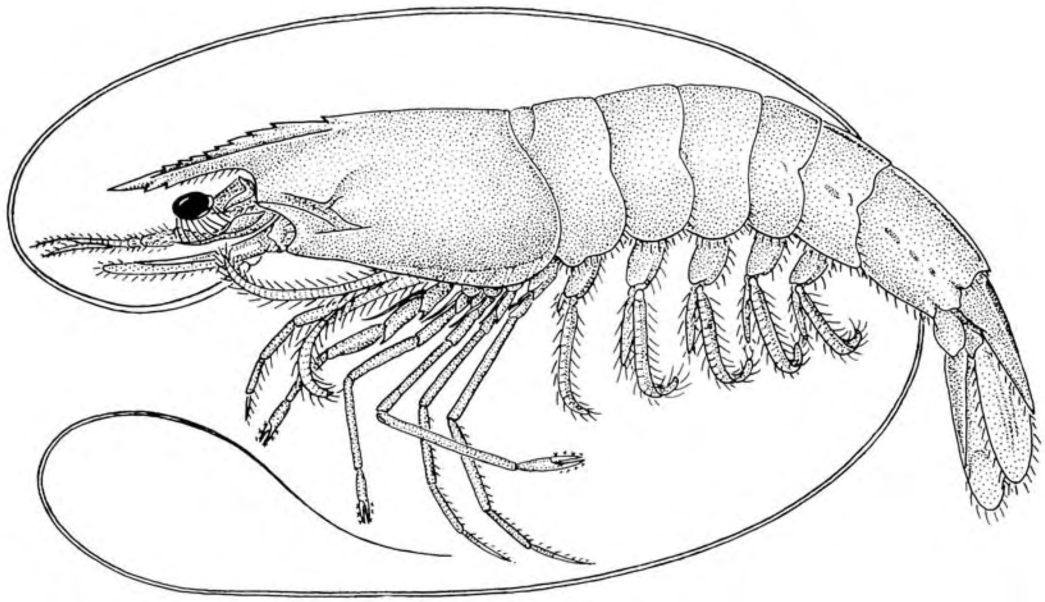
North Carolina
Fishery Management Plan

Shrimp



North Carolina MARINE FISHERIES
Dept. of Environment and Natural Resources

April 2006

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Fishery Management Plan

Shrimp

North Carolina Department of Environment and Natural Resources
Division of Marine Fisheries
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1. ACKNOWLEDGMENTS

The 2006 North Carolina Shrimp Fishery Management Plan (FMP) was developed under the direction of the North Carolina Marine Fisheries Commission (MFC) with the advice of the Shrimp Advisory Committee. The plan was prepared by the North Carolina Department of Environment and Natural Resource's Division of Marine Fisheries (DMF).

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3. EXECUTIVE SUMMARY

The goal of the North Carolina Shrimp Fishery Management Plan is to utilize a management strategy that provides adequate resource protection, optimizes the long-term commercial harvest, maximizes social and economic value, provides sufficient opportunity for recreational shrimpers, and considers the needs of all user groups. To achieve this goal, it is recommended that the following objectives be met:

1. Minimize waste and enhance economic value of the shrimp resource by promoting more effective harvesting practices.

2. Minimize harvest of non-target species of finfish and crustaceans and protected, threatened, and endangered species.

3. Promote the protection, restoration, and enhancement of habitats and environmental quality necessary for enhancing the shrimp resource.

4. Maintain a clear distinction between conservation goals and allocation issues.

5. Reduce conflicts among and within user groups, including non-shrimping user groups and activities.

6. Encourage research and education to improve the understanding and management of the shrimp resource.

The three species of shrimp, brown, pink, and white, included in this Fishery Management Plan (FMP) are essentially annual crops. Population size is regulated by environmental conditions, and while fishing reduces the population size over the season, fishing is not believed to have any impact on subsequent year class strength unless the spawning stock has been reduced below a minimum threshold level by environmental conditions. Estimates of population size are not available but since the fishery is considered to be fished at near maximum levels, annual landings are probably a good indication of relative abundance. Annual variations in catch are presumed to be due to a combination of prevailing environmental conditions and fishing effort. More recently, landings are showing the effects of changes in the economics of the fishery.

Because of high fecundity and migratory behavior, the three species are all capable of rebounding from a very low population size in one year to a large population size in the next, provided environmental conditions are favorable. Fluctuations in abundance resulting from changes in environmental conditions will continue to occur. Perhaps the most serious threat to the stocks is loss or degradation of habitat due to pollution or physical alteration. Especially vulnerable and critical to shrimp production is the salt marsh (for white and brown shrimp) and inshore seagrass habitat (especially for pink shrimp) which comprise the nursery areas for juvenile shrimp. Shrimp stocks of all three species in North Carolina are considered viable.

Commercial Fisheries

North Carolina's shrimp fishery is unusual in the Southeast United States because three species are taken here and the majority of the effort is expended in internal waters. Total landings from 1994-2003 have averaged 7,539,730 lbs per year (range 4.6-10.3 Mlb) caught on an average of 18,591 annual trips (range 14,399-23,901 trips). Inshore waters account for 76%

and ocean waters 24% of the total harvest.

For the most recent five year period 51% of the landings are from Pamlico Sound, 24% from the Atlantic Ocean and 10% from Core Sound. There has been a change in the species composition of the fishery. While brown shrimp comprise about two/ thirds of the harvest, historically pink shrimp made up 29% of the landings followed by white shrimp at 8%. For the most recent five year period the contribution has reversed with total landings of pink shrimp 5% and white shrimp 28%.

The majority of the shrimp harvest (93%) is taken by otter trawls followed by skimmer trawls (4%) and channel nets (3%). This represents a shift toward the use of skimmers and channel nets over what was observed in the past.

About 73-80% of the shrimp trawl trips occur in estuarine waters, with the remainder in ocean waters. Most of these Ocean trips are within state territorial seas (<3 mi offshore) and concentrated off the southern coast of North Carolina. Total annual shrimp trawling effort has decreased from 1995 to 2003 by about 5,700 trips. Annual shrimp trawling effort has fluctuated with shrimp abundance, but has gradually declined since the mid 1990s.

The fishery is characterized by a large number of small to medium size boats that fish internal waters in the southern part of the state and in the tributaries of larger water bodies in the central and northern waters. Medium and larger size vessels fish Pamlico Sound, Core Sound, the Atlantic Ocean and the larger rivers (Neuse, Pamlico, Pungo, Bay).

From 1994 to 2000, the average dockside value for the shrimp fishery was $17.1 million and ranged from $10.9 million (1998) to $25.4 million (2000). The price per pound for the same period averaged just below $2.50 per pound. However, since 2000, the price per pound paid to fishermen dropped to a low of $1.77 in 2003. Imports of low cost shrimp have put North Carolina shrimp fishermen at an economic disadvantage and this coupled with increased fuel prices have put the industry in a crisis situation.

Recreational Fishery

Shrimp are harvested recreationally throughout the state by otter trawls, seines, shrimp pots, and cast nets. Recreational Commercial Gear License (RCGL) harvest data show that trawlers harvested 101,595 lbs of shrimp in 2002 and 47,511 lbs in 2003. RCGL landings represented only 1.0% of total commercial landings in 2002 and 0.7% in 2003. Landings for other gears are not considered to be significant.

Management Issues and Recommendations

There were several major issues identified as being pertinent to the shrimp fishery: bycatch, habitat, and competition among shrimp fishermen as well as with other user groups. Aspects of these issues are addressed on a statewide basis while some others are examined from a water body perspective.

Bycatch of unwanted species in the shrimp fishery is a controversial topic and has been the subject of much debate. Many of the research recommendations in a 1999 report on the effects of trawling have not been acted upon primarily because of a lack of funding and these issues remain unresolved. However, some issues are addressed in this plan by recommendations for area closures, restrictions on gear size, and seasons that are proposed for specific water bodies. The need to quantify the magnitude and to reduce the bycatch in the fishery statewide remains the most pressing research need.

Protection of vulnerable habitats from the effects of trawling has been achieved through area closures in the past. Recommendations in this plan propose additional closures, season restrictions, and the increased use of gears that are more habitat friendly. Proposals that would protect habitat and water quality, which are essential for the maintenance of healthy shrimp populations, are also contained in the plan.

Many of the recommendations for changes in the management of specific water bodies address user conflicts through season and area and gear restrictions. A 90 foot headrope limit in internal waters, with the exception of Pamlico Sound and portions of the Neuse, Pamlico and Pungo rivers, would reduce conflict as well as decrease bycatch.

The use of trawls by RCGL holders and the significance of its impact on the shrimp fishery was examined. Recommendations include; a 48-quart limit on RCGL shrimp catches, allowing skimmer trawls as a RCGL gear and defining dimensions of a shrimp trap for use as a RCGL gear.

The advisory committee made recommendations to increase the minimum shrimp size (count) at which some water bodies are opened to trawling to help economic conditions in the fishery. While it is not possible for North Carolina to affect the volume of imports and their effect on shrimp prices, participation in national efforts is important to help alleviate the dire economic situation facing the domestic industry.

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 Division of Marine Fisheries (DMF) is the arm of the Department that carries out this responsibility. Enforcement authority for DMF enforcement officers is provided by G.S. 113-136. General Statute 113-163 authorizes research and statistical programs. The North Carolina Marine Fisheries Commission (MFC) is charged to "manage, restore, develop, cultivate, conserve, protect, and regulate the marine and estuarine resources of the State of North Carolina" (G.S. 143B-289.51). The MFC can regulate fishing times, areas, fishing gear, seasons, size limits, and quantities of fish harvested and possessed (G.S. 113-182 and 143B-289.52). General Statute 143B-289.52 allows the MFC to delegate authority to implement its regulations for fisheries "which may be affected by variable conditions" to the Director of DMF by issuing public notices called "proclamations". Thus, North Carolina has a very powerful and flexible legal basis for coastal fisheries management. The General Assembly has retained for itself the authority to establish commercial fishing licenses and mandates that there will be no fees charged for permits. It has delegated to the MFC authority to establish permits for various commercial fishing activities.

The Fisheries Reform Act of 1997 (FRA) establishes a process for preparation of coastal fisheries management plans in North Carolina (G.S. 113-182). The Act was amended in 1998 and again in 2004. 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 adopted pursuant to G.S. 143B-279.8, social and economic impact of the fishery to the State, and user conflicts.

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

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

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

Sustainable harvest is defined in the FRA as “The amount of fish that can be taken from a fishery on a continuing basis without reducing the stock biomass of the fishery or causing the fishery to become overfished. Overfished is defined as the condition of a fishery that occurs when the spawning stock biomass of the fishery is below the level that is adequate to replace the spawning class of the fishery. Overfishing is defined as fishing that causes a level of mortality that prevents a fishery form producing a sustainable harvest.

