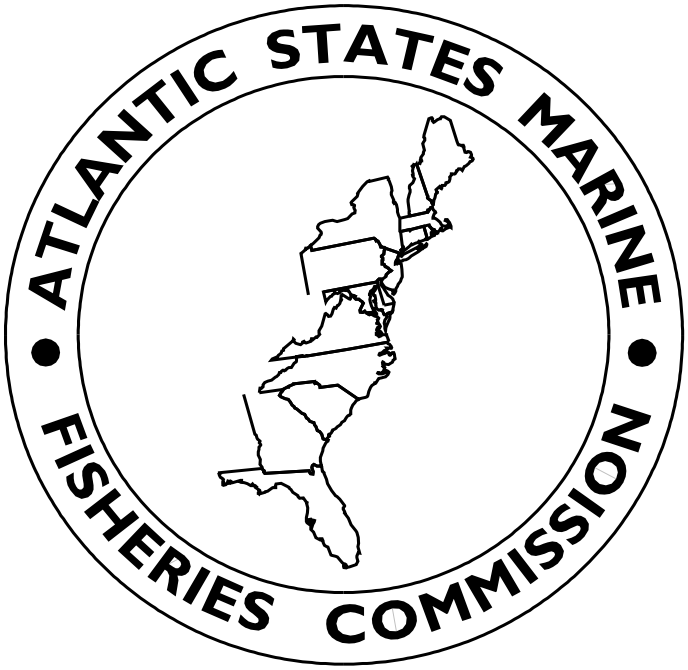
Fishery Management Report No. 38

of the

Atlantic States Marine Fisheries Commission



Amendment 2 to the Interstate Fishery Management Plan for Red Drum

June 2002

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ATLANTIC STATES MARINE FISHERIES COMMISSION

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Prepared by

Atlantic States Marine Fisheries Commission
Red Drum Plan Development Team

Plan Development Team Members:

Dr. Joseph C. Desfosse (ASMFC), Dr. Kathi Kitner, (SAFMC), Dr. Wilson Laney (US FWS), Mike Murphy (FL FWC), Rob O'Reilly (VA MRC), Lee Paramore (NC DMF), Roger Pugliese (SAFMC), Dr. Ray Rhodes (SC DNR), Dr. Charlie Wenner (SC DNR), and Spud Woodward (GA DNR).

This Amendment was prepared under the guidance of the Atlantic States Marine Fisheries Commission's South Atlantic State-Federal Fisheries Management Board, Chaired by Dr. Louis Daniel of the North Carolina Division of Marine Fisheries. Technical and advisory assistance was provided by the Red Drum Technical Committee, the Red Drum Stock Assessment Subcommittee and the Red Drum Advisory Panel.

This is a report of the Atlantic States Marine Fisheries Commission pursuant to U.S. Department of Commerce, National Oceanic and Atmospheric Administration Award Nos. NA07 FG0 024 and NA17 FG1 050.

EXECUTIVE SUMMARY

1. Introduction

Red drum, *Sciaenops ocellatus*, are managed jointly by the Atlantic States Marine Fisheries Commission (Commission) and the South Atlantic Fishery Management Council (Council). The current management objectives of both plans are: (1) assure escapement by controlling fishing mortality; (2) protect the spawning biomass from directed fishing mortality; (3) address incompatibility and inconsistency among state and federal regulations; and (4) promote cooperative collection, analysis, and utilization of biological and socioeconomic data. The Commission originally adopted a Fishery Management Plan (FMP) for Red Drum in 1984. The original management unit included the states from Florida to Maryland. In 1988, the Interstate Fisheries Management Program (ISFMP) Policy Board requested that all states from Florida to Maine implement plan requirements to prevent development of northern markets for southern fish. This action was the first of two revisions to the 1984 plan.

In 1990, the Council adopted an FMP for red drum which established a definition of overfishing and optimum yield consistent with the Magnuson Fishery Conservation and Management Act of 1976. With adoption of this plan, the Council prohibited the harvest of red drum in the exclusive economic zone (EEZ). The Council FMP, in recognition that all harvest would take place in state waters, recommended to the states that they implement measures necessary to provide the target level of escapement. The moratorium on harvest of red drum in the EEZ remains in effect.

Acknowledging the actions taken by the Council, the Commission undertook efforts to update its FMP to be consistent with the Council plan. This was the second revision of the plan and occurred with Amendment 1 in 1991. The goal of Amendment 1 was to attain optimum yield from the fishery over time. Optimum yield was defined as the amount of harvest that could be taken while maintaining the spawning stock biomass per recruit (SSBR) level at or above 30% of the level that would result if fishing mortality was zero. However, as a result of a lack of adequate information on the status of the adult stock, escapement rates of sub-adult red drum into the adult population were used as a proxy for SSBR.

The Commission recognized that substantial reductions in fishing mortality were necessary to increase the escapement of sub-adults to the spawning biomass. However, it also recognized the scarcity of information on the status of adult red drum along the Atlantic coast. Therefore, a "phase-in" approach was adopted which required all states to implement harvest controls necessary to attain a 10% SSBR. All states in the management unit modified regulations and/or commercial quotas to increase escapement of sub-adults. Until recently, these harvest regulations have remained unchanged since 1992. North and South Carolina have implemented substantive changes to their regulations in 2000-2001, to further restrict the harvest of red drum and increase the escapement of juveniles into the adult population.

The Council adopted new definitions of optimum yield and overfishing for red drum in 1998. Optimum yield was now defined as 40% static spawning potential ratio (SPR), an overfishing definition of less than 30% SPR, and a threshold overfishing level of 10% SPR. In 1999, the Council recommended that management authority for red drum be transferred to the states, through the Commission's Interstate Fishery Management Program (ISFMP) process. This document represents the first draft of Amendment 2 to the Commission's Red Drum FMP.

Statement of the Problem *(1.1.1)*

Management measures implemented by the states in response to the guidelines set forth in Amendment 1 to the Commission's Red Drum FMP have led to an increase in the escapement rates of juvenile red drum. However, the overall population remains in an overfished condition with SPR values less than 30% for both the northern and southern regions (North Carolina and north comprise the northern region; South Carolina-Georgia-east coast of Florida comprise the southern region). These management measures were intended to be an intermediate step in a phased in approach to recovering the red drum population, with the interim goal being to raise SPR to at least 10%. The Atlantic coast states from Florida through New Jersey have implemented measures to modify harvest regulations and/or commercial quotas to increase escapement of sub-adults. Under these regulations, the interim management goal appears to have been met and exceeded to some degree in each region. It was expected that additional harvest

restrictions would be required in some areas to meet the ultimate goal of the original FMP.

One of the reasons the Council has recommended transferring management authority to the Commission is the inability to accurately determine stock rebuilding targets and schedules under the new requirements of the revised Sustainable Fisheries Act (1996). Since there is no current estimate of the size of the adult population nor is there an estimate of what a rebuilt or healthy stock looks like, it is virtually impossible to determine what a rebuilding schedule should be. However, the duration of a rebuilding schedule should reflect, in part, a measure of the generation time of the species. For a long-lived, but relatively early spawning species as red drum, mean generation time would be on the order of 15-20 years based on age-specific egg production (Vaughan and Carmichael 2000). The maximum age of red drum in the northern region is 50-60 years, while in the southern region it is about 40 years. Given these factors, it may take quite some time for noticeable increases in the age structure of the adult population to become apparent.

Amendment 2 will address the next steps for rebuilding the red drum population as well as updating the FMP to meet the standards for Commission FMPs under the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA 1993).

2. Goals, Objectives, Management Unit, Overfishing Definition

Amendment 2 to the Interstate Fishery Management Plan for Red Drum completely replaces all previous Commission management plans for red drum.

- The management goal of Amendment 2 shall be to achieve and maintain the Optimum Yield (OY) for the Atlantic coast red drum fishery as the amount of harvest that can be taken by U.S. fishermen while maintaining the Static Spawning Potential Ratio (SPR) at or above 40%.

In support of this goal, the following objectives are recommended for Amendment 2:

- Achieve and maintain an escapement rate sufficient to prevent recruitment failure and achieve a static SPR at or above 40%.
- Provide a flexible management system to address incompatibility and inconsistency among state and federal regulations which minimizes regulatory delay while retaining substantial ASMFC, Council, and public input into management decisions; and which can adapt to changes in resource abundance, new scientific information and changes in fishing patterns among user groups or by area.
- Promote cooperative collection of biological, economic and sociological data required to effectively monitor and assess the status of the red drum resource and evaluate management efforts.
- To restore the age and size structure of the Atlantic coast red drum population.

Management Unit/Area *(2.4)*

The management unit for Amendment 2 is defined as the red drum resource throughout the range of the species within U.S. waters of the northwest Atlantic Ocean from the estuaries eastward to the offshore boundaries of the EEZ. The management area for Amendment 2 shall be the entire Atlantic coast distribution of the resource from Florida (east coast) through New Jersey. The management area is divided into a southern region which includes the waters of the Atlantic coast of Florida north to the North Carolina/South Carolina border. The northern region extends from the North Carolina/South Carolina border north through New Jersey.

Overfishing Definition *(2.5)*

Overfishing for red drum shall be defined as a fishing mortality rate (F) in excess of the fishing mortality rate at 30% Static Spawning Potential Ratio (SPR) or F30% SPR. The target fishing mortality rate shall be the fishing mortality rate at 40% Static Spawning Potential Ratio or 40% SPR.

Implementation Schedule *(2.8)*

Amendment 2 was approved and adopted by the Commission during May, 2002, at the Commission's Spring Meeting. States shall implement the provisions of Amendment 2 by January 1, 2003.

3. Monitoring Program Specifications/Elements

A red drum stock assessment will be performed by the stock assessment subcommittee every 3 to 5 years after implementation of this amendment. The technical committee and advisory panel will meet to review the stock assessment and all other relevant data sources. An annual report will be presented to the South Atlantic State-Federal Fisheries Management Board in order to evaluate adjustments to the management program as necessary. In addition to the general content of the report, the stock assessment report will also contain information on age/size structure, recruitment, spawning stock biomass, fishing mortality rates, catch and landings data and fishery-independent surveys as available.

4. Management Program Elements

Recreational Fishery Management Measures (*4.1*)

Bag and Size Limits *(4.1.1)* - In lieu of mandating specific bag and size limits for each management area, Amendment 2 specifies that all states must implement an appropriate bag and size limit which will attain the management goal of 40% SPR (see tables provided for each region)

Maximum Size Limit *(4.1.2)* - No red drum larger than 27" total length (TL) shall be harvested. All states must implement a 27" TL or smaller maximum size limit for red drum.

Commercial Fishery Management Measures (*4.2*)

In order to avoid the establishment of any new commercial fisheries for red drum, all states shall maintain their current level of restrictions, i.e. no relaxation of current commercial fisheries management measures.

Size Limits *(4.2.1)* - No red drum larger than 27" total length (TL) shall be harvested. All states must implement a 27" TL maximum size limit for red drum.

Trip or Possession Limits *(4.2.2)* - States without a commercial landings cap for red drum shall maintain their current commercial trip or possession limits. States may implement more restrictive limits. States which currently have a commercial fishery landings cap for red drum may reduce their trip limits in order to remain below their cap within any given fishing year.

Commercial Landings Cap/Payback of Overages *(4.2.3)* - States shall maintain their current commercial landings cap but may implement more restrictive limits. States which currently have a commercial fishery landings cap for red drum shall implement a pay-back regulation whereby any overage incurred in a fishing year shall be subtracted from the amount available in the fishing year immediately following the year in which the overage occurred. This pay-back regulation shall not apply to those states that allow the sale of bag limit caught fish. Any underage in a given year shall not be rolled over into the subsequent fishing year.

For-Hire Fisheries Management Measures *(4.3)*

Bag and Size Limits *(4.3.1)* - In lieu of mandating specific bag and size limits for each management area, Amendment 2 specifies that all states must implement an appropriate bag and size limit which will attain the management goal of 40% SPR.

Maximum Size Limit *(4.3.2)* - No red drum larger than 27" total length (TL) shall be harvested. All states must implement a 27" TL or smaller maximum size limit for red drum.

Habitat Measures (*4.4*)

No mandatory measures related to habitat or habitat protection are implemented through this amendment.

Alternative State Management Regimes *(4.5)*

Once approved by the South Atlantic State-Federal Fisheries Management Board, states are required to obtain prior approval from the Board of any changes to their management program for which a compliance requirement is in effect. Other non-compliance measures must be reported to the Board and can be implemented without prior Board approval A state can request permission to implement an alternative to any mandatory compliance measure only if

that state can show to the Board's satisfaction that its alternative proposal will have the same conservation value as the measure contained in this amendment or any addenda prepared under Adaptive Management (*Section 4.6*). States submitting alternative proposals must demonstrate that the proposed action will not contribute to overfishing of the resource. All changes in state plans must be submitted in writing to the Board and to the Commission either as part of the annual FMP Review process or the Annual Compliance Reports.

***De minimis* Fishery Guidelines** (*4.5.3*)
The ASMFC Interstate Fisheries Management Program Charter defines *de minimis* as "a situation in which, under existing condition of the stock and scope of the fishery, conservation, and enforcement actions taken by an individual state would be expected to contribute insignificantly to a coastwide conservation program required by a Fishery Management Plan or amendment."

As future management measures are implemented through addenda prepared subsequent to Amendment 2, a state may be granted *de minimis* status if, the South Atlantic State-Federal Fisheries Management Board determines that action by the state would contribute insignificantly to the overall management program. States may petition the Management Board at any time for *de minimis* status. Once *de minimis* status is granted, designated states must submit annual reports to the Management Board justifying the continuance of *de minimis* status. States must include *de minimis* requests as part of their annual compliance reports.

Adaptive Management *(4.6)*
The South Atlantic State-Federal Fisheries Management Board may vary the requirements specified in this amendment as a part of adaptive management in order to conserve the red drum resource. Specifically, the Management Board may change target fishing mortality rates and harvest specifications, other measures designed to prevent overfishing of the stock complex or any spawning component. Such changes will be instituted to be effective on the first fishing day of the following year, but may be put in place at an alternative time when deemed necessary by the Management Board. These changes should be discussed with the appropriate federal representatives and Councils prior to implementation in order to be complementary to the regulations for the EEZ.

Measures Subject to Change *(4.6.2)*
The following measures are subject to change under adaptive management upon approval by the South Atlantic State-Federal Fisheries Management Board:
(1) Fishing year and/or seasons;
(2) Area closures;
(3) Rebuilding targets and schedules, including the overfishing definition, maximum sustainable yield (MSY) and optimum yield (OY);
(4) Catch controls, including bag, size and trip limits;
(5) Effort controls;
(6) Reporting requirements;
(7) Gear limitations;
(8) Measures to reduce or monitor bycatch;
(9) Observer requirements;
(10) Management areas;
(11) Recommendations to the Secretaries for complementary actions in federal jurisdictions;
(12) Research or monitoring requirements;
(13) Stock enhancement protocols;
(14) *De minimis* requirements/criteria; and
(15) Any other management measures currently included in Amendment 2.

Recommendations to the Secretaries (*4.9*)
The Atlantic States Marine Fisheries Commission believes that the red drum resource covered by this fishery management plan continues to be severely overfished and in need of conservation. It would be inconsistent with this approach to allow any meaningful increase in fishing mortality. Therefore it is important that the federal government maintain the fishing mortality controls that have been a part of its fisheries management program for this species.

The Commission believes that the measures contained in Amendment 2 are necessary to recover overfished stocks and prevent the overfishing of the red drum resource. Therefore, the Atlantic States Marine Fisheries Commission recommends that the Secretary of Commerce continue the prohibition on harvest and/or possession of red drum in the Atlantic Coast Exclusive Economic Zone (EEZ) within the management area of the resource, i.e. south of the New York/New Jersey boundary. Specifically, the Commission requests that the Secretary of Commerce maintain the prohibition on harvest or possession of red drum in or from the Mid-Atlantic EEZ south of a line extending in a direction of 115° (degrees) from true North commencing at a point at 40° 29.6' N. latitude, 73° 54.1' W. longitude; such point being the intersection of the New York/New Jersey boundary with the 3 (three) nautical mile line denoting the seaward limit of state waters; and the South Atlantic EEZ. Red drum caught in the Mid-Atlantic and South Atlantic EEZ must be released immediately with a minimum of harm.

5. Compliance

Mandatory Compliance Elements for States (*5.1*)

A state will be determined to be out of compliance with the provisions of this fishery management plan, according to the terms of Section Seven of the ISFMP Charter if:

- its regulatory and management programs to implement *Section 4* have not been approved by the South Atlantic State-Federal Fisheries Management Board; or
- it fails to meet any schedule required by *Section 5.1.2*, or any addendum prepared under adaptive management (*Section 4.6*); or
- it has failed to implement a change to its program when determined necessary by the South Atlantic State-Federal Fisheries Management Board; or
- it makes a change to its regulations required under *Section 4* or any addenda prepared under Adaptive Management (*Section 4.6*), without prior approval of the South Atlantic State-Federal Fisheries Management Board.

Mandatory Elements of State Programs (*5.1.1*)

To be considered in compliance with this fishery management plan, all state programs must include harvest controls on red drum fisheries consistent with the requirements of *Sections 4.1, 4.2* and *4.3*; except that a state may propose an alternative management program under *Section 4.5*, which, if approved by the South Atlantic State-Federal Fisheries Management Board, may be implemented as an alternative regulatory requirement for compliance.

Regulatory Requirements (*5.1.1.1*)

Each state must submit its required red drum regulatory program to the Commission through the Commission staff for approval by the South Atlantic State-Federal Fisheries Management Board. During the period from submission until the South Atlantic State-Federal Fisheries Management Board makes a decision on a state's program, a state may not adopt a less protective management program than contained in this amendment or currently in effect.

1. All states are required to implement red drum harvest controls (e.g. bag and size limits) in order to achieve a minimum 40% Spawning Potential Ratio (SPR).

2. A maximum size limit of 27 inches or less shall be implemented for all red drum fisheries.

3. All states must maintain current or more restrictive commercial fishery regulations for red drum under the guidelines of Section 4.2.

Once approved by the South Atlantic State-Federal Fisheries Management Board, states are required to obtain prior approval from the Board of any changes to their management program for which a compliance requirement is in effect. Other measures must be reported to the Board but may be implemented without prior Board approval A state can request permission to implement an alternative to any mandatory compliance measure only if that state can show to the Board's satisfaction that its alternative proposal will have the same conservation value as the measure contained in this amendment or any addenda prepared under Adaptive Management (*Section 4.6*). States submitting alternative proposals must demonstrate that the proposed action will not contribute to overfishing of the resource. All changes in state plans must be submitted in writing to the Board and to the Commission either as part of the

annual FMP Review process or the Annual Compliance Reports.

Compliance Schedule (*5.1.2*)
States must implement this Amendment according to the following proposed schedule:

July 1, 2002:	States in the southern region (South Carolina, Georgia and Florida) must submit programs to implement Amendment 2 for approval by the South Atlantic State-Federal Fisheries Management Board. Programs must be implemented upon approval by the South Atlantic State-Federal Fisheries Management Board.
October 1, 2002:	States in the northern region (New Jersey, Delaware, Maryland, Virginia, North Carolina and the Potomac River Fisheries Commission) must submit programs to implement Amendment 2 for approval by the South Atlantic State-Federal Fisheries Management Board. Programs must be implemented upon approval by the South Atlantic State-Federal Fisheries Management Board.
January 1, 2003:	States with approved management programs must implement Amendment 2. States may begin implementing management programs prior to this deadline if approved by the South Atlantic State-Federal Fisheries Management Board.

Compliance reports should be submitted to the Commission by each jurisdiction annually, no later than May 1 of each year, beginning in 2004.

Compliance Report Content (*5.1.3*)
Each state must submit an annual report concerning its red drum fisheries and management program for the previous year. Reports should follow the standard format for compliance reports. The report shall cover:

- the previous calendar year's fishery and management program including activity and results of monitoring, regulations that were in effect and harvest, including estimates of non-harvest losses; and
- the planned management program for the current calendar year summarizing regulations that will be in effect and monitoring programs that will be performed, highlighting any changes from the previous year.

Recommended (Non-Mandatory) Management Measures *(5.3)*
The South Atlantic State-Federal Fisheries Management Board, through Amendment 2, requests that those states outside the management unit (New York through Maine, and Pennsylvania) implement complementary regulations to protect the overfished red drum spawning stock. Specifically, all states outside the management unit are requested to implement a provision to prohibit all harvest, possession or sale of red drum greater than 27 inches total length.

6. Management and Research Needs

Amendment 2 contains a list of management and research needs that should be addressed in the future in order to improve the current state of knowledge of red drum biology, stock assessment, population dynamics, habitat issues, and social and economic issues. By no means are these lists of research needs all-inclusive, and they will be reviewed and updated annually through the Commission's FMP Review process.

7. Protected Species

Amendment 2 provides an overview of protected species known to occur throughout the range of red drum and potential interactions with red drum fisheries.

ACKNOWLEDGMENTS

Amendment 2 to the Interstate Fishery Management Plan for Red Drum was developed under the supervision of the Atlantic States Marine Fisheries Commission's South Atlantic State-Federal Fisheries Management Board, chaired by Dr. Louis Daniel of North Carolina. Members of the Plan Development Team (PDT) included: Dr. Joseph C. Desfosse (ASMFC), Dr. Kathi Kitner, (SAFMC), Dr. Wilson Laney (USFWS), Mike Murphy (FL FWC), Rob O'Reilly (VA MRC), Lee Paramore (NC DMF), Roger Pugliese (SAFMC), Dr. Ray Rhodes (SC DNR), Dr. Charlie Wenner (SC DNR), and Spud Woodward (GA DNR).

Many thanks also to Tina Berger (ASMFC), Dianne Borgaard (NMFS), Patrick Opay (NMFS), Gregg Waugh (SAFMC) and Margaret Murphy (SAFMC) for their contributions to the Protected Species Section, and Carrie Selberg (ASMFC), and Myra Brouwer (SC DNR), for their contributions to the Habitat Section. Myra Brouwer also provided the Plan Development Team with great assistance in updating the red drum biological information included in *Section 1* of Amendment 2.

The Plan Development Team would also like to thank Sherman Baynard, Chair of the Red Drum Advisory Panel and all of the members of the Red Drum Advisory Panel, for their input and assistance during the development of this amendment.

Funding for this effort was provided to the Commission by U.S. Department of Commerce, National Oceanic and Atmospheric Administration Award Nos. NA07 FG0 024 and NA17 FG1 050.

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1.0 INTRODUCTION

1.1 BACKGROUND INFORMATION

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The Council adopted new definitions of optimum yield and overfishing for red drum in 1998 (SAFMC 1998a). Optimum yield was defined as 40% static spawning potential ratio (SPR), an overfishing level of less than 30% SPR, and a threshold overfishing level of 10% SPR. The Commission plan must now be reviewed to determine if there should be consistency with the Council definitions of optimum yield and overfishing. At the same time, new information on the status of red drum has been reviewed to determine progress toward the "phase-in" goals established by Amendment 1. Lastly, decisions must be made regarding the next step in attainment of optimum yield goals.

In 1999, the Council recommended that management authority for red drum be transferred to the states, through the Commission's Interstate Fishery Management Program (ISFMP) process. This document represents the first step in gathering public input and developing an amendment to the Commission's FMP.

1.1.1 Statement of the Problem

Management measures implemented by the states in response to the guidelines set forth in Amendment 1 to the Commission's FMP have led to an increase in the escapement rates of juvenile red drum. However, the overall population remains in an overfished condition with SPR values less than 30% for both the northern and southern regions (North Carolina and north comprise the northern region; South Carolina-Georgia-east coast of Florida comprise the southern region). These management measures were intended to be an intermediate step in a phased in approach to recovering the red drum population, with the interim goal being to raise SPR to at least 10%. The Atlantic coast states from Florida through New Jersey have implemented measures to modify harvest regulations and/or commercial quotas to increase escapement of sub-adults (Table 1). Under these regulations, the interim management goal appears to have been met and exceeded to some degree in each region. It was expected that additional harvest restrictions would be required in some areas to meet the ultimate goal of the original FMP.

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Amendment 2 will address the next steps for rebuilding the red drum population as well as updating the FMP to meet the standards for Commission FMPs under the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA 1993; 16 U.S.C. 5105 et seq.).

1.1.2 Benefits of Implementation

1.1.2.1 Social and Economic Benefits

Restoring and improving the stability of the overall red drum population will enhance the economic and social benefits attributable to this population in the ASMFC member states and the nation. Economic benefits would include use (e.g. consumptive use values related to recreational fishing, etc.) and non-use values (e.g. existence value, etc.) for current and future generations. The alternative state management ("conservation equivalency") approach for red drum will also be beneficial because it facilitates flexibility for state fishery management agencies to address socioeconomic considerations within their own states while achieving conservation targets. In addition, the identification of monitoring requirements and research needs important to considering the socioeconomic aspects of red drum management at the state and regional level should increase the likelihood of implementing and/or continuing those monitoring and research tasks.

Table 1. Summary of red drum regulations by state as of April 1, 2002.

State	Size Limit (TL)	Possession Limit	Other	Prohibition on Sale	Meets new FMP requirement[3]
ME[1]	None	None	None		
NH[1]	18-27"	None	0 fish > 27" TL		
MA	14"	None	None		
CT	None	None	0 fish < 32" TL		
RI	None	None	None		
NY	14"	None	2 fish > 32" TL		
NJ	18-27"	5 fish	Total of 5 fish, one of which may be > 27" TL		
PA[1]	None	None	None		
DE	18-27"	5 fish	1 fish > 27" TL		
MD	18-27"	5 fish	1 fish > 27" TL		
PRFC	18-27"	5 fish	1 fish > 27" TL	No	
VA	18-27"	5 fish	1 fish > 27" TL	No	
NC	18-27"	1 fish	0 fish > 27" TL; commercial cap of 250,000 lbs.; seven fish trip limit, must be less than 50% of catch by weight; gill nets < 5" stretch mesh must be tended from 5/1-10/31	No	
SC	15-24"	2 fish	Gamefish status	Yes	
GA[2]	14-23"	5 fish	0 fish > 27" TL	No	
FL	18-27"	1 fish		Yes [4]	

[1] Red drum do not occur in state waters
[2] Effective July 1, 2002
[3] To be determined following Plan Review Team/Management Board review
[4] Sale of native red drum prohibited

1.1.2.2 Ecological Benefits

See *Section 1.5.1* for a discussion of the biological and environmental impacts of the plan.

1.2 DESCRIPTION OF THE RESOURCE

1.2.1 Species Life History

1.2.1.1 General Information

Red drum are members of the family Sciaenidae which inhabit tropical and temperate waters worldwide (Johnson 1978). Chao (1976) reviewed the sciaenids of the western Atlantic, and determined that they encompassed 56 species in 21 genera. Sciaenids are commonly known as drums because many of them, including red drum, produce characteristic drumming sounds by contracting muscles on either side of their swimbladder (Jordan and Evermann 1896; Bigelow and Schroeder 1953; Fish and Mowbray 1970;

Guest and Laswell 1978).

The following taxonomic classification for red drum is after Greenwood *et al*. (1966). Taxa higher than superorder are not included.

Superorder: Acanthopterygii
Order: Perciformes
Suborder: Percoidei
Family: Sciaenidae
Genus: *Sciaenops*
Species: *ocellatus*

The accepted scientific name for red rum is *Sciaenops ocellatus*. The preferred common name for *Sciaenops ocellatus*, according to the American Fisheries Society's A List of Common and Scientific Names of Fishes from the United States and Canada is red drum (Robins *et al*. 1980). Other common names include: channel bass, spottail bass, red bass, bass, sea bass, spotted bass, redfish, bull redfish, spottail, rat red, pescado colorado, drum, banded drum, puppy drum (Hildebrand and Schroeder 1928), sweet William and billy bass (Wenner 1988).

1.2.1.2 General Distribution

Along the Atlantic coast, red drum range from the Chesapeake Bay to Key West, Florida. Historically, red drum were found as far north as Massachusetts in large enough numbers to support a moderate commercial fishery in New Jersey in the early 1930s (Lux and Mahoney 1969; Ross *et al*. 1995). On the Gulf of Mexico coast, they are found from extreme southwest Florida to Tuxpan, Mexico (Simmons and Breuer 1962; Matlock 1987). Red drum are distributed in oceanic waters and estuarine areas in relation to their maturity stage.

1.2.1.3 Spawning and Reproduction

Red drum spawn primarily during late summer and fall throughout its range along the Atlantic and Gulf coasts. Early studies indicated that spawning occurs from July through December with a peak in late September/October along the Atlantic coast (Hildebrand and Schroeder 1928; Mansueti 1960; Yokel 1966; Spitsbergen and Wolff 1974; Wolff 1976; Weinstein 1979). There is some evidence that within-season spawning peaks tend to coincide with the full moon (Peters and McMichael 1987; Comyns *et al*. 1991; Johnson and Funicelli 1991).

Early studies led investigators to conclude that red drum spawned in nearshore areas in the vicinity of inlets and passes throughout their range (Pearson 1929; Miles 1950; Simmons and Breuer 1962; Yokel 1966; Jannke 1971; Setzler 1977; Music and Pafford 1984; Holt *et al*.1985). However, evidence now suggests that red drum also utilize high-salinity estuarine areas along the south Atlantic coast (Murphy and Taylor 1990; Johnson and Funicelli 1991; Nicholson and Jordan 1994; Woodward 1994). Presumably, these expansive areas offer adequate conditions for survival of eggs and larvae and favorable circulation patterns that help transport larvae to suitable nursery areas (Ross and Stevens 1992). In the South Atlantic, red drum spawning has been documented from nearshore waters, in the vicinity of passes and inlets and inside estuaries such as Pamlico Sound and Mosquito Lagoon (Murphy and Taylor 1990; Wenner *et al*. 1990; Johnson and Funicelli 1991; Ross and Stevens 1992; Ross *et al*. 1995).

1.2.1.3.1 North Carolina

Nelson *et al*. (1991) summarized data on the spatial distribution and relative abundance of all life stages of red drum in southeastern estuaries. In North Carolina, spawning adults were reported to be common in salinities above 25 ppt in Bogue Sound and the Cape Fear River. Spawning adults were present but not frequently encountered in Pamlico Sound and the New River.

Ross and Stevens (1992) cited reports of red drum schooling over shoal and channel areas in Pamlico Sound near Hatteras, Ocracoke and Drum inlets, and near the mouths of bays and rivers on the western side of the Sound from August through early October. Red drum gather in these areas every year, presumably to spawn, since all fish landed from these schools have been in spawning condition. Marks and DiDomenico (1996) investigated movements, maturity and spawning seasonality of red drum in North Carolina coastal and estuarine waters. They report capturing the majority of spawning red drum (60%) in inlets and around shoals 2 - 5 km inside Oregon, Hatteras, Ocracoke and Drum inlets. In addition, 30% of reproductively active fish were captured in several areas of western Pamlico Sound between the Neuse and Pamlico rivers. Luczkovich et. al (1999) recently confirmed suspected spawning areas using hydrophone equipment to detect drumming sounds associated with spawning activity. Ichthyoplankton surveys were also used to corroborate spawning activity. Red drum spawning aggregations were identified in Pamlico Sound near Ocracoke and Hatteras inlets, and in the Bay River during August, September and October with peak activity in September. The authors deemed the mouth of the Bay River to be particularly critical for red drum spawning within the study area.

1.2.1.3.2 South Carolina

Nelson *et al*. (1991) reported spawning red drum to be common in Winyah Bay, Charleston Harbor, St. Helena Sound and the Broad River in salinities above 25 ppt in South Carolina. However, drumming activity, indicative of active spawning, (Holt *et al*. 1985) has not been detected in all of these estuaries. Hydrophone surveys were conducted along coastal South Carolina, from Winyah Bay to Calibogue Sound in 1994 (Roumillat and Tyree, unpubl.). Drumming activity was only recorded in two areas: a 40 m deep hole in the main channel leading to Charleston Harbor and two shallower areas (~ 12 m deep) off Morgan Island, near the mouth of the Coosaw River in St. Helena Sound. The latter two areas were located approximately 10 km inshore of ocean beaches. The occurrence of spawning aggregations of red drum at the mouth of Charleston Harbor has been further confirmed by the collection of viable eggs. The latter were positively identified as red drum eggs using a genetic analysis technique (Knott III 1998).

Wenner (2000) concluded that spawning activity in Charleston Harbor and in St. Helena Sound would explain recruitment of red drum to estuaries in the central and southern portion of the South Carolina coast. However, this does not explain the abundance of young red drum found in areas to the north of Charleston Harbor. Spawning in nearshore waters between Charleston Harbor and Georgetown, such as shoal areas around the Cape Romain Wildlife Refuge, would be a source of recruits to estuarine areas north of Charleston. However, this has not yet been investigated.

1.2.1.3.3 Georgia

Music and Pafford (1984) cited information obtained from anglers who target large red drum as evidence for spawning activity taking place in Georgia offshore waters. Anglers reported no fish in spawning condition from inshore waters. In addition, the study failed to obtain red drum larvae or postlarvae in ichthyoplankton samples. At the time, adult red drum occurred in low numbers off the Georgia coast; their greatest concentration was at the mouth of the Altamaha River in the central portion of the coast.

Nelson *et al*. (1991) reported spawning adults to be rare in all of Georgia's estuaries. However, more

recent investigations (Woodward 1994) reported capturing reproductively active fish (based on external examination and the extrusion of oocytes from females) inside the Altamaha River estuary. Many of the females captured contained hydrated oocytes or were spent. Similarly, Nicholson and Jordan (1994) reported capturing females in pre-spawn condition as far as 20 km up the Altamaha River delta. Fish remained in these "pre-spawn staging areas" for up to 13 days, moved down to the ocean inlets for several days and then returned to the upriver sites.

1.2.1.3.4 Florida

Along the Atlantic coast of Florida, red drum also spawn in nearshore waters and inside estuaries. Nelson *et al*. (1991) reported spawning red drum to be abundant in salinities above 25 ppt in the St. Johns River and the Indian River. Murphy and Taylor (1990) reported capturing female red drum in spawning condition 35 km south of Ponce de Leon Inlet and 90 km north of Sebastian inlet. Johnson and Funicelli (1991) corroborated estuarine spawning inside Mosquito Lagoon using hydrophone surveys conducted at dusk (when red drum courtship behavior and drumming presumably take place) and surface plankton tows to collect recently spawned eggs. Mosquito Lagoon extends over 54 km long and 4 km wide and is separated from the Atlantic Ocean by a narrow barrier beach. Ponce de Leon Inlet connects the lagoon to the Atlantic Ocean at its northern end and Haulover Canal (a manmade structure) links it to the Indian River at its southern end. Depth ranges from 0.1 - 5 m and salinity averages 32 ppt. Tidal fluctuations are minimal (less than 15 cm seasonally) and water movements result from wind-driven circulation (Dubbleday 1975; Smith 1987). Eggs collected within Mosquito Lagoon and Ponce de Leon Inlet were successfully hatched in the laboratory thus confirming spawning of red drum in these locations. Sites where drumming activity was recorded yielded the largest number of viable eggs; however, eggs were also collected in areas where drumming activity was not detected.

In North Carolina, Ross and Stevens (1992) reported that juvenile red drum (10-30 mm) recruited to nurseries during September-October. More recently, Ross *et al*. (1995) determined that spawning took place from August through early October. In South Carolina, Wenner *et al*. (1990) examined histological sections of red drum ovaries and determined that spawning activity lasted from early August through September. Music and Pafford (1984) collected six juvenile red drum in mid-July and mid-November in Georgia waters. Based on this, the authors stated that red drum in Georgia probably spawn from as early as June to as late as December. Woodward (1994) maintained that spawning in coastal Georgia occurs from as early as August and into October. Spawning on both coasts of Florida peaked from September through October (Murphy and Taylor 1990). Spawning red drum in Florida have been reported as early as July (Peters and McMichael 1987) and as late as November (Johnson and Funicelli 1991) and there is evidence that some spawning may also occur during early spring (Yokel 1966; Jannke 1971).

In the northern Gulf of Mexico, Fitzhugh *et al*. (1988) reported evidence for a spawning season extending from August through October. More recently, Wilson and Nieland (1994) used mean monthly gonosomatic index (GSI) values and histological data to establish the spawning season. They determined that the latter extends from mid August through October. Similarly, Comyns *et al*. (1991) reported that spawning in the north-central portion of the Gulf of Mexico took place from August through late October or early November with a peak in September. Perret *et al*. (1980) reported that spawning along the Gulf side of the Florida coast probably begins in September and peaks in October. Similarly, spawning in Alabama begins in mid-August, peaks in mid-September through October, and extends through December. In Louisiana, red drum are reported to spawn from August through November.

1.2.1.3.5 Age and Size at Maturity

Throughout their range, red drum exhibit differential maturity between the sexes. Males generally

mature at younger ages and smaller sizes than females. Studies carried out to determine age and size at maturity of red drum have generally shown differences among them due mainly to the use of different maturity schedules. Wilson and Nieland (1994) noted that discrepancies in maturity schedules could result not only from geographical variation, but also from lack of consistency in the methodologies used to assess reproductive status. It is crucial that assessments of ovarian development be established using histological criteria (West 1990). However, it was not until relatively recently that histological techniques have been utilized to reliably establish sex and maturity.

Recent studies have reported discrepancies in size at maturity for red drum (Table 2). Differences may result not only from natural variations over the species geographical range, but also from misinterpretation of reproductive states. The latter can in turn be due to inappropriate methodology or sampling at a time when it becomes difficult to differentiate between an immature individual from one that is in between spawning events. Furthermore, sizes appear in the literature as total length (TL) as well as fork length (FL) thus obscuring direct comparisons among studies. In order to provide comparable sizes, therefore, the following length conversions (Wenner 2000) were used:

$FL = 0.921\ TL + 17.573 \qquad r^2 = 0.999 \qquad N = 3374$
$TL = 1.084\ FL - 18.425 \qquad r^2 = 0.999 \qquad N = 3374$

Table 2. Published estimates of age and size at first maturity (since 1990) and age and size at 50% maturity for male and female red drum in the South Atlantic and Gulf of Mexico. Fork lengths were converted to mm TL using the above relationships.

Source	First Maturity				P_{50} Maturity			
	Males		Females		Males		Females	
	TL	Age	TL	Age	TL	Age	TL	Age
Ross *et al*. (1995)	523	1	742	3	656	2	847	3
Marks and DiDomenico (1996)	--	--	--	--	722	--	885	--
Wenner *et al*. (1990)	545	3	825	4	--	--	--	--
Wenner (2000)	573	2	691	3	713	3.5	792	4.3
Woodward (1994)	777	--	805	--	824	--	825	--
Murphy and Taylor (1990) - FL east coast	397	1 or 2	614	3	571	2	993	5
Murphy and Taylor (1990) - FL gulf coast	451	1 or 2	665	3	591	2	911	5
Wilson and Nieland (1994)	660	2	665	3	733	--	766	--

1.2.1.3.6 Fecundity

Red drum are reportedly only second to the most fecund species among sciaenids (Wilson and Nieland 1994). However, estimates of fecundity among wild red drum are few due to difficulty in sampling the spawning population. Estimates of red drum fecundity in the wild range from 0.5 to 15.8 million oocytes per season (Pearson 1929; Miles 1950; Holt *et al*. 1983a). Overstreet (1983) reported fecundity estimates for Mississippi red drum of 62 million and 95 million oocytes using gravimetric and volumetric methods,

respectively. Fecundity estimates obtained through laboratory experiments have ranged from 2.9 to 60 million ova per season (Colura 1974; Arnold *et al*. 1977; Roberts *et al*. 1978; Arnold 1988). Batch fecundity estimates for wild red drum in the Gulf of Mexico were initially provided by Fitzhugh *et al*. (1988). The authors provided the first evidence of group-synchrony among red drum and described ovarian development based on histological samples. Mean batch fecundity for red drum caught off Louisiana in the month of September was 1.7 million eggs, whereas that for October was 0.7 million. The authors used the hydrated oocyte method (Hunter and Macewicz 1985) to determine the mean number of oocytes per gram of ovarian weight. Significant differences in oocyte densities were reported between left and right ovarian lobes and among anterior, mid and posterior locations within each lobe. It was suggested that differences could have resulted from variations in the rate of hydration among locations. Wilson and Nieland (1994) expanded on the work begun by Fitzhugh *et al*. (1988) and estimated batch fecundity of wild red drum in the northern Gulf of Mexico. Analysis of 51 specimens yielded batch fecundity estimates ranging from 0.16 million to 3.27 million oocytes per batch with a mean batch fecundity of 1.54 million ova. Murphy and Crabtree (1999) recently provided batch fecundity estimates for red drum sampled offshore west-central Florida in 1996-1998. Their estimates were based upon examination of 77 females and ranged from 114,934 to 2,318,315 oocytes.

Spawning frequency is probably not constant over the duration of the spawning season for red drum and other group-synchronous spawners (Wilson and Nieland 1994). There is evidence that spawning peaks of red drum may coincide with new and full moons (Peters and McMichael 1987; Comyns *et al*. 1991). Hence, ideally, spawning frequencies should be estimated on a monthly basis for the duration of the spawning season. Wilson and Nieland (1994) calculated spawning frequency using two different methods. The postovulatory follicle method yielded variable estimates of spawning frequency between once every 3 days to once every 80 days. The average spawning frequency for the seven-season duration of the study was 8.8 days. The time-calibrated method (takes into account the proportion of day-0 females -- imminent spawners -- and day-1 females -- those showing evidence of a previous night's spawn) yielded frequencies of one spawn every 2-4 days. Given the above estimates of batch fecundity and spawning frequency, annual fecundity was estimated at 20-40 million ova for the average red drum female in the northern Gulf of Mexico. Comyns *et al*. (1991), used a mean batch fecundity of 2.128 million ova (obtained from data provided by Wilson and Nieland during September 1986, 1987 and 1988) and daily egg production estimates (derived from larval densities) to arrive at adult red drum biomass in the north-central Gulf of Mexico. However, the authors cautioned that the batch fecundity fraction was probably an underestimate since data were obtained from animals sampled with purse seines which are fished only during daylight hours. The mean spawning fraction, was reported as 0.20, indicating a spawning frequency of once every 5 days during the month of September.

1.2.1.4 Early Life History

Information on the distribution of red drum eggs along the South Atlantic coast is very limited. Nelson *et al*. (1991) reported red drum eggs to be commonly encountered in several southeastern estuaries, in salinities above 25 ppt. Laboratory experiments in Texas (Neill 1987; Holt *et al*. 1981) established that optimum temperature and salinity for hatching and survival of red drum larvae are 25^{o} C and 30 ppt, respectively. The spatial distribution and relative abundance of eggs in southeastern estuaries, as expected, mirrors that of spawning adults (Nelson *et. al.* 1991). Hence, eggs and early larvae utilize high salinity waters inside inlets and passes and in the estuary proper.

In Florida, Johnson and Funicelli (1991) collected viable red drum eggs in Mosquito Lagoon, Florida, with average daily water temperatures of 20 - 25^{o} C and average salinities of 30 to 32 ppt. The largest number of eggs collected during the study was in depths ranging from 1.5 to 2.1 m with the highest

concentrations of eggs found at the edge of the channel.

Upon hatching, red drum larvae are pelagic (Johnson 1978) and evidence from laboratory studies indicates that development is temperature-dependent (Holt *et al*. 1981). They make the transition between pelagic and demersal habitats upon reaching the nursery grounds when they are approximately 5 to 8 mm in length (Pearson 1929; Peters and McMichael 1987; Comyns *et al*. 1991; Rooker and Holt 1997). During this portion of their life cycle, they may utilize tidal currents (Setzler 1977; Holt *et al*. 1989) or density-driven currents (Mansueti 1960) for transport to low-salinity nurseries in the upper reaches of estuaries (Bass and Avault 1975; Setzler 1977; Weinstein 1979; Holt *et al*. 1983b; Holt *et al*. 1989; Peters and McMichael 1987; McGovern 1986; Daniel III 1988). Once in the nurseries, red drum larvae grow rapidly. Evidence suggests that red drum may select nursery areas based on the presence of environmental conditions that contribute to rapid growth (Baltz *et al*. 1998).

Limited information exists on the distribution of red drum larvae along the Atlantic coast. They are reportedly common in most major southeastern estuaries, with the exception of Albemarle Sound, and they are abundant in the St. Johns and Indian River estuaries, Florida (Nelson *et al*. 1991). Data on the spatial distribution of red drum larvae in the Gulf of Mexico has been summarized by Mercer (1984). More recently, Lyczkowski-Shultz and Steen (1991) investigated the distribution of red drum larvae in offshore and nearshore waters in the north central Gulf of Mexico east of the Mississippi River delta and south of the Mississippi barrier islands over the east Louisiana-Mississippi-Alabama shelf. They reported evidence of diel vertical stratification among red drum larvae found in depths < 25 m at both offshore and nearshore locations. Larvae (1.7 - 5.0 mm mean length) were found at depth during the night and higher in the water column during the day. At the time of this study, water was well mixed and temperature ranged between approximately 26 and 28^{o} C. No consistent relationship between the distribution of larvae and tidal stage was detected.

In the Gulf of Mexico, red drum larvae (<7 mm) have been collected in nearshore oceanic waters, passes and inlets to estuarine waters, and within estuaries (Mercer 1984). Peters and McMichael (1987) collected red drum larvae mostly from the lower reaches of Tampa Bay although some were collected on shallow water grass beds near the middle of the Bay. There was a general increase in size of larvae from the mouth of Tampa Bay up the bay toward its headwaters. In smaller estuaries, e.g. in South Florida, red drum may spawn further offshore and larvae are transported by currents to the mouth of the estuaries where, as small juveniles, they become concentrated on their way to nursery areas in the estuary. Red drum larvae have been collected within Mosquito Lagoon along Florida's Atlantic coast where adults readily spawn far from any estuarine inlet (Johnson and Finucane 1991). Surface water temperatures and salinities for collections containing larvae in Tampa Bay were 18.3-29.7^{o} C and 16-34 ppt, respectively (Peters and McMichael 1987).

1.2.1.5 Juveniles and Subadults

Estuarine distribution of juvenile red drum varies seasonally as the fish grow and begin to disperse. Along the South Atlantic coast, they utilize a variety of inshore habitats. Included are tidal freshwater habitats and the low-salinity reaches of estuaries, estuarine emergent vegetated wetlands (flooded salt marshes, brackish marsh and tidal creeks), estuarine scrub/shrub (mangrove fringe), submerged aquatic vegetation (SAV), oyster reefs and shell banks, and unconsolidated bottom (soft sediments) (SAFMC 1998b).

In general, juvenile red drum are found throughout South Atlantic estuaries in all of the habitat types described above. In the Chesapeake Bay, juveniles (20 - 90 mm TL) were collected in shallow waters

from September to November, but no indication as to the characteristics of the habitat was given (Mansueti 1960). According to Nelson *et al*. (1991), South Atlantic estuaries where juveniles (including subadults) are abundant are Bogue Sound, North Carolina; Winyah Bay, South Carolina; Ossabaw Sound, and St. Catherine/Sapelo Sound, Georgia; and the St. Johns River, Florida. They are highly abundant in the Altamaha River and St. Andrew/St. Simon Sound, Georgia, and the Indian River, Florida.

Red drum begin the subadult phase of their life cycle upon leaving the shallow nursery habitat at approximately 200 mm TL (10 months of age). They are considered subadults until they reach sexual maturity at 3-5 years (C. Wenner, pers. comm.). It is at this stage in their life cycle that red drum utilize a variety of habitats within the estuary and when they are most vulnerable to exploitation (Pafford *et al*. 1990; Wenner 1992). Tagging studies conducted throughout the species' range indicate that most subadult red drum tend to remain in the vicinity of a given area (Beaumarriage 1969; Osburn *et al*. 1982; Music and Pafford 1984; Wenner, *et al*. 1990; Pafford *et al*. 1990; Ross and Stevens 1992; Woodward 1994; Marks and DiDomenico 1996). Movement within the estuary is most likely related to changes in temperature and food availability (Pafford *et al*. 1990; Woodward 1994).

