and species of kingfish. The Marine Fisheries Commission will be advised of this at its May 2015 business meeting in New Bern. The commission is scheduled to vote on final approval of the Information Update to the fishery management plan at its November 2015 business meeting in Nags Head. Thank you for your interest in the State's fisheries.

NC Fishery Management Plan Kingfish 2007
[http://portal.ncdenr.org/c/document_library/get_file?uuid=3882c28f-da09-4978-93ab-13ba38eb0414&groupId=38337](http://portal.ncdenr.org/c/document_library/get_file?uuid=3882c28f-da09-4978-93ab-13ba38eb0414&groupId=38337)

**Email received Feb. 16, 2015 from Adam Tyler**

*I would like to offer these comments on the proposed Kingfish FMP review. According to the DMF website these fish are fine. As noted in the copy and paste below from the DMF website. Commercial landing did decline in 2013 but I firmly believe that was due to the arrival of spiny dogfish in the region. Dogfish tend to eat what is available and run schools of fish out of the area. When this occurs obviously these fish leave the area. However this year 2014 was a banner year for all 3 species of Kingfish. We have caught them locally up to Super Bowl Sunday. The lack of large schools of Spiny Dogfish this year allowed us to catch king fish till later than normal due to natural predators being minimal this year. So I do not feel that any changes are currently needed in this plan.* [Mr. Tyler also gave additional comments by phone concerning his interest in a correlation between dogfish abundance and kingfish abundance. He stated that he gillnets for both and when one is abundant the other is not. He asked if it would be possible for the division to investigate a correlation based on landings or other data (Kevin Brown personal communication.)]

| **Comments** | | | | | | |
|---|---|---|---|---|---|---|
|  Kingfishes (A) | | | | |  | A state fishery management plan completed in 2007 indicated a healthy age structure in the stock along with increasing trends in juvenile abundance, but commercial landings dropped in 2013. |

Adam Tyler

***Division Response***
The management strategy set forth under the 2007 Kingfish Fishery Management Plan is the use of management triggers where management actions may be considered based on trends in several indices (biological and fishery independent). Indices have been updated through 2013 and based on these the Division has determined there is no need for additional regulations for kingfish at this time. Currently, the only regulation for kingfishes in North Carolina relates to shrimp and crab trawls from December 1 through March 31. During this time it is unlawful to possess finfish caught incidental to shrimp and crab trawling in the Atlantic Ocean unless the weight of the combined catch of shrimp and crabs exceeds the weight of

finfish; except that an additional 300 pounds of kingfish may be taken by crab or shrimp trawlers working south of Bogue Inlet [Marine Fisheries Commission Rule 15A NCAC 03J .0202 (5)].

While it would be interesting to investigate a correlation in the abundance of dogfish and kingfish, the division does not feel it is necessary for the Informational Update to the Kingfish Fishery Management Plan at this time.

The Division is not proposing any changes in management strategies or measures for the N.C. Kingfish Fishery Management Plan. The upcoming Information Update will contain the most recent data to characterize the fishery and species of kingfish. The Marine Fisheries Commission will be advised of this at its May 2015 business meeting in New Bern. The commission is scheduled to vote on final approval of the Information Update to the fishery management plan at its November 2015 business meeting in Nags Head. Thank you for your interest in the State's fisheries.

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