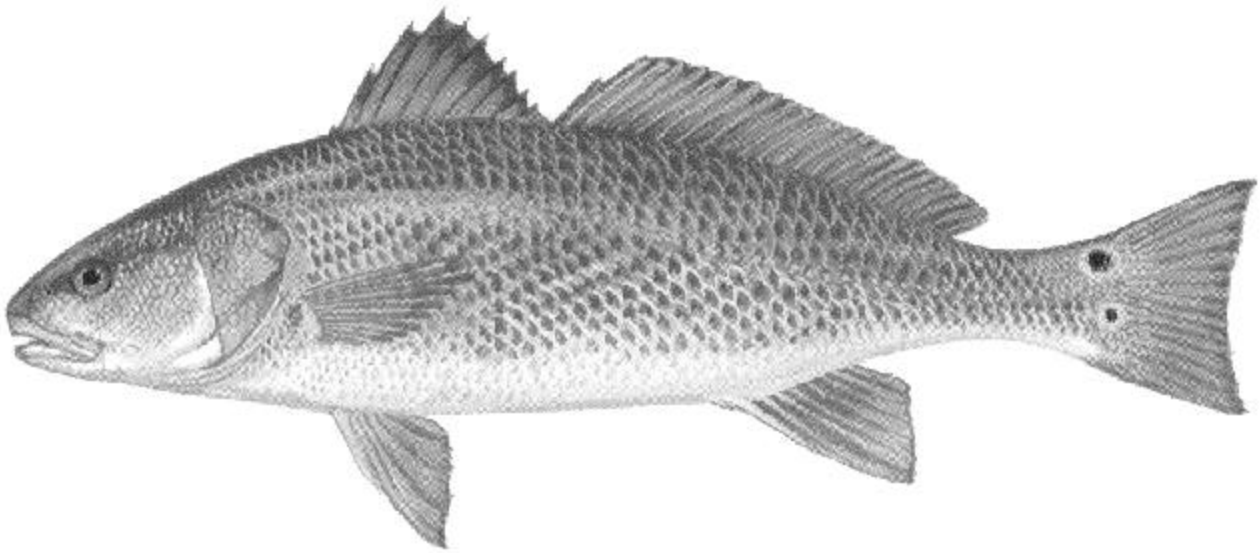
North Carolina
Fishery Management Plan

Red Drum



North Carolina
MARINE
FISHERIES
Dept. of Environment and Natural Resources

March 2001

RED DRUM

FISHERY MANAGEMENT PLAN

PREPARED BY THE

RED DRUM FISHERY MANAGEMENT PLAN ADVISORY COMMITTEE

AND THE

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

Approved March, 2001

1. ACKNOWLEDGEMENTS

The 2000 North Carolina Red Drum Fishery Management Plan (FMP) was developed by the North Carolina Department of Environment and Natural Resources' Division of Marine Fisheries (DMF) under the direction of the North Carolina Marine Fisheries Commission (MFC) with the advice of the Red Drum Public Advisory Committee. Deserving special recognition are the members of the Red Drum Public Advisory Committee and the Plan Development Team who contributed their time and knowledge to this effort.

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3. EXECUTIVE SUMMARY

Goals and Objectives

The goal of the 1999 North Carolina Red Drum Fishery Management Plan (FMP) is to restore the overfished stock of red drum (*Sciaenops ocellatus*) so that it might produce the long-term optimum yield. Plan objectives include:

1. Restore the size and age structure of the adult spawning stock to levels consistent with the FMPs developed under the South Atlantic Fishery Management Council (SAFMC) and the Atlantic States Marine Fisheries Commission (ASMFC). The most recent FMP calls for maintaining a spawning potential ratio (SPR) of 30% to prevent overfishing and an SPR of 40% to obtain optimal yield.
2. Reduce directed and bycatch mortality and increase the escapement of juvenile red drum from inshore nursery areas into the adult spawning stock.
3. Develop an information program to educate the public and elevate their awareness of the causes and nature of problems in the red drum stock, its habitat and fisheries, and explain the rationale for management efforts to solve these problems.
4. Develop regulations that provide adequate resource protection, optimize yield from the fishery, and consider the needs of all user groups.
5. Promote harvest practices that minimize the bycatch of undersized and unmarketable red drum.
6. Restore, improve and protect essential red drum habitat and environmental quality to increase growth, survival, and reproduction of red drum.
7. Improve our understanding of red drum population dynamics and ecology through the continuation of current studies and the development of better data collection methods, as well as, through the identification and encouragement of new research.
8. Initiate, enhance, and/or continue studies to collect and analyze the socio-economic data needed to properly monitor and manage the red drum fishery.

Stock Status and Interim Rules

The red drum stocks in North Carolina were classified as overfished in the 1997 DMF Stock Status Report and were therefore given high priority by the MFC for immediate FMP development. As of this designation, the most up to date stock assessment indicated that the SPR values for red drum were around 9%, well below the overfishing definition of 30%. As a result, interim measures were implemented in October of 1998 to prevent any further decline in the status of the red drum stocks. These interim measures included the following actions:

- Unlawful to possess red drum less than 18 inches total length (TL)

- Unlawful to possess red drum greater than 27 inches TL
- Unlawful to possess more than 100 pounds of red drum per vessel per day taken by commercial fishing equipment
- A one fish recreational creel limit
- A cap on the commercial harvest of 250,000 pounds per year
- Unlawful to use gill nets with a stretched mesh less than 5 inches from May 1 through October 31 in all internal waters unless attended*
  (* this rule was later modified – see Section 4.6 Interim Measures)

The 2000 stock assessment report has since been completed and indicates that the red drum stock in North Carolina is still overfished with best estimates of SPR at 18%. It should be noted that the improvements in these SPR values were based on data from 1992 through 1997 and do not reflect the harvest restrictions implemented as part of this plan through the interim rules process.

Commercial and Recreational Fisheries

While landings typically peak in the fall, red drum are harvested commercially and recreationally on a year round basis throughout North Carolina's estuarine and nearshore coastal waters. Commercially, red drum are harvested using a variety of gears with red drum constituting a bycatch fishery for most trips. In recent years, run around and anchored gill nets have accounted for most of the commercial landings.

The commercial dockside value of the red drum fishery is seasonally variable but has shown an upward trend since the 1970's. The average price paid per pound has steadily increased from $0.12 per pound in 1972 to $0.98 per pound in 1998. The dockside value of red drum in 1998 was $288,000. The total gross fishing income derived from red drum by commercial fishers varies substantially among fishers as well as from year to year. While red drum accounted for less than 2% of the total fishing income for all fishers in 1998, it represented a large share of the total income for the few fishers whose gross sales of red drum exceeded $3,000 (at least 15%).

Recreational anglers account for about 60% of the annual harvest of red drum. Red drum are consistently rated as one of the top target species by shore based recreational anglers. Economic data on the recreational red drum fishery indicate that anglers generate substantial revenues to the state of North Carolina while participating in this fishery. According to a survey conducted in 1997 there were 60,302 trips taken by recreational anglers targeting red drum. The average expenditure for a red drum fishing trip was estimated to be $310.20 for overnight trips and $27.20 for day trips. Overall the recreational red drum fishery in North Carolina was estimated to have generated more than $13 million dollars during 1997.

Habitat and Water Quality

Red drum utilize a variety of estuarine and oceanic habitats throughout their life cycle. The South Atlantic Fishery Management Council has recognized areas of Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC) for red drum. In North Carolina the primary EFH areas

include flooded salt marsh, fresh and brackish marsh, tidal creeks, submerged rooted vascular plants (sea grass), oyster reefs and shell banks, soft sediment bottom, ocean high salinity surf zones and artificial reefs. HAPC are those areas that are known to be critical to a particular life history stage for red drum, including spawning areas and nursery grounds. These areas include all coastal inlets, state-designated nursery habitats known to be important to red drum, currently known spawning sites and any future designated sites of spawning activity, and areas supporting submerged aquatic vegetation (SAV). Based on the importance of these areas to the protection of North Carolina's red drum stocks, a series of management recommendations have been made to protect red drum habitat and water quality. The recommendations are:

1) Protect all submerged aquatic vegetation.

   a) Complete mapping of submerged aquatic vegetation south of Bogue Sound and in the tributaries west of Pamlico and Albemarle sounds.

   b) Support and/or seek funding to conduct follow-up mapping of SAV to assess changes over time.

   c) Designate critical SAV areas, which may include unvegetated shallow areas historically supporting SAV, by MFC rule to prevent degradation from water or land based activities.

   d) Require any threats to designated SAV areas be assessed and any impacts mitigated with more than a 1:1 ratio to compensate for losses.

   e) Request that EMC and CRC prohibit new dredging or channelization in designated SAV areas.

   f) Identify areas where additional bottom-disturbing gear restrictions are needed due to impacts to SAV.

   g) To minimize propeller damage to grass beds in watersheds currently supporting SAV, require a minimum water depth at the terminal end of dock structures and continuous to open waters.

   h) Request that EMC adopt measures needed to fully achieve the identified nutrient reduction goals. Initiate nutrient and sediment load reduction planning in watersheds currently or historically supporting SAV.

   i) Work with CRC, EMC, and ACOE to require that approval or denials of permits are consistent with recommendations made by the MFC and Habitat and Water Quality Committee.

2) Protect important spawning areas.

   a) Support and conduct research to determine location and significance of spawning sites throughout the coast.

b) Designate significant spawning areas by MFC rule and determine if regulations are necessary to protect designated areas from fishing impacts.

c) Request that ACOE and DCM prohibit dredging in designated spawning areas from August to November.

d) Require that impacts to spawning areas be assessed and mitigated for with more than a 1:1 ratio.

e) Comment appropriately through the permit review process on dredging and beach nourishment projects to protect inlet processes and nearshore sand bars for spawning and larval transport.

f) Support recommendations made by the Coastal Habitat Protection Plans which will protect, enhance, or restore important spawning areas.

3) Protect shell bottom.

a) Find resources to complete shell bottom mapping and assess changes to the habitat over time.

b) Find resources to accelerate rebuilding of native oyster beds and other shell features, particularly in Pamlico Sound, as recommended in the Blue Ribbon Task Force on Oysters and the Oyster/Hard Clam FMP.

c) Prohibit all new channel dredging in shell bottom.

d) Require that any impacts to shell bottom be assessed and mitigated for with more than a 1:1 ratio.

e) Protect the condition of shell bottom, and other habitats important to red drum through the permit review process.

f) Support recommendations made by the Coastal Habitat Protection Plans and Oyster/Hard Clam FMP which will protect, enhance, or restore shell bottom.

4) Protect coastal wetlands.

a) Identify coastal wetlands, as well as other habitats, utilized by juvenile red drum through design and implementation of a statistically valid sampling program and assess temporal and spatial changes in recruitment success.

b) Work with CRC to require that bulkheading only be allowed in exceptional circumstances where existing human uses of property are at risk and where bulkheading will cause minimal

damage to marine and estuarine resources. This will require removing bulkheading as a general permit.

c) Require that any impacts to coastal wetlands be assessed and mitigated for with more than a 1:1 ratio.

d) Support and seek funding to remove bulkheads which are not critically necessary and restore the impacted wetlands, using alternative shoreline stabilization techniques when necessary.

e) Require that any impacts to coastal wetlands be assessed and mitigated for within each CHPP unit or watershed to compensate for losses from permitted and unpermitted activities, and coordinated through the North Carolina Wetland Restoration Program.

f) Work with CRC, EMC, and ACOE to require that approval or denials of permits are consistent with recommendations made by the MFC and Habitat and Water Quality Committee.

g) Support recommendations made by the Coastal Habitat Protection Plans which will protect, enhance, or restore coastal wetlands.

h) Determine benthic invertebrate condition in Primary and Secondary Nursery Areas throughout the coast, to assess quality and quantity of food availability.

5) Protect and enhance water quality in estuarine waters.

a) Recommend and support implementation of further measures to achieve identified nutrient reduction targets in all coastal watersheds as soon as possible and at least by identified deadlines.

b) Recommend and support development and implementation of additional measures to reduce sediment delivery and associated turbidity throughout coastal waters.

c) Recommend and support restoration of non-coastal wetlands and floodplains to offset for losses, restore natural water filtering and storage processes, and consequently improve water quality.

d) Support complete implementation of management actions recommended by the Albemarle-Pamlico Estuarine Study Comprehensive Conservation and Management Plan which will protect, enhance, and restore water quality and habitat of red drum.

e) Support recommendations made by the Coastal Habitat Protection Plans which will protect, enhance, or restore red drum habitat.

f) Support or seek funding for research to assess effect of sudden freshwater inputs, carried by storm runoff or canals on juvenile red drum.

Management Issues and Proposed Actions

In an effort to alleviate the fishing pressure on the overfished stocks of red drum, major issues and management options were developed through the FMP process. These issues and options were developed by the NCDMF through the cooperation and advice solicited from public, Red Drum Advisory Committee (RDAC), MFC, Finfish and Regional Advisory committees, as well as the scientific community. In order to achieve the desired goals of this FMP, the MFC, after taking into account the advice and comments from the various participants on this plan, has selected the preferred management options on the management issues. These include:

1. Gill Net Attendance and Other Gill Net Issues
    - Action: Require the attendance of gill nets with a stretch mesh less than 5 inches from May 1 through October 31 in all areas known to be critical juvenile red drum habitat (see Section 10.2.1)

2. Other Gear Restrictions (Circle Hooks and Rod Attendance)
    - Action: Develop an educational document on conservative fishing practices for red drum.

3. Recreational Bag and Size Limits
    - Action: 1 fish bag limit for fish between 18 to 27 inches total length (TL) with no possession of red drum less than 18 inches TL or greater than 27 inches TL.

4. Adult Harvest Limits (Recreational and Commercial)
    - Action: Prohibit all possession of red drum >27 inches TL until the red drum stocks are no longer considered to be overfished (30% SPR).

5. Commercial Harvest Limits (Trip Limits, Annual Cap, and Fishing Year)
    - Action: Allow for a sliding trip limit that can be increased or decreased at the discretion of the Director.
    - Action: Maintain the annual commercial cap at 250,000 lbs.
    - Action: Shift the current fishing year so that monitoring of the Annual Cap begins on September 1 as opposed to January 1.

4. INTRODUCTION

4.1 Legal Authority for Management

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

Many different state laws (General Statutes - G.S.) provide the necessary authority for fishery management in North Carolina. General authority for stewardship of the marine and estuarine resources by the North Carolina Department of Environment and Natural Resources (NCDENR) is provided in G.S. 113-131. The North Carolina Division of Marine Fisheries (DMF) is the arm of the Department which carries out this responsibility. General Statute 113-163 authorizes research and statistical programs. The North Carolina Marine Fisheries Commission (MFC) is charged to "manage, restore, develop, cultivate, conserve, protect, and regulate the marine and estuarine resources of the State of North Carolina" (G.S. 143B-289.51). The MFC can regulate fishing times, areas, fishing gear, seasons, size limits, and quantities of fish harvested and possessed (G.S. 113-182 and 143B-289.52). General Statute 143B-289.52 allows the MFC to delegate the authority to implement its regulations for fisheries "which may be affected by variable conditions" to the Director of DMF who may then issue public notices called "proclamations." Thus, North Carolina has a very powerful and flexible legal basis governing coastal fisheries management. The General Assembly has retained the authority to establish commercial fishing licenses, but has delegated to the MFC authority to set individual permit fees for various commercial fishing gears.

The Fisheries Reform Act of 1997 (FRA) established a process for preparing coastal fisheries management plans in North Carolina. The FRA states that:

> "the goal of the plans shall be to ensure the long-term viability of the State's commercially and recreationally significant species or fisheries. Each plan shall be designed to reflect fishing practices so that one plan may apply to a specific fishery, while other plans may be based on gear or geographic areas. Each plan shall:
>
> A. Contain necessary information pertaining to the fishery or fisheries, including management goals and objectives, status of the relevant fish stocks, stock assessments for multi-year species, fishery habitat and water quality considerations consistent with Coastal Habitat Protection Plans (CHPP) adopted pursuant to G.S. 143B-279.8, social and economic impact of the fishery to the State, and user conflicts.
>
> B. Recommend management actions pertaining to the fishery or fisheries.

C. Include conservation and management measures that prevent overfishing, while achieving, on a continuing basis, the optimal yield from each fishery."

Optimal yield is defined in the FRA as:

"The amount of fish that:

A. Will provide the greatest overall benefit to the State, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems;

B. Is prescribed on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant economic, social, or ecological factor; and

C. In the case of an overfished fishery, provides for rebuilding to a level consistent with producing the maximum sustainable yield in the fishery."

4.2 Goals and Objectives

The goal of the 1999 North Carolina Red Drum Fishery Management Plan (FMP) is to restore the overfished stock of red drum (*Sciaenops ocellatus*) so that it might produce the long-term optimum yield. To achieve these goals, it is recommended that the following objectives be met:

1. Restore the size and age structure of the adult spawning stock to levels consistent with the FMPs developed under the South Atlantic Fishery Management Council (SAFMC) and the Atlantic States Marine Fisheries Commission (ASMFC). The most recent FMP calls for maintaining a spawning potential ratio (SPR) of 30% to prevent overfishing and an SPR of 40% to obtain optimal yield.
2. Reduce directed and bycatch mortality and increase the escapement of juvenile red drum from inshore nursery areas into the adult spawning stock.
3. Develop a information program to educate the public and elevate their awareness of the causes and nature of problems in the red drum stock, its habitat and fisheries, and explain the rationale for management efforts to solve these problems.
4. Develop regulations that provide adequate resource protection, optimize yield from the fishery, and consider the needs of all user groups.
5. Promote harvest practices that minimize the bycatch of undersized and unmarketable red drum.
6. Restore, improve and protect essential red drum habitat and environmental quality to increase growth, survival, and reproduction of red drum.

7. Improve our understanding of red drum population dynamics and ecology through the continuation of current studies and the development of better data collection methods, as well as, through the identification and encouragement of new research.
8. Initiate, enhance, and/or continue studies to collect and analyze the socio-economic data needed to properly monitor and manage the red drum fishery.

4.3 Optimum Yield

The FRA mandates that fishery stocks be managed to produce Optimum Yield (OY). OY for the North Carolina red drum fishery will be defined as the amount of harvest, including release and discard mortality, that can be taken while maintaining a SPR at or above 40% the level that would result if fishing mortality did not exist (F=0). The red drum fishery in North Carolina will be considered to be overfished when the SPR is below 30% or when the harvest rate if continued would lead to SPR levels which will eventually result in SPR's below 30% and not allow harvest at OY on a continued basis.

4.4 Management Unit

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

4.5 General Problem Statement

The 2000 stock assessment report indicates that the red drum stock in North Carolina is overfished. The purpose of this plan is to recommend management measures that will restore the North Carolina red drum stock to levels above the overfished definition and ensure production of long-term optimum yield. Areas to be addressed in the management of North Carolina's red drum fishery are: 1) management strategies; 2) insufficient data and research needs; 3) habitat and water quality; and 4) socioeconomic factors.

4.6 Interim Measures

The guidelines that the MFC follows in setting priorities for the development of FMPs state that **priority** will be afforded those species whose status is designated as **overfished** or of **concern** on the DMF Stock Status Report.

The DMF is required, under the MFC guidelines, to recommend to the appropriate standing committee(s) any preservation management measures necessary and appropriate to maintain the well-being of the stock. These measures are intended to prevent further declines in an overfished fishery while a FMP is being developed.

Red drum were classified as overfished in the 1997 DMF Stock Status Report and were therefore given a high priority by the MFC for the immediate development of a fishery management plan. The MFC approved the following temporary rules in October 1998 to prevent declines in the stock during FMP development:

- Unlawful to possess red drum less than 18 inches total length (TL)
- Unlawful to possess red drum greater than 27 inches TL
- Unlawful to possess more than 100 pounds of red drum per vessel per day taken by commercial fishing equipment
- A one fish recreational creel limit
- A cap on the commercial harvest of 250,000 pounds per year.
- Unlawful to use gill nets with a stretched mesh less than 5 inches from May 1 through October 31 in all internal waters unless attended

The statewide gill net attendance rule was enacted to protect undersized red drum from high mortality resulting from bycatch in small mesh nets during the warmer months of the year. The original specification of the rule threatened to eliminate traditional small mesh gill net fisheries prosecuted during the spring and summer in deep water areas not typically inhabited by undersize red drum; the rules were modified in 1999 to reduce adverse impacts on such fisheries. The Director of Marine Fisheries suspended the temporary rule and enacted alternative requirements through proclamation in May 1999. The proclamation requires gill net attendance from May 1 through October 31 in the following areas:

- All primary and permanent secondary nursery areas
- All current and modified "No Trawl" areas
- Upper portions of the Pamlico, Pungo, Neuse, and Trent rivers
- Within 200 yards of any shoreline*

(*provision does not apply during October to the areas from the northern end of Core Sound south to the South Carolina line to allow the fall spot fishery to be prosecuted)

These revisions to the rule allow for protection of juvenile red drum in areas where they are typically found, such as shallow bays, creeks, and shorelines, as well as the shallow grass beds along the 'Outer Banks'. Deepwater areas where juvenile red drum are not typically found are exempt from the gill net attendance requirement. The MFC adopted the modified attendance requirements as a temporary rule that became effective on October 2, 1999. Detailed gill net rules can be found in Section 4.7.3. Specific problems associated with the bycatch of undersized red drum in gill nets are outlined in Section 10.2.1.

4.7 Existing Plans, Statutes, and Rules

4.7.1 Existing Plans

Red drum along the Atlantic coast are managed jointly by the Atlantic States Marine Fisheries Commission (ASMFC) and the South Atlantic Fishery Management Council (SAFMC). The ASMFC adopted an FMP for red drum along the Atlantic coast from Maryland through Florida in 1984 (ASMFC, 1984), then revised the FMP in 1988 when the Interstate Fisheries Management Program (ISFMP) Policy Board requested that all states from Maine through Florida implement plan requirements to prevent development of northern markets for southern fish. The SAMFC Red Drum FMP (SAMFC, 1990) was developed and passed in 1990 and was subsequently adopted as Amendment 1 to the ASMFC Red Drum FMP (ASMFC, 1991). This joint FMP, or Amendment 1, stated that intense fishing mortality on juvenile red drum in state waters was resulting in reduced recruitment to the adult spawning stock; this statement was supported by the 1990 stock assessment report which indicated that the red drum stock was overfished with extremely low SPR values ranging from 2-3 percent (Vaughan, 1990). The plan recommended closing the Exclusive Economic Zone (EEZ) to all harvest and possession of red drum to protect the adult stock and thereby placed further regulatory responsibility with the states. Amendment 1 also required that states adopt measures to prevent overfishing and rebuild the stock to a target of 30% SPR. Rebuilding was scheduled to occur in steps, starting with an initial goal of 10% SPR. This initial step required states to adopt one of two options: 1) 18-inch TL minimum, 27-inch TL maximum, and a five fish bag limit with the option of one fish exceeding 27-inch TL; or 2) 14-inch minimum, 27-inch TL maximum, and a 5 fish bag limit, with no fish exceeding 27-inches TL. North Carolina adopted option 1 in 1992. The most recent stock assessment (Vaughan and Carmichael, 2000) showed that SPR increased to 18% for the period of 1992-1997, indicating that the management measures imposed under the Amendment 1 were successful in improving the stock.

All states are in compliance with Amendment 1 and the initial SPR goal of 10 % has been met for both the Northern and Southern regional stocks. However, red drum are still overfished, as the overfishing target of 30% SPR has not been achieved. The ASMFC has not adopted further amendments to the FMP, although additional management measures will be necessary to fully rebuild the stock. In North Carolina the FRA requires management measures which prevent overfishing and rebuild the red drum stock to levels consistent with producing the long-term optimal yield. As a result, North Carolina has taken a pro-active role in management with the recent implementation of the interim rules (Section 4.6) to protect red drum. While current rules for red drum are more restrictive than what the ASMFC currently requires, development of Amendment 2 to the ASMFC red drum plan will likely evaluate whether they deem North Carolina's current restrictions as sufficient to prevent overfishing of the red drum stock.

The SAFMC recently adopted a target fishing mortality level to provide optimum yield that corresponds to 40% SPR and a threshold overfishing definition of 10% SPR to comply with provisions of the Sustainable Fisheries Act (SFA). Under SFA guidelines, if SPR levels fall below 10 percent, fishing mortality rates must be equal to F=0. The ASMFC plan still calls for a goal of 30 percent SPR however, an amendment to the FMP will be required to resolve the current disparity in management

goals. The ASMFC ISFMP approved development of Amendment 2 to the Red Drum FMP in March 2000. The amendment will likely address both the additional management measures necessary to fully recover the stocks and the disparity between the current SAFMC and ASMFC rebuilding targets and should be developed over the next year.

4.7.2 Statutes

All management authority for North Carolina's red drum fishery is vested in the State of North Carolina. General authorities that are noted in Section 4.1 provide the MFC with the regulatory powers to manage red drum. Although most red drum harvest is taken from coastal waters, the limited harvest from inland waters falls under the jurisdiction of the North Carolina Wildlife Resources Commission (WRC).

4.7.3 Rules

The following rules have been enacted to manage red drum stocks in North Carolina through the authority vested in the MFC.

SUBCHAPTER 3M-FINFISH

SECTION .0500 - OTHER FINFISH

.0501 RED DRUM

.0501 RED DRUM

(a) The Fisheries Director, may by proclamation, impose any or all of the following restrictions on the taking of red drum:

(1) Specify areas.
(2) Specify seasons.
(3) Specify quantity for fish taken by commercial gear.
(4) Specify means/methods.
(5) Specify size for fish taken by commercial gear.

(b) It is unlawful to remove red drum from any type of net with the aid of any boat hook, gaff, spear, gig, or similar device.

(c) It is unlawful to possess red drum less than 18 inches total length or greater than 27 inches total length.

(d) It is unlawful to possess more than one red drum per person per day taken by hook-and-line or for recreational purposes.

(e) It is unlawful to possess more than 100 pounds of red drum per vessel per day taken in a commercial fishing operation, regardless of the number of individuals or vessels involved.

(f) The annual commercial harvest limit (January through December) for red drum is 250,000 pounds. If the harvest limit is projected to be taken, the Fisheries Director shall, by proclamation, prohibit possession of red drum taken in a commercial fishing operation.

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. March 1, 1996; October 1, 1992; September 1, 1991;
Temporary Amendment Eff. May 1, 2000; July 1, 1999; October 22, 1998.

SUBCHAPTER 3J - NETS, POTS, DREDGES, AND OTHER FISHING DEVICES
SECTION .0100 - NET RULES, GENERAL
SECTION .0103 GILL NETS, SEINES, IDENTIFICATION, RESTRICTIONS

(a) It is unlawful to use a gill net with a mesh length less than 2-1/2 inches.

(b) The Fisheries Director may, by proclamation, limit or prohibit the use of gill nets or seines in coastal waters, or any portion thereof, or impose any or all of the following restrictions on the use of gill nets or seines:
(1) Specify area;
(2) Specify season;
(3) Specify gill net mesh length;
(4) Specify means/methods;
(5) Specify net number and length;

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

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

(d) It is unlawful to use gill nets:

(1) Within 200 yards of any pound net with lead and pound or heart in use;

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

(e) It is unlawful to use gill nets within 100 feet either side of the center line of the Intracoastal Waterway Channel south of Quick Flasher No. 54 in Alligator River at the southern entrance to the Intracoastal Waterway to the South Carolina line, unless such net is used in accordance with the following conditions:

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

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

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

(f) It is unlawful to use drift gill nets in violation of 15A NCAC 3J .0101(2) and Paragraph (e) of this Rule.

(g) It is unlawful to use unattended gill nets with a mesh length less than five inches in a commercial fishing operation in the following areas:

(1) Pamlico River, west of a line beginning at a point on Mauls Point at 35° 26' 56" N - 76° 55' 33" W; running 066° (M) to a point on Ragged Point at 35° 27' 33" N - 76° 54' 23" W;

(2) Within 200 yards of any shoreline in Pamlico River and its tributaries east of the line from Mauls Point at 35° 26' 56" N - 76° 55' 33" W; running 066° (M) to Ragged Point at 35° 27' 33" N - 76° 54' 23" W and west of a line beginning at a point on Pamlico Point at 35° 22' 18" N - 76° 29' 00" W ; running 018° (M) through Marker #1 to a point on Roos Point at 35° 18' 48" N - 76° 28' 16" W;

(3) Pungo River, east of a line beginning at a point on Durants Point at 35° 30' 30" N - 76° 35' 12" W; running 319° (M) to the northern side of the breakwater at 35° 31' 48" N - 76° 36' 53" W;

(4) Within 200 yards of any shoreline west of a line beginning at a point on Wilkinson Point at 34° 57' 53" N - 76° 48' 15" W; running 203° (M) to a point on Cherry Point at 34 °56' 27" N - 76° 48' 42" W.

(h) It is unlawful to use unattended gill nets with a mesh length less than five inches in a commercial fishing operation from May 1 through October 31 in the following internal coastal and joint waters of the state south of a line beginning at a point on Roanoke Marshes Point at 35° 48' 12" N - 75° 43' 06" W; running 122° (M) to a point on Eagle Nest Bay at 35° 44' 12" N - 75° 31' 09" W to the South Carolina State Line:

(1) All primary nursery areas described in 15A NCAC 3R .0103, all permanent secondary nursery areas described in 15A NCAC 3R .0104, and no trawl areas described in 15A NCAC 3R .0106(3),(4),(6), and (7);

(2) In the area along the Outer Banks, beginning at a point on Core Banks at 34° 58' 49" N - 76° 09' 59" W; running 292° (M) to a point on Wainwright Island at 34° 59' 28" N - 76° 12' 28" W; running 026° (M) to a point at 35° 00' 16" N - 76° 12' 12" W; running 034° (M) to a point at 35° 01' 35" N - 76° 11' 27" W; running 059° (M) to a point at 35° 06' 24" N - 76° 04' 20" W; running 044° (M) to a point at 35° 08' 26" N - 76° 02' 30" W; running 090° (M) to a point at 35° 09' 18" N - 75° 54' 49" W; running 063° (M) to a point 35° 19' 02" N - 75° 36' 19" W; running 038° (M) to a point at 35° 22' 48" N - 75° 33' 36" W; running 026° (M) to a point at 35° 28' 27" N - 75° 31' 21" W; running 010° to a point at 35° 35' 59" N - 75° 31' 12" W; running 355°(M) to a point 35° 45' 11" N - 75° 34' 06" W; running 122° (M) to a point at 35° 44' 11" N - 75° 31" 05" W. Thence running south along the shoreline across the inlets to the point of beginning;

(3) In Back and Core sounds, beginning at a point on Shackleford Banks at 34° 39' 59" N - 76° 34' 16" W; running 004°(M) to a point at Marker #3 at 34° 41' 19" N - 76° 33' 50" W; thence running 103° (M) to a point at 34° 40' 27" N - 76° 30' 41" W; thence running 019° (M) to a point near Marker ?A37" at 34° 43' 35" N - 76° 28' 35" W; thence running 350° (M) to a point at 34° 43' 45" N - 76° 28' 36" W; thence running 025° (M) to a point at 34° 48' 09" N - 76° 24' 47" W; thence running 042° (M) to a point near Drum Inlet at 34° 51' 03" N - 76° 20' 18" W; thence running 034° (M) to a point at 34° 53' 25" N - 76° 17' 21" W; thence running 008° (M) to a point at 34° 53' 55" N - 76° 17' 07" W; thence running 110° (M) to a point at 34° 53' 33" N - 76° 16' 25" W; thence running 026° (M) to a point at 34° 56' 33" N - 76° 13' 37" W; thence running 094° (M) to a point at 34° 56' 29" N - 76° 13'17" W; thence running 013° (M) to a point at 34° 58' 11" N - 76° 12' 18" W; thence running 330° (M) to a point at 34° 58' 48" N - 76° 12' 31" W; thence running 000° (M) to a point on Wainwright Island at 34° 59' 26" N - 76° 12' 22" W; thence running 096° (M) to a point on Core Banks at 34° 58' 49" N - 76° 09' 59" W; thence following the shoreline south across Drum and Barden inlets to the point of beginning;

(4) Within 200 yards of any shoreline, except from October 1 through October 31, south and east of Highway 12 in Carteret County and south of a line from a point on Core Banks at 34° 58' 49" N - 76° 09' 59" W; running 292° (M) to Camp Point at 35° 00' 05" N - 76° 14' 48" W to the South Carolina State Line.