1.2.1.5.1 North Carolina

The state of North Carolina has 147,000 acres of designated Primary Nursery Areas (PNA) and Secondary Nursery Areas (SNA) that generally comprise the upper reaches of tidal creeks and rivers and may include coastal wetlands, shell-bottom and soft sub-tidal bottom habitats (NCDMF 2001). The North Carolina Division of Marine Fisheries (NCDMF) surveys of juvenile red drum have documented their presence from the Cape Fear River, north through Buzzards Bay in Dare County (Ross and Stevens 1992). Juvenile red drum were consistently abundant in shallow waters (< 5 feet) near the mouths of the Pamlico and Neuse Rivers and in smaller bays and rivers between them. In general, habitats supporting juvenile red drum in North Carolina can be characterized as detritus or mud-bottom tidal creeks in western Pamlico Sound, and mud or sand bottom habitat in other areas (Ross and Stevens 1992).

North Carolina, unlike South Carolina and Georgia, possesses SAV beds that red drum presumably utilize as nursery areas as their current range overlaps SAV distribution (Laney 1997). The NC DMF has documented high abundance of late age-0 red drum in shallow, high salinity seagrass beds behind the Outer Banks (NC DMF 2000). However, investigations have shown juveniles to prefer areas with patchy grass coverage over sites with homogeneous vegetation (Mercer 1984; Ross and Stevens 1992; Rooker and Holt 1997). The extent to which red drum utilize SAV beds in North Carolina is unclear. This habitat does constitute important foraging grounds for 1 and 2-year old fish (SAFMC 1998). The NMFS recently identified approximately 200,000 acres of seagrass beds in coastal North Carolina. Expanses of seagrass are concentrated in the shallow areas of Core Sound and Pamlico Sound along the backside of the barrier islands. Seagrass extends south to the New River and is distributed patchily in Albemarle and Currituck Sounds, in western Pamlico Sound, and along the shores of the Pamlico and Neuse Rivers and their tributaries (NC DMF 2000).

Tagging studies indicate that late age-0 and 1 year-old red drum are common throughout the shallow portions of the estuaries and are particularly abundant along the shorelines of rivers and bays, in creeks, and over grass flats and shoals of the sounds. During the fall, those subadult fish inhabiting the rivers move to higher salinity areas such as the grass flats and shoals of the barrier islands and the front beaches. Fish that reside near inlets and along the barrier islands during the summer are more likely to enter the surf in the fall. During the winter, most subadults are recaptured in the estuaries, although some are taken in the surf and inlets. During spring and summer, recaptures are common along the barrier islands, near coastal inlets, and in the surf zone, with a large number of the subadults continuing to

frequent the rivers. By their second and third year of growth, red drum are less common in rivers. Instead, they are found along the barrier islands, inhabiting the shallow water areas around the outer bars and shoals of the surf and in coastal inlets over inshore grass flats, creeks or bays.

1.2.1.5.2 South Carolina

In South Carolina estuaries, juvenile red drum have been collected over a range of salinities in shallow tidal creeks and in tidal impoundments. Daniel (1988) collected post-larval and juvenile red drum (6 - 13 mm SL) in the upper reaches of the Wando River estuary and off the Intracoastal Waterway from August through December. Collection sites were characterized by shell hash, sand and mud bottom. Juveniles were rare in the tidal creeks throughout the winter and they reappeared in the collections again in the spring. Similarly, Wenner *et al*. (1990) collected post-larval and juvenile red drum from June 1986 through July 1988 in shallow tidal creeks in temperatures from 9 to 30^{o} C and salinities from 0.8 to 33.7 ppt. Smallest juveniles were observed in the creeks from August through October, indicating that this is the time when red drum recruit to nursery areas in South Carolina. With the onset of winter temperatures, juveniles left the shallow creeks for deeper water in the main channels of rivers (9 - 15 m) and returned again to the shallows in the spring. Juveniles are also present in areas where low-salinities do not occur, i.e. behind the barrier islands on the Isle of Palms, Capers Island, Bulls Island (C. Wenner, pers. comm.). Thus, the shallow areas of tidal creeks that run through *Spartina alterniflora* dominated marshes throughout the coast are the primary nursery areas for red drum in South Carolina.

Subadult red drum have been observed in larger tidal creeks and rivers, near inlets, jetties, sandbars, and even nearshore artificial reefs (Wenner 1992). Some of the subadult red drum in South Carolina also temporarily inhabit the front beaches of barrier islands. During winter months, schools of subadult red drum have been sighted in sheltered, shallow inshore areas. During 1994 and 1995, the Inshore Fisheries Section of the South Carolina DNR conducted several aerial surveys to attempt to evaluate abundance and habitat utilization of subadult red drum along the South Carolina coast. Aerial surveys were generally deemed inefficient at estimating the number of fish inhabiting particular areas, especially inlets and beachfront areas because the visibility of schools from the air depends on the interplay of temporal, climactic, topographic and behavioral factors. On the occasions when red drum schools were reliably located, they were found in flats at the confluence of rivers, inside inlets, creeks, sounds and bays. Aerial surveys proved useful to characterize the general topography of subadult red drum habitat in the intertidal and shallow-subtidal portions of the coast. It appears that typical habitats where subadult red drum are found in South Carolina are of two general types. In the northern portion of the coast, typical subadult habitat consists of broad (up to 200 m or more in width), gently sloping flats often leading to the main channel of a river or sound. Along the southern portion of the coast, subadult red drum habitat consists of more narrow (50 m or less), fairly level flats traversed by numerous small channels, typically 5-10 m wide by less than 2 m deep at low tide).

1.2.1.5.3 Georgia

Dahlberg (1972) collected juvenile red drum along beaches, in tidal canals, and low- and high-salinity tidal pools of the Sapelo Sound and St. Catherine's Sound estuarine systems in Georgia. A telemetry study conducted more recently on subadult and young adult red drum in Georgia (Nicholson *et al*. 1996) found that subadults co-occurred with adult fish in schools along beaches and shoals during fall months, and at natural and artificial reefs in offshore waters during the winter.

1.2.1.5.4 Florida

Along the east coast of Florida, juvenile red drum probably utilize similar habitats as those used by their west coast counterparts. Peters and McMichael (1987) collected more juveniles in quiet backwater areas

of Tampa Bay than at other sampling locales, but caught a significant number of small juveniles (10-20 mm SL) in seagrass beds.

Juvenile red drum (>6 and <75 mm SL) are found along estuary margins where they move into protected backwater areas as they grow (Peters and McMichael 1987). There is a wide range of acceptable habitat for juveniles: protected coves and lagoons with seagrass over sand or mud bottoms (Pearson 1929; Miles 1950), unvegetated, "open water" shores (Kilby 1955), and unvegetated muddy bottom (Springer and Woodburn 1960). Juveniles were usually collected in the shallow shore zones of the Indian River Lagoon (Snelson 1983).

Pre-recruit red drum (>70 and <450 mm TL) aggregate in the rivers, bays, canals, tidal creeks, boat basins, and passes within an estuary (Peters and McMichael 1987). They also move into shallow nearshore waters and seagrass beds. In colder areas, juveniles may move into passes or to nearshore continental shelf waters during the winter (Mercer 1984). At this size they usually occur in large aggregations and their voracious appetites make them vulnerable to fishing pressure (Peters and McMichael 1987). Red drum are euryhaline and have been collected on the east coast of Florida at salinities from 0-22.3 ppt (Springer 1960; Tagatz 1967). Springer (1960) collected red drum from 2-29^{o} C in the St. Lucie and Indian Rivers, Florida.

Fully recruited red drum (>449 mm TL) include large, immature "subadults" and sexually mature adults. Subadults frequent many of the same habitats preferred by pre-recruits and can be found in large aggregations on seagrass beds, over oyster bars, mudflats and sand bottom. Adults are also found within the estuary as well as nearshore continental shelf waters (Mercer 1984; Murphy and Taylor 1990). Adults appear to remain in the Mosquito/Indian River Lagoon throughout their lives (Johnson and Finucane 1991). Along the Florida Atlantic coast red drum are common in the benthic-open shelf habitat and occur in the surf zone, inlets, and lagoons (Gilmore et al. 1981; Snelson 1983). Tagging studies in Florida indicate that most subadult red drum remain close to the tag-release location for several years. However, Creek habitat was utilized by 10-26 month old red drum in the northern Indian River, Florida (Adams and Tremain 2000). Some fish repeatedly used this important habitat for up to 18 months.

1.2.1.5.5 Gulf of Mexico

Considerably more information exists on the distribution of juvenile red drum in the Gulf of Mexico, where seagrass beds, quiet backwater areas and bayous are the primary habitat (Holt *et al*. 1983b; Peters and McMichael 1987). In the Aransas estuary, Texas, Rooker and Holt (1997) reported on the importance of seagrass meadows for young red drum in Texas estuaries. Larvae and early juveniles (4 - 30 mm SL) preferred *Halodule wrightii* to *Thalassia testudinum* meadows, presumably due to differences in the structural complexity of the habitat. They also found that young red drum (6 - 27 mm SL) were never present over non-vegetated muddy-sand bottom; highest densities occurred in the ecotone between seagrass and non-vegetated sand bottom. In the Barataria Basin, Louisiana, young red drum (5 - 12 mm SL) were collected over sandy bottom that often included a mixture of clay, silt and shell fragments (Baltz *et al*. 1998).

1.2.1.6 Adults

Adult red drum migrate inshore and/or north and offshore and/or south in spring and fall, respectively, throughout their range along the Atlantic coast. Overall, adults tend to spend more time in coastal waters after reaching sexual maturity; however, they continue to frequent inshore waters on a seasonal basis.

1.2.1.6.1 North Carolina

In North Carolina, large schools of adult red drum have been observed in offshore waters south of Cape Hatteras in April and north of Cape Hatteras in May and June. Adult red drum are caught in large numbers in the Outter Banks region from late March through May and from October through November. Movements of adult red drum in coastal North Carolina have been documented based on the presence of adult fish in recreational and commercial landings, as well as information obtained from North Carolina's Adult Drum Volunteer Tagging Program. In the spring, around the month of April, adult fish move from offshore wintering grounds to North Carolina beaches. Large aggregations have been observed around Ocracoke, Hatteras and Oregon Inlets. They occur along the beaches near inlets for one to two months, with a large portion of the population moving inside Pamlico Sound during the summer months. Schools of adult fish are common in coastal inlets and in Pamlico Sound, particularly in the mouth of the Pamlico and Neuse rivers in August and September. During this time, spawning takes place. By late September most adult drum are found around the coastal inlets and along the beaches where they remain through November before moving offshore for winter. Anglers have reported catches of large red drum around the shoals and outer bars of the barrier islands, as well as around submerged structure up to a couple of kilometers offshore during December. Mercer (1984) reported schools of large red drum moving down from Virginia waters and along the coastal beaches of the Outer Banks during the fall. By late December, most large red drum have moved offshore where they are no longer available to nearshore fishing activity. The movement is reversed in spring, with large schools of adult red drum moving inshore and along the beaches from Cape Lookout to Cape Hatteras. Fish then proceed north with many of them utilizing coastal inlets to enter Pamlico Sound where they spend the summer. Other schools are reported to continue moving north to the Chesapeake Bay and the Virginia barrier islands.

1.2.1.6.2 South Carolina

The South Carolina Department of Natural Resources' Finfish Management Section initiated a study in 1994 to develop techniques for sampling adult red drum in the coastal ocean habitat. Initial sampling was conducted in spring 1994 near barrier island beaches in the vicinity of Charleston Harbor. Bottom longline sets were made perpendicular or parallel to the beach. However, the gear and platform that were used proved unsuitable and no fish were collected. Nonetheless, adult red drum are successfully captured by surf fishermen off South Carolina barrier island beaches during spring months.

Adult red drum have been collected in the Morgan River (St. Helena Sound), in the channel adjacent to Pelican Bank in late spring-early summer. SC DNR personnel have also documented adult red drum congregations at the tip of the north Charleston Harbor jetty. This is a high current area with patchy live-bottom along the edge of the drop-off into the main navigation channel. It is rich in food availability and attracts large concentrations of other species such as sandbar and finetooth sharks. Adult red drum have been collected in the area as early as May and as late as December.

Most sampling for adult red drum in South Carolina has concentrated on live-bottom habitats located 5-8 nm off beaches to the southeast and east of Charleston Harbor. These areas are characterized by scattered, low-relief (<1.5 m) limestone outcrops encrusted with sessile invertebrates that attract large aggregations of bait fish and portunid crabs. The current plume extending from Charleston Harbor creates considerable variations in turbidity in these areas. Resident species of finfish include black seabass, pinfish, spottail pinfish and toadfish. Offshore migrating red drum utilize these areas heavily during the fall. However, schools do not appear to spend much time in these areas, as evidenced by the lack of recaptures of tagged fish on subsequent days sampling in the same location. Rather, schools seem to "pulse" through these areas to feed as they move offshore.

In addition to natural live-bottom areas off South Carolina, adult red drum also utilize "created live-bottom" areas and artificial reefs during their fall migration. Created live-bottom exists in an area southeast of Charleston Harbor referred to as "The Humps." This area is located to the south and west of the offshore dredge disposal area for Charleston Harbor. A substantial berm of large chunks of marl 2-3 m above the surrounding bottom was created by spoil disposal barges. These marl lumps are heavily colonized with anemones and other sessile invertebrates. Crabs are abundant and the bottom profile also attracts schools of bait fish and high numbers of resident black seabass. Catches of adult red drum are sometimes high in this area albeit not as consistently as over natural live bottom.

Charter boat captains and private boat anglers report nearshore artificial reefs to be productive areas for large adult red drum, particularly in the fall. Anglers have reported large schools of red drum at the Capers and 4KI reefs. The Fish America and Whitewater reefs in the southern part of the state are also productive areas for large red drum according to charterboat logbooks.

The Inshore Fisheries Section of the SC DNR has been conducting routine sampling of the shallow areas of several South Carolina estuaries since 1985. Trammel nets have been the predominant gear used. Although the sampling design of this particular project does not target adult red drum, they are usually captured inshore throughout the year, but greatest catches have typically occurred in July - September in 20-25 ppt salinity. The area around Fort Johnson and the mouth of Charleston Harbor have yielded the greatest catches of adult red drum over the years (SC DNR unpublished data).

1.2.1.6.3 Georgia

Studies conducted in Georgia have revealed the importance of the Altamaha River estuary to adult red drum for spawning activity (Woodward 1994; Nicholson and Jordan 1994). After the spawning season ends, adult red drum leave the delta and move to shoal and sandbar areas near inlets. They remain in these areas until mid-November, when a drop in temperature (below 20^{o} C) prompts them to move to nearshore waters.

Nicholson and Jordan (1994) found adult red drum from late November until the following May at natural and artificial reefs along tide rips or associated with the plume of major rivers. Data from this study suggested high seasonal fidelity to a specific area. Fish that were tagged in the fall along shoals and beaches were relocated 9 - 22 km offshore during winter months and back at the original capture site in the spring. In the summer, fish moved up the Altamaha River as far as 20 km to what the authors refer to as "pre-spawn staging areas" and returned to the same shoal or beach again in the fall.

1.2.1.6.4 Florida

In eastern Florida, adult red drum are found mostly in nearshore waters and within the Mosquito/Indian River Lagoon system (Muller 1999). Extensive tagging in the northern Gulf also has shown only limited movement, although fish tagged off Louisiana have been captured as far east as Cape San Blas, Florida. Along Florida's Atlantic coast adults tagged during an age-validation study showed very little movement in the Mosquito or northern Indian River Lagoons (Murphy and Taylor 1991). Carr and Chaney (1976) tracked a large red drum in this area and observed it entering almost every estuarine creek that it encountered, moving 140 m up one of the creeks at night. However,some mature adults appear to move between adjacent estuarine systems, but without any apparent seasonal pattern (M. Murphy, Florida Fish and Wildlife Conservation Commission unpublished data).

1.2.1.6.5 Gulf of Mexico

In the Gulf of Mexico, several investigators (Overstreet 1983; Lohoefener *et al.* 1987; Lohoefener *et al.*

1988; Mullin *et al*. 1996) reported finding large schools of adult red drum from spring through fall. Murphy and Crabtree (1999) sighted 49 schools of adult red drum between Indian Rocks Beach and Siesta Key in Tampa Bay, Florida, from June 1996 through October 1998. Of these, 44 schools were observed during fall months, presumably indicating spawning aggregations.

1.2.1.7 Age and Growth

1.2.1.7.1 Larvae and juveniles

Growth and mortality in early life dictate recruitment success and subsequent year-class strength among marine fishes. These parameters are in turn affected by both biotic and abiotic factors that can be highly variable. Growth of red drum larvae and juveniles has been shown to be affected by temperature (Holt *et al*. 1981; Lee *et al*. 1984; Holt 1987; Baltz *et al*. 1998) and prey availability (G. J. Holt, unpubl. data in Rooker *et al*. 1999). Rooker and Holt (1997) found that recent growth of newly settled red drum in the Aransas Estuary, Texas, was positively related to temperature with a 2% increase in growth rate per ^{o}C increase. However, the authors point out that the observed difference in recent otolith growth may not be directly related to somatic growth since there is evidence for a lapse in the former compared to the growth of the animal (Neilson and Geen 1984). Long-term growth rates, however, did not exhibit a significant relationship to water temperature in the Aransas Estuary. Comyns *et al*. (1989), showed a strong positive relationship between growth and water temperature among red drum larvae sampled in the north-central Gulf of Mexico. Growth rates were substantially higher than those reported for laboratory reared animals (Lee *et al*. 1984).

Early publications (Pearson 1929; Miles 1950; Simmons and Breuer 1962; Bass and Avault 1975; Theiling and Loyacano 1976; Wakeman and Ramsey 1985) reported growth rates for larval and juvenile red drum based on analyses of the temporal sequence of length frequency distributions. Estimates of growth obtained in this manner, however, may be biased by factors such as gear avoidance, recruitment, emigration and mortality. More reliable estimates of age and growth can be established through examination of daily growth rings on otoliths. Peters and McMichael (1987) reported similar growth rates between juvenile red drum in Tampa Bay, Florida, and juvenile red drum in other areas of the Gulf of Mexico (Pearson 1929; Miles 1950; Simmons and Breuer 1962; Bass and Avault 1975) and the Chesapeake Bay (Hildebrand and Schroeder 1928; Mansueti 1960). However, their growth equations yielded higher growth estimates than those resulting from length-frequencies. The authors used growth increments on otoliths to establish age-at-size and size-at-age relationships and verified daily growth ring formation on otoliths of red drum larvae using laboratory reared specimens. The resulting relationship between observed number of rings and fish age indicated that rings were laid down once per day beginning on the day of hatch. Daily growth ring deposition on otoliths of young red drum has also been validated in the laboratory with the use of chemical marks on otoliths of known-age individuals (S. A. Holt, unpubl. data as referenced in Rooker *et al*. 1999). Comyns *et al*. (1989) investigated growth rates of wild red drum larvae in the north-central Gulf of Mexico in September and October of 1983 and 1984, and in September of 1985. Growth of red drum larvae < 4 mm was slower than that of larger larvae. Length estimates derived from growth equations in this study were similar to those obtained by Peters and McMichael (1987) for red drum larvae in Tampa Bay, Florida. Similarly, Rooker and Holt (1997), examined growth rates among cohorts of newly settled red drum in the Aransas Estuary during the recruitment period (September to December) of 1994. They found that fish exhibited rapid growth rates ranging from 0.5 to 0.8 mm d-1. Growth rates were considerably variable among cohorts and were highest for mid-season cohorts and lowest for early and late cohorts. More recently, Rooker *et al*. (1999) reported instantaneous growth coefficients of newly settled red drum ranging from 0.049 in 1994 to 0.051 in 1995 in the Aransas Estuary.

1.2.1.7.2 Subadults and adults

Age determination in this species is typically carried out through analysis of thin sections of sagittal otoliths. Analysis of checkmarks on scales only offers reliable ages for subadult red drum ages 0 - 4 (C. Wenner, pers. comm.). Early published reports agree that the first annular mark in this species does not appear until the second year, when fish are from 14 to 18 months old (Pearson 1929; Rohr 1964; Theiling and Loyacano 1976; Hysmith *et al*. 1983; Wakefield and Colura 1983; Matlock 1984, referenced in Murphy and Taylor 1990). More recently, it has been maintained that the first annular mark forms during the second winter or spring when the animal is between 18 and 21 months old, depending on the hatch date used (Wenner *et al*. 1990; Murphy and Taylor 1990; Pafford *et al*. 1990; Ross *et al*. 1995).

Marginal increment analysis is used to establish the time of annulus formation on both scales and otoliths. Among red drum, annulus formation occurs during spring months (Beckman *et al*. 1989; Murphy and Taylor 1990; Wenner *et al*. 1990; Pafford *et al*. 1990; Ross *et al*. 1995). The frequency of ring deposition can be validated by mark-recapture studies and/or analysis of otoliths from fish injected with a chemical marker such as oxytetracycline (OTC). In red drum, growth ring deposition has been established to occur only once per year (Beckman *et al*. 1988, 1989; Murphy and Taylor 1990; Pafford *et al*. 1990; Murphy and Taylor 1991; Ross *et al*. 1995).

Red drum is a long-lived species. The oldest and largest red drum have historically been reported from waters between Cape Lookout and the Virginia barrier islands (Ross *et al*. 1995). Among fish, the potential to attain maximum growth may be inversely related to the length of the spawning season (Conover 1990). Hence, it is not surprising that the oldest and largest individuals inhabit the high latitude fringes of their range. Along the Atlantic coast of the United States, individuals as old as 57 years (Foster, unpublished, as referenced in Ross *et al*. 1995) have been reported off North Carolina. In South Carolina, the oldest fish captured was 41 years old (Wenner *et al*. unpublished data), whereas Georgia (Woodward 1994) and eastern Florida (Murphy and Taylor 1990) have reported individuals as old as 51 years and 33 years, respectively. Along the Gulf coast, red drum have been aged up to 24 years in Florida (Murphy and Taylor 1990) and 37 years in the northern Gulf of Mexico (Beckman *et al*. 1989).

Growth in fishes has historically been described by means of the von Bertalanffy (1938) growth model. This model was utilized by early investigators to describe growth in red drum until Condrey *et al*. (1988) introduced the double von Bertalanffy growth curve. The latter combines growth for fish younger and older than a transitional age that separates two distinct growth phases in the life history of the species: rapid growth during the subadult period and diminishing growth as individuals attain and live beyond sexual maturity. The transitional age, t_x, is equal to $(K_2\ t_2 - K_1\ t_1) / (K_2 - K1)$ where K_1 and t_1 correspond to individuals younger than t_x and K_2 and t_2 are for individuals older than t_x Estimates of double von Bertalanffy parameters were summarized in the 1989 red drum stock assessment report (Vaughan and Helser 1990) for the South Atlantic states (**Table 3**).

Table 3. Estimates of double von Bertalanffy parameters for red drum by state.

State	L_{max}	K_1	K_2	t_1	t_2	t_x
North Carolina	1,168.2	0.26	0.07	-0.80	-15.9	4.7
South Carolina	1,041.9	0.29	0.07	-0.61	-18.1	5.7
Georgia	1,148.9	0.24	0.03	-1.88	-44.6	3.9
Florida	1,037.0	0.30	0.14	-1.15	-7.5	4.7

Data from Vaughan and Helser (1990).

Additional parameter estimates have appeared in the literature since then. Ross *et al*. (1995) used a double von Bertalanffy model to describe growth of red drum sampled in North Carolina from October 1987 through December 1990. The following parameter estimates were reported: L_{max} = 1,163 mm FL, K_1 = 0.30/year, K_2 = 0.07/year, t_1 = -0.33 year, t_2 = -15.4 years, t_x = 4.4 years.

The 1992 red drum stock assessment report (Vaughan 1993) introduced a different model to describe growth in this species. In this model (developed by Geaghan at LSU and referenced in Hoese *et al*. 1991) Lmax is not constant as it is assumed to be in the regular von Bertalanffy model. Instead, it is a linear function of age: Lmax = b_0 + b_1 * t where Lmax and b_0 are total lengths, b_1 is total length per year, and t is age. The linear von Bertalanffy curve has been found appropriate for describing the rapid growth of red drum at early ages and their slower growth in later years (Vaughan 1996). Table 4 (adapted from Vaughan 1996) summarizes estimates of single and linear von Bertalanffy parameters for the north and south regions of the Atlantic coast from 1986 through 1994.

Few studies describing the growth of red drum have been published since 1990. Murphy and Taylor (1990) sampled commercial and recreational catches of red drum from the east (Mosquito/Upper Indian River Lagoon) and west (Tampa Bay) coasts of Florida between 1981-1983. They reported rapid growth until ages 4 or 5 and a marked decline in growth rate thereafter. Growth rates did not differ between male and female subadult red drum (ages 1-3) nor was there a difference for von Bertalanffy growth parameters K and t_0. However, asymptotic length, L4, was greater for Atlantic coast red drum. Estimates of von Bertalanffy parameters for the Atlantic coast were L_{max} = 978.8 mm FL, K = 0.148/year, t_0 = -0.149. Estimates for Gulf coast red drum were L_{max} = 934.1 mm FL, K = 0.460/year, t_0 = 0.029. Maximum observed lengths for Atlantic and Gulf coast fish were 1,110 mm FL and 980 mm FL, respectively.

Table 4. Red drum growth described by single and linear von Bertalanffy models weighting inversely by number of fish at age. L_{max} and b_0 are total lengths in millimeters, K is the growth coefficient, and t_0 is years. Data is for the period 1986 - 1994 (Numbers in parentheses are standard errors).

Single von Bertalanffy parameters

Type	n	L_{max}	K	t_0
North region	1969	1,186.4	0.18 (0.004)	-1.47 (0.009)
South region	19,383	1,055.8	0.283 (0.001)	-0.23 (0.01)

Linear von Bertalanffy parameters

Type	b_0	b_1	K	t_0
North region	1,043.4	0.15 (0.03)	0.363 (0.009)	-0.12 (0.05)
South region	992.9	0.09 (0.01)	0.344 (0.002)	-0.04 (0.01)

Data from Vaughan (1996)

Wenner *et al*. (1990) reported single von Bertalanffy parameter estimates derived from analysis of otolith sections, scales, and tag-recapture for subadult red drum sampled in estuarine areas of South Carolina. Estimates derived from otolith analysis were as follows: L_{max} = 979 mm TL, K = 0.035/year, t_0 = 1.095. Lengths-at-age for the models were similar to mean observed lengths at age and were in agreement with those reported earlier by Music and Pafford (1984) for subadult red drum sampled in Georgia.

Ross *et al*. (1995) sampled red drum from October 1987 through December 1990 in North Carolina waters. Growth was rapid until fish reached 5 years of age and was described by means of single and double von Bertalanffy models. Parameters for the single growth curve were L_{max} = 1,114 mm FL, K = 0.19/year, t_0 = -1.48. As reported by Murphy and Taylor (1990) and Vaughan and Helser (1990), growth rates did not differ between the sexes. Maximum observed lengths for male and female red drum were 1,250 mm FL and 1,343 mm FL, respectively.

1.2.1.8 Stock Structure

Gold and Richardson (1991) identified weakly differentiated subpopulations occurring in the northeast Gulf of Mexico, Mosquito Lagoon, Florida, and along the North and South Carolina coast. Seyoum et al. (2000) also found genetic evidence for separate populations on the Atlantic and Gulf of Mexico coasts of Florida, but found no evidence of a separate population in Mosquito Lagoon. Red drum along the Gulf of Mexico side of the Florida peninsula may be somewhat isolated from red drum in the northern and western Gulf of Mexico. Tagging studies conducted by SC DNR revealed a high fidelity of returns to state waters where subadult red drum were tagged and released (C. Wenner, pers. comm). Less than 5% of the returns came from adjacent state waters. No adults tagged and released in South Carolina have been recaptured in other states.

1.2.1.9 Movements/Migration Patterns

1.2.1.9.1 North Carolina

The movements of juvenile and adult red drum in North Carolina have been summarized by Mercer (1984) and described from tagging studies conducted by NC DMF from 1986 through 1995 (Ross and Stevens 1992; Marks and DiDomenico 1996). Tagging studies in North Carolina, which are currently ongoing, have consisted of two segments: tagging of primarily subadult red drum by Division staff and tagging of larger adult red drum by anglers participating in a state-sponsored volunteer tagging program. Since the mid-1980's greater than 25,000 red drum have been tagged (Figure 1). Overall, both adult and subadult red drum tagged in North Carolina's estuaries have shown limited movement, with greater than 99% of all recaptures occurring within coastal waters.

The NC DMF has focused on tagging subadult (primarily one-year old) red drum. While most of the effort has been concentrated in the Pamlico River and over the grass flats located behind the barrier islands of Pamlico Sound during the months of June through October, tagging efforts have occurred year round throughout state coastal waters. Late age-0 and age-1 red drum have consistently shown limited movement. During the study period 1991-1995 over 65% of the 1,197 tagged red drum <18 inches were captured within 10 km of the release site. Late age-0 and age-1 red drum are common throughout the shallow portions of North Carolina's estuaries and are particularly abundant along the shorelines of rivers and bays, in creeks, and over grass flats and shoals common in many of the sounds. During the fall, increased tag returns indicate that a portion of the subadult fish residing in the rivers move toward higher salinity areas such as the grass flats and shoals of the barrier islands and inlets and the surf. Those subadults that reside near the coastal inlets and along the barrier islands during the summer are more likely to enter the surf in the fall. During the winter, tag return rates are low with most subadults

recaptured in the estuaries, although some are taken in the surf and inlets. During spring and summer, recaptures are common along the barrier islands, near coastal inlets, and in the surf zone, with a large number of the subadults continuing to be recaptured in the rivers. By their second and third year of growth, red drum are less common in the rivers. Instead they are frequently caught along the barrier islands, inhabiting the shallow water areas around the outer bars and shoals of the surf and in coastal inlets, over inshore grass flats, creeks or bays.

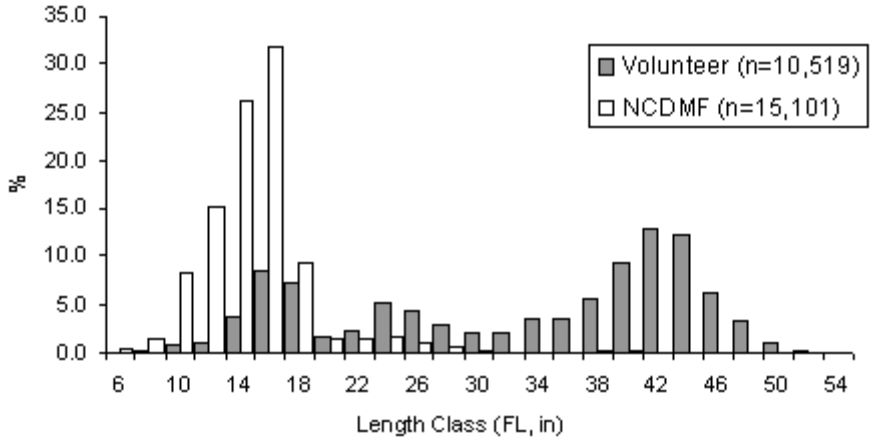

Figure 1. Length frequency of red drum tagged in North Carolina (all gears combined), 1983-1998. Data are divided into fish tagged by Division staff and those tagged by recreational anglers through cooperative volunteer tagging program (Source: NC DMF unpublished data).

Movements of adult red drum have been documented based on the presence of adult fish in recreational and commercial landings, as well as by information obtained from North Carolina's Adult Drum Volunteer Tagging Program. In the spring, around the month of April, adult fish move from offshore wintering grounds towards North Carolina beaches. Large aggregations have been observed around Ocracoke, Hatteras and Oregon Inlets. They occur along the beaches near inlets for one to two months, with a large portion of the population moving inside Pamlico Sound during the summer months. In August and September schools of adult fish are common in coastal inlets and in Pamlico Sound, particularly in the mouth of the Pamlico and Neuse rivers. During this time, spawning activity takes place. By late September most adult drum are found around the coastal inlets and along the beaches where they remain through November before moving offshore for winter. Anglers have reported catches of large red drum around the shoals and outer bars of the barrier islands, as well as around submerged structures up to a couple of kilometers offshore during December. Mercer (1984) reported schools of large red drum moving down from Virginia waters and along the coastal beaches of the Outer Banks during the fall. By late December, most large red drum have moved offshore where they are no longer available to nearshore fishing activity. During the spring the movement is reversed with large schools of adult red drum moving inshore and along the beaches from Cape Lookout to Cape Hatteras. Fish then proceed north with many of them utilizing coastal inlets to enter Pamlico Sound where they will spend

the summer. Other schools of fish are reported to continue moving north to the Chesapeake Bay and the Virginia barrier islands.

1.2.1.9.2 South Carolina

The Marine Resources Division of the South Carolina Department of Natural Resources (SC DNR) has conducted fishery-independent tagging of red drum in inshore waters along the coast since 1986. A total of 27,881 red drum have been tagged since then with close to 4,000 individuals tagged in 1996 alone (Figure 2).

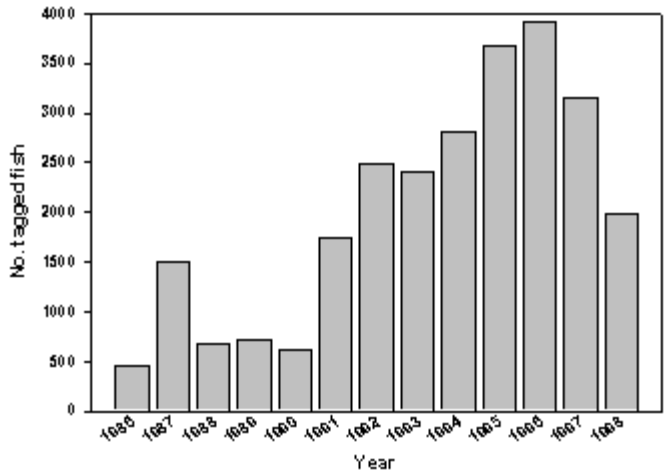

Figure 2. Number of red drum tagged in South Carolina waters by year (Source: SC DNR unpublished data).

Project personnel have recaptured over 7,500 fish whereas anglers have recaptured 5,600. Among angler recaptures, 90% have occurred within 9 nautical miles from the site of release whereas 99.4% of red drum recaptured by DNR personnel have remained within 9 nautical miles of the release site. The longest distance traveled by an individual was 233 nautical miles (Figure 3).

Of the animals that have been recaptured over 150 nautical miles from the site of release (7 in all), 4 were recaptured in Florida, one in Georgia and 2 in North Carolina. Interestingly, all long-distance travelers were 2 years old or younger. Tagged red drum have remained at large up to 2,350 days. Slightly over 45% of the animals reported by anglers have remained at large from 1 to 149 days. Similarly, about 46% of those recaptured by DNR personnel have been at large less than 150 days (Figure 4).

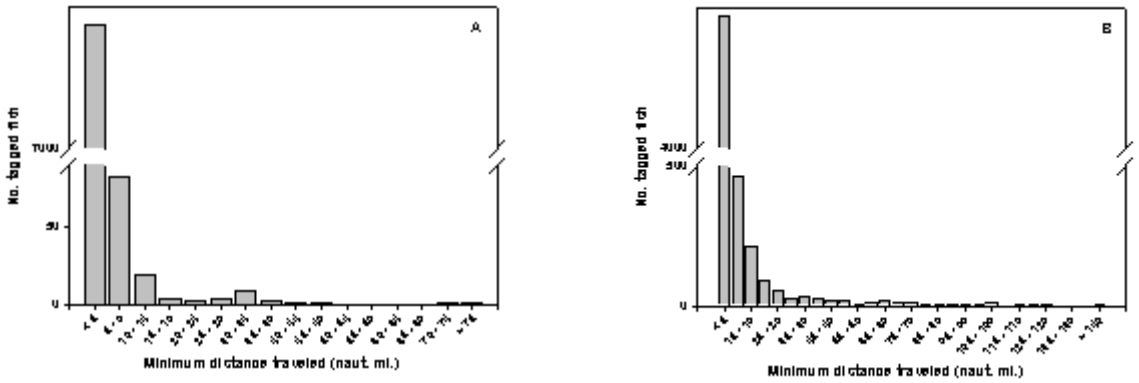

Figure 3. Minimum distance traveled by red drum captured by SC DNR personnel (A) and those captured by anglers (B) (Source: SC DNR unpublished data).

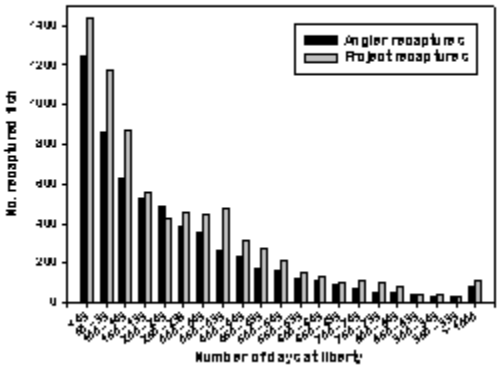

Figure 4. Number of days at liberty for red drum recaptured by SC DNR personnel and those recaptured by anglers (Source: SC DNR unpublished data).

Wenner (1999) summarized data for 1994 through 1997 as part of a fishery-independent assessment of subadult red drum in the South Atlantic Bight. A total of 3,610 red drum were tagged in South Carolina waters in three strata: Charleston Harbor, Cape Romain, and lower Stono - Kiawah Rivers. Over 50% of the red drum tagged during the study were recaptured near the mark-and-release site. Approximately 20% were recaptured less than one nautical mile away from the release site. Anglers recaptured over 87% of the tagged fish 5 nautical miles or less from the point of marking. Approximately 5% of the total number of fish recaptured by anglers (n = 593) moved more than 25 nautical miles and only 2 individuals moved over 100 nautical miles. Marked red drum were at large from 1 to 1,076 days. As can be

expected, the number of days at liberty was a function of the distribution of fishing effort throughout the year.

In addition to employing fishery-independent surveys to provide life-history information and assess the status of the red drum population in South Carolina, the Marine Division has also conducted a Marine Gamefish Tagging Program since 1974 as a vehicle for promoting conservation through catch-and-release. The latter is the largest state-sponsored public gamefish tagging program in the Southeastern United States. Since its inception, over 12,000 anglers have participated in the program.

Close to 45,000 red drum have been tagged by anglers since 1989 (Figure 5) with a recapture rate of about 13%. Trends in the seasonality of the fishery are evident. Most tagging and recapture activity takes place in the fall, resulting mostly from a "fair weather fishermen" effect rather than an increase in the availability of fish during this time. Recapture data from the tagging program shows that movement of red drum, in particular sub-adults, is minimal. The majority of recaptures have occurred less than 3 nautical miles from the release site. In instances where fish moved more than 30 nautical miles, approximately one third were adult fish.

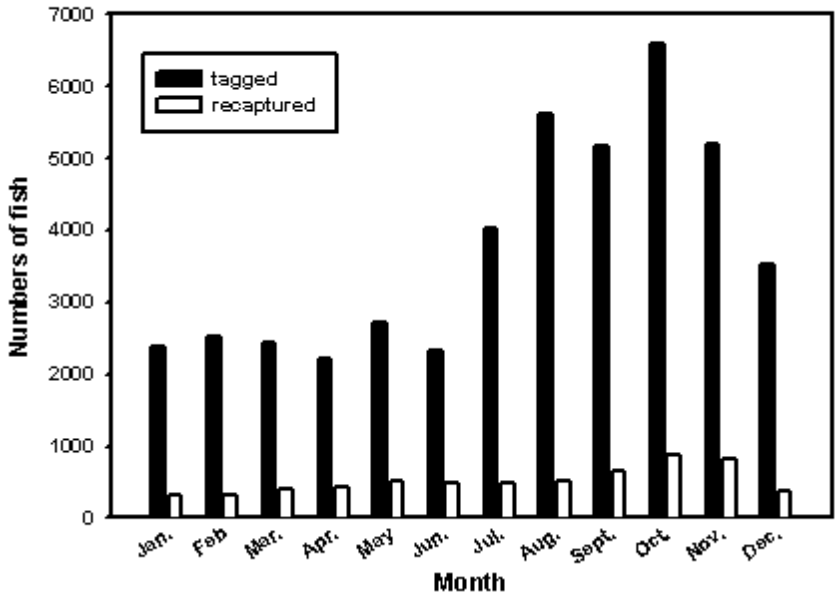

Figure 5. Numbers of red drum tagged and recaptured as part of the South Carolina Marine Gamefish Tagging Program from 1989 - 2000 (Source: SC DNR unpublished data).

The Inshore Fisheries Section of the Marine Division also conducts a fishery-dependent program to obtain harvest data and supplement life-history information on several target species, including red drum. Anglers are asked to donate their filleted fish carcasses by placing them in chest freezers located in several locations along coastal South Carolina. Anglers fill out information cards and leave them in freezers with the fish racks. In return, participating anglers receive a custom-designed T-shirt and the satisfaction of knowing that they are contributing to the conservation of the resource.

Data from the South Carolina freezer program, which was initiated in 1995, indicates that most of the harvest of red drum occurs during the fall of the year, specifically during October and November (Figure 6).

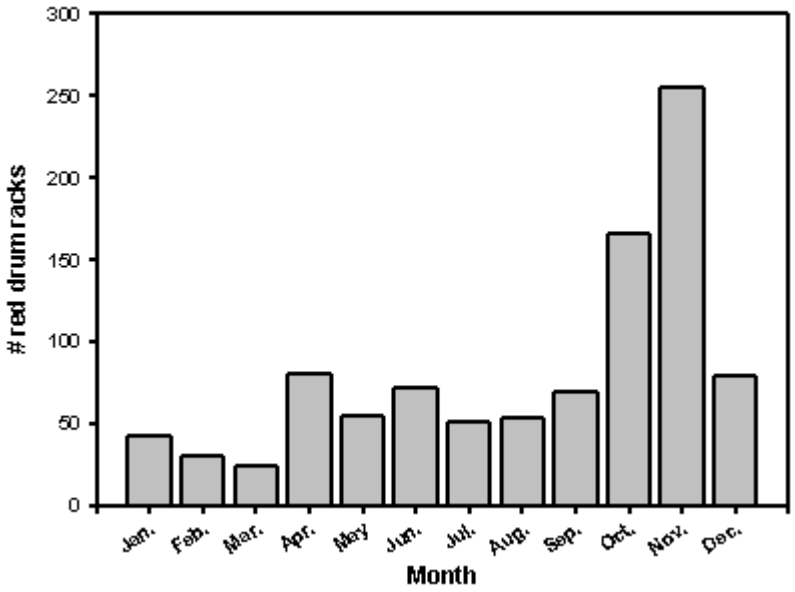

Figure 6. Number of red drum carcasses donated to the South Carolina Freezer Program by month. Data pooled for the period 1995 - 2001 (Source: SC DNR unpublished data).

1.2.1.9.3 Georgia

Woodward (1994) conducted a tagging and population dynamics study in coastal Georgia. Movement of subadult red drum was limited to within 5 km of the site of release. Only 4% of the immature fish that were tagged and released were recovered more than 30 km from the release site. Music and Pafford (1984) and Pafford *et al*. (1990) report a similar pattern for subadult red drum. Adults leave shoal and sandbar areas around mid-November and enter nearshore waters of the Atlantic Ocean were they form large aggregations entering estuaries on a seasonal basis. One such aggregation was sampled for age composition, and was found to comprise individuals from 5 to 35 years of age (Woodward 1994).

Based on relocations of telemetered subadult and young adult red drum in coastal Georgia, Nicholson *et al*. (1996) determined that young adult red drum exhibit a similar movement pattern and seasonal distribution to that observed among adults. Their use of biotelemetry tracking methods revealed the importance of the Altamaha River delta to adult red drum in Georgia. Adults in pre-spawning condition were found in inshore waters (6-12 m deep) during the summer months and offshore from late November through the following May.

1.2.1.9.4 Florida

No information was available at the time Amendment 2 was developed.

1.2.1.10 Mortality

Natural mortality (M) is estimated from the relationship to size at age in Boudreau and Dickie (1989). Separate estimates were made of M for subadults (mean of 0.20 for the northern region and 0.23 for the southern region from ages 1-5) and adults (mean of 0.12 for the northern region and 0.13 for the southern region from ages 6 and older).

1.2.1.11 Foods/Feeding

Red drum larvae begin feeding exogenously at 4 days post hatch, once food reserves in the yolk-sac are exhausted (Johnson 1978). As larvae, red drum feed mainly on copepods (Simmons and Breuer 1962; Bass & Avault 1975; Holt *et al*. 1983b; Steen and Laroche 1983; Baltz *et al*. 1998) and mysids, the latter comprising up to 97% of the diet by number and 86% by volume (Peters and McMichael 1987). Other important items in the diet of larval red drum are copepod nauplii and eggs (Steen and Laroche 1983). Generally, red drum larvae have been found to have little dietary overlap with other size classes (Peters and McMichael 1987).

Red drum utilize the entire water column when feeding. However, they concentrate on locating prey on the bottom (Yokel 1966). When feeding in shallow estuarine waters, it is not uncommon to observe the fish "tailing," a feeding behavior whereby the fish's caudal and dorsal fins protrude outside the water as the animal searches the bottom for prey items (Gunter 1945; Simmons and Breuer 1962; Yokel 1966; Overstreet and Heard 1978). Red drum may also occasionally feed at the surface when preying on fish such as menhaden (Matlock 1987).

Upon reaching the juvenile stage, red drum prey mainly on amphipods, mysids, and palaemonetid shrimp. However, the importance of these prey items in the diet of juveniles can vary among regions. Daniel (1988) performed stomach content analysis on red drum 30 - 500 mm SL in Charleston Harbor, South Carolina. Mysids were not found to be an important prey item except among red drum 16 - 30 mm SL (34% by volume). Amphipods were also prey to juvenile red drum, but were not a significant item in their diet. Peters and McMichael (1987) found mysids to be present in the diet of all size classes examined > 8 mm, although total volumes were small, especially among larger juveniles (> 75 mm). Amphipods were found in stomachs of juvenile red drum, becoming the dominant prey item for fish 30 - 60 mm. Juvenile red drum also consumed shrimp (*Palaemonetes pugio*, *Hippolite zostericola* and one species of Alphaeidae), but they were not an important item in the diet except for juveniles 75 - 90 mm, where shrimp comprised 56% of the food volume. Llanso *et al*. (1998) found non-decapod crustaceans, mainly amphipods and mysids, to be the most abundant prey item in the diet of red drum < 200 mm living in an impounded area of Tampa Bay, Florida. Similarly, Bass and Avault (1975) found that red drum 10 - 49 mm preyed on mysid shrimp almost exclusively. Mysids were found in stomachs of juvenile drum from 10 - 169 mm. Other items commonly reported in the diet of juvenile red drum are polychaetes and decapod post-larvae (Steen and Laroche 1983; Llanso *et al*. 1998).