4.2 RECOMMENDED MANAGEMENT PROGRAM

4.2.1 Goals and objectives

The goal of the North Carolina Shrimp Fishery Management Plan is to utilize a management strategy that provides adequate resource protection, optimizes the long-term commercial harvest, maximizes social and economic value, provides sufficient opportunity for recreational shrimpers, and considers the needs of all user groups. To achieve this goal, it is recommended that the following objectives be met:

1. Minimize waste and enhance economic value of the shrimp resource by promoting more effective harvesting practices.

2. Minimize harvest of non-target species of finfish and crustaceans and protected, threatened, and endangered species.

3. Promote the protection, restoration, and enhancement of habitats and environmental quality necessary for enhancing the shrimp resource.

4. Maintain a clear distinction between conservation goals and allocation issues.

5. Reduce conflicts among and within user groups, including non-shrimping user groups and activities.

6. Encourage research and education to improve the understanding and management of the shrimp resource.

4.2.2 Sustainable Harvest

Sustainable harvest for the penaeid shrimp fishery in North Carolina is defined as the amount of harvest that can be taken by fishermen without reducing the spawning stock below the level necessary to ensure adequate reproduction. This is appropriate for an annual crop such as shrimp when recruitment is dependent largely on environmental conditions rather than female biomass. That is, a relatively small number of mature shrimp can provide sufficient recruits for the subsequent year’s production. The sustainable harvest for the Shrimp FMP in North Carolina is the annual harvest of the three species of shrimp combined.

4.2.3 Management strategy

The proposed management strategy for the shrimp fisheries in North Carolina is to 1) optimize resource utilization over the long-term, and 2) minimize waste. The first strategy will be accomplished by protection of critical habitats, and gear and area restrictions to protect the stock. Minimization of waste will be accomplished by gear modifications (trawl mesh size, bycatch reduction devices, area closures, etc.), culling practices, and harvest restrictions. To achieve this management strategy, it will be necessary to prioritize management issues. Highest priority will be given to biological issues (habitat, water quality, stock protection, waste reduction, etc.), followed by social issues, and economic issues.

4.3 DEFINITION OF MANAGEMENT UNIT

The management unit includes the three major shrimp species of shrimp: brown (*Farfantepenaeus aztecus),* pink (*Farfantepenaeus duorarum*), and white (*Litopenaeus setiferus*) and its fisheries in all coastal fishing waters of North Carolina, which includes the Atlantic Ocean offshore to three miles.

4.4 GENERAL PROBLEM(S) STATEMENT

4.4.1 Trawling issues

Shrimp management has evolved into its present form over the past 30 years, with designated primary and secondary nursery areas as well as no trawling areas permanently closed to shrimping and shrimp trawling, and other areas opened and closed based on shrimp size as determined by DMF sampling. "Target" opening sizes have been determined regionally and closed areas are opened when that size is reached Dissatisfaction on the part of some fishermen and dealers with the areas opened or closed and the size of the shrimp at opening warrant a look into our present management scheme.

Inshore shrimp trawling has long been a source of controversy. Proposed legislation to ban trawling entirely or in specific portions of the state comes up every few years and the timing of this FMP was influenced by such a proposal. The Plan will examine the present management regime, current scientific evaluation of its effects on habitat and incidental catch, and look at the appropriateness of trawling in certain areas at certain times of year.

The two major issues of concern with inshore trawling are its effects on habitat and its impact on the non-targeted species that are caught incidentally to trawling. The destructive effects of trawling on bottom structure, sea grass beds, oyster rocks, etc. are well documented. Not so well understood are the impacts to benthic organisms, trawling's role in oxygenating sediments, supporting other fisheries such as the blue crab, and disturbing heavy metal deposits.

The impact of discarding bycatch, or incidentally captured non-targeted species, on fish populations is not well understood. Very little information exists to characterize and enumerate the discards of certain species so that those numbers can be incorporated into a stock assessment. It is harder still to determine what effect trawling has in relation to habitat loss, natural population fluctuations, hurricanes, and poor water quality. With the development of this FMP, the questions surrounding trawling were addressed and methods of dealing with this harvest method discussed and handled. The incidental catch of finfish by trawls and the discarded portion of that bycatch is the major problem, real or perceived, with the shrimp fishery. The DMF has been a leader among the south Atlantic states in requiring bycatch reduction devices (BRD's) in the tailbags of shrimp trawls in 1992 to eliminate as much bycatch as possible, but more research and trials on more devices is needed. Existing BRD's are very ineffective at excluding southern flounder and other demersal species from the trawls and the Advisory Committee of the Southern Flounder FMP has recommended that the issue be addressed in the Shrimp FMP.

4.4.2 Conflict and competition with other users

Although not as controversial as in the past, conflicts still exist within the shrimp fishery such as, fixed gear (crab pots, gill nets, pound nets, etc.) versus mobile gear (shrimp trawls), and large trawlers versus smaller trawlers. The DMF's management practices of when to close and open areas to shrimping are frequently debated. When an area is "closed", is it closed to all shrimping, or just shrimp trawling? Should there be a more formally adopted average minimum shrimp size that must be reached before an area is considered for opening? Are there areas of the state that are presently opened to trawling that should be closed? Should there be limits placed on the amount of shrimp Recreational Commercial Gear License (RCGL) holders can retain to discourage illegal selling? Measures to address these conflicts will be covered in the Plan.

The present method of dealing with a relatively new "shrimp trap" idea is to classify it as a shrimp pound net set and require that the owner have a Standard Commercial Fishing License (SCFL) and apply for a permit to set them. The application process includes a public comment period to ensure that traditional uses of an area such as fishing, navigation, etc. are not impacted by the proposed set. These "traps" are very effective and non-bottom disturbing and may be useful in reducing some Recreational Commercial Gear License (RCGL) trawling gear use if allowed under some system to be discussed. Proliferation of these traps in small bays and waterways and the displacement of traditional uses are major concerns to be dealt with, but a small scale trap of this nature could be a beneficial alternative to shrimp trawling.

Another relatively new source of concern that has the potential to influence all of the above issues is the increase in imported shrimp from Asian and Central American countries. The importation of shrimp and prawns into the United States has increased significantly in recent years, driving down prices for domestic wild-caught shrimp. Should North Carolina's Shrimp Plan attempt to set us on a better footing to compete internationally, or should our focus be to maintain the traditional, community-based fisheries economy?

4.4.3 Insufficient assessment data

Because of tremendous variation in the bycatch based on seasonal, day vs. night, area, gear, and other parameters, the characterization and quantification of bycatch is very difficult and costly. Determining its effects on fish populations when combined with poor water quality, high natural mortality among juvenile shrimp, natural population fluctuations, weather events, and many other factors is even harder. Thus far, the DMF's limited resources have been devoted to research on bycatch reduction devices (BRD's) that work and meet the requirements of the SAFMC. Characterizing the composition and amount of bycatch and discards has not been a priority. The prevention of catching it in the first place has been NC's goal.

4.5 EXISTING PLANS STATUTES, AND RULES

4.5.1 Plans

There are currently no state or interstate FMPs that apply specifically to the shrimp fishery in North Carolina. There is a South Atlantic Fishery Management Council (SAFMC) Shrimp Fishery Management Plan and Amendments that have, until now, not been an issue that affects NC fishermen. In December 2003, as part of Amendment 6, the Council voted to establish a control date of December 10, 2003 for the shrimp fishery in the Atlantic Exclusive Economic Zone (EEZ). This control date was set to place the industry on notice that a limited access program may be developed. The amendment also includes options to monitor and measure bycatch within the fishery. The Council's preferred monitoring option is the implementation of the Atlantic Cooperative Statistics Program Release, Discard and Protected Species Module. This module establishes a minimum set of standard data to be collected to characterize and estimate levels of bycatch. This is the first North Carolina Shrimp FMP. The FMP will be reviewed and updated at least every five years.

4.5.2 Statutes

All management authority for North Carolina's shrimp fishery is vested in the State of North Carolina. Statutes that have been applied to the shrimp fishery include:

- ♦ It is unlawful to fish in the ocean from vessels or with a net within 750 feet of a properly licensed and marked fishing pier. G.S. 113-185
- ♦ It is unlawful to engage in trash or scrap fishing (the taking of young of edible fish before they are of sufficient size to be of value as individual food fish) for commercial disposition as bait, for sale to any dehydrating or nonfood processing plant, or for sale or commercial disposition in any manner. The MFC's rules may authorize the disposition of the young of edible fish taken in connection with the legitimate commercial fishing operations, provided it is a limited quantity and does not encourage "scrap fishing". G.S. 113-185
- ♦ It is unlawful to willfully take, disturb or destroy any sea turtles including green, hawksbill, loggerhead, Kemp's ridley, and leatherback turtles, or their nests or eggs. It shall be unlawful willfully to harm or destroy porpoises. G.S. 113-189
- ♦ It is unlawful for any person without the authority of the owner of the equipment to take fish from nets, traps, pots, and other devices to catch fish which have been lawfully placed in the open waters of the State. G.S. 113-268 (a)
- ♦ It is unlawful for any vessel in the navigable waters of the State to willfully, wantonly, and unnecessarily do injury to any seine, net or pot. G.S. 113-268 (b)
- ♦ It is unlawful for any person to willfully destroy or injure any buoys, markers, stakes, nets, pots, or other devices or property lawfully set out in the open waters of the state in connection with any fishing or fishery. G.S. 113-268 (c)

4.5.3 Marine Fisheries Commission Rules

Definitions: Several of the definitions in the North Carolina Fisheries Rules for Coastal Waters have a bearing on the Shrimp FMP. Mesh length is defined as the diagonal distance from the inside of one knot to the outside of the other knot, when the net is stretched hand-tight. A pound net set is a fish trap consisting of a holding pen, one or more enclosures, lead or leaders, and stakes or anchors used to support such trap. The leads(s), enclosures, and holding pen are not conical, nor are they supported by hoops or frames. 15A NCAC 3I .0101 (b) (3) and

(29).

Endangered or Threatened Species: The Fisheries Director may close any area or restrict the harvest of anything by proclamation if the methods involved in taking threaten endangered or threatened species. No commercial fishing equipment can be used in the sea turtle sanctuary off Onslow County. 15A NCAC 3I .0107 (b) and (c).

Recreational Harvest: One of the commercial fishing gears authorized for use under the RCGL is a shrimp trawl with a headrope length of 26 feet or less. One of these can be used per vessel and mechanical means (hand winches and block and tackle) for pulling the trawl in cannot be used. Shrimp trawls for recreational purposes must be marked by attaching to the codend (tailbag), one floating buoy, any shade of hot pink in color, made of solid foam or other solid buoyant material and be no less than 5 inches in diameter and length. The buoy must be identified by being engraved with the owner's last name and initials or have that identification engraved on metal or plastic tags. If a vessel is used, the buoy must also be engraved with the gear owner's current motorboat registration number or owner's U.S. vessel documentation name. The RCGL allows the use of up to five eel, fish, shrimp or crab pots, in any combination. It is unlawful for a person to use more than one shrimp pot attached to the shore along privately owned land or to a privately owned pier without possessing a valid RCGL. Buoys must be any shade of hot pink in color, be no less than 5 inches in diameter and length, and be engraved with the owner's last name and initials. If a vessel is used the buoy must also be engraved with the gear owner's current motor boat registration number or owner's U.S. vessel documentation name. Crab trawls are not permitted to be used by holders of the RCGL. 15A NCAC 3J .0302, and 15A NCAC 3O .0302 (a) (2).