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

5. GENERAL LIFE HISTORY

5.1 Description and Distribution

The red drum is one of twenty-two members of the drum family (Sciaenidae) that includes many of North Carolina's most important inshore commercial and recreational species. Species in this family are typically known as the drums, and other common drum species landed in North Carolina include weakfish, Atlantic croaker, spot, spotted seatrout, kingfishes (sea mullet), and black drum. Red drum and many others in this family produce drumming sounds by vibrating their swim bladders with special muscles. Other common names for red drum include channel bass, redfish, spottail bass, and puppy drum. Red drum are common along the Atlantic coast over a wide range of habitats from Chesapeake Bay to Key West, Florida. Historically, landings reached as far north as Massachusetts and there was a moderate commercial fishery off the coast of New Jersey in the 1930's. There are few reports of landings from areas north of Chesapeake Bay since the 1950's, which suggests a decline in red drum distribution along the Atlantic coast.

5.2 Reproduction and Development

Red drum spawning has long been accepted to occur at night in high salinity areas in or around the major estuarine passes and inlets (Pearson, 1929; Johnson, 1978). There is now evidence that substantial spawning activity may take place inside the estuaries. Red drum have been collected in spawning condition inside Hatteras and Ocracoke Inlets and near the mouths of bays and rivers on the western side of Pamlico Sound (Ross et al., 1995). Researchers from East Carolina University using hydrophones to detect spawning sounds documented spawning activity of red drum near Ocracoke Inlet and on the western side of Pamlico Sound near Bay River (Figure 1). Eggs captured during this survey were identified as red drum eggs and provide further evidence of spawning activity within the estuary (Luzkovich et al., 1999).

Laboratory tests show optimal conditions for spawning are salinities ranging from 25-35 ppt and temperatures between 22-30 ° C (Holt et al., 1981). The buoyant eggs are small (approximately 1 mm in diameter) and hatch within 24 to 36 hours of fertilization. Larvae, while found over a wide range of salinities (0-33 ppt) in North Carolina (Ross and Stevens, 1992), have been shown in laboratory experiments to have optimum growth and survival at salinity levels between 5-10 ppt (Neill, 1987). Larvae are distributed throughout the estuary by tidal and wind driven currents. The majority will be transported to the upper reaches of the estuary where they settle out in shallow, low-salinity nursery areas with abundant food supplies, such as coastal creeks, protected bays with sandy or muddy bottoms, and grass beds (Mercer, 1984; Daniel; 1988; Wenner et al., 1990; Ross et al., 1992).

Red drum are eurythermal and have been collected over a wide range of temperatures ranging from 2° C to 33° C (Simmons and Breuer, 1962). During extreme cold conditions in the

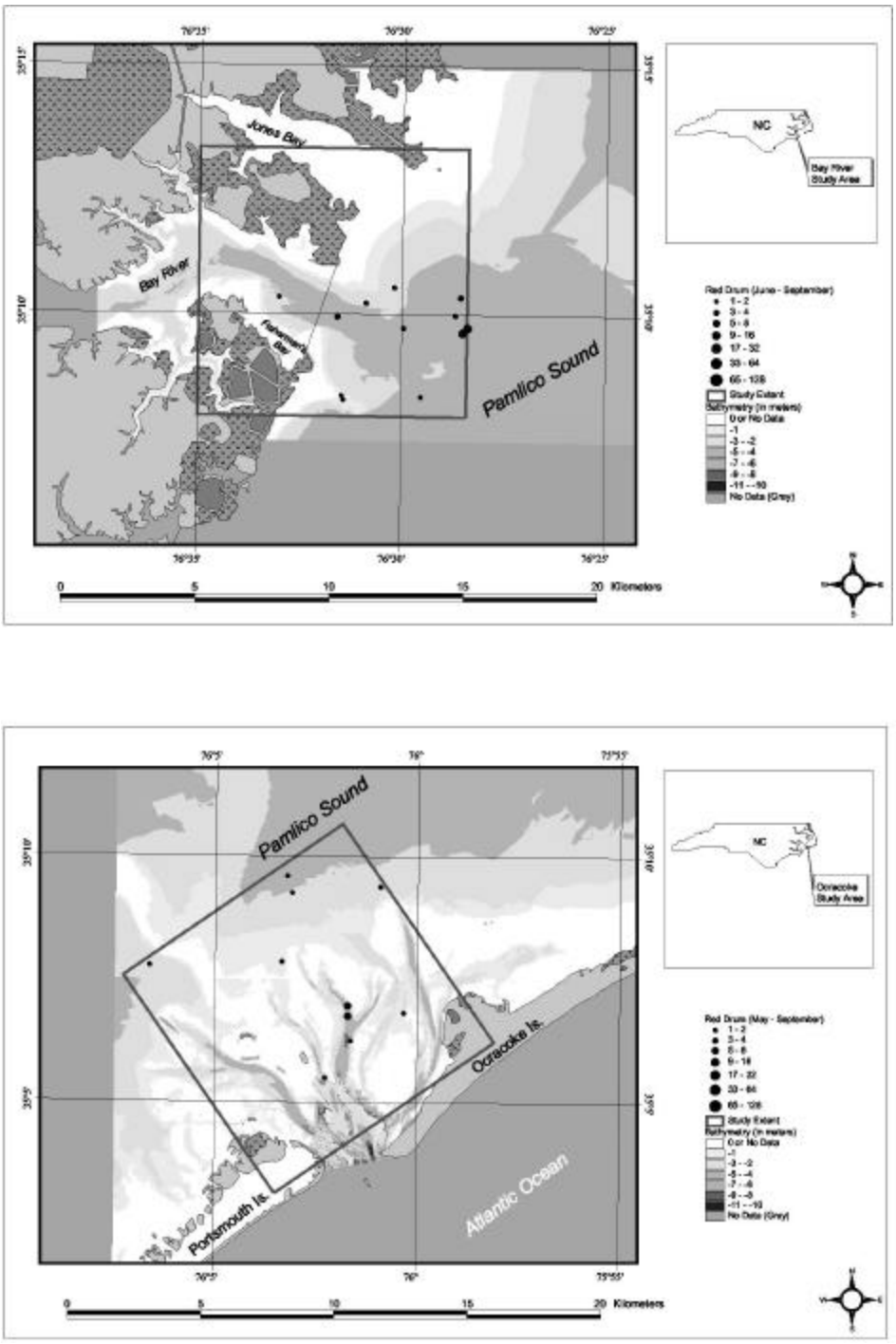


Figure 1. Red drum spawning sites identified in the Bay River and Ocracoke Inlet areas through acoustic sampling (Luczkovich et al., 1999).

winter, small juvenile red drum leave the shallow water habitats for channels and other deep water areas and then return to shallow water areas the following spring as water temperatures rise (Wenner et al.,

1990). The distribution of larvae and juveniles in the estuary varies seasonally as the fish grow and disperse. In North Carolina, juvenile red drum are found year-round over a wide range of salinity and habitats, although they generally prefer the shallow shorelines of the various bays and rivers, and the shallow grass flats behind the barrier islands (Ross and Stevens, 1992).

Red drum grow rapidly during their first year, reaching 9-10 inches TL by early summer when they leave the shallow nursery grounds, and 12 to 14 inches TL by their first birthday in September. The legal size limit of 18 inches TL is reached when they are around 20 months old during the late fall and early spring (Daniel, 1988; Wenner et al., 1990; Ross et al., 1995), and most grow beyond the maximum size limit of 27 inches TL during their second full year of life. Red drum mature 1-2 years later at 3 to 4 years old and 30 to 36 inches TL (Ross et al., 1995). Once mature, red drum tend to spend more time in the ocean but are still estuarine dependent as they come inshore to feed, develop, and spawn. The oldest red drum aged was captured in North Carolina waters and was 62 years of age (Ross et al., 1995).

5.3 Diet and Food Habits

The diet of red drum during various stages of development has been studied by Daniel (1988), Music and Pafford (1984), and reported in SAFMC (1990). Stomach content analysis shows that dominant food sources coincide with habitat changes. Early juveniles 0.2-0.6 inches TL preyed on copepods, while mysids, small benthic shrimp common in salt marsh, were the dominant food source for juveniles 0.6-1.2 inches TL. The diet preference shifts to fish for red drum between 3.0-6.0 inches TL, coinciding with movement out of shallow marshes and into deeper creeks in the winter. Decapod crustaceans, predominantly mud crabs and fiddler crabs, comprise 96% of the diet of red drum between 7.9-11.8 inches TL. Red drum over 11.8 inches TL depend on a more diverse food base, although they remain a predominately benthic feeder. Overall, crustaceans comprised 72% of their prey, fish comprised 17% and plant matter comprised 11%. Fiddler crab and mud crab were the overall predominant prey.

5.4 Migration Patterns

The movements of juvenile and adult red drum were summarized by Mercer (1984) and described from tagging studies conducted by DMF from 1986 through 1995 (Ross and Stevens, 1992; Marks and DiDomenico, 1996). Tagging studies in North Carolina, consist of two segments: tagging of one-year old sub-adult red drum by Division staff, and tagging of adult red drum by anglers participating in a state-sponsored volunteer tagging program. More than 25,000 red drum have been tagged since the mid-1980's (Figure 2).

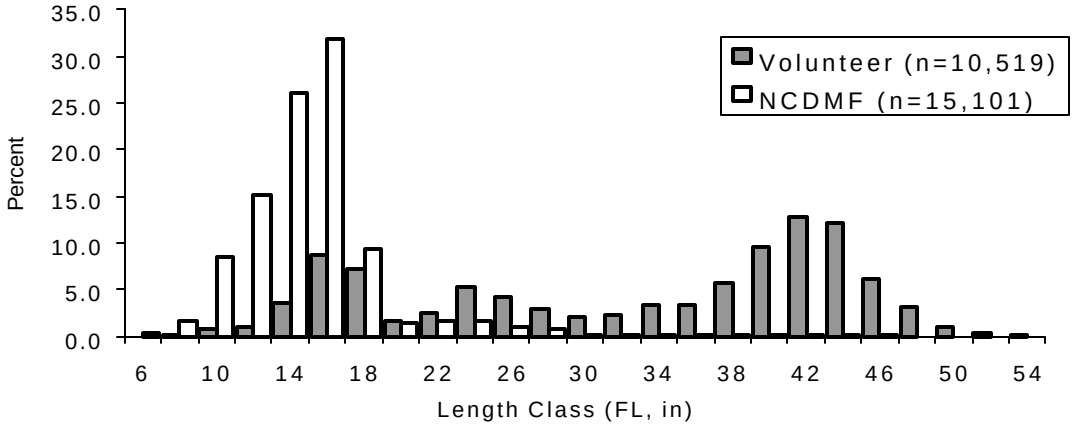


Figure 2. Length frequency of red drum tagged in North Carolina (all gears combined), 1983-1998. Data are divided into fish tagged by Division staff and those tagged by recreational anglers through the cooperative volunteer tagging program (Source: NCDMF unpublished).

Most of the DMF tagging effort is concentrated during June through October in the Pamlico and Neuse rivers and over grass flats behind the barrier islands of Pamlico Sound, while tagging efforts by the volunteer participants occur year round throughout state coastal waters. Late age 0 and age 1 red drum show limited movement. During 1991-1995, over 65% of tagged red drum under 18 inches were recaptured 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. Tag returns indicate that in the fall a portion of the sub-adult 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. Sub-adults residing near coastal inlets and barrier islands during the summer likely enter the surf in the fall. Tag return rates are low during winter, with most returns coming from sub-adults recaptured in the estuaries and a few 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 sub-adults continuing to be recaptured in the rivers. Red drum of age 2 to 3 have generally left the coastal rivers and are recaptured along the barrier islands, the shallow water areas around the outer bars and shoals of the surf, and in coastal inlets, over inshore grass flats, creeks or bays.

Movements of adult red drum have been documented through recreational and commercial landings records and through the state-sponsored volunteer tagging program. During the spring adult red drum occur along the beaches and inlets for one to two months as they move from offshore wintering grounds and appear in recreational catches of surf fishermen primarily from Cape Lookout to Cape Hatteras. Large aggregations have been observed around Ocracoke, Hatteras, and Oregon inlets. A large portion of the population moves inside Pamlico Sound during the summer months, while other schools of fish are reported to continue moving north to the Chesapeake Bay and the Virginia barrier islands. Schools of adult fish are common in coastal inlets and in Pamlico Sound, particularly in

the mouth of the Pamlico and Neuse rivers, during the spawning season in August and September. 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. Mercer (1984) documented schools of large red drum moving south from Virginia waters and along the coastal beaches of the Outer Banks during the fall. Anglers have reported catches of large red drum during December around the shoals and outer bars of the barrier islands and around submerged structures up to a couple of kilometers offshore. By late December, most large red drum have moved offshore where they are no longer available to near-shore fishing activity.

6. STATUS OF STOCKS

Red drum were designated as overfished in the DMF's 1999 Stock Status Report due to high fishing mortality rates and low recruitment of juvenile fish to the adult stock (NCDMF, 1999). 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 (NC to MD) and Southern (SC to FL) 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 all the commercial landings, an average of 85% of the recreational landings, and the only fishery-independent data that are available for the region.

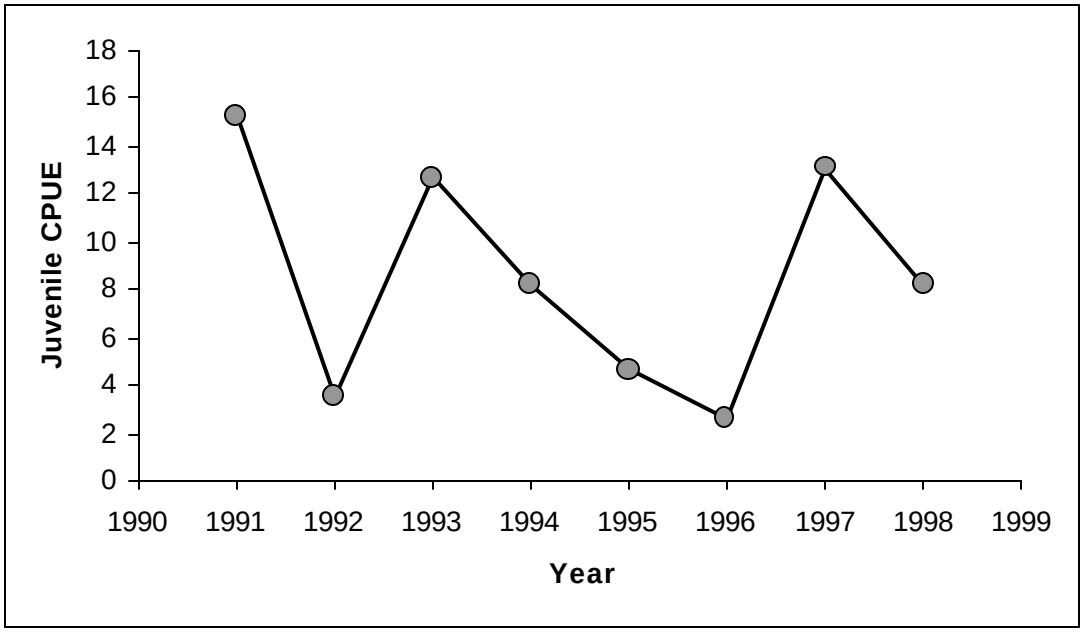
An updated stock assessment including fishery and survey data through 1998 considered several population models and attempted to account for the increasing proportion of red drum that are released by recreational fishermen (Vaughan and Carmichael, 2000). After reviewing the recent assessment, the Red Drum Assessment Group (RDAG) determined that the preferred approach incorporated the FADAPT model and the "Delta" catch at age matrix (RDAG, 2000). The Delta catch at age matrix includes 10% discard mortality of released fish allocated into length classes based on the difference in length distributions before and after the implementation of slot limits. The status of red drum in North Carolina presented here is summarized from Vaughan and Carmichael's (2000) assessment of Northern region red drum based on the RDAG's preferred model configuration (See Appendix 1 and 2 for details).

The red drum stock in North Carolina is overfished. It should be noted, however, that this designation is based on data through 1998 and does not reflect the full impacts of the harvest restrictions implemented late in the 1998 fishing season. Best estimates of SPR for the North Carolina stock are 18% for the period of 1992-1997, still well below the overfishing definition of 30%, but significantly improved over the average for 1986-1991 of 1.3%. 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 inches total length.

Juvenile abundance survey data also reflect recent improvements in the stock. Survey values declined steadily from 1993 to 1996, then increased to the second-highest observed value in 1997 and remained about average in 1998 (Figure 3). The restrictive regulations implemented in 1998 should afford these cohorts considerable protection and lead to further increases in escapement and SPR as they reach maturity.

Figure 3. North Carolina juvenile abundance index for red drum, 1991-1998.



Although there are currently no data to assess the abundance of the adult stock and calculate spawning stock biomass, age frequency distributions have been used as crude indicator of trends in this component of the population. Comparison of length frequencies collected from 1969-1971 with those from 1986-1991 and 1992-1998 shows that a greater proportion of the 1969-1971 sample was composed of adult fish, which suggests that a greater proportion of older fish were available in 1969-1971 than in either of the more recent periods (Figure 33). Further, many more cohorts were represented in the sample of adult fish from the 1969-1971 period than in samples from the more recent periods. Overall, these comparisons suggest that the adult red drum population declined significantly over the last 30 years.

The DMF has tagged red drum in estuarine waters since 1986 to determine migration patterns and estimate mortality of the exploited age classes. Ross et al. (1995) reported first-year recapture

rates, adjusted for tag loss and mortality, of 51 to 62% for juvenile and sub-adult red drum from the 1985-1989 cohorts. These high recapture rates resulted in low survival estimates (6 – 24%) and high first-year exploitation rates (46-62%) that correspond to annual F rates of F=1.24 to F=2.54. First year recaptures, adjusted for tag loss and mortality, dropped somewhat from 1990-1995, averaging 29% of the fish released and ranging from 21 to 52%. However, survival remained low, only averaging about 22% (F=1.3) over the period.

Quantitative assessment results, tag-based survival estimates, and survey data all indicate that red drum were severely overfished during most of the last 15 years. The stock has improved gradually, and SPR and escapement estimates have continually increased in the last ten years. However, the stock must still improve considerably if it is to surpass the 30% SPR overfishing definition and ultimately reach the management target of 40% SPR. Furthermore, since management is based on attaining a certain level of escapement to the adult stock, there are no data available to assess the current status of the adult population, and a healthy adult population should ideally contain individuals approaching maximum age of 60 years. In order for the red drum stock to be considered healthy and viable, the 40% SPR target must be maintained continuously over time. Increases in the harvest rates (relaxation of current regulations) of red drum should only be allowed if those increases do not result in lowering SPR values below the overfishing definition.

7. DESCRIPTION OF FISHERIES

7.1 Commercial Fishery

Red drum are commercially harvested in North Carolina using a variety of gears and constitute a bycatch fishery for most gears and trips. A small, seasonally directed fishery along the Outer Banks peaks in the fall. 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. 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. Annual landings during the 1970's averaged 83,074 lbs/year and ranged from 7,500 to 201,941 lbs (Figure 4). Annual landings from the 1980's were greater than those from the 1970's, averaging 203,813 lbs/year and ranging from 52,561 to 283,020 lbs. Landings during the 1990's averaged 166,256 lbs./year and ranged from 52,502 to 294,366 lbs. The majority of the landings have historically originated from Pamlico and Core sounds and the Atlantic Ocean (Table 1). No commercial gear dominated landings during the 1970's. Long haul seines and common haul seines were generally the most productive, although gill nets, pound nets, and fish trawls occasionally dominated. Anchored and run-around gill nets were the dominant gear

Table 1. Commercial landings of red drum in North Carolina by percent by water area (Source: NMFS, North Carolina Trip Ticket Program 1999).

Year	New River	Newport River	North River	Pamlico River	Pamlico Sound	Pasquotank River	Perquimans River	Pungo River	Roanoke River	Roanoke Sound	Shallotte River	Stump Sound	Topsail Sound	White Oak River
72	0.00	0.00	0.00	0.45	34.32	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00
73	0.00	0.00	0.00	0.00	19.41	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00
74	0.00	0.19	0.00	1.50	36.57	0.00	0.00	0.00	0.00	5.51	0.00	0.00	0.00	0.00
75	0.00	0.07	0.00	0.33	25.12	0.00	0.00	0.00	0.00	2.29	0.00	0.00	0.00	0.00
76	0.00	0.00	0.00	1.03	32.57	0.00	0.00	0.00	0.00	2.46	0.00	0.00	0.00	0.00
77	0.00	0.00	0.00	0.00	33.13	0.00	0.00	0.00	0.00	0.96	0.00	0.00	0.00	0.00
78	0.00	0.00	1.24	0.05	14.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
79	0.00	0.87	0.99	5.09	27.86	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.00
80	0.00	0.67	3.03	0.04	36.44	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00
81	0.00	1.22	1.80	0.56	53.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
82	0.17	1.85	1.95	0.00	14.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
83	4.21	5.29	3.79	0.94	24.27	0.00	0.00	0.00	0.00	0.18	0.00	0.84	0.84	0.50
84	2.30	4.66	2.24	0.91	7.16	0.00	0.00	0.00	0.00	0.69	0.00	0.59	1.17	0.36
85	4.61	5.53	5.64	0.01	9.45	0.00	0.00	0.00	0.00	0.02	0.00	1.33	1.50	1.61
86	2.27	3.21	2.59	4.29	24.65	0.00	0.00	0.00	0.00	0.19	0.00	0.71	1.46	0.93
87	1.58	4.75	2.15	2.52	28.85	0.00	0.00	0.00	0.00	1.05	0.00	0.05	0.72	0.65
88	1.51	4.39	3.82	2.99	24.96	0.00	0.00	0.00	0.00	0.18	0.14	0.00	0.76	0.45
89	0.91	1.97	1.78	0.97	35.68	0.00	0.00	0.00	0.00	0.52	0.00	0.01	0.35	0.60
90	2.39	2.02	1.98	0.15	35.34	0.00	0.00	0.00	0.00	0.37	0.03	0.00	0.91	1.11
91	3.52	6.29	3.96	1.11	36.94	0.00	0.00	0.00	0.00	0.39	0.00	0.19	1.30	1.34
92	2.25	0.62	0.40	1.22	47.02	0.00	0.00	0.00	0.00	1.18	0.00	0.30	0.94	1.03
93	1.24	0.66	0.50	0.89	41.23	0.61	0.00	0.00	0.00	1.78	0.00	0.08	0.40	0.48
94	0.63	0.09	0.07	1.40	51.77	0.19	0.63	0.00	0.01	0.22	0.01	0.41	0.28	0.33
95	2.97	0.04	0.23	3.59	63.39	0.02	0.00	0.47	0.00	0.44	0.04	0.54	0.25	0.40
96	2.13	0.99	0.33	1.42	42.75	0.00	0.01	0.26	0.00	0.25	0.01	0.31	0.46	0.61
97	0.37	0.55	1.30	1.19	40.02	0.01	0.00	0.22	0.00	2.17	0.01	0.18	1.29	0.36
98	0.66	0.30	0.13	0.87	76.40	0.14	0.00	0.15	0.00	3.70	0.00	0.07	0.38	0.28

Year	Albemarle Sound	Alligator River	Atlantic Ocean	Bay River	Bogue Sound	Cape Fear River	Core Sound	Croatan Sound	Currituck Sound	Inland Waterway	Lockwood Folly	Masonboro Sound	Neuse River
72	0.70	0.00	40.39	0.00	0.24	0.00	20.07	0.00	0.00	0.00	0.00	0.00	3.59
73	0.24	0.00	46.69	0.00	0.00	0.35	31.79	0.00	0.00	0.00	0.00	0.00	1.21
74	0.65	0.00	24.87	0.00	0.84	0.10	28.87	0.10	0.00	0.00	0.00	0.08	0.72
75	6.12	0.00	50.97	0.00	0.34	0.05	10.51	0.25	0.05	0.00	0.00	0.00	3.89
76	18.22	0.00	16.56	0.00	0.56	0.07	3.01	0.00	0.00	0.08	0.08	0.11	25.25
77	0.00	0.00	31.84	0.00	0.00	0.72	20.81	0.00	0.00	0.00	0.00	0.00	12.54
78	0.00	0.00	71.69	0.00	0.00	0.00	7.74	0.00	0.00	0.00	0.00	0.00	4.32
79	0.08	0.00	21.06	0.00	0.08	0.00	37.61	0.00	0.00	0.19	0.00	0.00	5.79
80	0.00	0.00	29.26	1.01	0.16	0.03	23.43	0.00	0.00	0.07	0.00	0.09	5.74
81	0.00	0.00	29.85	0.00	0.13	0.09	9.95	0.00	0.00	0.16	0.00	0.00	2.85
82	0.33	0.00	58.57	0.00	3.00	0.00	13.51	0.20	0.00	0.37	0.00	0.00	5.61
83	0.82	0.00	31.54	0.00	2.54	0.26	17.79	0.35	0.00	2.91	0.02	0.52	2.40
84	0.25	0.00	58.39	0.00	3.06	0.56	12.78	0.16	0.00	2.84	0.02	0.19	1.69
85	0.03	0.00	47.78	0.00	5.16	1.27	10.30	0.00	0.00	4.65	0.00	0.36	0.75
86	1.68	0.00	27.81	0.02	2.71	0.76	14.99	0.04	0.00	4.19	0.00	0.63	6.88
87	13.03	0.00	16.78	0.00	2.13	1.81	12.61	1.12	0.00	3.53	0.01	0.91	5.74
88	4.90	0.12	23.19	0.05	2.63	1.90	17.83	0.42	0.00	3.59	0.00	0.10	6.08
89	3.50	0.04	19.31	0.00	2.85	2.90	19.27	0.98	0.03	1.80	0.00	0.35	6.17
90	0.43	0.00	26.04	0.04	2.78	1.56	17.78	0.79	0.00	4.41	0.00	0.19	1.69
91	5.56	0.00	13.95	0.00	4.14	2.13	12.19	0.64	0.00	5.07	0.00	0.81	0.46
92	9.06	0.02	10.75	0.09	1.13	2.90	12.30	2.02	0.29	4.65	0.03	1.10	0.68
93	15.52	0.01	15.08	0.00	1.07	3.39	5.49	3.97	2.93	1.70	0.00	1.32	1.65
94	5.36	0.34	24.40	0.13	0.42	2.35	4.61	0.49	0.18	0.63	0.45	2.13	2.48
95	1.57	0.09	10.73	0.76	1.59	0.89	8.23	0.89	0.07	0.62	0.07	0.19	1.91
96	0.88	0.34	15.21	0.96	9.96	4.09	11.40	0.20	0.02	1.09	0.63	1.01	4.69

97	0.67	0.00	13.39	1.51	1.42	3.77	20.91	0.56	0.01	4.23	0.98	0.95	3.91
98	3.70	0.00	2.27	0.12	0.19	0.86	2.96	1.59	3.10	0.27	0.00	0.16	1.70

during the 1980's and 1990's, accounting for greater than 70% percent of annual commercial landings (Figure 5). 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.

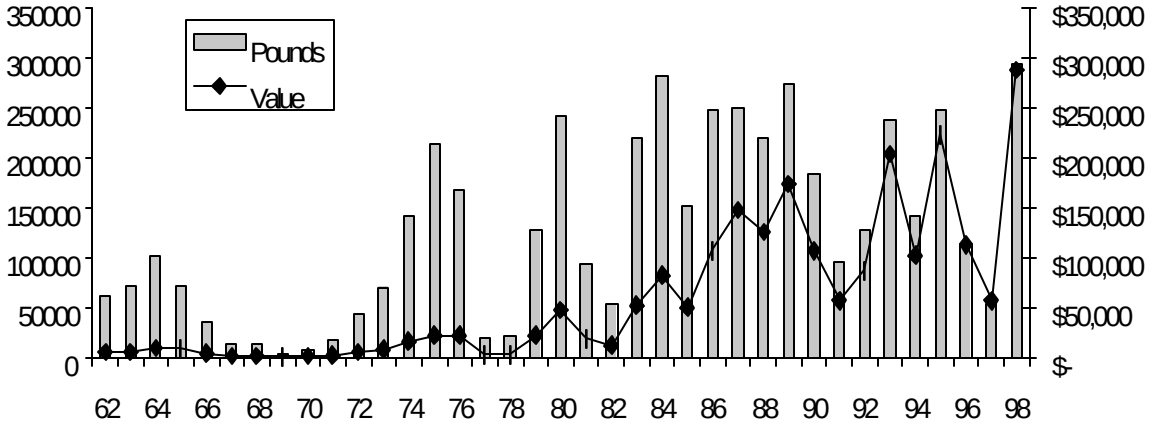


Figure 4. Commercial landings and ex-vessel total value of red drum in North Carolina (Source: NMFS SEFC and North Carolina Trip Ticket Program).

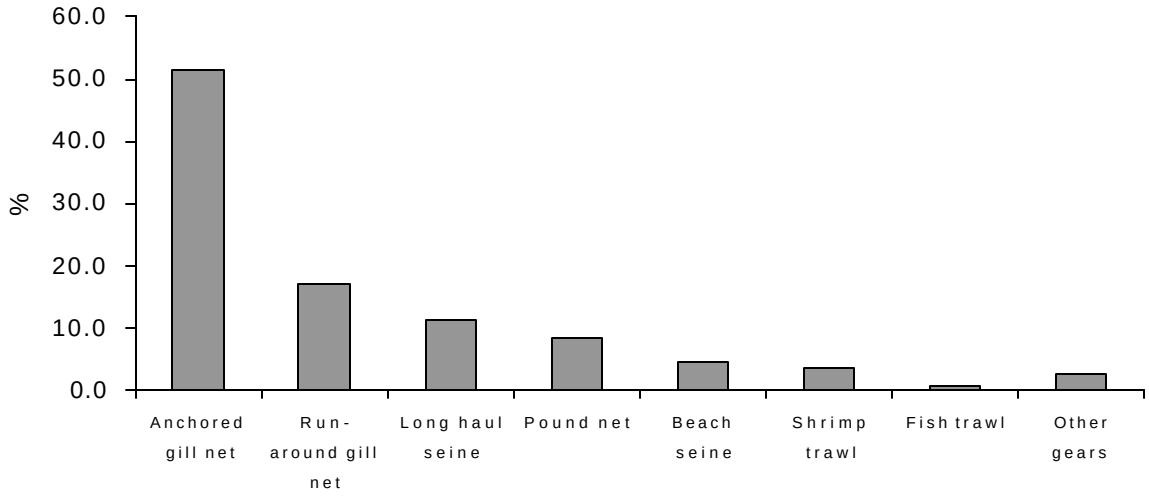


Figure 5. Percent commercial landings (pounds) of red drum from 1987-1998 by gear type.