Decapod crustaceans become an increasingly important part of the diet of red drum as they grow (Bass and Avault 1975; Music and Pafford 1984). Daniel (1988) found decapod crustaceans, primarily mud crabs, *Panopeus herbstii*, and fiddler crabs, *Uca* spp. to be the predominant component in the diet of red drum 200 - 300 mm SL making up almost 96% of the total prey volume. Llanso *et al*. (1998) reported that as red drum grew over 200 mm, crabs (*Rithropanopeus harisii*, *Pinnixia* spp., *Uca* spp., *Upogebia affinis*) were added to the diet. Wenner *et al*. (1990) noted that red drum in South Carolina consume all three species of fiddler crabs, *Uca minax*, U. *pugilator*, and *U. pugnax*, whereas these species are not as important in the diet of fish inhabiting the Gulf of Mexico. Apparently, this difference in resource utilization is due partly to differential abundances of fiddler crab species between the two regions and

partly to decreased accessibility to the habitats of fiddler crabs in the Gulf of Mexico. Bass and Avault (1975) maintain that, in the Gulf of Mexico, decapod crustaceans begin forming part of the diet when red drum are approximately 20 mm. Decapods that are consumed, in order of appearance, are grass shrimp, penaeid shrimp, and crabs, with the blue crab, *Callinectes sapidus* being the predominant prey species. Boothby and Avault (1971) and Overstreet and Heard (1978) found that blue crabs and penaeid shrimp were predominant in the diet of red drum in Mississippi Sound and Louisiana, respectively. Fish also make up an important part of the red drum diet; their importance also increases among larger red drum. Daniel (1988) found that fishes -- mostly juveniles of the spot, *Leiostomus xanthurus*, and mummichog, *Fundulus heteroclitus* -- were most significant in the diet of larger red drum in Charleston Harbor, South Carolina. Wenner *et al*. (1990) and Music and Pafford (1984) found that red drum in South Carolina and Georgia preyed on the same fish species, with the exception of the ophicthid eel, *Ophicthus ophis*, which was prey to red drum in Georgia but not in South Carolina. Menhaden are one of the predominant species consumed by red drum in the Gulf of Mexico (Boothby and Avault 1971; Matlock 1987).

1.2.1.12 Predator/Prey Relationships

No information was available at the time Amendment 2 was developed.

1.2.1.13 Ecological Role/Community Ecology

Juvenile red drum may spend the first four or five years of life within estuaries (Pearson 1929) where they compete with other estuarine species for food. Young-of-the-year red drum (15-245 mm TL) in North Carolina estuaries were frequently collected with bay anchovy, inland silverside, Atlantic silverside, sheepshead minnow, striped mullet, menhaden, spot, Atlantic croaker, mojarras, gobies, summer flounder, and southern flounder (ASMFC 1984). Red drum may compete with other sciaenid species for benthic resources.

Adult red drum occur offshore, often under schools of blue runner and little tunny in the Gulf of Mexico. When near shore, schools of red drum often occur near black drum Atlantic tarpon, and pompano (Overstreet 1983).

1.2.1.14 Related Species and Hybrids

Red drum is one of 22 members of the family Sciaenidae found along the Atlantic and/or Gulf coasts of the United States (Robins et al. 1980). This family is commonly known as the drums since many of its members, including red drum, produce drumming sounds by vibrating their swim bladders with special muscles (Jordan and Evermann 1896; Bigelow and Schroeder 1953; Fish and Mowbray 1970; Guest and Lasswell 1978). Chao (1978) assessed the phylogenetic relationships of all western Atlantic genera of Sciaenidae on the basis of swim bladder, otoliths (sagitta and lapillus), and external morphology, and presented a tested key to species and genera. The genus *Sciaenops* is monotypic.

1.2.1.15 Salinity

Red drum are euryhaline, tolerating salinities between 0 to 35 ppt (Peters and McMichael 1987; Daniel 1988). In Florida, red drum have been collected in salinities ranging from 0 to 35 ppt (Tagatz 1967; Jannke 1971; Funicelli *et al*. 1988; Johnson and Funicelli 1991). Daniel (1988) collected 2,716 red drum (4-450 mm SL) in salinities from 7 to 36 ppt in the Charleston Harbor estuary, South Carolina. Also in South Carolina, tagged subadult red drum have been captured in fresh water up the Ashley and Cooper rivers and recreational anglers commonly fish for red drum in those areas (J. Archambault, pers. comm.). In North Carolina estuaries, red drum (10-391 mm TL) were collected over a salinity range of 0 to 33 ppt (Ross *et al*. 1987). Neill (1987), in a review of environmental requirements for red drum, noted that adult and subadult red drum are most often found in salinities of 20 to 40 ppt and rarely above 50 ppt while

juveniles ranged into the freshest parts of estuaries. The author stated that eggs and newly hatched larvae required salinities above 25 ppt, but salinities between 5 and 10 ppt were optimum for juveniles 1-10 cm SL. Crocker *et al*. (1981) evaluated growth and survival of red drum larvae and juveniles in fresh and salt water. They found that tolerance to freshwater was size-dependent. Red drum larvae (23 days old, 6.2 mm SL) showed 5% survival, postlarvae (34 days old, 16.2-19.7 mm SL) had 70% survival and juveniles (57 days old, 56.9 mm SL) showed 95% survival when subjected to dechlorinated freshwater for 96 hours. Survival in control salinities of 10 ppt was 90% or greater. Similarly, Yokel (1966) suggested a direct relationship between size and salinity preference, with juveniles preferring lower salinities and larger individuals more common at higher salinities. However, both larval and juvenile red drum are present in areas where low salinities do not generally occur, i.e. behind barrier islands along the South Carolina coast (C. Wenner, pers. comm.). Wakeman and Wolschlag (1983) studied osmotic adaptation with respect to blood serum osmolality and oxygen uptake in hatchery-reared (1.3-3.8 g) and wild, juvenile red drum. They observed rapid stabilization of serum osmolalities and standard metabolic rates suggesting that red drum are well adapted to rapid salinity changes.

1.2.1.16 Temperature

Red drum are eurythermal and have been collected over a temperature range of 2-33^{o} C, although they tend to move to deeper water at extreme temperatures (Simmons and Breuer 1962). In Florida, Funicelli *et al*. (1988) collected red drum in water temperatures ranging from 2-31^{o} C, and Peters and McMichael (1987) collected juveniles in 8.9-33^{o} C water in Tampa Bay. In North Carolina, red drum (10-415 mm FL) were collected in temperatures ranging from 7.5-30^{o} C (Ross, pers. comm.; as cited in SAFMC 1990b).

Daniel (1988) collected red drum (4-450 mm TL) with a low surface temperature of 7.3^{o} C in January 1987 and a high of 32^{o} C in July 1986, in a South Carolina estuary. Neill (1987) noted that the optimum temperature for survival of red drum larvae and hatching of red drum eggs was 25^{o} C (at 30 ppt salinity) and suggested that this temperature may be the overall optimum for the species. Similarly, Holt *et al*. (1987) found that red drum larvae developed optimally in water temperatures between 25-30^{o} C in salinities between 25-30 ppt. More recently, Rooker *et al*. (1999) conducted a study on post-settlement red drum in the Aransas Estuary, Texas, and reported that growth and survival are enhanced in temperatures ranging around 26^{o} C.

Estuarine animals such as red drum can typically tolerate rapid changes in environmental variables. However, red drum have exhibited marked susceptibility to cold temperatures as indicated by periodic fish kills in coastal areas during severe winters. Gunter (1947) reported that larger juveniles and adults were more susceptible to the effects of winter cold waves than were small fish. High red drum mortality in Texas during freezes was documented by Gunter (1941) and Gunter and Hildebrand (1951). Red drum were killed in three out of nine severe cold spells at Sanibel Island, Florida, but mortality was not severe (Storey and Gudger 1936). In South Carolina, dead red drum were found in Hamlin Sound, Clark Sound, and on the front beach of Dewees Island after the Christmas 1989 freeze (C. Wenner, pers. comm.). Red drum were found dead or dying in the power plant intake canal and on shoals that had iced over in the lower Cape Fear River estuary, North Carolina during the severe winters of 1976 and 1977 (Schwartz *et al*. 1981).

Experiments conducted by Neill (1987) suggested that juvenile red drum (10-40 mm SL) can survive a gradual decrease in temperature to values as low as 8-10^{o} C in 5-10 ppt water with high hardness (> 100 ppm Ca++). More recently, Whitehurst and Robinette (1994) found no mortality of juveniles (131-158 mm TL) subjected to gradual temperature declines to below 4^{o} C at 9 ppt salinity. The authors attributed

the high survival rates in part to salinities close to 11 ppt, a value that Wakeman and Wolschlag (1983) determined to be isosmotic to red drum blood. When the ambient salinity is isosmotic with the blood, red drum presumably experience less physiological stresses (Craig *et al*. 1995) thus improving their ability to withstand environmental challenges. Whitehurst and Robinette (1994) also speculated that the quality of the water used in their bioassay helped to increase tolerance of juvenile red drum to cold temperatures since some opportunistic pathogens were probably removed by their filtering mechanism.

Ward *et al*. (1993) conducted experiments to compare critical thermal maxima (CTMax) and minima (CTMin) between juvenile red rum from Texas and North Carolina. CTMax and CTMin are the mean of the upper and lower temperatures at which an organism is so affected as to be unable to escape lethal conditions. The CTMax for Texas juveniles (29.84^{o} C) was slightly greater than that for North Carolina fish (29.23^{o} C), although this difference was considered to lack biological significance. However, the authors noted that juveniles acclimated to sublethal low temperatures had higher survival rates when exposed to low temperature stress than fish acclimated to higher temperatures. In a similar study, Procarione and King (1993) found that juvenile red drum from South Carolina did not resist low water temperatures better than Texas fish at any acclimation temperature.

1.2.2 Stock Assessment Summary

An assessment of the status of the Atlantic stock of red drum was conducted using recreational and commercial fishery data from 1986 through 1998 (Vaughan and Carmichael 2000). This assessment updated data and analyses from the 1989, 1991, 1992 and 1995 stock assessments (Vaughan and Helser 1990; Vaughan 1992, 1993, 1996).

As summarized in Vaughan and Carmichael (2000) available length-frequency distributions and age-length keys were used to convert recreational and commercial catches to catch in numbers at age. Separable and tuned virtual population analyses were conducted on the catch in numbers at age to obtain estimates of fishing mortality rates and population size (including recruitment to age-1). In turn, these estimates of fishing mortality rates combined with estimates of growth (length and weight), sex ratios, sexual maturity and fecundity were used to estimate yield per recruit, escapement to age-4, and static (or equilibrium) spawning potential ratio (static SPR, based on both female biomass and egg production).

Three virtual analysis approaches (separable, spreadsheet, and FADAPT VPA) were applied to catch matrices for two time periods (early: 1986-91, and late: 1992-98) and two regions (Northern: North Carolina and north, and Southern: South Carolina through east coast of Florida). Additional catch matrices were developed based on different treatments for the catch and release recreationally caught red drum (B2-type). These approaches included assuming 0% mortality vs. 10% mortality for B2 (released) fish. For the 10% mortality on B2 fish, sizes were assumed the same as caught fish (BASE1), or positive difference in size distribution between the early period and the later period (DELTA), or intermediate (PROP). Hence, a total of 8 catch matrices were developed (2 regions and 4 B2 assumptions for 1986-98) to which the three VPA approaches were applied. The question of when offshore emigration or reduced availability begins (during or after age 3) continues to be a source of bias that tends to result in overestimates of fishing mortality. Additionally, the continued assumption (Vaughan and Helser 1990; Vaughan 1992, 1993, 1996) of no fishing mortality on adults (ages 6 and older), causes a bias that results in underestimates of fishing mortality for adult ages (0 versus some positive value). Because of emigration and the effect of the slot limit for the later period, a range in relative exploitations of age-3 to age-2 red drum was considered. Tuning indices were developed from the MRFSS, and state indices for use in the spreadsheet and FADAPT VPAs.

The SAFMC Red Drum Assessment Group favored the FADAPT approach with catch matrix based on DELTA and a selectivity for age-3 relative to age-2 of 0.70 for the northern region, and 0.87 for the southern region. In the northern region, estimates of static SPR increased from about 1.3% for the period 1987-91, to approximately 18% (15% and 20%) for the period 1992-98. For the southern region, estimates of static SPR increased from about 0.5% for 1988-91, to approximately 15% for 1992-98.

Population models used in this assessment (specifically yield per recruit and static spawning potential ratio) are based on equilibrium assumptions: because no direct estimates are available as to the current status of the adult stock, model results imply potential longer term, equilibrium effects. Because current status of the adult stock is unknown, a specific rebuilding schedule cannot be determined. However, the duration of a rebuilding schedule should reflect, in part, a measure of the generation time of the fish species under consideration. For a long-lived, but relatively early spawning species such as red drum, mean generation time would be on the order of 15 to 20 years based on age-specific egg production. Maximum age is 50 to 60 years for the northern region, and about 40 years for the southern region.

1.2.3 Abundance and Present Condition

An updated stock assessment for red drum was recently published (Vaughan and Carmichael 2000). In the northern region, SPR increased from about 1.3% for the period 1987-1991 to approximately 18% (15-20%) for 1992-1997. For the southern region, estimates of SPR increased from about 0.5% for the period 1987-1991, to approximately 15% for 1992-1997. In addition, escapement rates of juveniles into the adult population are estimated to be 18% for the northern region and 17% for the southern region. Concern has been expressed by the Red Drum Technical Committee and Stock Assessment Subcommittee that the escapement estimate for the northern region may be overly optimistic given the additional unmeasured discard mortality from both recreational and commercial net fisheries. Also, the estimate for the southern region may not be reflective of escapement rates throughout the region where there appear to be significant regional differences between Florida and Georgia/South Carolina. The red drum population on the east coast of Florida appears to be recovering much faster than in neighboring state waters, which may be a result of very strict harvest controls.

As stated earlier, there are no current estimates of the size of the adult red drum stocks however, the assessment committee believes that the incorporation of results from fishery-independent trammel net surveys provides a more accurate estimate of escapement rates and recruitment. According to the updated assessment, recruitment has seriously declined in the southern region from a high of 1.2 million recruits to age-1 in 1987 to 200,000 in 1998 (Vaughan and Carmichael 2000). Recruitment in the northern region has fluctuated without trend ranging from 550,000 recruits in 1991 to 75,000 in 1998.

1.2.3.1 North Carolina

Red drum in North Carolina are classified as overfished (SPR <30%) due to high fishing mortality rates and low recruitment of juvenile fish to the adult stock (NCDMF 2001). Information necessary to estimate abundance at age for adult red drum and calculate spawning stock biomass (SSB) are lacking because slot limits restrict the age classes that may be harvested, and fishery-independent survey data are not available for the adult fish. Therefore, the primary benchmarks used in determining the status of red drum are spawning potential ratio (SPR) and escapement or survivability to age-4. Although early assessments evaluated the Atlantic Coastal red drum population as a single stock, recent assessments are divided into northern and southern components to better account for the limited migration of the species (Vaughan 1996). Northern region assessment results are largely representative of the North Carolina stock, since North Carolina accounts for an average of 96% of the commercial landings, an average of 85% of the recreational landings, and the only fishery-independent data that are available for the region.

The most recent estimates of SPR for the northern region are based on data from 1992 through 1997. This period represents the changes adopted by North Carolina as a result of Amendment 1. Regulations in the period were a recreational bag limit of 5 fish, an 18-27" slot limit, including one fish which could exceed 27"; commercial regulations included an 18-27" slot limit on the sale of red drum and one red drum exceeding 27" was allowed for personal consumption per day. In addition to changes implemented through Amendment 1, North Carolina also imposed a 250,000 pound quota on the commercial fishery to prevent this fishery from expanding beyond historical harvest levels. The best estimate of SPR for the North Carolina stock is 18% for 1992-1997, still well below the overfishing definition of 30%, but significantly improved over the 1.3% for 1986-1991. Escapement increased from 1.2% in the early period to 18% in the later period, while fully recruited fishing mortality declined from F=1.67 for 1986-1991 to F=0.71 for 1992-1997. In addition, the selectivity of age classes 3 to 5 also declined between the early and late period, indicating that older fish were subjected to less fishing pressure in the later period, likely the result of a reduced bag limit on red drum >27" total length.

Although the red drum stock in North Carolina is currently considered to be overfished, it should be noted that this designation is based on data through 1997 and does not reflect the full impacts of the harvest restrictions implemented by the NCDMF and NCMFC late in the 1998 fishing season as part of the development of a state level red drum FMP. There are two primary goals of the recent regulatory changes: 1) reduce the recreational and commercial harvest rates to levels which prevent overfishing and 2) reduce unnecessary and unquantifiable bycatch of red drum in the gill net fishery. Actions taken include a reduction in the recreational bag limit from 5 to 1 fish, an 18-27"slot limit on all harvest, no possession of red drum >27", a daily commercial trip limit which has ranged from 100 lbs. to five fish and a requirement to attend small mesh gill nets (<5" stretch mesh) from May 1 through October 31 in areas known to be critical juvenile red drum habitat. Additionally, in the last year, the NCDMF has maintained a daily commercial trip limit ranging from 5 to 10 fish and also requires that at least 50% of the landings by weight for an individual trip consist of edible finfish other than red drum making this exclusively a bycatch fishery. This most recent action is intended to prevent any directed effort in the commercial fishery, while still allowing unavoidable bycatch to be landed and therefore accounted for in future assessments.

1.2.3.2 South Carolina

A stratified-random, fishery independent trammel net survey in South Carolina estuaries has shown a steady decline in the abundance of sub-adult red drum (ages <1 to age 4+). The mean CPUE has dropped from ~8 fish in 1991 to less than 2 fish in 2000. The abundance of age-1 fish in the survey has also decreased. The survey catch data are correlated with the recreational harvest indicating that the fisheries independent survey tracks the MRFSS. Along with declining mean catches, the research survey demonstrated a declining trend in the frequency of occurrence of red drum in net sets as well as the frequency of occurrence of "pods" of red drum larger than 10 fish. In summary, these data show that:

(1) the abundance of sub-adults inside the estuary has declined over time;
(2) recruitment of age-1 fish to the fishery has shown a decline over the decade with the exception of the brief upward tick in the time series in 1995 which resulted from the abundance of the 1994 yearclass;
(3) frequency of encounter of red drum in the survey has declined which suggests that the spatial distribution of the fish has contracted with decreasing abundance;
(4) the occurrence of larger aggregations of red drum in the estuaries has declined as overall abundance has declined;
(5) the trend in the survey catches is reflected in the recreational estimates of the harvest from the MRFSS;

(6) declining trends in abundance of sub-adult red drum was similar in all estuarine systems sampled.

South Carolina initiated a statewide, fishery-independent survey of its recreational fishery in 1986 (State Finfish Survey). Standardized annual data sets for length composition are available from 1988 to the present and for CPUE data from 1990 to the present, based on the private boat fishery in inland waters. South Carolina has also had a mandatory, universal trip logbook system for the charterboat fishery in place since July, 1992 that provides a CPUE database. The state uses these sources of fishery-dependent data in addition to the MRFSS, due in part to concerns about the accuracy of the MRFSS in regards to South Carolina's recreational fishery. Specific problems are the allocation of MRFSS private boat effort between inland and near shore (0-3 miles) ocean areas since 1995 and estimation of effort in the charterboat mode. State personnel believe that the allocation of private boat effort to inland waters has been disproportionately low in recent years versus the historical pattern, resulting in underestimation of the red drum catch. State personnel also believe that the MRFSS has attributed excess effort to the charterboat mode, resulting in significant overestimation of the red drum catch for this mode in some years. There is also concern about the relatively small sample sizes and geographic distribution of the length composition and CPUE data for red drum in the MRFSS.

The interpretation of the data from the state's fishery-dependent sources is somewhat contradictory to the conclusions drawn from the trammel net survey. The private boat CPUE data suggest increasing recruitment from 1990-1996, followed by a moderate decline in 1997. Since then, CPUE has remained rather stable in the central and northern parts of the state, but a continuing decline in recruitment is indicated in the southern part of the state. The charterboat CPUE data, based on somewhat larger fish, suggest that the population of that component is either stable or increasing slightly.

The state has also conducted two statewide opinion polls of saltwater recreational fisheries license holders regarding their perceptions of the status of the red drum stocks in South Carolina. In 1996, 72% of the survey respondents thought that the population had either increased or showed no change during the previous five years. In the 2001 survey, a smaller majority (59%) of the respondents were in this category.

1.2.3.3 Georgia

According to the most recent assessment (Vaughan and Carmichael 2000), red drum in the southern region are overfished, and it can then be inferred that red drum in Georgia are overfished. However, the southern region includes both South Carolina and Florida, and there is no separate analysis of data for Georgia. Therefore, the assessment may not accurately represent the situation in Georgia with regard to escapement and SPR within the populations found in that state's waters. Consequently, the results of the southern region assessment must be carefully interpreted when discussing the status of red drum in Georgia.

Mark-recapture studies and trammel net surveys conducted from 1994-1997 showed high mortality within the population resident in the St. Simons estuary, particularly for red drum less than age-2. However, estimates of instantaneous total mortality determined from catch curves based on trammel net data were significantly less that those estimated from fishery-dependent data (MRFSS) for all of coastal Georgia. This suggests that survival to age-5 may have been greater than indicated in regional stock assessments completed in the early 1990s. However, the aforementioned trammel net and tagging surveys were terminated in 1997, so there is no recent fishery-independent information from which to estimate either fishing or total mortality.

Pafford *et al*. (1990) reported on the age composition and relative abundance of cohorts within a sample of approximately 300 adult red drum collected from the Altamaha River delta. This sample showed a spawning biomass comprised of fish from age 5 to age 40. Young adults (<age-10) were a much smaller portion of the sample than expected, suggesting that recent recruitment had been low. However, there have been no surveys of the age composition of the adult stock in Georgia since that time. Therefore, nothing is known about the current status of the adult portion of the stock, either in terms of age composition or absolute abundance.

The estimated catch of red drum within the recreational fishery as determined from the MRFSS shows no evident trends during the 1990s or since the implementation of current harvest regulations. The total catch declined in the late 1990s only to rebound in 2000 to a level similar to that estimated in the years of the early 1990s. It is unclear whether the reduced catches of the late 1990s are attributable to inadequacies within the MRFSS or to low abundance of red drum. In either case, it is impossible to draw strong conclusions from fishery-dependent data in the absence of an index of juvenile or sub-adult abundance.

1.2.3.4 Florida

Fishing mortality rates for red drum appeared to increase on the Atlantic coast during the late 1990's. The harvest of red drum increased sharply in 2000. The number of fishing trips made by anglers catching or seeking red drum had varied without trend for much of the latter half of the 1990's but increased to peak or near peak levels in 2000. Total-catch rates for anglers were steady during the late 1990's before dropping in 2000.

A precise analysis of the condition of the red drum stocks in Florida is not possible because there is no information on the size of red drum that make up a large portion of the harvest. Creel clerks measure some of the harvested red drum they encounter on their surveys and while they can ask anglers the number of red drum disposed of or released dead or alive, they do not gather information on the size of these fish. Since 1998, 19-34% of the harvest has been attributable to these unseen fish. In Murphy (2002) the size of red drum in this unseen harvest were assumed; 1) the same as the size in the examined harvest, 2) the same as scientific samples of red drum from haul seines, 3) distributed as 95% undersized, 5% legal, and 5% over-sized, or 4) distributed as 40% undersized, 30% legal, and 30% over-sized.

The abundance of young newly recruited age-0 red drum declined during the latter half of the 1980's but has since increased. The estimates of absolute abundance of red drum ages 1-3 depended heavily on the assumed lengths of the unseen harvest but had a midpoint of about 0.55 million fish on the Atlantic coast of Florida. Since the mid 1990's the model estimates of total abundance for ages1-3 have not changed significantly.

Estimates of equilibrium (year-specific) escapement rates were highly dependent on the scenario chosen for the length structure of the unseen harvest. Florida Atlantic coast estimates ranged from 24% if the unseen harvested was mostly under-sized red drum (scenario #3 above) to 48% if the unseen harvest was mostly legal and over-sized fish (scenario #4 above). Year-class-specific escapement rates indicate that the level of escapement in 2000 is clearly higher than the Florida Fish and Wildlife Commission's target if the unseen red drum harvest is mostly legal and over-sized fish or is distributed the same as the lengths of red drum sampled by FWC-FMRI scientists using haul seines (scenario #2 above). However, if the unseen harvest is distributed as mostly under-sized fish, then it is unlikely that escapement rates are meeting the 30% target.

1.3 DESCRIPTION OF THE FISHERIES

1.3.1 Commercial Fisheries

No directed commercial fishery currently exists for Atlantic red drum in state waters and the EEZ was closed to harvest by the SAFMC in 1990 to prevent any directed fishery for red drum from developing in federal waters. Traditionally landings have occurred almost exclusively in state waters as prior to the EEZ closure landings in federal waters were a bycatch of other fisheries and did not exceed 2,000 lbs in any year since 1985 (Table 5). Commercial landings of red drum along the Atlantic coast were high during the early 1950's and have generally fluctuated from 150,000 to 400,000 lbs since (Figure 7). Currently, North Carolina is the only state along the Atlantic coast with any significant annual landings of red drum and has accounted for greater than 95% of the coastwide landings since 1989 (Table 6). Landings of red drum in North Carolina are primarily a bycatch in other fisheries, particularly those targeting flounder, striped mullet, spotted seatrout and weakfish. Virginia consistently reports annual landings but has only exceeded 10,000 lbs in three of the last 10 years. Landings north of Virginia are less frequent. Florida has had a no sale provision on native caught red drum since January 1, 1989. In 1987, South Carolina declared red drum a gamefish and established a no sale provision except for mariculture grown fish. Landings in Georgia are limited to hook and line captured fish and typically do not exceed 3,000 lbs. Overall Atlantic landings for the period of 1989 through 2000 were dominated by anchored and runaround gill nets followed by long hauls, pound nets and beach seines (Figure 8).

Table 5. EEZ commercial red drum bycatch harvested in the Atlantic (Source: NMFS SEFC).

Year	Pounds	Ex-vessel Value (1982 Dollars)
1979	679	108
1980	19,992	3,621
1981	3,985	992
1982	3,913	887
1983	4,920	1,244
1984	11,778	2,882
1985	1,832	488
1986	1,883	707
1987	1,149	428
1988	991	248

Historic landings data are summarized in the figures below and represent the period along the Atlantic coast before Florida and South Carolina prohibited the sale of native red drum. Historic commercial landings and nominal value information can be subdivided into five major gear categories: gill nets, pound nets, seines, hand gear and trawls (Figures 9-13).

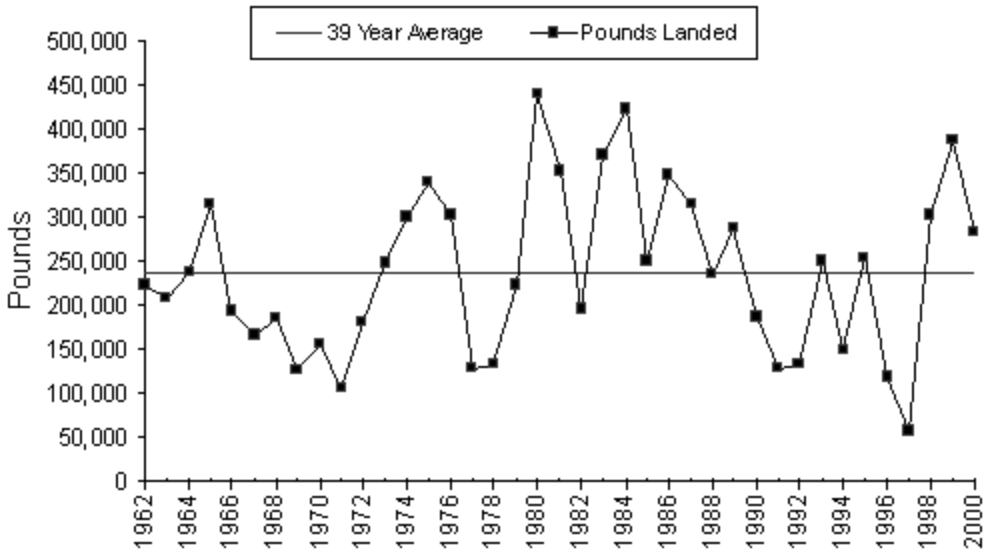

Figure 7. Total commercial landings of red drum in the Atlantic (Source: NMFS Annual Reports).

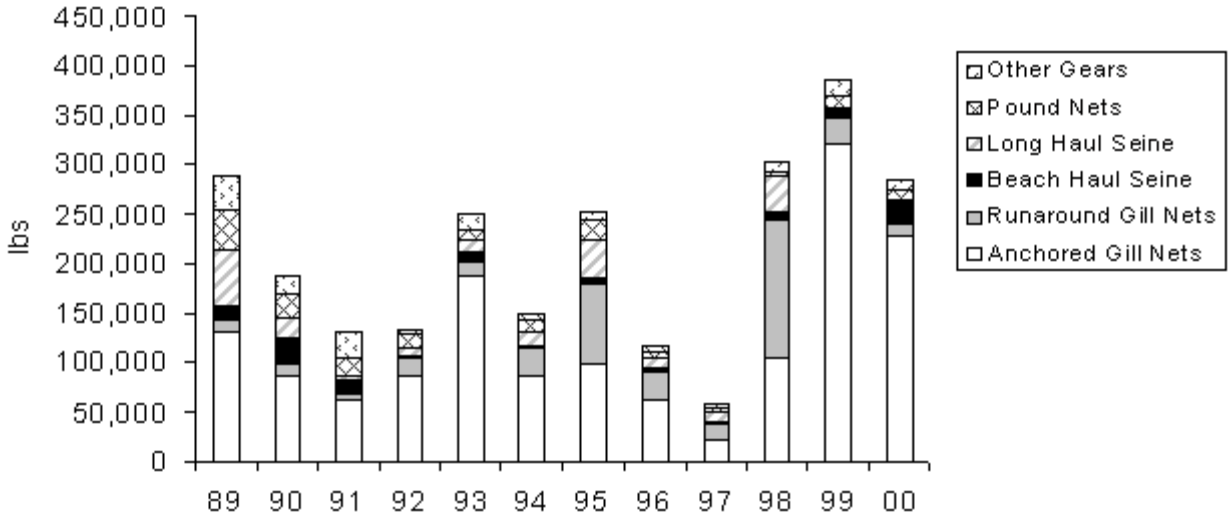

Figure 8. Commercial landings of Atlantic coast red drum for 1989-2000 by major gear groups.

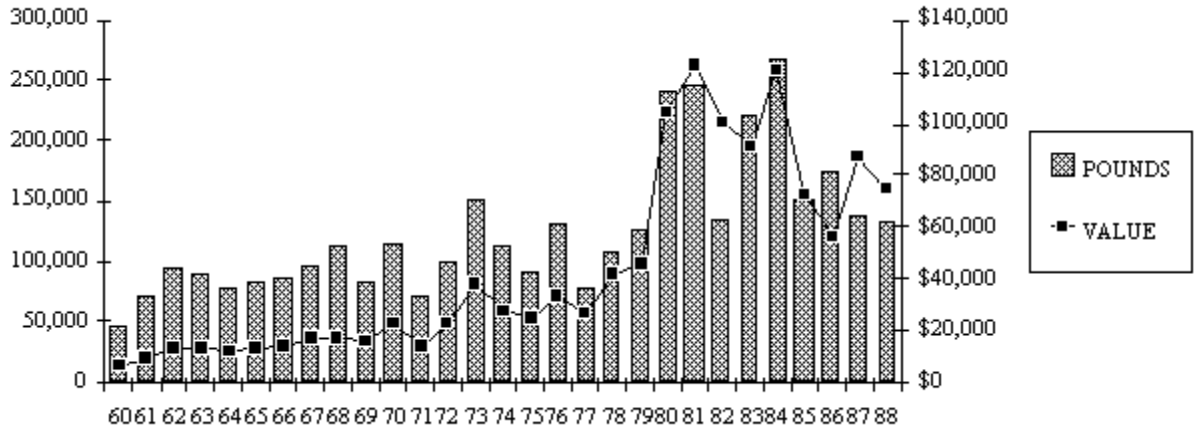

Figure 9. Commercial landings and nominal ex-vessel value of Atlantic coast red drum caught by run-around, anchor and other gill nets (Source: NMFS SEFC).

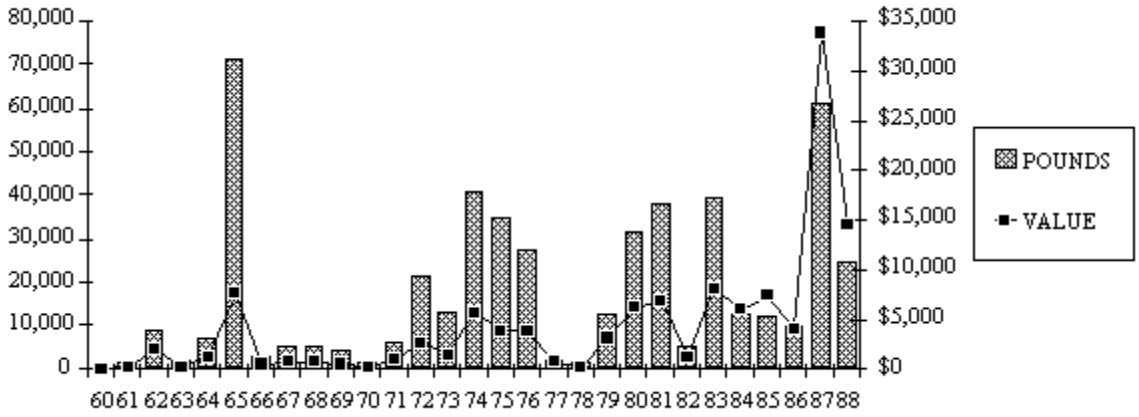

Figure 10. Commercial landings and nominal ex-vessel total revenue of Atlantic coast red drum caught by pound, trammel and stop nets (Source: NMFS SEFC).

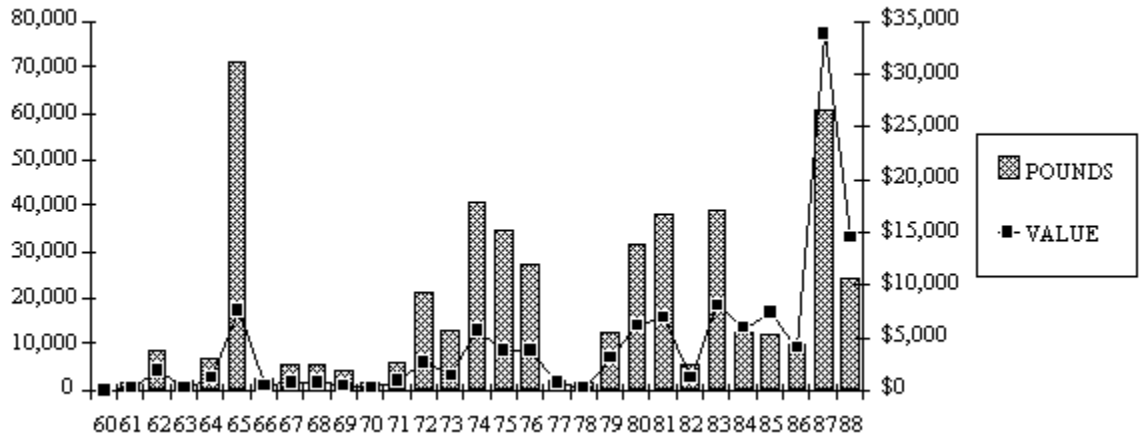

Figure 11. Commercial landings and nominal ex-vessel total revenue of Atlantic coast red drum caught by long haul, beach and common seines (Source: NMFS SEFC).

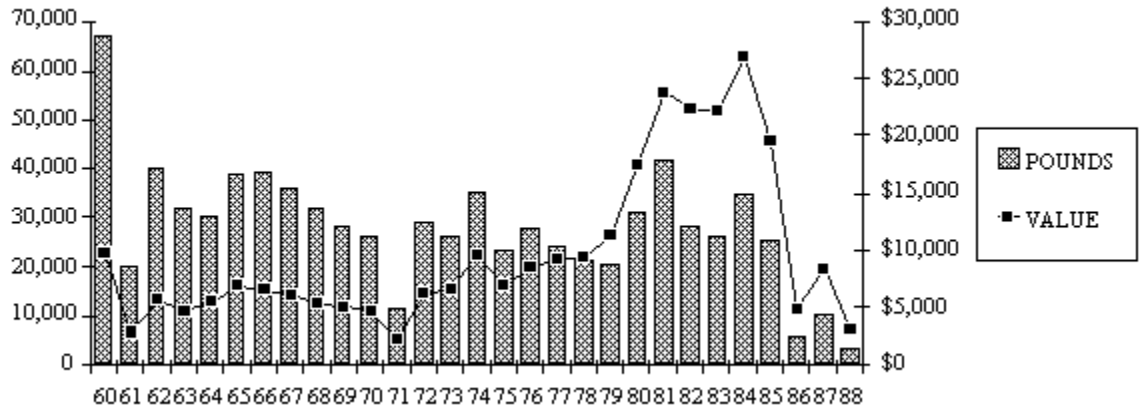

Figure 12. Commercial landings and nominal ex-vessel total revenue of Atlantic coast red drum caught by hand lines, trolling, spears (gigs) and cast net (Source: NMFS SEFC).

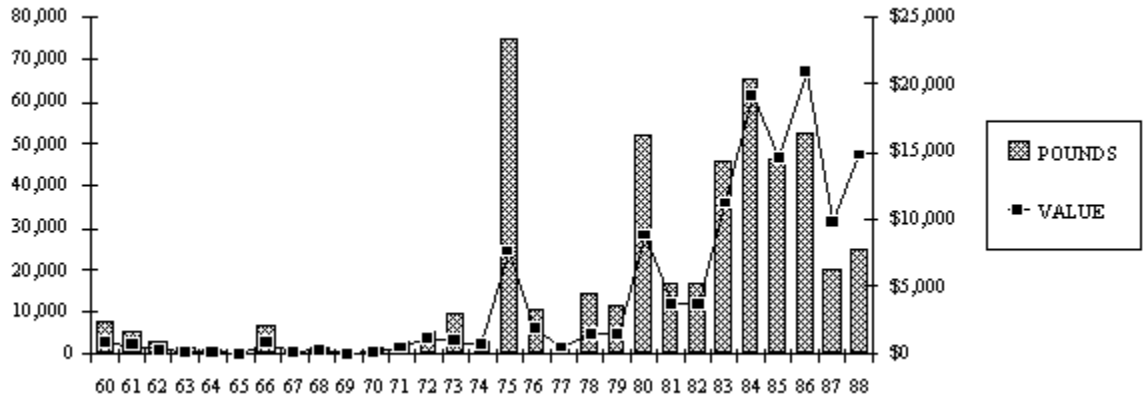

Figure 13. Commercial landings and nominal ex-vessel total revenue of Atlantic coast red drum caught by finfish, shrimp and crab trawls (Source: NMFS SEFC).

1.3.1.1 Mid-Atlantic States

Commercial landings of red drum were recorded in the 1930s from the State of New Jersey, the most northerly this fishery has been prosecuted. Landings reached approximately 63,800 lbs mainly from a deep water, ocean pound net fishery prosecuted in water depths up to 60-70 ft. This bycatch fishery was eliminated with the demise of the gear during a hurricane. During the last 40 years annual landings in this region have rarely exceeded 20,000 lbs and averaged only 9,982 lbs for the period of 1960-2000 (Figure 14). Virginia consistently reports landings but has rarely exceeded 10,000 lbs in the last 25 years (Table 6). During the last 10 years Virginia landings have ranged from 2,073 to 24,771 lbs and averaged 7,922 lbs per year. Maryland is the northernmost state where annual landings typically occur and has averaged 1,158 lbs of red drum per year from 1991-2000. Although landings north of Maryland are rare, New Jersey and New York have reported landings within the last 6 years in amounts ranging from 8 to 1,215 lbs per year.

Table 6. Commercial red drum landings (in pounds) for Atlantic coast states (Source: NMFS Annual Reports and SEFC Reports).

Year	RI	NY	NJ	DE	MD	VA	NC	SC	GA	FLEC	Total
1950	0	0	0	0	1,300	182,900	200,900	33,500	20,000	189,200	627,800
1951	0	0	0	0	4,200	75,800	182,400	120,000	20,000	135,500	538,000
1952	0	0	0	1,500	0	46,900	222,700	73,000	13,500	130,100	487,700
1953	0	0	0	0	400	20,800	285,100	54,500	14,100	127,400	502,300
1954	0	0	0	0	3,800	39,000	267,400	17,000	14,000	138,800	480,000
1955	0	0	0	0	100	37,600	135,400	66,700	6,500	96,200	342,500
1956	0	0	0	0	300	20,700	30,100	57,000	1,200	106,700	216,000
1957	0	0	0	0	0	23,300	139,600	600	0	108,000	271,500
1958	0	0	0	0	2,800	35,000	6,600	200	0	102,300	146,900
1959	0	0	0	0	200	33,300	5,000	0	0	131,200	169,700
1960	0	0	0	0	200	29,400	79,300	4,200	400	129,000	242,500
1961	0	0	0	0	0	12,000	89,700	900	1,000	114,500	218,100
1962	0	0	0	0	0	12,900	60,900	0	0	149,300	223,100
1963	0	0	0	0	0	2,700	71,200	0	0	134,200	208,100
1964	0	0	0	0	0	4,600	101,500	11,500	0	119,000	236,600
1965	0	0	0	0	1,200	94,900	71,400	0	0	146,300	313,800
1966	0	0	0	0	200	3,100	35,200	200	2,700	153,000	194,400
1967	0	0	0	0	0	1,100	12,800	900	5,800	147,100	167,700
1968	0	0	0	0	0	100	12,500	0	5,500	167,000	185,100
1969	0	0	0	0	400	700	3,900	700	2,700	119,000	127,400
1970	0	0	0	0	0	100	7,500	400	2,200	146,800	157,000
1971	0	0	0	0	0	700	17,200	1,300	1,200	85,200	105,600
1972	0	0	0	0	0	5,900	42,900	1,200	3,400	128,400	181,800
1973	0	0	0	900	0	6,200	70,300	600	3,700	166,500	248,200
1974	0	0	0	0	0	15,700	142,000	2,300	3,100	137,300	300,400
1975	0	0	0	200	0	19,600	214,000	12,400	10,000	83,300	339,500
1976	0	0	0	0	0	18,600	168,200	2,600	7,300	106,000	302,700
1977	0	0	0	200	0	300	19,700	800	5,000	103,500	129,500
1978	0	0	0	300	0	2,100	21,774	4,325	328	104,696	133,523
1979	0	0	0	0	100	1,900	126,517	1,767	935	92,684	223,903
1980	0	0	0	0	0	400	243,223	4,107	1,493	191,222	440,445
1981	0	0	0	0	0	200	93,420	0	261	258,374	352,255
1982	0	0	0	0	0	1,700	52,561	2,228	251	139,170	195,910
1983	0	0	0	0	100	41,700	219,871	2,274	1,126	105,164	370,235
1984	0	0	0	0	0	2,600	283,020	3,950	1,961	130,885	422,416
1985	0	0	0	0	0	1,100	152,676	3,512	3,541	88,929	249,758

Table 6. Continued

Year	RI	NY	NJ	DE	MD	VA	NC	SC	GA	FLEC	Total
1986	0	0	0	0	1,000	5,400	249,076	12,429	2,939	77,070	347,914
1987	0	0	0	0	0	2,600	249,657	14,689	4,565	42,993	314,504
1988	0	0	0	0	8,100	4,000	220,271	0	3,281	284	235,936
1989	0	0	0	0	1,000	8,200	274,356	165	3,963	0	287,684
1990	0	0	0	0	29	1,481	183,216	0	2,763	0	187,489
1991	0	0	0	0	7,533	24,771	96,045	0	1,637	0	129,986
1992	0	0	0	0	742	2,352	128,497	0	1,759	0	133,350
1993	0	0	0	0	121	8,637	238,099	0	2,533	0	249,390
1994	5,094	0	0	0	1,152	4,080	142,159	0	2,141	0	149,532
1995	0	668	0	0	6	2,992	248,193	0	2,578	0	253,769
1996	0	8	0	0	0	2,073	113,401	0	2,271	0	117,745
1997	43	0	0	0	24	4,049	52,548	0	1,395	0	58,016
1998	0	0	311	0	419	6,436	294,415	0	672	0	302,253
1999	0	57	241	0	707	12,368	372,749	0	1,115	0	387,180
2000	0	47	0	0	877	11,457	271,013	0	707	0	284,054

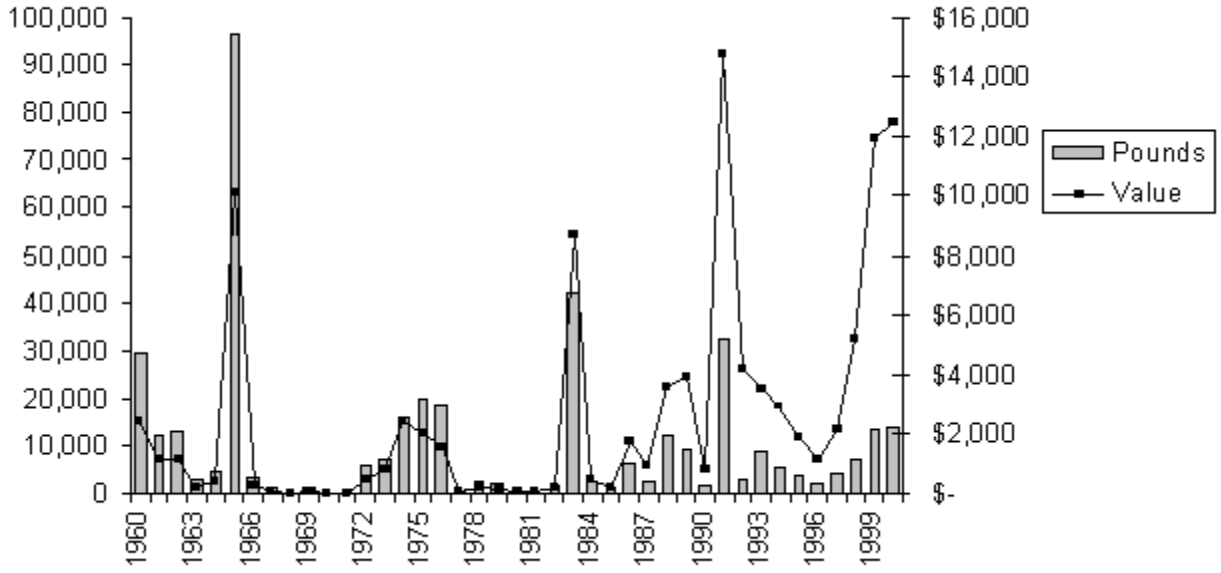

Figure 14. Commercial landings and ex-vessel total revenue of red drum in Mid-Atlantic states, 1960-2000 (Source: NMFS SERO).

1.3.1.2 North Carolina

Red drum are commercially harvested in North Carolina using a variety of gears and constitute a bycatch fishery for most gears and trips. Historically, red drum have not been a dominant component of the commercial landings, although prior to North Carolina imposing a possession limit on red drum greater than 32 inches TL (changed to 27 inches TL in 1992), Outer Banks fishermen occasionally targeted large red drum with long haul seines in Pamlico Sound. The minimum size limit for red drum was increased from 14 to 18 inches TL in 1991 to reduce mortality of immature red drum, resulting in an increase in the age of entry into the commercial fishery of about 8 months (Figure 15). Due to current size restrictions (18-27 inches TL), red drum harvested by the commercial sector are generally from a single year class and catches vary annually dependent upon individual year class strength. There is currently no harvest of adult red drum in North Carolina, and landings are dominated by age-1 and age-2 fish.

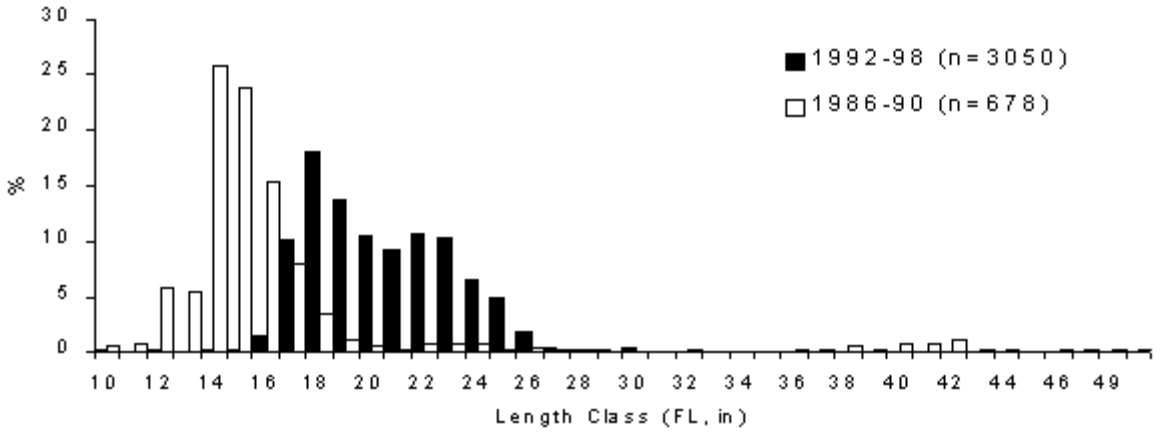

Figure 15. Length frequency of red drum sampled from the North Carolina commercial fishery (all gears combined) for the periods of 1986-1990 and 1992-1998 (Source: NCDMF unpublished).