Trawls:
- ♦ The Brant Island and Piney Island military prohibited areas are closed to fishing and navigation at all times. 15A NCAC 3I .0110 (a) and 3R .0102
- ♦ It is unlawful to use trawl nets for the taking of finfish in internal waters, except that it shall be permissible to take or possess finfish incidental to crab or shrimp trawling in accordance with the following limitations: it is unlawful to possess more than 500 pounds of finfish from December 1 through February 28 and 1,000 pounds of finfish from March 1 through November 30. The Director may close by proclamation any area to trawling for specific time periods in order to secure compliance with this rule. 15A NCAC 3J .0104 (a)
- ♦ It is unlawful to use trawl nets in internal coastal waters from 9:00 p.m. on Friday through 5:00 p.m. on Sunday except for the areas described in the next bullet. 15A NCAC 3J .0104 (b) (1)
- ♦ It is unlawful to use trawl nets from December 1 through February 28 from one hour after sunset to one hour before sunrise in portions of the Pungo, Pamlico, Bay, Neuse, and New rivers. 15A NCAC 3J .0104 (b) (5) (A) (B) (C) (D) (E).
- ♦ It is unlawful to use trawl nets in Albemarle Sound and its tributaries. 15A NCAC 3J .0104 (b) (3)
- ♦ Trawls cannot be used to take oysters. 15A NCAC 3J.0104 (2)
- ♦ The Director may by proclamation, require bycatch reduction devices or codend modifications in trawl nets to reduce the catch of finfish that do not meet size limits or are unmarketable as individual foodfish by reason of size. 15A NCAC 3J .0104 (d)
- ♦ It is unlawful to use shrimp trawls for the taking of blue crabs in internal waters, except that it shall be permissible to take or possess blue crabs incidental to commercial shrimp trawling provided that the weight of the crabs shall not exceed 50 percent of the total weight of the combined crab and shrimp catch; or 300 pounds, whichever is greater. For

RCGL trawling, 50 crabs, not to exceed 100 blue crabs if two or more RCGL holders are on board. The Fisheries Director may, by proclamation, close any area to trawling for specific time periods in order to secure compliance with this rule. 15A NCAC 3J .0104 (f) and (g)

- It is unlawful to use nets from June 15 through August 15 in the waters of Masonboro Inlet or in the ocean within 300 yards of the beach between Masonboro Inlet and a line running 138° through the water tank on the northern end of Wrightsville Beach, a distance parallel with the beach of 4,400 yards. It is unlawful to use trawls within one-half mile of the beach between the Virginia line and Oregon Inlet. 15A NCAC 3J. 0202 (1) (2)
- From December 1 through March 31 it is unlawful to possess finfish caught incidental to shrimp and crab trawling in the Atlantic Ocean unless the weight of the combined catch of shrimp and crabs exceeds the weight of finfish; except that crab trawlers working south of Bogue Inlet may keep up to 300 pounds of kingfish, regardless of their shrimp or crab catch weight. 15A NCAC 3J .0202 (5) (a) (b)
- It is unlawful to use trawl nets upstream of the Highway 172 Bridge in New River from 9:00 p.m. through 5:00 a.m. when opened by proclamation from August 15 through November 30. 15A NCAC 3J .0208
- In Dare County commercial fishing gear may not be used within 750 feet of licensed fishing piers when opened to the public. Commercial fishing gear may not be used in the Atlantic Ocean off of portions of Onslow, Pender, and New Hanover counties during specified time frames. 15A NCAC 3J .0402 (a) (1) (A) (ii) (2) (A) (B) (i) (ii) (3) (A) (B) (i) (ii) (iii)
- It is unlawful to take or possess crabs aboard a vessel taken by trawl in internal waters except in areas and during such times as the Fisheries Director may specify by proclamation. 15A NCAC 3L .0202 (a)
- It is unlawful to use a trawl net in any primary or permanent secondary nursery area. 15A NCAC 3N .0104, 3N .0105 (a), 3R .0103 and 3R .0104
- Special secondary nursery areas may be opened to shrimp and crab trawling from August 16 through May 14. 15A NCAC 3N .0105 (b), and 3R .0105

Channel Nets:

- It is unlawful to use a channel net until the Director specifies by proclamation when and where channel nets and other fixed nets for shrimping can be used. 15A NCAC 3J .0106 (a)(1).
- It is unlawful to set a channel net without yellow light reflective tape on the staffs, stakes and buoys. 15A NCAC 3J .0106 (a)(2).
- Channel nets can not be set with any portion of the set within 50 feet of the center line of the Intracostal Waterway (ICW) channel or in the middle third of any navigation channel marked by the Corps of Engineers or the Coast Guard. Fishermen must attend channel nets by being no more than 50 yards from the set at all times. 15A NCAC 3J .0106 (a)(3), (4) and (5).
- The maximum corkline length of a channel net that can be used or possessed is 40 yards. No channel net, net buoys or stakes can be left in coastal waters from December 1 through March 1. From March 2 through November 30, cables and any attached buoy must be connected together with non-metal line when not attached to the net. Metallic floats or buoys to mark sets are unlawful. 15A NCAC .0106 (b) (c) (d) and (e).
- Channel nets must be properly marked with yellow light reflective tape and the owner's identification on each buoy. Identification includes one of the following: owner's NC motorboat registration number **or** the US vessel documentation number **or** owner's last name and initials. Channel nets, anchor lines or buoys are not to be used in any way

that constitutes a hazard to navigation. 15A NCAC .0106 (f) and (g).

Pound Net Sets: Shrimp pound net set initial applications, renewals and transfers are to comply with the permitting procedures and requirements for obtaining all DMF-issued permits. Identification requirements, application process, criteria for the granting of the permit, operational requirements and other elements of the shrimp pound net set permits are found in 15A NCAC 3J .0107. A permittee must hold a valid SCFL or RSCFL in order to hold a Pound Net Set Permit. 3O .0501(b)(1)

Shrimp-specific Rules: The Director has proclamation authority to open the state's waters to the taking of shrimp. This authority includes hours of harvest and any other conditions appropriate to management of the fishery. If sampling indicates that undersized shrimp or other species are present, the Director may close waters to shrimping and prohibit the use of any nets but cast nets. In closing waters, prominent landmarks or other permanent type markers should be considered. 15A NCAC 3L .0101

The taking of shrimp by any method is prohibited from 9:00 p.m. on Friday through 5:00 p.m. on Sunday **except** in the Atlantic Ocean, and with the use of fixed and channel nets, hand seines, shrimp pots, and cast nets. 15A NCAC 3L .0102

Trawl nets must have a minimum mesh size of 1 ½ inches; fixed nets, channel nets, float nets and hand seines must be at least 1 ¼ inches; cast nets have no minimum mesh size. Shrimp cannot be taken with a net constructed in such a manner as to contain an inner or outer liner of any mesh size. Chafing gear shall be no less than 4 inches mesh length, except small meshed chafing gear can be used only on the bottom one-half of the tailbag as long as it is not tied to form another tailbag. 15A NCAC 3L .0103

Channel nets cannot take shrimp unless they are in compliance with 3J .0106. Shrimp pots must be used in compliance with 3J .0301. There is a limit of 100 shrimp per person per day taken with a cast net in closed area. 15A NCAC 3L .0104

It is unlawful to use pots with leads or leaders to take shrimp. Leads or leaders for this purpose are defined as any fixed or stationary net or device used to direct fish into any gear used to capture fish. Any device with leads or leaders used to capture fish is not a pot. 3J .0301 (l)

No Trawling Areas: Trawl nets cannot be used in any of the Primary Nursery Areas described in 15A NCAC 3R .0103 or in any of the Secondary Nursery Areas described in 15A NCAC 3R .0104. Trawl nets can not be used in any Special Secondary Nursery Area designated in 15A NCAC 3R .0105 except that the Director may open any of the Special Secondary Nursery Areas to shrimp or crab trawling from August 16 through May 14 subject to the provisions of 15A NCAC 3L .0100 and .0200. Trawl nets are also prohibited in the Trawl Nets Prohibited areas described in 15A NCAC 3R .0106. 15A NCAC 3N .0104 and .0105 and 3R .0104, .0105 and .0106.

4.5.4 Other States Shrimp Rules and Regulations

See Appendix 1 for a list of rules and regulations for other shrimp producing states.

4.5.5 Federal Regulations

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

5. STATUS OF STOCK

5.1 GENERAL LIFE HISTORY

There are three shrimp species that make up the shrimp fishery in North Carolina. These are the brown shrimp, *Farfantepenaeus aztecus*, the pink shrimp, *F. duorarum* and the white shrimp, *Litopenaeus setiferus*. The lifecycle of these three species are similar in that the adults spawn offshore and eggs are hatched into free-swimming larvae. These larvae develop through several stages into post-larvae. Once post-larval shrimp enter the estuaries growth is rapid and is dependent on salinities and temperatures. After reaching sub-adult sizes between 70 - 120 mm TL, they migrate seaward. It is hypothesized that as shrimp increase in size, they seek higher more stable salinities because of a decrease in the ability to osmoregulate (Bishop et al. 1980). In general, shrimp are omnivorous, feeding primarily on sediment, detritus, algae, and benthic organisms. Feeding occurs mostly at night, although some daytime feeding will occur in turbid water. Shrimp are dioecious (separate sexes) with females growing larger than males. Shrimp copulate with the male depositing spermatophore onto the female's thelycom. Fertilization takes place when the female expels ova and spermatozoa simultaneously. Shrimp are very fecund with females expelling between 500,000 to 1,000,000 eggs. Spawning occurs before they reach 12 months old. Environmental requirements for the three species are listed in Table 5.1.

Brown shrimp:

Brown shrimp occur from Massachusetts to the Florida Keys and into the Gulf of Mexico to northwestern Yucatan. Highest abundances occur in the Gulf of Mexico, off Mississippi, Louisiana, and Texas. The species supports a major commercial fishery along the South Atlantic coast, primarily in North and South Carolina.