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 6). Additional management actions have been implemented as interim measures during FMP development and are described in Section 4.6.

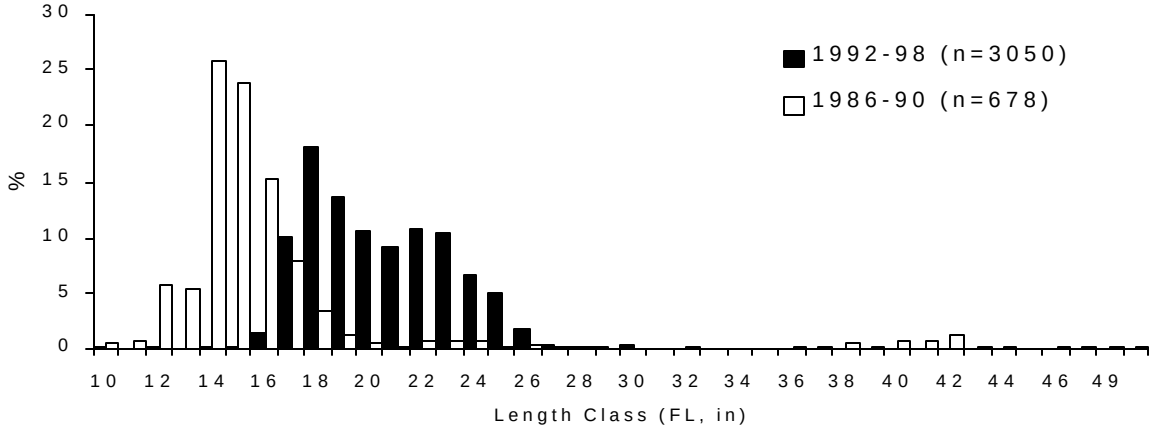


Figure 6. Length frequency of red drum sampled from the North Carolina commercial fishery (all gears combined) for the periods of 1986-1990 and 1992-1998 (Source: NCDMF unpublished).

Prior to the implementation of the current 100-pound trip limit, 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. During 1994-1998, 1.1% of the total 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 pursue 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 2). The recent implementation of a 100-pound trip limit on the commercial harvest of red drum effectively eliminates any large-scale directed harvest of red drum, however some fishers still actively pursue red drum at current harvest limits.

Bycatch fisheries are those that harvest red drum incidentally to other targeted species. Such fisheries account for about one-half of the red drum landed annually. Red drum were reported in, 24,497 trips from 1994 to 1998; the majority (91.2% or 22,356 trips) reported landings less than 50 pounds. Among the gears used to harvest red drum are small and large mesh gill nets, runaround gill nets, swipe nets, haul seines, pound nets, and beach seines.

Table 2. Landings summary for red drum by trip for the period of 1994 to 1998.

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

7.2 Recreational Fishery

Red drum are pursued by recreational anglers year-round throughout the sounds, rivers, and beaches of North Carolina. Angling methods used to catch red drum, include conventional, spinning, and fly tackle, using live, dead, and artificial bait. Red drum are consistently reported as one of the top target species by shore based recreational anglers, and were the number 1 or 2 target species in 1993, 1995, 1996 and 1999.

Recreational landings averaged 275,579 lb and accounted for approximately 60% of the total red drum harvested in North Carolina during 1994-1998. Similar to the commercial fishery, recreational landings vary annually in response to changes in year-class abundance. For example, landings increased from 38,825 lb in 1997 to 569,380 lb in 1998 (Table 3). Undersized red drum accounted for 19% of the recreational harvest from 1994-1998, with a range of 1% in 1998 to 35% in 1997. Because the management program is designed to protect the adult stock, most (95%) of the red drum harvested by recreational anglers from 1994-1998 were juvenile fish under 32 inches TL. However, citation data from the DMF indicates an increasing trend in both the total number of citations issued and the number of release citations issued (Table 4). Additionally, it should be noted that in since 1987, there has been an upward trend in the number of citations awarded for releases versus weigh-ins. Since 1991, between 91% and 99% of all citations awarded have been for fish that were released.

Table 3. Red drum catches for recreational anglers (MRFSS), for 1989 - 1998. All weights are in pounds. Commercial weights are included as a reference with combined weights reported.

Year	Recreational			**Commercial**	**Total**
	Numbers		Weight	**Weight**	**Weight**
	A + B1*	B2*	A + B1		
	# Landed	**# Released**			lbs. landed
1989	62,359	7,566	214,849	274,356	489,205
1990	33,149	12,452	302,994	183,216	486,210
1991	38,658	121,178	108,268	96,045	204,313
1992	23,593	60,230	109,134	128,497	237,631
1993	49,493	182,301	266,459	238,099	504,558
1994	28,953	107,662	192,060	142,119	334,179
1995	83,686	155,421	382,428	248,122	630,550
1996	35,406	34,986	192,740	112,330	304,660
1997	8,580	254,219	38,285	52,564	84,849
1998	110,271	192,586	569,380	294,366	863,746

Definitions of recreational catch type:
*A = fish brought ashore in whole form which can be identified, enumerated, weighed, and measured by interviewers.
*B = fish not brought ashore that can be separated into: B1 = fish caught used as bait, filleted, or discarded &
B2 = those released alive.

Table 4. The number of award citations issued on an annual basis for catches of red drum. Citations are rewarded for releases (40 inch minimum) and weigh-ins (45 pounds).

Year	# Citations	# Released	% Released
1987	215	150	70
1988	324	266	82
1989	335	275	82
1990	419	374	89
1991	335	308	92
1992	451	427	95
1993	644	627	97
1994	876	868	99
1995	622	607	98
1996	685	655	96
1997	737	704	96
1998	515	483	94

- Due to current regulations all new citations are for release only.

8. DESCRIPTION OF THE SOCIOECONOMIC CHARACTERISTICS OF THE FISHERY

8.1 Commercial fishing

8.1.1 Ex-vessel value and price

The value of North Carolina's red drum landings increased from about $5,000 in 1972 to over $21,700 in 1976. The value then fell sharply during the following two years. Within a decade, landed value grew more than 260%, from $47,000 in 1980 to over $173,750 in 1989. The commercial value of red drum fluctuated during 1990s, with an average of approximately $138,000 and a range of about $57,000 in 1991 to more than $288,000 in 1998 (Figure 7). The price received by fishermen for red drum exhibited an upward trend when evaluated on both a current or deflated[1] basis (Figure 8). Between 1972 and 1993, the price increased from $0.12 to $0.86 per pound. In 1998, fishermen received $0.98 per pound for red drum. Overall, these data indicate that the price paid for red drum has become more attractive to commercial fishermen over time probably because of the increased demand in the Atlantic Coast. One likely explanation for the increase in demand is the ban on the allowance of any commercial red drum fishing over the bag limit in Georgia as well as the ban on the sale of red drum in South Carolina, Florida, Louisiana, Alabama, and Texas. The state of Mississippi allows for a annual harvest of 35,000 pounds leaving North Carolina as the only consistent source of marketable red drum along the entire Atlantic and Gulf coasts.

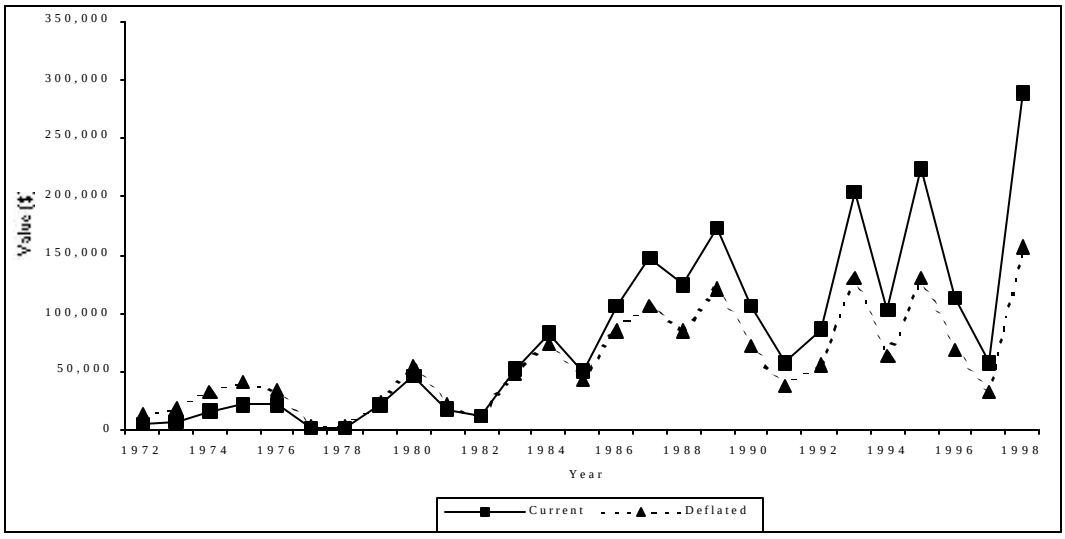


Figure 7. Ex-vessel value of red drum landings in North Carolina, 1972-1998.

1 The deflated values can be viewed as those that would be observed if consumer purchasing power had remained constant at the 1982 level.

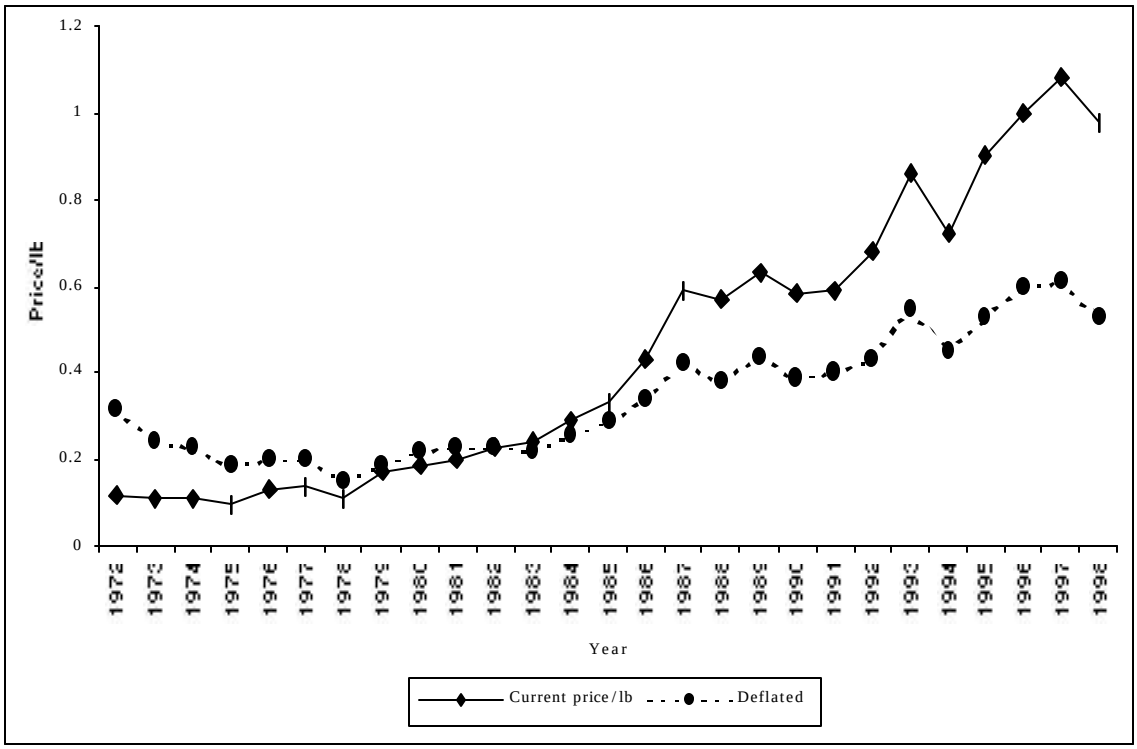


Figure 8. Average ex-vessel price for red drum in North Carolina, 1972-1998.

8.1.2 Fishing income

Total gross fishing income varies substantially among fishermen as well as from year to year. The 1997 average total annual gross income per ETS-holder of $20,237 (ranged from $37 to over $159,000), for instance, exceeded the 1998 average value, $18,726 (ranged from $23 to more than $220,000), by 8% (Table 5). Although red drum accounted for less than 2% of the total gross fishing income for all fishermen during 1998, it represented a large share of total fishing income for those with gross sales of red drum of $3,000 or more (at least 15%).

8.1.3 Marketing, distribution, and processing

The marketing, distribution, and processing activities associated with red drum fishing may be very limited due to the small-directed fishery in North Carolina. However, the extent of these activities is unknown but is thought to be small.

8.1.4 Economic impacts of commercial fishing

Although there is a limited directed commercial harvest for red drum in North Carolina, the economic impacts for harvesting, processing, and distribution attributable to the fishery are unknown. However, red drum fishery is an important source of income for some fishermen.

Table 5. Gross fishing income distribution for red drum fishers in North Carolina, 1997-1998.

1997					
		Red drum	Other species	Total	
Value ($) of sales	# ETS-holders	Average	Average	Average	% contributed by red drum
Under $10	283	$6	$19,793	$19,799	0.03
10-100	289	34	19,214	19,248	0.18
100-200	42	135	25,991	26,126	0.52
200-500	29	292	15,166	15,458	1.89
500-1000	9	702	30,107	30,809	2.28
1,000-2,000	4	1,528	22,294	23,822	6.41
2,000-3,000	0	0	0	0	0.00
3,000-4,000	1	3,057	75,702	78,760	3.88
4,000-5,000	2	4,619	73,458	78,077	5.92
5,000-10,000	1	6,480	31,014	37,494	17.28
10,000-20,000	0	0	0	0	0.00
Greater than 20,000	0	0	0	0	0.00
Total	660	86	20,151	20,237	0.43
1998					
Under $10	252	$5	$18,873	$18,878	0.03
10-100	348	38	17,905	17,943	0.21
100-200	68	146	19,019	19,165	0.76
200-500	81	322	16,472	16,794	1.92
500-1000	26	661	15,774	16,435	4.02
1,000-2,000	24	1,319	18,813	20,133	6.55
2,000-3,000	6	2,545	34,153	36,698	6.93
3,000-4,000	2	3,690	11,797	15,487	23.82
4,000-5,000	1	4,083	21,526	25,609	15.95
5,000-10,000	3	6,418	35,380	41,797	15.35
10,000-20,000	6	14,788	23,313	38,101	38.81
Greater than 20,000	2	27,144	38,109	65,252	41.60
Total	819	352	18,374	18,726	1.88

8.2 Recreational fishing

8.2.1 Historical trends in landings

The bulk of red drum landings in North Carolina are from recreational anglers. In general, recreational landings have exceeded commercial landings in recent years (Figure 9). For example, annual landings by recreational anglers averaged approximately 238,000 pounds during 1989-1998 and ranged from 38,280 to 569,380 pounds, while commercial fishery landings ranged from 52,500 to 294,370 pounds and averaged 177,000 pounds during the same period.

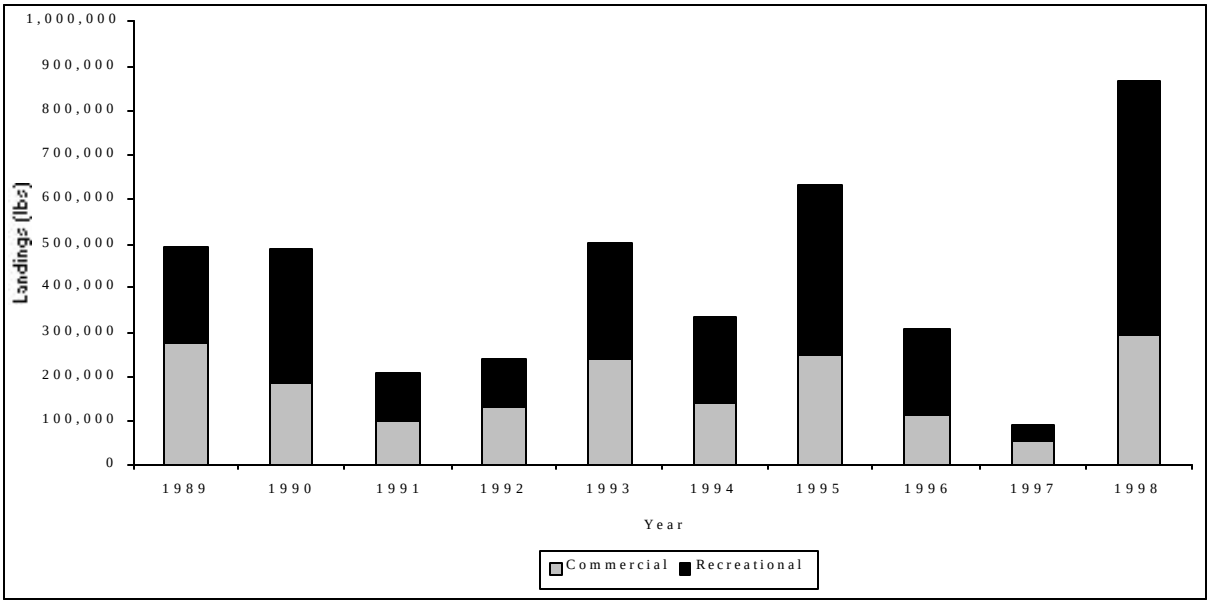


Figure 9. Percent of total landings of red drum by commercial and recreational fishing, 1989-1998

8.2.2 Recreational fishing activity

Red drum anglers are diverse in terms of modes of participation. The Marine Recreational Fishery Statistics Survey (MRFSS) data estimated that a majority of trips targeting red drum in North Carolina were made from beach bank and private boats (Table 6). Of the 121,487 trips targeting red drum in 1998, 52% were taken in beach bank and 35% were private boat trips. In contrast, few charterboat trips specifically targeted red drum as compared to other fishing modes. It should be noted that in recent years the number of inshore charter boats operating in North Carolina has increased with many of these operations relying on red drum as one of the primary species in which clients wish to target.

Table 6. Recreational fishing trips targeting red drum by mode in North Carolina, 1996-1998.

Mode	**1996**	**1997**	**1998**
Manmade	8,715	6,264	14,766
Beach bank	85,801	44,322	63,651
Charterboats	723	296	482
Private boats	15,296	9,421	42,588
Total trips targeting red drum	110,536	60,302	121,487

8.2.3 Economic value of the recreational fishery

Economic analyses of the recreational red drum fishery indicate that anglers receive tremendous benefits from catch and also generate significant revenues to the state of North Carolina. The MRFSS Southeast Economic Survey estimated that 60,302 trips targeting red drum were made in North Carolina in 1997. Of the total number trips taken by red drum anglers, 67.6% were overnight trips and 32.4% were day trips. The average expenditure per trip was $310.20 for overnight trips and $27.70 for day trips. Therefore, the estimated recreational fishing expenditures attributable to red drum anglers totaled about $13.2 million (Table 7). Survey results also indicated that red drum anglers valued an increase in their catch at about $113,000 (John Whitehead, personal communication).

Table 7. Estimated expenditures by anglers targeting red drum in North Carolina, 1997.

	Amount per trip		
Expenditures types	Day trips	Multiple night trips	**Total expenditures by all anglers**
Lodging	$0.0	$151.7	
Travel	$5.4	$120.0	
Bait, equipment, boat	$22.3	$38.5	
Total	$27.7	$310.5	
Total trips	19,538 (32.4%)	40,764 (67.6%)	
Total expenditures	$541,203	$12,644,993	$13,186,196

8.3. Demographic characteristics

8.3.1 Commercial fisherman

Red drum commercial fishermen have demographic characteristics similar to those of North Carolina fishermen as a whole. Approximately 96% of all North Carolina commercial fishermen were male and 79% were born in the state. About 81% of fishermen were married, and at least 68% had a high school education or beyond. Johnson and Orbach (1996) presented a detailed description of demographic characteristics across regions.

8.3.2 Recreational fisherman

The MRFSS data indicate that the majority (68%) of all surveyed red drum recreational fishermen was between 26 and 55 years old with 14.2% over 65 years of age (Table 8). With respect to years of experience in recreational fishing, North Carolina's fishermen averaged 18.2 years in 1997. Most (95.4%) of these fishermen were white and predominately male (83.5%). Approximately 73% of red drum fishermen in North Carolina were employed. The reported household income ranged from $15,000 to over $175,000 with about 54% earning more than $45,000 per year.

8.4 Research Needs

- Collect costs-earnings in the commercial fishery.
- Collect socioeconomic data in the commercial fishery.
- Determine the economic impacts of recreational red drum fishery.
- Increase coverage and frequency of MRFSS sampling for red drum.

Table 8. Socioeconomic characteristics of red drum recreational fishermen, North Carolina, 1997*

Sociological characteristics	**Percent**
Age	
16-25	5.8%
26-35	18.4%
36-45	21.2%
46-55	26.1%
56-64	14.3%
65 & up	14.2%
Ethnicity	
White	95.4%
Black	3.0%
Asian	0.3%
American Indian	1.0%
Other	0.3%
Gender	
Male	83.5%
Female	16.5%
Years of saltwater fishing in NC	18.2
Household Income	
Less than $15,000	5.2%
$15,001-$25,000	9.6%
$25,001-$35,000	14.9%
$35,001-$45,000	16.6%
$45,001-$60,000	19.6%
$60,001-$75,000	14.4%
$75,001-$100,000	11.2%
Greater than $100,000	8.5%
Employment status	
Employed	72.7%
Unemployed	27.6%

* Preliminary results. Percentages may change due to data corrections.

9. ENVIRONMENTAL STATUS

9.1 Habitat

9.1.1 Essential Fish Habitat

As described in the life history section of the plan, red drum utilize a variety of estuarine and oceanic habitats throughout their life cycle. 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 (sea grass), oyster reefs and shell banks, unconsolidated bottom (soft sediment), ocean high salinity surf zones, and artificial reefs (SAFMC, 1998). The area covered ranges from Virginia through the Florida Keys, to a depth of 50 meters (163.5 ft) offshore. In North Carolina, all of these habitats are important for red drum at various stages of development, with the exception of mangrove fringe.

Of the designated EFH, Habitat Areas of Particular 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, 1998). 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 sea water and fresh water 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, 1998). Although general habitat usage is known, quantitative ranking of fish utilization within and between habitats in North Carolina can not currently be done with the existing available data (SAFMC, 1998).

9.1.2 Designated Nursery Areas

There are approximately 147,000 acres of designated Primary Nursery Areas (PNA) and Secondary Nursery Areas (SNA) (15A NCAC 3N .0101 - .0105) in North Carolina. These nursery areas are generally located in the upper portions of tidal creeks and rivers and may include coastal wetlands, shell bottom, and soft sub-tidal bottom (Figure 10 & Figure 11). PNAs and SNAs do not encompass the majority of SAV beds, which are generally located in the lower portions of the estuary. The DMF has

collected data on the distribution and abundance of juvenile red drum through fishery independent surveys since 1979, and has conducted a directed red drum seine survey since 1987. Survey results, although not inclusive of all areas utilized by juvenile red drum, have documented juveniles from the Cape Fear River, north through Buzzard Bay in Dare County (Ross and Stevens, 1992). Juveniles were most consistently abundant at the stations located near the mouths of the Pamlico and Neuse rivers and the bays and rivers between these two large rivers. Areas supporting juvenile red drum can be characterized as detritus or mud bottom creeks in the western Pamlico Sound and Pamlico and Neuse rivers, grass beds behind the Outer Banks, and mud or sand bottom in shallow water in other areas. The most common habitat characteristics among sites were shallow water depth (<5 feet) and relatively wind-protected water bodies (Ross and Stevens, 1992).

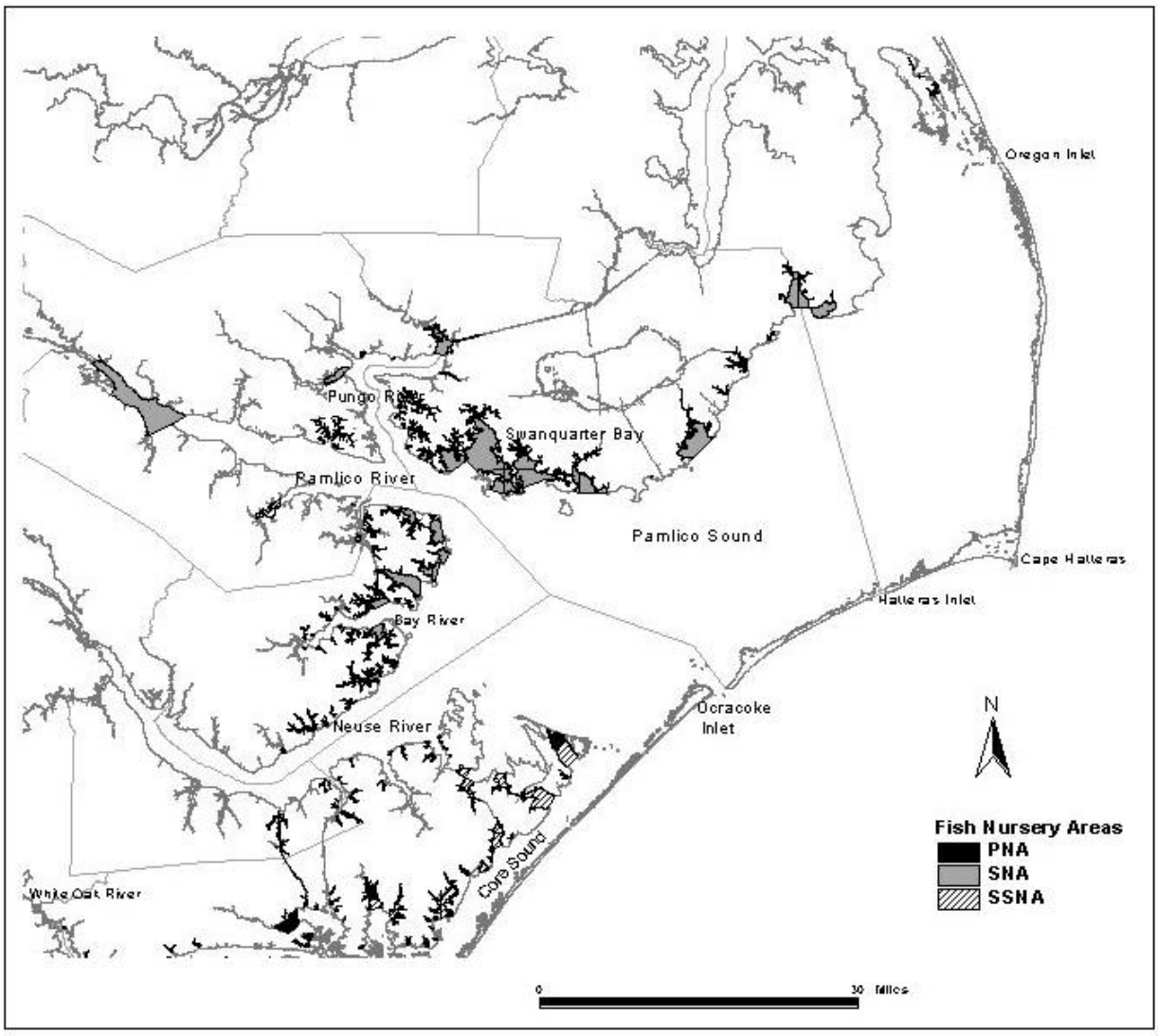


Figure 10. Designated fishery nursery areas – northern North Carolina coast.

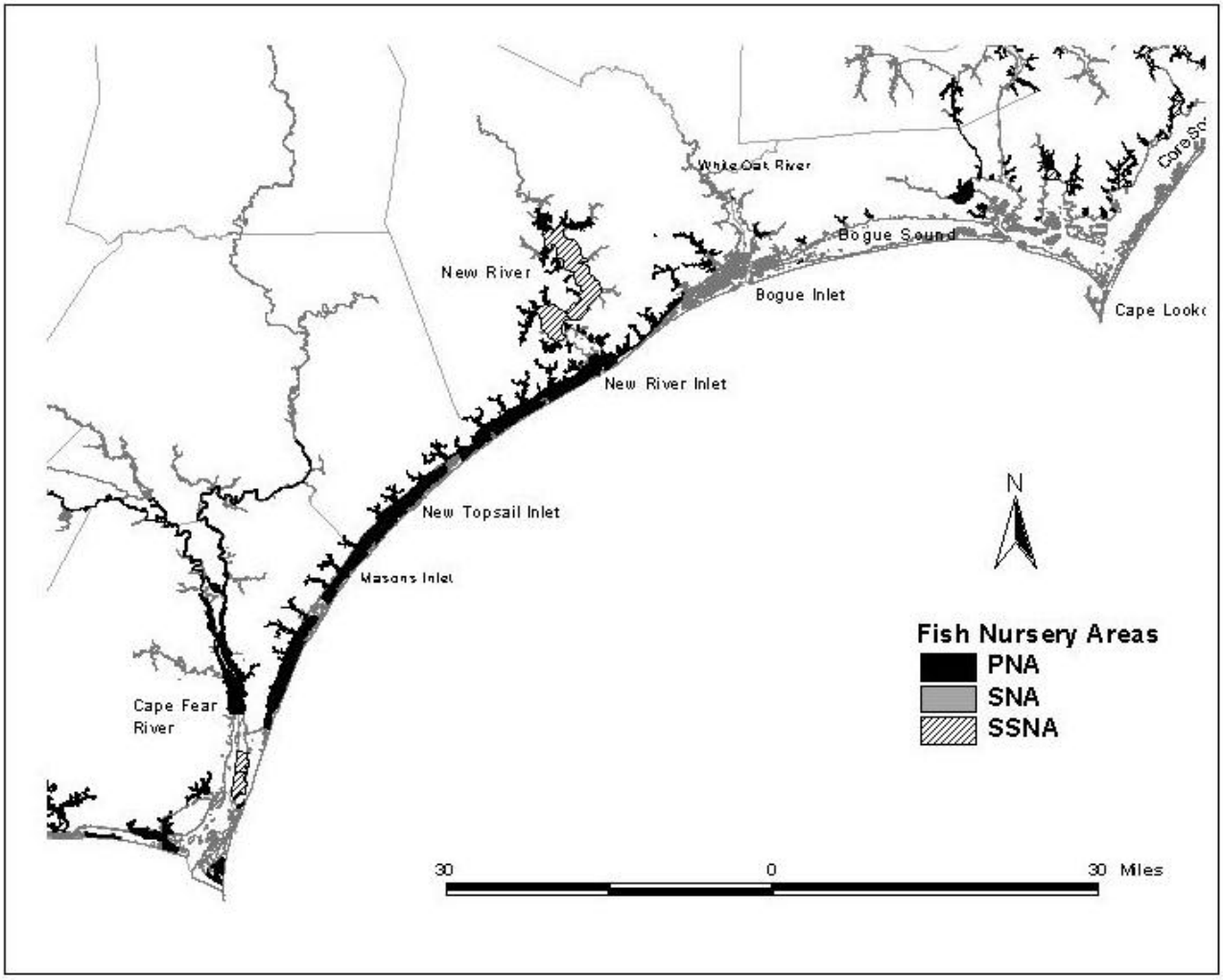


Figure 11. Designated fishery nursery areas – southern North Carolina coast.