Historically, annual landings of red drum have been highly variable from year to year. Annual landings during the 1970's averaged 83,009 lbs per year and ranged from 7,500 to 214,000 lbs (Figure 16). Annual landings from the 1980's were greater than those from the 1970's, averaging 203,813 lbs per year and ranging from 52,561 to 283,020 lbs. Landings during the 1990's averaged 186,932 lbs per year and ranged from 52,548 to 372,749 lbs. The majority of the landings have historically originated from Pamlico and Core sounds and the Atlantic Ocean. During the 1970's, no commercial gear dominated landings although long haul seines and common haul seines were generally the most productive gears with gill nets, pound nets, and fish trawls occasionally contributing larger catches. Anchored and run-around gill nets were the dominant gear during the 1980's and 1990's, accounting for greater than 70% percent of annual commercial landings (Figure 17). Most of these gill net fisheries are seasonal, targeting spotted seatrout, flounder, and striped mullet along the barrier islands and mainland shorelines. Although they catch red drum incidentally, such fisheries make an important contribution to the overall catch.

A directed fishery that developed in the mid-1990's used run-around gill nets to encircle schools of red drum and accounted for 31% of all red drum commercially harvested from 1994-1998. Prior to the

implementation of trip limits in 1998, nearly one-half of the total annual commercial harvest of red drum was accounted for by only a few trips landing large amounts of red drum. A total of 1.1% of the trips that reported landings of red drum accounted for 48.5% of the total harvest. For this period, the largest landings of red drum primarily occured behind the 'Outer Banks' from Oregon Inlet to Ocracoke during the spring and fall. Gears that typically had large landings of red drum were runaround gill nets and long haul nets. These gears have proven to be effective in circling large schools of red drum. Participation in the run-around gill net fishery increased during this period as many of these fishers actively pursued schools of red drum. While there have been a few exceptional long haul catches of up to 10,000 pounds, a typical catch for a run-around gill net trip would range from 100 to 1000 pounds (Table 7). In October of 1998, the implementation of a 100-pound trip limit on the commercial harvest of red drum effectively eliminated any large-scale directed harvest of red drum, however some fishers still actively pursued red drum at these reduced harvest limits. As a result, the NCDMF has recently further reduced the daily commercial trip limit to levels ranging from 10 to 5 red drum and requires that at least 50% of the landings by weight for an individual trip consist of edible finfish other than red drum. The intent of the rule is to make this exclusively a bycatch fishery.

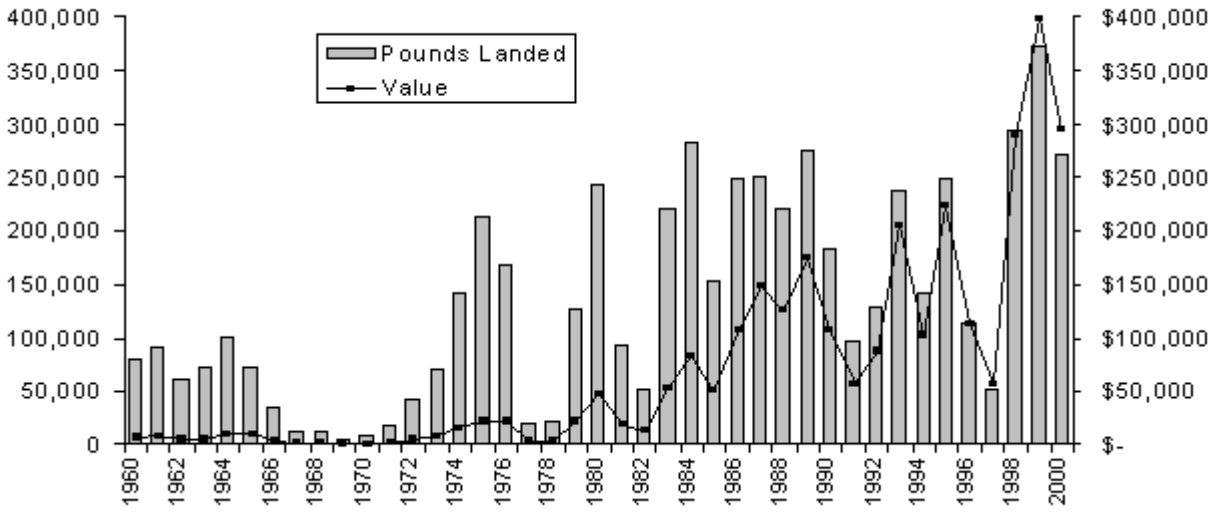

Figure 16. Commercial landings and ex-vessel total revenue of red drum in North Carolina, 1960-2000 (Source: NMFS SERO).

1.3.1.3 South Carolina

South Carolina designated red drum a gamefish in 1987. Thus, they cannot be sold unless they are either transported into the State with proper documentation showing legal capture, or if the fish is a product of a bonafide mariculture operation. Red drum landings never exceeded 14,000 lbs with a nominal value of $12,000 in the last 30 years (Figure 18).

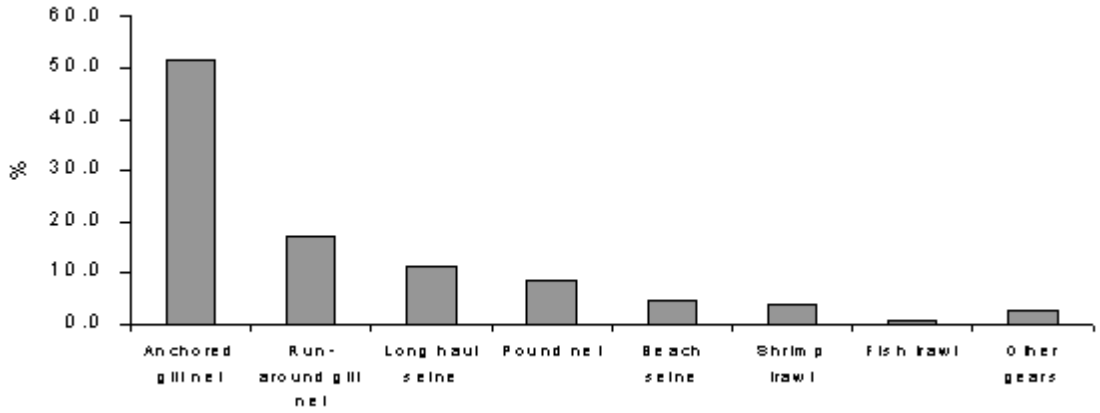

Figure 17. Percent commercial landings of red drum from 1987-1998 by gear type (Source North Carolina Trip Ticket Program).

Table 7. North Carolina Landings summary for red drum by trip for the period of 1994 to 1998 (Source North Carolina Trip Ticket Program).

Pounds landed/trip	1994	1995	1996	1997	1998	Percent
1-50	3797	6900	4563	2320	4776	91.3%
51-100	121	335	184	62	464	4.8%
101-200	65	131	77	29	153	1.9%
201-300	22	40	21	9	56	0.6%
301-400	12	14	7	1	28	0.3%
401-500	7	4	8	4	29	0.2%
501-1000	19	32	20	7	60	0.6%
1001-2000	8	18	6	6	30	0.3%
2001-3000	5	8	1	0	11	0.1%
3001-4000	2	3	3	2	1	0.0%
4001-5000	2	5	0	0	2	0.0%
5001-6000	0	0	0	0	1	0.0%
6001-7000	0	0	0	0	0	0.0%
7001-8000	0	0	0	0	0	0.0%
8001-9000	1	0	0	0	1	0.0%
9001-10,000	0	1	0	0	1	0.0%
>10,000	1	1	0	0	0	0.0%
Total # Trips	4062	7492	4890	2440	5613	100.0%

1.3.1.4 Georgia

A small commercial gill net fishery existed in Georgia prior to the 1950s, but presently there is not a directed commercial fishery for red drum. Red drum enter the market through recreational fishermen who sell their catch (Figure 19), often directly to restaurants which is not illegal as long as they were not harvested with net gear. Thus, many red drum do not enter official commercial statistics.

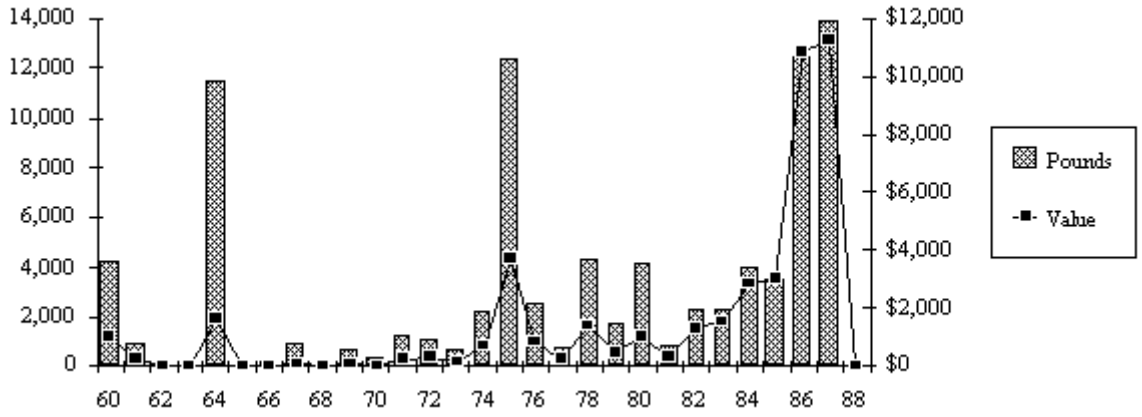

Figure 18. Commercial landings and ex-vessel total value of red drum in South Carolina, 1960-1988 (Source: NMFS SEFC).

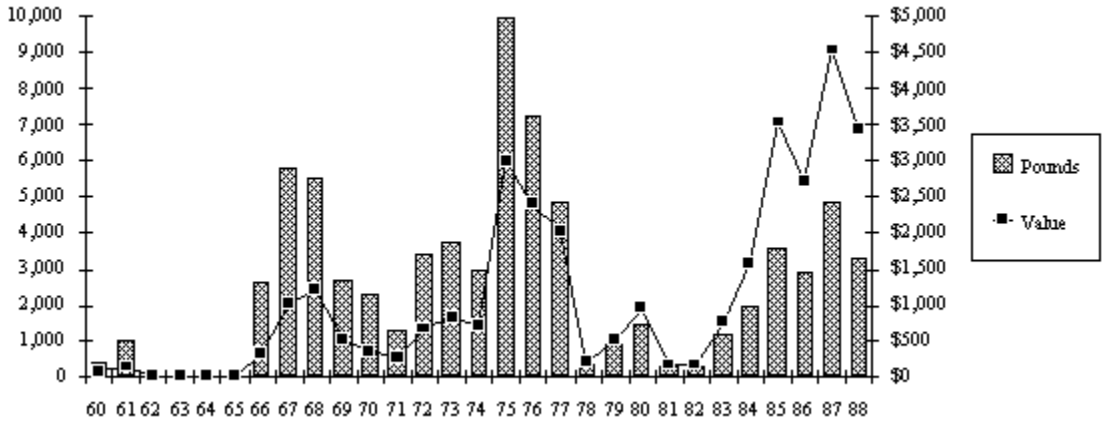

Figure 19. Commercial landings and ex-vessel total revenue of red drum in Georgia, 1960-1988 (Source: NMFS SEFC).

1.3.1.5 Florida

Commercial landings on the East coast of Florida fluctuated between 85,000 lbs to 250,000 lbs annually between 1962 and 1987 (Figure 20). In the past, the majority of the catch was taken by either a bycatch of the mullet gill net fishery or by a directed fishery utilizing trammel nets. Commercial landings ceased when regulations prohibiting their sale became effective in 1988. The existence of and potential for harvest of red drum in the EEZ off the east coast of Florida has been noted by commercial and recreational fishermen. In Council deliberations it was noted that one purse seiner was prosecuted for catching approximately 50,000 lbs of red drum outside of 2 mi off the east coast of Florida.

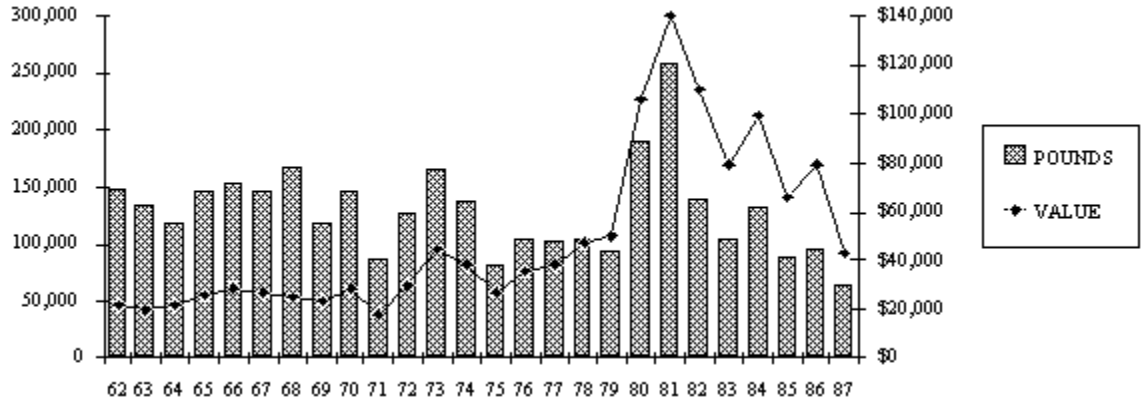

Figure 20. Commercial landings and ex-vessel total revenue of red drum in Florida, 1960-1987 (Source: NMFS SEFC).

1.3.1.6 Socio-cultural

No information was available at the time Amendment 2 was developed.

1.3.1.7 Economic

Reported annual red drum commercial landings (i.e. pounds) in the Atlantic states had averaged about 322,000 pounds with an average, deflated (i.e. 1982 dollars) total value of $140,00 during the 1980's (Table 8), a 61% increase in the total value compared to 1970's. In contrast, the average reported landings in the Atlantic states in the 1990's were only 61% of 1980's average landings, and the total deflated ex-vessel value declined to an average of about $100,000 (Table 8) even though the highest nominal ($412,000) and deflated ($215,000) total ex-vessel value was recorded in 1999. In general, the overall ex-vessel prices, nominal and deflated, in the Atlantic states have generally increased since the 1970's (Table 8).

These trends in red drum landings and values in the Atlantic states mainly reflect the interaction of regulatory actions and market demand. Before the 1980's, commercial red drum landings in both the Atlantic and Gulf states were generally associated with commercial fishing effort in near-shore and estuarine waters and catches of juvenile red drum. In the early 1980's, the ex-vessel price of red drum began to increase significantly as Cajun-style blackened redfish was introduced to restaurant menus (Martin 1986) through out the country. Commercial fishermen in the Gulf began targeting schooling adult red drum in the EEZ (GMFMC 1987) and concern grew in the Atlantic states that large-scale purse

Table 8. Commercial red drum landings (lbs) and ex-vessel value in Atlantic states including North Carolina, 1970-2000 (Pers. Comm. NMFS, Fish. Stats. and Econ. Div.).

	All Atlantic States					North Carolina			NC percent of:	
Year	Pounds Landed	Nominal Value	Defl. Value	Nom. Price/lb	Defl. Price/lb	Pounds Landed	Nominal Value	Defl. Value	Atlantic Pounds	Defl. Value
1970	157,000	$ 30,061	$ 94,830	$ 0.19	$ 0.60	7,500	$ 648	$ 2,044	4.8%	2.2%
1971	105,600	20,068	64,115	0.19	0.61	17,200	1,718	5,489	16.3%	8.6%
1972	181,800	35,992	91,350	0.20	0.50	42,900	5,228	13,269	23.6%	14.5%
1973	248,200	54,651	115,297	0.22	0.46	70,300	7,775	16,403	28.3%	14.2%
1974	300,400	57,606	115,443	0.19	0.38	142,000	15,777	31,617	47.3%	27.4%
1975	339,500	57,007	112,885	0.17	0.33	214,000	21,537	42,648	63.0%	37.8%
1976	302,700	62,522	90,743	0.21	0.30	168,200	21,700	31,495	55.6%	34.7%
1977	129,500	43,487	55,117	0.34	0.43	19,700	2,672	3,387	15.2%	6.1%
1978	133,523	51,458	58,542	0.39	0.44	21,774	2,480	2,821	16.3%	4.8%
1979	223,903	72,609	71,890	0.32	0.32	126,517	21,728	21,513	56.5%	29.9%
1980	440,445	155,134	170,103	0.35	0.39	243,223	47,133	51,681	55.2%	30.4%
1981	352,255	158,851	168,096	0.45	0.48	93,420	18,817	19,912	26.5%	11.8%
1982	195,910	123,912	123,912	0.63	0.63	52,561	12,273	12,273	26.8%	9.9%
1983	370,235	142,161	148,704	0.38	0.40	219,871	51,958	54,349	59.4%	36.5%
1984	422,216	187,111	164,421	0.44	0.39	283,020	82,458	72,459	67.0%	44.1%
1985	249,758	122,950	101,277	0.49	0.41	152,676	50,384	41,502	61.1%	41.0%
1986	349,669	190,776	169,721	0.55	0.49	249,076	106,808	95,025	71.2%	56.0%
1987	314,814	206,651	142,322	0.66	0.45	249,657	148,205	102,070	79.3%	71.7%
1988	235,936	132,658	76,814	0.56	0.33	220,271	125,289	72,547	93.4%	94.4%
1989	287,684	182,552	134,924	0.63	0.47	274,356	173,755	128,422	95.4%	95.2%
1990	187,489	110,658	77,819	0.59	0.42	183,216	106,450	74,859	97.7%	96.2%
1991	129,986	73,696	54,109	0.57	0.42	96,045	56,989	41,842	73.9%	77.3%
1992	133,350	93,072	59,738	0.70	0.45	128,497	86,859	55,750	96.4%	93.3%
1993	249,390	210,566	124,008	0.84	0.50	238,099	203,955	120,115	95.5%	96.9%
1994	154,626	108,270	61,727	0.70	0.40	142,159	102,322	58,336	91.9%	94.5%
1995	254,437	228,609	132,297	0.90	0.52	248,193	223,413	129,290	97.5%	97.7%
1996	117,753	117,013	63,080	0.99	0.54	113,392	112,915	60,871	96.3%	96.5%
1997	58,059	61,285	36,986	1.06	0.64	52,548	56,950	34,369	90.5%	92.9%
1998	302,475	294,590	172,578	0.97	0.57	294,415	288,429	168,968	97.3%	97.9%
1999	387,227	411,656	214,740	1.06	0.55	372,749	397,974	207,603	96.3%	96.7%
2000	285,269	308,437	169,099	1.08	0.59	271,013	294,864	161,658	95.0%	95.6%
Ten Year Averages:										
1970	212,213	$ 48,546	$ 87,021	$ 0.24	$ 0.44	83,009	$ 10,126	$ 17,069	32.7%	18.0%
1980	321,912	160,275	140,029	0.52	0.44	203,813	81,708	65,024	63.5%	49.1%
1990	197,479	170,942	99,708	0.84	0.50	186,931	163,626	95,200	93.3%	94.0%

seine fishing would begin developing along the Atlantic coast which could lead to recruitment over fishing (ASMFC 1984). Recreational fishing lobbying efforts to assign the red drum "gamefish" status also began developing in the Atlantic states, especially Florida (e.g. Thunberg *et al.* 1993). In 1987, the

red drum was given gamefish status in South Carolina, and Florida began taking management actions to remove red drum as a commercially targeted species. In 1988, the ISFMP (ASMFC 2001) requested that all states from Maine to Florida implement red drum regulations "...to prevent development of northern markets for southern fish." By January 1989, Florida had implemented a one-fish bag limit for recreational and commercial fishermen and a ban on sale of native red drum.

The deflated ex-vessel price of red drum has generally increased between 1994 and 2000, while the ex-vessel price index of edible fish has displayed a downward trend during the same time period (NMFS 2001a). The red drum ex-vessel price increase during this time period compared to the edible fish index would suggest that the demand for red drum has outpaced the overall demand for fish in the U.S. To make definitive statements on how changes in demand and supplies, including imported red drum products, over time have affected red drum prices would require an extensive econometric analysis and an understanding the market structure. Regardless, it appears that the increase in red drum ex-vessel prices during the 1990's probably included regulatory constraints on U.S. caught red drum commercial fishing (supplies), as well as an increase in the demand for red drum. It should also be noted that harvesting of adult red drum with a lower ex-vessel price compared to estuarine-oriented juveniles complicates the analysis of price trends during the 1970's and 1980's (SAFMC 1990b) compared to the 1990's, but other factors may moderate this complication. Specifically, the harvest of adults was obviously constrained by regulatory actions in the Atlantic states starting in the 1980's, and the higher market prices for juvenile created a strong incentive for targeting juvenile fish compared to adults.

Commercial landings of red drum in North Carolina have represented the most consistent and nearly sole source of red drum landings and related ex-vessel values in the Atlantic states. During the 1990's, North Carolina commercial harvest has annually averaged about 93% and 94%, respectively, of the total landings and deflated ex-vessel value for the Atlantic states (Table 8) while in the 1970's the deflated value of North Carolina landings only averaged 18% of the Atlantic total. During the 1990's, nominal total ex-vessel value for red drum landings in North Carolina averaged $163,600 fluctuating between approximately $57,000 in 1991 to $398,000 in 1999. The deflated total ex-vessel value averaged about $95,200 (Table 8) during the 1990's and also reached a high in 1999, about $208,000 and a low of approximately $34,400 in 1997. Both the nominal and deflated ex-vessel price of red drum in North Carolina has shown a generally increasing trend during the 1990's with the nominal price reaching a low of $0.58 in 1990 to a high of $1.08 in 1999 (Figure 21). The deflated ex-vessel price fluctuated between $0.65 in 1997 and $0.41 in 1990 (Figure 21). As previously discussed, the upward increase in North Carolina ex-vessels was probably influenced by the decline in red drum supplies due to regulatory actions in the Southeast, especially in the Gulf states.

Trends in the total annual ex-vessel value by major gear groups in the Atlantic states during the 1980's reflect the decline in Florida landings and the increase in North Carolina landings. Before 1985, red drum catches from the "Combined Gear" category, as reported for the east coast of Florida, comprised more than 50% of the total nominal ex-vessel value of Atlantic red drum landings (Table 9). With a decline in Florida landings after 1985, gill net catches, mostly from North Carolina, represented over 50% of the total nominal ex-vessel of Atlantic red drum landings (Table 9) by 1988. Seine catches also accounted for a significant portion of the total ex-vessel value during the 1986-98 period (Table 9). Annual average, deflated ex-vessel prices for red drum by gear groups have been the highest from hand gears and lowest for pound nets and incidental trawl catches (Table 9) plus trawl prices had the lowest deflated minimum price during the 1980-2000 period. Fish size may account for the higher prices for hand gear catches compared to other gears because hand gear catches are often composed of one or two year old fish which usually fetch a higher price per pound than large adult fish which were historical

caught by trawls or other gear used in the EEZ (SAFMC 1990b).

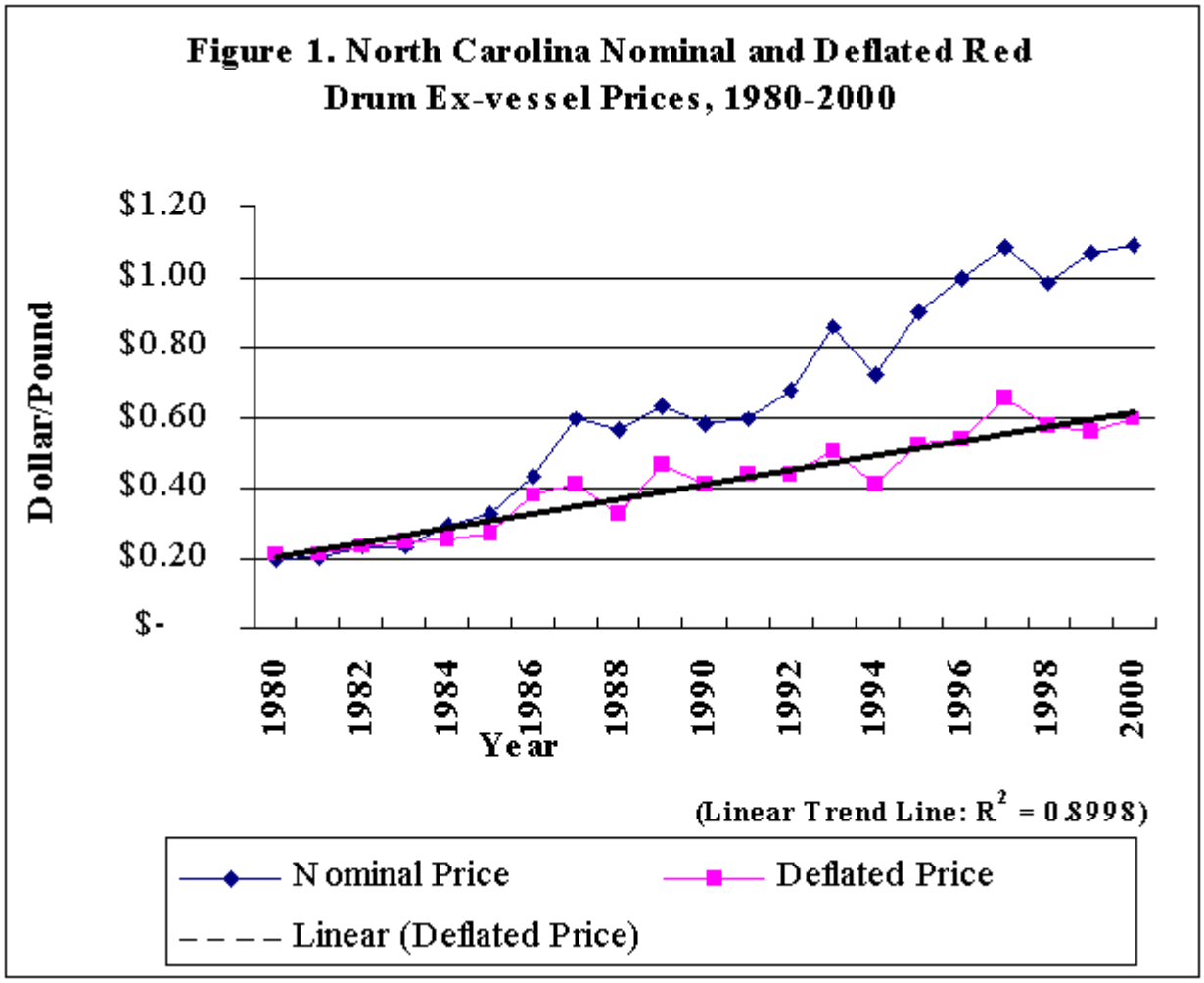

Figure 21. North Carolina nominal and deflated red drum ex-vessel prices, 1980-2000.

There is no recent research on the red drum marketing (e.g. retail price trend analysis, import trends, market structure, etc.) in the United States. Except for commercial aquaculture operations, the lack of available market studies on red drum is partly indicative of the lack of interest in developing markets for red drum due to current regulatory constraints on directly harvesting and/or marketing red drum in the U.S. It does appears that there is at least a regional demand for red drum in the Gulf states because anecdotal information indicates that some of the red drum caught in North Carolina are sold in the Gulf states. A small amount of red drum is still landed in the Gulf states, about 38,000 pounds in 2000 at a nominal ex-vessel price of $1.52.

Table 9. Average deflated ex-vessel prices of red drum landings by gear in the Atlantic states, 1980-2000.

Gear Group	Average	Maximum	Minimum
"Combined Gear"*	0.69	0.79	0.57
Gill Nets	0.42	0.65	0.22
Seines	0.40	0.65	0.22
Hand Gear	0.70	1.05	0.47
Other	0.51	0.71	0.18
Pots & Traps	0.53	0.78	0.37
Pound Nets	0.38	0.54	0.18
Trawl	0.35	0.79	0.13

"Combined Gear" - category used for all Florida red drum landings in the 1980s; * Commercial harvesting was disallowed in Florida after 1988
Gill nets - includes runaround, anchor and other gill nets
Seines - includes beach, common and long haul seines
Hand Gear - includes hand lines, spears (gigs), rakes and rod and reel
Other - all other gear
Pots & Traps - includes fish and crab traps
Trawls - includes shrimp, finfish and crab otter trawls

1.3.2 Recreational Fisheries

Recreational fishing for red drum along the Atlantic coast has taken many forms over the years and historically extended farther north than at present. Red drum was a prized sport fish as far north as Barnaget Light, New Jersey where surf fishermen commonly landed large adult 25-45 lb fish. This fishery no longer exists; only an occasional large red drum is caught.

The present recreational fishery in the Mid-Atlantic region extends mainly from Assateague Island, Maryland southward along Virginia's barrier islands to Cape Charles and into the Chesapeake Bay. Two distinct fisheries are prosecuted in the Chesapeake- a puppy drum fishery and a large-fish trophy fishery. The State of Virginia awards citations for red drum larger than 40 lbs. caught by recreational fishermen in the Virginia Sport Fishing Tournament. In 1988, red drum ranked fifteenth in total number of citations awarded for all species. Approximately 70% of the 124 red drum entered for citation in 1988 were released alive. The number of citations awarded annually since 1988 has trended upward peaking at 694 in 1999. This was the first year that Virginia awarded citations for released red drum only.

The recreational fishery for trophy red drum which exists along the South Atlantic has been primarily a surf fishery along the outer beaches of barrier islands. The largest (94 lbs 2 oz) red drum ever recorded caught by recreational fishermen was caught in the surf on the Atlantic coast. Small red drum are caught in estuaries from Chesapeake Bay to Florida. The salt-water angling surveys indicated that 88% of red drum caught in the Mid-Atlantic region in 1965 were caught in sounds, rivers and bays, whereas in 1970 only 47% were caught in estuarine waters. In the South Atlantic more red drum (59%) were caught in the ocean in 1965, but in 1970, 79% were caught in sounds, rivers and bays than in the ocean in all survey years. Red drum catch data by month and year on the eastern shore of Virginia were reported for 1955 to 1965. Catch rates were never high but relative highs occurred during 1957 and 1962 at 0.14 fish

per man-hour. More fish were landed during May and September, but catch rates were highest for April, June and September. A low of 0.01 fish per man-hour occurred in 1959. A 1963 sport fishery survey in the Cape Canaveral area of Florida found that catch per unit effort was highest in October and April.

1.3.2.1 Seasonality

Between False Cape, Virginia and South Carolina most red drum are caught from mid-March or early April to early December. The best fishing for adult red drum runs from late March to early June and for juvenile red drum from late September to November. The fishing season in Chesapeake Bay is from late April or May to November. The best fishing for adults is from mid-May to mid-June and from August to October for juveniles. The red drum fishing season from False Cape, Virginia to Delaware Bay extends from April or May to November and the best fishing is from May-June and September-October. Along the North Carolina coast surf fishing is best from March to June and October to November. Peak seasons along the barrier beaches and inlets are from mid-March through early June and mid-September through November. In the Pamlico Sound large red drum are also available from mid-May through early October, especially around river mouths and high shoals. Small red drum are caught along barrier island beaches from June through December with September through December being the peak seasons. They are also caught during this period in estuarine waters, particularly around grass flats and shorelines. The fishing season for red drum is year round from Georgia to southeastern Florida. From Altamaha Sound to Fort Pierce Inlet, best fishing for small fish is August to December inshore, and for large fish, March to May and September to December in beach and shoal areas. Best fishing for small red drum from St. Lucie Inlet to southern Florida is from April to August and from August to November for large ones. Adult red drum generally remain in coastal waters during spring and fall months and during late summer move offshore, presumably to spawn. Generally, adult drum move offshore during the coldest months.

1.3.2.2 Fishing Gear

Red drum are caught by bottom fishing, jigging and casting from shore, as well as, bottom fishing, casting, live-lining and trolling from boats. Baits include soft or shedder crabs, shrimp, clams, squid, cut or whole mullet, spot, herring or menhaden, as well as artificial lures such as spoons, jigs, weighted bucktails, feathers, plugs and streamer flies. Red drum have been harvested by gill netting and gigging for home consumption in North and South Carolina. In South Carolina, 94% of the gill net fishermen who fished in 1978, fished recreationally. This recreational gill net fishery no longer exists since the State of South Carolina declared red drum a gamefish and harvest is restricted to hook and line and during designated months, gigs.

The NMFS salt-water angling surveys (1960-1970) indicated that the number of red drum per angler declined in all regions from 1965 to 1970. The average reported weight of fish decreased in both the Mid and South Atlantic regions from 1960 to 1970, but increased from 1960 to 1965 and decreased slightly from 1965 to 1970.

NMFS initiated the Marine Recreational Fisheries Statistics Survey (MRFSS) in 1979 to obtain estimates of participation, catch and effort by recreational fishermen in U.S. marine waters to establish a reliable data base for estimating the impact of recreational fishing on marine resources. The MRFSS is the data base the Regional Fishery Management Councils utilize in estimating recreational catch of a particular species. Data collection involves the acquisition of two sets of information resulting from a telephone survey of households and an intercept survey of fishermen at fishing sites. Combining these independent sources of data produces the estimations of total effort, participation and total catch. In recent years the survey has been expanded and number of intercepts increased through participation by state fishery management agencies in most South Atlantic states. This increased support by the states has increased

the precision of the catch and effort estimates.

The recreational fishery has expanded significantly over the last twenty years the survey has been conducted. Recreational anglers along the Atlantic coast captured (numbers) approximately 2.1 million red drum in 1995 representing the highest recorded level to date (Table 10). While the overall total number of red drum captured continues at historic highs, the recreational landings in pounds and numbers harvested peaked around 1985 and has since declined and leveled off to near the 20 year average (Figure 22). This is in part due to the imposition of minimum and maximum size limits by Atlantic coast State agencies as recommended in the ASMFC FMP (ASMFC 1994a). These regulatory changes have resulted in a dramatic rise in the number of red drum releases which have increased from less than 15,000 in 1981 to greater than 1.6 million in 1995 (Figure 23). The percentage of red drum released versus those harvested has increased from less than 10% in the early 1980's to greater than 60% in every year since 1991. A total of 81.7% of all red drum captured in 1997 were released. The south Atlantic region typically accounts for greater than 95% of the entire coastwide landings of red drum (Table 11). Over the past 10 years, east Florida has been the largest contributor, landing nearly 40% of the red drum by weight.

Table 10. Estimated total number and pounds of red drum caught, landed and percent released alive by recreational fishermen in the Atlantic (Source: MRFSS).

Year	Total Catch in Numbers	Number Released Alive	% Released Alive	Number Harvested	Harvested Weight (lbs)
1981	187,195	13,023	7.0	174,171	761,458
1982	428,408	16,046	3.7	412,362	911,022
1983	687,811	64,757	9.4	623,055	1,129,769
1984	1,101,720	54,359	4.9	1,047,360	2,616,660
1985	1,218,726	217,517	17.8	1,001,208	2,203,057
1986	655,104	187,753	28.7	467,351	1,964,420
1987	1,488,722	713,729	47.9	774,993	1,636,715
1988	1,300,753	709,316	54.5	591,437	1,909,422
1989	592,987	303,810	51.2	289,177	914,510
1990	614,604	340,927	55.5	273,677	1,357,769
1991	1,428,501	978,615	68.5	449,885	1,282,980
1992	872,670	535,142	61.3	337,528	1,171,251
1993	1,338,638	985,100	73.6	353,538	1,213,751
1994	1,695,350	1,280,353	75.5	414,998	1,442,404
1995	2,127,778	1,601,248	75.3	526,530	1,715,055
1996	1,162,090	787,049	67.7	375,041	1,363,702
1997	1,384,929	1,130,962	81.7	253,968	812,269
1998	1,202,422	895,295	74.5	307,128	1,327,350
1999	1,469,225	1,154,529	78.6	314,696	1,229,814
2000	1,667,359	1,274,703	76.5	392,656	1,562,546

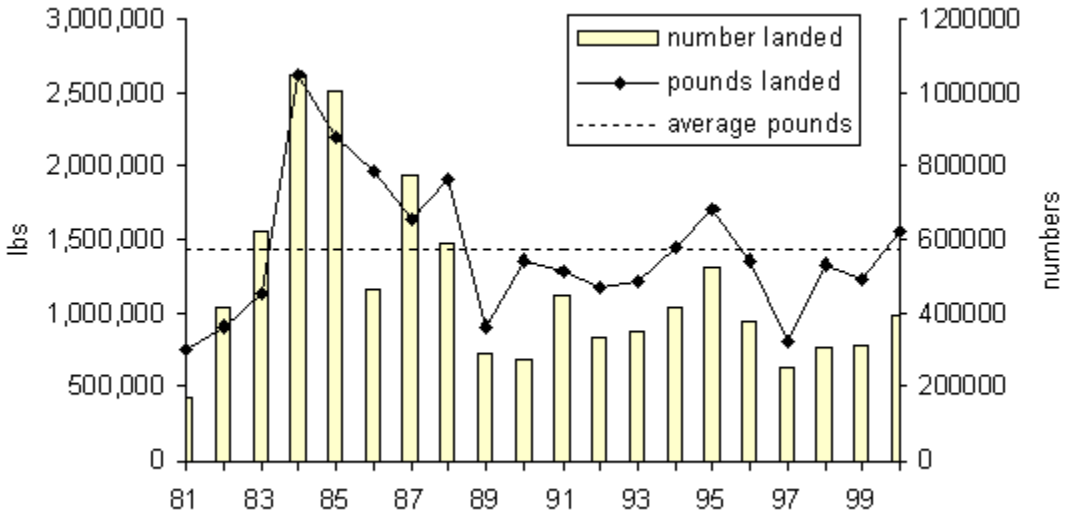

Figure 22. Total recreational red drum catch and landings for Atlantic coast (Source: MRFSS).

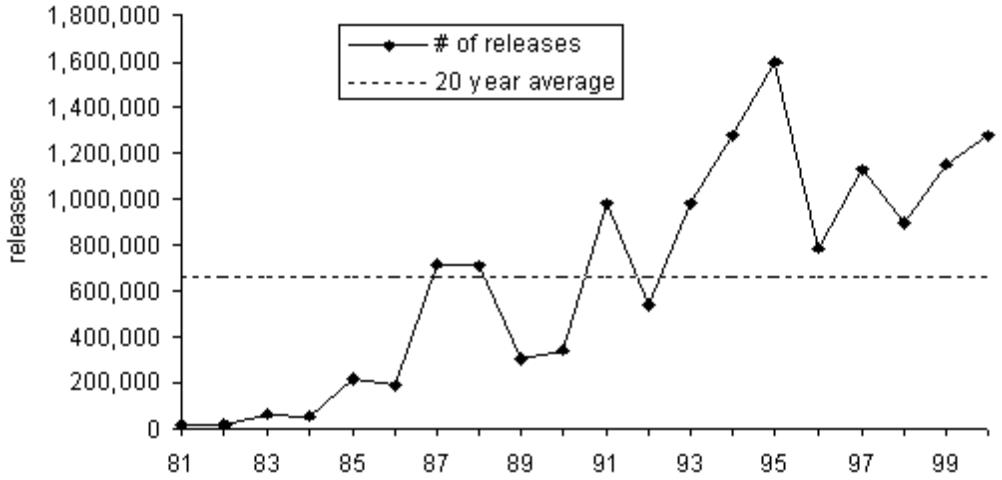

Figure 23. Total recreational red drum releases (numbers) for Atlantic coast (Source: MRFSS).

Table 11. Total landings of red drum (lb) caught by Atlantic coast recreational anglers by state and year (Source: MRFSS).

Year	MD	VA	NC	SC	GA	FLEC	Total
1980	0	0	201,965	198,680	30,021	248,534	679,200
1981	8,079	436,258	28,775	49,057	10,059	94,910	627,139
1982	0	0	50,370	245,004	23,643	359,249	678,265
1983	6,231	44,626	97,529	165,871	58,938	678,285	1,051,479
1984	0	4,421	614,738	211,895	233,458	1,050,129	2,164,134
1985	0	0	50,263	667,237	242,122	450,190	2,101,658
1986	609,710	179,002	8,475	309,626	101,737	348,074	1,741,403
1987	0	37,573	157,039	772,576	204,073	190,349	1,537,463
1988	0	6,570	334,172	921,624	228,086	6,892	1,670,190
1989	2,348	27,236	214,850	396,774	127,245	146,061	914,514
1990	2,679	0	302,993	631,818	161,712	258,569	1,357,771
1991	5,635	30,582	108,266	284,290	337,207	516,998	1,282,978
1992	0	55,324	109,135	411,484	198,751	396,555	1,171,249
1993	0	45,505	266,459	282,614	328,246	290,930	1,213,754
1994	0	3,684	192,061	314,632	353,616	578,412	1,442,405
1995	0	66,270	405,621	417,596	300,340	525,231	1,715,058
1996	0	1,512	204,554	396,396	164,754	596,483	1,363,699
1997	0	1,810	39,077	296,157	129,836	345,391	812,271
1998	0	34,861	591,429	129,619	84,350	487,093	1,327,352
1999	0	92,794	326,304	103,775	166,628	540,312	1,229,813
2000	0	93,105	297,837	89,687	221,031	860,892	1,562,552

The Atlantic coast recreational red drum fishery can be summarized from the MRFSS into various fishing modes. These include fishing from the following areas: shore based, beach based, man made structure, private boats and charter boats. Recreational landings are summarized based on state, mode of fishing, and year for the period of 1981 through 2000 (Tables 12-15). The coastwide mean weight of landed fish by mode has varied over the years, although in recent years the variability has decreased due to the restrictive slot limits imposed on harvest by the various state agencies (Table 12).

Anglers fishing for red drum from charterboats have traditionally contributed a very small portion of red drum catch during the 1980's, with the highest level, 5% of total catch, occurring in 1984. That contribution has increased somewhat with charter boats landing 7% by number and 6% by weight of all red drum harvested on the east coast from 1989 to 1999. Private boats accounted for the greatest proportion of the landings from 1989 to 1999 landing 74% by number and 71% by weight of the total red drum harvest. Beach bank and shore anglers combined to account for 17% by number and 22% by weight of the total red drum harvest over the period.

Historically, recreational catch of red drum from the EEZ has been minor. Recreational catch of red drum from EEZ waters in 1987, as identified in the MRFSS totaled less than 6,000 fish in the South Atlantic (0.4% of total number of fish caught) and less than 3,000 fish from the Mid-Atlantic region (0.2% of total number of fish caught). The EEZ was closed to the harvest of red drum by the SAFMC in 1990 (SAFMC 1990a).

Catch frequency, as derived from the MRFSS 1992-1998, is divided into the northern (North Carolina north) and southern (South Carolina south) management units (Figure 24). Catch per angler trip shows that less than 10% of the red drum trips result in more than 5 red drum for both regions, while greater than 70% of the trips in the northern area and >60% of the trips in the southern area land only one red drum.

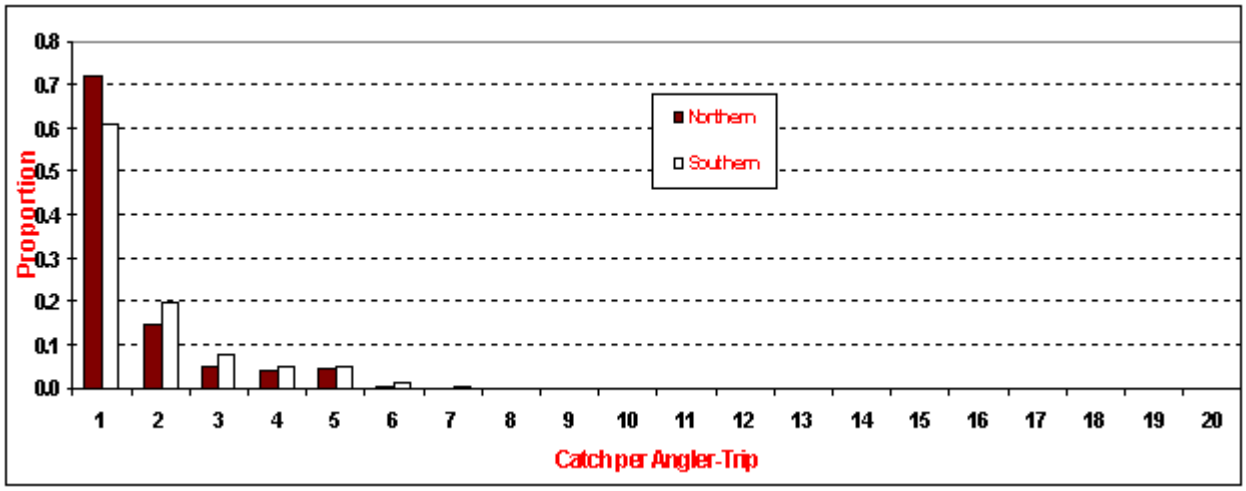

Figure 24. Comparison of catch of Atlantic red drum per angler-trip for southern and northern regions, 1992-1998.

Table 12. Mean weight (lb) of red drum landed by recreational anglers by state, mode and year (Source: MRFSS).

State	Mode	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
MD	Boat [1]		9.913		1.914			62.77			2.20		
	Shore												2.65
	Pr. Boat										2.20	1.98	1.54
VA	Boat [1]		7.004		1.095	1.762		5.432	40.09				2.20
	Shore				1.652			3.608	0.441	2.099	2.65		2.43
	Pr. Boat										1.98		1.32
NC	Boat [1]	1.322	0.881	4.168	0.080	0.770	2.866	1.102	2.432	3.378		26.01	29.54
	Pr. Boat										2.87	4.19	2.20
	Shore	3.731	2.748	2.327	2.360	7.941	2.984	2.129	2.871	2.580			
	Man-made										1.54	1.76	2.43
	Beach/ Bank										3.97	12.57	2.87
SC	Boat [1]	2.309	1.431	1.976	1.701	1.501	2.884	2.552	1.807	3.362	3.53	2.43	1.54
	Shore	2.620	5.038	1.082	3.584	1.121	2.701	1.711	1.257	1.432	3.75	7.94	2.20
	Pr. Boat										3.09	5.73	2.43
GA	Boat [1]	1.147	1.488	1.181	1.232	1.145	1.008	1.684	1.775	2.514	1.98	4.63	2.43
	Shore	0.784		0.017	0.636	0.504	0.643	1.461	0.726	1.137	2.20	1.76	2.65
	Pr. Boat										2.43	2.20	1.98
FLEC	Boat [1]	1.896	2.521	1.439	1.896	1.911	1.508	3.346	4.379				
	Shore	4.150	0.954	4.704	1.658	1.183	1.433	1.668		0.643	4.85	6.61	4.63
	Pr. Boat										3.75	5.73	5.29

[1] Charter boat after 1988

Table 12. Continued.