Brown shrimp reach sexual maturity at 140-145 mm and spawn in the ocean in deep water during February and March. Larvae are then transported by wind and currents from the high salinity ocean waters in the estuaries. Ten to 17 days later, the larval shrimp have grown into postlarvae and are approximately between 8-14mm. They generally enter on a flood tide. They are then carried by wind driven currents to the upper reaches of the estuaries beginning in February with peaks occurring in mid-March through mid-April (Williams 1955a, 1965). It takes approximately 4-6 weeks for postlarvae to grow to the juvenile stage. Rapid development into sub-adults begins to occur with reported growth rates ranging from 1-2.5 mm per day and is dependent on temperature and salinities (Williams 1955; Steele 2002). Significant growth occurs between 11^{O}C and 18^{O}C (Zein-Eldin and Aldrich 1965; Steele 2002). Growth is enhanced if salinities are greater than 10 ppt (Amant et al. 1966; Steele 2002). As the individuals increase in size, they move to the deeper, saltier waters of the sound and return to the sea in late fall. Brown shrimp are omnivorous, and feed on different plants and animals and organic debris (Steele 2002). Juveniles between 25-65 mm feed on detritus and microorganisms from the top layer of sediment while larger shrimp (65-104 mm) became active predators feeding on polychaetes, amphipods, nematodes as well as detritus and algae (Jones 1973; Steele 2002). Brown shrimp prefer peat and muddy bottoms but are also found on sand, silt, or clay mixed with shell and rock fragments (Steele 2002). They also are found on bottoms covered with plant debris (Williams 1959). They are often more active in open waters at night than in daytime. They have a maximum life span of 18 months, although few live this long.

Pink shrimp:

Pink shrimp are found from southern Chesapeake Bay to the Florida Keys, and around the coast through the Gulf of Mexico to Yucatan. The largest population of pink shrimp is off southwestern Florida in the Tortugas and Sanibel as well as in the southeastern portion of Golfo de Campeche. However, significant quantities of pink shrimp are also found off North Carolina, and along the northeast Florida coast (Steele 2002).

Spawning occurs in ocean waters from April through July with postlarvae being carried into the estuary on wind-driven currents from May through November (Williams 1965). The northernmost breeding population of pink shrimp is off North Carolina (Williams 1955a). Once in the nursery areas, the shrimp undergo rapid growth (1 to 1.8 mm/day). As they grow and develop, they move toward the deeper waters of the sound and eventually into the ocean. Pink shrimp are active at night and burrow into the bottom during the day. A significant number of pink shrimp overwinter in the North Carolina estuaries before moving into the ocean the following spring. Pink shrimp are bottom feeders and feed primarily in shallow waters among marine plants. As with brown shrimp, the majority of feeding occurs at night, but feeding may also occur during the day when the water is turbid. Stomach content analysis of shrimp in Tampa Bay revealed sand, debris, algae, diatoms, seagrass particles, dinoflagellates, foraminiferans, nematodes, polychaetes, ostracods, copepods, mysids, isopods, caridean shrimp, caridean eggs, mollusks and fish scales. Female pink shrimp reach sexual maturity at 85 mm while males are sexually mature at 74 mm. They have a maximum life span of 24 months and can reach a size of 10-11 in.

White Shrimp:

White shrimp occur along the Atlantic coast from Fire Island, New York to Saint Lucie Inlet Florida (Steele 2002). They also are found in the Gulf of Mexico from the mouth of the Ochlockonee River, Florida to the Golfo de Campeche to the vicinity of Ciudad Campech usually in depths less than 90 ft. (Muncy 1984; Steele 2002).

Spawning occurs in the ocean at depths greater than 30 ft and within five miles of shore from March to November, peaking from April to October. It appears to be triggered by increasing bottom water temperatures in the spring and decreases with decreasing water temperature in the fall (Muncy 1984). Planktonic postlarvae move inshore with tidal currents, entering estuaries two to three weeks after hatching where they then become benthic. Shallow muddy bottoms in waters of low to moderate salinity serve as optimum nursery grounds for juvenile white shrimp. Juveniles reach lengths of about 2-3.1 cm by June or July, and move from shallow marshes into deeper creeks, rivers, and bays. White shrimp migrate out of the estuaries and southward during fall and early winter, and make up the valuable spring fishery for adult females in Georgia, South Carolina, and southern North Carolina. Some of the slower-growing individuals overwinter in the estuaries, but usually do not survive in North Carolina. White shrimp mortality has been reported at water temperatures of 46^{o} F and lower, with total mortality occurring at 37^{o} F or lower. Winter water temperatures in North Carolina sometimes are lethal for white shrimp. White shrimp are omnivorous, selective particulate feeders that search the sand grains and pass bits of food forward to the mouth. Gut content analysis findings include inorganic and organic debris, as well as fragments of different animals including nematodes, annelids, mollusks and crustaceans, particles of higher plants and a variety of diatoms and algae (Steele 2002). Soft muddy bottoms are the preferred habitat of white shrimp with highest abundances in areas of extensive brackish marshes

Table 5.1. Environmental Requirements of three shrimp species found in North Carolina.

Species	Salinity	Temperature	Oxygen	Recruit	Season
Brown Shrimp	2-35 ppt	7^{o} to 37^{o} C (44.6^{o} to 98.6^{o} F)	Less than 2 ppm causes stress	Feb-March	Summer and fall
Pink Shrimp	0-45 ppt	6^{o} to 38^{o} C (42.8^{o} to 100.4^{o} F)	0.2 to 6.0 ppm	June-October	Spring
White Shrimp	2-35 ppt	7^{o} to 38^{o} C (44.6^{o} to 100.4^{o} F)	Less than 2 ppm causes stress	April-May	Late Summer and fall

Movement:

DMF conducted several tagging studies on the three species of shrimp in the 1960s through the early 1970s (Table 2). Shrimp were marked with biological stains and fluorescent pigments and released throughout this time period within different areas of Pamlico Sound, Core Sound, Bogue Sound, New River and Cape Fear River. These shrimp were recovered in shrimp houses throughout the coastal counties. Rewards ranged from .50 cents to $1.00 per returned shrimp.

McCoy and Brown (1967) marked brown and pink shrimp from Jarrett Bay and North River in Core Sound and white shrimp in Dutchman Creek-Elizabeth River and Cape Creek of the lower Cape Fear River. A combined average of 65% of all returned shrimp were recaptured before reaching the Atlantic ocean with resulting movement toward the higher salinity areas of Beaufort Inlet from Core Sound and Cape Fear Inlet from Cape Fear River.

Table 5.2. Migration studies in North Carolina of three shrimp species found in North Carolina.

Study	Year	Waterbodies	Species	Release number	Percent return
McCoy and Brown, 1967	April-Oct 1966	Core Sound Lower Cape Fear	Brown, Pink, White	26,989	6.2
McCoy, 1968	June-Sept, 1967	Pamlico Sound	Brown, Pink	11,414	10.5
McCoy, 1972	May, July, 1968	Core and Bogue Sound, New River	Brown, Pink	9,231	42.4
Purvis and McCoy, 1974	1971-1972	Pamlico Sound	Brown	7,325	19.1

White shrimp did move upriver in the Cape Fear River. However, this was caused by the strong tidal influences in the river. Of those shrimp that made it to the Atlantic Ocean, all three species had a pronounced southward coastal migration. It was concluded in this study that the brown and pink shrimp are more endemic to North Carolina while the white shrimp from the southeastern coastal NC contribute to the shrimp fishery of South Carolina, Georgia, and Florida.

McCoy (1968) marked pink shrimp from West Bay that moved to the Atlantic Ocean through Core Sound and through Drum and Beaufort inlets. Pink shrimp from Adams Creek moved toward Beaufort Inlet and through southern Pamlico Sound to Drum Inlet and Bardens Inlet. This suggests that a significant portion of Pamlico Sound pink shrimp reach the ocean through Beaufort and Bardens inlets by migrating through Core Sound.

Brown shrimp marked by McCoy (1968) in Swan Quarter Bay and Jones Bay generally moved toward the central and southern Pamlico Sound area. Data were unclear as to the most probable route to the Atlantic Ocean but it did suggest that few shrimp from the northern and western sound reached the ocean. Brown shrimp randomly released in Pamlico Sound in 1972 generally moved toward the nearest inlet (Ocracoke). However, no mass migration from the sound to the ocean occurred to any appreciable degree resulting in the conclusion that the Pamlico Sound brown shrimp fishery is a self contained fishery with shrimp growing to large sizes (16 - 30 count heads off) before migrating to the ocean (Purvis and McCoy 1972).

Pink shrimp marked in Core Sound moved to the ocean through Barden and Beaufort inlets with the majority of the movement through Beaufort Inlet. Bogue Sound pink shrimp moved toward the ocean via Beaufort and Bogue inlets with the largest number of recaptures occurring from the western half of the sound. There appeared to be no significant movement of pink shrimp between Core and Bogue Sound. Brown shrimp released in New River moved in a southerly direction along the coast (McCoy 1972).

5.2 STOCK STATUS

All three species of shrimp included in this Fishery Management Plan (FMP) are essentially annual crops. Population size is regulated by environmental conditions, and while fishing reduces the population size over the season, fishing is not believed to have any impact on subsequent year class strength unless the spawning stock has been reduced below a minimum threshold level by environmental conditions. Estimates of population size are not available but since the fishery is considered to be fished at near maximum levels, annual landings are probably a good indication of relative abundance. Annual variations in catch are presumed to be due to a combination of prevailing environmental conditions and fishing effort. More recently, landings are showing the effects of changes in the economics of the fishery.

Because of high fecundity and migratory behavior, the three species are all capable of rebounding from a very low population size in one year to a large population size in the next, provided environmental conditions are favorable. Fluctuations in abundance resulting from changes in environmental conditions will continue to occur. Perhaps the most serious threat to the stocks is loss of habitat due to pollution or physical alteration. Especially vulnerable and critical to shrimp production is the salt marsh (for white and brown shrimp) and inshore seagrass habitat (especially for pink shrimp) which comprise the nursery areas for juvenile shrimp. Shrimp stocks of all three species in North Carolina are considered viable.

6. STATUS OF FISHERIES

6.1 COMMERCIAL

6.1.1 History

Between the Civil War and the end of the first decade of the twentieth century, shrimp were caught with dip nets, cast nets and seines. Most were consumed locally but some were used as bait and fertilizer. Distant markets were limited by little interest in shrimp for food, production capability, few transportation options, and the lack of refrigeration (Maiolo 2004; Maiolo et al. 1980).

Just after the turn of the twentieth century, the South Atlantic and Gulf states became the center of the commercial shrimp fishery in the United States. Interest in the fishery developed rapidly in the Southport, NC area. The adoption of the otter trawl completely changed the means of harvesting, which fit nicely with the earlier innovations in power boating at the end of the previous century and market stimulation from the New York area. The creation of canning factories in Southport followed (Maiolo 2004; Maiolo et al. 1980).

The introduction of the otter trawl technology in North Carolina seems to have first involved sampling nets used by the U.S Bureau of Fisheries in Beaufort in 1912. Even with this new and efficient capture technology, interest in the fishery was not uniform among coastal fishing villages. As late as the 1920s many fishermen still referred to shrimp as *pests* that fouled their nets and many residents, both coastal and inland, did not consider the animals suitable to eat.

In March of 1916, a New Jersey fisherman brought a shrimp trawler to Southport and taught local fishermen how to use the otter trawl in the near shore ocean waters. Interest among fishermen expanded quickly in spite of a sluggish local market. By 1925, over 300 North Carolina fishermen were engaged in the shrimp fishery, mostly in Brunswick County.