9.1.3 Submerged Aquatic Vegetation

Laney (1997) summarized use of SAV beds by red drum. The current regional red drum range overlaps SAV occurrence, indicating some dependence upon this habitat. However, red drum also occur in areas lacking SAV, such as in South Carolina and Georgia. Oyster reefs may replace or supplement SAV beds as important nursery habitat in those areas. Red drum eggs, larvae, postlarvae, and juveniles have been documented in SAV beds. Juveniles were found to be more abundant in ecotonal areas with patchy grass coverage than in homogeneously vegetated sites (Mercer, 1984; Reagan, 1985; Ross and Stevens, 1992). Submersed aquatic vegetation is particularly important as foraging grounds for one and two-year-old fish (SAFMC, 1998). Some studies indicate relatively low levels of SAV utilization by early juvenile red drum in North Carolina (Thayer et al., 1984). However, their abundance in SAV beds may vary seasonally or spatially, being more common in grass beds during

the summer or where located close to spawning areas (Zieman, 1982). Data collected by DMF through the seine survey and tagging studies indicate high abundance of late age-0 red drum in shallow high salinity grass beds behind the Outer Banks.

The National Marine Fisheries Service (NMFS) recently completed mapping sea grass beds in North Carolina using field surveys and aerial photographs taken from 1985 to 1990 and (Figure 12). This is a conservative estimate of grass coverage since areas south of Bogue Sound and west of Hwy 17 in the Albemarle Sound system were not mapped. In addition, mapping from aerial photographs underestimates the grass coverage in low salinity areas, where submerged vegetation is difficult to delineate from aerials due to increased turbidity, darker water color, and overhanging canopy cover. Approximately 200,000 acres of SAV beds were delineated, making North Carolina second only to Florida in abundance of sea grass beds. Grass beds are concentrated in the shallow portions of Core Sound and Pamlico Sound along the back-side of the barrier islands. SAV extends south to approximately the New River and is also found in patchy distributions in Albemarle and Currituck sounds, along the west shore of Pamlico Sound, and along the shores of the Pamlico and Neuse rivers and their tributaries.

9.1.4 Other Nursery Areas

In addition to designated PNAs and SNAs, red drum use other estuarine areas as nursery grounds. There are approximately 254,000 acres of fresh, brackish, and salt marsh in North Carolina (DCM, 1999) which are potential red drum nursery areas. Juvenile and sub-adult red drum also use oyster reefs (Daniel, 1988; Bahr and Lanier, 1981; Lenihan and Peterson, 1998). Young fish (age 0-1) occur throughout shallow estuarine waters, particularly in creeks, along the shoreline of rivers and bays, and over grass flats and shoals in Pamlico Sound and other smaller sounds during spring and summer (DMF, unpub. data). Studies have shown that juvenile red drum in vegetated areas suffer significantly less predation mortality than those in unvegetated areas (Rooker et al., 1998). Habitat complexity and coverage within an estuarine system are therefore critical to survival of juvenile red drum.

9.1.5 Spawning Areas

The inlets, adjacent waters and outer ocean bars, as well as waters inside Pamlico Sound, are critical areas for spawning activity, as well as feeding and daily movements of sub-adult and adult fish (SAFMC, 1998; Luzkovich et al., 1999). In North Carolina, concentrations of red drum occur around Ocracoke, Hatteras, and Oregon Inlets and along adjacent beaches and shoals in the spring prior to entering Pamlico Sound for the summer (SAFMC, 1998). In August they form schools around inlets to spawn and remain in the vicinity through November. Gravid and spent adults have been documented by DMF in the vicinity of Hatteras, Ocracoke, and Drum

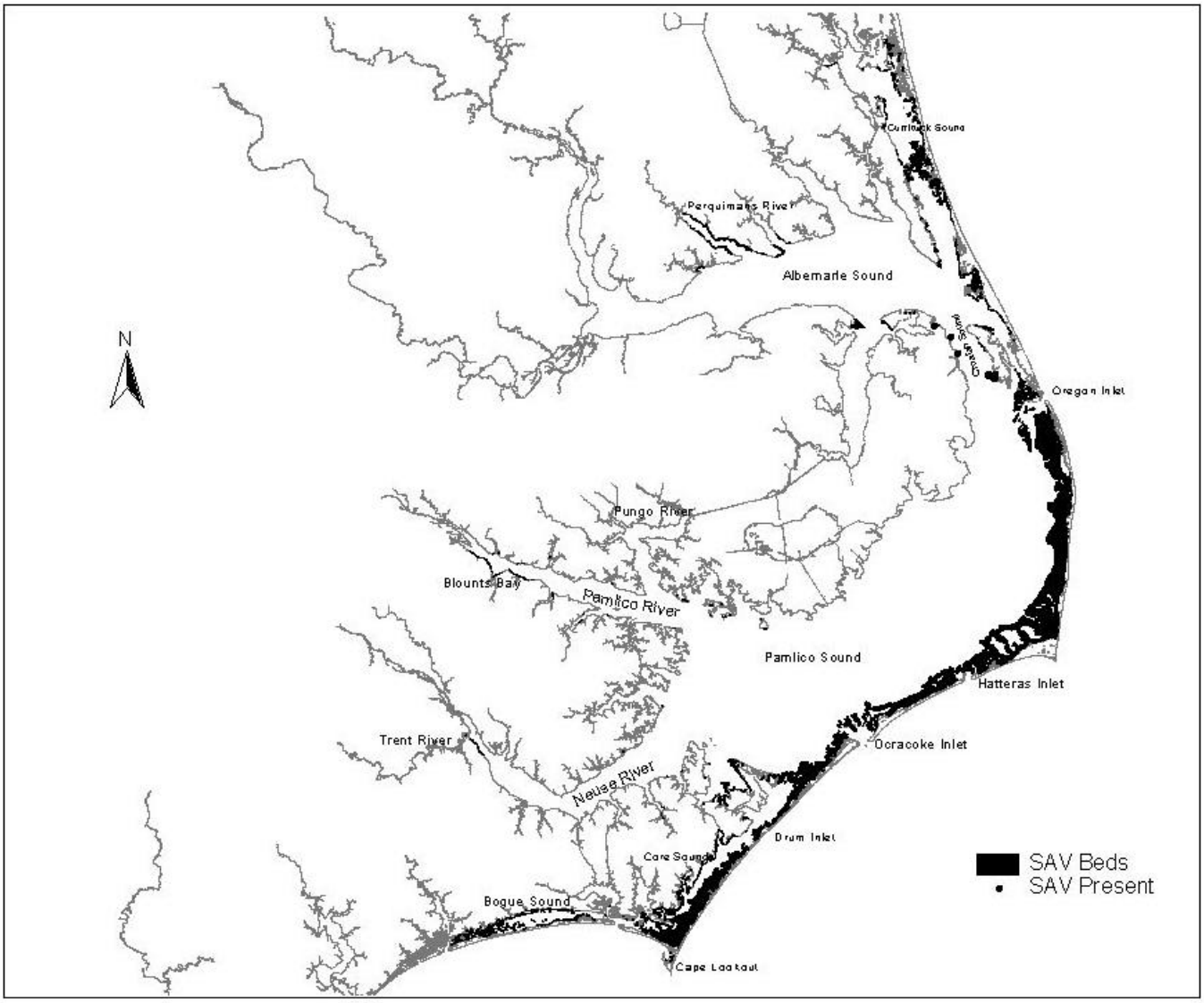


Figure 12. Distribution of submersed rooted vascular beds in North Carolina.

inlets, as well as in the mouth of the Pamlico, Neuse, and Bay rivers, indicating spawning activity in these areas (Ross and Stevens, 1992). Suspected spawning areas were confirmed by Luczkovich et al. (1999) using hydrophone surveys to detect characteristic spawning knocks and ichthyoplankton surveys to locate sciaenid eggs. Red drum spawning was detected on the east (Ocracoke and Hatteras Inlet areas) and west (Bay River) sides of Pamlico Sound in August, September, and October, with the greatest amount of activity occurring in September (Figure 1). Luczkovich et al. (1999) concluded that areas near the mouth of Bay River appear the most critical for spawning red drum within their study area.

9.1.7 Condition of Habitat

Protection of the quantity and quality of red drum habitat, particularly areas designated as EFH and HAPC, is critical to the goal of this plan, which is to restore the overfished stock of red drum so that it might produce the long-term maximum sustainable yield. Threats to red drum habitat have been identified in regional fishery management plans for red drum (ASMFC, 1994; SAFMC, 1990). Dredging and filling activity for land development, drainage, marina construction, boat access, or bulkheading of shorelines results in loss of wetlands. According to the North Carolina Division of Coastal Management (DCM), 29,560 acres (11.6%) of existing salt, brackish, and freshwater marsh appear to be physically altered. Prevention of barrier island processes, such as overwash and inlet migration, suppress development of new tidal marsh. Loss of shell bottom may occur due to harvesting of oysters, use of certain fishing gear, and disease outbreaks. Loss of SAV can be caused directly by navigational dredging, propeller dredging, or hydraulic dredging for shellfish. Loss of SAV can also occur indirectly due to increased turbidity associated with eutrophication from non-point source stormwater runoff and atmospheric deposition, as well as increased sediment loading from runoff and re-suspension. Pollutants in runoff may originate from residential or commercial development, failing sewage systems, agriculture, and forestry activities. Non-point source runoff degrades other habitats as well, including subtidal bottom, tidal marsh, oyster reefs, and the water column. Restriction of access to nursery grounds through impounded wetlands, roadways and causeways limits habitat available to juvenile red drum. Inlets and nearshore bar systems can be degraded by dredging, construction of jetties, or other activities that prevent inlet migration.

9.1.7 Habitat Protection Status

Protection of habitats critical to red drum falls under the authority of several agencies. A portion of North Carolina's coastal wetlands and tidal creeks have been designated as Primary and Secondary Nursery Areas by the North Carolina Marine Fisheries Commission (Figure 10 & Figure 11). Use of trawl nets, long haul seines, swipe nets, dredges, and mechanical harvest of shellfish is prohibited in PNAs and SNAs (15A NCAC 3N .0104). Regulations by the Coastal Resources Commission (CRC) do not allow authorization of projects that can violate water quality standards or adversely affect the life cycle of estuarine resources (15A NCAC 7H .0207), including PNAs, SAV, and oyster beds. Waters designated as PNAs by the MFC or that have a special water quality classification by the North Carolina Environmental Management Commission (EMC), such as Outstanding Resource Waters (ORW), are given additional consideration of impacts by DCM prior to issuing development permits.

The CRC regulates development activities in Areas of Environmental Concern, which include coastal wetlands (15A NCAC 7H .0205). Generally, no development is allowed in coastal wetlands except water dependent activities, such as docks. The EMC manages wetlands through the 401/404 Certification Program, under the federal Clean Water Act. This program focuses on avoiding and

minimizing filling of wetlands and streams through review of all Environmental Assessments, Coastal Area Management Act (CAMA) Major, and US Army Corps of Engineers (ACOE) permit applications to determine if the project will violate water quality standards or if a 401 certification is needed. Although both the Division of Water Quality (DWQ) and DCM are authorized to protect wetlands and submerged lands, dredging, filling, and other shoreline modifications are permitted. Approximately 35 – 55% of North Carolina's original wetlands have been destroyed in the last 200 years. Between 1984 and 1996, permits were issued to bulkhead approximately 255 miles of shoreline (DCM, unpubl. Data). It is estimated that estuarine shoreline continues to be armored at a rate of at least 25 mi/yr. (NCCF, 1998). Bulkheading of estuarine shorelines results in direct and gradual loss of wetlands and reduces nursery area available to juvenile red drum.

Although current programs recognize the relatively greater biological value of nursery areas and outstanding resource waters, they fail to adequately address cumulative impacts from piecemeal development. Consequently, permits continue to be issued which result in wetland loss. The DWQ Wetlands / 401 certification program authorized 1,248.11 acres of wetland losses in the eight coastal river basins during fiscal year 1997/1998, and 2,019.87 acres during fiscal year 1998/1999 (Table 9, NCWRP, B. Mullin, pers. Comm.). The greatest loss occurred in the Neuse river basin in both years. The majority of the losses in the Neuse were attributed to one large project in each fiscal year, the Buckhorn Reservoir and the Global Transpark. Approximately five percent of the impacts were attributed to projects that impacted less than one acre of wetlands.

Table 9. DWQ 401 Permitted Wetland Impacts (acres) in the Eight Coastal River Basins

River Basin	1997/1998	1998/1999
Cape Fear	81.19	190.91
Chowan	21.89	5.25
Lumber	15.73	10.78
Neuse	986.8	1645.56
Pasquotank	6.58	39.16
Roanoke	5.4	4.38
Tar-Pamlico	11.0	23.09
White Oak	119.52	100.74
Total	1248.11	2019.87

Several MFC regulations restrict harvesting methods in shell bottom to avoid unnecessary damage to the habitat. The Fisheries Director is delegated authority by the MFC to close areas to the taking of shellfish to protect populations for management purposes (15A NCAC 3K .0101b), to

designate Shellfish / Seed Management Areas (15A NCAC 3K .0103) and to protect these areas through gear and harvest restrictions. Other regulations prohibit trawling across oyster management areas (15A NCAC 3K .0203) or mechanical harvest or dredging of oysters in certain areas (15A NCAC 3K .0204), including Core Sound and portions of Pamlico Sound. Completion of mapping of North Carolina shellfish beds by DMF would enhance the ability to enforce existing regulations and make it possible to quantify changes to this habitat relative to changes in land use, water quality, and regulatory measures.

Regulations by MFC which restrict shellfish dredging and mechanical harvest in designated areas also protect SAV beds from physical damage. Regulations by CRC state that activities which will directly impact SAV, such as dredging or construction of docking facilities, should be avoided (15A NCAC 7H .0208(a)(5). Some areas of significant SAV coverage have been classified by EMC as Outstanding Resource Waters (Figure 13 & Figure 14). Regulations by CRC prohibit dredge and fill activities in ORW. In addition, regulations require new development adjacent to ORW to comply with specified stormwater provisions (15A NCAC 2H .1007) and non-discharge permits to meet reduced loading rates and increased buffer zones. Completion of bottom mapping south of Bogue Sound and follow-up mapping, would enhance the ability to enforce these regulations and assess changes in habitat condition.

The CRC includes inlets as Ocean Hazard Areas and regulates such areas to minimize loss of life and property, prevent encroachment of permanent structures on public beach areas, preserve the natural ecological conditions of the barrier dune and beach system, and reduce the public costs of inappropriately sited development (15A NCAC 7H .0303). Of 22 inlets in North Carolina, four have been stabilized to varying degree with jetties. Of particular importance to red drum are the Hatteras, Oregon, and Ocracoke Inlets where spawning concentrations are known to occur. All three of these inlets and their adjacent shoals are at least partially protected from development by public ownership. Oregon Inlet borders Cape Hatteras National Seashore to the north and Pea Island Wildlife Refuge to the south. Ocracoke Inlet borders the north end of Cape Lookout National Seashore and the south end of Cape Hatteras National Seashore. Hatteras Inlet is completely within Cape Hatteras National Seashore. The National Park Service is responsible for managing these areas. Oregon Inlet is the only inlet of the three that has been stabilized with a jetty. Approval of proposed stabilization projects at Oregon Inlet and Mason Inlet will threaten maintenance of natural inlet processes in the future, potentially degrading spawning areas for adults, foraging grounds for sub-adults, and transport processes for larvae. Dredging of inlets in late summer and fall, when red drum are concentrated in and near the inlets, would negatively impact the species by displacing adults, disrupting spawning activity, and possibly causing mortality of adults or fertilized eggs. Removal or alteration of nearshore sandbars or shoals for beach nourishment projects will negatively impact red drum through removal or reduction of benthic epifauna prey species. In addition, removal of the shoaling topographic features, which attract red drum, will displace individuals and temporarily reduce a preferred habitat niche for the species. Since 1939, North Carolina has had 108 beach nourishment projects, totalling 43,456,012 cubic yards of sand on 64 miles of beach. There are currently multiple municipalities at various stages of planning or implementing nourishment projects which could potentially add sand on roughly 142

additional miles of beach within the next ten years. This includes projects on approximately 16 beach communities from Kitty Hawk in the north to Ocean Isle in the south.

The number, size, and frequency of these projects is increasing rapidly over time. Nourishment of a large percentage of North Carolina's beaches over a relatively short period of time would certainly have a significant impact on nearshore ocean areas utilized by red drum.

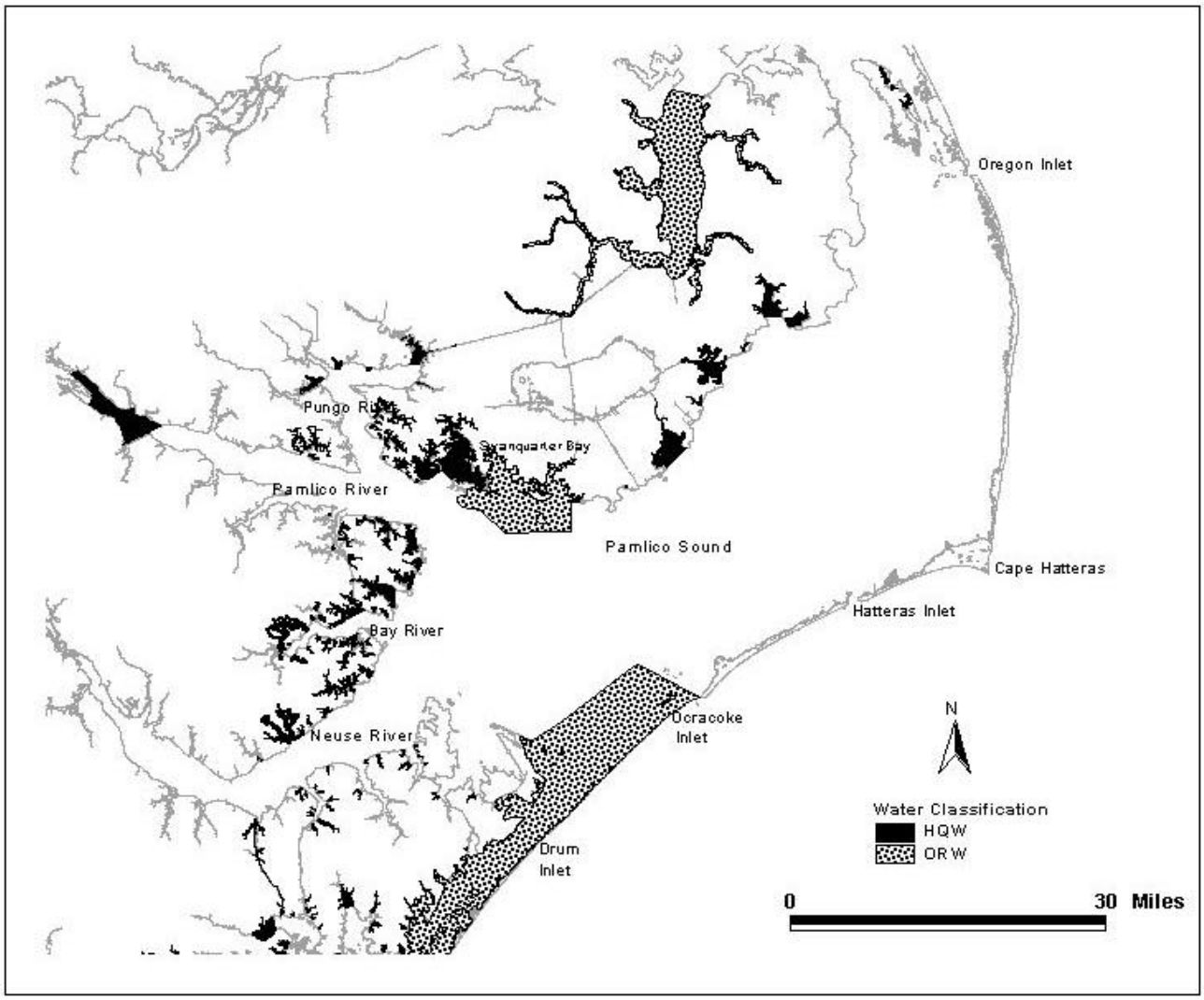


Figure 13. Designated ORW and HWQ waters – northern North Carolina coast.

Protection of ocean habitat in state waters (shoreline to 3 miles offshore) falls under authority of several state and federal agencies and councils, including DCM, ACOE, US Environmental Protection Agency (EPA), SAFMC, US Fish and Wildlife Service (USFWS), and NMFS. Federal laws which pertain to nearshore ocean habitat include Coastal Zone Management Act Section 307, Clean Water Act, Rivers and Harbor Act, Endangered Species Act, Magnuson-Stevens Fishery Conservation and

Management Act, Marine Mammal Protection Act, Marine Plastic Pollution Research and Control Act, National Environmental Policy Act, and Outer Continental Shelf Lands Act. Of particular importance to adult red drum is protection of nearshore bars and shoals off the capes. Currently, these dynamic sand areas are not specifically protected. Both DCM and the ACOE have authority to permit use of these areas for beach nourishment projects and recommend conditions for sand source and quality.

The SAFMC, under the Magnuson-Stevens Act, provides protection for red drum habitat through implementation of regulations related to fishery-related impacts, and commenting on non-fishing projects which may affect fish habitat. The Council has developed and approved policies on oil and gas exploration, development, and transportation; dredging and dredge material disposal; and ocean dumping.

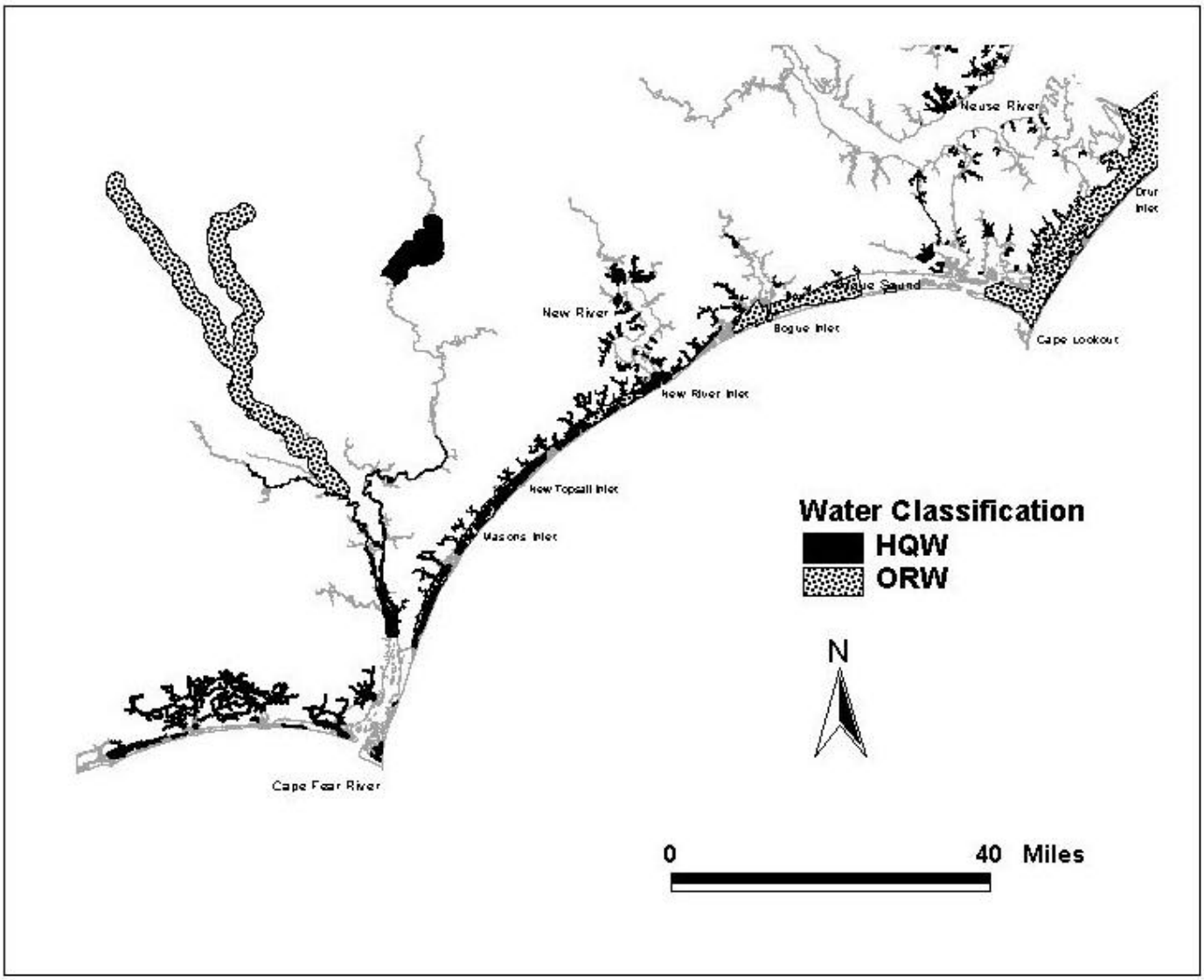


Figure 14. Designated ORW and HWQ waters – southern North Carolina coast

9.2 Water Quality

Red drum are a euryhaline and eurythermal species, occurring under a wide range of conditions. However, there are optimal temperature, salinity, and pH thresholds for different life stages of the species which enhance survival and growth. Red drum are most often found in seawater of 20 to 40 ppt as adults and sub-adults, while juveniles range into the freshest parts of estuaries. Spawning is concentrated in brackish to saline waters near major river mouths and inlets and is optimum at temperatures between 22 and 30°C and at lunar spring tides (SAFMC, 1998). Eggs and larvae require salinity of 25 – 35 ppt for proper buoyancy while planktonic.

The temperature range for the species is 2–33°C. A pH level of 9.4 or lower is needed to prevent excessive mortality of larval red drum. Elevated pH levels and low water temperatures can reduce survival of red drum larvae (Lyon and Fisher, 1998). Several studies indicate that mortality during early post-settlement is substantial and that survival through this stage is critical to recruitment success (Rooker et al., 1998b; Baltz et al., 1998). In mesocosm experiments, Rooker et al. (1998b) found a 3–9% decrease in mortality per millimeter increase in length of fish. Consequently, faster growth rates associated with high water temperatures increase recruitment success.

Because red drum remain within one estuarine system for several years, and have been shown not to avoid contaminated areas, they are vulnerable to water quality problems within a watershed. Toxicity tests show that juvenile red drum are significantly more sensitive to organophosphorus pesticides than mummichogs (red drum mean LC_{50} = 6.3–7.1 mu g/L) (Van Dolah et al., 1997). Leachate from dock pilings has not been shown to significantly affect survival of juvenile red drum in South Carolina (Wendt et al., 1996). However, there was evidence of elevated concentrations of heavy metals and PAHs in sediment near pilings, which could be lead to a cumulative impact on benthic prey.

Ditching and drainage of uplands and wetlands accelerates the quantity and rate at which pollutants enter estuarine waters, decreases the amount of filtering that occurs prior to pollutants entering the waters, and may alter the salinity regime in the upper estuary. Toxic levels of sediment contamination and repeated occurrence of hypoxia / anoxia events can affect the abundance of benthic prey available to red drum, reducing the quality of the habitat (Lenihan and Peterson, 1998). Pate and Jones (1981) found that productivity of several species of juvenile fish was significantly less in PNAs which received moderate to high levels of drainage from ditched uplands.

Water quality in Pamlico Sound, where juvenile, sub-adult, and adult red drum are concentrated, is evaluated by the DWQ in several basinwide plans, primarily in the Tar-Pamlico River (subbasin 8) and Neuse River (subbasins 13 and 14) Basinwide Plans (DWQ, 1999). Lower Core Sound is included in the White Oak River Basinwide Plan. The northern portion of Pamlico Sound, including Oregon and Hatteras inlets, is in the Pasquotank River Basinwide Plan. Subbasin 8 in the Tar-Pamlico basin includes part of Pamlico Sound and its tributaries from Swan Quarter National Wildlife Refuge north to Long Shoal River, and extends across the sound to Ocracoke Island. Data indicate good water quality in most natural water bodies in subbasin 8 (DWQ, 1999). Most canals were

degraded by non-point sources, primarily agricultural in origin. However, sampling was minimal, consisting of only two benthic invertebrate stations and no water chemistry, fish community, or fish tissue stations. Much of the subbasin is undeveloped and includes Mattamuskeet and Swanquarter National Wildlife refuges. Primary land use is agriculture, and there are no major point source discharges. Use Support Ratings, which represent the percent of a water area supporting the intended water classification use, for Subbasin 8 were 99% fully supporting for estuarine waters. Elevated fecal coliform levels and related shellfish closures were the source of impairment for the other 1% of surface waters.

Subbasins 13 and 14 in the Neuse River basin include Bay River, Jones Bay, Broad Creek, West Bay, Cedar Island Bay, and upper Core Sound, as well as the lower portion of Pamlico Sound, from the mouth of the Neuse River to Ocracoke Inlet. In both of these subbasins, biological monitoring indicated very good water quality (DWQ, 1998). Algal blooms were uncommon. One dinoflagellate bloom was documented in the upper portions of Bay River in 1990. West Thoroughfare Bay had slightly higher coliform, nutrient, and turbidity values than surrounding areas, which was attributed to runoff from bridge traffic and nearby boat dockage. Use Support Ratings ranked both subbasins as 99% fully supporting. There is one discharger located in Bay River (Bay River Waste Water Treatment Plant, 0.3 mgd). Sampling stations in this area are located in Bay River, Jones Bay, and West Bay; no stations are located in the open Sound. Benthic macroinvertebrate sampling conducted in Bay River and Jones Bay in 1995 found high Estuarine Biotic Index (EBI) values and moderate to high taxa counts, indicating high water quality.

While water quality and biological monitoring indicate that most waters in Pamlico Sound appear very good, other areas immediately upstream of Pamlico Sound were highly degraded (DWQ, 1998; DWQ, 1999). Subbasin 10 in the Neuse River Basin (New Bern to Pamlico Sound) and subbasin 7 in the Tar-Pamlico Basin (Washington to Roos Point) are sites of frequent algal blooms, fish kills, low DO events, and *Pfiesteria* outbreaks. In the Neuse subbasin, 53% of the estuarine waters were rated as fully supporting, while in the Tar-Pamlico subbasin only 27% of the estuarine waters were rated as fully supporting.