State	Mode	1992	1993	1994	1995	1996	1997	1998	1999	2000
MD	Shore									
	Charter									
	Pr. Boat									
VA	Shore					2.65		2.87	18.74	6.17
	Charter									
	Pr. Boat	4.19	5.29	3.53	21.61		1.98	2.87	6.39	3.97
NC	Man-made	5.95	4.63	6.17	4.41	2.87	1.76	5.73	4.85	5.29
	Beach/ Bank	4.63	4.85	6.39	4.85	6.17	6.83	4.19	4.63	5.73
	Charter	6.17	28.44	12.79	5.29	12.13	8.82	10.14	4.63	6.61
	Pr. Boat	4.19	6.83	6.39	4.19	6.61	4.41	5.07	5.29	4.63
SC	Shore	3.97	1.54	2.20	1.76	3.31	2.87	2.87	3.31	1.32
	Charter	2.65	1.54	3.09	2.43	3.53	2.43	3.53	1.76	3.31
	Pr. Boat	3.53	2.65	2.20	1.98	2.87	2.20	2.65	2.43	2.65
GA	Shore	2.65	2.87		1.54	4.41		4.41	3.75	1.32
	Charter	2.43	2.65	2.43	2.20	1.98	2.65	2.43	3.09	2.65
	Pr. Boat	2.43	3.09	2.65	2.20	2.87	3.31	3.53	2.43	2.65
FLEC	Shore	3.75	3.97	5.29	5.51	4.19	5.73	4.19	4.41	5.29
	Charter	4.85	5.95				7.05	4.19	3.97	4.63
	Pr. Boat	3.75	4.63	4.63	5.29	3.97	3.75	4.63	4.19	4.41

Table 13. Total numbers of red drum caught* by Atlantic coast recreational anglers by state, mode and year, MRFSS 1980-2000 (Source: MRFSS). [* includes red drum landed, discarded, and released alive (A+B1+B2)]

State	Mode	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
MD	Boat [1]		815		3255			9704			97		
	Pr. Boat										3835	1279	1627
	Shore												550
VA	Boat [1]		62283		10832	2509	1351	34017	915	2685			2228
	Pr. Boat										14159	934	8963
	Shore				14202			13185	1948	4660	4886		20390
NC	Boat [1]	3456	2154	3502	65818	15134	13799	1675	30758	77501		548	655
	Pr. Boat										22154	15120	47040
	Shore	52907	12379	15369	39142	81327	7669	10019	51727	66913			
	Man-made										5118	3776	14316
	Beach/ Bank										42653	26157	97825
SC	Boat [1]	186245	27754	109593	77018	136953	169402	179996	449107	496801	1451	19708	16303
	Pr. Boat										156183	199171	181352
	Shore	21212	1992	28553	14247	5425	286679	16198	85388	101699	12682	2398	28147
GA	Boat [1]	27767	6759	22579	42720	206287	246424	126486	357293	282977	4680	226	9592
	Pr. Boat										117248	225046	240871
	Shore	965		11331	11455	14181	30074	7859	14280	7844	791	7295	5141
FLEC	Boat [1]	100958	26043	183329	340633	533250	637818	182455	498229	197770			
	Pr. Boat										179303	100467	478084
	Shore	23285	60246	31908	88679	137568	153889	28755	12039	61600	27747	12480	270416

[1] Charter boat after 1988

Table 13. Continued.

State	Mode	1992	1993	1994	1995	1996	1997	1998	1999	2000
MD	Shore									1408
	Charter									
	Pr. Boat							2768	2148	
VA	Shore		46932		7771	1716	58251	27529	25615	7939
	Charter									
	Pr. Boat	28658	17508	12062	29454	1280	53423	79201	219704	206256
NC	Man-made	12543	70612	31757	40540	11862	58923	41870	18997	13106
	Beach/Bank	27596	131554	41212	140758	31033	140799	53240	85389	51799
	Charter	19	591	1733	2225	506	1136	9895	2316	936
	Pr. Boat	43664	29036	61913	69590	29096	67462	209334	205182	185112
SC	Shore	28542	18735	20160	18074	8870	12398	4442	5976	8099
	Charter	3229	62405	42797	136010	51143	33011	11533	13580	3646
	Pr. Boat	127032	184373	391264	411191	247153	259385	114807	112289	114743
GA	Shore	1514	3927	8389	2006	967	3498	2629	2325	14825
	Charter	7414	9694	22023	44999	5508	1813	4618	3732	1617
	Pr. Boat	202999	232475	249841	444528	125759	56466	51564	79812	198127
FLEC	Shore	82351	30587	143933	124414	84036	113188	107960	86446	102219
	Charter	1212	671	598		848	3158	12236	26808	33938
	Pr. Boat	305596	499538	667669	656219	562313	519449	468795	578907	723589

Table 14. Number of red drum landed by Atlantic coast recreational anglers by state, mode and year, MRFSS 1980-1988 (Source: Vaughan and Helser 1989).

State	Mode	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
MD	Boat [1]		815		3255			9704			97		
	Pr. Boat										917	1279	1627
	Shore												1118
VA	Boat [1]		62283		10832			25034	915				2228
	Pr. Boat										7122		8963
	Shore				14202	2509		13185	1948	3127	4886		5928
NC	Boat [1]	3456	2154	3502	64358	15134	13799	1675	22750	64854		548	237
	Pr. Boat										17459	9689	7651
	Shore	52907	9782	15370	39142	78124	7669	10019	45222	63377			
	Man-made										3776	3776	2421
	Beach/Bank										41124	19135	28350
SC	Boat [1]	66195	27272	108966	67936	136953	160576	157958	382708	269745	1451	14333	6288
	Pr. Boat										115158	103618	92357
	Shore	17506	1992	27400	14042	5425	278518	12098	85388	77992	10884	714	27188
GA	Boat [1]	25850	6759	19867	42013	203510	238547	833334	129811	100653	1897	101	4729
	Pr. Boat										49465	70450	157216
	Shore	486		11331	11258	14182	28852	3331	4873	2178	195	5753	857
FLEC	Boat [1]	80116	14837	181255	286834	482086	234148	100854	64382				
	Pr. Boat										21692	37881	69998
	Shore	23285	60246	20918	81140	130685	147610	11406		10712	13055	6400	32729

[1] Charter boat after 1988

Table 14. Continued.

State	Mode	1992	1993	1994	1995	1996	1997	1998	1999	2000
MD	Shore									
	Charter									
	Pr. Boat									
VA	Shore		5261			572	955	3035	991	3416
	Charter									
	Pr. Boat	13275	8744	1378	3665		966	10036	11434	18608
NC	Man-made	2061	8860	3832	7613	9755	2452	4960	3505	6113
	Beach/Bank	11591	30416	12206	48735	13901	2618	18851	19018	21589
	Charter	19	449	986	1125	506	136	6252	1558	325
	Pr. Boat	9922	9768	11929	31120	12583	3542	84575	40657	30072
SC	Shore	21481	9526	9794	13940	5336	8304	525	1370	1990
	Charter	3200	16252	28045	76699	22209	17093	2640	5107	649
	Pr. Boat	87853	93411	91676	111791	103104	103625	43344	37592	33204
GA	Shore	1057	2565		1427	290		1297	926	7720
	Charter	4048	5769	20208	23206	4701	1458	3468	1834	277
	Pr. Boat	78756	97376	114006	110283	55260	37583	20164	64523	82916
FLEC	Shore	40469	9528	29664	26136	37679	34689	34219	25562	34011
	Charter	727	671				1263	2409	8054	5924
	Pr. Boat	63069	54941	91274	70791	109144	39283	71354	92564	145842

Table 15. Number of red drum caught* and released alive by Atlantic coast recreational anglers by state, mode and year, MRFSS 1989-2000 (Source: MRFSS). [* includes red drum landed, discarded, and released alive (A+B1+B2)]

State	Mode	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
MD	Boat [1]												
	Pr. Boat										2918		
	Shore												4432
VA	Boat [1]							8983		2685			
	Pr. Boat										7037	934	
	Shore						1351			1533			14462
NC	Boat [1]				1460				8008	12646			418
	Pr. Boat										4695	5431	39389
	Shore		2597			3204			6505	3537			
	Man-made										1342		11895
	Beach/Bank										1529	7022	69475
SC	Boat [1]	120050	482	627	9083		8825	22038	66399	227054		5375	10015
	Pr. Boat										41025	95553	88995
	Shore	3706		1153	205		8160	4100		23707	1798	1684	959
GA	Boat [1]	1917		2892	706	2778	7877	43153	227484	182326	2783	125	4863
	Pr. Boat										67783	154596	83655
	Shore	479			197		1222	4528	9407	5666	596	1542	4284
FLEC	Boat [1]	20843	11206	2074	53799	51164	403670	81601	433848	197770			
	Pr. Boat										157611	62586	408086
	Shore			10990	7539	6883	6279	17349	12039	50888	14692	6080	237687

[1] Charter boat after 1988

Table 15. Continued.

State	Mode	1992	1993	1994	1995	1996	1997	1998	1999	2000
MD	Shore									1408
	Charter									
	Pr. Boat							2768	2148	
VA	Shore		41671		7771	1144	57296	24494	24624	4523
	Charter									
	Pr. Boat	15383	8764	10684	25789	1280	52457	69165	208270	187648
NC	Man-made	10482	61752	27925	32927	2107	56471	36910	15492	6993
	Beach/Bank	16005	101138	29006	92023	17132	138181	34389	66371	30210
	Charter		142	747	1100		1000	3643	758	611
	Pr. Boat	33742	19268	49984	38470	16513	63920	124759	164525	155040
SC	Shore	7061	9209	10366	4134	3534	4094	3917	4606	6109
	Charter	29	46153	14752	59311	28934	15918	8893	8473	2997
	Pr. Boat	39179	90962	299588	299400	144049	155760	71463	74697	81539
GA	Shore	457	1362	8389	579	677	3498	1332	1399	7105
	Charter	3366	3925	1815	21793	807	355	1150	1898	1340
	Pr. Boat	124243	135099	135835	334245	70499	18883	31400	15289	115211
FLEC	Shore	41882	21059	114269	98278	46357	78499	73741	60884	68208
	Charter	485		598		848	1895	9827	18754	28014
	Pr. Boat	242527	444597	576395	585428	453169	480166	397441	486343	577747

1.3.2.3 Socio-cultural

No information was available at the time Amendment 2 was developed.

1.3.2.4 Economic

Starting in 1999, a recreational fishing expenditure survey was conducted in the Southeast region as an "add-on" to the NMFS Marine Recreational Fisheries Statistics Survey (MRFSS) (Genter *et al*. 2001). Angler daily trip expenditures were estimated for each fishing mode by resident group (i.e. non-resident and state resident) within each state including North Carolina, South Carolina, Georgia, and Florida. For example, resident private boat anglers fishing in North Carolina, South Carolina, Georgia, and on the east coast of Florida, averaged $71, $36, $161, and $37, respectively. Non-resident anglers averaged $92, $67, $78, and $141, when saltwater fishing in North Carolina, South Carolina, Georgia, and along the east coast Florida, respectively (Genter *et al*. 2001).

Expenditures related to anglers targeting a given species such as red drum were not estimated in the above study. Southwick Associates (2001) did prepare a preliminary estimate of red drum expenditures by red drum anglers in Virginia, the Carolinas, Georgia, and Florida by applying the average expenditure to the number of red drum targeting trips in a given state (Table 16). On a per-trip basis, largest expenditures are reported for resident activity in Florida, South Carolina and North Carolina (Table 16). The average expenditures are significantly higher when equipment items are included compared to trip-related costs only. Equipment expenditures are primarily comprised of boat and tackle costs. The large difference between trip-related and equipment expenditures is also seen in the U.S. Fish and Wildlife Service's 1996 National Survey (USFWS 1997), but was not as prevalent in the 1991 National Survey when the general economy was not as robust as in 1996 and 1999. It can be speculated that increased expenditures for equipment by red drum and other anglers may be driven in part by a strong economy as well as other factors such as fish population, changing angler preferences (i.e. flats boats), etc.

Based upon these preliminary estimates, 1999 expenditures by all anglers was over $1.3 billion, and resident and non-resident anglers targeting red drum in 1999 were $75.7 million and $1.26 billion, respectively (Table 16). Within the South Atlantic states, Florida had the highest estimated total expenditure by non-resident anglers, $59.2 million, followed by North Carolina, $10.4 million; South Carolina, $4.0 million; and Georgia, $111,000 (Table 16). Estimated resident angler expenditures within the South Atlantic states were $1.1 billion, $78.8 million, $32.1 million, and $11.1 million for Florida, South Carolina, North Carolina, and Georgia, respectively (Table 16). For the South Atlantic states, estimated red drum angler expenditures represented over 20 % of all marine angler expenditures in the South Atlantic states as reported by Genter *et al*. 2001. The economic "importance" and impacts of these angler expenditures and related implications will be discussed in *Sections 1.5.3.1* and *1.5.3.2.*

Table 16. Trips and expenditures per state for red drum, 1999 (Southwick Associates 2001).

			Residency		Travel Expense/Trip		Total Expenses/Trip		Total Annual Travel Expenditures			Total Annual Expenditures		
	Fishing	Total Red	Non		Non		Non		Non		All	ALL items (travel and equipment)		
Florida	Mode	Drum Trips	Resident	Resident	Resident	Resident	Resident	Resident	Resident	Resident	Anglers	Non-Res	Resident	All Anglers
	Shore	350,008	86,651	263,356	$ 68	$ 27	$ 159	$ 150	$5,856,940	$7,203,525	$13,060,465	13,747,889	39,450,951	53,198,840
	Charter	24,658	18,104	6,554	180	112	423	616	3,266,187	736,648	4,002,835	7,666,661	4,034,342	11,701,003
	Priv/Rent	1,514,726	166,917	1,347,809	96	58	226	804	16,081,734	77,796,768	93,878,502	37,748,364	1,083,332,196	1,121,080,560
	Total	1,889,392	271,672	1,617,720					25,204,860	85,736,942	110,941,802	59,162,914	1,126,817,489	1,185,980,403
Georgia	Shore	2,179	257	1,922	115	32	270	79	29,636	61,077	90,713	69,480	152,264	221,744
	Charter	600	141	458	155	152	27	380	21,961	69,840	91,800	3,806	174,108	177,914
	Priv/Rent	24,099	635	23,464	78	161	59	460	49,289	3,785,528	3,834,817	37,620	10,785,599	10,823,219
	Total	26,878	1,034	25,844					100,885	3,916,445	4,017,330	110,906	11,111,972	11,222,877
North	Shore	81,851	46,047	35,804	76	64	175	349	3,477,857	2,277,691	5,755,548	8,062,574	12,486,169	20,548,743
Carolina	Charter	119	92	27	111	202	257	1,105	10,189	5,347	15,536	23,620	29,311	52,931
	Priv/Rent	34,267	10,821	23,446	92	71	214	837	997,100	1,671,312	2,668,412	2,311,537	19,623,310	21,934,847
	Total	116,237	56,950	59,277					4,485,145	3,954,350	8,439,496	10,397,731	32,138,790	42,536,621
South	Shore	12,328	5,009	7,318	104	54	249	317	522,322	396,033	918,355	1,247,213	2,319,695	3,566,908
Carolina	Charter	3,100	2,239	860	221	140	528	818	494,832	120,165	614,997	1,181,572	703,846	1,885,418
	Priv/Rent	96,955	10,095	86,860	67	36	160	873	677,185	3,119,073	3,796,258	1,616,998	75,810,700	77,427,698
	Total	112,382	17,343	96,039					1,694,340	3,636,272	5,329,611	4,046,783	78,834,241	82,880,024
Virginia	Shore	8,092	1,806	6,286	117	41	265	134	211,685	255,484	467,168	477,864	844,587	1,322,451
	Charter	0	0	0	122	61	275	203	0	0	0	0	0	0
	Priv/Rent	30,000	8,523	21,477	75	49	170	355	640,648	1,049,557	1,690,204	1,446,221	7,623,117	9,069,337
	Total	38,092	10,329	27,763					852,332	1,305,040	2,157,373	1,924,085	8,467,704	10,391,788
Total	Shore	454,458	139,771						10,098,439	10,193,811	20,292,250	23,605,020	55,253,666	78,858,686
	Charter	28,476	20,577						3,793,168	932,000	4,725,168	8,875,658	4,941,608	13,817,266
	Priv/Rent	1,700,047	196,990						18,445,956	87,422,238	105,868,193	43,160,739	1,197,174,922	1,240,335,661
	Total	2,182,981	367,338						32,337,663	98,548,049		76,641,417	1,257,370,196	1,333,011,613

The NMFS also conducted an add-on survey to the MRFSS in the southeast region during 1997. The purpose of the add-on survey was to obtain socio-demographic, economic and fishing behavioral information on recreational anglers throughout the southeastern United States (Holiman 2000). Summarized information on the demographic and economic characteristics of the recreational fishery in North Carolina was also provided in the FMP (NCDMF 2001) for 1997-1998. The majority (95.4%) of recreational anglers targeting red drum in North Carolina waters in 1997 were white and predominantly male (83.5%) and averaged 18.2 years of experience in recreational fishing. The majority (68%) of North Carolina red drum anglers surveyed was between 26 and 55 years of age and about 73% of them were employed, earning between $15,000 to over $175,000 per year. Slightly more than half reported earning over $45,000 per year.

Table 17. Red drum target effort trips in the South Atlantic by state for the period 1985-2000. Figures are thousands of trips (Source: MRFSS data as reported by Holiman 1999 and Southwick 2001).

Year	North Carolina	South Carolina	Georgia	East Florida	Total
1985	3,380.36	1,571.87	438.86	9,926.71	15,317.80
1986	2,977.06	1,447.73	639.43	9,840.15	14,904.37
1987	3,861.94	1,648.12	751.35	10,686.78	16,948.19
1988	4,762.89	1,906.13	666.72	11,485.19	18,820.93
1989	3,848.90	1,080.63	625.89	10,805.93	16,361.35
1990	3,867.93	931.06	705.44	8,067.60	13,572.03
1991	3,762.39	1,796.21	740.82	11,086.64	17,386.06
1992	4,372.00	1,457.23	572.15	10,340.03	16,741.41
1993	4,716.08	1,776.21	673.46	9,630.11	16,795.86
1994	5,170.14	1,987.30	955.82	11,815.06	19,928.32
1995	5,106.67	1,530.25	781.72	11,617.80	19,036.44
1996	4,741.82	1,434.08	617.36	10,525.86	17,319.12
1997	4,891.51	1,606.38	575.87	11,298.96	18,372.72
1998	4,461.46	1,714.09	571.86	10,089.81	16,837.22
1999	4,555.04	1,213.32	472.58	8,194.17	14,435.11
2000	6,090.99	1,276.87	763.93	11,162.94	19,294.73
Total	70,567.18	24,377.50	10,553.26	166,573.72	272,071.66

Although marine angler expenditures at the state and county level are useful, economists do not consider expenditures and related economic impacts to be the best approach for determining the economic value of the recreational fishing experience. From an economic perspective, the appropriate approach to quantifying the economic value of recreational fishing is based upon consumer surplus (Edwards 1991). In general, consumer surplus or welfare is the value of the trip over and above the actual expenditure on the trip. For non-market goods, like shore or private boat fishing, consumer surplus can be directly estimated by asking anglers what they are willing to pay or be compensated for changes in quantity or quality of their fishing experience (SAFMC 1990b). Consumer surplus can also be indirectly

approximated using a specialized travel cost model, Random Utility Models (RUMs), which is used to estimate angler site selection patterns based on individual trip costs and other site characteristics including fish catch rates. A RUM oriented valuation of marine recreational fishing for private boat angler was done by Haab *et al*. (2000) using data collected during the 1997 MRFSS add-on in the Southeastern states. Controlling for other site selection characteristics, they estimated the marginal value of an increase in historical catch and keep (harvest) by one additional fish harvested in a given state. In the South Atlantic states, the estimated value of one additional red drum caught per trip was the highest for South Carolina ($5.13), followed by Florida's east coast ($3.39), Georgia ($1.88), and North Carolina ($.36). It is assumed that a reduction in the number of red drum that could be caught and retained by the angler due to more stringent bag limits would have a similar magnitude in value change per fish for an angler. The loss of red drum fishing opportunities per trip for the following South Atlantic states were also estimated: South Carolina ($20.79), Florida's east coast ($8.73), Georgia ($3.04), and North Carolina ($1.87). For example, if "elimination of access" to North Carolina's red drum recreational fishery occurred, it would result in a consumer surplus or welfare loss of almost $232,000 based upon 124,053 annual red drum targeting trips, i.e. the value of red drum above angler expenditures (Haab *et al*. 2000). Besides the specifics of eliminating "access", there are other qualifiers to this estimate. The RUM analysis will tend to overestimate losses from reduction in catch and keep rates because it does not account for switching to other species by anglers (Haab *et al*. 2000). In addition, values associated with catch and releases vs. retention were not addressed, although the importance of red drum catch and retention in fishing success has been debated by researchers (e.g. Duda 1993).

1.3.3 For-Hire Fisheries

The for-hire fishery for red drum is charter boat fishery, concentrated on the Atlantic Coast from North Carolina to Florida, with a substantial fishery in the Gulf of Mexico as well. A head boat fishery for red drum is virtually nonexistent (ASMFC 1994b). NMFS headboat survey data from 1981 to 1997 estimated headboat landings of red drum to be far less than 1% of total recreational fishery landings (Holiman 1999).

Whitmore (1994) looked at relative directed effort in the South Atlantic charter fishery. Relative effort was based on the product of the number of boats and the number of months/12 fished. Directed red drum effort ranked 9th out of 16 species, well behind black sea bass, groupers, and king mackerel, but ahead of summer flounder, Spanish mackerel, and sharks. Nearly 50% of the relative effort occurred in Georgia, with the remaining effort distributed fairly evenly between North Carolina and South Carolina. Florida did not have a charter fishery directed at red drum in 1994 and 1995.

From 1983 to 1998, estimated red drum harvest in the South Atlantic charter fishery fluctuated between 3,348 fish (8,868 lbs.) in 1989 and 119,067 fish (283,813 lbs.) in 1995. Harvest declined annually from 1995 to 1998. The 1998 harvest of 14,769 fish (91,303 lbs.) comprised 39% of the catch and 5% (7% by weight) of the total recreational harvest.

From 1983 to 1998, the percentage of party/charter boat trips targeting red drum has fluctuated between 0.20% in 1985 to 5.22% in 1995. This peak of 5.22% in 1995 coincides with peak catch and landings over the same time period. This percentage has declined annually from 1995 to 1.15% in 1998. In contrast, the percentage of anglers targeting red drum in the shore and private/rental boat fisheries in 1998 was 3.19% and 5.10%, respectively (Holiman 1999). Comparing the charter boat fisheries by state, the highest percentage of charter boat anglers targeting red drum in 1998 was South Carolina (4.4%), followed by Georgia (2.4%), Florida East Coast (0.9%), North Carolina (0.2%), and Virginia (0.0%). Popularity of fishing for red drum by charter boat anglers has increased from 1998 to 2000 in Florida

(0.9% to 3.9%) and Georgia (2.4% to 8.7%), while decreasing in South Carolina (4.4% to 2.2%) and essentially remaining very low in North Carolina (0.2% to 0.1%).

In South Carolina, red drum has been the most sought-after species in the inshore charter-boat fishery from 1995 to 1999. In 1999, of 2,900 inland boat trips, 1,476 (51%) were targeted at red drum, followed by anglers targeting any species (16%), and spotted seatrout (15%). The number of permitted boats fishing in inland waters (where the majority of the effort is directed at red drum) has increased nearly annually from 39 boats in 1993 to 98 boats in 1999. Directed effort for red drum increased significantly from 1,359 angler-hours in 1993 to 12,875 angler-hours in 1999. Catch has shown an increasing trend similar directed effort from 1993 to 1999, while CPUE has fluctuated between 0.5 and 0.7 fish per angler-hour. By comparison, private boat CPUE showed the same trend though was consistently lower than charter CPUE. Of the reported 10,656 red drum caught by the charter fishery, 85% were released (Low 2001).

1.3.3.1 Seasonality

A 1994 ASMFC survey of Atlantic seaboard charter and headboat fisheries showed that the charter boats fish year-round for red drum in South Carolina and Georgia, and fish 9 months for red drum in North Carolina (data indicated no red drum charter fishery in 1994) (ASMFC 1994b). In South Carolina prior to 1998, the charter-boat effort for red drum peaked in April and during September - November. The fishery has since evolved into a year-round fishery, with substantial effort each month in 1999 (Low 2001). Charter boats near Brunswick, Georgia, will target red drum year-round, with peak the season from September through December in the saltwater marshes surrounding St. Simons Island.

1.3.3.2 Fishing Gear

Charter boats are generally not exclusive to red drum, turning to target other species when the bite is hot and at different times of the year. Fly fishing charters are gaining popularity. Fishing is for red drum is predominantly inshore and estuarine. In 1993, 15% of charter trips in South Carolina were in estuarine waters. These estuarine charters sought red drum and spotted seatrout as the principal species. The majority (70%) of South Carolina charter trips was offshore and not targeting red drum. Common fishing techniques include bottom fishing from North Carolina through Georgia, with additional live lining in North Carolina and trolling in South Carolina (ASMFC 1994). Charter boats near Cape Canaveral, Florida, will pole flat-bottom boats in estuarine waters and fish with spinning gear on light line (6-10 lbs.). In the fall near Morehead City, North Carolina, charter boats fish the estuarine waters for red drum using cut bait. Historically, Matlock (1978) indicated that charter boats were still, troll, and drift fishing in the open ocean and bays.

In South Carolina, 98% of red drum effort, and 95% of the catch is concentrated in inland waters. The remaining effort is concentrated in open ocean waters from 0-3 miles, with some effort in ocean waters >3 miles. Open ocean effort is typically bottom fishing over natural structure, but does include some manmade structure. Inland trips are typically made with smaller boats with an average of 2 anglers. Ocean trips are typically larger boats carrying an average of 4 anglers.

1.3.3.3 Socio-Cultural

The 1997-98 Southeast Region Marine Recreational Economics Survey estimated the following demographic information about the charter boat fishery (including but not limited to those targeting red drum). The age range of 26-55 years comprised 78% of charter boat anglers, with a mean age of 43 years. Nearly 90% of charter boat anglers are male, and 90% are white. An estimated 83% of charter anglers are employed, and 91% of those employed are employed full-time. Nearly 80% of those not

employed considered themselves to be retired, while 12% claimed they were looking for employment. Of those employed, the mean annual income of charter anglers is $75,000, compared to $56,000 for private/rental boat anglers and $48,000 for shore anglers; however, this estimate may have been biased due to the high percentage of non-respondents (>30%). A majority of the charter boat anglers are non-residents for fisheries in North Carolina (78%), Florida (73%), and South Carolina (72%). By contrast, the Georgia charter boat fishery is comprised of mostly resident anglers (76%) (Southwick Associates 2001).

1.3.3.4 Economic

Southwick Associates (2001) estimated the total economic impact[1] of the 1999 red drum charter fishery (Virginia to Florida) to be $16.4 million in total sales (output), $4.7 million in income, 230 FTE[2] jobs, and $1.0 million in sales and income taxes (Table 18). Total economic impact of the red drum charter fishery accounted for an estimated 12% of the total economic impact of the red drum recreational fishery.

Total economic importance[3] of the 1999 red drum charter fishery (Virginia to Florida) was estimated at $25.6 million in total sales (output), $7.3 million in income, 359 FTE jobs, and $1.6 million in sales and income taxes. Total economic importance of the red drum charter fishery represents 1% of the total economic importance of the red drum recreational fishery. This small percentage is due primarily to a substantial amount of economic stimuli generated by the expenditures of resident private/rental boat anglers relative to shore and charter anglers, particularly in Florida and South Carolina.

1.3.3.5 Data Collection Efforts

South Carolina instituted a mandatory permitting and reporting system in 1992. All vessels transporting fishermen for a fee in SC waters are required to have a permit. As a condition of the permit, vessel owners are required to submit monthly logs of each fishing trip. Boat operators are required to submit reports of the daily numbers of anglers, hours fished, species caught, number of fish by species kept and released and pounds of each species kept. In addition, operators are asked to voluntarily provide information on location fished (based on a grid map), general areas (estuarine, coastal or offshore), target species and fishing method (troll, bottom) (ASMFC 1994b; Low 2001).

The MRFSS methodology is robust for the private/rental boat and shore modes; however effort estimates for charter boats can be problematic. Estimation of the fishing effort for the party/charter boat sectors of the recreational fishery is difficult due to the relatively low incidence of reported fishing activity in these modes by households contacted in the telephone survey. Most participants in the party/charter mode of fishing are non-coastal residents while telephone sampling for effort is concentrated only in coastal areas (ASMFC 1994b). Further, the sampling timeframe does not adequately cover relatively short charter fishery for red drum in Virginia. However, MRFSS estimates of red drum catch and effort in the South Carolina charter fishery compare reasonably well to data collected through South Carolina's mandatory charter trip reporting program. Estimates of effort in inland waters was 3,979 angler-trips (MRFSS) compared to 3,108 (SC MRD). Similarly, estimated catch was 13,580 fish (MRFSS) compared to 10,656 (SC MRD). The comparison breaks down when looking at pounds landed: 8,861 (MRFSS) compared to 4,740 (SC MRD) (Low 2001).

[1] Total economic impact refers to the economic stimuli (business and financial activity) provided by non-residents fishing in a given state. It is the sum of direct, indirect, and induced economic impacts.

[2] FTE represents full-time equivalent jobs.

[3] Total economic importance refers to the combined economic stimuli provided by resident & non-resident expenditure combined.

Table 18. Estimated economic impacts and importance of anglers targeting red drum, 1999 (Southwick Associates 2001).

		Economic Impacts						Economic Importance					
Florida	Mode	Total Sales (Output)	Income	Jobs	State Sales Tax Revenues	State Income Tax Revenues	Federal Income Tax Revenues	Total Sales (Output)	Income	Jobs	State Sales Tax Revenues	State Income Tax Revenues	Federal Income Tax Revenues
	Shore	$ 25,501,103	$ 7,271,664	349	$ 824,871	$ 0	$ 737,347	$ 98,679,083	$ 28,138,434	1,352	$ 3,191,920	$ 0	$ 2,853,237
	Charter	14,220,969	4,055,123	195	459,998	0	411,189	21,704,312	6,189,005	297	702,058	0	627,565
	Priv/Rent	70,019,834	19,966,222	960	2,264,894	0	2,024,574	2,079,504,023	592,972,545	28,500	67,264,615	0	60,127,401
	Total	109,741,905	31,293,008	1,504	3,549,763	0	3,173,110	2,199,887,418	627,299,984	30,149	71,158,593	0	63,608,203
Georgia	Shore	141,957	38,937	2	2,779	1,686	3,999	453,054	124,269	6	8,870	5,379	12,764
	Charter	7,775	2,133	0	152	92	219	363,504	99,706	5	7,117	4,316	10,241
	Priv/Rent	76,864	21,083	1	1,505	913	2,165	22,113,380	6,065,498	299	432,928	262,560	623,007
	Total	226,596	62,153	3	4,436	2,690	6,384	22,929,938	6,289,472	310	448,914	272,255	646,012
North	Shore	15,391,028	4,270,120	232	322,503	157,709	394,827	39,226,466	10,883,075	591	821,949	401,947	1,006,279
Carolina	Charter	45,089	12,510	1	945	462	1,157	101,043	28,034	2	2,117	1,035	2,592
	Priv/Rent	4,412,602	1,224,242	67	92,461	45,215	113,197	41,872,466	11,617,186	631	877,393	429,060	1,074,158
	Total	19,848,719	5,506,871	299	415,909	203,386	509,181	81,199,974	22,528,295	1,224	1,701,460	832,042	2,083,029
South	Shore	2,289,403	628,935	37	62,361	17,145	59,972	6,547,469	1,798,693	105	178,345	49,032	171,515
Carolina	Charter	2,168,911	595,834	35	59,079	16,242	56,816	3,460,901	950,764	55	94,271	25,917	90,661
	Priv/Rent	2,968,184	815,407	48	80,850	22,228	77,754	142,127,417	39,044,655	2,277	3,871,385	1,064,343	3,723,121
	Total	7,426,498	2,040,177	119	202,280	55,614	194,542	152,135,786	41,794,112	2,438	4,144,001	1,139,293	3,986,297
Virginia	Shore	948,120	263,752	13	16,725	8,996	26,654	2,623,849	729,912	35	46,286	24,895	73,763
	Charter	0	0	0	0	0	0	0	0	0	0	0	0
	Priv/Rent	2,869,417	798,225	39	50,618	27,225	80,667	17,994,288	5,005,718	242	317,426	170,727	505,865
	Total	3,817,538	1,061,977	51	67,343	36,220	107,321	20,618,137	5,735,630	278	363,711	195,622	579,628
Total	All Modes	137,243,719	38,902,209	1,925	4,172,398	261,691	3,883,217	2,456,153,117	697,911,863	34,121	77,452,969	2,243,590	70,322,541

The NMFS Southeast Fishery Science Center has conducted the Southeast Headboat Survey since 1972. However, this survey monitors primarily offshore headboats where the harvest of red drum is negligible.

1.3.4 Subsistence Fishing

No information on subsistence fishing for red drum was available at the time Amendment 2 was developed.

1.3.5 Non-Consumptive Factors

Non-consumptive considerations include non-consumptive use values and non-use values. Consumptive use values are associated with capture fisheries including catch-release fishing while non-consumptive use values are usually associated with "eco-tourism." A field trip to view the schooling of juvenile red drum in their estuarine habitat or a fish-watching hobbyist visiting an aquarium to watch large adult red drum in a tank are examples of activities that generate non-consumptive use value related to red drum. In contrast, "non-users" may also derive benefits of some part of the environment, such as red drum, based upon the knowledge that actions have been or will be taken to enhance and/or preserve a portion of the environment (Russell 2001). Economists also divide non-use value into two categories, bequest value and "pure" existence value. As the name implies, bequest value is based upon concern for future generation use or non-use of natural resources while existence value is oriented toward current generations. Consequently, total value (TV) of a resource from an economic perspective can be categorized into the three components as adapted from Hanley & Spash (1993):

$$TV = CS + XV + BV$$

where CS is consumer surplus (i.e. use value) including expected CS, XV is existence value, and BV is bequest value. Estimating total value and/or component values can be problematic, but in general, these values can be estimated two major methods. The indirect methods attempt to analyze markets or other behavioral information (e.g. fishing access site selection by anglers) in order to estimate willingness to pay (WTP) and/or willingness to accept (WTA) changes in environmental quality like catch and retention rates (Russell 2001). Random Utility Models or RUMs (see *Section 1.3.4*) are one example of an indirect method, which can be used to estimate changes in consumer surplus related to red drum fishing. In contrast, the direct method is limited to one methodology, the Contingent Valuation Method (CVM). CVM is based upon directly asking a relevant sample of consumers, not necessarily users of a resource, carefully constructed hypothetical questions about environment goods (e.g. red drum) in order to estimate WTP or WTA related to changes in a portion of the environment (Russell 2001). Both approaches have strengths and weaknesses, but the CVM approach is the only method for estimating nonuse values (Hanley & Spash 1993).

Pace (1995) estimated the total value of stocking or "enhancing" red drum stocks (See *Section 1.5.4* for the cost-benefits aspects of red drum stocking) in South Carolina (SC) by surveying a sample of SC anglers and respondents in sample of all SC households using a CVM oriented mail questionnaire in 1994. Pace (1995) pooled angler and non-angler household, but the weighting of the sample results are skewed toward many of the non-angler respondents which have little or no interest in recreational fishing or other uses (e.g. "fish watching"). Consequently, it is assumed that their responses are a rough approximation of nonuse values (benefits) related to stocking red drum in South Carolina. Pace (1995) reported that the average, annual WTP per household (1994 dollars) was $1.73 for red drum stocking with annual aggregate value of about $2.2 million based on total SC households in 1994. The average of the WTP value seems reasonable because it has similar magnitude as reported by Haab *et al*. (2000) for

red drum anglers as approximated using RUMs. Regardless, the preservation and enhancement of red drum stocks can also generate benefits for non-users, not just anglers.

1.3.6 Interactions with Other Fisheries, Species, or Users

No information was available at the time Amendment 2 was developed.

1.4 HABITAT CONSIDERATIONS

1.4.1 Description of Habitat Important to the Stocks

1.4.1.1 Spawning Habitat

Early studies led investigators to conclude that red drum spawned in nearshore areas in the vicinity of inlets and passes throughout their range (Pearson 1929; Miles 1950; Simmons and Breuer 1962; Yokel 1966; Jannke 1971; Setzler 1977; Music and Pafford 1984; Holt *et al*. 1985). However, evidence now suggests that red drum also utilize high-salinity estuarine areas along the coast (Murphy and Taylor 1990; Johnson and Funicelli 1991; Nicholson and Jordan 1994; Woodward 1994). These expansive areas offer adequate conditions for survival of eggs and larvae and favorable circulation patterns that help transport larvae to suitable nursery areas (Ross and Stevens 1992). Red drum spawning has been documented from nearshore waters, in the vicinity of passes and inlets and inside estuaries such as Pamlico Sound and Mosquito Lagoon (Murphy and Taylor 1990; Wenner *et al*. 1990; Johnson and Funicelli 1991; Ross and Stevens 1992; Ross *et al*. 1995).

1.4.1.2 Eggs and Larvae Habitat

Nelson *et al*. (1991) reported red drum eggs to be commonly encountered in several southeastern estuaries, in salinities above 25 ppt. Indeed, laboratory experiments in Texas (Neill 1987; Holt *et al*. 1981) established that optimum temperature and salinity for hatching and survival of red drum larvae are 25^{o} C and 30 ppt, respectively. The spatial distribution and relative abundance of eggs in estuaries, as expected, mirrors that of spawning adults (Nelson et. al. 1991) and eggs and early larvae utilize high salinity waters inside inlets and passes and in the estuary proper. In Florida, Johnson and Funicelli (1991) collected viable red drum eggs in Mosquito Lagoon, Florida, in average daily water temperatures of 20-25^{o} C and average salinities of 30-32 ppt. The largest number of eggs collected during the study was in depths ranging from 1.5 to 2.1 m and highest concentrations of eggs were found at the edge of the channel.

Upon hatching, red drum larvae are pelagic (Johnson 1978) and evidence from laboratory studies indicates that development is temperature-dependent (Holt *et al*. 1981). They make the transition between pelagic and demersal habitats upon reaching the nursery grounds (Pearson 1929; Peters and McMichael 1987; Comyns *et al* 1991; Rooker and Holt 1997). Then they may utilize tidal currents (Setzler 1977; Holt *et al*. 1989) or density-driven currents (Mansueti 1960) to attain low-salinity nurseries in the upper reaches of estuaries (Mansueti 1960; Bass and Avault 1975; Setzler 1977; Weinstein 1979; Holt *et al*. 1983b; Holt *et al*. 1989; Peters and McMichael 1987; McGovern 1986; Daniel 1988). Once in the nurseries, red drum larvae grow rapidly and evidence suggests that red drum may select nursery areas based on the presence of environmental conditions that contribute to rapid growth (Baltz *et al* 1998).

Red drum larvae along the Atlantic coast are reportedly common in most major southeastern estuaries, with the exception of Albemarle Sound, and they are abundant in the St. Johns and Indian River estuaries, Florida (Nelson *et al*. 1991). Data on the spatial distribution of red drum larvae in the Gulf of Mexico has been summarized by Mercer (1984).

More recently, Lyczkowski-Shultz and Steen (1991) reported evidence of diel vertical stratification among red drum larvae found in depths < 25 m at both offshore and nearshore locations. Larvae (1.7-5.0 mm mean length) were found at depth during the night and higher in the water column during the day. At the time of this study, water was well mixed and temperature ranged between approximately 26-28^{o} C. No consistent relationship between the distribution of larvae and tidal stage was detected.

1.4.1.3 Juvenile Habitat

Juvenile red drum utilize a variety of inshore habitats throughout their range including tidal freshwater habitats, low-salinity reaches of estuaries, estuarine emergent vegetated wetlands, estuarine scrub/shrub, submerged aquatic vegetation, oyster reefs, shell banks, and unconsolidated bottom (SAFMC 1998b). In general, juvenile red drum are found throughout southeastern estuaries in all the habitat types described above. In the Chesapeake Bay, juveniles (20-90 mm TL) were collected in shallow waters from September to November, but no indication as to the characteristics of the habitat was given (Mansueti 1960). According to Nelson *et al*. (1991), southeastern estuaries where juveniles (including subadults) are abundant are Bogue Sound, NC; Winyah Bay, SC; Ossabaw Sound, and St. Catherine/Sapelo Sound, GA; and the St. Johns River, FL. They are highly abundant in the Altamaha River and St. Andrew/St. Simon Sound, GA, and the Indian River, FL.

North Carolina Division of Marine Fisheries (NCDMF) surveys of juvenile red drum indicate juvenile red drum were consistently abundant in shallow waters (<5 feet) near the mouths of the Pamlico and Neuse Rivers and in smaller bays and rivers between them. In general, habitats supporting juvenile red drum in North Carolina can be characterized as detritus or mud-bottom tidal creeks in western Pamlico Sound and mud or sand bottom habitat in other areas (Ross and Stevens 1992). Within SAV beds, investegations have shown juveniles to prefer areas with patchy grass coverage over sites with homogeneous vegetation (Mercer 1984, Ross and Stevens 1992, Rooker and Holt 1997). Also in an Texas estuary, young red drum (6-27 mm SL) were never present over non-vegetated muddy-sand bottom; highest densities occurred in the ecotone between seagrass and non-vegetated sand bottom (Rooker and Holt 1997).

1.4.1.4 Subadult Habitat

Red drum begin the subadult phase of their life cycle upon leaving the shallow nursery habitat at approximately 200 mm TL (10 months of age). It is at this stage in their life cycle that red drum utilize a variety of habitats within the estuary and when they are most vulnerable to exploitation (Pafford *et al*. 1990; Wenner 1992). Tagging studies conducted throughout the species' range indicate that most subadult red drum tend to remain in the vicinity of a given area (Beaumarriage 1969; Osburn *et al* 1982; Music and Pafford 1984; Wenner *et al*. 1990; Pafford *et al* 1990; Ross and Stevens 1992; Woodward 1994; Marks and DiDomenico 1996). Movement within the estuary is most likely related to changes in temperature and food availability (Pafford *et al*. 1990; Woodward 1994).

During 1994 and 1995, the Inshore Fisheries Section of the South Carolina DNR conducted several aerial surveys to attempt to evaluate abundance and habitat utilization of subadult red drum along the South Carolina coast. Aerial surveys were generally deemed inefficient at estimating the number of fish inhabiting particular areas, especially inlets and beachfront areas because the visibility of schools from the air depends on the interplay of temporal, climactic, topographic and behavioral factors. On the occasions when red drum schools were reliably located, they were found in flats at the confluence of rivers, inside inlets, creeks, sounds and bays. Aerial surveys proved useful to characterize the general topography of subadult red drum habitat in the intertidal and shallow-subtidal portions of the coast. It appears that typical habitats where subadult red drum are found in South Carolina are of two general

types. In the northern portion of the coast, typical subadult habitat consists of broad (up to 200 m or more in width), gently sloping flats often leading to the main channel of a river or sound. Along the southern portion of the coast, subadult red drum habitat consists of more narrow (50 m or less), fairly level flats traversed by numerous small channels, typically 5-10 m wide by less than 2 m deep at low tide).

1.4.1.5 Adult Habitat

Along the Atlantic Coast adult red drum migrate North and inshore in the spring. In the fall, they migrate offshore and south. Overall, adults tend to spend more time in coastal waters after reaching sexual maturity. However, they do continue to frequent inshore waters on a seasonal basis. Less is known about the biology of red drum once they reach the adult stage and accordingly, there is a lack of information on habitat utilization by adult fish. The SAFMC's Habitat Plan (SAFMC 1998b) cited high salinity surf zones and artificial reefs as essential fish habitat (EFH) for red drum in oceanic waters, which comprise the area from the beachfront seaward. In addition, nearshore and offshore hard/live bottom areas have been known to attract concentrations of red drum. The following description of these habitats was adapted from that provided in the SAFMC's Habitat Plan (1998b).

Hard bottom, also called live bottom (Struthsaker 1969), is a grouping of coral habitats characterized by a thin layer of live corals and other biota superimposed on different sediment types, relic reefs or rocky outcrops. The coral assemblages in this type of habitat vary according to geographical area. On the South Atlantic coast, however, coral communities are dominated by ahermatypic species (gorgonians, Oculina). In the SAB, hard/live bottom habitats are often relatively small areas scattered over the continental shelf north of Cape Canaveral, FL. They are most numerous off northeastern Florida. Most occur at depths greater than 27 m, but they are also found inshore at depths less than 27 m off the coasts of North and South Carolina. Bottom water temperatures in deeper hard/live bottom areas range from approximately 11-27^{o} C whereas inshore areas typically exhibit cooler temperatures. Data are part of SEAMAP's South Atlantic Bottom Mapping Work Group effort, which began in 1992.

Besides natural hard/live bottom habitats, red drum also utilize artificial reefs and other man-made structures. Currently, approximately 120,000 acres (155 nm^2) of ocean and estuarine bottom along the south Atlantic have been permitted for the development of artificial reefs. Artificial reefs are considered hard/live bottom and were included in SEAMAP's bottom mapping project. Most Atlantic states have established, or are in the process of developing, artificial reef management programs.

Nicholson and Jordan (1994) found adult red drum from late November until the following May at natural and artificial reefs along tide rips or associated with the plume of major rivers in Georgia. Data from this study suggested high seasonal fidelity to a specific area. Fish that were tagged in the fall along shoals and beaches were relocated 9-22 km offshore during winter months and back at the original capture site in the spring. In the summer, fish moved up the Altamaha River as far as 20 km to what the authors refer to as "pre-spawn staging areas" and returned to the same shoal or beach again in the fall.

1.4.2 Identification and Distribution of Habitat and Habitat Areas of Particular Concern

Habitat Areas of Particular Concern (HAPCs) are defined by the Atlantic States Marine Fisheries Commission as areas within the species habitat which satisfy one or more of the following criteria: (1) provide important ecological function, (2) are sensitive to human-induced environmental degradation, (3) are susceptible to coastal development activities, or (4) are considered to be rarer than other habitat types. For red drum, this includes the following habitats: tidal freshwater, estuarine emergent vegetated wetlands (flooded saltmarshes, brackish marsh, and tidal creeks), estuarine scrub/shrub (mangrove

fringe), submerged rooted vascular plants (sea grasses), oyster reefs and shell banks, unconsolidated bottom (soft sediments), ocean high salinity surf zones, and artificial reefs. The South Atlantic Fisheries Management Council (SAFMC) which has a similar designation for their HAPCs has recognized HAPCs for red drum along the U.S. coast including all coastal inlets, all state-designated nursery habitats (i.e. Primary Nursery Areas in North Carolina), sites where spawning aggregations of red drum have been documented and spawning sites yet to be identified, and areas supporting submerged aquatic vegetation (SAV). The SAFMC (1998b) also cited barrier islands off the South Atlantic states as being of particular importance since they maintain the estuarine environment in which young red drum develop. Passes between barrier islands are of concern because the productivity of the estuary depends on the slow mixing of fresh and seawater that occurs in these areas. Finally, inlets, channels, sounds and outer bars are of particular importance to red drum since spawning activity is known to occur in these areas throughout the South Atlantic. Moreover, subadult and adult red drum utilize these areas for feeding and daily movements.

As previously mentioned, evidence suggests that spawning occurs within passes and inlets and inside high salinity estuaries of the southeast U.S. coast. Hence, all such geographic features throughout the red drum's range constitute potential spawning habitat and are of critical importance to the species' survival. Specific areas of the Atlantic coast where red drum spawning is currently known to take place are: North Carolina - waters of Pamlico Sound near Hatteras, Ocracoke and Drum Inlets and between the Neuse and Pamlico rivers in the western portion of the sound; South Carolina - main channel leading to Charleston Harbor and estuarine waters of St. Helena Sound; Georgia - the Altamaha River estuary; Florida - Ponce de Leon inlet and the Mosquito Lagoon system.