The use of the otter trawl net technology prompted the development of trawl vessels. The type that was first used in the fishery involved open skiffs from 15-20 ft in length that were powered by small gasoline engines. “Decked” trawlers were introduced in the 1920s. Refrigeration (in the form of production of ice for shipment of fishery products), rail and truck transportation, and a close proximity to the eastern markets (as opposed to Florida and the Gulf states) began to make the North Carolina shrimp fishery lucrative. More than two hundred seasonal and part time workers found employment in the Southport packinghouses where many headed shrimp for a nickel per five gallon bucket. The majority of shrimp were shipped to markets in northeastern New York because local markets were still not developed (Maiolo 2004; Maiolo et al. 1980).

The first shrimp trawling in Carteret County occurred around 1930 after local fishermen learned how to harvest the resource from the Southport fishermen. At first shrimping only occurred in between finfishing seasons. At the same time, a channel net fishery was developing near Harkers Island and in other communities in eastern Carteret County. A series of local customs developed among the fishermen by which the fishery was prosecuted. Many remain in place even today. A similar fishery has recently developed near Sneed’s Ferry, but without the same kinds of local customs (Maiolo 2004).

Pamlico County fishermen began landing shrimp caught in pound nets about this time as well, and shrimp trawling caught on in northern Pamlico Sound in the late 1930s when a Louisiana fisherman demonstrated the use of the otter trawl. Shrimping in the northern counties was conducted both nearshore and in the Pamlico Sound. In 1934, the Sound was closed to trawling to prevent finfish bycatch. But the following year the regulation was modified to allow shrimp trawling from 15 August to 1 December (Maiolo et al. 1980; and Maiolo 2004).

Like fishermen in other coastal communities in North Carolina who stitched shrimp harvesting into their patterns of annual rounds, fishermen in the northern part of the state pursued shrimping during the summer between oyster dredging and fall finfishing. Just as today, in the southern part of the state, some fishermen followed the shrimp south into South Carolina and Georgia in late summer and into fall (Maiolo 2004; Maiolo et al. 1980).

As the fishery expanded during the 1930s, the construction of larger vessels specifically designed for shrimp trawling expanded. Two of the most common vessels were the "Florida trawler" for ocean trawling in the southern part of the state, and the "Core Sounder" for estuarine trawling. Along with this, masts and booms, or masts and "A" frames, were developed. Additionally, power winches replaced retrieval of the nets by hand. The construction of trawls and doors locally which, up to then had occurred in Florida and Louisiana, began during this period (Maiolo 2004, and Maiolo et al 1980).

Difficulties in organizing production and distribution capacity, along with the failure to expand markets into the interior of the state, resulted in inconsistencies in the demand for North Carolina shrimp prior to the outbreak of World War II. Additionally, poor ex-vessel prices hampered development of the state's fishery. The War created a jolt in the popularity of the shrimp with consumers, because, unlike meat products, seafood was not rationed. There were still problems in the industry. The supply of seafood products, including shrimp decreased because of the war effort. There were fewer fishermen, boats, and equipment, until about 1944 when restrictions on strategic materials were eased. Also during this period trawling was restricted to inside waters because of the threat of German submarine attacks outside of the inlets. One result of this was increased effort in Pamlico Sound (Maiolo 2004).

Quick freezing technology was developed during the war years as well. Shrimp was no longer a perishable product, but a relatively stable commodity that the producer could control by freezing and holding for better prices when the market changed. However, this seems to have had a limited effect on North Carolina harvesting and distribution. Frozen shrimp from other regions had an impact on the markets, but most of North Carolina's product was still shipped fresh to Northern markets (Maiolo 2004).

When the war concluded, and a recovering economy was redirected toward domestic matters, the fishing industry benefited along with the rest of the nation. There was a boom in construction of diesel-powered, large trawlers, and a considerable increase in shrimping effort. Prices increased dramatically, and North Carolina's contribution to the Southeast shrimp landings became significant. Vessels were equipped with radar, fathometers, radios, steel cables and drum hoists (Maiolo 2004; and Maiolo et al 1980).

Technological advances in the shrimping industry have increased the catching efficiency of larger boats, particularly in Pamlico Sound. In the 1940s and early 1950s, a 45-60 ft vessel pulled a single trawl with a headrope length of 60-65 ft. Now, with "four-barreled rigs" the same vessel can pull four nets with a combined headrope length of 120-160 ft. Four-barreled rigs allow fishermen to pull two nets from each outrigger. Conventional two-seam otter trawls are used for the bottom-hugging pink and brown shrimp, while four seam and tongue trawls with floats on the headrope are used for the white shrimp which have the ability to jump over two-seam trawls when disturbed. In Pamlico Sound, these large vessels stay out four or five days and tow from one to three hours, often working day and night. Smaller vessels make daily trips and employ shorter tow times. In the Core Sound area, the fishery occurs mainly at night, with trips lasting one night. In the southern area, fishing is conducted on a day-trip basis, mostly during daylight hours.

Modern safety and navigation equipment have allowed North Carolina shrimpers to steam longer distances, for longer periods of time to shrimp; and also to engage in a constantly changing variety of harvesting activities other than shrimping throughout the calendar year. This widely recognized diversity of fishing activity occurs all along the Atlantic coastline and in the Gulf of Mexico. It is a continuation of adaptive strategies to changing resource opportunities and regulations as well as technology that dates back before the shrimp industry was born. In this respect, the history and development of harvesting activity in the shrimp industry may be seen as one more addition to the annual cycle of North Carolina's commercial (and to some extent, recreational) fishermen (Maiolo 2004; Orbach and Johnson 1988).

Small scale fishermen generally, and shrimpers specifically, historically have been loathe to accept assistance from outside the community or to become active in organizations that promote their interests. In regard to assistance, it is anathema to their culture of self-reliance and this was demonstrated just recently when offered compensation for losses due to Hurricane Floyd. In regard to the latter, beginning with attempts to shore up the harvesting sector with government sponsored cooperatives in the 1930s, and through the development of the North Carolina Fishermen's Association in mid-century, either because of a distrust of organizational structures and/or the difficulty of participating in them because of time constraints shrimpers have been reluctant to organize or unite (Maiolo 2004).

6.1.2 Status

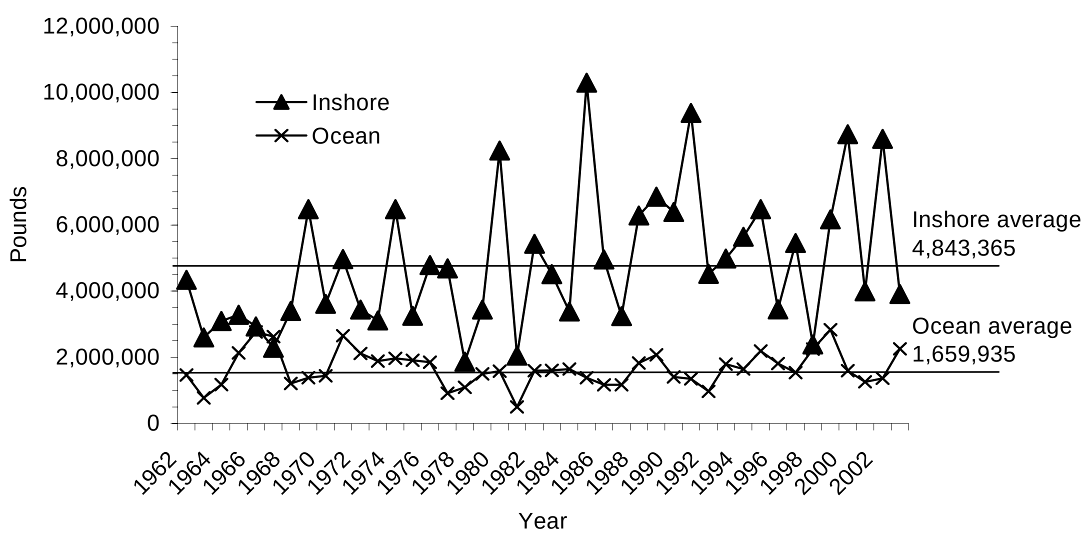

Figure 6.1. Annual shrimp landings (lbs) for North Carolina: 1962 – 2003.

6.1.3 State Landings and Effort

Landings in the North Carolina shrimp fishery vary from year to year and are dependent primarily on environmental conditions (Figure 6.1 and Table 6.1). The annual average was 6,503,301 lbs for the period 1962-2003; 74% were harvested from inshore waters and 26% from the Atlantic Ocean. This management plan will concentrate on landings from 1983-1993 and from the most recent ten year period, 1994-2003, to evaluate trends in the fishery. The information from the earlier period will be used to illustrate historical trends while that from the later period will demonstrate changes in the fishery, especially species composition. North Carolina instituted a trip ticket program in 1994 that has produced more accurate information than what was available prior to 1994. However, species composition was not recorded from 1994-1998. Total landings from 1994-2003 have averaged 7,356,983 lbs per year (range 4.6-10.3 Mlb) caught on an average of 18,319 annual trips (range 14,102-23,886 trips). The contribution to the landings continues to be 75% for inshore waters and 25% for the Atlantic Ocean.

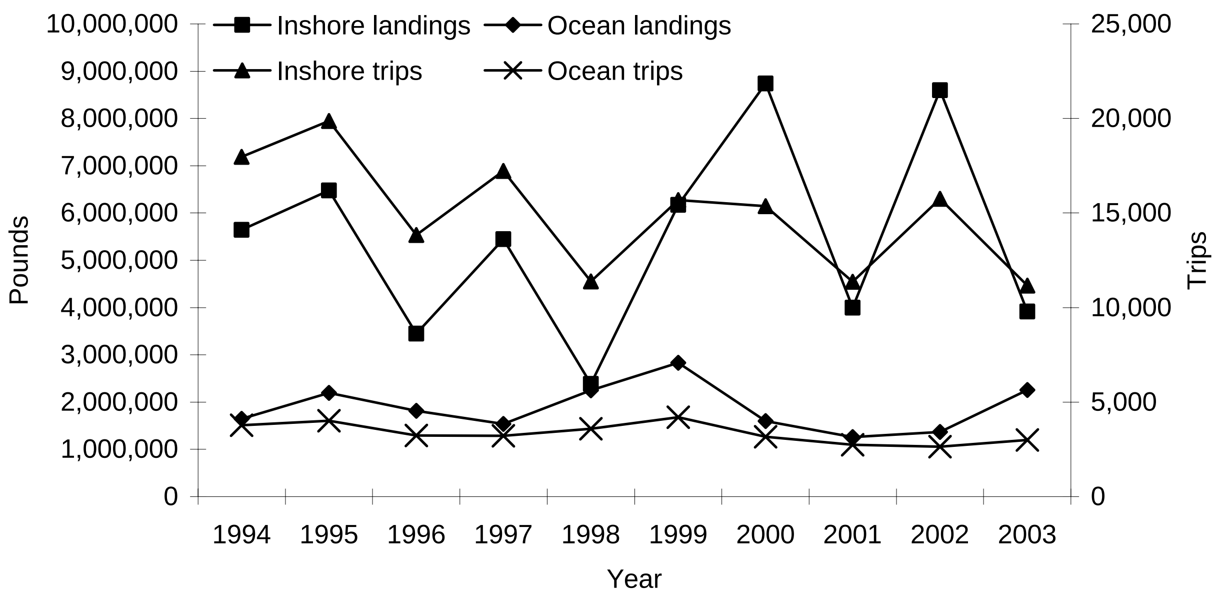

Figure 6.2. Landings (lbs) and trips for 1994-2003.