Benthic invertebrate sampling results from DWQ for Jones Bay contrast with results reported in Hackney et al. (1998) of low species richness dominated by tolerant opportunistic species. The difference could be attributed to different sampling methods, or natural temporal and spatial variability. The latter study, which was conducted as part of the EPA Environmental and Assessment Program (EMAP), surveyed 165 sites within the sounds and rivers of North Carolina from 1994 through 1997 to evaluate environmental conditions. These investigators found that 37.5 to 75.8% of randomly selected stations had contaminated surface sediment, and that 19 to 36% of the sites were highly contaminated. Contaminants surveyed included nickel, arsenic, DDT, PCBs, and mercury. These pollutants are carried into the water by stormwater runoff and deposited in estuarine sediments. It was estimated that 13.4% of the estuarine bottoms were incapable of supporting benthic production. Many of the most contaminated sites were located in shallow waters adjacent to wetlands which are important nursery grounds, particularly the lower portions of the Pamlico River, Neuse River, Bay River, and to a somewhat lesser extent, along the west shoreline of Pamlico Sound. Fish pathologies such as sores and

lesions were more common at sites with high sediment contamination (as great as 50% of examined fish), but sores were also found at less contaminated sites. Sediments from many sites were toxic to biological organisms in laboratory bioassays. Riggs et al. (1989) also conducted studies to determine the concentrations of heavy metals in the Pamlico and Neuse rivers. In the Neuse River, sediments in the vicinity of point source discharges had significantly greater levels of specific metals than in control areas. In addition, 17 sites were found to exceed control sites in metal concentrations by a factor of two or more. In the Pamlico River, heavy metal contamination was less severe, although arsenic, cobalt, and titanium exceeded the levels found in the Neuse. There is now a large body of evidence suggesting that a major portion of North Carolina's estuaries may not fully support food chains that support productive recreational and commercial fisheries (Hackney et al., 1998).

While sediment toxicity may result in abiotic sediments, seasonal anoxia and hypoxia in many of North Carolina's rivers may play an equally important role in explaining the absence of benthic organisms, particularly in deeper portions of the estuary. Increasing coastal eutrophication, due to increased fertilizer use, discharge of animal and human waste, filling of wetlands, and atmospheric nitrogen deposition, is intensifying the duration, frequency, and spatial scale of oxygen depletion events and low oxygen stress in many estuaries, including North Carolina's rivers and sounds (Paerl et al., 1995; Cooper and Brush, 1991). During stratification of the water column in the Neuse River estuary in 1993, Lenihan and Peterson (1998) found that protracted hypoxia / anoxia caused mass mortality of oysters, other invertebrates, and fishes on a low profile oyster reef at all water depths greater than 5 m (16.4 ft). Occupancy of burrows in an oyster reef decreased from 100% at all depths prior to hypoxia to 0% at 6 m (19.6 ft), 75% at 3 m (9.8 ft), and 80% at 4 m (13.1 ft) immediately after a hypoxia event. Mobile invertebrates such as mud crabs (*Panopeus herbstii*) avoided oxygen depletion by moving upward on the reef where possible. As the frequency of hypoxia events increases, food availability for sub-adult and adult red drum will potentially be decreased, particularly in deeper habitats and where oyster reef height has been reduced by fishing efforts.

Hurricanes can play an important role in water quality in Pamlico Sound and other areas of North Carolina's coast and are considered an important natural perturbation that is necessary for the long term maintenance of estuarine systems (Meeder and Meeder, 1989). With increasing destruction of wetlands and hydrological modifications, however, the effect of flooding and storm damage is intensified, and the resulting runoff is more severely contaminated. In 1996, Hurricanes Bertha and Fran dominated summer and fall weather patterns. The storms resulted in severe flooding of coastal waters, anoxia, and multiple fish kills in both Neuse and Pamlico rivers and Pamlico Sound (DWQ, 1998). Shortly after the passage of Hurricane Floyd in September 1999, some anoxic conditions were documented in Pamlico Sound in September (DWQ, DMF, unpub. data). However, later storms and strong winds prevented prolonged stratification of the water column and increased oxygen concentrations, thus apparently minimizing fish kills in the sound. Large inputs of nutrients and toxic chemicals were introduced into the system from flooded and failing hog lagoons and wastewater treatment plants, and from organic matter displaced from swamps and upland sources. A delayed ecological response to these nutrient inputs in the form of hypoxia, fish kills, and fish disease may occur in the spring and summer of 2000 or later (Paerl, pers. comm.).

9.2.1 Water Quality Protection Status

The EMC has classified certain waters as Outstanding Resource Waters and High Quality Waters (HQW), based on excellent water quality, high value for fisheries, or other exceptional ecological significance (15A NCAC 2B .0216). Standards for these waters are more stringent, requiring greater treatment of waste for point discharges, reduced loading rates for non-discharge permits, increased buffer zones and compliance with stormwater management rules specified in 15A NCAC 2H .1006. Waters classified as ORW or HQW, or which have been designated as Primary Nursery Areas by MFC are given additional consideration of impacts prior to issuance of a CAMA permit. Figure 13 & Figure 14 indicate the location of ORW, HQW, and designated PNAs in the coastal area. All ocean waters are classified as SB by the Division of Water Quality.
SB waters are those waters best used for primary recreation, secondary recreation, and aquatic life propagation and protection.

Waters that have been designated as PNAs by MFC or have a special EMC water quality classification, such as ORWs, are given additional consideration of impacts by DCM and DWQ prior to issuing a permit. The Neuse River Basin and Tar-Pamlico River Basin were designated as Nutrient Sensitive Waters by EMC in 1988 and 1989, respectively, due to increases in algal blooms and fish kills in the upper estuary. The blooms were linked to excessive nutrient levels. Regulations and water quality standards were developed to reduce loading of non-point sources of nutrient runoff. These changes in effluent and development standards are intended to reduce eutrophication of waters in areas utilized by red drum.

The presence and survival of SAV is highly dependent on water quality conditions. Water clarity, often measured by turbidity levels, is a critical parameter for survival and growth of SAV, requiring at least 20% incident light penetration in high salinity areas and 13% in low salinity areas (ASMFC, 1999). Light penetration is reduced by increased turbidity, which is caused by suspension of phytoplankton and sediment in the water column. Sediment was the largest cause of water degradation in the Albemarle-Pamlico estuarine area (DEM, 1989). To reduce sediment loading and resulting eutrophication of estuarine waters, it is therefore necessary to control non-point runoff. Reduction in nutrient levels entering the estuaries through point discharges as well as air deposition is also necessary to reduce eutrophication. Bottom-disturbing activities such as navigational dredging, shellfish dredging, clam kicking, or shrimp and crab trawling are an acute source of turbidity in local areas (ASMFC, 1999). Additional monitoring, which includes turbidity measurements, is needed to monitor conditions and changes in SAV coverage.

Ocean dumping of dredge spoil, industrial waste, and treated sewage effluent are permitted activities which potentially threaten water quality of the nearshore oceanic environment. Point source discharges are regulated by DWQ and EPA. Stormwater discharge is also regulated by DWQ. The ACOE, pursuant to the Clean Water Act, regulates the disposal of dredged material. The NMFS, USFWS, EPA, DMF, and SAFMC review and make recommendations on proposed permits to reduce impacts of such activities. There are currently no direct discharges of sewage to North

Carolina's ocean waters. There is one cooling water discharge in the ocean. Carolina Power and Light's cooling water is piped under Oak Island and discharges approximately 0.5 miles from shore. It discharges over 100 million gallons of water a day that is approximately 40º C. There are 18 minor and 1 major NPDES sites located on the barrier islands that discharge to the estuarine side of the islands or on land. One site is in Brunswick County, five are in New Hanover County, six are in Carteret County, one is in Hyde County, and six are in Dare County. Ocean dumping of sewage waste has lead to incidents of beach pollution inseveral other states, including New York, New Jersey, and Florida (Moore 1992). Adverse impacts to the fishing industry have been shown to result from dumping sewage sludge and industrial wastes (Cross et al. 1985). Ocean outfalls should be prohibited in North Carolina to minimize water quality degradation to the water column. However discharges into estuarine waters can degrade water quality in the adjacent ocean waters.

In 1998, the North Carolina Division of Environmental Health, Shellfish Sanitation Office began a recreational beach monitoring program. Samples are collected for bacteriological analysis, primarily to determine safety for swimmers. These data can be an indication of water quality conditions for marine life as well. If problems are detected, pollution sources may be identified and addressed. In general, sampling results have been within the SB water quality standards (< geometric mean of 200/100 ml MF fecal coliform). It has been necessary, however, to post precautionary swimming advisories at Hanby Beach, Carolina Beach, Emerald Isle, and Kill Devil Hills because of potential contamination from stormwater discharge onto the beach or water (JD Potts, DEH, pers. comm.). There are approximately 13 stormwater outfalls that discharge on the beach near the mean high tide line or lower. Beach communities appear to be increasingly using "temporary" pumping of storm water to the beach as a solution to stormwater runoff. The runoff during heavy rain events flood the streets, in part due to improper siting of structures in flood zones, excessive impervious surface, and lack of upland stormwater retention areas. There currently are no stormwater rules prohibiting or regulating pumping of stormwater onto the beach or into the surf zone.

In summary, although there are water quality designations and regulations in place, even the most stringent levels of existing protection continue to allow authorization of additional development and associated activities at levels resulting in cumulative degradation of red drum habitat. Net reductions in nutrient loading from the Tar-Pam and Neuse nutrient sensitive waters management program may be offset by additional loading from increasing urbanization of the watersheds, as well as airborne deposition. For example, data from the US Department of Agriculture found a 62% increase in urban/developed land and a 158% increase in uncultivated crop land in the Tar-Pamlico basin from 1982 to 1992. In the Neuse River basin during the same time period, there was a 75 % increase in urban/developed land and a 234% increase in uncultivated crop land (DWQ 1999; DWQ 1998). Both activities contribute to increased nutrient and sediment loading.

10. PRINCIPAL ISSUES AND MANAGEMENT OPTIONS

10.1 Identification of Issues

Major issues and management options developed during the FMP process are summarized in this section. Management issues in the North Carolina red drum fishery have been solicited from the public, Red Drum Advisory Committee, Marine Fisheries Commission, Finfish and Regional Advisory committees, DMF, DENR, and the scientific community.

10.1.1 Issues Addressed in this Plan

1. Gill Net Attendance and Other Gill Net Issues
2. Other Gear Restrictions (Circle Hooks and Rod Attendance)
3. Recreational Bag and Size Limits
4. Adult Harvest Limits (Recreational and Commercial)
5. Commercial Harvest Limits

10.1.2 Other Issues of Concern

1. Area Closures to Protect the Adult Stock
2. Bycatch of red drum in flounder gill net fishery

10.2 Issues and Management Strategies

10.2.1 Gill Net Attendance and Other Gill Net Issues

Issue

Sub-legal red drum bycatch in the inshore small mesh gill net fishery.

Background

The Red Drum FMP process began in 1998 as a result of red drum stocks in North Carolina being classified as "overfished" by the DMF. In an effort to aid in the recovery of the red drum population and in accordance with the guidelines of the FRA of 1997, interim management measures

were taken to prevent further declines in the red drum stock during FMP development. Interim management measures were recommended by the DMF and passed as temporary rules by the MFC.

One of these temporary rules implemented in October 1998 made it unlawful to use unattended gill nets with a stretched mesh less than 5 inches in all state internal waters from May 1 through October 31. This decision was partially based on a DMF gill net mesh selectivity study. Data from the study indicate that gill net mesh sizes less than 5 inches take red drum less than 18 inches (Figure 15). Further, sampling indicates that the mortality rate of red drum taken in gill nets is high, particularly during the warmer summer months when water temperatures are high and undersized red drum are locally abundant (Figure 16).

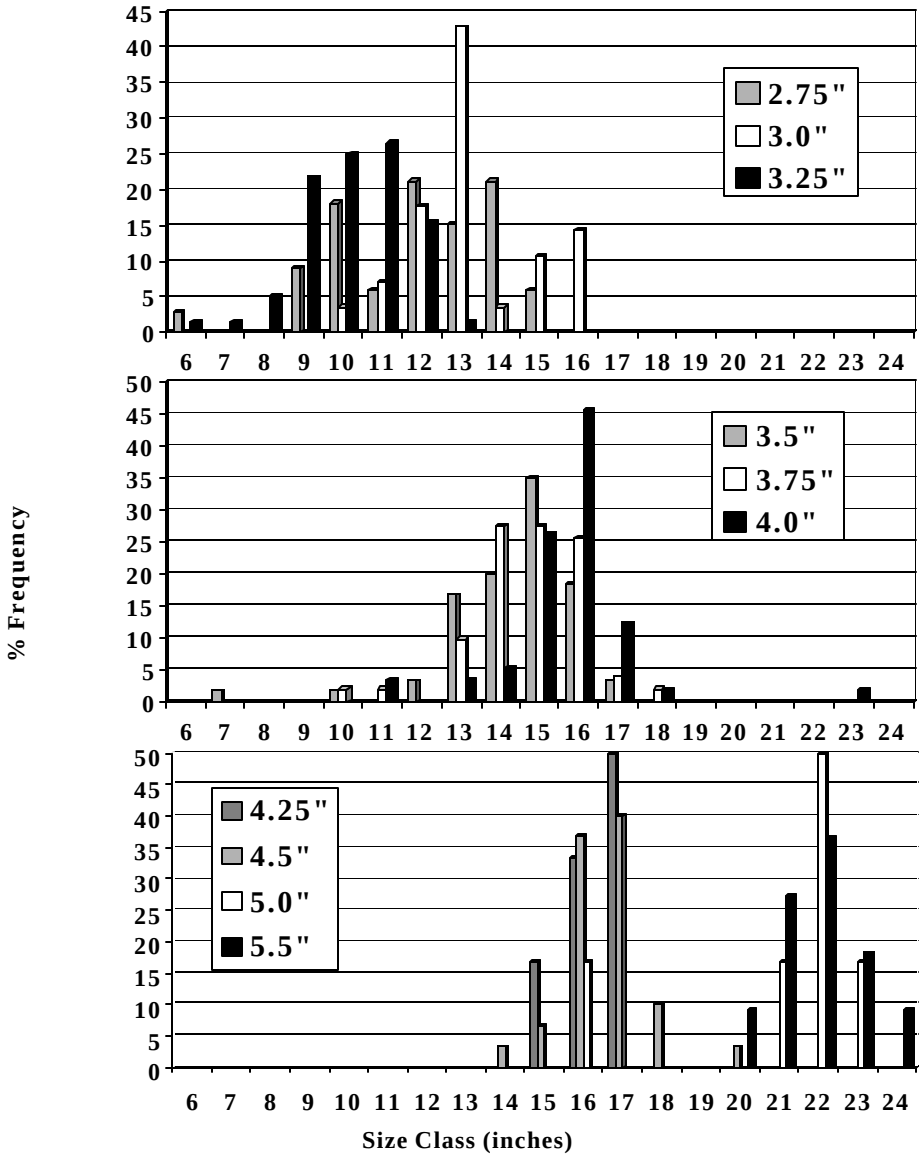


Figure 15. Selectivity of red drum in varying mesh size gill nets.

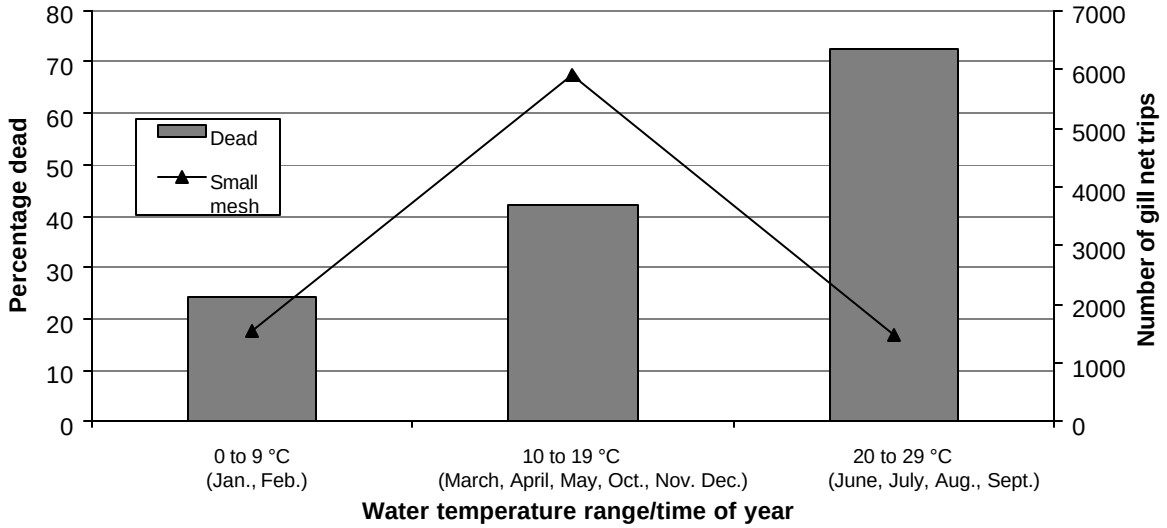


Figure 16. Gill net selectivity study in western Pamlico Sound showing percent red drum mortality from gill nets.

After this temporary rule was passed, concerns were raised by commercial fishermen about the potential impact the rule would have on small mesh gill net fisheries that do not typically encounter undersized red drum. These fishermen felt the rule threatened to eliminate traditional small mesh gill net fisheries prosecuted during the spring and summer months for bluefish, Spanish mackerel, and weakfish (Figure 17, Figure 18 & Figure 19). These fisheries are prosecuted in deepwater areas not typically inhabited by undersized red drum. Additionally, fishermen who participate in the fall spot fishery occurring from Core Sound and southward felt they would also be needlessly affected by the rule because the bycatch of undersized red drum in this fishery is minimal. Spot fishers were particularly concerned over attendance rules during October, the month when they take most of their landings (Figure 20).

The DMF Director, after consultation with the MFC, suspended the temporary rule and enacted a gill net proclamation in May 1999 that attempted to address the concerns expressed by gill net fishermen and the Red Drum FMP Committee. The proclamation required gill net attendance from May 1 through October 31 in areas where juvenile red drum typically occur, such as shallow bays, creeks, shorelines, and over shallow grass beds ("no trawl" areas). During September 1999, the MFC voted to incorporate these revisions into a gill net attendance temporary rule. The current gill net rules reflect those changes and went into effect on October 2, 1999.

Areas with attendance requirements include:

- All primary and secondary nursery areas
- All current and modified "No Trawl" areas Upper portions of the Pamlico, Pungo, Neuse, and Trent rivers

- Within 200 yards of any shoreline*

(*provision does not apply for the month of October in the area from the northern end of Core Sound south to the South Carolina line to allow for the fall spot fishery to be prosecuted)

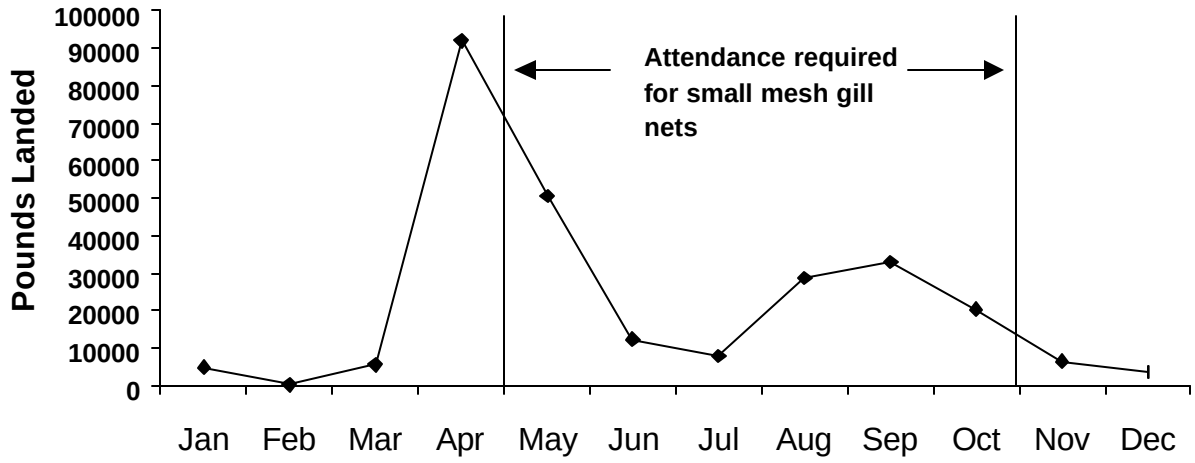


Figure 17. Average monthly bluefish landings from inshore gill nets for years 1994-98.

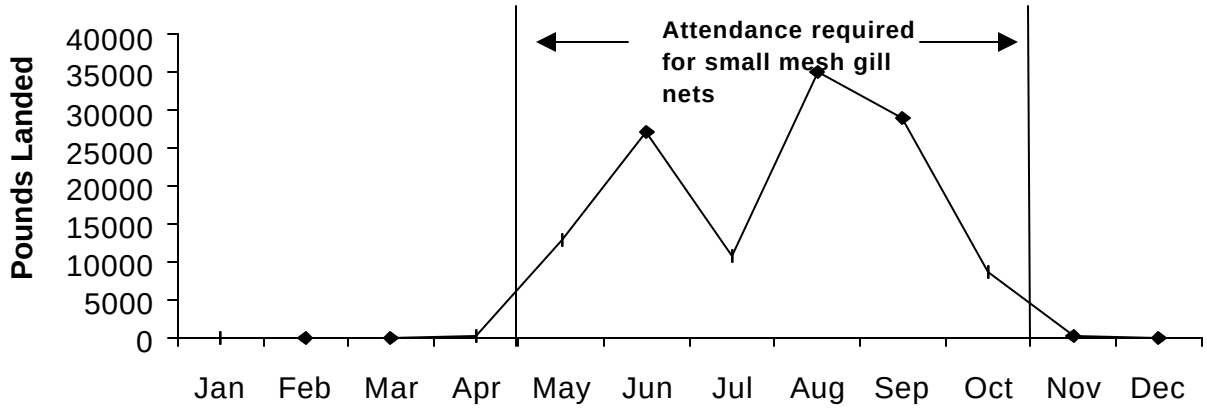


Figure 18. Average monthly Spanish mackerel landings from inshore gill nets for years 1994-98.

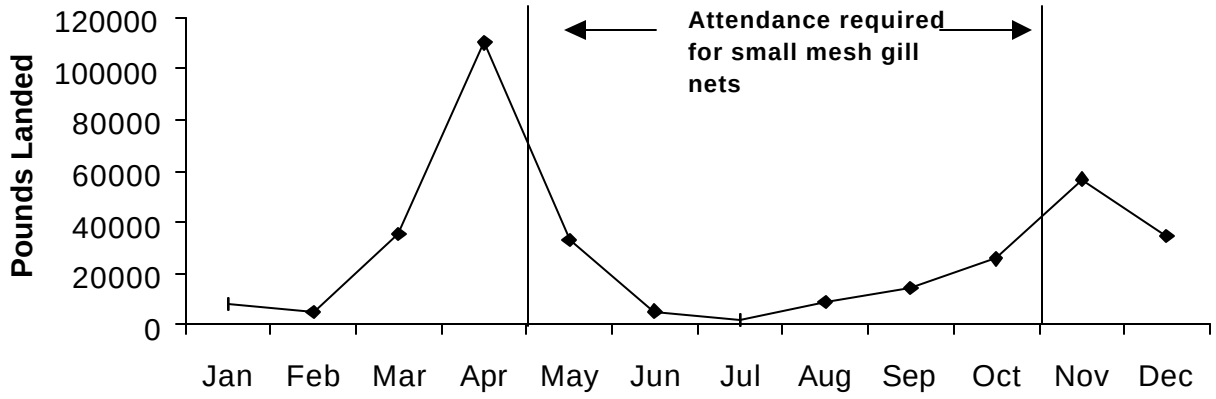


Figure 19. Average monthly weakfish landings from inshore gill nets for years 1994-98.

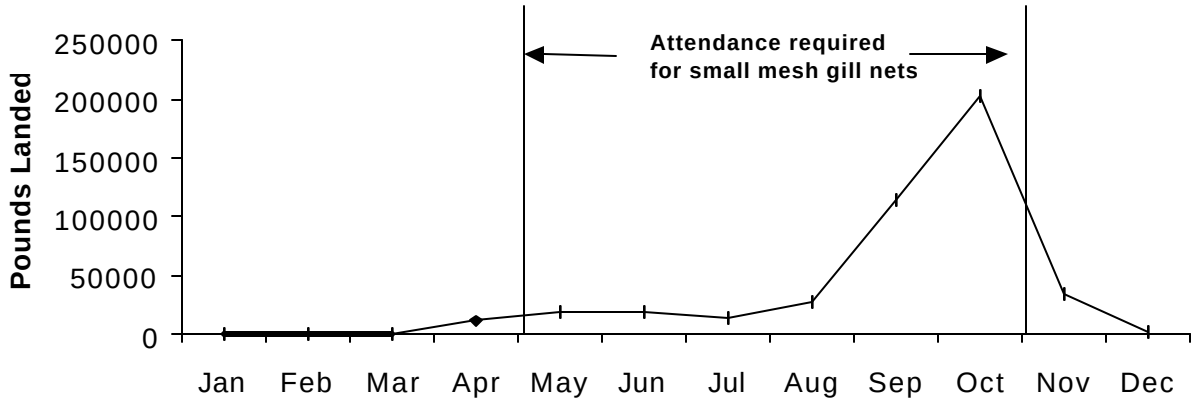


Figure 20. Average monthly spot landings from inshore gill nets for years 1994-98.

The public raised concerns over the revised gill net attendance requirements. There was a fear that major areas of the sounds and rivers were being opened to gill nets that would subsequently capture large numbers of undersized red drum. Based on observations over the past 15 years, DMF biologist are of the opinion that these changes do not compromise the overall intent of the originally proposed gill net attendance temporary rule to protect juvenile red drum. Data collected through tagging studies and independent gill net work indicate that juvenile red drum are most common in shallow water areas such

as creeks, bays, along shallow shorelines, and over grass beds. Additional data collected over the past year in the Disease Incidence Sampling Survey supports these observations.

The Disease Incidence Sampling Survey is being conducted to look at the incidence of fish disease in the coastal river systems. The rivers sampled include the Pamlico, Pungo, Neuse, and New rivers. Trammel nets are used as the sampling gear with 2-50 yard shots constituting a set. Each sample consists of one shallow water (<6ft) and one deep water (>6 ft) set being made in tandem. Each river system is sampled separately on a monthly basis using a stratified random sampling regime. Since the study began in September 1998, a total of 372 shallow and 322 deep water sets have been made (Table 10). Of the 824 red drum captured during the study, 799 were from the shallow water sets versus 25 from the deep water sets (Table 11). Greater than 93% of the red drum captured in the study were less than the legal size limit of 18 inches (Figure 21).

Table 10. Sampling effort and incidence of red drum by month in shallow (<6 ft) and deep (>6ft) water trammel net sets. Data is combined for all river systems sampled.

	Total Sets Made		Sets w/ Red Drum in Catch	
Yr/Mo	Shallow	Deep	Shallow	Deep
98-09	10	10	6	0
98-10	29	30	14	1
98-11	32	20	9	0
98-12	30	25	4	0
99-01	30	26	5	1
99-03	25	22	2	0
99-04	29	26	7	0
99-05	31	28	7	0
99-06	35	33	14	0
99-07	33	29	23	2
99-08	37	35	24	2
99-09	25	19	13	3
99-10	26	19	11	3
Total	372	322	139	12

Table 11. Incidence of red drum, total sampling effort, and CPUE of red drum by river system and sampling area (shallow vs deep).

River System	Red Drum Collected		Total Sets Made		# Red Drum per Set	
	Shallow	Deep	Shallow	Deep	Shallow	Deep
Neuse River	282	4	79	76	3.57	0.05
Pamlico River	379	2	77	74	4.92	0.03
Pungo River	60	1	24	24	2.50	0.04
New River	78	18	192	148	0.41	0.12
Combined	799	25	372	322	2.15	0.08

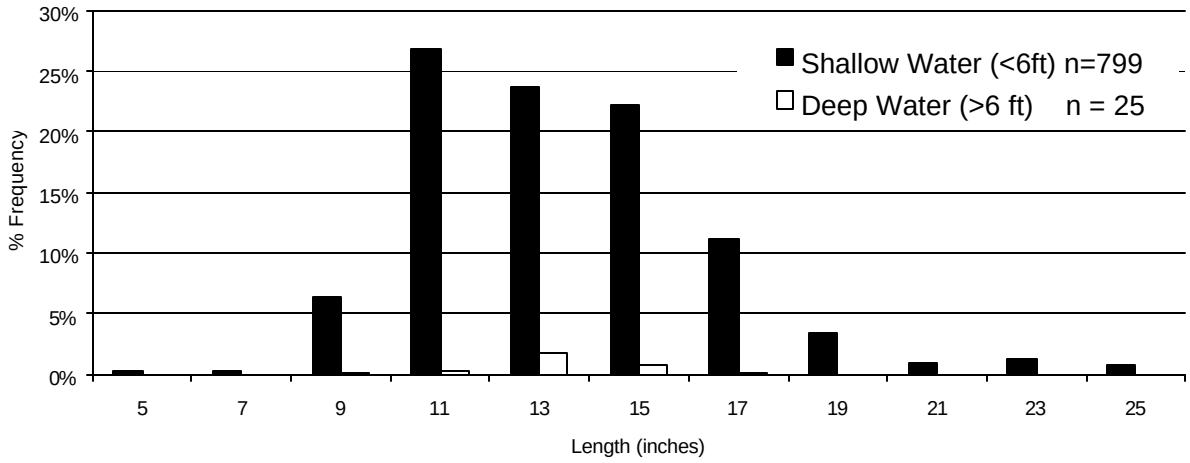


Figure 21. Length frequencies of red drum collected in shallow and deep water areas of the Pamlico, Pungo, Neuse and New Rivers.

Another concern was raised that lifting the 200 yard attendance requirement in the month of October for the areas of Core Sound to the south would lead to high rates of capture of undersized red drum. To address this concern the Division collected data during the fall of 1999 to characterize the red

drum bycatch associated with the fall spot gill net fishery in Core Sound. During this study, DMF staff collected both independent and dependent (observer trips) data.

The fishery independent sampling regime involved the setting of four 100-yard multiple mesh gill nets (3, 3.5, 4, 4.5-inch stretched mesh) in historical spot fishing locations in Core Sound (Figure 22). Each of the four 100-yard shots was set at varying distances from the shoreline. Data were analyzed to determine incidence of red drum and spot in gill nets with relation to distance from shore. A total of 48 sets were made with 123 red drum captured ranging from 12 to 17 inches in length (Figure 23). Most spot were landed in the 3 inch webbing and were taken at less than 100 yards from shore (Figure 24). Red drum were most susceptible in the 4 inch webbing and were captured less than 50 yards from shore (Figure 25).