A species' primary nursery areas are indisputably essential to its continuing existence. Primary nursery areas for red drum can be found throughout estuaries, usually in shallow waters of varying salinities that offer certain degree of protection. Such areas include coastal marshes, shallow tidal creeks, bays, tidal flats of varying substrate, tidal impoundments, and seagrass beds. Since red drum larvae and juveniles are ubiquitous in such environments, it is impossible to designate specific areas as deserving more protection than others. Moreover, these areas are not only primary nursery areas for red drum, but they fulfill the same role for numerous other resident and estuarine-dependent species of fish and invertebrates.

Similarly, subadult red drum habitat extends over a broad geographic range and adheres to the criteria that define HAPCs. Subadult red drum are found throughout tidal creeks and channels of southeastern estuaries, in backwater areas behind barrier islands and in the front beaches during certain times of the year. Therefore, the estuarine system as a whole, from the lower salinity reaches of rivers to the mouth of inlets, is vital to the continuing existence of this species.

1.4.2.1 SAFMC EFH Designations for Red Drum

The South Atlantic Fishery Management Council recognizes several habitats as Essential Fish Habitat (EFH) for red drum. These natural communities include tidal freshwater, estuarine emergent vegetated wetlands (flooded salt marsh, brackish marsh, and tidal creeks), estuarine scrub/shrub (mangrove fringe), submerged rooted vascular plants (seagrass), oyster reefs and shell banks, unconsolidated bottom (soft sediment), ocean high salinity surf zones, and artificial reefs (SAFMC 1998b). The area covered ranges from Virginia through the Florida Keys, to a depth of 50 m offshore.

1.4.2.2 SAFMC HAPC Designations for Red Drum

Of the designated EFH, Habitat Areas of Concern (HAPC) have been recognized for red drum by the SAFMC. Areas which meet the criteria for HAPC include all coastal inlets, all state-designated nursery habitats of particular importance to red drum, documented sites of spawning aggregations from North Carolina to Florida, other spawning areas identified in the future, and areas supporting submerged aquatic vegetation (SAV) (SAFMC 1998b). These HAPC include the most important habitats required during the life cycle of the species, including spawning areas and nursery grounds. Other areas of concern are barrier islands, since these geological formations are vital to maintain estuarine conditions needed by larval and juvenile stages. Inlets between barrier islands are also very important, as the slow mixing of seawater and freshwater is critical to the ecological functioning of an estuary, including maintenance of salinity and current regimes and the creation of sandy shoals. Unnatural or human-induced changes that reduce or increase flow into estuaries may result in environmental stress in organisms (SAFMC 1998b).

1.4.3 Present Condition of Habitat and Habitat Areas of Particular Concern

1.4.3.1 Coastal Spawning Habitat: Condition and Threats

It is reasonable to assume that areas where coastal development is taking place rapidly, habitat quality may be compromised. Coastal development is a continuous process in all states and all coastal areas in the nation are experiencing significant growth. The following section describes particular threats to the nearshore habitats in the South Atlantic that are either documented areas of spawning activity for red drum or meet the characteristics of suitable spawning habitat.

The most conspicuous threat to the spawning habitat for red drum is navigation and related activities such as dredging and hazards associated with ports and marinas. According to the SAFMC (1998b), impacts from navigation related activities on habitat include direct removal/burial of organisms from dredging and disposal of dredged material, effects due to turbidity and siltation; release of contaminants and uptake of nutrients, metals and organics; release of oxygen-consuming substances, noise disturbance, and alteration of the hydrodynamic regime and physical characteristics of the habitat. All of these impacts have the potential to substantially decrease the quality and extent of red drum spawning habitat.

Besides creating the need for dredging operations that directly and indirectly affect spawning habitat for red drum, ports also present the potential for spills of hazardous materials. The cargo that arrives and departs from ports includes highly toxic chemicals and petroleum products. Although spills are rare, constant concern exists since huge expanses of productive estuarine and nearshore habitat are at stake. Additional concerns related to navigation and port utilization are discharge of marine debris, garbage and organic waste into coastal waters. Impacts from these activities are most conspicuous and thus better documented in estuarine waters and are described in the next section. The extent to which such activities may impact coastal spawning habitat for red drum is unknown.

Maintenance and stabilization of coastal inlets is of concern in certain areas of the southeast. Studies have implicated jetty construction to alterations in hydrodynamic regimes thus affecting the transport of larvae of estuarine-dependent organisms through inlets (Miller *et al*. 1984; Miller 1988).

1.4.3.2 Estuarine Spawning, Nursery, Juvenile and Subadult Habitat: Condition and threats

Coastal wetlands and their adjacent estuarine waters constitute primary nursery, juvenile and sub-adult habitat for red drum along the coast. Between 1986 and 1997, estuarine and marine wetlands nationwide experienced an estimated net loss of 10,400 acres. However, the rate of loss was reduced over 82% since the previous decade (Dahl 2000). Most of the decline resulted from urban and rural activities and the

conversion of wetlands for other uses. Along the southeast Atlantic coast, the state of Florida experienced the greatest loss of coastal wetlands due to urban or rural development (Dahl 2000). However, the loss of estuarine wetlands in the southeast has been relatively low over the past decade although there is some evidence that invasion by exotic species, such as Brazilian pepper (*Schinus terebinthifolius*), in some areas could pose potential threats to fish and wildlife populations in the future (T. Dahl, pers. comm.).

Throughout the coast, the condition of red drum estuarine habitat varies according to location and the level of urbanization. In general, it can be expected that estuarine habitat adjacent to highly developed areas will exhibit poorer environmental quality than more distant areas. Hence, environmental quality concerns are best summarized on a watershed level.

Threats to estuarine habitats of the southeast are numerous. The SAFMC (1998b) included a comprehensive summary of threats to Essential Fish Habitat (EFH) in the Habitat Plan for the South Atlantic Region. The following sections are based largely on information presented in the latter and include specific information on immediate threats to particular regions as well as the EPA's vulnerability assessment of coastal watersheds.

Nutrient enrichment of estuarine waters throughout the southeast is a major threat to the quality of estuarine habitat available to red drum. Forestry practices contribute significantly to nutrient enrichment in the southeast. Areas involved are extensive and many are in proximity to estuaries. Urban and suburban development are perhaps the most immediate threat to red drum habitat in the southeast. The almost continuous expansion of ports and marinas in the South Atlantic poses a threat to aquatic and upland habitats. Certain navigation-related activities are not as conspicuous as port terminal construction but have the potential to significantly impact the estuarine habitat upon which red drum depend. Activities related to watercraft operation and support pose numerous threats including discharge of pollutants from boats and runoff from impervious surfaces, contaminants generated in the course of boat maintenance, intensification of existing poor water quality conditions, and the alteration or destruction of wetlands, shellfish and other bottom communities for the construction of marinas and other related.

Estuarine habitats of the southeast can be negatively impacted by hydrologic modifications. The latter include activities related to aquaculture, mosquito control, wildlife management, flood control, agriculture and silviculture. Also, ditching, diking, draining and impounding activities associated with industrial, urban and suburban development qualify as hydrologic modifications that may impact the estuarine habitat. Alteration of freshwater flows into estuarine areas may change temperature, salinity and nutrient regimes as well as alter wetland coverage. Studies have demonstrated that changes in salinity and temperature can have profound effects in estuarine fishes (Serafy *et al*. 1997) and that salinity partly dictates the distribution and abundance of estuarine organisms (Holland *et al*. 1996). Hence, red drum are probably as susceptible as any other estuarine organism to such changes in the physical regime of their environment.

1.4.3.3 Adult Habitat: Condition and Threats

Threats to the red drum's adult habitat are not as numerous as those faced by postlarvae, juveniles and subadults in the estuary and coastal waters. According to the SAFMC (1998b), threats to the nearshore and offshore habitats that adult red drum utilize in the South Atlantic include navigation and related activities, dumping of dredged material, mining for sand and minerals, oil and gas exploration and commercial and industrial activities.

Offshore mining for minerals may pose a threat to red drum habitat in the future. Currently, there are no mineral mining activities taking place in the South Atlantic. However, large phosphate deposits have recently been discovered off North Carolina.

A more immediate threat is the mining for sand for beach nourishment projects. Associated threats include burial of bottoms near the mine site or near disposal sites, release of contaminants directly or indirectly associated with mining (i.e. mining equipment and materials), increase in turbidity to harmful levels, and hydrologic alterations that could result in diminished desirable habitat.

1.4.4 Ecosystem Considerations

No information was available at the time Amendment 2 was developed.

1.5 IMPACTS OF THE FISHERY MANAGEMENT PLAN

1.5.1 Biological and Environmental Impacts

Adoption of more stringent state-level management measures to meet the management goal of Amendment 2 should initially decrease the mortality of sub-adult red drum and increase escapement into the adult population. This increased level of escapement will promote rebuilding of the adult populations on the Atlantic coast which in theory, should result in increased recruitment, fueling the rebuilding process. A rebuilt adult population will lead to a stable adult age structure and reduce the risk of poor recruitment events influenced by environmental factors.

1.5.2 Social Impacts

No information was available for each of these topics at the time Amendment 2 was developed.

1.5.2.1 Recreational Fishery

1.5.2.2 Commercial Fishery

1.5.2.3 For-Hire Fisheries

1.5.2.4 Subsistence Fishery

1.5.2.5 Non-consumptive Factors

1.5.3 Economic Impacts

It is obvious that regulatory regimes in the Atlantic states have been oriented toward allowing or allocating consumptive use of red drum by recreational anglers (SAFMC 1990b). From an economic perspective, the allocation of common property resources such red drum at the Federal level is based upon the incremental allocation of the resource to their highest valued use. This allocation approach is supposed to be done based on changes in net economic benefits using cost and benefit analysis techniques (NMFS 2000a). Estimating changes in producer and consumer surplus associated with different management actions play a critical role if such estimates are available. At the state level, economic impacts of expenditures by non-resident recreational anglers vs. in-state commercial fishing businesses might be considered as "...acceptable measures of cost/benefit tradeoffs because loss of expenditures represent real losses from the state perspective..." (SAFMC 1990b). Given this generalization, the economic impacts of red drum recreational anglers at the state-level will be presented, but the usefulness of economic impact information is limited. First, the ASMFC is oriented toward both regional and national needs, consequently, changes in net economic value due to regional management targets may approximate the Federal perspective. Even in the absence of the ASMFC regional orientation, red drum angler consumer surplus may be more sensitive to regulatory actions (e.g. decreasing the bag limit from 5 to 2 fish) than overall expenditures by red drum anglers.

1.5.3.1 Recreational Fishery

With the caveats noted in *Section 1.5.3*, expenditures by recreational anglers targeting red drum are germane to regulatory actions to state and local economies. Southwick Associates (2001) estimated the economic impacts and importance of recreational red drum anglers using estimated total (aggregate) expenditures (Table 16). A difference is made between economic impacts and importance (Steinback 1999). Economic impacts refer to the economic stimuli provided by non-residents fishing in a given state. Economic importance refers to the combined stimuli provided by resident and non-resident expenditures. This dichotomy is important because expenditures by the nonresidents are usually considered to be new income or an "export" for a state, whereas the money from residents1 is essentially a redistribution of income of state residents. Economic impact analysis focuses on the net change in an economy brought about by a certain activity or projected changes in a given activity. For example, if the level of resident expenditures were to decrease, much of the money is assumed to be spent elsewhere in the state economy, effecting little net change in the income of the state. If, however, the nonresidents visiting a given state decreased the amount of money they spent on saltwater fishing, there would be a net loss of that income to an individual state. Of course, the loss would be minimal if nonresidents found a substitute activity in the state.

In contrast, the total expenditures by all anglers including residents of the region are still a measure of the level of the activity in the state and are also important in policy decisions concerning the total participation in the activity. For example, if a policy is proposed to stimulate the participation by nonresidents based on the results of an economic impact study, the decision makers need to consider the current total participation and the ability of the coastal communities to support an expansion while serving local participants. In addition, resident expenditures may have a significant effect on the distribution and magnitude of income, employment, and sales in the economy. Therefore, an analysis of impacts by resident anglers in the coastal region and state is still important to documenting the economic interdependence of businesses linked to recreational saltwater fishing activities in the region. An economic impact analysis addresses market transactions resulting from the use of a resource. Economic value or consumer surplus, on the other hand, is a non-market measure that estimates the value people receive from an activity after subtracting for their costs and expenditures. This concept is also known as consumer surplus.

There are three types of economic impacts: direct, indirect and induced (Southwick Associates 2001). A direct impact is defined as the economic impact of the initial purchase made by the consumer. For example, when a person buys a fishing rod for $50, there is a direct impact for the retailer, and the economy of $50. Indirect impacts are the secondary effects generated from a direct impact. Indirect impacts indicate that sales in one industry affect not only that industry, but also the industries that supply the first industry. For example, the retailer must purchase additional rods plus pay other costs such as electricity, rent, etc.; the rod manufacturer must purchase additional plastics and metals for production; plastics manufacturers must buy resins, and so on. Therefore, the original expenditure of $50 for the rod benefits a host of other industries. An induced impact results from the wages and salaries paid by the directly and indirectly impacted industries. The employees of these industries spend their income on various goods and services. These expenditures are induced impacts which, in turn, create a continual cycle of indirect and induced effects.

The sum of the direct, indirect and induced impact effects is the total economic impact of the activity under study. As the original retail purchase (direct impact) goes through round after round of indirect and induced effects, the economic impact of the original purchase is multiplied, benefitting many industries and individuals. Likewise, the reverse is true. If a particular item or industry is removed from

the economy, the economic loss is greater than the original retail sale. Once the original retail purchase is made, each successive round of spending is smaller than the previous round until the measurement of each round becomes impractical.

The estimated total sales effects of recreational anglers targeting red drum for the four state ranging from Virginia to Florida was $137.2 million for non-resident anglers (i.e. economic impact of sales) with an economic importance effect of $2.46 billion in sales (Table 18). Total income and job effects were $38.9 million and over 1,925 jobs, respectively, and $697.9 million sales and 34,121 jobs when non-resident and resident effects are combined (Table 18).

The economic impacts and importance of the recreational fisheries for red drum in the South Atlantic states is obviously substantial. Regulatory actions (e.g. smaller bag limits in certain states) to sustain the future beneficial effects of angler expenditures need to be taken. Valuation studies (e.g. Haab *et al.* 2000) indicate that more stringent regulatory actions could decrease the short-term non-market value (i.e. consumer surplus) of red drum fishing trips. Factors mitigating the decline in value include anglers that normally catch and retain fewer fish than limited by current or proposed bag limits, anglers switching to other species, and/or catch and release preferences, not retention, may dominate the value of red drum fishing for some anglers. Given these factors, the long-term sustainable benefits associated with more stringent recreational fishing regulations will most likely more than compensate for short-term losses, especially losses that accrue to a limited number of anglers that only specialize in catching and retaining more than one or two red drum on a trip. Moreover, the potential for further expansion in total saltwater fishing effort (Milon 2000) in Southeast U.S. reinforces the need to take regulatory actions to buffer future growth in red drum fishing effort so the consumptive oriented economic benefits of red drum recreational fishing can be sustained for future generation.

1.5.3.2 Commercial Fishery

The total ex-vessel value of the commercial red drum fisheries in the Atlantic states has historically been inconsequential relative to other commercial fisheries. For example, even when the total annual (nominal) ex-vessel value of reported red drum landings in the Atlantic states was at a record high, about $412,000, in 1999 (Table 8), this red drum total value was less than 0.1% of the total ex-vessel value, about $1.21 billion, of all species landed in the Atlantic states in 1999 (NMFS 2001a). Even in the state of North Carolina when the highest total ex-vessel value of red drum landings was recorded in the same year, this red drum value was only 0.4% of the total ex-vessel landings in North Carolina. Moreover, given this small percentage of North Carolina fisheries value, the economic impacts (e.g. sales, income, jobs, etc.) of the commercial red drum harvest also would be minor in the aggregate.

Although the aggregate economic impact of the commercial red drum harvest is very minor in North Carolina and other Atlantic states, red drum harvesting can apparently constitute an important source of revenue for a few fishermen. In North Carolina, for instance, red drum catches comprised 39% or more of gross revenues generated by all species sold by 8 license holders during 1998. In addition, gross revenues from red drum sales represented 15% or more of the gross revenues of all species sales by commercial anglers. However, this group was only comprised of 14 license holders or about 2% of all North Carolina license holders (NCDMF 2001).

According to Edwards (1991), the efficient allocation of a natural resource, such as red drum, in order to maximize net economic value is probably not reached by allocating all of the resource to a given user group. With the minor exception of North Carolina, red drum fisheries in the South Atlantic states are dominated by one user group, recreational anglers, due to the regulatory regime by individual states.

Whether the allocative effects of these regimes are maximizing net value from an economic perspective appears to be a moot point. Due to over-fishing risks associated with commercial fishing (SAFMC 1990b) and other considerations, individual states have selected recreational fishing as the mode of consumption[1] for their wild red drum resources as influenced by the collective policy making process of the ASMFC.

It is worth noting that North Carolina has considered the economic effects of placing additional constraints on the commercial fishing oriented by-catch of red drum (NCDMF 2001), but still opted for more stringent commercial regulations. A preliminary, incremental analysis of angler consumer surplus vs. commercial fisheries oriented producer surplus indicates that this approach for North Carolina is apparently reasonable from an economic perspective (J. Whitehead, personal communication).

1.5.3.3 For-Hire Fisheries

No information was available at the time Amendment 2 was developed.

1.5.3.4 Subsistence Fishery

No information was available at the time Amendment 2 was developed.

1.5.3.5 Non-Consumptive Factors

From an economic perspective, non-consumptive considerations include non-consumptive use values and non-use values. Eco-tourism activities that include the viewing of red drum in their natural habitat would obvious benefit from the management objectives in this plan. In addition, there are non-use values associated with preserving red drum stocks and these values at the state level maybe of similar magnitude, about $2 million per year (1994 dollars), as the estimated aggregate gross value associated with stocking red drum (see *Section 1.3.5*). In contrast, degradation of red drum stocks, especially by consumptive users such as recreational anglers, will reduce associated non-use values, and perhaps negatively impact the general public's valuation of state and regional fishery management institutions to effectively preserve common property resources under their jurisdiction. Stated another way, maintaining the sustainability of red drum resources clearly extends about the benefits accruing to just consumptive user groups even if management institutions are compelled to focus on reducing the impact of these user groups.

1.5.4 Other Resource Management Efforts

There is no doubt that fish stocking, whether used to restore a declining population and/or increase the availability of "catchable" fish, is a controversial fishery management tool (e.g. Travis *et al*. 1998). Using cost-benefit or cost effectiveness techniques to evaluate this tool has probably "enhanced" its controversy. With this in mind, cost-benefit analysis of stocking red drum in South Carolina based upon the extrapolation of pilot studies indicates that projected economic benefits could exceed costs for most reasonable stocking scenarios. A 1994 analysis by the University of South Carolina (Pace 1995) estimated that the net present value of stocking 500,000 4-inch fish would be about $12.8 million (1994 dollars) over a 15-year period based upon a discount rate of 12.5%. A recent revision of the 1994 analysis based on annually stocking 5 million, 25-mm (one inch) red drum fingerlings and a more conservative analysis approach (e.g., ten year projection period, estimating benefits in 1994 dollars and costs in 2001 dollars, etc.) indicated that the 10-year net present value was still positive, $12,000, even for the highest discount rate, 16%, and lowest estimated benefit level, benefits in 1994 dollars.

[1] Catch and release by anglers is still considered a form of consumptive use although the impact on the red drum resource is obviously less damaging than catch and retention.

Moreover, if all benefits and costs are projected in 2001 dollars, the 10-year net present value was about $533,000 at a discount rate of 16%. In summary, deterministic cost-benefit analyses of red drum stocking approaches based upon the South Carolina experience suggests that red drum stocking warrants further consideration as resource management tool for restoring and/or maintaining red drum stocks in the South Atlantic states.

1.5.4.1 Artificial Reef Development/Management

The Georgia Department of Natural Resources is responsible for the development and maintenance of a network of man-made reefs both in estuarine waters and in the open Atlantic Ocean. Funding for the artificial reef program is provided by Federal Aid in Sport Fish Restoration, fishing license revenues, and private contributions. To date, there are 15 reefs within the estuary proper, which are constructed of a variety of materials including concrete rubble, metal cages, and manufactured reef units. These provide habitat for juvenile red drum and several other species of recreationally important fishes. In 2001, three "beach" reefs were constructed in locations within Georgia's territorial waters just off the barrier island beaches. These are experimental in nature, but should provide some habitat for juvenile and adult red drum.

There are 19 man-made reefs in the EEZ ranging from depths of 40 to 130 feet. These reefs are constructed of a variety of materials including surplus vessels, concrete rubble, barges, bridge spans, and manufactured reef units. Both juvenile and adult red drum are known to use these reefs during the autumn and winter months.

1.5.4.2 Bycatch Issues

The Georgia Department of Natural Resources requires the use of bycatch reduction devices (BRDs) and turtle excluder devices (TEDs) in commercial food shrimp and whelk trawlers. Observers are placed onboard commercial food shrimp trawlers, commercial whelk trawlers, commercial bait shrimp trawlers, and with commercial cast netters to collect information on the catch of non-targeted species. Red drum occur very infrequently in the catch of any of the aforementioned gears. The catch of red drum in sport bait trawls and in recreational cast nets is unknown, but suspected to be minimal.

1.5.4.3 Land/Seabed Use Permitting

The Marsh Act and Shore Act, both promulgated in 1976 by the Georgia General Assembly prevent unregulated alteration of estuarine habitat. Consequently, permits are required for any activity that might degrade the physical integrity of the estuary, such as dock construction, dredging, and filling.

1.6 LOCATION OF TECHNICAL DOCUMENTATION FOR AMENDMENT 2

1.6.1 Review of Resource Life History and Biological Relationships

Background information on red drum life history characteristics were taken from the Source Document for the South Atlantic Fishery Management Council's Red Drum Fishery Management Plan (SAFMC 1990b) and updated by South Carolina Department of Natural Resources as part of a final report submitted to the NMFS as part of the contractual obligations for Grant Number NA 77FL0290 awarded by NMFS to SCDNR (Completion date: June 30, 2001; electronic copies available from C.A. Wenner, SCDNR, P.O. Box 12559, Charleston, SC 29422 or via email: wennerc@mrd.dnr.state.sc.us).

1.6.2 Stock Assessment Document

The most recent stock assessment was conducted in 2000, using data up to and including 1998 (Vaughan and Carmichael 2000). Previous assessments were performed in 1989, 1991, 1992 and 1995 (Vaughan and Helser 1990; Vaughan 1992, 1993, 1996).

1.6.3 Social Assessment Document
No information was available at the time Amendment 2 was developed.

1.6.4 Economic Assessment Document
Preliminary estimates on the economic impacts of anglers targeting red drum in Virginia, North Carolina, South Carolina, Georgia and Florida have been made by Southwick Associates (2001). Using data collected by the MRFSS in combination with a 1997 Add-on MRFSS Economic Study, Haab *et al.* (2000) also estimated economic values (e.g. consumer surplus) associated with access to fishing and the quality of marine recreational fishing, including estimates related to anglers catching and retaining red drum in the South Atlantic states.

1.6.5 Law Enforcement Assessment Document
The Commission's Law Enforcement Committee has developed a guidelines document for evaluation of potential management measures in Commission FMPs. This document will be used to provide recommendations to the South Atlantic Board concerning the enforceability of proposed measures.

1.6.6 Habitat Background Document
Habitat materials used in the development of Amendment 2 were adapted from a contract report prepared by the SC DNR as part of the contractual obligations for grant number NA 77FL0290 awarded by NMFS to SC DNR.

2.0 GOALS AND OBJECTIVES

2.1 HISTORY AND PURPOSE OF THE PLAN
2.1.1 History of Prior Management Actions
The Commission adopted a Fishery Management Plan (FMP) for Red Drum in 1984 (ASMFC 1984). The original management unit included the states from Florida to Maryland. In 1988, the Commission's Interstate Fisheries Management Program (ISFMP) Policy Board requested that all states from Florida to Maine implement measures to prevent the development of northern markets for southern fish. This action was the first of two revisions to the original FMP. The second was the adoption of the South Atlantic Council's Red Drum Fishery Management Plan (SAFMC 1990a) as Amendment 1 to the Interstate FMP (ASMFC 1994).

The South Atlantic Council's Red Drum FMP was approved in October 1990 which closed the federal waters to the harvest and possession of red drum. Amendment 1 to the Council's FMP specifies Maximum Sustainable Yield (MSY) at 30% Spawning Potential Ratio (SPR), Optimum Yield (OY) at 40% SPR, and an overfishing level at less than 30% SPR (SAFMC 1998a). Amendment 2 to the Council FMP identified, described and recommended measures to protect Essential Fish Habitat (EFH) and EFH Habitat Areas of Particular Concern for red drum as part of the Council's comprehensive habitat amendment (SAFMC 1998b).

Discussions between the Council's Red Drum Committee and the Commission's South Atlantic Board, led the Council to recommend transferring the regulatory authority of the Secretary of Commerce to the states (through the South Atlantic Board) under the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA 1993; USC sec. 5101, et seq). This action was one factor which necessitated the development of an amendment to the current Commission FMP for red drum. The Management Board's intent has been to initiate the development of a new amendment once the stock assessment was updated,

incorporating the results of the multi-state trammel net survey, along with the most recent fishery-dependent data.

2.1.2 Purpose and Need for Action

Management measures implemented by the states in response to the guidelines set forth in Amendment 1 have led to an increase in the escapement rates of juvenile red drum. However, the overall population remains in an overfished condition with SPR values less than 30% for both the northern and southern regions. These management measures were intended to be an intermediate step in a phased-in approach to recovering the red drum population, with the interim goal being to raise SPR to at least 10%. The Atlantic coast states from Florida through New Jersey have implemented measures to modify harvest regulations and/or commercial quotas to increase escapement of sub-adults (Table 1). Under these regulations, the interim management goal appears to have been met and exceeded to some degree in each region. It is has been expected that additional harvest restrictions would be required to meet the ultimate goal of the FMP.

One of the reasons the Council has recommended transferring management authority to the Commission is the inability to accurately determine stock rebuilding targets and schedules under the new requirements of the revised Sustainable Fisheries Act (1996). Since there is no current estimate of the size of the adult population nor is there an estimate of what a rebuilt or healthy stock looks like, it is virtually impossible to determine what a rebuilding schedule should be. However, the duration of a rebuilding schedule should reflect, in part, a measure of the generation time of the species. For a long-lived, but relatively early spawning species as red drum, mean generation time would be on the order of 15-20 years based on age-specific egg production (Vaughan and Carmichael 2000). The maximum age of red drum in the northern region is 50-60 years, while in the southern region it is about 40 years. Given these factors, it may take quite some time for noticeable increases in the age structure of the adult population to become apparent.

Amendment 2 will address the next steps for rebuilding the red drum population as well as updating the FMP to meet the standards for Commission FMPs under the Atlantic Coastal Act (ACFCMA 1993).

2.2 GOAL

The management goal of Amendment 2 shall be to achieve and maintain the Optimum Yield (OY) for the Atlantic coast red drum fishery as the amount of harvest that can be taken by U.S. fishermen while maintaining the Static Spawning Potential Ratio (SPR) at or above 40%.

2.3 OBJECTIVES

1. Achieve and maintain an escapement rate sufficient to prevent recruitment failure and achieve a static Spawning Potential Ratio (SPR) at or above 40%.

2. Provide a flexible management system to address incompatibility and inconsistency among state and federal regulations which minimizes regulatory delay while retaining substantial ASMFC, Council, and public input into management decisions; and which can adapt to changes in resource abundance, new scientific information and changes in fishing patterns among user groups or by area.

3. Promote cooperative collection of biological, economic and sociological data required to effectively monitor and assess the status of the red drum resource and evaluate management efforts.

4. To restore the age and size structure of the Atlantic coast red drum population.

2.4 SPECIFICATION OF THE MANAGEMENT UNIT

The management unit is defined as the red drum (*Sciaenops ocellatus*) resource throughout the range of the species within U.S. waters of the northwest Atlantic Ocean from the estuaries eastward to the offshore boundaries of the EEZ. The selection of this management unit is based on the biological distribution of the species along the Atlantic coast and historical harvest patterns which have identified fisheries for red drum extending north through New Jersey.

2.4.1 Management Areas

The management area shall be the entire Atlantic coast distribution of the resource from Florida through New Jersey. The management area is divided into a southern region which includes the waters of the Atlantic coast of Florida north to the North Carolina/South Carolina border. The northern region extends from the North Carolina/South Carolina border north through New Jersey.

2.5 DEFINITION OF OVERFISHING

Overfishing for red drum shall be defined as a fishing mortality rate (F) in excess of the fishing mortality rate at 30% Static Spawning Potential Ratio (SPR) or F30% SPR. The target fishing mortality rate shall be the fishing mortality rate at 40% Static Spawning Potential Ratio or F40% SPR.

2.6 STOCK REBUILDING PROGRAM

The current status of the adult red drum population is unknown. Therefore, a specific rebuilding program and schedule cannot be determined. One of the reasons the Council has recommended transferring management authority to the Commission is the inability to accurately determine stock rebuilding targets and schedules under the new requirements of the revised Sustainable Fisheries Act (1996). Since there is no current estimate of the size of the adult population nor is there an estimate of what a rebuilt or healthy stock looks like, it is virtually impossible to determine what a rebuilding schedule should be. However, the duration of a rebuilding schedule should reflect, in part, a measure of the generation time of the fish species under consideration. For a long-lived, but relatively early spawning species such as red drum, mean generation time would be on the order of 15 to 20 years based on age-specific egg production. Maximum age is 50 to 60 years for the northern region, and about 40 years for the southern region.

2.7 IMPLEMENTATION SCHEDULE

Amendment 2 was approved and adopted by the Commission during May, 2002, at the Commission's Spring Meeting. States in the southern region (South Carolina, Georgia and Florida) shall submit their proposed regulations to implement Amendment 2 by July 1, 2002, while states in the northern region (North Carolina, Virginia, Maryland, Delaware, New Jersey and the Potomac River Fisheries Commission) shall submit their proposed regulations by October 1, 2002. All states in the management unit subject to the provisions of Amendment 2 shall fully implement the provisions of Amendment 2 by January 1, 2003.

3.0 MONITORING PROGRAM SPECIFICATIONS/ELEMENTS

The Red Drum Technical Committee will meet at least once each year to review the stock assessment and all other relevant data pertaining to stock status. The Technical Committee will report on all required monitoring elements outlined in *Section 3* and forward any recommendations to the South Atlantic Board. The Technical Committee shall also report to the Management Board the results of any other

monitoring efforts or assessment activities not included in *Section 3* that may be relative to the stock status of red drum or indicative of ecosystem health and interactions.

The Red Drum Advisory Panel will meet at least once each year to review the stock assessment and all other relevant data pertaining to stock status. The Advisory Panel will forward its report and any recommendations to the Management Board.

The Red Drum Plan Review Team will annually review implementation of Amendment 2 and any subsequent adjustments (addenda), and report to the Management Board on any compliance issues that may arise. The PRT will also prepare the annual Red Drum FMP Review and coordinate the annual update and prioritization of research needs (*Section 6.0*).

3.1 ASSESSMENT OF ANNUAL RECRUITMENT

Recruitment of red drum can be described as occurring in two phases: the recruitment of larval red drum into estuarine nursery grounds and recruitment of young adults (age-4+) to the spawning portion of the population which typically inhabits waters outside the estuary. Little is know about either type of recruitment along the Atlantic coast since there have been few long-term surveys with uniform protocols.

There is strong evidence that red drum return to the area of their natal estuary to spawn. Thus, while genetically all Atlantic coast red drum are similar, there are numerous reproductively isolated populations in the region. This suggests that annual recruitment of juveniles and subsequent survival of these juveniles to adulthood may vary greatly among these populations.

Natural mortality is presumed to be very high during the first few weeks of life. Likewise natural mortality within the estuarine habitats that serve as nurseries during the first 6-8 months of life may be high and vary tremendously from year to year. Severe winter weather may result in a decline in estuarine water temperatures to the point that they are lethal to over-wintering red drum or at the very least retard growth.

The estuarine nursery habitats used by young red drum are extremely diverse along the Atlantic coast. For example, young red drum may are found in submerged aquatic vegetation (SAV) in areas like the Chesapeake Bay, the sounds of North Carolina, and the Mosquito Lagoon in Florida. In the South Atlantic Bight, juvenile red drum are found in small estuarine waterways flushed twice daily by tides of 2 to 3 meters. They remain within the estuary for the next 3-5 years. After the onset of maturity they are found infrequently within the estuary.

Many of the habitats used by red drum are difficult to sample with conventional approaches. And, the time period between larval settlement and recruitment to most recreational and commercial gears is typically 8-10 months. Consequently, there is little time to assess the abundance of a cohort before either direct or release mortality from fishing activities affect the population.

Each state should use a method that is most appropriate for their habitats. For example, seine surveys may be effective in areas of lower tidal amplitude with firm substrates. These surveys such as the one used by the North Carolina Division of Marine Fisheries can provide data on the abundance of age-0 red drum. In the central South Atlantic Bight, an area with higher tidal amplitudes and generally softer substrates, seine surveys may prove ineffective. Passive entanglement gear surveys may be an alternative and useful for measuring the abundance of red drum just prior to the transition to chronological age-1.

Each state should develop a sampling protocol (area and habitat type sampled, sampling intensity and gear type) which shall be consistent through the time period for which a juvenile abundance index (JAI) shall be used. The index should exhibit a significant ($p<0.05$) positive correlation to either the magnitude of future landings or the relative abundance of the same yearclass later in life (i.e. relative abundance of juveniles versus the relative abundance of sub-adults or adults of that same yearclass).

The Red Drum Technical Committee will review each state's sampling protocol and make recommendations to the Board regarding the suitability of the proposed protocol. If rejected, the Committee will provide a written explanation to the sponsor explaining the reasons for its recommendation.

3.2 ASSESSMENT OF SPAWNING STOCK BIOMASS

The status of the Spawning Stock Biomass (SSB) of red drum along the Atlantic coast is unknown. Some states have conducted sporadic and limited sampling of adult red drum in order to characterize the relative abundance of various yearclasses within the SSB. Others have relied on the catch records of anglers to describe the status of the SSB. However, there has never been a coordinated, regional effort to ascertain the size and age composition of the SSB of Atlantic coast red drum. This paucity of information greatly reduces the ability of stock assessment scientists to evaluate the efficacy of current or proposed management measures.

The Stock Assessment Subcommittee shall review the methods used thus far to collect information on the SSB in states along the Atlantic coast. The Committee shall also explore alternative methods for describing the status of the SSB. Following this review, the Committee shall develop a specific recommendation for a sampling protocol to collect data on the Atlantic coast red drum SSB. At the minimum, separate protocols shall be defined for the Northern Region and the Southern Region. It may be necessary to define specific protocols for individual states. These sampling protocols shall be designed as an ongoing process of data collection which complements the methods used to estimate survival and escapement in the estuarine populations of immature red drum.

The sampling programs should produce the following information: the age composition of the SSB; the relative abundance of yearclasses within the SSB; the proportion of new recruits (<age 10) to older adults in the SSB, and the sex ratio of the SSB. In addition, the sampling program should also address the need to tag large numbers of adult red drum to facilitate the collection of data on natural and fishing mortality.

The recommendation of the Stock Assessment Subcommittee will be forwarded to the Red Drum Technical Committee for consideration. The Technical Committee will review each state's sampling protocol and make recommendations to the Board regarding the suitability of the proposed protocol. If rejected, the Committee will provide a written explanation to the sponsor explaining the reasons for its recommendation. Upon approval by the Technical Committee, the recommendation shall be forwarded to the South Atlantic Board for action.

3.3 ASSESSMENT OF FISHING MORTALITY

Total mortality of red drum has two components: natural mortality (M) and fishing mortality (F). Fishing mortality is the rate at which fish are removed from the population by human activities. This includes the legal harvest and removals from bycatch, poaching, and hook-and-release mortality.

Fishing mortality rates can be estimated using a variety of fishery-dependent and -independent methods including catch curve analyses of length-frequency data from recreational harvest and entanglement gear

surveys. Fishing mortality can also be estimated from mark/recapture studies. To date, a virtual population analysis (VPA) of a composite catch matrix developed from commercial and recreational harvest data has been used to make retrospective estimates of age-specific fishing mortality for two regions. However, this approach is biased by the fact that some red drum leave the estuary prior to age-4 and are credited as deaths due to fishing. Also, the slot size limits in effect in each state severely truncate the age distribution of harvest data. Estimates of partial recruitment from fishery independent surveys have been used to reduce effects of the latter bias.

Fishery independent surveys are free of the bias associated with harvest regulations, but not of the bias associated with emigration of fish from the estuary. Consequently, even estimates of mortality developed from catch curve analysis of fishery independent data may be biased. However, such estimates may have a negative bias since the fish that emigrated are protected from fishing mortality and may survive to join the spawning population.

Each state should develop a data collection protocol for a survey to determine mortality and survival of juvenile red drum in their territorial waters. When possible, states should use identical protocols. These sampling programs shall produce the following information: estimates of age-specific fishing mortality; estimates of natural mortality; and estimates of escapement to age-4. States are encouraged to explore alternatives to VPA methods, such as fishery-independent surveys and the use of mark/recapture experiments.

The Red Drum Technical Committee will review each state's sampling protocol and make recommendations to the Board regarding the suitability of the proposed protocol. If rejected, the Committee will provide a written explanation to the sponsor explaining the reasons for its recommendation. Upon approval by the Technical Committee, the recommendation shall be forwarded to the South Atlantic Board for action.

3.4 SUMMARY OF MONITORING PROGRAMS

The South Atlantic State-Federal Fisheries Management Board encourages all state fishery management agencies to pursue full implementation of the Atlantic Coastal Cooperative Statistics Program (ACCSP), which will meet the fishery-dependent monitoring and reporting requirements of this amendment. The Board recommends a transition or phased-in approach be adopted for full implementation of the ACCSP. Until such time as the ACCSP is implemented, the Board encourages state fishery management agencies to initiate implementation of specific ACCSP modules, and/or pursue pilot evaluation studies to assist in development of reporting programs to meet the ACCSP standards (please refer to the ACCSP Program Design document for specific reporting requirements and standards). The ACCSP partners are the 15 Atlantic coastal states (Maine-Florida), the District of Columbia, the Potomac River Fisheries Commission, the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, the three regional fishery management Councils, and the Atlantic States Marine Fisheries Commission. Participation by program partners in the ACCSP does not relieve states from their responsibilities in collating and submitting harvest/monitoring reports to the Commission as may be required under this amendment.

3.4.1 Catch and Landings Information

3.4.1.1 Recreational Catch and Effort Data Collection Program(s)

The ACCSP recreational data collection program for private/rental and shore modes of fishing will be conducted through a combination telephone and intercept survey. Recreational effort data will be collected through a telephone survey with random sampling of households until such time as a more

comprehensive universal sampling frame is established. Recreational catch data will be collected through an access-site intercept survey. A minimum set of standard data elements will be collected in both the telephone and intercept surveys (refer to the ACCSP Program Design document for details). The ACCSP will implement research and evaluation studies to expand sampling and improve the estimates of recreational catch and effort. This amendment does not institute a separate data collection program for recreational red drum fisheries.

3.4.1.2 Commercial Catch and Effort Data Collection Program(s)

This amendment does not implement any new data collection programs for red drum fisheries. Commercial data shall be collected through existing state programs until the development and implementation of the ACCSP program. The ACCSP commercial data collection program will eventually be a mandatory, trip-based system with all fishermen and dealers required to report a minimum set of standard data elements (refer to the ACCSP Program Design document for details).

3.4.2 Biological Information

The ACCSP is in the process of developing guidelines and protocols for the collection of biological data from fishery-dependent sources for all Atlantic coast fisheries.

The Marine Sportfish Carcass Recovery Program, a partnership with Georgia Power and several coastal marinas and fish camps is used to collect biological data on red drum and other finfish harvested by recreational anglers. Freezers located near fish cleaning stations serve as collection points for filleted fish carcasses. These carcasses are collected by GADNR personnel and processed for biological information such as species, length, gender, and age. This information complements the catch and effort data collected through the MRFSS and provides the basis for an age-length key.

The South Carolina DNR conducts a program to collect the carcasses of red drum and other species taken by recreational anglers. Freezers are located at various fishing access points along the coast where anglers can bag the carcasses along with capture data for collection by state personnel. The state also collects biological data from red drum at various fishing tournaments.

3.4.3 Socio-economic Information

Currently there are no programs designed specifically to collect socio-economic data pertaining to red drum fisheries. The Atlantic Coastal Cooperative Statistics Program (ACCSP) is currently developing a comprehensive coastwide data collection program that will include these data.

The ACCSP will require the collection of baseline social and economic data on all commercial fisheries (refer to the ACCSP Program Design document for details). A minimum set of standard data elements will be collected by all social and economic surveys (refer to the ACCSP Program Design document for details).

The ACCSP will require the collection of baseline social and economic data on all recreational fisheries through add-ons to existing recreational catch/effort surveys (refer to the ACCSP Program Design document for details). A minimum set of standard data elements will be collected by all social and economic surveys (refer to the ACCSP Program Design document for details). This amendment does not institute a separate data collection program for socio-economic data for red drum fisheries.

3.4.4 Observer Programs

Currently there are no dedicated observer programs for red drum fisheries. As part of its overall program, the ACCSP will implement a comprehensive at-sea observer program. The ACCSP at-sea observer program will be a mandatory program. As a condition of state and/or federal permitting, vessels will be required to carry at-sea observers when requested. A minimum set of standard data elements will be collected through the ACCSP at-sea observer program (refer to the ACCSP Program Design document for details). Specific fisheries priorities will be determined by the Discard/Release Prioritization Committee of the ACCSP.

3.5 STOCK ENHANCEMENT

3.5.1 Fishery status

Analysis of the data obtained during the regular stock assessments indicates a steady increase in escapement during the last 16 years. However, results of the most recent assessment indicate that the population is still classified as over-fished (escapement = 18% and 17% for northern and southern regions respectively) (Vaughan and Carmichael 2000). In addition, in spite of increases in estimates of escapement, data on juvenile abundance shows a decline throughout the region during the 10 year period between 1989 and 1999. For example, recruitment estimates decreased in the southern region from 1.2 million to 200,000 between 1989 and 1999 and a similar pattern was observed for the northern region (Vaughan and Carmichael 2000). In order to reach the minimum Spawning Potential Ratio (SPR) of 30% (threshold for over-fishing) additional management measures will be required in all states. To date, management measures have relied solely on traditional approaches including size and creel limits, closed seasons, gear restrictions, change to game species status, etc. In North Carolina and Florida, creel limits have already been reduced to one fish/day and thus further conventional management options are limited. Similarly, South Carolina has recently reduced creel limits to two fish within a slot limit.

3.5.2 Experimental Stocking Programs

In the past, stocking of hatchery fish has not been considered as part of a management strategy to increase populations of red drum. This omission has been primarily due to biological and economic uncertainties associated with the effectiveness of stocking efforts. However, over the last 20 years, researchers on the Gulf and Atlantic coasts have been systematically examining the use of stocking to increase population abundance and address concerns associated with use of hatchery produced fish. A large-scale red drum stocking program was initiated in 1978 in Texas. This program, managed by the Texas Parks and Wildlife Commission, has been expanded and now routinely releases 35-40 million unmarked red drum fingerlings (1" TL) annually into a number of bays and sounds within the state. Long- term comparisons between stocked and unstocked estuaries in Texas revealed significantly higher abundance of year classes in the stocked estuaries (Matlock 1990). While work in the Laguna Madre between 1990 and 1993 found that out-of-phase stocked fish made up 20% of the catch (MacEachron *et al*. 1995, 1998). It is important to note that in-phase fish were also stocked in these estuaries and so the 20% estimate represents a minimum hatchery contribution.

3.5.3 Stocking Issues and Considerations

In spite of the work underway in Texas, a number of questions remain including: do stocked fish displace wild fish; does stocking increase abundance of legal size fish; do stocked fish survive at the same rate as their wild conspecifics; do stocked fish survive to contribute to the broodstock population; does stocking adversely affect the genetic integrity of the wild population. In 1990, research programs in South Carolina (Smith *et al*. 1997) and Florida (Willis *et al*. 1995) were developed to methodically attempt to address each of these questions in research scale stocking experiments. These studies have demonstrated that, depending on stocking density, stocked fish can make up to a 77% contribution of the fish in a year

class near the stocking site. As was shown in Texas, stocked fish can provide up to 20% of a year class in the entire estuary up to 30 km from the release site. Further, contribution did not decrease significantly through age 2 (Smith *et al*. 1999) indicating that survival of stocked fish was similar to the wild fish. Mature hatchery fish were recaptured in known spawning aggregations up to six years after stocking suggesting that they can add to the SPR (Smith *et al*. 1997). The issue of supplementation vs displacement is currently being address in a study underway in the Charleston Harbor estuary, South Carolina. The Ashley River, which historically has had the lowest abundance of red drum among all sites routinely monitored in South Carolina, was shown to increase above the historic levels with age1 fish after stocking 1-2 inch size red drum. In addition, the catch per unit effort in this estuary was higher for the stocked year class than in any other estuary in the state and marked hatchery fish made up 75% of the year class. A mathematical model r2 = 0.8) comparing stocked and unstocked estuaries also demonstrated that stocking resulted in an increase in abundance (4X) and did not displace wild fish (Jenkins *et al*. SC DNR, unpublished data).

3.5.4 Population Genetics

Genetic analysis of red drum along the Atlantic coast found has shown that the makeup of the population is consistent with what would be expected from random matings (Seyoum *et al*. 2000; Chapman *et al*. 1999). Further, analysis of genetic characteristics of a number of year classes within South Carolina demonstrated that each year class in the state is dominated by offspring of as few as 100 families. This does not necessarily suggest that broodstock numbers are low but that only that a limited number of families are lucky enough to encounter the optimum suite of environmental conditions necessary to obtain a survival advantage over other families. This phenomenon has been documented in other populations and is called the "Sweepstakes Effect" (Hedgecock *et al*. 1992). This pattern of red drum recruitment minimizes the potential for adverse genetic effects of a hatchery program as long as the broodstock are frequently changed. In essence fish that are produced in the hatchery during a particular year have effectively won the "sweepstakes" (Chapman *et al*. in press).

3.5.5 Recommendations

The information obtained to date is not sufficient to suggest that a large-scale stocking program should be initiated immediately. However, in recent years scientists in both Georgia (Woodward 2000) and North Carolina (Copeland *et al*. 1998) have developed white papers examining the pros and cons of using stocking to reduce variability in year class abundance and to hasten stock recovery. These scientists concluded that if a stocking program was conducted using the "Responsible Model" described by Blankenship and Leber (1995), and as practiced by researchers in South Carolina and Florida, then a quantitative assessment of the biological and economic impacts of stocking can be obtained. In short, additional research focused on evaluating the potential of stocking hatchery fish to augment traditional fishery management practices should be encouraged to determine if this is a reasonable approach to restoring healthy populations of red drum. Such efforts should be undertaken in conjunction with ongoing or new monitoring efforts so that stocking effects can be clearly defined. The South Atlantic Board, at the request of the Red Drum Technical Committee, has appointed a subcommittee on red drum stock enhancement. This subcommittee, along with the Red Drum Stock Assessment Subcommittee has been charged with developing a position statement regarding the use of cultured red drum for stock enhancement.

3.6 BYCATCH MONITORING PROGRAM

When the ACCSP is implemented, quantifiable data should be available to evaluate the extent of bycatch in red drum fisheries, as well as the bycatch of red drum in other fisheries. Independent studies of these two aspects of the bycatch question are encouraged and identified as a research need (see *Section 6*).

Bycatch of red drum in other fisheries may be an important component of the total mortality experienced by the population.