Annual effort for commercial shrimp trawls in North Carolina waterbodies is shown in Table 6.1 (DMF, unpub. data). About 78-86% of the shrimp trawl trips occur in estuarine waters, with the remainder in ocean waters, primarily within state territorial seas (<3 mi offshore) off the central and southern coast of North Carolina. Total annual shrimp trawling effort has decreased from 1995 to 2003 by about 9,645 trips. Annual shrimp trawling effort has fluctuated with shrimp abundance, but it appears to have gradually declined since 1994. However, the lower commercial fishing effort observed from 1999 – 2003, compared to earlier years is thought to be mostly due to a change in licensing procedure. In 1999 a recreational commercial gear license (RCGL) became available to fishermen. Under this license, shrimp may be caught recreationally using a trawl, but cannot be sold. Some fishermen who possessed commercial licenses prior to this being available switched from a commercial license to the RCGL. Effort from RCGL licenses is not included in the data shown in Table 6.1. In 2002 and 2003 5,373 and 2,646, respectively, RCGL trips for shrimp were estimated (DMF, unpub. data).

Regionally, shrimp trawl effort has generally been greatest in Core and Bogue sounds and associated estuaries [5,115-9,964 trips/year (Table 6.1)]. The Southern estuaries account for the second largest number of inside trawl trips per year, ranging from 3,095-4,814 trips/year. In ocean waters, shrimp trawling is highly concentrated in the southern portion of the state [Onslow through Brunswick counties (2,371-3,455 trips/year)], primarily in the summer (Table 6.1). In contrast, the annual effort in the central district (Carteret County) has ranged from 130 to 391 trips per year, and in the northern district (Virginia line through Hyde County) has ranged from 2 to 47 trips per year. Commercial shrimp trawl effort has remained relatively stable over time in the southern ocean waters of the state.

Table 6.1. Annual number of trips reported for shrimp trawls in inside and ocean waters[1], 1994-2003 (DMF, unpub. data).

	Rivers and sounds				Ocean waters (< 3 miles)					
Year	Albemarle estuaries	Core/Bouge estuaries	Pamlico estuaries	Southern estuaries	Northern district	Central district	Southern district	Total	Percent inside trips	Percent Ocean trips
1994	2	9,495	4,602	3,892	2	186	3,380	21,559	83.45%	16.55%
1995	0	9,964	5,090	4,814	47	303	3,391	23,609	84.15%	15.85%
1996	4	7,615	2,814	3,412	12	280	2,611	16,748	82.67%	17.33%
1997	0	8,189	4,515	4,530	18	183	2,715	20,150	85.53%	14.47%
1998	0	6,006	1,750	3,630	2	348	2,816	14,552	78.24%	21.76%
1999	0	6,946	3,969	4,762	18	391	3,455	19,541	80.23%	19.77%
2000	4	5,511	5,426	4,414	10	266	2,672	18,303	83.89%	16.11%
2001	7	5,115	3,148	3,095	6	130	2,497	13,998	81.19%	18.81%
2002	5	6,602	4,862	4,282	0	198	2,371	18,320	85.98%	14.02%
2003	0	5,887	1,737	3,540	1	306	2,493	13,964	79.95%	20.05%
Average	2	7,133	3,791	4,037	12	259	2,840	18,074	82.79%	17.21%

[1] Albemarle Area: Albemarle Sound, Currituck sound, and all tributaries of Albemarle Sound.
Pamlico Area: Pamlico, Croatan, and Roanoke sounds; Pamlico, Bay, Neuse, and Pungo rivers.
Core/Bogue Area: Core and Bogue sounds; Newport, White Oak, and North rivers.
Southern Area: Masonboro, Stump, and Topsail sounds; Cape Fear, New, Shallotte, and Lockwood Folly rivers; ICW.
Northern district ocean waters: Virginia line through Hyde County.
Central district ocean waters: Carteret County.
Southern district ocean waters: Onslow County to the South Carolina line.
A trip may consist of multiple days in Pamlico Sound and the Atlantic Ocean.

6.1.4 Landings by Waterbody

An examination of harvest by waterbody for the most recent five year period shows that 53% of the landings are from Pamlico Sound, 23% from the Atlantic Ocean and 8% from Core Sound (Table 6.2). No other water bodies contribute more than 4% to the state's total landings. The totals for some water bodies have been combined for purposes of this discussion. For example, some of the water bodies in the southern part of the state where shrimp trawling is not allowed have been combined into the Inland Waterway; the shrimping activity took place in the Waterway that runs through the waterbody where the landings were recorded. It must also be taken into consideration that species composition was not noted on trip tickets for the years 1994 – 1998.

Table 6.2. Percent contribution of landings (1999 – 2003) by waterbody and species.

Waterbdy	Percent brown	Percent pink	Percent white	Percent unclassified	Percent total
Pamlico Sound	67.22	27.96	24.78	60.50	53.15
Ocean	16.13	11.61	40.97	15.99	22.87
Core Sound	7.24	48.22	3.69	11.91	8.31
New River	1.57	7.56	9.23	1.72	3.94
Newport River	1.44	0.51	6.54	1.62	2.85
Neuse River	2.14	1.38	0.61	3.68	1.88
North River-Carteret	0.88	1.01	4.55	0.36	1.85
Other	0.84	0.43	1.73	1.10	1.11
Cape Fear River	0.02	0.02	2.76	0.97	0.90
Inland Waterway	0.58	0.35	1.57	0.76	0.87
White Oak River	0.14	0.02	2.78	0.10	0.86
Bogue Sound	0.60	0.88	0.75	0.14	0.59
Pamlico River	0.81	0.03	0.04	0.64	0.55
Bay River	0.26	0.01	0.00	0.51	0.21
Pungo River	0.12	0.00	0.00	0.00	0.07

6.1.5 Landings by Gear

The vast majority of the shrimp harvest (93%) is taken by otter trawls however, there has been a slight shift in the types of gear used to harvest shrimp in North Carolina in recent years (Figure 6.3). A type of trawl that has gained wide popularity in the central and southern areas since about 1991 is the skimmer trawl. This gear originated in the Gulf Coast states and is very effective at capturing white shrimp. Skimmers are modified wing nets sewn to an aluminum or steel pipe frame. The bottom of each outside pipe has a skid that rides over the bottom. The vessel can work in depths from two to fifteen feet and the tailbags can be hauled in more often without stopping to haul back. This increases the efficiency of the harvest and allows the bycatch to be released more frequently, thus reducing mortality. An increasing number of vessels in Carteret, Onslow, and Pender counties are switching from otter trawls to skimmers as their efficiency on brown shrimp harvest is improved. Skimmer nets account for 2% of the average annual state landings.

Channel nets are stationary nets that fish the surface and middle depths on an outgoing tide. They resemble a staked-out trawl anchored and staked to the bottom to keep it open. The nets are set at night on an ebb tide across a channel or slough in the path of seaward- migrating shrimp. The mouth of the net is oriented toward the direction of the oncoming current. The tailbag of the channel net is emptied into a skiff every 15 to 30 minutes. The net is retrieved from the water before the tide changes to prevent it from being turned inside out. The channel net must be set near inlets where the current is strong and where shrimp have concentrated to move out to sea. This activity is concentrated from Beaufort Inlet to Rich’s Inlet. Channel nets account for 2% of the average annual shrimp landings.

Although not a significant contributor to shrimp landings, shrimp pound nets have recently been developed and employed in the taking of primarily brown shrimp. Shrimp pound nets are trap nets with a V-shaped lead that directs a shrimp to a funnel connected to a box-shaped pound. One of the leads extends to the shoreline and the other extends out towards a channel or deeper water. Shrimp enter the nets at night and can swim back out of the nets during the day, so the nets must be fished every day around dawn to prevent loss. Interest in the use of shrimp pounds has increased since 2003 and issues raised are addressed in this plan.

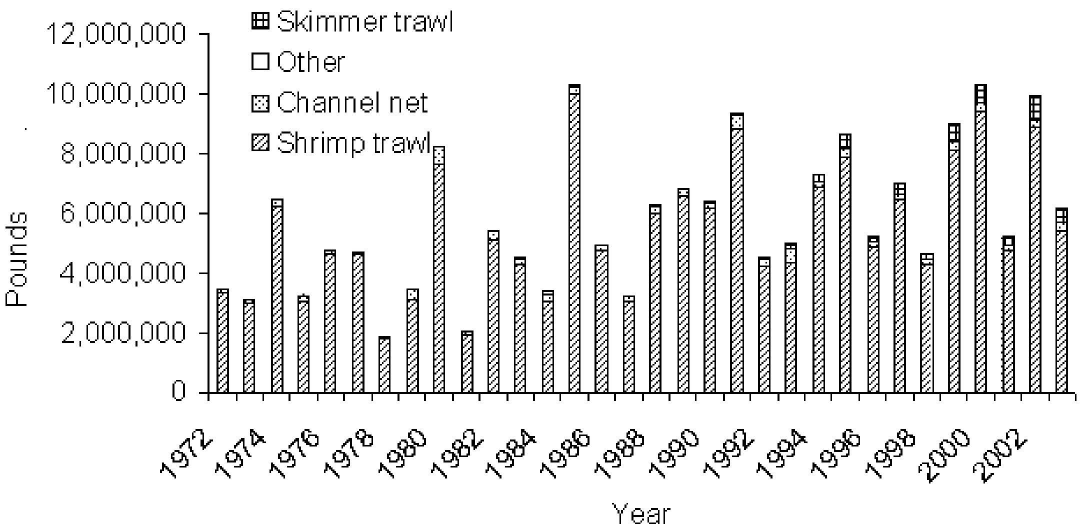

Figure 6.3. Inshore shrimp landings by gear for North Carolina: 1972 – 2003.

The cast net is another type of gear used to harvest shrimp. A few pink and brown shrimp are captured around the marshes and shallows during the summer with this circular net weighted around the perimeter that is thrown out over the shrimp. The weighted edges of the cast net sink to the bottom entrapping the shrimp, and they are pulled in to the catcher by a line attached to the top of the net. The cast net is most successful on white shrimp in the fall as they school in large concentrations and leave the creeks and tributaries and head for the sounds and, eventually, the ocean. Throwing from boats or bridges over creeks is productive when they are migrating.