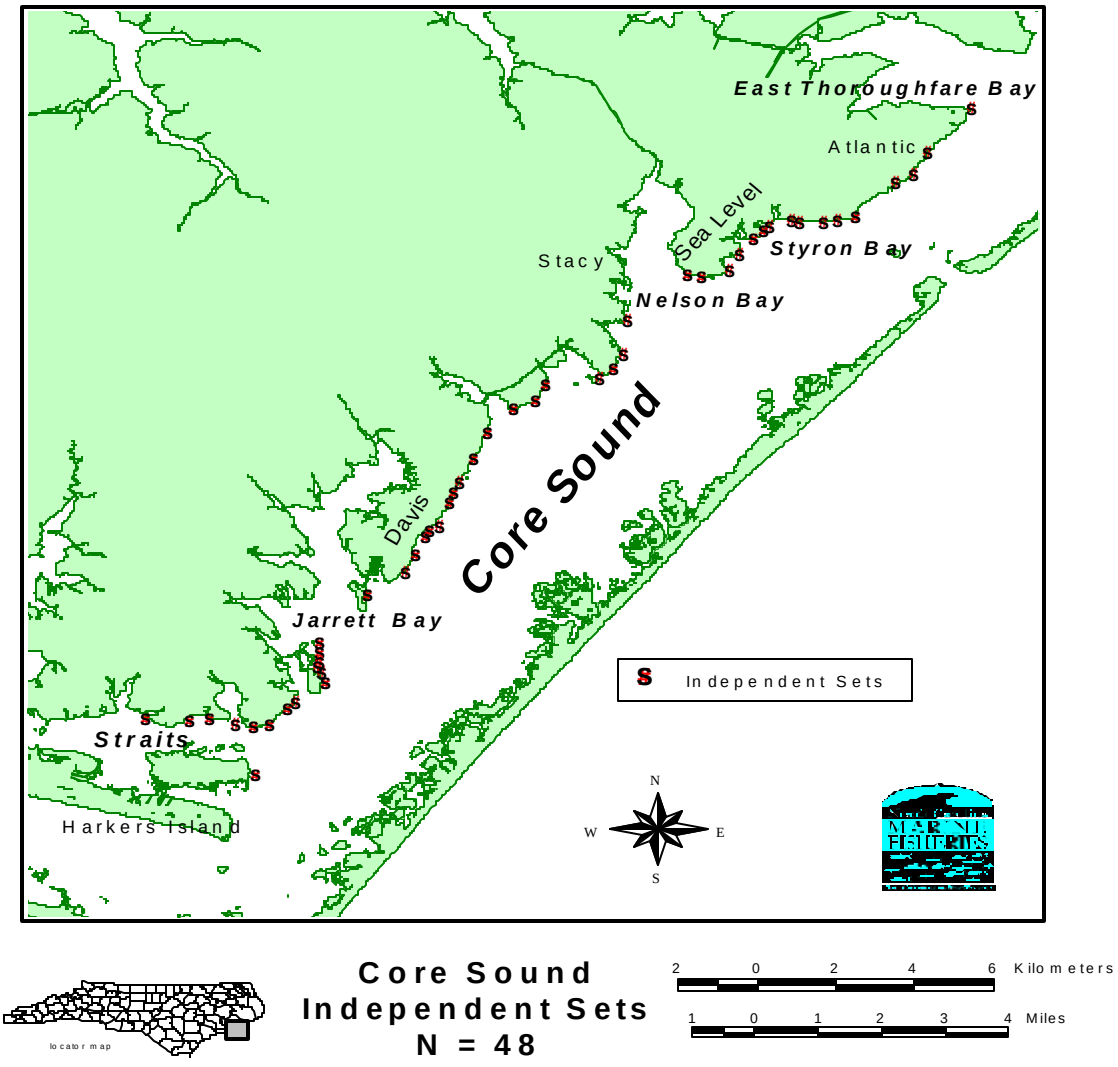


Figure 22. Location of independent gill net sets in Core Sound.

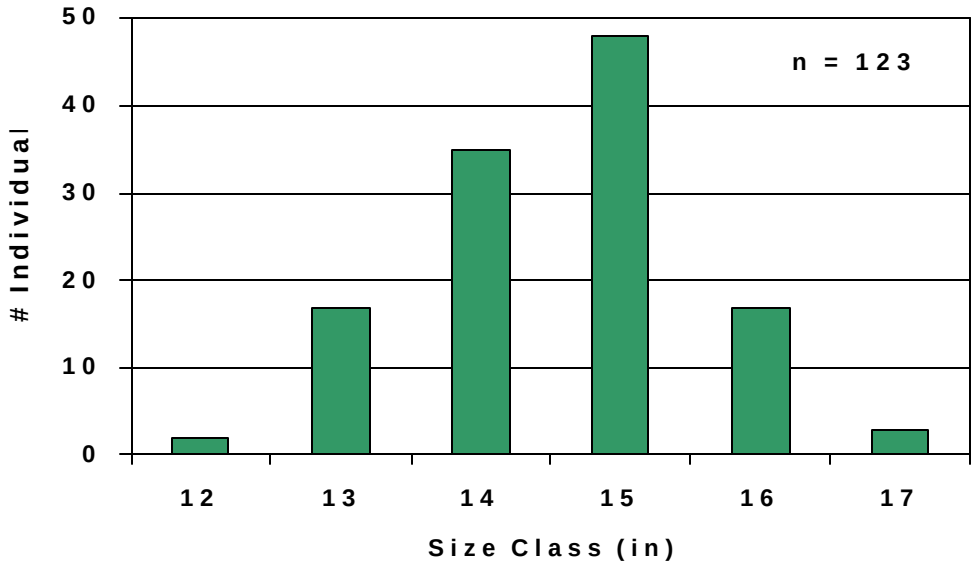


Figure 23. Length frequency distribution of red drum captured in independent gill net study during October 1999.

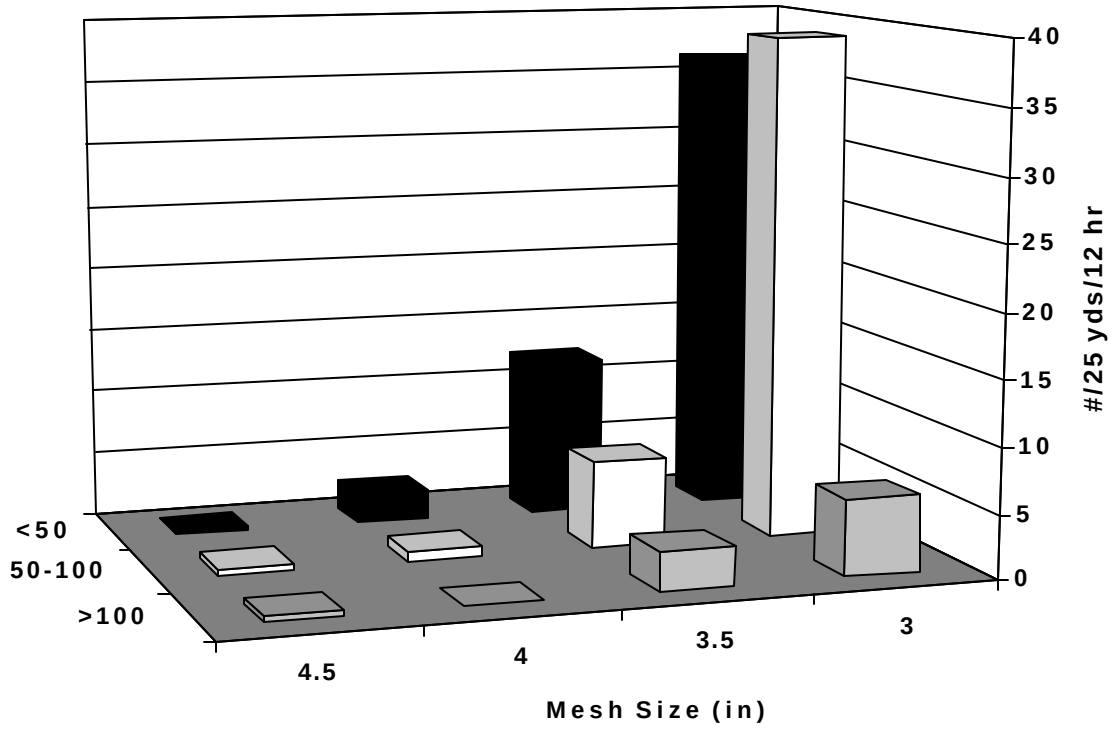


Figure 24. Independent spot CPUE by mesh size and distance from shore. N=48 (total # of sets)

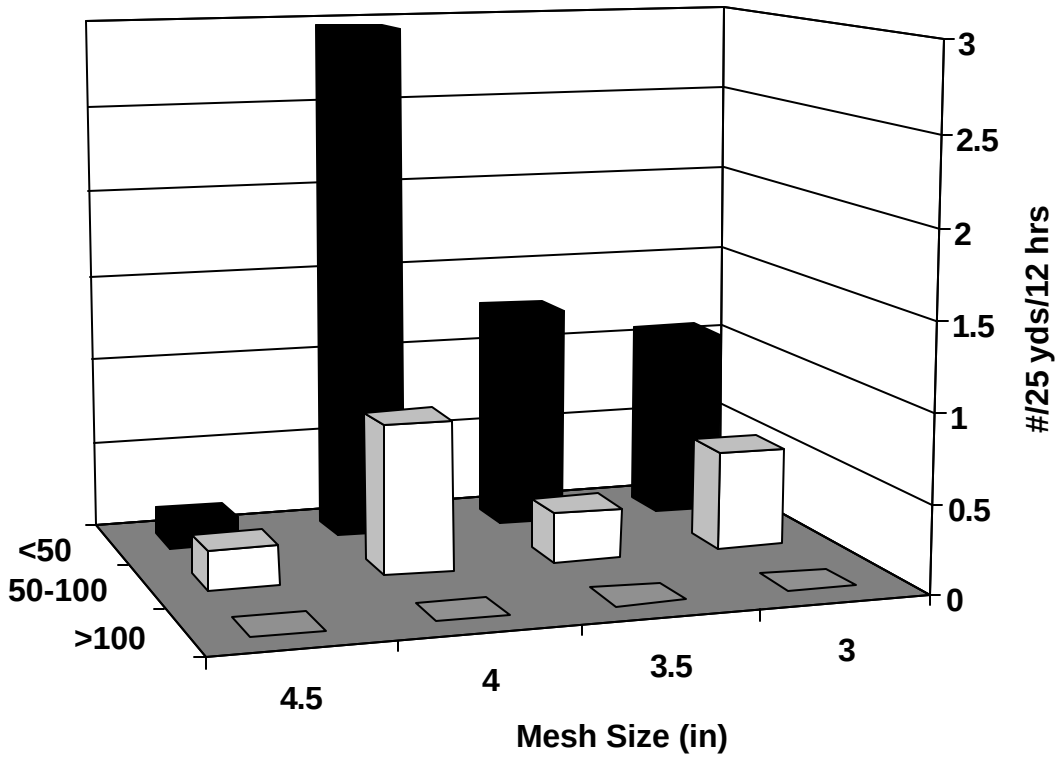


Figure 25. Independent red drum CPUE by mesh size and distance from shore N=48 (total # of sets) Total red drum captured = 123.

The fishery dependent monitoring program involved sending observers on a total of 30 sets from the commercial spot fishery (Figure 26). Spot landings occurred primarily in 3¼ and 3 1/8 inch webbing with the greatest CPUE (lbs/25 yds/12 hours) occurring at greater than 100 yards from shore (Figure 27). A total of 9 red drum was captured on observer trips, with the majority being captured less than 100 yards from shore (Figure 28). Mesh sizes used by commercial fishers in the spot fishery ranged from 3 to 3¼ inches, with an overall mean spot CPUE of 14.3 and a red drum CPUE of 0.15 (Table 12). Observed commercial gill net trips landed 150 pounds of spot to every pound of red drum (Table 13). Overall red drum bycatch estimates in the spot gill net fishery during the month of October indicate that the catch of undersized red drum is minimal.

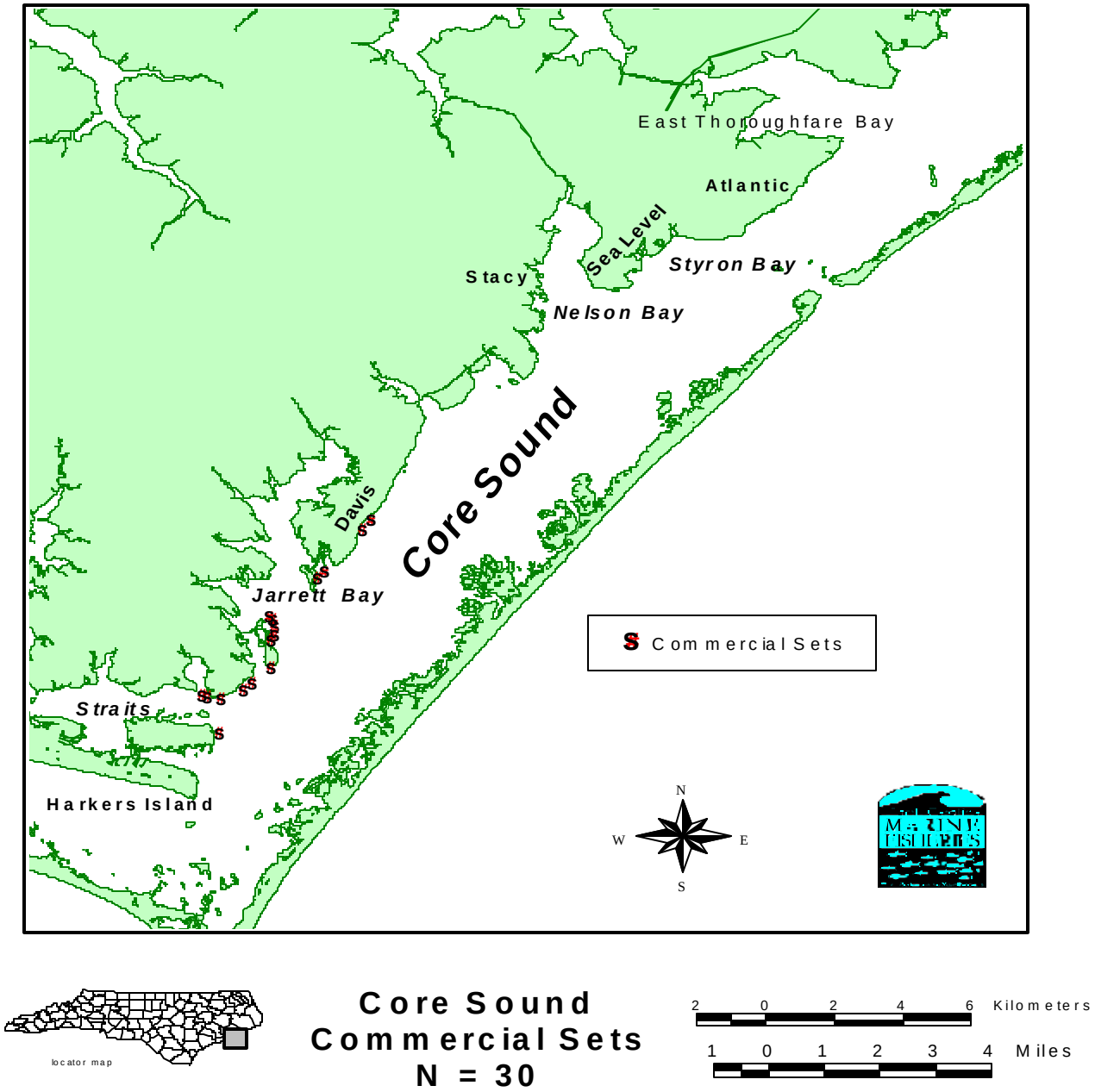


Figure 26. Location of sampled commercial spot gill net sets in Core Sound.

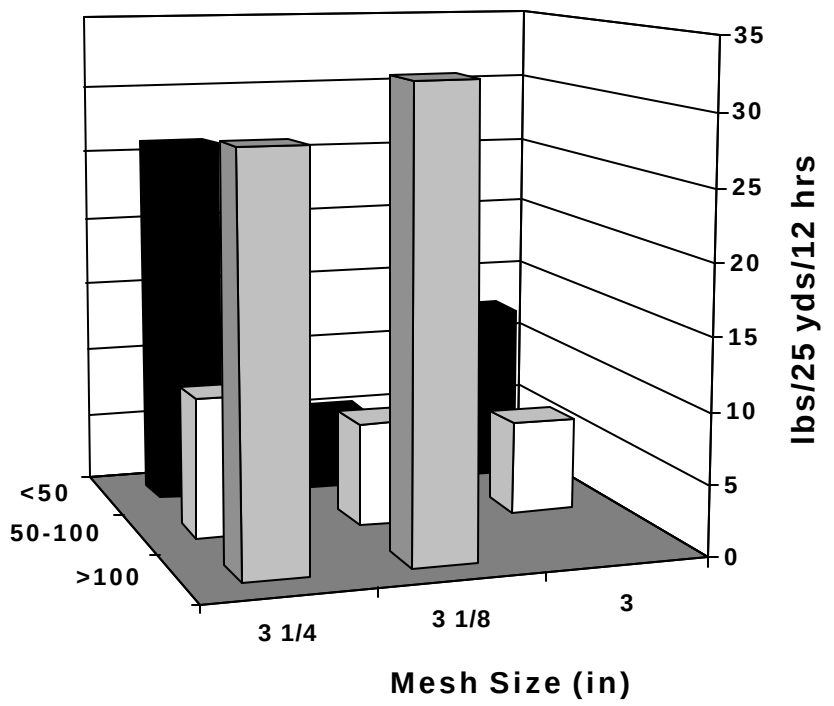


Figure 27. Commercial Spot CPUE by mesh size and distance from shore N=30 (total # of nets)

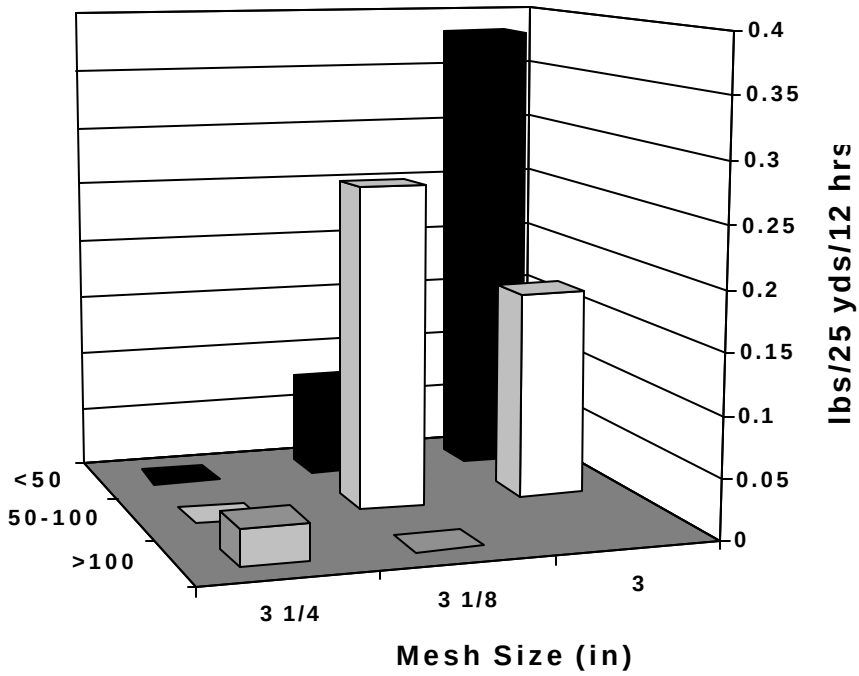


Figure 28. Commercial red drum CPUE by mesh size and distance from shore N=30 (total # of sets)
Total red drum captured (n = 9)

Table 12. Summary of observed gear parameters for Core Sound commercial spot gillnets during October, 1999.

Stretched Mesh Size (in)	Twine Size	Mean Yards Fished	Mean Soak Time (hrs)	Mean Distance from Shore (yds)	Mean Spot CPUE lbs\25 yards\12 hr	Mean Red Drum CPUE lbs\25 yards\12 hr
3 - 3 ¼	**177-208**	**650 (545 - 765)***	**14.44 (14.06 - 14.84)***	**114.2 (99.5 - 128.9)***	**14.3 (8.8 - 19.8)***	**0.15 (0.05 - 0.25)***

* = 95% confidence intervals

Table 13. Red drum bycatch estimates for October 1999 Core Sound spot gillnet fishery.

	Total Spot (lbs)	Total Drum (lbs)	Ave Drum wt. (lbs)	Spot:Drum	CS Gillnet Spot Landed Oct. 98	Estimated Total Drum (lbs)	Estimated Total Drum (#'s)
Observed Commercial Trips	4,255	28.44	2.99	**150 : 1**	48,911	**327**	**109**
Independent 3-inch > 50 yd off	176.74	3.85	1.38	**46 : 1**	48,911	**1,074**	**780**
Independent 3 and 3 ½-inch > 50 yd off	213.89	5.84	1.44	**37 : 1**	48,911	**1,336**	**931**

Discussion

Bycatch is an important issue facing the DMF and the MFC. The Guidelines for North Carolina Fishery Management Plans as adopted by the MFC set a standard for FMPs to design management measures which minimize waste of fishery resources, including both target and bycatch species. Seasonally, small mesh gill nets in North Carolina estuarine waters are used to target spotted seatrout,

striped mullet, and other species along the barrier islands and mainland shorelines. Red drum are caught incidentally in these nets, and prior to the implementation of an 18 inch minimum size limit in 1991 they often made an important contribution to the overall catch. Since effort in the gill net fishery continues to increase, it is reasonable to assume that large numbers of undersized red drum that were once harvested from these fisheries are now discarded. Data from the DMF indicate that the potential bycatch of red drum in small mesh gill nets is high because undersized red drum are available in all inshore waters throughout the year. Data also indicate that the mortality rates for red drum captured in gill nets are positively related to water temperature, with the highest mortality rates during the summer and the lowest mortality rates in the winter. Requiring gill net attendance for small mesh gill nets that select for undersized red drum will help minimize the potential for discard mortality both by reducing effort in the fishery and by having nets actively attended so captured sub-legal fish can be returned to the water in a timely manner. Negative impacts to existing fisheries can be reasonably reduced by only requiring gill net attendance in those coastal habitat areas where undersized red drum are commonly found.

Other Gill Net Issues

During the FMP process gill net fishers have expressed concern over the need for changes to the gill net attendance area along the 'Outer Banks'. The changes that are proposed will fine tune the current line (as enacted as part of the interim rules) to protect shallow water areas containing SAV while allowing small mesh gill netters the opportunity to move closer inshore in areas where SAV are not present.

Background

In the Outer Banks region, an area running from Wanchese to Portsmouth Island, small mesh gill net attendance is required in the modified "No Trawl" area. In developing current attendance lines in this area, the "No Trawl" line as listed in the current rules was modified by the DMF at recommendations of local fishers. Modifications were made in areas where the "No Trawl" line extended further out into the sound than necessary, possibly putting commercial fishers in the direct path of working trawlers and outside of productive deep water fishing grounds. The current gill net attendance line (modified "No Trawl") is designed to protect the shallow grass beds to the east while allowing fishers to set nets in deep water areas to the west. The protected area to the east of the line includes shallow shoals and flats characterized by dense SAV (submerged aquatic vegetation, i.e. eelgrass, shoalgrass, etc.) and is the primary habitat for sub-legal red drum along the 'Outer Banks'.

The DMF considered the recommendations of local fishers in developing the gill net attendance line and then made some additional modifications in order to straighten the line to relieve some of the difficulty in enforcement. One modification included straightening out the proposed line at an area just south of Hatteras Inlet in the vicinity of Clark Reef and Legged Lump. Since implementation of the current attendance rules the DMF has received several complaints from local fishers concerning the straightening of the line in the Legged Lump area. Fishers contend that the modifications exclude fishers from historically productive deep water areas and forces them to set nets further offshore than necessary to avoid small red drum. The Red Drum Advisory Committee (RDAC) is now asking the MFC to consider modifying the current attendance line to its originally proposed shape in the area of Legged

Lump (Figure 29). The area of Legged Lump is the site of Old Hatteras Inlet. As a result there is an area of deep water that cuts eastward into the otherwise shallow water areas of the reef. This area has traditionally been productive for bluefish and gray trout. Additionally the local geography offers a break from westward winds allowing local fishers a safe place to fish during inclement weather.

In addition to changes proposed in the Legged Lump area, additional changes are being proposed in response to concerns raised by commercial fishers in other areas along the 'Outer Banks'. The contention among these fishers is similar in that the current attendance area along the 'Outer Banks' extends to far offshore outside SAV areas, unnecessarily forcing gill net fishers into less productive and potentially hazardous conditions created by the deep water. In other areas the line extends to far inshore leaving SAV areas unprotected.

Through existing NOAA SAV data and data compiled by Mr. Gene Balance through a Fishery Resource Grant on SAV coverage along the 'Outer Banks', a series of changes are being proposed to the current attendance line. The technical changes to the line call for the addition of five points to the line, along with the modification of two points (Figure 30). Overall, these changes result in a net gain in the amount of SAV that will be protected, while changes also allow fishers to move inshore into more productive areas and away from potentially hazardous conditions associated with fishing offshore in deeper water.

Current Authority

The MFC has granted proclamation authority to the Director to specify the means/methods to take red drum, in addition to other parameters (NCAC 15A 3M .0501). The MFC also has granted proclamation authority to the Director to impose a variety of restrictions on gill nets (3J. 0103(b)) and passed temporary rules related to gill net attendance (3J. 0103 (g)(h)). A listing of the current rules as they apply to red drum can be found in Section 4.7.

Management Options/Impacts

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

1) No Action/Maintain current restrictions
   - \+ Reduce bycatch and discard mortality of undersized red drum
   - \+ Reduce bycatch and discard mortality of other finfish and crabs
   - \+ Decrease mortality of juvenile red drum/bias in assessment
   - \+ Allows traditional deepwater small mesh net fisheries to continue
   - \+ Protect critical habitat for juvenile red drum
   - \- Potential economic burden on fishers
   - \- Increased law enforcement duties

2) Modify current attendance to exempt Legged Lump attendance area and maintain current restrictions

+ Allow fishers to fish small mesh net in historical area
+ Provide sheltered area to set and retrieve nets
- Concern over enforcing crooked attendance line

3) Expand attendance into November on western side of Pamlico Sound and maintain current restrictions
   + Greater protection for undersized red drum
   - Potential negative impact on commercial gill net fishery

Research Needs

1) Information on gill net effort by area/season.
2) Conduct at sea samples to estimate red drum discards from gill nets.
3) Estimates of release mortality from gill nets.
4) Data on harvest and releases of red drum captured in gill nets under the RCGL.

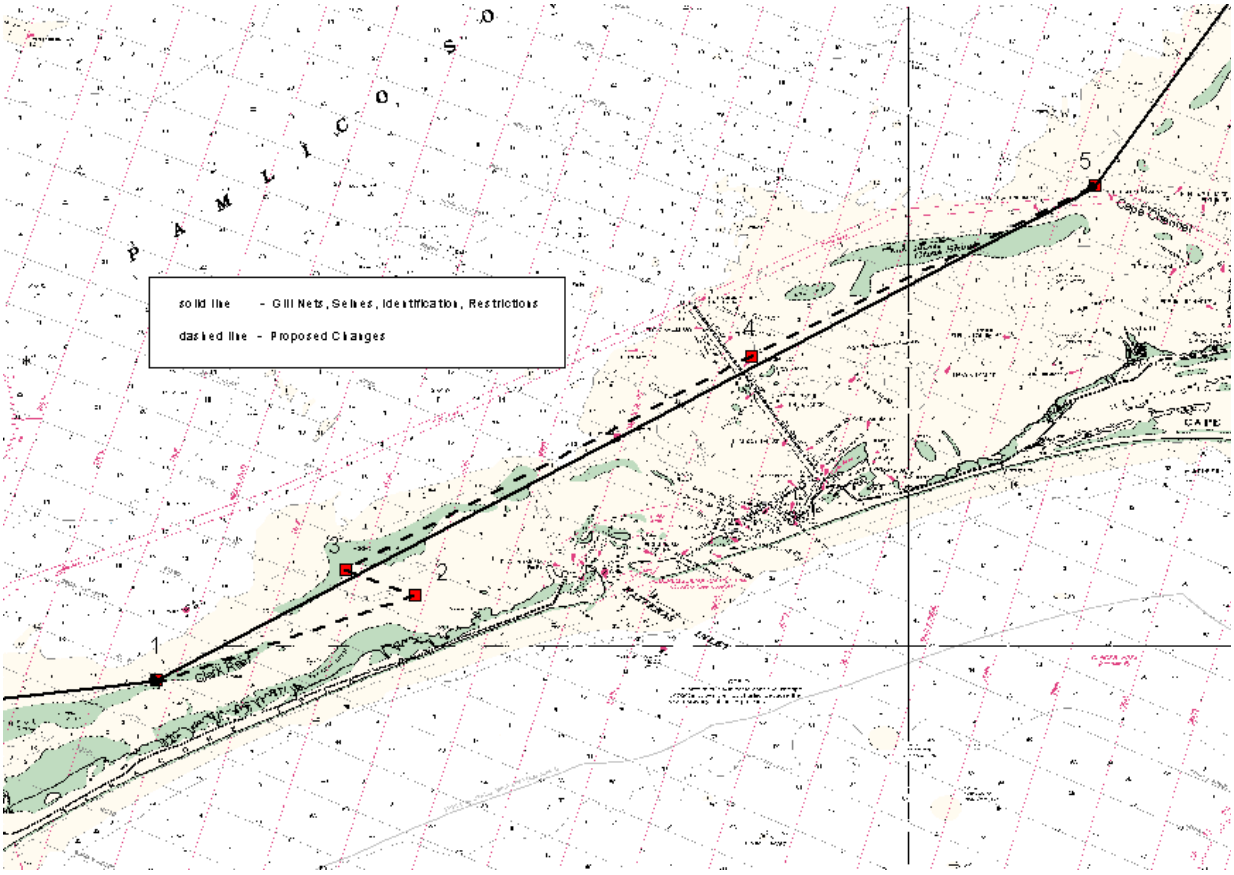


Figure 29. Map of the proposed change to the gill net attendance line in the area of Legged Lump.

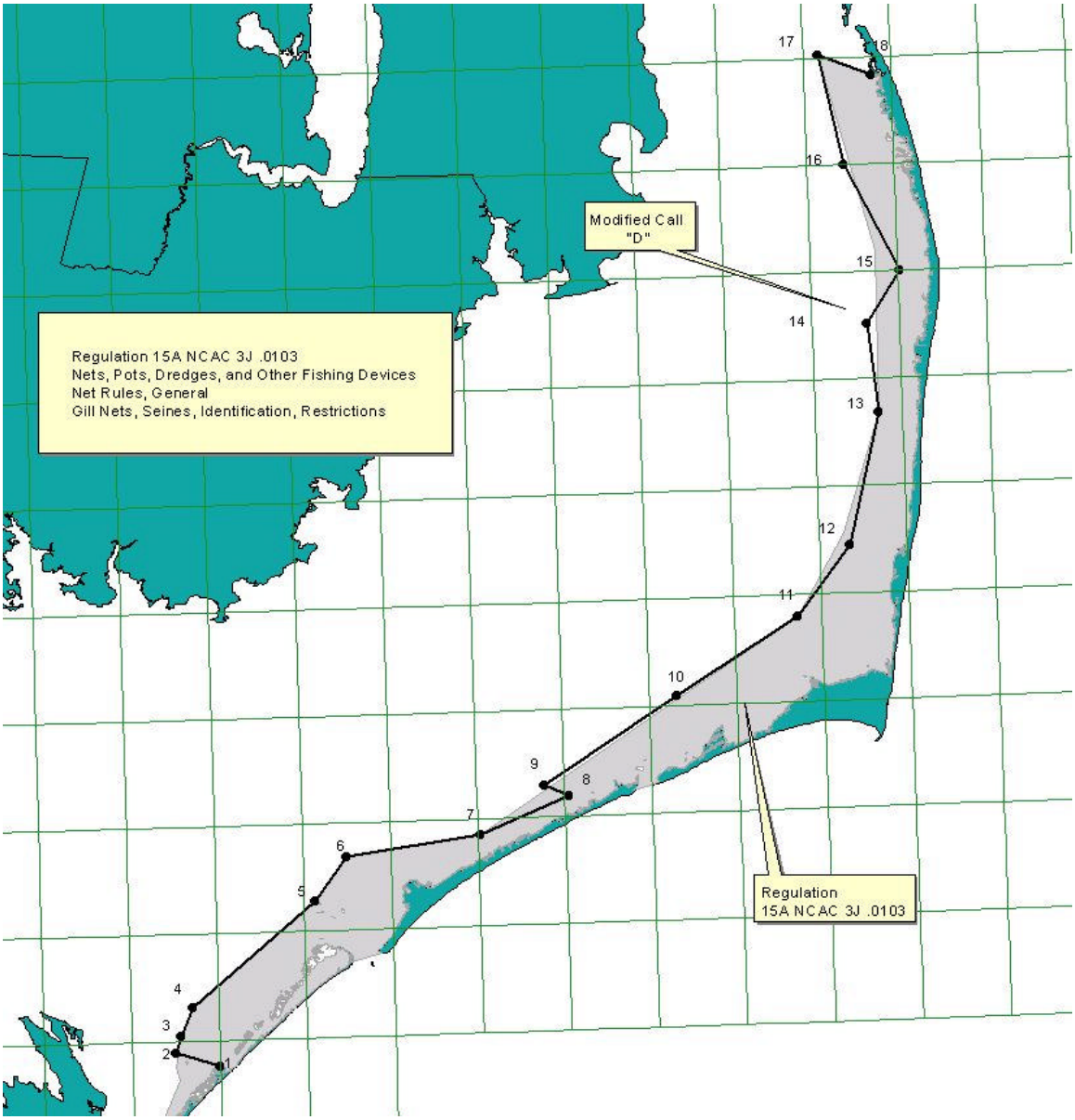


Figure 30. Map of the current gill net attendance area along the Outer Banks. The gray shaded area denotes the current gill net attendance area. The black line denotes the proposed changes to the gill net attendance area.