3.7 TAGGING STUDIES/PROGRAM

Tagging of fish and shellfish with individually-numbered tags is a proven technique for determining movement and migration routes and rates, growth rates and patterns, estimation of mortality/survival, estimation of population size (if assumptions are met), stock identification and determination of movement/migration corridors and habitat use. The use of more sophisticated electronic tags can provide additional habitat information such as temperature (of both water and fish body), depth and specific location. The species' Advisory Panel, Stock Assessment Subcommittee, Technical Committee and/or Management Board (for ASMFC), Advisory Panel or Committee (for Fishery Management Councils) and working groups for International Fisheries Commissions may decide to recommend that tagging studies be performed. Alternatively, such studies may be initiated independently by one or more of the partners in the fishery management process.

Fish and shellfish tagging is a technical activity which is usually conducted by scientific personnel; however a number of other entities have become involved in or conducted their own tagging studies. Should a tagging study be proposed for red drum, a number of considerations should be addressed. Any proposed study must have stated objectives which directly relate to scientific or management purposes. A second important consideration is whether a species can be tagged with minimal mortality, as the utility of study data will be highly questionable if handling/tagging mortality is high. Should a species prove tag-able, an appropriate tag should be selected for use. The Red Drum Technical Committee has reviewed tag retention studies and suggests that either internal anchor tags (for fish less than 550 mm TL) or harpoon tags (for fish greater than 550 mm TL) are the best for this species. However, internal anchor tags should only be used by individuals or organizations who have been properly trained in their application. The ideal tag should be one which has a unique alpha-numeric identifier and organization contact information, is easily emplaced, has a high rate of retention, is readily visible to potential recoverers without increasing an animal's susceptibility to predation, and remains permanently legible, or in the case of internally-embedded coded wire (CWT) or passive integrated transponder (PIT) tags, is easily and consistently detectable. The implantation location and type of CWT or PIT tags should be fully coordinated with other investigators tagging the same species. Tag number sequences and colors of externally visible tags should be coordinated with other investigators conducting similar studies, via the Interstate Tagging Committee, to ensure that duplication does not occur, and contact information for recoveries and returns should be clearly imprinted on the tag. Tagging should be conducted in a consistent manner by personnel who have been properly trained. Consideration should be given to requiring certification of both professional staff and volunteer angler taggers by the sponsoring organization, in order to increase both the efficiency of tagging and the survival of tagged fish or shellfish through minimization of handling/tagging mortality. The ASMFC Interstate Tagging Committee is in the process of developing a certification for tagging programs, for which sponsoring organizations may wish to apply.

Tagging studies should be highly publicized among the fishing public to maximize the rate of return from both commercial and recreational sectors. In most cases, efforts should be undertaken to accurately measure the rate of tag encounter and return reporting. Each study conducted should ideally assess short-term tagging (handling) mortality; short and long-term tag loss; and reporting rates for each fishery sector. Advertised/promised rewards should be provided promptly upon receipt of data. Study managers should insist on complete and accurate return information. Numbers of animals tagged should be sufficiently high to ensure that the desired information will be produced by the study. Careful and

appropriate study design (i.e., purpose, location, sample size, duration, recapture procedures, analysis) is vital to ensure success. Prior to study implementation, a repository for any resultant data should be specified, and long-term commitments made by the sponsoring program, and resources made available to analyze and publish the results. Funds should be provided/reserved to process recaptured tagged animals reported after the program has ended. In angler programs, participants with tagging kits should be notified when the program has ended. All incoming tagging data should be added to the existing database until no additional data are received. Failure to respond to reports of recaptured fish will be detrimental to surrounding tagging programs. Tag reporting apathy develops in anglers when they do not receive replies from the tagging entity.

The Interstate Tagging Committee strongly encourages programs which are implemented with: 1) connection to an agency or scientific entity for study design and data analyses; 2) an established constituent base to promote the program; 3) training for individuals on proper fish handling and tagging techniques; and 4) identified research needs and objectives. Investigators may wish to consider collaboration with existing tag database managers (e.g., National Marine Fisheries Service, Southeast Fishery Science Center, Miami, FL, 305-361-4248; NMFS Northeast Fishery Science Center, Woods Hole, MA, 02543; or U.S. Fish and Wildlife Service, Fishery Resources Office, Annapolis, MD, 410-263-2604) for data entry and analysis. Studies should not be undertaken without adequate consideration of all of these issues.

Any public or private entity which is proposing new tagging studies for red drum should seek guidelines from and provide a proposal to the Interstate Tagging Committee for review and coordination prior to initiation of any study. The proposal should use the ASMFC's Protocols for Tagging Programs as guidance in developing the proposed study. If the proposed study is an integral component of the FMP, study design should ideally be reviewed and approved by the Stock Assessment Subcommittee and/or Technical Committee as well, during the FMP review process. Tagging studies outside the ASMFC jurisdiction may choose not to participate in the ASMFC review process.

The ASMFC's Interstate Tagging Committee was developed to serve as a technical resource for jurisdictions other than the ASMFC, as well as for private, non-profit tagging groups, who may plan to tag red drum. Protocols have been developed by the Committee as a source of information, advice and coordination for all Atlantic coast tagging programs. A copy of the protocol is available on the ASMFC web site. Copies of proposals for review and coordination should be provided to the Interstate Tagging Coordinator at the ASMFC.

3.8 HABITAT MONITORING PROGRAM

Periodic review of various programs to monitor habitat and water quality could play an important role in understanding red drum population dynamics. The following topics should be examined: nutrient loading; long-term water quality monitoring; hypoxia events; incidence of red tides, harmful dinoflagellates and *Pfiesteria*; habitat modification permits; and wetlands protection.

Due to the close association between red drum and oyster reef habitats, state programs for mapping oyster grounds could be beneficial in providing habitat for red drum. A similar relationship between red drum and seagrass in Florida waters exists and these areas should be evaluated as to their importance to red drum as nursery and feeding grounds.

4.0 MANAGEMENT PROGRAM IMPLEMENTATION

Amendment 2 addresses management of red drum in the territorial waters of the states from New Jersey to Florida. Under the Atlantic Coastal Fisheries Cooperative Management Act, the Commission is requesting that the current moratorium on harvest and possession of red drum from Federal waters (EEZ) be maintained (see *Section 4.9*).

4.1 RECREATIONAL FISHERIES MANAGEMENT MEASURES

4.1.1 Recreational Bag and Size Limits

In lieu of mandating specific bag and size limits for each management area, Amendment 2 specifies that all states must implement an appropriate bag and size limit which will attain the management goal of 40% Spawning Potential Ratio (40% SPR) (Tables 19 & 20). For states in the northern region which still have a commercial harvest of red drum, the overall harvest restrictions for commercial and recreational combined must be sufficient to attain a 40% SPR. The estimated reductions in fishing mortality due to recent changes in North Carolina's commercial regulations have been incorporated into the analyses (Table 19) (Please note that additional analyses were conducted which varied both the minimum and maximum size limits and these results may have been presented during public hearings in some states. Due to the number of possible combinations these were not included in Amendment 2. Appendix A contains one such analysis conducted for the southern region using a minimum size of 15 inches total length.)

4.1.2 Maximum Size Limit

No red drum larger than 27" total length (TL) shall be harvested. All states must implement a 27" TL or smaller maximum size limit for red drum.

4.2 COMMERCIAL FISHERIES MANAGEMENT MEASURES

In order to avoid the establishment of any new commercial fisheries for red drum, all states shall maintain their current level of restrictions, i.e. no relaxation of current commercial fisheries management measures. Exceptions to this may be made under the guidance of *Section 4.2.2* or as approved by the South Atlantic Board under Alternative Management (*Section 4.5*). The intent of Amendment 2 is to not relax any of the current commercial fisheries management measures until such time as the Board determines that the Atlantic Coast red drum resource has recovered sufficiently to allow further, or increased levels of harvest. Current (as of April 1, 2002) commercial fisheries management measures are listed in Table 1 for each state.

4.2.1 Size Limits

No red drum larger than 27" total length (TL) shall be harvested. All states must implement a 27" TL or smaller, maximum size limit for red drum.

4.2.2 Trip or Possession Limits

States without a commercial landings cap for red drum shall maintain their current commercial trip or possession limits. States may implement more restrictive limits if so desired.

States which currently have a commercial fishery landings cap for red drum may reduce their trip limits in order to remain below their cap within any given fishing year.

Table 19. Static Spawning Potential Ratio (SPR) for range of bag limits for the northern region (NC through NJ), with increasing minimum size (a) and decreasing maximum size (b), assuming a 40% reduction in commercial fishing mortality due to new management measures implemented by the state of North Carolina in 2000 (based on analyses in Vaughan and Carmichael 2001).

(a)	Increasing minimum size limit (maximum size = 27")						
Bag Limit	18	19	20	21	22	23	24
1	**40.6**	**43.3**	**46.4**	**49.6**	**52.0**	**54.1**	**57.6**
2	37.6	**40.4**	**43.5**	**46.7**	**49.5**	**52.2**	**56.4**
3	36.2	38.9	**42.1**	**45.4**	**48.4**	**51.4**	**55.9**
4	35.3	37.9	**41.1**	**44.7**	**47.8**	**51.1**	**55.9**
5	34.9	37.5	**40.8**	**44.2**	**47.5**	**51.0**	**55.8**

(b)	Decreasing maximum size (minimum size limit = 18")						
Bag Limit	21	22	23	24	25	26	27
1	**60.3**	**56.9**	**54.3**	**50.8**	**48.0**	**44.9**	**40.6**
2	**59.5**	**55.5**	**52.4**	**48.4**	**45.4**	**42.0**	37.6
3	**59.3**	**55.1**	**51.5**	**47.3**	**44.1**	**40.7**	36.2
4	**59.3**	**55.1**	**51.3**	**47.0**	**43.4**	39.8	35.3
5	**59.3**	**55.1**	**51.3**	**46.9**	**43.0**	39.4	34.9

Table 20. Static Spawning Potential Ratio (SPR) for range of bag limits for the southern region (SC through FL), with (a) increasing minimum size and (b) decreasing maximum size (Vaughan and Carmichael 2001).

(a)	Increasing minimum size limit (maximum size = 27")						
Bag Limit	14	15	16	17	18	19	20
1	39.7	39.5	39.4	**40.3**	**40.7**	**41.0**	**41.5**
2	32.1	32.6	33.5	34.9	36.0	36.8	37.4
3	28.7	29.5	31.2	32.7	33.9	34.8	35.6
4	26.8	27.8	29.8	31.4	32.8	33.9	34.7
5	25.7	26.9	28.9	30.8	32.1	33.2	34.0

(b)	Decreasing maximum size (minimum size limit = 14")						
Bag Limit	21	22	23	24	25	26	27
1	**56.8**	**54.5**	**52.2**	**49.6**	**47.0**	**44.1**	39.7
2	**52.8**	**49.9**	**46.9**	**43.7**	**40.6**	37.1	32.1
3	**50.8**	**47.6**	**44.3**	**40.8**	37.4	33.8	28.7
4	**49.7**	**46.3**	**42.8**	39.2	35.6	31.8	26.8
5	**49.1**	**45.6**	**42.0**	38.3	34.6	30.8	25.7

Amendment 2 does not require specific trip or possession limits for the commercial fishery, however, for the past three years North Carolina has had a state-imposed commercial trip limit ranging from 100 pounds to five fish. These changes were brought about through the implementation of the North Carolina Red Drum FMP. The current bycatch trip limit in North Carolina is a seven (7) fish daily limit and requires that at least 50% of the landings by weight for an individual trip consist of edible finfish other than red drum, making this a bycatch fishery. Additionally, it is important to note that these changes are subsequent to the most recent stock assessment and should therefore act to reduce harvest and increase SPR values.

4.2.3 Commercial Landings Cap/Payback of Overages

States which currently have a commercial fishery landings cap for red drum shall maintain their current commercial cap. States may implement a more restrictive cap if so desired.

States which currently have a commercial fishery landings cap for red drum shall implement a pay-back regulation whereby any overage incurred in a fishing year shall be subtracted from the available amount in the fishing year immediately following the year in which the overage occurred. This pay-back regulation shall not apply to those states that allow the sale of bag limit caught fish. Any underage in a given year shall not be rolled over into the subsequent fishing year. The intent of Amendment 2 is to rebuild the red drum resource, therefore, any underages shall be used to further the recovery efforts of the planned management strategy contained herein.

4.2.4 Commercial Gear Restrictions

Amendment 2 does not impose any new commercial gear restrictions for harvesting red drum. North Carolina requires the attendance of small mesh gill nets (<5" stretch mesh) from May 1 through October 31 in areas known to be critical for juvenile (undersized) red drum. These areas include primary and secondary nursery areas, areas within 200 yards of any shoreline, and the area of shallow grass flats located behind the Outer Banks.

4.2.5 General Administrative Provisions

Presently there are individual state and federal permits and reporting requirements that may affect red drum fisheries. A comprehensive reporting and permitting system, the Atlantic Coastal Cooperative Statistics Program (ACCSP) is in the process of being developed and implemented.

4.2.5.1 Permits

This amendment does not implement a separate permitting system for red drum fishermen or vessels. However, the ACCSP is designing an integrated and comprehensive permit system for all commercial dealers and fishermen.

4.2.6 Data Collection and Reporting Requirements

The reporting requirements for red drum fisheries will be based in part on the existing state and federal systems as applicable. The Atlantic States Marine Fisheries Commission, National Marine Fisheries Service, United States Fish & Wildlife Service, the New England, Mid-Atlantic, and South Atlantic Fishery Management Councils, and all the Atlantic coastal states are currently developing a coastwide fisheries statistics program (Atlantic Coastal Cooperative Statistics Program). A minimum set of reporting requirements based on a trip-level for fishermen and dealers is being developed and once adopted by each state/agency, will become the minimum standard for data collection on the Atlantic coast. Nothing in the proposed program would prohibit a state/agency from requiring more detailed information on a trip basis if so desired. As the ACCSP provisions are adopted they will be incorporated

into the reporting requirements for red drum fisheries.

4.2.6.1 Vessel Registration System

The ACCSP has recommended the development of a standardized national fishing vessel registration system (VRS) through upgrades and expansions of the current Vessel Identification System (VIS). The VIS is an integration of the Coast Guard documentation and individual state registration systems. A minimum set of standard data elements will be collected through the VIS (refer to the ACCSP Program Design documents for details). This amendment does not institute a separate vessel registration system for red drum fisheries.

4.2.6.2 Quota Monitoring

This amendment does not implement any new quota monitoring programs. The ACCSP will require tracking of all commercial fishing quotas through an Interactive Voice Response (IVR) system. A minimum set of standard data elements will be collected through all IVR systems (refer to the ACCSP Program Design documents for details).

4.2.6.3 Bycatch Monitoring

There are currently no provisions in Amendment 2 to implement mandatory monitoring of bycatch of red drum in gillnet fisheries or other fisheries.

4.3 FOR-HIRE FISHERIES MANAGEMENT MEASURES

4.3.1 Bag and Size Limits

In lieu of mandating specific bag and size limits for each management area, Amendment 2 specifies that all states must implement an appropriate bag and size limit which will attain the management goal of 40% SPR (Tables 19 & 20).

4.3.2 Maximum Size Limit

No red drum larger than 27" total length (TL) shall be harvested. All states must implement a 27" TL or smaller maximum size limit for red drum.

4.3.3 Data Collection and Reporting Requirements

4.3.3.1 For-Hire Catch/Effort Data Collection Programs

This amendment does not institute a separate data collection program for for-hire red drum fisheries. The ACCSP is conducting an evaluation study to determine the best method(s) of data collection for for-hire fisheries. A minimum set of standard data elements are being evaluated by ACCSP for collection in all for-hire catch/effort surveys (refer to the ACCSP Program Design documents for details).

4.4 HABITAT CONSERVATION AND RESTORATION RECOMMENDATIONS

1. Each state should implement identification and protection of red drum habitat within its jurisdiction, in order to ensure the sustainability of that portion of the spawning stock that either is produced or resides within its boundaries. Such efforts should inventory historical habitats through mark-recapture studies or other means as available, identify those habitats presently used for spawning or nursery areas (*Section 3.8*), specify those that are targeted for recovery, and impose or encourage measures to retain or increase the quantity and quality of red drum essential habitats.

2. Each state should notify in writing the appropriate federal and state regulatory agencies of the locations of habitats used by red drum. Regulatory agencies should be advised of the types of threats to red drum populations and recommended measures which should be employed to avoid, minimize or

eliminated any threat to current habitat extent or quality.

3. Each state should establish Habitat Areas of Particular Concern (HAPCs) or similar designations appropriate for each state which hosts significant amounts of red drum spawning and nursery habitat. Each protected area should include sufficient amounts of necessary habitats for red drum, i.e., oyster reef, intertidal marsh or submerged rooted vascular vegetation, tidal creeks, intertidal flats, and adjacent deepwater estuarine to provide for individuals from age 0 to age 5 to reside therein. States may determine that such areas may warrant Marine Protected Area status and be closed to harvest either seasonally or permanently. It may be advantageous to locate such areas within existing special management areas such as National Wildlife Refuges, National Parks, including National Seashores, or state-designated areas such as Primary Nursery Areas (North Carolina).

4. Each state should establish freshwater inflow targets for estuaries documented as important red drum spawning, nursery or wintering habitat. Such targets should be derived where possible from flow data which predate significant hydrological alterations, and should mimic as closely as possible a natural hydrograph (defined as the pattern which predates significant anthropogenic alterations).

5. Where sufficient knowledge is available, states should seek to designate red drum essential habitats for special protection. These locations should be designated High Quality Waters or Outstanding Resource Waters and should be accompanied by requirements for non-degradation of habitat quality, including minimization of non-point source runoff, prevention of significant increases in contaminant loadings, and prevention of the introduction of any new categories of contaminants into the are (via restrictions on National Pollutant Discharge Elimination system (NPDES) discharge permits for facilities in those areas).

6. State fishery regulatory agencies should develop protocols and schedules for providing input on water quality regulations to the responsible agency, to ensure to the extent possible that water quality needs for red drum are restored, met and maintained. Water quality criteria for red drum spawning and nursery areas should be established or existing criteria should be upgraded to levels which are sufficient to ensure successful reproduction. Any action taken should be consistent with federal Clean Water Act guidelines and specifications.

7. State marine fisheries agencies should work with permitting or planning agencies in each state to develop permit conditions and planning considerations to avoid or mitigate adverse impacts on H.A.P.C.s or other habitats necessary to sustain red drum. Standard permit conditions and model policies that contain mitigation protocols should be developed. The development of Memoranda of understanding (MOU) with other state agencies is recommended for joint review of projects and planning activities to ensure that habitat protections are adequately implemented.

8. Federal and state fishery management agencies should take steps to limit the introduction of compounds which are known or suspected to accumulate in red drum tissue and which pose a threat to human health or red drum health.

9. Each state should establish windows of compatibility for activities known or suspected to adversely affect red drum life states and their habitats, such as navigational dredging, bridge construction and dredged material disposal, and notify the appropriate construction or regulatory agencies in writing.

10. Projects involving water withdrawal from spawning or nursery habitats (e.g. power plants, irrigation,

water supply projects) should be scrutinized to ensure that adverse impacts resulting from larval/juvenile impingement, entrainment, and/or modification of flow, temperature and salinity regimes due to water removal will not adversely impact red drum spawning stocks, including early life stages.

11. States should endeavor to ensure the proposed water diversions/withdrawals from rivers tributary to spawning and nursery habitats will not reduce or eliminate conditions favorable to red drum use of these habitats.

12. The use of any fishing gear or practice which is documented by management agencies to have an unacceptable impact on red drum (e.g. habitat damage, or bycatch mortality) should be prohibited within the affected essential habitats (e.g. trawling in spawning areas or primary nursery areas should be prohibited).

13. Each state should review existing literature and data sources to determine the historical extent of red drum occurrence and use within its jurisdiction. Further, an assessment should be conducted of areas historically but not presently used by red drum, for which restoration is feasible.

14. Every effort should be made to eliminate existing contaminants from red drum habitats where a documented adverse impact occurs.

15. States should work in concert with the U.S. Fish and Wildlife Service, Division of Fisheries Resources and Ecological Services, and the National Marine Fisheries Service, Office Of Habitat Conservation, to identify hydropower dams and water supply reservoirs which pose significant threat to maintenance of appropriate freshwater flows to, or migration routes for, red drum spawning areas and target them for appropriate recommendations during Federal Energy Regulatory Commission (FERC) re-licensing evaluation.

4.5 ALTERNATIVE STATE MANAGEMENT REGIMES

Once approved by the South Atlantic State-Federal Fisheries Management Board, states are required to obtain prior approval from the Board of any changes to their management program for which a compliance requirement is in effect. Other non-compliance measures must be reported to the Board but may be implemented without prior Board approval A state can request permission to implement an alternative to any mandatory compliance measure only if that state can show to the Board's satisfaction that its alternative proposal will have the same conservation value as the measure contained in this amendment or any addenda prepared under Adaptive Management (*Section 4.6*). States submitting alternative proposals must demonstrate that the proposed action will not contribute to overfishing of the resource. All changes in state plans must be submitted in writing to the Board and to the Commission either as part of the annual FMP Review process or the Annual Compliance Reports.

4.5.1 General Procedures

A state may submit a proposal for a change to its regulatory program or any mandatory compliance measure under this amendment to the Commission, including a proposal for *de minimis* status. Such changes shall be submitted to the Chair of the Plan Review Team, who shall distribute the proposal to the Management Board, the Plan Review Team, the Technical Committee, the Stock Assessment Committee and the Advisory Panel.

The Plan Review Team is responsible for gathering the comments of the Technical Committee, the Stock Assessment Committee and the Advisory Panel, and presenting these comments as soon as possible to the

Management Board for decision.

The South Atlantic State-Federal Fisheries Management Board will decide whether to approve the state proposal for an alternative management program if it determines that it is consistent with the "target fishing mortality rate applicable", and the goals and objectives of this amendment.

4.5.2 Management Program Equivalency

The Red Drum Technical Committee, under the direction of the Plan Review Team, will review any alternative state proposals under this section and provide to the South Atlantic State-Federal Fisheries Management Board its evaluation of the adequacy of such proposals.

4.5.3 *De minimis* Fishery Guidelines

The ASMFC Interstate Fisheries Management Program Charter defines *de minimis* as "a situation in which, under the existing condition of the stock and scope of the fishery, conservation, and enforcement actions taken by an individual state would be expected to contribute insignificantly to a coastwide conservation program required by a Fishery Management Plan or amendment" (ASMFC 2001b).

As future management measures are implemented through addenda prepared subsequent to Amendment 2, a state may be granted *de minimis* status if, the South Atlantic State-Federal Fisheries Management Board determines that action by the state with respect to a particular management measure would not contribute significantly to the overall management program. States may petition the South Atlantic State-Federal Fisheries Management Board at any time for *de minimis* status. Once *de minimis* status is granted, designated states must submit annual reports to the South Atlantic State-Federal Fisheries Management Board justifying the continuance of *de minimis* status. States must include *de minimis* requests as part of their annual compliance reports.

4.6 ADAPTIVE MANAGEMENT

The South Atlantic State-Federal Fisheries Management Board may vary the requirements specified in this amendment as a part of adaptive management in order to conserve the red drum resource. Specifically, the Management Board may change target fishing mortality rates and harvest specifications, other measures designed to prevent overfishing of the stock complex or any spawning component. Such changes will be instituted to be effective on the first fishing day of the following year, but may be put in place at an alternative time when deemed necessary by the Management Board. These changes should be discussed with the appropriate federal representatives and Councils prior to implementation in order to be complementary to the regulations for the EEZ.

4.6.1 General Procedures

The Plan Review Team will monitor the status of the fishery and the resource and report on that status to the South Atlantic State-Federal Fisheries Management Board annually, or when directed to do so by the Management Board. The Plan Review Team will consult with the Technical Committee, the Stock Assessment Committee and the Advisory Panel, if any, in making such review and report. The report will contain recommendations concerning proposed adaptive management revisions to the management program.

The South Atlantic State-Federal Fisheries Management Board will review the report of the Plan Review Team, and may consult further with Technical Committee, the Stock Assessment Committee or the Advisory Panel. The Management Board may direct the PRT to prepare an addendum to make any changes it deems necessary. The addendum shall contain a schedule for the states to implement its

provisions.

The Plan Review Team will prepare a draft addendum as directed by the Management Board, and shall distribute it to all states for review and comment. A public hearing will be held in any state that requests one. The Plan Review Team will also request comment from federal agencies and the public at large. After a 30-day review period, the Plan Review Team will summarize the comments and prepare a final version of the addendum for the Management Board.

The Management Board shall review the final version of the addendum prepared by the Plan Review Team, and shall also consider the public comments received and the recommendations of the Technical Committee, the Stock Assessment Committee and the Advisory Panel; and shall then decide whether to adopt or revise and adopt the addendum.

Upon adoption of an addendum implementing adaptive management by the Management Board, states shall prepare plans to carry out the addendum, and submit them to the Management Board for approval according to the schedule contained in the addendum.

4.6.2 Measures Subject to Change

The following measures are subject to change under adaptive management upon approval by the South Atlantic State-Federal Fisheries Management Board:

(1) Fishing year and/or seasons;
(2) Area closures;
(3) Rebuilding targets and schedules, including the overfishing definition, Maximum Sustainable Yield (MSY) and Optimum Yield (OY);
(4) Catch controls, including bag, size and trip limits;
(5) Effort controls;
(6) Reporting requirements;
(7) Gear limitations;
(8) Measures to reduce or monitor bycatch;
(9) Observer requirements;
(10) Management areas;
(11) Recommendations to the Secretaries for complementary actions in federal jurisdictions;
(12) Research or monitoring requirements;
(13) Stock enhancement protocols;
(14) *De minimis* requirements/criteria; and
(15) Any other management measures currently included in Amendment 2.

4.7 EMERGENCY PROCEDURES

Emergency procedures may be used by the South Atlantic State-Federal Fisheries Management Board to require any emergency action that is not covered by or is an exception or change to any provision in Amendment 2. Procedures for implementation are addressed in the ASMFC Interstate Fisheries Management Program Charter, Section Six (c)(10) (ASMFC 2001b).

4.8 MANAGEMENT INSTITUTIONS

The management institutions for red drum shall be subject to the provisions of the ISFMP Charter (ASMFC 2001b). The following is not intended to replace any or all of the provisions of the ISFMP Charter. All committee roles and responsibilities are included in detail in the ISFMP Charter and are

only summarized here. Future revisions to the ISFMP Charter may take precedence over some language contained in this amendment, specifically in regards to the roles and responsibilities of the various bodies identified in this section.

4.8.1 ASMFC and the ISFMP Policy Board

The ASMFC (Commission) and the ISFMP Policy Board are generally responsible for the oversight and management of the Commission's fisheries management activities. The Commission must approve all fishery management plans, and amendments, including this Amendment 2; and must also make all final determinations concerning state compliance or noncompliance. The ISFMP Policy Board reviews any non-compliance recommendations of the various Management Boards and Sections and, if it concurs, forwards them on to the Commission for action.

4.8.2 South Atlantic State-Federal Fisheries Management Board

The South Atlantic State-Federal Fisheries Management Board was established under the provisions of the Commission's ISFMP Charter (Section Four [b]) and is generally responsible for carrying out all activities under this amendment (ASMFC 2001b).

The South Atlantic State-Federal Fisheries Management Board (Board) establishes and oversees the activities of the Plan Development or Plan Review Team, the Technical Committee and the Stock Assessment Subcommittee; and requests the establishment of the Commission's Red Drum Advisory Panel. Among other things, the Board makes changes to the management program under adaptive management and approves state programs implementing the amendment and alternative state programs under *Sections 4.5* and *4.6*. The Board reviews the status of state compliance with the FMP or amendment at least annually, and if it determines that a state is out of compliance, reports that determination to the ISFMP Policy Board under the terms of the ISFMP Charter.

4.8.3 Red Drum Plan Development / Plan Review Team

The Red Drum Plan Development Team (PDT) and the Red Drum Plan Review Team (PRT) will be composed of a small group of scientists and/or managers whose responsibility is to provide all of the technical support necessary to carry out and document the decisions of the South Atlantic State-Federal Fisheries Management Board. Both are chaired by an ASMFC FMP Coordinator. The Red Drum PDT/PRT is directly responsible to the Board for providing information and documentation concerning the implementation, review, monitoring and enforcement of Amendment 2. The Red Drum PDT/PRT shall be comprised of personnel from state and federal agencies who have scientific and management ability and knowledge of red drum. The PDT will be responsible for preparing all documentation necessary for the development of Amendment 2, using the best scientific information available and the most current stock assessment information. The PDT will either disband or assume inactive status upon completion of Amendment 2. Alternatively, the Board may elect to retain PDT members as members of the PRT or appoint new members. The PRT will provide annual advice concerning the implementation, review, monitoring, and enforcement of Amendment 2 once it has been adopted by the Commission.

4.8.4 Red Drum Technical Committee

The Red Drum Technical Committee will consist of representatives from state or federal agencies, Regional Fishery Management Councils, Commission, university or other specialized personnel with scientific and technical expertise and knowledge of the red drum fishery. The Board will appoint the members of the Technical Committee and may authorize additional seats as it sees fit. Its role is to act as a liaison to the individual state and federal agencies, provide information to the management process, and review and develop options concerning the management program. The Technical Committee will

provide scientific and technical advice to the Management Board, PDT, and PRT in the development and monitoring of a fishery management plan or amendment.

4.8.5 Red Drum Stock Assessment Subcommittee

The Red Drum Stock Assessment Subcommittee shall be appointed by the Technical Committee at the request of the Management Board, and will consist of scientists with expertise in the assessment of the red drum population. Its role is to assess the red drum population and provide scientific advice concerning the implications of proposed or potential management alternatives, or to respond to other scientific questions from the Board, Technical Committee, PDT or PRT. The Stock Assessment Subcommittee will report to the Technical Committee.

4.8.6 Red Drum Advisory Panel

The Red Drum Advisory Panel was established according to the Commission's Advisory Committee Charter. Members of the Advisory Panel are citizens who represent a cross-section of commercial and recreational fishing interests and others who are concerned about red drum conservation and management. The Advisory Panel provides the Board with advice directly concerning the Commission's red drum management program. Advisory Panel meetings will be held in conjunction with Board meetings insofar as possible.

4.8.7 Federal Agencies

4.8.7.1 Management in the Exclusive Economic Zone (EEZ)

Management of red drum in the United States Exclusive Economic Zone is currently under the jurisdiction of the South Atlantic Fishery Management Council under the Magnuson-Stevens Act (16 U.S.C. 1801 et seq.). In the absence of a Council Fishery Management Plan, management is the responsibility of the National Marine Fisheries Service (NMFS) as mandated by the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5105 et seq.).

4.8.7.2 Federal Agency Participation in the Management Process

The Commission has accorded the United States Fish and Wildlife Service (USFWS) and the National Marine Fisheries Servive (NMFS) voting status on the ISFMP Policy Board and the South Atlantic State-Federal Fisheries Management Board in accordance with the Commission's ISFMP Charter. The NMFS also participates on the Red Drum Plan Development Team, Plan Review Team, Technical Committee and Stock Assessment Subcommittee. The USFWS also participates on the Red Drum Plan Development Team.

4.8.7.3 Consultation with Fishery Management Councils

In carrying out the provisions of Amendment 2, the states, as members of the South Atlantic State-Federal Fisheries Management Board, shall closely coordinate with the South Atlantic Fishery Management Council in order to cooperatively manage the Atlantic coast red drum population. In accordance with the Commission's ISFMP Charter, a representative of the South Atlantic Fishery Management Council shall be invited to participate as a full member of the South Atlantic Board. This representative is currently the Executive Director of the South Atlantic Council.

4.9 RECOMMENDATIONS TO THE SECRETARIES FOR COMPLEMENTARY ACTIONS IN FEDERAL JURISDICTIONS

The Atlantic States Marine Fisheries Commission believes that the red drum resource covered by this fishery management plan continues to be severely overfished and in need of conservation. It would be inconsistent with this approach to allow any meaningful increase in fishing mortality. Therefore it is important that the federal government maintain the fishing mortality controls that have been a part of its fisheries management program for this species. The Commission believes that the measures contained in Amendment 2 are necessary to recover overfished stocks of red drum and prevent the overfishing of the red drum resource. Therefore, the Atlantic States Marine Fisheries Commission recommends that the Secretary of Commerce continue the prohibition on harvest and/or possession of red drum in the Atlantic Coast Exclusive Economic Zone (EEZ) within the management area of the resource, i.e. south of the New York/New Jersey boundary. Specifically, the Commission requests the Secretary of Commerce maintain the prohibition on harvest or possession in or from both the Mid-Atlantic EEZ south of a line extending in a direction of 115^{o} from true north commencing at a point at 40^{o} 29.6' N. latitude, 73^{o} 54.1' W. longitude; such point being the intersection of the New Jersey/New York boundary with the 3 nautical mile line denoting the seaward limit of state waters; and the South Atlantic EEZ. Red drum caught in the Mid-Atlantic and South Atlantic EEZ must be released immediately with a minimum of harm.

4.10 COOPERATION WITH OTHER MANAGEMENT INSTITUTIONS

At this time, no other management institutions have been identified that would be involved with management of red drum on the Atlantic Coast. Nothing in Amendment 2 precludes the coordination of future management collaboration with other management institutions should the need arise.

5.0 COMPLIANCE

Full implementation of the provisions of this amendment is necessary for the management program to be equitable, efficient and effective. States are expected to implement these measures faithfully under state laws. Although the Atlantic States Marine Fisheries Commission does not have authority to directly compel state implementation of these measures, it will continually monitor the effectiveness of state implementation and determine whether states are in compliance with the provisions of this fishery management plan. This section sets forth the specific elements states must implement in order to be in compliance with this fishery management plan, and the procedures that will govern the evaluation of compliance. Additional details of the procedures are found in the ASMFC Interstate Fisheries Management Program Charter (ASMFC 2001b).

5.1 MANDATORY COMPLIANCE ELEMENTS FOR STATES

A state will be determined to be out of compliance with the provisions of this fishery management plan, according to the terms of Section Seven of the ISFMP Charter if:

- its regulatory and management programs to implement *Section 4* have not been approved by the South Atlantic State-Federal Fisheries Management Board; or
- it fails to meet any schedule required by *Section 5.1.2*, or any addendum prepared under adaptive management (*Section 4.6*); or
- it has failed to implement a change to its program when determined necessary by the South Atlantic State-Federal Fisheries Management Board; or
- it makes a change to its regulations required under *Section 4* or any addendum prepared under

adaptive management (*Section 4.6*), without prior approval of the South Atlantic State-Federal Fisheries Management Board.

5.1.1 Mandatory Elements of State Programs

To be considered in compliance with this fishery management plan, all state programs must include harvest controls on red drum fisheries consistent with the requirements of *Sections 4.1, 4.2* and *4.3*; except that a state may propose an alternative management program under *Section 4.5*, which, if approved by the Management Board, may be implemented as an alternative regulatory requirement for compliance.

5.1.1.1 Regulatory Requirements

Each state must submit its required red drum regulatory program to the Commission through the ASMFC staff for approval by the South Atlantic State-Federal Fisheries Management Board. During the period from submission, until the Management Board makes a decision on a state's program, a state may not adopt a less protective management program than contained in this amendment or contained in current state law. The following lists the specific compliance criteria that a state/jurisdiction must implement in order to be in compliance with Amendment 2:

1. All states are required to implement red drum harvest controls (e.g. bag and size limits) in order to achieve a minimum 40% Spawning Potential Ratio (SPR)

2. A maximum size limit of 27 inches or less shall be implemented for all red drum fisheries.

3. All states must maintain current or more restrictive commercial fishery regulations for red drum under the guidelines of *Section 4.2*.

Once approved by the South Atlantic State-Federal Fisheries Management Board, states are required to obtain prior approval from the Board of any changes to their management program for which a compliance requirement is in effect. Other measures must be reported to the Board but may be implemented without prior Board approval A state can request permission to implement an alternative to any mandatory compliance measure only if that state can show to the Board's satisfaction that its alternative proposal will have the same conservation value as the measure contained in this amendment or any addenda prepared under Adaptive Management (*Section 4.6*). States submitting alternative proposals must demonstrate that the proposed action will not contribute to overfishing of the resource. All changes in state plans must be submitted in writing to the Board and to the Commission either as part of the annual FMP Review process or the Annual Compliance Reports.

5.1.1.2 Monitoring Requirements

States (Florida through Virginia) shall document and roughly characterize all areas currently closed to fishing which may provide de facto reserves for larval and juvenile red drum. Such characterization shall include an estimate of the acreage of each of the closed areas, bottom habitat type such as mud, shell, or gravel, and any other descriptive information available. States shall provide this information within two years of the implementation date of this amendment.

The PDT and Technical Committee will work to develop appropriate protocols for designing fishery-independent surveys for red drum (*Sections 3.1, 3.2 and 3.3*). Such surveys may be implemented under *Section 4.6* (Adaptive Management) through the Commission's addendum process including the

opportunity for public comment.

5.1.1.3 Research Requirements

The PDT and Technical Committee will prioritize the research needs for red drum. Appropriate programs for meeting these needs may be implemented under *Section 4.6* (Adaptive Management) through the Commission's addendum process including the opportunity for public comment.

5.1.1.4 Law Enforcement Requirements

All state programs must include law enforcement capabilities adequate for successfully implementing that state's red drum regulations. The adequacy of a state's enforcement activity will be monitored annually by reports of the ASMFC Law Enforcement Committee to the Red Drum Plan Review Team. The first reporting period will cover the period from January 1, 2003 to December 31, 2003.

5.1.1.5 Habitat Requirements

There are no mandatory habitat requirements in Amendment 2. See *Section 4.4* for Habitat Recommendations.

5.1.2 Compliance Schedule

States must implement Amendment 2 according to the following schedule:

July 1, 2002:	States in the southern region (Florida, Georgia and South Carolina) must submit programs to implement Amendment 2 for approval by the South Atlantic State-Federal Fisheries Management Board. Programs must be implemented upon approval by the Management Board.
October 1, 2002:	States in the northern region (Virginia, Maryland, PRFC, Delaware and New Jersey) must submit programs to implement Amendment 2 for approval by the South Atlantic State-Federal Fisheries Management Board. Programs must be implemented upon approval by the Management Board.
January 1, 2003:	States with approved management programs must implement Amendment 2. States may begin implementing management programs prior to this deadline if approved by the Management Board.

Reports on compliance must be submitted to the Commission by each jurisdiction annually, no later than May 1, beginning in 2004.

5.1.3 Compliance Report Content

Each state must submit an annual report concerning its red drum fisheries and management program for the previous calendar year. A standard compliance report format has been prepared and adopted by the ISFMP Policy Board. States should follow this format in completing the annual compliance report.

5.2 PROCEDURES FOR DETERMINING COMPLIANCE

Detailed procedures regarding compliance determinations are contained in the ISFMP Charter, Section Seven (ASMFC 2001b). Future revisions to the ISFMP Charter may take precedence over the language contained in this amendment, specifically in regards to the roles and responsibilities of the various groups contained in this section. The following summary is not meant in any way to replace the language found

in the ISFMP Charter.

In brief, all states are responsible for the full and effective implementation and enforcement of fishery management plans in areas subject to their jurisdiction. Written compliance reports as specified in the Plan or Amendment must be submitted annually by each state with a declared interest. Compliance with Amendment 2 will be reviewed at least annually. The South Atlantic State-Federal Fisheries Management Board, ISFMP Policy Board or the Commission, may request the Red Drum Plan Review Team to conduct a review of plan implementation and compliance at any time.

The South Atlantic State-Federal Fisheries Management Board will review the written findings of the PRT within 60 days of receipt of a State's compliance report. Should the Management Board recommend to the Policy Board that a state be determined to be out of compliance, a rationale for the recommended non-compliance finding will be included addressing specifically the required measures of Amendment 2 that the state has not implemented or enforced, a statement of how failure to implement or enforce the required measures jeopardizes red drum conservation, and the actions a state must take in order to comply with Amendment 2 requirements.

The ISFMP Policy Board shall, within thirty days of receiving a recommendation of non-compliance from the South Atlantic State-Federal Fisheries Management Board, review that recommendation of non-compliance. If it concurs in the recommendation, it shall recommend at that time to the Commission that a state be found out of compliance.

The Commission shall consider any Amendment 2 non-compliance recommendation from the Policy Board within 30 days. Any state which is the subject of a recommendation for a non-compliance finding is given an opportunity to present written and/or oral testimony concerning whether it should be found out of compliance. If the Commission agrees with the recommendation of the Policy Board, it may determine that a state is not in compliance with Amendment 2, and specify the actions the state must take to come into compliance.

Any state that has been determined to be out of compliance may request that the Commission rescind its non-compliance findings, provided the state has revised its red drum conservation measures or shown to the Board and/or Commission's satisfaction that actions taken by the state provide for conservation equivalency.

5.3 RECOMMENDED (NON-MANDATORY) MANAGEMENT MEASURES

The South Atlantic State-Federal Fisheries Management Board, through Amendment 2, requests that those states outside the management unit (New York through Maine, and Pennsylvania) implement complementary regulations to protect the overfished red drum spawning stock. Specifically, all states outside the management unit are requested to implement a provision to prohibit all harvest, possession or sale of red drum greater than 27 inches total length.

5.4 ANALYSIS OF ENFORCEABILITY OF PROPOSED MEASURES

The ASMFC Law Enforcement Committee will, during the implementation of this amendment, analyze the enforceability of new conservation and management measures as they are proposed.

6.0 MANAGEMENT AND RESEARCH NEEDS

Characterized as high (H), medium (M) and low (L) priority. These will be reviewed annually as part of the Commission's FMP Review process. The annual Red Drum FMP Review will contain an updated list for future reference.

6.1 STOCK ASSESSMENT AND POPULATION DYNAMICS

- Design an appropriate state or estuary-specific fishery-independent survey of sub-adult and adult red drum to be implemented in Virginia, North Carolina, South Carolina, Georgia, and Florida. The purpose would be to provide an index of abundance of immature red drum. (H)
- Each state should develop an on-going red drum tagging program that can be used to estimate both fishing and natural mortality and movements. This should include concurrent evaluations of tag retention, tagging mortality, and angler tag reporting rates. (H)
- Improve catch/effort estimates and biological sampling from recreational and commercial fisheries for red drum, including increased effort to intercept night fisheries for red drum. (H)
- Determine the chronic mortality rate of red drum following regulatory and voluntary discard from commercial and recreational fishing gear, including recreational net fisheries. Evaluate effects of water temperature and depth of capture. (M)
- Evaluate alternatives to VPA for red drum stock assessment. (M)

6.2 RESEARCH AND DATA NEEDS

6.2.1 Biological

- Fully evaluate the effects and effectiveness of using cultured red drum to restore native stocks along the Atlantic coast. (H)
- Explore methods to effectively sample the adult population in estuarine, nearshore, and open ocean waters. (H)
- Continue tagging studies to determine stock identity, inshore/offshore migration patterns of all life stages (i.e. basic life history info gathering). Specific effort should be given to developing a large-scale program for tagging adult red drum (M).
- Determine habitat preferences, environmental conditions, growth rates, and food habits of larval and juvenile red drum throughout the species range along the Atlantic coast. Assess the effects of environmental factors on stock density/yearclass strength. (M)
- Refine maturity schedules on a geographic basis. Thoroughly examine the influence of size and age on reproductive function. Investigate the possibility of senescence in female red drum. (L)

6.2.2 Social

- Examine the effectiveness of controlling fishing mortality and minimum size in managing red drum fisheries.
- Encourage the NMFS to conduct socioeconomic add-on surveys via the MRFSS that are specifically oriented to red drum recreational fishing (Example: the 2000 Northeast Summer Flounder Survey).

6.2.3 Economic

- Encourage the NMFS to continue funding socioeconomic add-on surveys via the MRFSS that include data elements germane to red drum recreational fisheries management.
- Where appropriate, encourage member states to conduct studies to evaluate the economic costs and benefits associated with current and future regulatory regimes impacting recreational anglers including anglers oriented toward catch and release fishing trips.

- Fully evaluate the efficacy of using cultured red drum to restore native stocks along the Atlantic Coast including risk adjusted cost-benefit analyses.
- Conduct a special survey and related data analysis to determine the economic and operational characteristics of the "for-hire sector" targeting red drum especially fishing guide oriented businesses in the South Atlantic states.
- Estimate the economic impacts (e.g. sales, jobs, income, etc.) of recreational red drum fisheries at the state and regional level including the "for-hire sector" (e.g. fishing guides). (Note: The economic impact analysis [Southwick Associates 2001] cited in this document is considered preliminary.)
- Encourage the NMFS to continue funding research on projecting future participation in marine recreational fishing in the Atlantic states with an emphasis on forecasts for major fisheries such as red drum.

6.2.4 Habitat

- Identify spawning areas of red drum in each state from North Carolina to Florida so these areas may be protected from degradation and/or destruction. (H)
- Identify changes in freshwater inflow on red drum nursery habitats. Quantify the relationship between freshwater inflows and red drum nursery/sub-adult habitats. (H)
- Determine the impacts of dredging and beach re-nourishment on red drum spawning and early life history stages. (M)
- Investigate the concept of estuarine reserves to increase the escapement rate of red drum along the Atlantic coast. (M)
- Identify the effects of water quality degradation (changes in salinity, DO, turbidity, etc.) on the survival of red drum eggs, larvae, post-larvae, and juveniles. (M)
- Quantify relationships between red drum production and habitat. (L)
- Determine methods for restoring red drum habitat and/or improving existing environmental conditions that adversely affect red drum production. (L)

Included in the following section are needs and recommendations for research outlined in the SAFMC's (1998) Habitat Plan for the South Atlantic Region and the National Marine Fisheries Service Habitat Research Plan (Thayer *et al*. 1996) as they apply to red drum.

- Investigate the relationship between habitat and yield of red drum throughout its range, including seasonality and annual variability as well as the influence of chemical and physical fluxes on these relationships (See 6.2.4 #5).
- Identify and quantify limiting conditions to red drum production, particularly in H.A.P.C.s (See 6.2.4 #6).
- Conduct cause-and-effect research to evaluate the response of red drum populations and H.A.P.C.s to anthropogenic stresses including responses to alterations in upland areas and the role of buffer zones (See 6.2.4 #7).
- Encourage research in the development of bio- or photo-degradable plastic products to minimize impact of refuse on inshore, coastal and offshore habitats that red drum utilize at various stages of development.
- Quantify the impacts of acid deposition on red drum estuarine habitats.
- Conduct research on habitat restoration and clean-up techniques including the development of new approaches and rigorous evaluation protocols. Research should focus on such topics as contaminant sequestration, bio-remediation techniques, the role and size of buffer zones, and the role of habitat heterogeneity in the restoration process.

- Conduct research to assess the impacts of oil, gas and mineral exploration, development or transportation on red drum and red drum H.A.P.C.s
- Determine impacts of dredging nearshore and offshore sandbars for beach re-nourishment on all life history stages of red drum, particularly spawning adults (See 6.2.4 #2).

7.0 PROTECTED SPECIES

In the fall of 1995, Commission member states, the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) began discussing ways to improve implementation of the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA) in state waters. Historically, these policies have been only minimally implemented and enforced in state waters (0-3 miles). In November 1995, the Commission, through its Interstate Fisheries Management Program (ISFMP) Policy Board, approved amendment of its ISFMP Charter (Section Six (b)(2)) so that protected species/fishery interactions are addressed in the Commission's fisheries management planning process. Specifically, the Commission's fishery management plans will describe impacts of state fisheries on certain marine mammals and endangered species (collectively termed "protected species"), and recommend ways to minimize these impacts. The following section outlines: (1) the federal legislation which guides protection of marine mammals and sea turtles, (2) the protected species with potential fishery interactions; (3) the specific type(s) of fishery interaction; (4) population status of the affected protected species; and (5) potential impacts to Atlantic coastal state and interstate fisheries.