6.1.6 Landings by Species

The North Carolina shrimp fishery harvests three species: brown, pink, and white. Data on the species composition of the shrimp catch were not collected prior to 1983 or from 1994 through 1998 so discussion of the contribution of each species to the total landings will concentrate on the time periods 1983-1993 and 1999-2003. Historically (1983-1993) brown shrimp accounted for 62.7% of the state total, averaged 4.6 Mlb and annual totals ranged from 1.1 Mlb in 1987 to 10.3 Mlb in 1985 (Figure 6.4). North Carolina brown shrimp commercial landings have averaged 4.5 Mlb since 1999 (Figure 6.5). During this time, landings have fluctuated from a high of 6.5 Mlb in 2000 to a low of 1.7 Mlb in 1999. Environmental factors, principally temperature and salinity, have a major influence on the yearly harvest. Generally, 84% of all brown shrimp landed are caught in estuarine waters with Pamlico Sound, Core Sound, New River, and Neuse River accounting for most of the harvest (Table 6.2). Over 95% of all brown shrimp landed are caught by shrimp trawls. Channel nets and skimmer trawls account for the remaining landings. South Atlantic commercial brown shrimp landings have averaged 8.5 Mlb since 1985. North Carolina is the largest producer of brown shrimp on the Atlantic Coast, accounting for 61% of the total. Pink shrimp have historically (1983-1993) accounted for about 28.8% of the shrimp landings. North Carolina commercial pink shrimp landings averaged 2.1 Mlb from 1983-1993 (Figure 6.4). Environmental factors especially severity of winter temperatures, have a significant influence on the yearly harvest. However, since 1999, pink shrimp landings have averaged only 0.3 Mlb. despite a series of mild winters in the late 1990's and early 2000's. Pink shrimp have accounted for 4% of the state's harvest during the last five years (Figure 6.5). The cause of this decrease is not known. The majority of pink shrimp landed are caught in estuarine waters (88%). There are two seasonally distinct fisheries one from late April through June, and the fall fishery that runs from September through November. Core Sound accounts for 48% of the landings, followed by Pamlico Sound (27%), and the ocean [12% (Table 6.2)]. Over 87% of all pink shrimp landed are caught by shrimp trawls. Channel nets (10%) and skimmer trawls (2%) account for the remainder.

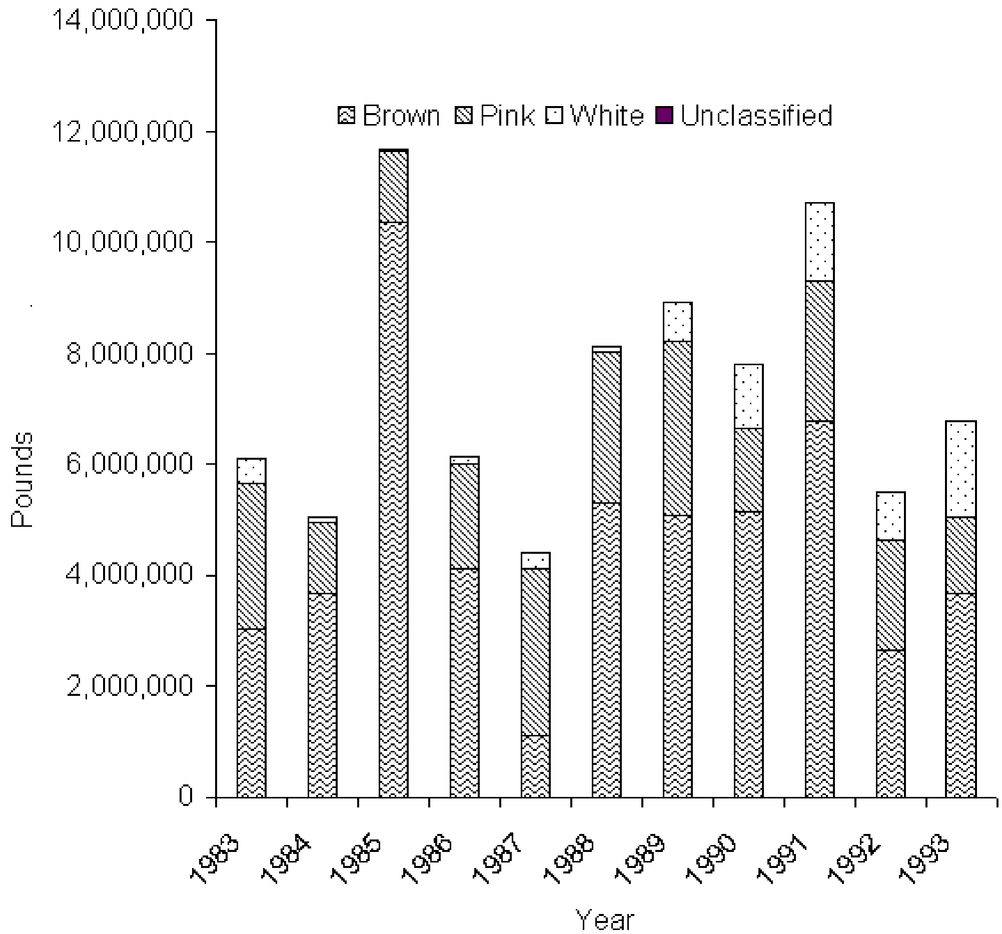

Figure 6.4. North Carolina landings of shrimp by species 1983-1993.

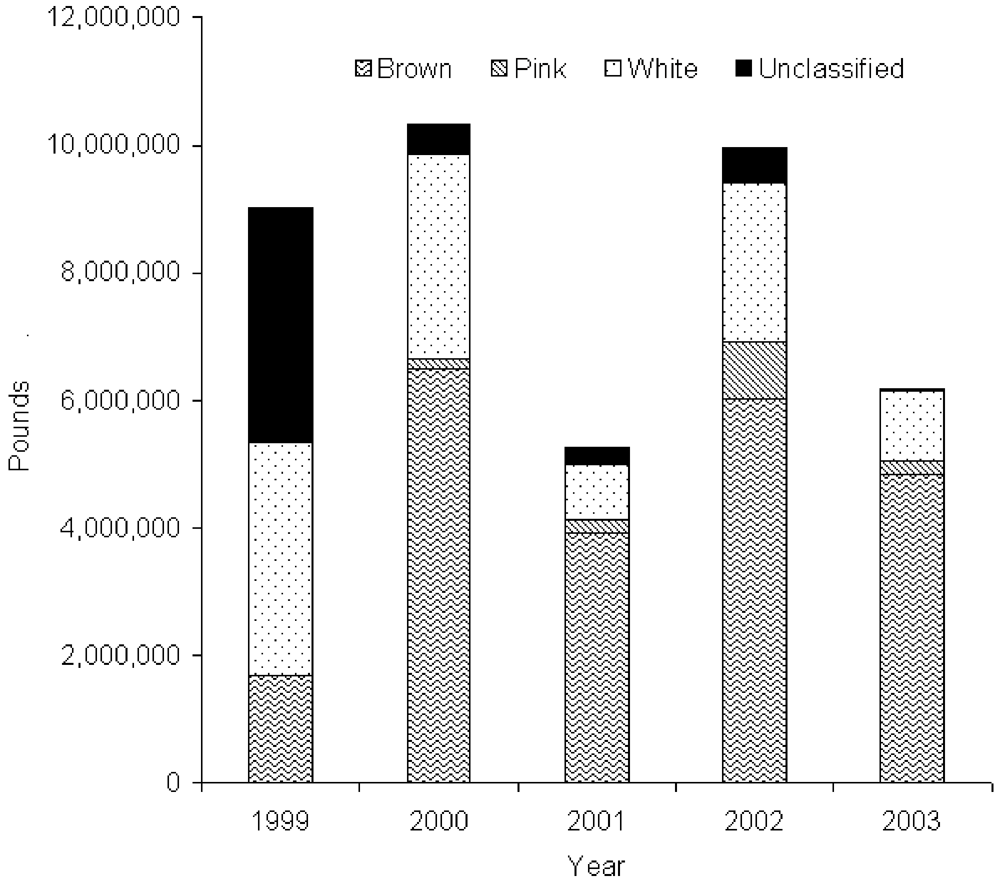

Figure 6.5. North Carolina landings of shrimp by species: 1994 – 2003.

During the period 1983-1993, North Carolina commercial white shrimp landings averaged 0.6 Mlb heads-on (Figure 6.4). Landings fluctuated from a high of 1.7 Mlb in 1993 to a low of 44,666 pounds in 1985 (Figure 6.4). The landings increased significantly for the most recent five years to an average of 2.2 Mlb that was 28% of the state landings (Figure 6.5). These fluctuations are not unusual for a species so vulnerable to environmental conditions, especially low winter water temperatures. The percentage of the white shrimp catch taken in the ocean is higher (41%) than the other two species, which reflects its greater abundance in the southern part of the state where the majority of the ocean fishery occurs. Over 76% of white shrimp landed were caught in shrimp trawls. The other 24% were captured in channel nets (5%) or skimmer trawls (19%). On average, during 1978-90, 70% of all white shrimp were landed in the southern coastal area (Onslow, Pender, New Hanover and Brunswick counties) and 26% in the central area (Pamlico and Carteret counties), and the remaining 4% were taken in the northern area. Since 1999 the majority of white shrimp have been harvested from the Ocean (41%), Pamlico Sound (25%) and New River (9%) (Table 6.4) which reflects the effects of a series of mild winters that has allowed white shrimp populations to be abundant in the northern portion of the state.

There are two seasonal fisheries for white shrimp in North Carolina. The spring fishery lasts from late April until June and the fall fishery that begins in late August and may last through December. In the spring fishery, "roe" (female) white shrimp are caught by trawlers primarily targeting the more abundant pink shrimp. The majority of white shrimp landed come from the fall fishery, where it is the target species in the southern coastal area and other areas if they are abundant.

North Carolina's shrimp fishery is unusual in the southeast because all three species are taken here and the majority of the effort, about 76%, is expended in internal waters. While Georgia and Florida allow limited inside shrimping, the majority of their and South Carolina's fisheries are conducted in the Atlantic Ocean and white shrimp comprise the most of their harvest (Table 6.3). North Carolina's landings for the period 1999-2002 were 32% of the total for the South Atlantic followed by South Carolina (26%), Georgia (23%) and Florida (19%).

Table 6.3. Shrimp landings in pounds from the South Atlantic, 1999-2002.