10.2.2 Other Gear Restrictions (Circle Hooks and Rod Attendance)

Issue

Public hearings for the Red Drum Public Information Document resulted in several management suggestions dealing with gear restrictions that the RDAC considered as management options for the red drum FMP. These issues include: minimum mesh sizes for gill nets, prohibited gears, circle hooks, rod attendance, and restricted areas.

Background/Discussion

1) Minimum Mesh Sizes: This issue was initially discussed to determine what mesh sizes would constitute large versus small mesh. Mesh sizes less than 5.0" stretch catch undersized red drum. The attendance requirement was considered to try and reduce mortality of undersized red drum in small mesh gill nets. No other action on mesh sizes has been considered by the DMF. Current gill net attendance rules are addressed in section 10.2.1 "Gill Net Attendance."

2) Prohibited Gears: The DMF has no recommendation for the consideration of prohibiting any gear types.

3) Circle Hooks and Rod Attendance requirements: Circle hooks have gained popularity in recent years due to their efficiency in hooking fish and facilitating quick and easy releases. The practice of using circle hooks and attending rods when fishing for red drum as opposed to setting up multiple rods and allowing the fish to hook themselves, often deep, is good practice. An informational brochure that describes the goals and actions of the red drum FMP as well as what responsible fishermen may do to assist in the recovery of red drum may be an excellent alternative to requiring these options.

4) Restricted Areas: The attendance requirement for small mesh gill nets in primary and secondary nursery areas as well as grass beds is an effort to reduce mortality on undersized juvenile red drum. Modifications to this requirement, that may be considered restricted areas to an extent, are being considered in the gill net attendance section of the FMP. Other areas, such as areas where large adult red drum congregate to spawn, particularly lower Neuse River and Pamlico Sound, will be considered in the issue paper on the adult fishery.

Current Authority

The MFC has granted proclamation authority to the Director to specify the means/methods to take red drum, in addition to other parameters (NCAC 15A 3M .0501). The MFC also has granted proclamation authority to the Director to impose a variety of restrictions on gill nets (3J. 0103(b)) and passed temporary rules related to gill net attendance (3J. 0103 (g)(h)). A listing of the current rules as they apply to red drum can be found in Section 4.7.

Management Options/Impacts

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

Circle Hook Restrictions

1) No Action/Status Quo

+ No effect on current fishing practices
- Fail to potentially reduce hook and line release mortality

2) Require Circle Hooks in Critical Areas

+ Potential reduction in release mortality
- Difficult to enforce

3) Educational Document on Conservative Fishing Practices for Red Drum

+ Educate public
+ Promote conservation of resource
- Potential that public will ignore recommendations

Rod Attendance Restrictions

1) No Action/Status Quo

+ No effect on current fishing practices
- Fail to reduce hook and line release mortality
- Fail to educate public on potentially more conservative fishing practices

2) Require Rod Attendance in Critical Areas

+ Potential reduction in release mortality
+ Reduce user conflicts over space in surf
- Difficult to enforce

3) Educational Document on Conservative Fishing Practices for Red Drum

+ Educate public
+ Promote conservation of resource
- Potential that public will ignore recommendations

10.2.3 Recreational Bag and Size Limits

10.2.3.1 Bag Limit

Issue

The recreational bag limit for red drum is currently 1 fish per person per day from 18 to 27 inches TL. The North Carolina fishery management plan for red drum may consider options to modify the current bag limit and other recreational management measures.

Background

The recreational fishery for red drum in North Carolina occurs year round with peaks in the spring and fall. Similar to the commercial fishery, the recreational red drum fishery is annually variable and dependent upon individual year class strength. Available data from the MRFSS from 1994-1998 indicate that:

1. Recreational landings of red drum have averaged 275,579 pounds.
2. Landings of red drum vary annually. The recreational landings of red drum increased from 38,285 pounds in 1997 to 569,380 pounds in 1998.
3. Undersized red drum (<18 inches) can make up a substantial portion of the recreational landings. From 1994 to 1998 an average of 18.9% of the recreational harvest has been undersized, ranging from 0.8% in 1998 to 34.6% in 1997.
4. From 1994 through 1998, 95% of the red drum harvested by recreational fishermen were juvenile fish (<32 inches TL).

The possession of red drum over 27 inches TL was prohibited as an interim measure in the initiation of the red drum fishery management plan in the fall of 1998. This issue is fully discussed in the section on Adult Harvest Limits.

Discussion

The reduction in the recreational bag limit from 5 to 1 was intended to reduce the recreational harvest while still allowing recreational anglers to possess a fish for personal consumption. The reduction in overall harvest is intended to allow for the continued use of the resource by the public, while aiding in the recovery of the currently overfished stocks of red drum in North Carolina.

The most recent stock assessment for red drum in North Carolina indicates a marked improvement in the escapement of juveniles to the adult stocks. However, with a target of 40% escapement, and an overfished definition of 30% escapement, the current level of escapement, estimated to be 18%, is still well below acceptable levels.

The best available data on reductions in harvest as a result of changes in the bag limit are generated using the MRFSS data. For the period of 1995 through 1998 the predicted percent reduction in harvest (numbers of fish landed) as a result of decreasing the bag from 5 to 2 fish results in an annual reduction of landings ranging from 4% to 20% (Table 14). The reduction in pounds taken ranges from 4% to 19%. A further reduction in landings occurs by reducing the bag limit from 5 to 1 fish. With a one fish bag limit the predicted reduction in the number of red drum landed annually ranges from 22% to 40%. By weight this results in an annual reduction ranging from 21% to 38%.

Table 14. North Carolina red drum recreational red drum catch statistics showing the effects of a reduced bag limit on the harvest of red drum.

Percent reduction in the North Carolina recreational red drum landings during 1995-98 (**NUMBER**) if given bag limits were in place.

Time Period	ESTIMATED CATCH	ESTIMATED HARVEST AT BAG OF 4	PERCENT REDUCTION AT BAG OF 4	ESTIMATED HARVEST AT BAG OF 3	PERCENT REDUCTION AT BAG OF 3	ESTIMATED HARVEST AT BAG OF 2	PERCENT REDUCTION AT BAG OF 2	ESTIMATED HARVEST AT BAG OF 1	PERCENT REDUCTION AT BAG OF 1
1995	83,877	81,629	2.7	78,049	6.9	72,563	13.5	58,863	29.8
1996	32,505	32,505	0.0	31,462	3.3	29,499	9.3	24,455	25.1
1997	9,405	9,405	0.0	9,405	0.0	9,042	4.0	7,020	22.4
1998	107,889	103,792	4.0	96,633	10.5	86,096	20.0	64,750	40.0

Percent reduction in the North Carolina recreational red drum landings during 1995-98 (**POUNDS**) if given bag limits were in place.

Time Period	ESTIMATED CATCH	ESTIMATED HARVEST AT BAG OF 4	PERCENT REDUCTION AT BAG OF 4	ESTIMATED HARVEST AT BAG OF 3	PERCENT REDUCTION AT BAG OF 3	ESTIMATED HARVEST AT BAG OF 2	PERCENT REDUCTION AT BAG OF 2	ESTIMATED HARVEST AT BAG OF 1	PERCENT REDUCTION AT BAG OF 1
1995	383,825	373,714	2.6	359,551	6.3	336,047	12.4	276,571	27.9
1996	185,753	185,753	0.0	182,360	1.9	172,854	7.0	146,332	21.3
1997	48,118	48,118	0.0	48,118	0.0	46,134	4.2	35,075	27.2
1998	558,575	535,958	4.0	501,068	10.3	450,638	19.4	349,877	38.4

It should be noted that the largest reductions in landings as a result of reducing the bag limit occur when overall annual landings are high (i.e. 1998, 1999) and resulting numbers of red drum taken during any one trip are higher. Preliminary comparisons of data from 1998 and 1999 indicate that reducing the bag limit from 5 fish to 1 fish in 1999 resulted in approximately a 50% reduction in landings (Table 15). Therefore, it is reasonable to assume that as red drum stocks continue to rebuild the likelihood of large year classes will increase and a reasonable reduction in harvest will be realized at a reduced bag limit of 1 or 2 fish.

Table 15. Comparison of 1998 projected red drum landings with bag limit of one fish per person and actual MRFSS 1999 catch estimates through October. Preliminary data (does not include releases)

State	1998 (through October with 5 fish bag limit)	1999 (through October with 1 fish bag limit)	% Difference
North Carolina	555,328	289,633	-48

State	1998 (adjusted for a 1 fish bag through October)	1999 (through October with 1 fish bag limit)	% Difference
North Carolina	312,318	289,633	-7

10.2.3.2 Size Limits

Issue

The size limit for red drum is currently a slot limit that permits fish from 18 to 27 inches TL to be harvested by both commercial and recreational fishermen. The North Carolina fishery management plan for red drum may consider options to modify the current slot limit.

Background

Prior to 1994, the slot limit on red drum was 14 to 27 inches TL. With concern over the status of the stock, DMF recommended increasing the minimum size to 18 inches TL in an effort to reduce mortality on these small fish and give them the opportunity to move out of the rivers where they tend to be most vulnerable to large catches. The result of this change was a shift in the harvest being taken from the western side of Pamlico Sound and the tributary rivers, to the eastern side of Pamlico Sound. This action also reduced fishing mortality on age 1 red drum. Red drum, however, have historically been a bycatch in small mesh gill net fisheries. Consequently, the same gear is being set in the same general locations at the same time of year and likely having a bycatch, sometimes substantial, of small red drum. This concern was a major factor behind the attendance requirement.

Figure 31 shows the distribution of age classes during an average year after the minimum size limit was increased from 14 to 18 inches TL. Age 0 red drum made up a very small proportion of the reported catch with numbers at age 1 and age 2 increasing sharply and then declining dramatically at age 3 and older. The reason for the sharp rise at age 1 and 2 is the observation that these age classes

comprise a large fraction of the red drum within the slot limit from 18-27 inches TL. Approximately 50% of red drum age 3 and older are 27 inches TL or larger.

Figure 31. Red drum catch in numbers at age for fish harvested in 1994.

Prior to the current restrictions, recreational and commercial fishermen were allowed one fish over 27 inches TL per day and commercial sale of fish > 27 inches TL was prohibited. However, the interim rules for red drum prohibits any possession or sale of red drum larger than 27 inches total length. This issue is fully discussed in Section 10.2.4 (adult harvest limits).

Discussion

The DMF recommendation to maintain the current slot limit is intended to allow for the continued, limited harvest of juvenile red drum while protecting the adult spawning stock. This recommendation may appear contrary to what is done for many other fish species and it is. The management of most fish species typically calls for size limits that permit individual fish to spawn at least once, thereby "replacing themselves" before they are harvested (Table 16, Table 17 & Figure 32). To follow this strategy for red drum would result in a minimum size limit of 34 inches TL, and create tremendous discard mortality concerns in both the commercial and recreational fisheries.

Table 16. Percent maturity for male and female red drum by age, 1988-1995.

	Male			Female		
Age	Immature	Mature	% Mature	Immature	Mature	% Mature
0	1			1		
1	88	12	12.0	72		
2	227	111	32.8	398	11	2.7
3	7	78	91.8	64	22	25.6
4		24	100.0	3	29	90.6
5		13	100.0		12	100.0
6+		298	100.0		335	100.0
Total	323	536		538	409	

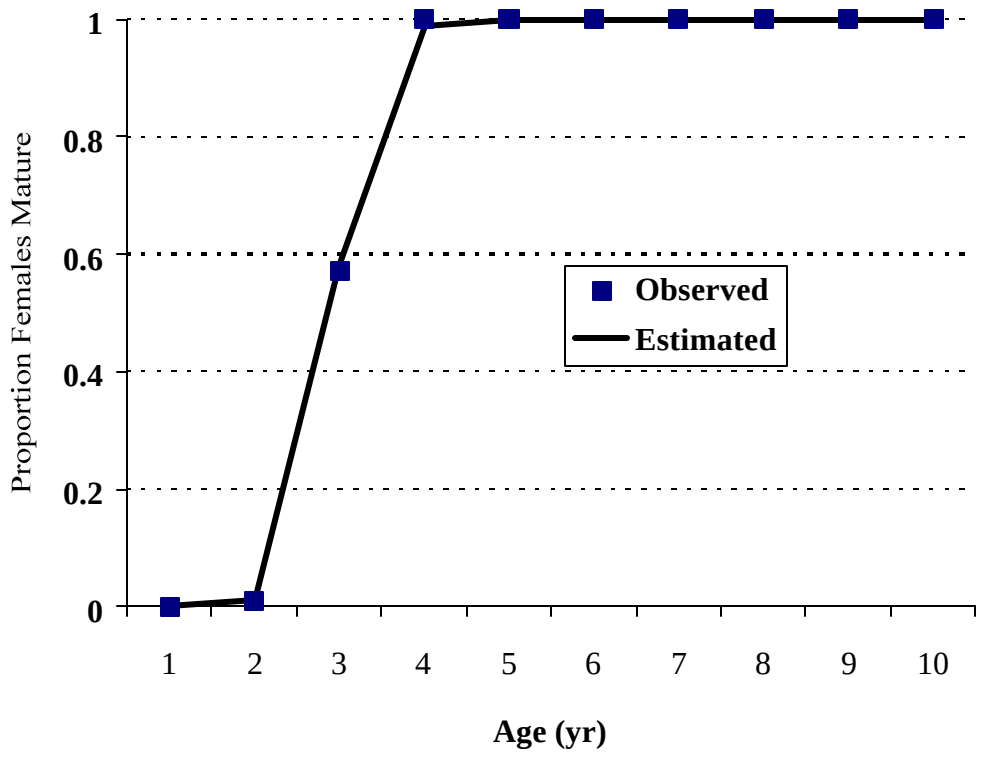


Figure 32. Red drum female maturity schedule, observed and logfit model fit.

Table 17. Percent maturity for male and female red drum by size class, 1988-1995.

Size class (inches TL)	Male			Female		
	Immature	Mature	% Mature	Immature	Mature	% Mature
11				1		
13				2		
14	4			2		
15	7			2		
16	15			4		
17	14			2		
18	8			5		
19	5			5		
20	4			2		
21	3			3		
22	11	4	26.7	11		
23	28	5	15.2	22		
24	36	4	10.0	51		
25	47	4	7.8	82		
26	26	14	35.0	49	1	2.0
27	16	13	44.8	44		
28	14	9	39.1	30	1	3.2
29	7	15	68.2	21	5	19.2
30	5	8	61.5	11	3	21.4
31	1	12	92.3	8	2	20.0
32		8	100.0	3	5	62.5
33	1	7	87.5	6	2	25.0
34		11	100.0		4	100.0
35		8	100.0	1	7	87.5
36+		124			157	100.0
Total	252	246		367	187	

Management plans (SAFMC and ASMFC) for red drum have taken the view that juvenile red drum may be harvested but that the adult stock should be protected. This strategy permits those adults that are able to achieve maturity spawn over many seasons rather than just once or twice.

The current slot limit of 18 to 27 inches TL permits the harvest of juvenile red drum and eliminates the harvest of adults. An increase in the maximum allowable size limit would not only be out of compliance with the ASMFC plan, but would allow fishermen to harvest young adult fish that are preparing to spawn for the first time.

A reduction in the lower slot limit to 14 inches TL would result in large numbers of smaller fish being taken earlier in the year. While the 100 pound trip limit is currently in place, 100 pounds of 14 inches TL red drum is equal to approximately 83 fish, whereas 100 pounds of 18 inches TL red drum is

equal to approximately 42 fish (Table 18). A smaller lower bound on the slot limit would also increase the vulnerability of these fish to fishing pressure for a longer period of time, thereby increasing the likelihood that the commercial harvest cap will be reached prior to the end of the fishing year. On both the recreational and commercial sides, a lower size limit would result in a dramatic increase in the total numbers of red drum harvested and have a negative impact on the stock assessment and our recovery efforts.

Table 18. Weight at length of red drum collected 1987-1998.

FL (in)	WT (lbs)	TL (in)	WT (lbs)	# per 100 lbs. based on TL
13	1.0	13	0.9	105.7
14	1.2	14	1.2	85.6
15	1.5	15	1.4	70.3
16	1.8	16	1.7	58.4
17	2.2	17	2.0	49.1
18	2.6	18	2.4	41.6
19	3.1	19	2.8	35.6
20	3.6	20	3.3	30.7
21	4.2	21	3.8	26.6
22	4.9	22	4.3	23.2
23	5.6	23	4.9	20.4
24	6.3	24	5.5	18.0
25	7.2	25	6.3	16.0
26	8.1	26	7.0	14.3
27	9.1	27	7.8	12.8
28	10.1	28	8.7	11.5
29	11.3	29	9.7	10.3
30	12.5	30	10.7	9.4
31	13.8	31	11.8	8.5
32	15.2	32	12.9	7.7
33	16.7	33	14.2	7.1
34	18.3	34	15.5	6.5
35	20.0	35	16.9	5.9
36	21.8	36	18.3	5.5

Current Authority

The MFC has granted proclamation authority to the Director to specify the means/methods to take red drum, in addition to other parameters (NCAC 15A 3M .0501). A listing of the current rules as they apply to red drum can be found in Section 4.7.

Management Options/Impacts

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

1) Status quo (1 fish 18-27 inches TL)
   - \+ Reduced harvest/fishing mortality from previous bag limit (5)
   - \+ Increase likelihood of reaching management goals (SPR rates)
   - \- Limits harvest for individuals
   - \- Potential for increased release mortality

2) Two fish 18-27 inches TL
   - \+ Increased fish available for personal consumption
   - \+ Reduced harvest/mortality as opposed to previous bag limit (5)
   - \- Minimal reduction in harvest as opposed to 1 fish bag
   - \- Increase in time necessary to reach management goals

3) One fish 18-32 inches TL: Commercial size limit 18-27 inches TL
   - \+ Availability of larger fish for personal consumption
   - \+ Reduction in harvest/fishing mortality as opposed to previous bag limit (5)
   - \+ Increased data available for stock assessment
   - \- Discrepancy in recreational and commercial size limits
   - \- Increased time in which any single year class is available for harvest

10.2.4 Adult harvest limits

Issue

The interim rules for the initiation of the Red Drum FMP include a prohibition on the harvest and possession of red drum greater than 27 inches TL. The FMP for red drum may consider options to modify or eliminate this current prohibition.

Background

The goal of the 1999 North Carolina Red Drum FMP is to restore the overfished stock of red drum so that it might produce the long-term maximum sustainable yield and regain its ecological integrity. To achieve these goals, it was recommended that the following objectives be met:

1. Restore the size and age structure of the adult spawning stock to levels consistent with the FMPs developed under the SAFMC and the ASMFC.
2. Reduce mortality and increase the escapement of juvenile red drum from inshore nursery areas into the adult spawning stock from current levels.

While these are but two of the adopted objectives of the FMP, they demonstrate the need to deal with the issue of the continued harvest of adult red drum. That this need has been recognized for several years is clear based on the regulatory history of this stock.

Restrictions on the harvest of adult red drum were first put into place in 1976 with the allowance of two (2) fish greater than 32 inches TL. In 1990, a 5 fish bag limit was put into place on juvenile red drum with an allowance of 1 adult fish 32 inches TL or greater. In 1992 the maximum size limit was reduced to 27 inches TL with no sale of fish greater than 27 inches TL. The harvest of one large, adult red drum was allowed until October 1998. As an interim measure to the Red Drum FMP, required in the guidelines for FMP development, The MFC prohibited the harvest and possession of red drum greater than 27 inches TL in October 1998.

Discussion

The DMF recommendation to prohibit the harvest, possession, and sale of red drum greater than 27 inches TL was based on several factors. The relative abundance of the oldest adult red drum has declined since the 1968-1972 time period (Figure 33). When the age structure of red drum collected from recent time periods are compared with those collected from 1968-1972, the percentage of adult red drum taken from the 25+ oldest age classes has consistently declined. The 25+ oldest age classes, while representing 57% of the adult red drum collected in the early period (1968-1972), accounted for only 12% of the fish collected during the period of 1987-1991 and 10% during the 1992-1998 time period. Additionally, the broad age distribution represented in the 1968-1972 sample

comes from a relatively small sample size (n=191) while the more truncated distribution in the late periods (1987-1998) comes from a much larger sample size (n=905). While older fish (e.q. 25+ year classes) are still represented in the most recent data, their occurrence is rare and they appear to make up a smaller proportion of the overall population.

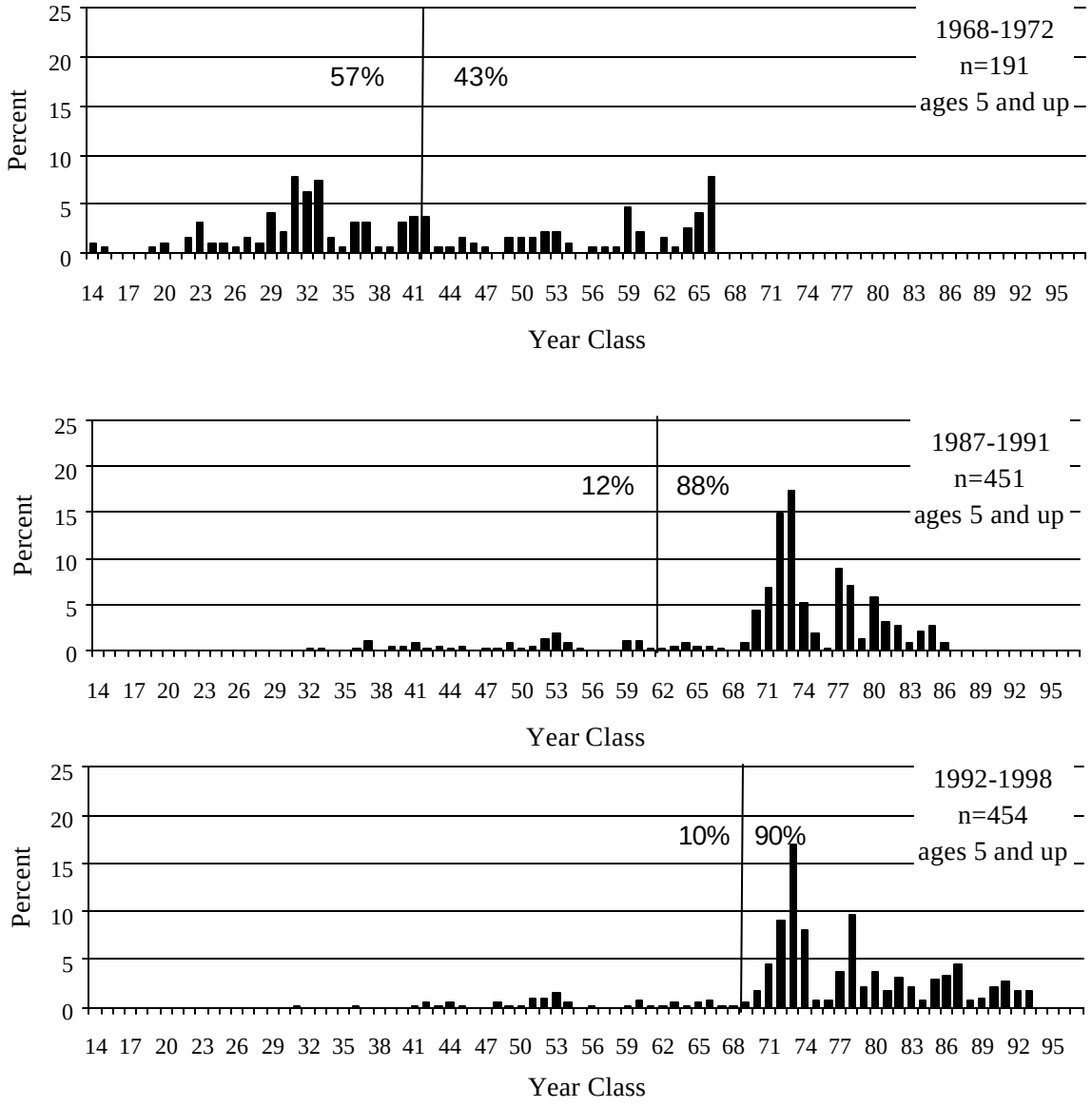


Figure 33. Relative abundance of adult drum (ages 5+) collected from the time periods of 1968-72, 1987-1991 and 1992-1998. The vertical line in each graph separates the 25 youngest year classes from the 25+ oldest year classes. The percent values reported represent the percentage of fish that make up the 25 youngest year classes versus the 25+ oldest year classes.

Stock diversity is often evaluated on the basis of population age structure. Consequently, a fish stock with a full complement of age classes in the population is considered highly diverse. When over exploitation occurs, which is currently the case in red drum, there is a decline in the number of age classes represented in the fishery. The absence of a diverse age structure compromises the ability of any fish stock to recover. Because adult red drum are large and have high reproductive output, they are extremely valuable to the stock's reproductive potential and allowing any harvest could increase the chance of recruitment failure.

The DMF has recommended maintaining the current slot limit of 18 to 27 inches TL and prohibiting the harvest of adult red drum (> 27 inches TL). This recommendation permits the continued, limited harvest of juvenile red drum that provides for a reasonable level of survival and escapement. This recommendation also provides for the maximum possible protection of the adult spawning stock. As was discussed in the section on size limits (10.2.3.2), this recommendation is contrary to what is done for many other fish species. The management of most fish species typically calls for size limits that permit individual fish to spawn at least once, thereby "replacing themselves" before they are harvested. Following this strategy for red drum, however, would result in a minimum size limit of 34 to 36 inches TL, and create tremendous discard mortality in both the commercial and recreational fisheries. Consequently, management plans (SAFMC and ASMFC) for red drum have taken the view that this species may be harvested under strict controls as juveniles, but should be protected as adults. This strategy permits adults that reach maturity to spawn over many seasons rather than just once or twice.

The North Carolina red drum population is recovering and is making progress towards reaching the goal of 40% escapement (a proxy for spawner potential ratio). However, we are only about half way there. Consequently, given the intuitive relationship between adult spawning stock and recruitment, we must protect the existing spawning stock. A continued prohibition on adult harvest will increase the likelihood of greater stock diversity and improved spawning success necessary to reach the ultimate goal of the plan.

The DMF and other management agencies recognize the lack of information on the adult stock, but have elected to take a precautionary approach to insure continuing good year classes and make further progress toward achieving the ultimate goal of 40% spawner potential ratio. As a result of this lack of information on the absolute abundance of adult red drum and in recognition of their vital importance to the recovery of this stock, it would be irresponsible to harvest what we are not sure we have. Therefore, until such time that the stock has fully recovered, the DMF position remains that adult red drum should be protected to the fullest extent possible. Presently, this can only be achieved by prohibiting all harvest and possession.

Current Authority

The MFC has granted proclamation authority to the Director to specify the means/methods to take red drum, in addition to other parameters (NCAC 15A 3M .0501). A listing of the current rules as they apply to red drum can be found in Section 4.7.

Management Options/Impacts

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

1) Prohibit all possession and sale of red drum >27 inches TL

+ Protects adult spawning stock
+ Increase likelihood of good year classes (recruitment)
+ Increase stock diversity
+ Increase likelihood of reaching management targets
- Potential economic impact on recreational fishery
- Impact on historical use as food fish
- Limits availability of data for assessment of stock diversity

2) Trophy fishery (1 fish over 50 inches TL)

+ Potential positive impact on recreational fishery
+ Collect fishery dependent data on recreational fishery
+ Provide some use as food
- Selectively harvest larger, more productive fish
- Limits protection of adult stock
- Delays stock recovery
- Decreases likelihood of good recruitment/year classes

3) Special Scientific Collecting Permit to retain 1 fish > 27 inches TL

+ Controlled harvest of adults with mandatory reporting
+ Potential positive impact on recreational fishery
+ Collect fishery dependent data for age assessment
+ Provide some use as food
- Limits protection of adult stock
- Delays stock recovery
- Decreases likelihood of good recruitment/year classes

4) No harvest of adults (>27 inches TL) until the 30% SPR target has been exceeded

+ Controlled harvest of adults with mandatory reporting
+ Protection of adult stocks at target levels
+ Potential positive impact on recreational fishery
+ Increases likelihood of a sustained fishery
+ Potential for some use as food fish
- Delays any harvest of adult fish until target is met

- Requires reduction in mortality on juvenile fish to increase escapement/SPR rates

Research Needs

1) Assess discard mortality of adult red drum (commercial and recreational),
2) Characterize the trophy recreational fishery (tackle, geographic location, bait, water temperature, seasonality, hook types, etc.),
3) Assess adult population for abundance, distribution, and stock diversity,
4) Assess magnitude of red drum bycatch in estuarine flounder gill net fishery.

10.2.5 Commercial harvest limits

Issue

Current regulations for the commercial harvest of red drum limit commercial fishing operations to 100 pounds of red drum per vessel per day and caps the annual commercial harvest at 250,000 pounds. The Red Drum FMP may consider options that modify the current trip limit and other commercial management measures.

Background

Red drum are commercially harvested in North Carolina using a variety of gears and constitute a bycatch fishery for most gears and trips. From 1994 to 1998, 24,497 trips reported landing red drum. The majority of these trips (91.2% or 22,356 trips) reported landings less than 50 pounds. Reported gears used to harvest red drum include small and large mesh gill nets, run-around gill nets, swipe nets, haul seines, pound nets, and beach seines; several other gears report incidental landings. Red drum harvested by the commercial sector are generally from a single year class and catches vary annually depending upon individual year class strength.