7.1 MARINE MAMMAL PROTECTION ACT (MMPA) REQUIREMENTS

Since its passage in 1972, one of the underlying goals of the Marine Mammal Protection Act (MMPA) has been to reduce the incidental serious injury and mortality of marine mammals permitted in the course of commercial fishing operations to insignificant levels approaching a zero mortality and serious injury rate. Under 1994 Amendments, the Act requires the National Marine Fisheries Service (NMFS) to develop and implement a take reduction plan to assist in the recovery or prevent the depletion of each strategic stock that interacts with a Category I or II fishery. Specifically, a strategic stock is defined as a stock: (1) for which the level of direct human-caused mortality exceeds the potential biological removal (PBR)[1] level; (2) which is declining and is likely to be listed under the Endangered Species Act (ESA) in the foreseeable future; or (2) which is listed as a threatened or endangered species under the ESA or as a depleted species under the MMPA. Category I and II fisheries are those that have frequent or occasional incidental mortality and serious injury of marine mammals, respectively, whereas Category III fisheries have a remote likelihood of incidental mortality and serious injury of marine mammals.

Under 1994 mandates, the MMPA also requires fishermen in Category I and II to register under the Marine Mammal Authorization Program (MMAP), the purpose of which is to provide an exception for commercial fishers from the general taking prohibitions of the MMPA. All fishermen, regardless of the category of fishery they participate in, must report all incidental injuries and mortalities caused by commercial fishing operations.

Section 101(a)(5)(E) of the MMPA requires the authorization of the incidental taking of individuals from

[1] PBR is the number of human-caused deaths per year each stock can withstand and still reach an optimum population level. This is calculated by multiplying "the minimum population estimate" by "½ stock's net productivity rate" by "a recovery factor ranging from 0.1 for endangered species to 1.0 for healthy stocks."

marine mammal stocks listed as threatened or endangered under the ESA in the course of commercial fishing operations if it is determined that (1) incidental mortality and serious injury will have a negligible impact on the affected species or stock; (2) a recovery plan has been developed or is being developed for such species or stock under the ESA; and (3) where required under Section 118 of the MMPA, a monitoring program has been established, vessels engaged in such fisheries are registered in accordance with Section 118 of the MMPA, and a take reduction plan has been developed or is being developed for such species or stock. Currently, there are no permits that authorize takes of threatened or endangered species by any commercial fishery in the Atlantic. Permits are not required for Category III fisheries, however, any serious injury or mortality of a marine mammal must be reported.

7.2 ENDANGERED SPECIES ACT (ESA) REQUIREMENTS

The taking of endangered sea turtles and marine mammals is prohibited under Section 9 of the ESA. In addition, NMFS may issue Section 4(d) protective regulations necessary and advisable to provide for the conservation of threatened species. There are several mechanisms established in the ESA to avoid the takings prohibition in Section 9. First, a 4(d) regulation may include less stringent requirements intended to reduce incidental take and thus allow for the exemption from the taking prohibition. Section 10(a)(1)(B) of the ESA authorizes NMFS to permit, under prescribed terms and conditions, any taking otherwise prohibited by Section 9 of the ESA, if the taking is incidental to, and not the purpose of, carrying out an otherwise lawful activity. Finally, Section 7(a) requires NMFS to consult with each federal agency to ensure that any action that is authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any listed species. Section 7(b) authorizes incidental take of listed species after full consultation and identification of reasonable and prudent alternatives or measure to monitor and minimize such take.

7.3 PROTECTED SPECIES WITH POTENTIAL FISHERY INTERACTIONS

Under Section 7 of the Engangered Species Act of 1973, as amended, a review of listed species and designated critical habitat(s) known to occur in the area of proposed action(s) and potential impacts to these species and habitat(s) is required of federal FMPs. Although not required for Commission FMPs, the following is included for informational purposes.

Marine listed species and critical habitat designations in the eastern U.S.

Endangered	
Blue whale	*Balaenoptera musculus*
Humpback whale	*Megaptera novaeangliae*
Fin whale	*Balaenoptera physalus*
Northern right whale	*Eubalaena glacialis* (Critical Habitat Designated)
Sei whale	*Balaenoptera borealis*
Sperm whale	*Physeter macrocephalus*
Leatherback sea turtle	*Dermochelys coriacea*
Hawksbill sea turtle	*Eretmochelys imbricata*
Kemp s Ridley turtle	*Lepidochelys kempii*
Green turtle	*Chelonia mydas*
Shortnose sturgeon	*Acipenser brevirostrum*
Atlantic salmon	*Salmo salar*

Note: Green turtles in U.S. waters are listed as threatened except for the Florida breeding population which is listed as endangered. Due to the inability to distinguish between these populations away from the nesting beach, green turtles are considered endangered wherever they occur in U.S. Atlantic and Gulf

of Mexico waters.

Threatened

Loggerhead turtle	*Caretta caretta*
Gulf Sturgeon	*Acipenser oxyrinchus desotoi*
Johnson's seagrass	*Halophilia johnsonii* (Critical Habitat Designated)

Proposed Species

Smalltooth sawfish	*Pristis pectinata*

Proposed Critical Habitat

None

Candidate Species

Dusky shark	*Carcharhinus obscrurus*
Sand Tiger Shark	*Odontaspis taurus*
Night Tiger	*Carcharhinus signatus*
Atlantic sturgeon	*Acipenser oxyrhynchus oxyrhynchus*
Mangrove rivulus	*Rivulus mamoratus*
Opposum pipefish	*Microphis barchyurus lineatus*
Key silverside	*Menidia conchorum*
Goliath grouper	*Epinephelus itajara*
Speckled hind	*Epinephelus drummondhayi*
Warsaw grouper	*Epinephelus nigritus*
Nassau grouper	*Epinephelus striatus*

Species Under U.S. Fish and Wildlife Service Jurisdiction:

West Indian manatee	*Trichechus manatus* (Critical Habitat Designated)
American crocodile	*Crocodylus acutus* (Critical Habitat Designated)

7.4 PROTECTED SPECIES INTERACTIONS WITH EXISTING FISHERIES

Since the majority of directed harvest of red drum occurs in recreational fisheries, one may assume that interactions with protected species would be limited. Hand line and rod and reel fisheries are listed as Category III fisheries under the MMPA due to their low risk of interacting with marine mammals. These types of fisheries may catch sea turtles incidentally, although it is assumed that this would be a rare occurrence. Red drum may occur as bycatch in some commercial fisheries that have been identified as having interactions with protected species (e.g. gillnets, haul seines, stop nets, and pound nets).

7.4.1 Marine Mammals

The risk to endangered whale species as posed by the recreational fishery for red drum should be considered minimal if not non-existent, due to the lack of interaction in both time and space. Mortalities of bottlenose dolphins due to ingestion of hooks and/or line have been documented (Gorzelany 1998; Wells *et al.* 1998), though particular fisheries could not be determined and the gear had been discarded or was consumed via a fish that had been hooked and broke away with the gear. Commercial fisheries where red drum may occur as a bycatch species have been listed by NMFS as Category II fisheries (e.g. North Carolina inshore gillnet, Southeast Atlantic gillnet, Mid-Atlantic/North Carolina haul seines), primarily due to interactions with bottlenose dolphins and harbor seals.

7.4.2 Sea Turtles

All sea turtles that occur in U.S. waters are listed as either endangered or threatened under the ESA. Five species occur along the U.S. Atlantic coast, namely, loggerhead (*Caretta caretta*), Kemp's Ridley (*Lepidochelys kempii*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), and hawksbill (*Eretmochelys imbricata*).

Several thousand commercial vessels are engaged in hook and line fisheries which target various species, including coastal species, reef fish and pelagics (NMFS and USFWS 1991). In addition to commercial take, the recreational fishery along the Atlantic coast is extensive. Turtle captures on hook and line gear are not uncommon, but the level of take and percent mortality are unknown. It is assumed that most turtles are released alive, although ingested hooks and entanglement in associated monofilament/steel line have been documented as the probable cause of death in some stranded turtles. Marine turtles are vulnerable to entanglement and drowning in gill and trammel nets, especially when the gear is left unattended (NMFS and USFWS 1991). Turtle mortality resulting from the use of gill nets has been documented (Ulrich 1978; Crouse 1982).

7.4.3 Seabirds

No information was available at the time Amendment 2 was developed. It is assumed that interactions between recreational fisheries for red drum and seabirds is not significant. There may be interactions between seabirds and some commercial fisheries where red drum is a bycatch species.

7.5 POPULATION STATUS REVIEW OF RELEVANT PROTECTED SPECIES

Information for the following section was adapted from the Biological Evaluation document for the South Atlantic Council's proposed actions to conserve and manage common dolphin, *Coryphaena hippurus*, pompano dolphin, *Coryphaena equiselis*, and wahoo, *Acanthocybium solandri*, in the United States EEZ of the Atlantic, Caribbean and Gulf of Mexico.

7.5.1 Marine Mammals

7.5.1.1 Sperm Whale, Physeter macrocephalus

Sperm whales are listed as endangered under the Endangered Species Act of 1973, as amended (ESA). They are also protected under the Marine Mammal Protection Act of 1972 (MMPA). The primary reason for this species' decline was commercial whaling. The International Whaling Commission (IWC) prohibited commercial hunting of sperm whales in 1981 (Reeves and Whitehead 1997).

For management purposes, the IWC recognizes four stocks of sperm whales: the North Pacific, North Atlantic, Northern Indian Ocean and Southern Hemisphere. However, to date, the worldwide stock structure of sperm whales remains unclear (Dufault *et al.* 1999). In the western North Atlantic, sperm whales range from Greenland to the Gulf of Mexico and the Caribbean. Their occurrence in the waters of the United States EEZ appears to be seasonal. Based on sightings data, during the winter, concentrations of sperm whales are found east and northeast of Cape Hatteras. In the spring, this concentration shifts northward to east of Delaware and Virginia as well as throughout the central portion of the mid-Atlantic Bight and southern portion of Georges Bank. Their distribution is similar during the summer, except sperm whales are also sighted east and north of Georges Bank as well as on the continental shelf south of New England. During the fall, sperm whales continue to be abundant on the continental shelf south of New England and are found along the edge of the continental shelf in the mid-Atlantic Bight (CETAP 1982; Scott and Sadove 1997). The best considered abundance estimate for sperm whales in the western North Atlantic comes from surveys covering the Gulf of St. Lawrence to Florida suggesting a population of 4,072 (CV=0.36) (Waring *et al.* 2001). Currently, the population

trend for this species is undeterminable due to insufficient data.

In the Gulf of Mexico, sperm whales have been observed in every season (Mullin *et al.* 1994, as cited in NMFS 2001b). This, together with stranding data and historical whaling catches, has led to speculation that sperm whales in the Gulf of Mexico constitute a distinct stock. The National Marine Fisheries Service treated them as such in the U.S. Atlantic and Gulf of Mexico marine mammal stock assessments (Waring *et al.* 2000). Concentrations of sperm whale sightings have been recorded just beyond the 100 m depth contour in the northern Gulf of Mexico, east of the Mississippi River Delta and it is believed that these offshore waters are an important area for this endemic population (NMFS 2001b). Based on estimates determined from surveys conducted during 1991-1994, the current abundance estimate for the Gulf is 530 animals (Waring *et al.* 2000).

Although it is not known for certain, sperm whales are believed to live at least 60 years (Rice 1989). Males sexually mature between the ages of 12 and 20 though they may not physically mature until about age 40. Females attain sexual maturity generally around age 9 and are regarded as physically mature at 30 (Wursig *et al.* 2000). Females birth a single calf approximately every four to seven years (Wursig *et al.* 2000). In general, females and immature whales form pods that are almost exclusively confined to warmer waters whereas the adult males can be found traveling to higher latitudes (Reeves and Whitehead 1997). Mature males return to lower latitudes during the winter to breed. Currently it is unknown whether the sperm whales found in the Gulf of Mexico undergo similar seasonal movements. Sperm whales typically prefer deep-water habitats, however, are periodically found in coastal waters (Scott and Sadove 1997). Their occurrence closer to shore is usually associated with the presence of food. Sperm whales prey primarily on large sized squid but also occasionally take octopus and a variety of fish including shark and skate (Leatherwood and Reeves 1983).

Sperm whales were hunted in America from the 17th century through the early 20th century though specific numbers of animals taken are unknown (Townsend 1935, as cited in NMFS 2001b). The IWC has estimated nearly a quarter-million sperm whales were killed worldwide from commercial whaling during the 19th century alone and another 700,000 taken from the early 1900's through the early 1980's (NMFS 2001b and references therein). Since the IWC ban on commercial harvesting of sperm whales, human-induced mortality or injury does not appear to be a significant factor impacting the recovery of the species (Perry *et al.* 1999, as cited in NMFS 2001b). Due to their more offshore distribution and benthic feeding habits, sperm whales seem less subject to entanglement in fishing gear than some cetacean species. Documented interactions have primarily involved offshore fisheries such as pelagic drift gillnets and longline fisheries, though no interactions between sperm whales and longlines have been recorded in the U.S. Atlantic (in January 1999, NMFS issued a Final Rule to prohibit the use of driftnets in the North Atlantic swordfish fishery, 50 CFR Part 630). Overall, the fishery-related mortality or serious injury for the western North Atlantic stock is considered to be less than 10% of the Potential Biological Removal level (PBR). PBR is a calculation required under the MMPA which estimates the number of animals that can be removed annually from the population or stock (in addition to natural mortality) while allowing that stock to remain at an optimum sustainable population level (OSP). The estimated PBR for the western North Atlantic sperm whale is 7.0 and 0.8 for the Gulf of Mexico stock (Waring *et al.* 2001). Other impacts known to kill or injury sperm whales include ship strikes and ingestion of foreign material (i.e. fishing line, plastics).

7.5.1.2 Blue Whale, Balaenoptera musculus

Blue whales are listed as endangered under the Endangered Species Act of 1973, as amended (ESA). They are also protected by the Marine Mammal Protection Act of 1972 (MMPA). Modern whaling

severely depleted the world's stocks of blue whales decreasing their population to only a small fraction of what it was thought to be in the early 20th century. Blue whales were given complete protection in the North Atlantic in 1955 under the International Convention for the Regulation of Whaling though Iceland did not recognize their protected status until 1960 (Sigurjónsson 1988).

Blue whales are the largest of the baleen whales, which instead of teeth, use a series of plates rooted in the upper jaw (made of material similar to that of finger-nails) to strain food from the water. As with most baleen whales, it is thought that blue whales undertake seasonal north/south movements, with summers spent in higher latitudes feeding and winters in lower latitudes, possibly breeding or calving. In the western North Atlantic, blue whales range from the Arctic to the mid-latitudes with only occasional sightings observed in the U.S. Atlantic EEZ during the late summer (CETAP 1982; Wenzel *et al.* 1988). Records also exist of this species occurring off Florida and in the Gulf of Mexico though their distribution in southern waters remains largely unknown (Yochem and Leatherwood 1985). It has generally been accepted that the North Atlantic consists of two stocks of blue whales (western and eastern) however, stock structure has not been examined through molecular or other appropriate analyses. The U.S. Navy has acoustically tracked blue whales in much of the North Atlantic including subtropical waters north of the West Indies and in deep water east of the U.S. EEZ (Clark 1995). Evidence from acoustic work has suggested that individual blue whales may range over the entire ocean basin leading some to speculate that they form a single population that breeds at random (NMFS 1998). The few population estimates that currently exist for blue whales in the western North Atlantic tend to be specific to particular areas (NMFS 1998). Mitchell (1974) estimated the entire western North Atlantic population to number in the low hundreds during the late 1960s and 1970s. It's thought that since their protection from commercial hunting, some populations of blue whales have shown signs of recovery while others have not been monitored to the extent of being able to determine their status.

Blue whales are the largest of the cetaceans reaching lengths of over 25 meters in the North Atlantic. Females give birth approximately every two to three years bearing a single calf. Assumed to be a long-lived species, they are thought to attain sexual maturity between 5 and 15 years of age (Mizroch *et al.* 1984; Yochem and Leatherwood 1985). Their diet consists primarily of krill.

Though commercial whaling has had a severe effect on the status of blue whales worldwide, the western North Atlantic population has not been subjected to hunting since the 1960s. Today, potential threats are more likely to occur from collisions with vessels, entanglement in fishing gear and habitat degradation in the forms of both noise and chemical pollution. Currently, there are no confirmed records of mortalities or serious injuries from fishery interactions occurring in the U.S. Atlantic EEZ. It is unclear as to whether blue whales are just less prone to becoming entangled or if their large size allows them to break through nets or carry gear away with them. If the latter is the case, there may be undiscovered mortalities resulting from gear-related injuries. The total level of human-caused mortality and serious injury is unknown but believed to be insignificant (Waring *et al.* 2001). The estimated PBR for the western North Atlantic blue whale is 0.6. NMFS has put into effect a Recovery Plan for blue whales that was published in 1998.

7.5.1.3 Fin whale, Balaenoptera physalus

Fin whales are listed as endangered under the Endangered Species Act of 1973, as amended (ESA). They are also protected under the Marine Mammal Protection Act of 1972 (MMPA). Modern whaling depleted most stocks of fin whales. Commercial hunting in the North Atlantic ended in 1987 though Greenland still conducts an "aboriginal subsistence" hunt allowed under the International Whaling Commission.

The overall distribution pattern of fin whales is complex. They appear to display a less obvious north/south pattern of migration exhibited by other baleen whales. Based on acoustic studies, a general southward "flow pattern" from the Labrador/Newfoundland region south past Bermuda and into the West Indies occurs in the fall (Clark 1995).

Fin whales are known to occur from the Gulf of Mexico northward to the arctic pack ice (NMFS 1998a). They are common in the waters of the U.S. Atlantic EEZ primarily from Cape Hatteras northward (Waring *et al.* 2001). For management purposes, NMFS recognizes only a single stock of fin whales in the U.S. waters of the western North Atlantic, though genetic data support the idea of several subpopulations (Bérubé *et al.* 1998). A survey conducted in 1999 from Georges Bank northward to the Gulf of St. Lawrence, led to an estimate of 2,814 (CV=0.21) individuals for the western North Atlantic population. This however, is considered a conservative estimate due to the extensive range of the fin whale throughout the entire North Atlantic and the uncertainties regarding population structure and exchange between surveyed and un-surveyed areas. To date, there is insufficient information in order to determine population trends.

Fin whales are thought to attain sexual maturity at around 10 years of age or older though it appears that exploited populations can mature as early as age 6 or 7 (Gambell 1985). The calving interval is estimated to be about 2 years but may be longer in unexploited populations (Agler *et al.* 1993). Regional distribution of fin whales is most likely influenced by prey availability with krill and small schooling fish such as capelin, *Mallotus villosus* , herring, *Clupea harengus*, and sand lance, *Ammodytes* spp., believed to be their main prey items (NMFS 1998a).

Aside from the threat of illegal whaling or increased legal whaling, potential threats affecting fin whales include collisions with vessels, entanglement in fishing gear and habitat degradation from chemical and noise pollution. Fin whales are known to have been killed or seriously injured by inshore fishing gear (gillnets and lobster lines) off eastern Canada and the United States (NMFS 1998a). The total level of human-caused mortality or serious injury is unknown, but is considered to be less than 10% of the calculated PBR (4.7) and thus not significant (Waring *et al.* 2001). A draft Recovery Plan for fin whales is available but the plan has not yet been finalized.

7.5.1.4 Sei whale, Balaenoptera borealis

Sei whales are listed as endangered under the Endangered Species Act of 1973, as amended (ESA). They are also protected under the Marine Mammal Protection Act of 1972 (MMPA). Sei whales began to be regularly hunted by modern whalers after the populations of larger, more easily taken species (i.e. humpbacks, right whales and gray whales, *Eschrichtius robustus*) had declined. Most stocks of sei whales were also reduced, in some cases drastically, by whaling efforts throughout the 1950's into the early 1970's. International protection for the sei whale began in the 1970's though populations in the North Atlantic continued to be harvested by Iceland until 1986 when the International Whaling Commission's moratorium on commercial hunting in the Northern Hemisphere came into effect.

The sei whale is one of the least well studied of the "great whales". Hence little is known about the distribution and current status for most stocks. They are believed to undertake seasonal north/south movements, with summers spent in higher latitudes feeding and winters in lower latitudes. In the western North Atlantic, it is thought that a large segment of the population is centered in northerly waters, perhaps the Scotian Shelf during the summer feeding season (Mitchell and Chapman 1977). Their southern range during the spring and summer includes the northern areas of the U.S. Atlantic EEZ (i.e. Gulf of Maine and Georges Bank). Strandings along the northern Gulf of Mexico and in the Greater

Antilles, indicate those areas to be the southernmost range for this population (Mead 1977). The sei whale is generally found in deeper waters though they are known for periodic excursions into more shallow and inshore waters when food is abundant (Payne *et al.* 1990).

Sei whales are not known to be common anywhere in U. S. Atlantic waters (NMFS 1998a). Stock identification in the western North Atlantic remains unclear however, there is some evidence of two stocks consisting of a Nova Scotia stock and a Labrador Sea stock (Mitchell and Chapman 1977). The Nova Scotia stock is thought to extend along the U. S. coast to at least North Carolina. The total number of sei whales in the U. S. Atlantic EEZ is not known and there are no recent abundance estimates.

Sei whales attain sexual maturity at approximately 8-10 years of age and females are thought to calve every two years or so (Lockyer and Martin 1983). Their primary food are calanoid copepods and euphausiids (NMFS 1998a).

Since the cessation of commercial whaling, threats to sei whales in the western North Atlantic appear to be few although they include ship collisions and entanglement in fishing gear. Because of their offshore distribution and overall scarcity in U. S. Atlantic waters, reports of entrapments and entanglements tend to be low. It is unknown whether sei whales are less prone to interact with fishing gear or if they break through or carry the gear away with them causing mortalities that go largely unrecorded. There were no reported fishery-related mortalities or serious injuries observed by NMFS during 1991-1997 however, the total level of human-caused impacts is unknown but thought to be insignificant (Waring et al 1999). PBR for the western North Atlantic sei whale is unknown since there is no minimum estimate of population size however, any fishery-related mortality would be unlawful as there is no recovery plan currently in place.

7.5.1.5 Humpback whale, Megaptera noveangliae

Humpback whales are listed as endangered under the Endangered Species Act of 1973, as amended (ESA). They are also protected under the Marine Mammal Protection Act of 1972 (MMPA). Because of their nature to aggregate on both summer and winter grounds, often near coasts, humpbacks were relatively easy prey for shore-based whalers. As a result, their populations were severely depleted by the time they achieved protection from commercial hunting in 1966.

Humpback whales utilize the northwestern Atlantic as a feeding ground during the summer with most then migrating to calving and breeding areas in the Caribbean during the winter (Clapham *et al.* 1993; Katona and Beard 1990). A significant number of animals however, are observed in mid- and high-latitude regions in the winter (Swingle *et al.* 1993). Based on sighting and stranding information, it appears that young humpbacks in particular have increased in occurrence along the coasts of Virginia and North Carolina during the winter (Wiley *et al.* 1995). There have also been increased wintertime sightings off the coastal waters further southeast (Waring *et al.* 1999a). Photographic mark-recapture analyses from the Years of the North Atlantic Humpback (YONAH) project conducted in 1992/1993, gave an ocean-basin-wide estimate of 10,600 individuals (CV=0.067) which to date is regarded as the best available estimate for the North Atlantic. It appears that the humpback whale population is increasing though it is unclear whether this increase is ocean-wide or confined to specific feeding grounds.

Female humpbacks are thought to reach sexual maturity between 4 and 6 years of age whereas males tend to be older attaining sexual maturity between 7 and 15 years (NMFS 2001b). Calving intervals observed for the western North Atlantic are approximately every 2 to 3 years (Clapham and Mayo 1990).

Humpback whales are described as opportunistic feeders, foraging on a variety of food items including euphausiids and small schooling fish such as herring, sand lance and mackerel (Paquet *et al.* 1997; Payne *et al.* 1990). In the mid-latitudes during the winter, juvenile humpbacks are also known to eat bay anchovies and menhaden, *Brevoortia tyrannus*.

Although habitat degradation, such as chemical and noise pollution, may be adversely affecting the recovery of humpbacks, the major threats appear to be vessel collisions and entanglements with fishing gear (see Waring *et al.* 2001 for synopsis of mortality/injury). Wiley *et al.* (1995) examining stranding data obtained principally from the mid-Atlantic, found that in the 20 cases where evidence of human impact was discernable, 30% had major injuries possibly caused by a vessel collision and 25% had injuries consistent with entanglement in fishing gear. Presently, there is insufficient information on the North Atlantic population overall to reliably determine population trends. Even though the total level of human-caused mortality or serious injury is not actually known, the total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR (33) and is therefore considered to be significant (Waring *et al.* 1999a). A Recovery Plan is in effect (NMFS 1991a).

7.5.1.6 Northern right whale, Eubalaena glacialis

Northern right whales are listed as endangered under the Endangered Species Act of 1973, as amended (ESA). They are also protected under the Marine Mammal Protection Act of 1972 (MMPA). Hunting is the major reason the western North Atlantic right whale population has declined to less than 300 individuals. Presently, the North Atlantic right whale is considered one of the most critically endangered populations of large whales in the world (Clapham *et al.* 1999). The species was continually hunted off the east coast of the United States for three centuries possibly reducing its numbers to less than 100 individuals by the time international protection from the League of Nations came into effect in 1935 (Waring et al. 2001). Right whales have been protected from commercial whaling under legislation of the International Whaling Commission since 1949 (NMFS 1991b).

Western North Atlantic right whales occur in the waters off New England and northward to the Bay of Fundy and the Scotian Shelf during the summer (Waring *et al.* 2001). During the winter, a segment of the population, consisting mainly of pregnant females, migrates southward to calving grounds off the coastal waters of the southeastern United States. Right whales use mid-Atlantic waters as a migratory pathway between their summer feeding grounds and winter calving grounds. During the winters of 1999/2000 and 2000/2001, considerable numbers of right whales were recorded in the Charleston, South Carolina area (NMFS 2001d). Currently, it remains unclear whether this is typical or reflects a northern expansion of the normal winter range.

Based on photo-identification techniques, the western North Atlantic population size was estimated to be 291 individuals in 1998 (Kraus *et al.* 2000). This estimate may be low if animals were not photographed and identified or if animals were incorrectly presumed dead due to not being seen for an extended period of time. The population growth rate estimated for the western North Atlantic population during the late 1980's through early 1990's suggested that the stock was slowly recovering (Knowlton *et al.* 1994). However, a review of work conducted in 1999 indicated that the survival rate of the northern right whale had declined during the 1990's (Waring *et al.* 2001). One factor currently under review for this decline is the apparent increase in the calving interval. The mean calving interval pre-1992 was estimated at 3.67 years. An updated analysis using data through the 1997/98 season indicated that the mean calving interval had increased to more than 5 years (Kraus *et al.* 2000). Reasons under consideration for this shift include contaminants, biotoxins, nutrition/food limitation, disease and inbreeding problems.

The primary sources of human-caused mortality and injury of right whales include ship strikes and entanglement in fishing gear. A recent study estimated that 61.6% of right whales show injuries consistent with entanglement in gear while 6.4% exhibited signs of injury from vessel strikes (Hamilton *et al.* 1998). With the small population size and low annual reproductive rate, human-caused mortalities have a greater impact on this species relative to other species. As such, due to the overall decline in the western North Atlantic right whale population, the PBR is set at zero (Waring *et al.* 2001).

Three right whale critical habitats were designated by NMFS (59 FR 28793; June 3, 1994). Two are off New England, Cape Cod/Massachusetts Bay and Great South Channel. The third is off the southeastern coast of the United States [between 31° 15' N. latitude (approximately the mouth of the Altamaha River, Georgia) and 30° 15' N. latitude (approximately Jacksonville Beach, Florida) extending from the coast out to 15 nautical miles offshore and the coastal waters between 30° 15' N. latitude and 28° 00' N. (approximately Sebastian Inlet, Florida) from the coast out to 5 miles]. Programs to foster both awareness and mitigate potential problems of anthropogenic injury and mortality to right whales have been implemented in both the northeast and southeast areas. One such program is the Mandatory Ship Reporting System requiring vessels over 300 tons to report information on their location, speed and direction once in a critical habitat. In return they receive information on right whale occurrence and recommendations on measures to avoid collisions with whales. A Recovery Plan was published in 1991 by NMFS and is in effect (NMFS 1991b). A revised plan is due out presently.

7.5.1.7 Bottlenose Dolphin, Tursiops truncatus

The bottlenose dolphin is a depleted species as listed under the Marine Mammal Protection Act of 1972 (MMPA). The species is not listed as threatened or endangered under the Endangered Species Act, but because this stock is listed as depleted under the MMPA, it is a strategic stock. The species ranges on the Atlantic coast from New Jersey south to central Florida (NMFS 2001c). Population size and stock structure continue to be studied but is believed to be depleted due to several high mortality events in the past 20 years. There are data suggesting that the population was at an historically high level immediately prior to the 1987-88 mortality event (Keinath and Musick 1988); however, this mortality event was estimated to have decreased the population by as much as 53%. The PBR for the U.S. Atlantic coastal bottlenose dolphin stock is 25. Total annual estimated average fishery-related mortality or serious injury to this stock during 1994-98 was 45.8 bottlenose dolphins (CV = 0.67).

Bottlenose dolphins are known to interact with commercial fisheries and occasionally are taken in various kinds of fishing gear including gillnets, seines, long-lines, shrimp trawls, and crab pots (Read 1994; Waring *et al.* 1994), especially in near shore areas where dolphin densities and fishing effort are greatest. Although there are limited observer data directly linking serious injury and mortality to fisheries (e.g. in the coastal gillnet fishery complex in the mid-Atlantic), the total number of bottlenose dolphin assumed from this stock which stranded showing signs of fishery or human-induced mortality exceeded PBR in 1993, 1996, 1997, and by the end of October in 1998. The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR, and therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate (NMFS 2001c).

7.5.2 Sea Turtles

7.5.2.1 Biological Synopsis: Loggerhead Sea Turtle

The threatened loggerhead turtle is the most abundant species of sea turtle in U.S. waters. This species commonly occurs on the Atlantic coast of the U.S. throughout the inner continental shelf from Florida through Cape Cod, Massachusetts. This species is found in a wide range of habitats throughout the

temperate and tropical regions of the globe. These include open ocean, continental shelves, bays, lagoons, and estuaries (NMFS and USFWS 1995).

The activity of the loggerhead is limited by temperature. Keinath *et al*. (1987) observed sea turtle emigration from the Chesapeake Bay when water temperatures cooled to below 18º C, generally in November. Sea turtles emigrate from the estuarine rivers, coastal bays and sounds when water temperatures cool to below 18º C (Keinath *et al*. 1987) and conversely immigrate when temperatures warm to 20º C (Burke *et al.* 1989; Musick *et al*. 1984). Work in North Carolina showed a significant movement of sea turtles into more northern waters at 11º C (Chester *et al.* 1994). Scientists studying movements of turtles in New York waters have seen loggerheads remain in that area for extended periods at temperatures as low as 8º C. Surveys conducted offshore and sea turtle strandings during November and December off North Carolina suggest that sea turtles emigrating from northern waters in fall and winter months may concentrate in nearshore and southerly areas influenced by warmer Gulf stream waters (Epperly *et al*. 1995). This is supported by the collected work of Morreale and Standora (1998) who tracked 12 loggerheads and 3 Kemp's ridleys by satellite. All of the turtles tracked similar spatial and temporal corridors, migrating south from Long Island Sound, NY, in a time period of October through December. The turtles traveled within a narrow band along the continental shelf and became sedentary for one to two months south of Cape Hatteras. Some of the turtles lingered between Cape Lookout Shoals and Frying Pan Shoals offshore of Wilmington, North Carolina prior to moving south or into the Gulf Stream.

Since they are limited by water temperatures, sea turtles do not usually appear on the summer foraging grounds in the Gulf of Maine until June, but are found in Virginia as early as April. They remain in these areas until as late as November and December in some cases, but the large majority are leaving the Gulf of Maine by mid-September. Aerial surveys of loggerhead turtles at sea north of Cape Hatteras indicate that they are most common in waters from 22 to 49 m deep, although they range from the beach to waters beyond the continental shelf (Shoop and Kenney 1992). There is no information regarding the activity of these offshore turtles.

Loggerhead sea turtles are primarily benthic feeders, opportunistically foraging on crustaceans and mollusks. Under certain conditions they also feed on finfish, particularly if they are easy to catch (*e.g.,* caught in gillnets or inside pound nets where the fish are accessible to turtles).

During 1996, a Turtle Expert Working Group (TEWG) met on several occasions and produced a report assessing the status of the loggerhead sea turtle population in the Western North Atlantic (WNA). Of significance is the conclusion that in the WNA, there are at least 4 loggerhead subpopulations separated at the nesting beach (TEWG 1998). This finding was based on analysis of mitochondrial DNA, which the turtle inherits from its mother. It is theorized that nesting assemblages represent distinct genetic entities, but further research is necessary to address the stock definition question. These nesting subpopulations include the following areas: northern North Carolina to northeast Florida, south Florida, the Florida Panhandle, and the Yucatan Peninsula. Genetic evidence has shown that loggerheads from Chesapeake Bay southward to Georgia are nearly equally divided in origin between South Florida and northern subpopulations. Work is currently ongoing in the Northwestern North Atlantic to collect samples which will provide information relative to turtles north of the Chesapeake, which is most of the action area for this consultation.

The loggerhead turtle was listed as threatened under the ESA on July 28, 1978, but is considered endangered by the World Conservation Union (IUCN) and under the Convention on International Trade

in Endangered Species of Flora and Fauna (CITES). The significance of the results of the TEWG analysis is that the northern subpopulation may be experiencing a significant decline (2.5 percent - 3.2 percent for various beaches). A recovery goal of 12,800 nests has been assumed for the Northern Subpopulation, but current nests number around 6,200 (TEWG 1998). Since the number of nests declined in the 1980's, the TEWG concluded that it is unlikely that this subpopulation will reach this goal given current stresses on population performance. Considering this apparent decline and the current lack of information on the stock definition of the northern subpopulation, a conservative approach must be implemented and adverse effects from fisheries minimized as a priority for recovery.

The most recent 5-year ESA sea turtle status review (NMFS and USFWS 1995) reiterates the difficulty of obtaining detailed information on sea turtle population sizes and trends. Most long-term data is from the nesting beaches, and this is often complicated by the fact that they occupy extensive areas outside U.S. waters. The TEWG was unable to determine acceptable levels of mortality. This status review supports the conclusion of the TEWG that the northern subpopulation may be experiencing a decline and that inadequate information is available to assess whether its status has changed since the initial listing as threatened in 1978. The current recommendation from the 5-year review is to retain the threatened designation but note that further study is needed before the next status review is conducted.

7.5.2.2 Biological Synopsis: Leatherback Sea Turtle

The leatherback is the largest living turtle and ranges farther than any other sea turtle species, exhibiting broad thermal tolerances (NMFS and USFWS 1995). Leatherback turtles are often found in association with jellyfish. The turtles feed primarily on the Cnidarians (medusae, siphonophores) and tunicates (salps, pyrosomas). These turtles are found throughout the action area of this consultation and, while predominantly pelagic, they occur annually in places such as Cape Cod Bay and Narragansett Bay during certain times of the year, particularly in the fall. Of the turtle species common to the action area, leatherback turtles seem to be the most susceptible to entanglement in pot gear and pelagic trawl gear. The susceptibility to entanglement in pot gear may be the result of attraction to gelatinous organisms and algae that collect on buoys and buoy lines at or near the surface.

Nest counts are the only reliable population information available for leatherback turtles. Recent declines have been seen in the number of leatherbacks nesting worldwide (NMFS and USFWS 1995). The status review notes that it is unclear whether this observation is due to natural fluctuations or whether the population is at serious risk. With regard to repercussions of these observations for the U.S. leatherback populations in general, it is unknown whether they are stable, increasing, or declining, but it is certain that some nesting populations (*e.g.*, St. John and St. Thomas, U.S. Virgin Islands) have been extirpated.

7.5.2.3 Biological Synopsis: Kemp's Ridley Sea Turtle

The Kemp's ridley is the most endangered of the world's sea turtle species. The only major nesting site for ridleys is a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963). Estimates on the adult population reached a low of 1,050 in 1985, and increased to 3,000 individuals in 1997. First-time nesting adults increased from 6 percent to 28 percent from 1981 to 1989, and from 23 percent to 41 percent from 1990 to 1994, indicating that the ridley population may be in the early stages of exponential growth (TEWG 1998).

Juvenile Kemp's ridleys use northeastern and mid-Atlantic coastal waters of the U.S. Atlantic coastline as primary developmental habitat during summer months, with shallow coastal embayments serving as important foraging grounds. Post-pelagic ridleys feed primarily on crabs, consuming a variety of species,

including *Callinectes* sp., *Ovalipes* sp., *Libinia* sp., and *Cancer* sp. Mollusks, shrimp, and fish are consumed less frequently (Bjorndal 1997). Juvenile ridleys migrate south as water temperatures cool in fall, and are predominantly found in shallow coastal embayments along the Gulf Coast during fall and winter months. Although the natural tendency of sea turtles is to migrate south to warmer waters, they may be susceptible to rapid drops in water temperatures in the enclosed, shallow bays of the mid-Atlantic. In November and early December, 1999, 184 sea turtles, including 178 Kemp's ridleys, stranded along the Massachusetts coast as a result of cold-stunning.

Ridleys found in mid-Atlantic waters are primarily post-pelagic juveniles averaging 40 centimeters in carapace length, and weighing less than 20 kilograms (Terwilliger and Musick 1995). Next to loggerheads, they are the second most abundant sea turtle in Virginia and Maryland waters, arriving in these areas during May and June, and migrating to more southerly waters from September to November (Keinath *et al.* 1987; Musick and Limpus 1997). In the Chesapeake Bay, ridleys frequently forage in shallow embayments, particularly in areas supporting submerged aquatic vegetation (Lutcavage and Musick 1985; Bellmund *et al.* 1987; Keinath *et al.* 1987; Musick and Limpus 1997). The juvenile population in Chesapeake Bay is estimated to be 211 to 1,083 turtles (Musick and Limpus 1997).

Juvenile ridleys follow regular coastal routes during spring and fall migrations to and from developmental foraging grounds along the mid-Atlantic and northeastern coastlines. Consequently, many ridleys occurring in coastal waters off Virginia and Maryland are transients involved in seasonal migrations. However, Maryland's and Virginia's coastal embayments - which contain an abundance of crabs, shrimp, and other prey as well as preferred foraging habitat such as shallow subtidal flats and submerged aquatic vegetation beds - are likely used as a foraging ground by Kemp's ridley sea turtles (J. Musick, VIMS, 1998; pers. comm.; S. Epperly, NMFS SEFSC, 1998; pers. comm.; M. Lutcavage, New England Aquarium, 1998; pers. comm.). No known nesting occurs on Virginia or Maryland beaches.

7.5.2.4 Biological Synopsis: Green Sea Turtle:

Green turtles are distributed circumglobally, mainly in waters between the northern and southern 20EC isotherms (Hirth 1971). In the western Atlantic, several major nesting assemblages have been identified and studied. However, most green turtle nesting in the continental United States occurs on the Atlantic Coast of Florida. Nesting has been documented along the Gulf coast of Florida, at Southwest Florida beaches, as well as the beaches on the Florida Panhandle. On the west coast of Florida the Florida Department of Environmental Protection (FDEP) documented 35 nests in 1996, only 6 in 1997, and 45 in 1998. However, most documented green turtle nesting activity occurs on Florida index beaches, which are on the east coast and were established to standardize data collection methods and effort on key nesting beaches. The pattern of green turtle nesting shows biennial peaks in abundance, with a generally positive trend during the six years of regular monitoring since establishment of the index beaches in 1989, perhaps due to increased protective legislation throughout the Caribbean. The FDEP documented 3,061 nest in 1996, 731 in 1997, and 5,512 in 1998 on the east coast of Florida. There is evidence that green turtle nesting has been on the increase during the past decade.

While nesting activity is obviously important in determining population distributions, the remaining portion of the green turtle's life is spent on the foraging grounds. Juvenile green sea turtles occupy pelagic habitats after leaving the nesting beach. Pelagic juveniles are assumed to be omnivorous, but with a strong tendency toward carnivory during early life stages. At approximately 20 to 25 cm carapace length, juveniles leave pelagic habitats, and enter benthic foraging areas, shifting to a chiefly herbivorous diet (Bjorndal 1997). Post-pelagic green turtles feed primarily on sea grasses and benthic algae, but also consume jellyfish, salps, and sponges. Known feeding habitats along U.S. coasts of the western Atlantic

include shallow lagoons and embayments in Florida, and similar shallow inshore areas elsewhere. Some of the principal feeding pastures in the western Atlantic Ocean include the upper west coast of Florida, the northwestern coast of the Yucatan Peninsula, the south coast of Cuba, the Mosquito Coast of Nicaragua, the Caribbean Coast of Panama, and scattered areas along Colombia and Brazil (Hirth 1971). The preferred food sources in these areas are *Cymodocea, Thalassia, Zostera, Sagittaria,* and *Vallisneria*.

Juvenile green turtles occur north to Long Island Sound, presumably foraging in coastal embayments. In North Carolina, green turtles are known from estuarine and oceanic waters. Recently, green turtle nesting occurred on Bald Head Island, just east of the mouth of the Cape Fear River, on Onslow Island, and on Cape Hatteras National Seashore. No information is available regarding the occurrence of green turtles in the Chesapeake Bay, although they are presumably present in very low numbers.

In the western Atlantic region, the summer developmental habitat encompasses estuarine and coastal waters as far north as Long Island Sound, Chesapeake Bay, and the North Carolina sounds, and south throughout the tropics (Musick and Limpus 1997). Most of the individuals reported in U.S. waters are immature (Thompson 1988). Individuals that use waters north of Florida during the summer must return to southern waters in autumn, or face the risk of cold stunning.

7.5.3 Seabirds

To address on-going concerns regarding seabird and fisheries interactions, NMFS recently initiated an Interagency Seabird Working Group (ISWG). The group is comprised of representatives from NMFS, U.S. F.W.S., regional Councils and Department of State. The first meeting of the ISWG was held via video/teleconference January 15, 2002. The new initiative is looking to find practicable and effective solutions to seabird/fishery interactions. The immediate focus is to address issues through the implementation of the National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries, however, it is recognized that potential interactions of seabirds and fisheries other than longlines also need to be addressed.

To date, no specific seabird interaction assessments have been conducted for the fisheries managed by the South Atlantic, Gulf and Caribbean Councils though incidental takes of seabirds have been recorded by both the Southeast Fisheries Science Center (SEFSC) Pelagic Longline and New England and Mid-Atlantic Gillnet Fisheries Observer Programs.

7.6 EXISTING AND PROPOSED FEDERAL REGULATIONS/ACTIONS PERTAINING TO RELEVANT PROTECTED SPECIES

No additional information was available concerning existing or proposed federal regulations outside of the information as noted previously in Section 7 of Amendment 2.

7.7 POTENTIAL IMPACTS TO ATLANTIC COASTAL STATE AND INTERSTATE FISHERIES

North Carolina has implemented mandatory gillnet attendance for nets with a stretched mesh less than five (5) inches in internal state waters from May 1 through October 31, where juvenile red drum typically occur (NCDMF 2001) . This was partially based on a DMF gillnet mesh selectivity study. Data from the study indicated that gillnet mesh sizes less than five inches take red drum less than 18 inches. Further, sampling indicated that the mortality rate of red drum taken in gillnets is high, particularly during the warmer summer months when water temperatures are high and undersized red drum were locally abundant

7.8 IDENTIFICATION OF CURRENT DATA GAPS AND RESEARCH NEEDS RELATIVE TO PROTECTED SPECIES

No information was available during the time of development of this amendment.

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9.0 APPENDICES

Appendix A. Escapement (ESC) and Static Spawning Potential Ratio (SPR) for range of bag limits for the southern region (SC through FL), with decreasing maximum size based on a 15" minimum total length (analysis based on methodology in Vaughan and Carmichael 2001).

ESC	**Decreasing maximum size limit (minimum size = 15")**						
Bag Limit	21	22	23	24	25	26	27
1	**59.5**	**56.8**	**54.1**	**51.1**	**48.1**	**44.8**	**40.1**
2	**56.1**	**52.8**	**49.3**	**45.6**	**42.0**	38.1	32.8
3	**54.4**	**50.8**	**46.9**	**42.9**	39.1	35.0	29.6
4	**53.5**	**49.7**	**45.7**	**41.5**	37.4	33.2	27.8
5	**53.1**	**49.2**	**45.0**	**40.9**	36.6	32.4	26.9

SPR	**Decreasing maximum size (minimum size limit = 15")**						
Bag Limit	21	22	23	24	25	26	27
1	**57.6**	**55.1**	**52.5**	**49.8**	**46.9**	**43.8**	39.1
2	**54.3**	**51.2**	**48.0**	**44.5**	**41.1**	37.5	32.1
3	**52.7**	**49.3**	**45.6**	**41.9**	38.4	34.4	29.0
4	**51.8**	**48.2**	**44.5**	**40.6**	36.8	32.7	27.3
5	**51.5**	**47.8**	**43.9**	**40.0**	36.0	32.0	26.4

10.0 GLOSSARY

Escapement - The ratio of survival of one recruit from 0.5 years of age to 6 years of age with fishing mortality > 0 versus fishing mortality = 0 (M = 0.44 for ages < 6).

Exclusive Economic Zone (EEZ) - An area extending from the seaward boundary of the States' territorial seas to 200 nautical miles from the baseline from which the territorial sea is measured.

Environmental Impact Statement (EIS) - Required by the National Environmental Policy act of 1969 whenever major Federal actions may significantly affect the quality of the environment, including the human environment. A draft (DEIS) and a final (FEIS) environmental impact statement are prepared.

Fork length (FL) - The measurement of a fish, from the most anterior tip of the head (snout) to the center of the fork of the tail (caudal fin).

Maximum Sustainable Yield (MSY) - The largest quantity (by weight) of fish that can be harvested annually from a resource without reducing its long-term productive potential.

Optimum Yield (OY) - Optimum yield for the Atlantic coast red drum fishery is the amount of harvest that can be taken by U.S. fishermen while maintaining the spawning stock biomass per recruit level at or above 30% of the level that would result at a fishing mortality rate of F=0.

Overfishing - Overfishing is defined as a fishing mortality rate that will, if continued, reduce the spawning potential ratio below 30% of the level that would exist at equilibrium without fishing. The Atlantic coast red drum stock will be considered overfished when the SPR is below 30% of the level that would have existed in the absence of fishing.

Regulatory Impact Review (RIR) - An assessment of the economic impacts of proposed management measures and alternatives considered in an FMP.

Spawning Stock Biomass (SSB) - The weight of all adult females in the population, calculated from the following: In each age class, the number of individuals left alive (times) the percent of those that are mature (times) the average weight of the individuals.

Spawning Stock Biomass Per Recruit (SSBR) - The total contribution of a cohort to the SSB over its lifetime is found by summing the cohort's contributions at each age. This total value can be scaled by the original number of recruits (R), as SSBR, to provide a general case regardless of the absolute number of recruits. Maximum spawning stock biomass per recruit is obtained under the conditions of no fishing mortality. Combinations of instantaneous fishing mortality (F) and the average age at which the cohort becomes subjected to fishery exploitation (t_c) give rise to lower levels of spawning stock biomass per recruit; all of these can be expressed as percentages of the maximum.

Spawning Stock Biomass Per Recruit Ratio or Spawning Potential Ratio (SPR) - A measure of reproductive potential of a fish stock and is defined as the ratio of spawning stock biomass per recruit of its fished magnitude ($SSBR_{fished}$) to its unfished magnitude ($SSBR_{unfished}$).

Standard Length (SL) - is the measurement of a fish, from the most anterior tip of the head (snout) to the base of the tail (caudal fin).

Total Length (TL) - is the measurement of a fish, from the most anterior tip of the head (snout) to the most posterior tip of the tail (caudal fin).

Total Allowable Level of Foreign Fishing (TALFF) - Only that portion of optimum yield which will not be harvested by U.S. fishermen.