The directed fishery for red drum in North Carolina primarily occurs behind the Outer Banks from Oregon Inlet to Ocracoke during the spring and fall. Historically this fishery employed run-around gill nets and haul nets to circle schools of red drum and had limited participation. Participation in the fisheries has increased in recent years with the increased use of run-around gill nets. During 1994-1998, 1.1% of the total trips that reported landings of red drum in North Carolina accounted for 48.5% of the total harvest. 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 1,000 pounds with occasional catches from 1,000 to 5,000 pounds (Table 3). These data indicate that approximately one-half of the red drum harvested commercially in North Carolina is from the directed fishery and approximately one-half is caught as bycatch in other fisheries such as gill nets, long haul seines and pound nets.

Available data from the NCDMF Trip Ticket Program indicate:

1. From 1994-1998 annual commercial landings of red drum have averaged 170,100 pounds with a dockside value of $156,782 and an average of 92 cents per pound.

2. The reported harvest of red drum has exceeded 250,000 pounds four times since 1972, occurring in 1984, 1989, 1998 and 1999 (Table 19). The commercial cap was first established in 1990 at 300,000 pounds and lowered to the current value of 250,000 pounds in 1991. The 1998 and 1999 fishing seasons are the only two years that the commercial fishery for red drum has closed due to the cap being met.

3. Since 1994, anchored and runaround gill nets have accounted for greater than 70% of the reported harvest (Table 20).

4. Most reported landings of red drum are bycatch from a variety of gears and fisheries. From 1994 through 1998 greater than 91% of the trips that landed red drum reported landings of less than 50 pounds a trip. However, for those fishers who directed on red drum, the average pounds landed per trip were significantly higher with catches of several hundred pounds or more not uncommon (Table 21).

Table 19. Commercial landings and dockside value of red drum from 1972 through 1998. Landings prior to 1994 are reported landings, while landings from 1994-98 are from the commercial trip ticket program.

Year	Pounds	Value ($)	Price/lb.
72	42919	$ 5,228	$ 0.12
73	70264	$ 7,775	$ 0.11
74	142437	$ 15,781	$ 0.11
75	214236	$ 21,537	$ 0.10
76	168259	$ 21,700	$ 0.13
77	19637	$ 2,673	$ 0.14
78	21774	$ 2,480	$ 0.11
79	126517	$ 21,728	$ 0.17
80	243223	$ 47,133	$ 0.19
81	93420	$ 18,817	$ 0.20
82	52561	$ 12,273	$ 0.23
83	219871	$ 51,958	$ 0.24
84	283020	$ 82,458	$ 0.29
85	152676	$ 50,384	$ 0.33
86	249076	$ 106,808	$ 0.43
87	249657	$ 148,205	$ 0.59
88	220271	$ 125,289	$ 0.57
89	274356	$ 173,755	$ 0.63
90	183216	$ 106,450	$ 0.58
91	96045	$ 56,989	$ 0.59
92	128497	$ 86,859	$ 0.68
93	238099	$ 203,955	$ 0.86
94	142119	$ 102,326	$ 0.72
95	248122	$ 223,310	$ 0.90
96	113330	$ 112,873	$ 1.00
97	52564	$ 57,007	$ 1.08
98	294366	$ 288,397	$ 0.98

Table 20. Average and percent of annual red drum landings by gear for the period of 1994 to 1998.

Gear	Average Landings	% of Landings
Anchored Gill Nets	74,470	44%
Runaround Gill Nets	52,286	31%
Haul Seine	21,636	13%
Pound Net	6,403	4%
Beach Seine	4,345	3%
Other Gears	10,960	6%

Total	170,100	100%

Table 21. Landings summary for red drum by trip for the period of 1994 to 1998.

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

Prior to implementation of the current temporary rule that protects the spawning stock by prohibiting the possession of red drum larger than 27 inches TL, commercial fishermen were allowed to keep one adult red drum caught incidental to their fishing operations. Because these larger fish (> 27 inches TL) could not be sold, they were not reported on trip tickets and the magnitude of this harvest is unknown.

Discussion

The DMF and MFC cap the commercial harvest of red drum at 250,000 pounds and recently implemented a temporary rule (October 1998) that limits individual trips to 100 pounds per day. It was the intent of the MFC to develop a bycatch fishery and eliminate any directed harvest. In 1998, prior to the 100 pound trip limit being implemented, the cap was reached and the fishery was closed in October. High catches in 1998 are largely attributed to both a strong year class and increased fishing effort. Despite implementation of the 100 pound trip limit in 1999, the red drum commercial fishery was again closed in early November once the 250,000-pound cap was reached.

The commercial cap, established in 1990, was set as a precautionary measure to insure that a directed fishery did not develop. It was not based on biological information and was not intended to reduce fishing mortality to any specified level. Concern of a growing directed fishery increased during the early to mid 1980s as markets developed in response to the "blackened redfish" craze. Additional actions taken by other states, such as designating red drum as "gamefish" and prohibiting their sale or limiting harvest through strict possession limits and quotas, increased demand in those states which still allow harvest (Table 22). Increased demand led to increased value for red drum landed by commercial fishers and has made targeting red drum much more lucrative (Table 19). This helps to explain why from 1990 through 1998 North Carolina has accounted for greater than 77% of all red drum landed in the southeastern United States (Table 23).

The recent implementation of the 100 pound daily trip limit is an effort to further reduce landings and eliminate any directed harvest while still allowing the harvest of those red drum historically taken as a bycatch to other directed fisheries. Reductions in harvest are intended to aid the recovery of the currently overfished stocks of red drum in North Carolina. While the most recent stock assessment for red drum in North Carolina indicates a marked improvement in the escapement of juveniles to the adult stocks, estimated escapement levels are still well below target levels and the fishery is still considered to be overfished.

Recent closures of the commercial red drum fisheries in 1998 and 1999 have occurred in the fall. This timing coincides with the flounder gill net season, a fishery that typically involves landing red drum as bycatch. In order to avoid closures of the red drum fishery in the fall when the flounder season peaks and prevent discarding of red drum bycatch, it may be feasible to monitor red drum landings during a period other than the traditional January through December calendar year. As an example, the fishing year could be adjusted to address the needs of the various fisheries that take red drum as a bycatch. A season that starts in late summer/early fall would allow for the red drum season to begin in a period when landings are highest and end during the summer when landings are lower and gill net fishing effort is minimal thereby reducing regulatory discards (Table 24 & Table 25). This change in the fishing year could also decrease the likelihood of exceeding the cap due to improved monitoring, as landings and effort would be lower during the period when the cap is being approached.

Table 22. Current red drum regulations for states Virginia through Texas, 02/16/99

State	Fishery	Size limits	Possession Limits	Season	Quota	Comments
Virginia	Commercial	18" TL to 27" TL slot	5 fish per person per day Only 1 per person per day over 27" TL	Open	None	Individual possession limits apply regardless of number of persons involved
	Recreational	18" TL to 27" TL slot	5 fish per person per day Only 1 per person per day over 27" TL	Open	None	
North Carolina	Commercial	18" TL to 27" TL slot	100 pound per day trip limit	Open	250,000lb	Internal small mesh gill net attendance May 1- Oct. 31

	Recreational	18" TL to 27" TL slot	1 fish per person per day	Open	None	
South Carolina	Commercial	no sale	no sale	Open	None	
	Recreational	14" TL to 27" TL slot	5 per person per day (none over 27" TL)	Open	None	**Hook & Line** season year round **Gig** season Mar-Nov.
Georgia	Commercial	14" TL to 27" TL slot	5 per person per day (none over 27" TL)	Open	None	
	Recreational	14" TL to 27" TL slot	5 per person per day (none over 27" TL)	Open	None	Only hook & line allowed
Florida	Commercial	no sale	no sale	Open	None	no gigging or spears
	Recreational	18" TL to 27" TL slot (none over 27" TL)	1 per person per day	Open	None	no gigging or spears
Alabama	Commercial	no sale	no sale	Open	None	
	Recreational	16" TL to 26" TL slot	3 per person per day (1 per person per day over 26" TL)	Open	None	
Mississippi	Commercial	18" TL minimum	(see season & quota)	Opens Oct. 1 annually	35,000 lb	
	Recreational	18" TL to 27" TL slot	3 per person per day (1 per person per day over 30" TL)	Open	None	
Louisiana	Commercial	no sale	no sale	Open	None	
	Recreational	16" TL to 27" TL slot	5 per person per day (1 per person per day over 27" TL)	Open	None	Off water, 2 possession limits are allowed
Texas	Commercial	no sale	no sale	Open	None	
	Recreational	20" TL to 28" TL slot	3 per person per day (1 **additional** fish per person per day over 28" TL, trophy tag required)	Open	None	Bonus tag given to anglers who return information from 1st trophy catch

Table 23. Reported landings of red drum from the eastern United States including the Atlantic and Gulf coasts from 1990-1998. Only states with reported landings are included in the table (Source: NMFS).

	1990		1991		1992		1993		1994	
	Pounds	% of total landings	Pounds	% of total landings	Pounds	% of total landings	Pounds	% of total landings	Pounds	% of total landings
New York	-	-	-	-	-	-	-	-	-	-
New Jersey	-	-	-	-	-	-	-	-	5,094	2.57
Rhode Island	-	-	-	-	-	-	-	-	-	-
Maryland	29	0.02	7,533	4.90	742	0.38	121	0.04	1,152	0.58
Virginia	1,481	0.77	24,771	16.12	2,352	1.20	8,629	2.58	4,080	2.06
North Carolina	**183,216**	**95.10**	**96,045**	**62.52**	**128,497**	**65.59**	**238,099**	**71.08**	**142,159**	**71.86**
South Carolina	-	-	1,475	0.96	-	-	-	-	-	-
Georgia	2,763	1.43	1,637	1.07	1,759	0.90	2,533	0.76	2,141	1.08
Florida	-	-	-	-	-	-	-	-	-	-
Alabama	-	-	19	0.01	-	-	-	-	-	-
Mississippi	5,166	2.68	22,143	14.41	62,551	31.93	83,704	24.99	40,246	20.34
Louisiana	-	-	-	-	-	-	1,884	0.56	2,957	1.49
Texas	-	-	-	-	-	-	-	-	-	-
Total	192,655	100.00	153,623	100.00	195,901	100.00	334,970	100.00	197,829	100.00

	1995		1996		1997		1998		All Years Combined	
	Pounds	% of total landings	Pounds	% of total landings	Pounds	% of total landings	Pounds	% of total landings	Pounds	% of total landings
New York	668	0.24	8	0.01	-	-	57	0.02	733	0.04
New Jersey	-	-	-	-	-	-	311	0.09	5,405	0.28
Rhode Island	-	-	-	-	43	0.05	165	0.05	208	0.01
Maryland	6	0.00	-	-	24	0.03	419	0.12	10,026	0.52
Virginia	2,992	1.07	2,073	1.38	4,049	4.95	6,436	1.90	56,863	2.96
North Carolina	**248,193**	**89.10**	**113,392**	**75.58**	**52,605**	**64.35**	**294,415**	**87.09**	**1,496,621**	**77.81**
South Carolina	-	-	-	-	-	-	-	-	1,475	0.08
Georgia	2,578	0.93	2,271	1.51	1,395	1.71	672	0.20	17,749	0.92
Florida	-	-	-	-	-	-	-	-	-	-
Alabama	-	-	-	-	-	-	-	-	19	0.00
Mississippi	24,110	8.66	30,363	20.24	23,633	28.91	30,798	9.11	322,714	16.78
Louisiana	-	-	1,925	1.28	-	-	4,769	1.41	11,535	0.60
Texas	-	-	-	-	-	-	-	-	-	-
Total	278,547	100.00	150,032	100.00	81,749	100.00	338,042	100.00	1,923,348	100.00

Table 24. Statewide monthly and annual commercial landings (lb) of red drum for the period of 1994-99.

MONTH	YEAR					
	94	95	96	97	98	99*
JAN	18123	2142	17531	2827	926	27701
FEB	34939	1622	4518	796	1581	10616

MAR	1765	470	4356	725	2542	6285
APR	5231	1232	4538	3445	1769	11239
MAY	7347	2968	10991	9201	6026	17820
JUN	7449	13562	17395	4716	53936	20733
JUL	9903	22526	6907	6741	94416	44732
AUG	22859	25035	19894	3807	58325	49728
SEP	21728	74205	14325	6500	73910	84864
OCT	8827	54371	7639	8302	661	92161
NOV	2353	28409	4309	3688	168	7196
DEC	1596	21580	935	1757	105	0
Total	142120	248122	113338	52505	294365	373035

*1999 landings are preliminary

Table 25. Statewide monthly and annual commercial landings (lb) of red drum for the period of 1994-99. Values expressed as a %.

MONTH	YEAR					
	94	95	96	97	98	99*
JAN	13%	1%	15%	5%	<1%	7%
FEB	25%	1%	4%	2%	1%	3%
MAR	1%	<1%	4%	1%	1%	2%
APR	4%	<1%	4%	7%	1%	3%
MAY	5%	1%	10%	18%	2%	5%
JUN	5%	5%	15%	9%	18%	6%
JUL	7%	9%	6%	13%	32%	12%
AUG	16%	10%	18%	7%	20%	13%
SEP	15%	30%	13%	12%	25%	23%
OCT	6%	22%	7%	16%	<1%	25%
NOV	2%	11%	4%	7%	<1%	2%
DEC	1%	9%	1%	3%	<1%	0%
Total	100%	100%	100%	100%	100%	100%

* 1999 landings are preliminary

Current Authority

The MFC has granted proclamation authority to the Director to specify the means/methods to take red drum, in addition to other parameters (NCAC 15A 3M .0501). A listing of the current rules as they apply to red drum can be found in Section 4.7.

Management Options

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

Commercial Trip Limit

1) Status quo (100 lb./daily limit per commercial operation)

+ Continued harvest as bycatch
- Potential regulatory discards
- Limited to 100 lbs./trip

2) Increase Commercial Trip Limit

+ Increased harvest/economic potential for individual trips
+ Potential reduction in discards
- Potential for increased directed fishery
- Increased likelihood of shortened fishing year

3) Decrease Commercial Trip Limit

+ Potential reduction in harvest
+ Further decrease likelihood of directed fishery
- Potential economic burden on commercial fishery
- Increased regulatory discards
- Increased enforcement burden

4) Allow for sliding trip limit that can be increased or decreased at Director's discretion

+ Continued harvest as bycatch
+ Controlled harvest through trip limits
- Potential for increased directed fishery
- Requires use of proclamation authority by Director
- More frequent changes in regulations

Commercial Cap

1) No Action/Status Quo

+ No reduction in harvest for commercial fishers
- Potential for regulatory discards if cap is reached

2) Increase Commercial Cap (e.g. 300,000 lbs.)

+ Increased economic potential for commercial fishery
- Decreased potential for regulatory discards due to cap being reached
- Potential for increased harvest/mortality

3) Decrease Commercial Cap

+ Potential for reduced harvest/mortality
- Increased likelihood of regulatory discards
- Potential economic burden on commercial fishers

Commercial Fishing Year

(season in which the commercial harvest is monitored – current fishing year runs from January through December)

1) No Action/Status Quo (January through December fishing year)

+ No changes to current monitoring system
- Potential closure of fishery during times when bycatch rates are high
- Potential to exceed cap due to delayed monitoring

2) Modify Current Commercial Fishing Year (e.g. September through August fishing year)

+ Fishery less likely to close during fall when bycatch rates are high
+ Less likely to exceed cap due to delayed monitoring
- Difficult to implement during initial year

Research Needs

1) Continued data on discard mortality from commercial gears
2) Assess magnitude of bycatch in flounder gill net fishery

11. MANAGEMENT PROGRAM

A management program has been developed in an effort to meet the goals and objectives of this FMP as listed in Section 4.2. This section outlines the need for additional data in order to improve our ability to assess the status of the red drum stocks, details the preferred management actions as recommended by the MFC, and summarizes the research needs covered in this plan.

11.1 Data Needs

Additional data are needed to improve red drum stock assessments, better evaluate the effects of current management actions, and identify additional management actions that will allow complete recovery of the North Carolina red drum stock. A listing of data needs, based on reviews by the Red Drum Stock Assessment Panel (2000) and Vaughan and Carmichael (2000) is provided below.

1. Improved Fishery-Dependent Sampling.

Currently available catch statistics may not be complete for a number of reasons that are described in detail below. Failure to account for all removals from the population, and to properly allocate harvest and discard losses into size and age categories, contributes to uncertainty and bias in stock assessment results. In addition, adequate monitoring of non-harvest losses is necessary to develop management measures that prevent waste.

There is no sampling of at-sea discarding in commercial fisheries. Although red drum are considered a bycatch species, as noted in the description of commercial fisheries (Section 7.1), they are encountered by many different fisheries throughout the state. Given the restrictive allowable harvest of red drum, the mortality associated with discarding by these fisheries represents a potentially significant, but largely unknown, removal from the population. In addition to estimates of total removals, data are also needed on the size and age distribution of bycatch losses.

Sampling of the recreational fishery should be improved. Recreational harvest accounts for around one-half of the total North Carolina harvest each year, so reliable and precise estimates of total harvest and adequate characterization of the length, weight, and age composition of the harvest are crucial. The number of MRFSS intercepts should be increased, collection of biological samples from the recreational harvest should be improved, and additional sampling, especially at night when many directed recreational trips occur, should be pursued. Data on the length distribution of recreational discards is severely needed. Although important for many species, this is especially critical for red drum because of both the steadily increasing proportion of red drum that are released and the nature of the management program. Since red drum are managed through a possession limit and a slot size limit, drum may be discarded that are below the minimum size, above the maximum size, or in excess of the possession limit. Although Vaughan and Carmichael (2000) showed that red drum assessment results are sensitive to the length and age allocation of discards, there are currently no data available to reliably characterize discards.

2. Improved Fishery-Independent Sampling

Additional surveys at age are needed to better monitor the abundance of red drum. The only fishery-independent measure of red drum abundance that is available for North Carolina is the Juvenile Abundance Index. Surveys should be developed to sample both the sub-adult (ages 1-5) and the adult population (age 6+). Sampling of sub-adults would improve estimates of recruitment and better warn of recruitment failure and could provide more accurate data for estimates of SPR and escapement. Sampling of the adult population is needed to provide data on the age structure of the population and long-term sampling could possibly provide an index of the spawning stock that could potentially be used to estimate spawning stock abundance and biomass.

3. Improved Estimates of Vital Rates

Assessment and population model results are sensitive to input parameters such as natural mortality, fecundity, and growth rates. Research should be directed at estimating these important vital rates for red drum in North Carolina.

4. Improved Tagging Programs

Although the DMF has conducted mark-recapture studies for many years, this program has not provided satisfactory estimates of mortality. Some difficulties are related to the behavior of red drum, while others are related to a lack of information on important parameters. Models designed to estimate mortality from recapture data generally require that tagged and non-tagged individuals mix evenly in the population. However, since red drum have a propensity to remain in an area, this important assumption is likely violated. Developing state-wide mortality estimates will require expanded distribution of tagged fish and attention to release locations. Estimating mortality for the adult stock from recapture data is problematic because adult fish often move offshore and are less available to the fisheries, and because long-term tag retention is potentially critical when dealing with a long-lived, demersal species such as red drum. At this time, there is no way to determine whether the lack of returned tags from fish at large more than 5 years is due to tag loss, reduced availability, or excessive mortality. Long-term tag retention studies should be pursued, and additional adult fish should be tagged and released. Statistical models for analyzing recapture data are improving, leading to greater sophistication and precision as well as more useful results. However, many advanced approaches require input data that has not been collected historically. For example, North Carolina has no programs in place to estimate the reporting rate of red drum tags, although such information could greatly improve the performance of recapture models. The tagging program should be modified to include high reward tags to allow estimation of reporting rate.

11.2 Management Strategies and Proposed Actions

Listed below are the management strategies and proposed actions for each of the management issues that are considered in Section 10.2. Each numbered strategy is followed by a reference to the Principal Issue and Management Option section that supports it, e.g. (10.1.1) and the Objectives from Section 4.2 that it addresses, e.g. [2,3]. Changes to the current rules that are required to implement these actions are attached to this document as Appendix 4.

11.2.1 Gill Net Attendance and Other Gill Net Issues

Issue: Sub-legal red drum bycatch in the inshore small mesh gill net fishery.

Problem: Gill nets with a stretch mesh length of less than 5 inches commonly catch red drum below the legal size of 18 inches TL. There is a high mortality associated with these captures, particularly during the summer when water temperatures are at their warmest. While small mesh gill nets are common throughout the inshore waters of North Carolina through out the year, sub-legal red drum are generally only encountered in certain shallow water habitats.

Proposed Action: Maintain the current gill net restrictions as implemented through the interim rule process to protect juvenile red drum and accept the proposed modifications to the attendance line along the 'Outer Banks' (10.2.1)[1,2,4,5].

11.2.2 Other Gear Restrictions (Circle Hooks and Rod Attendance)

Issue: The use of circle hooks and rod attendance to potentially minimize the mortality associated with catching and releasing red drum.

Problem: Red drum, particularly large adults, are commonly deep hooked using conventional fishing methods and standard j-hooks. Circle hooks have gained popularity in recent years and can potentially have a positive effect on the number of released red drum that survive a capture in which they were deep hooked. Additionally, attending a rod as opposed to setting up multiple rods can also minimize deep hooking by allowing fishermen more time to attend their rods and less time for a fish to swallow a hook deep.

Proposed Action: Develop an educational document on conservative fishing practices for red drum (10.2.2) [3,4].

11.2.3 Recreational Size and Bag Limit

Issue: Recreational size and bag limit **(**currently is 1 fish per person per day from 18 to 27 inches TL).

Problem: The North Carolina red drum fishery is currently considered overfished. In order to reduce fishing mortality and begin a stock recovery, it is necessary to reduce the current harvest rates of red drum in North Carolina. This FMP has been pro-active in this reduction through the use of the interim

rules process (Section 4.6). For example, during the beginning of this plan process, an interim rule was adopted (October, 1998) by the MFC reducing the allowable bag limit from five fish to one with an 18 to 27 inch TL slot limit. This reduction in the bag limit is estimated to have resulted in a 40-50% reduction in the take of red drum annually by the recreational fishery.

Action: Maintain the current one fish bag limit with an 18 to 27 inch TL slot limit (10.2.3)[1,2,4].

11.2.4 Adult Harvest Limits

Issue: Protection of the adult spawning stock of red drum while the stock recovers.

Problem: The North Carolina red drum fishery is currently considered overfished. The best available data on the adult red drum age structure shows a decline in the relative abundance of the oldest adult red drum in the past 30 years. Additionally, with high mortality on juvenile red drum, recruitment of these fish to the adult population has been insufficient to sustain this fishery over time. Therefore, it is deemed necessary to protect the existing spawning population of red drum until such time that the recruitment into the adult stock from juvenile fish is sufficient to sustain this fishery and allow for additional harvest of adults. The MFC implemented a prohibition on the possession of all red drum >27 inches TL as part of the interim rule process during the initial stage of this plan.

Action: Maintain the current prohibition on all possession of red drum >27 inches TL and consider a limited and controlled harvest once the fishery has SPR values of 30% or greater and is no longer considered to be overfished (10.2.4) [1,4].

11.2.5 Commercial Harvest Limits

Issue: The three issues dealt with in the commercial harvest limits include: commercial trip limit, commercial cap, and commercial fishing year.

Problem: The North Carolina red drum fishery is currently considered overfished. The best available data on red drum landings indicate that over the last two decades red drum have been taken primarily as a bycatch to other targeted species. However, during the early to mid 1990's there has been a proliferation of directed trips on red drum using primarily run-around and anchored gill nets. This effort, along with the continued bycatch of red drum in other fisheries, has increased the fishing pressure on juvenile red drum. As a set of interim rules at the beginning of this FMP process, the MFC implemented the following measures on the commercial harvest: 1) a continuation of the existing 250,000 pound cap and 2) a 100-pound daily trip limit per commercial fishing operation. Prior to this rule, the 1998 commercial red drum harvest exceeded the 250,000 pound annual cap and the fishery subsequently closed in October. The 100-pound trip limit was intended to decrease the commercial take of red drum by around 50%. This was intended to be similar to the reduction in the recreational

take that has been realized by going from a five to one fish daily limit. Unfortunately, the annual cap was reached in the 1999 and 2000 fishing years resulting in early closures to the commercial red drum harvest, even after implementation of the 100-pound trip limit. The early closures while complicated by the abundance of strong year classes of fish, are the result of the continuation of targeted effort on red drum as opposed to there more traditional take as a bycatch. Furthermore, the early closure precludes the traditional bycatch of red drum taken during the fall flounder season. A proposed change in the fishing year would allow monitoring of the annual red drum harvest to begin on September 1 and run through August 31 as opposed to a January 1 through December 31 season. This change would insure that the traditional fall bycatch of red drum could be taken at the beginning of the fishing year. Additionally, allowing the DMF Director to set the commercial trip limit at his discretion would allow the trip limit to be set at a level where the commercial cap would not be exceeded and would increase the likelihood that the fishery would not have to be closed.

Action: 1) Allow for a sliding trip limit that can be increased or decreased at the Director's discretion. 2) Maintain the current commercial cap of 250,000 pounds. 3) Modify the current commercial fishing year (i.e. September through August fishing year) (10.2.5)[1,2,4].

11.3 Habitat and Water Quality Management Recommendations

11.3.1 Issue/Purpose

Protect, enhance, and restore habitats and water quality utilized or required by red drum.

11.3.2 Management Recommendations

6) Protect all submerged aquatic vegetation.

   a) Complete mapping of submerged aquatic vegetation south of Bogue Sound and in the tributaries west of Pamlico and Albemarle sounds.

   b) Support and/or seek funding to conduct follow-up mapping of SAV to assess changes over time.

   c) Designate critical SAV areas, which may include unvegetated shallow areas historically supporting SAV, by MFC rule to prevent degradation from water or land based activities.

   d) Require any threats to designated SAV areas be assessed and any impacts mitigated with more than a 1:1 ratio to compensate for losses.

   e) Request that EMC and CRC prohibit new dredging or channelization in designated SAV areas.

f) Identify areas where additional bottom-disturbing gear restrictions are needed due to impacts to SAV.

g) To minimize propeller damage to grass beds in watersheds currently supporting SAV, require a minimum water depth at the terminal end of dock structures and continuous to open waters.

h) Request that EMC adopt measures needed to fully achieve the identified nutrient reduction goals. Initiate nutrient and sediment load reduction planning in watersheds currently or historically supporting SAV.

i) Work with CRC, EMC, and ACOE to require that approval or denials of permits are consistent with recommendations made by the MFC and Habitat and Water Quality Committee.

7) Protect important spawning areas.

a) Support and conduct research to determine location and significance of spawning sites throughout the coast.

b) Designate significant spawning areas by MFC rule and determine if regulations are necessary to protect designated areas from fishing impacts.

c) Request that ACOE and DCM prohibit dredging in designated spawning areas from August to November.

d) Require that impacts to spawning areas be assessed and mitigated for with more than a 1:1 ratio.

e) Comment appropriately through the permit review process on dredging and beach nourishment projects to protect inlet processes and nearshore sand bars for spawning and larval transport.

f) Support recommendations made by the Coastal Habitat Protection Planswhich will protect, enhance, or restore important spawning areas.

8) Protect shell bottom.

g) Find resources to complete shell bottom mapping and assess changes to the habitat over time.

h) Find resources to accelerate rebuilding of native oyster beds and other shell features, particularly in Pamlico Sound, as recommended in the Blue Ribbon Task Force on Oysters and the Oyster/Hard Clam FMP.

i) Prohibit all new channel dredging in shell bottom.

j) Require that any impacts to shell bottom be assessed and mitigated for with more than a 1:1 ratio.

k) Protect the condition of shell bottom, and other habitats important to red drum through the permit review process.

l) Support recommendations made by the Coastal Habitat Protection Plans and Oyster/Hard Clam FMP which will protect, enhance, or restore shell bottom.

9) Protect coastal wetlands.

a) Identify coastal wetlands, as well as other habitats, utilized by juvenile red drum through design and implementation of a statistically valid sampling program and assess temporal and spatial changes in recruitment success.

b) Work with CRC to require that bulkheading only be allowed in exceptional circumstances where existing human uses of property are at risk and where bulkheading will cause minimal damage to marine and estuarine resources. This will require removing bulkheading as a general permit.

c) Require that any impacts to coastal wetlands be assessed and mitigated for with more than a 1:1 ratio.

d) Support and seek funding to remove bulkheads which are not critically necessary and restore the impacted wetlands, using alternative shoreline stabilization techniques when necessary.

e) Require that any impacts to coastal wetlands be assessed and mitigated for within each CHPP unit or watershed to compensate for losses from permitted and unpermitted activities, and coordinated through the North Carolina Wetland Restoration Program.

f) Work with CRC, EMC, and ACOE to require that approval or denials of permits are consistent with recommendations made by the MFC and Habitat and Water Quality Committee.

g) Support recommendations made by the Coastal Habitat Protection Plans which will protect, enhance, or restore coastal wetlands.

h) Determine benthic invertebrate condition in Primary and Secondary Nursery Areas throughout the coast, to assess quality and quantity of food availability.

10) Protect and enhance water quality in estuarine waters.

a) Recommend and support implementation of further measures to achieve identified nutrient reduction targets in all coastal watersheds as soon as possible and at least by identified deadlines.

b) Recommend and support development and implementation of additional measures to reduce sediment delivery and associated turbidity throughout coastal waters.

c) Recommend and support restoration of non-coastal wetlands and floodplains to offset for losses, restore natural water filtering and storage processes, and consequently improve water quality.

d) Support complete implementation of management actions recommended by the Albemarle-Pamlico Estuarine Study Comprehensive Conservation and Management Plan which will protect, enhance, and restore water quality and habitat of red drum.

e) Support recommendations made by the Coastal Habitat Protection Plans which will protect, enhance, or restore red drum habitat.

f) Support or seek funding for research to assess effect of sudden freshwater inputs, carried by storm runoff or canals on juvenile red drum.

11.4 Research Needs Summary

The following research needs were compiled from those listed in the issue papers in Section 10.0 as well as those outlined in Section 11.1 Data Needs. Proper management of red drum is dependent upon most of these research needs being met.

1. Estimate of at-sea discards and associated mortality rates in commercial fisheries. Including the assessment of the red drum bycatch associated with the estuarine flounder gill net fishery.
2. Increased recreational sampling through the MRFSS intercepts and addition of nighttime sampling effort.
3. Data on the lengths of recreational releases.
4. Development of independent surveys to monitor both the sub-adult and adult red drum populations.
5. Continued and better collection of life history parameters such as growth, age, maturity, natural mortality, and fecundity.
6. Information on gill net effort by area/season.
7. Data on harvest and releases of red drum captured in gill nets under the RCGL.
8. Assess discard mortality of adult red drum (commercial and recreational).
9. Characterize the trophy recreational fishery (tackle, geographic location, bait, water temperature, seasonality, hook types, etc.).
10. Assess adult population for abundance, distribution, and stock diversity.

11. Collect costs-earnings in the commercial fishery.
12. Collect socioeconomic data in the commercial fishery.
13. Determine the economic impacts of recreational red drum fishery.
14. Increase coverage and frequency of MRFSS sampling for red drum.

* Additional research recommendations, as developed by the SAFMC Red Drum Assessment Group, are attached (Appendix 2, p. 14).

11.5 Review Cycle

As provided in the Fisheries Reform Act of 1997, the Red Drum Fishery Management Plan will be reviewed and revised at least every three years with the support of advisors.

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