Area		Brown Shrimp	Pink Shrimp	White Shrimp	Grand Total
Florida East Coast	1999	750,416	779,190	3,742,541	5,272,147
	2000	543,328	896,301	2,365,320	3,804,949
	2001	1,219,258	554,680	2,361,459	4,135,397
	2002	1,000,400	575,965	3,225,038	4,801,403
Florida Total		**3,513,402**	**2,806,136**	**11,694,358**	**18,013,896**
Georgia	1999	1,352,545		5,340,885	6,693,430
	2000	772,932		4,599,183	5,372,115
	2001	1,432,459		2,730,175	4,162,634
	2002	682,247		4,182,129	4,864,376
Georgia Total		**4,240,183**	**0**	**16,852,372**	**21,092,555**
North Carolina	1999	1,672,959	10,060	3,659,314	5,342,333
	2000	6,489,508	161,424	3,214,295	9,865,227
	2001	3,920,556	211,864	863,159	4,995,579
	2002	6,015,420	879,673	2,503,681	9,398,774
North Carolina Total		**18,098,443**	**1,263,021**	**10,240,449**	**29,601,913**
South Carolina	1999	2,018,660	8,744	5,949,805	7,977,209
	2000	1,428,585	1,880	4,608,530	6,038,995
	2001	2,327,931	1,462	2,095,295	4,424,688
	2002	1,480,591	904	3,700,097	5,181,592
South Carolina Total		**7,255,767**	**12,990**	**16,353,727**	**23,622,484**
Grand Total		**33,107,795**	**4,082,147**	**55,140,906**	**92,330,848**

6.1.7 Regional Summary

The shrimp fishery in the northern portion of the state is conducted in Pamlico, Croatan, and Roanoke sounds and Pamlico, Pungo, Bay and Neuse rivers. The otter trawl is the predominant gear used in this portion of the state. Commercial activity occurs in all waters, while recreational activity usually occurs in the rivers and nearshore areas of the sounds.

A variety of methods are used to catch shrimp in the central area including trawls, skimmers, channel nets, shrimp pounds, and cast nets. Trawls are used on all three species in both the estuary and the ocean with two seam trawls used for brown and pink shrimp and four seam and tongue trawls for white shrimp, which tend to swim higher in the water column and have the ability to jump to the surface when disturbed. Most trawling in the central portion of the state is conducted at night.

In the southern portion of the state, the fishery is characterized by a large number of small boats fishing internal waters (primarily the Intracoastal Waterway, New and Cape Fear rivers) and larger craft fishing the Atlantic Ocean primarily off New River, Carolina Beach, and Brunswick County. Many of the small boats are fished by individuals who shrimp part-time or for personal consumption. Use of gears other than trawls has increased primarily in the area from New River to Rich's Inlet. Channel, float, and butterfly nets make use of tidal currents to push shrimp into the nets and offer the advantages of less fuel consumption and less bycatch than traditional shrimp trawls. Channel nets are fished extensively in the areas around New River and Topsail inlets. To shrimp with a “float net”, fishermen attach large floats to the doors and top lines of trawls to make the net fish up in the water column and are pulled slowly forward to harvest shrimp that are migrating to the inlets at night. Butterfly nets utilize this same harvest strategy but are attached to a metal frame and are held stationary in the water column to capture shrimp as the current carries them into the net. Skimmer trawls have become more popular around New River and Topsail Sound. These alternative gears are employed very little in areas south of Rich's Inlet, however tidal conditions seem favorable for their use. Cast nets and seines are also used to harvest shrimp primarily for recreational uses, personal consumption, and to harvest live shrimp for the commercial bait fishery.

6.2 RECREATIONAL

Recreational Fishery

Shrimp are harvested recreationally throughout the state by otter trawls, seines, shrimp pots and cast nets. No license is required to use cast nets and they are allowed in all areas. There is a 100 shrimp per person limit in those areas closed to other methods of shrimping.

Otter trawls, seines, and shrimp pots require a Recreational Commercial Gear License (RCGL) for their use and can be used in areas open to those gears. The RCGL limits the size of the gear to a 26 foot head rope for trawls, a 100 foot seine and five shrimp pots.

The DMF conducted surveys of RCGL holders in 2002 and 2003 concerning their use of this license. RCGL use of seine and shrimp pots is negligible [<0.2% (DMF, Statistics Program)] and only information gathered from RCGL holders who used trawls is presented here.

RCGL trawlers landed 101,595 lbs of shrimp in 2002 and 47,511 lbs in 2003, a 53% reduction. A substantial reduction in harvest also occurred in the commercial fishery where landings decreased 38% during the same period. RCGL landings represented only 1.0% of total commercial landings in 2002 and 0.7% in 2003. Commensurate with the year to year decline in RCGL shrimp landings, there was a decline in license sales and a significant decline in the effort or number of trawling trips between 2002 and 2003.

There were 5,373 trawling trips in 2002 as opposed to only 2,646 trips in 2003, a decrease of 51%. For comparison purposes, the coastline of the state was divided into four regions. These regions are defined in Figure 6.6.

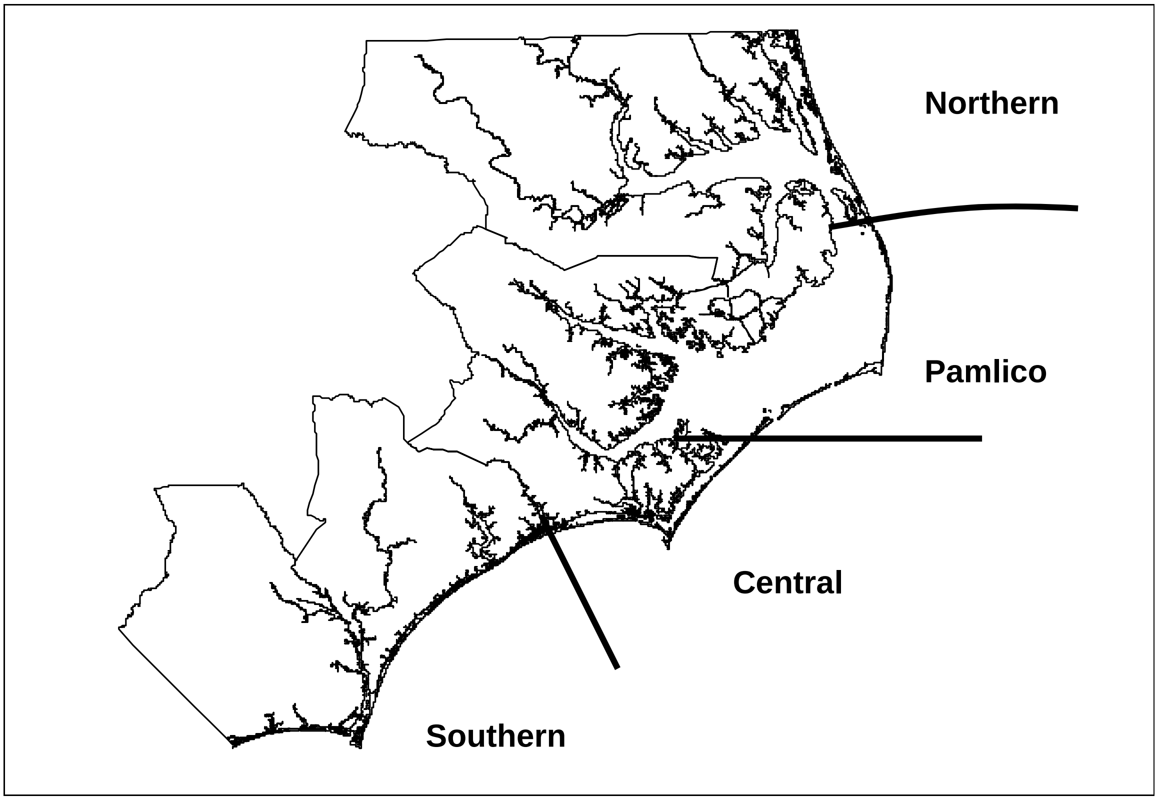

Figure 6.6. Regions used to describe distribution of RCGLs.

The amount of trips and landings relative to the four coastal regions were similar in 2002 and 2003 (Figure 6.7). The Pamlico region had the highest proportion of landings and effort/trips followed by the Southern region. Landings and effort showed little change in either of these areas between 2002 and 2003. In the Northern area, effort increased from 15 to 20% and landings increased from 8 to 18%. Both effort and landings decreased between years in the Central region, from 19 to 11% and 19 to 09% respectively.

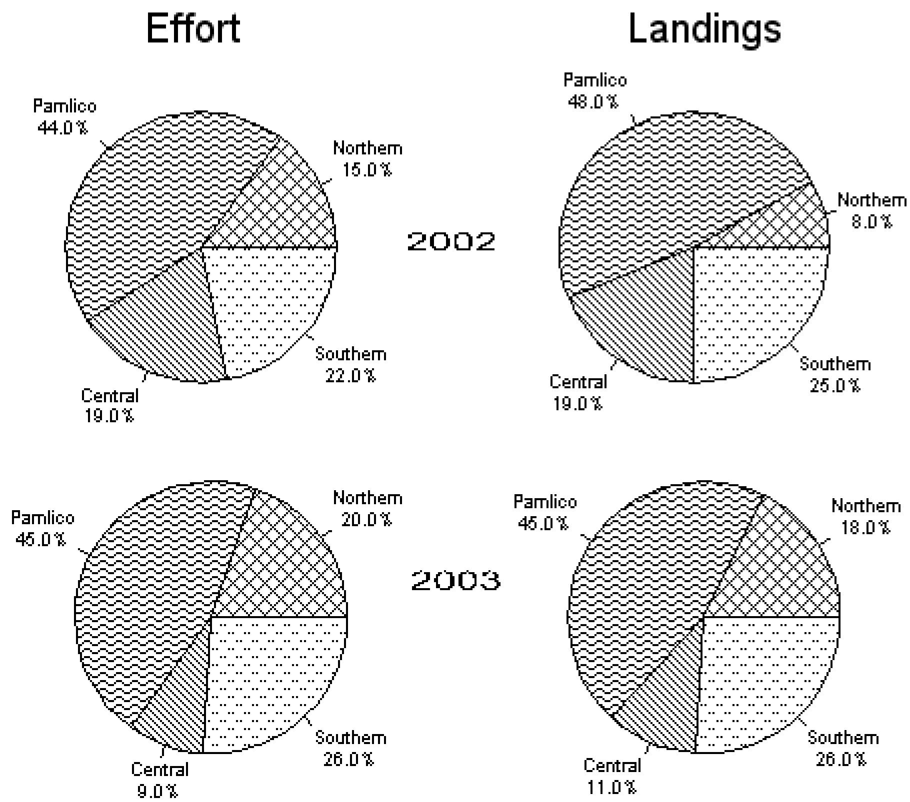

Figure 6.7. Distribution of shrimp trawl effort and landings in North Carolina.

Acreages of estuarine waters where RCGL harvesting activities occur is different across the Northern, Pamlico , Central, and Southern regions (Figure 6.8). The Southern area has only 3% of the total waters but averaged 25.5% of the RCGL shrimp harvest in 2002-2003. The Pamlico area, with 56% of the acreage, had the highest shrimp harvest with an average of 46.5% during 2002-03. The Central Area has 8% of the total acreage and averaged 15% of the landings in 2002-03. The Northern area has the second highest acreage (33%) and the lowest average landings (13%) over 2002-03.

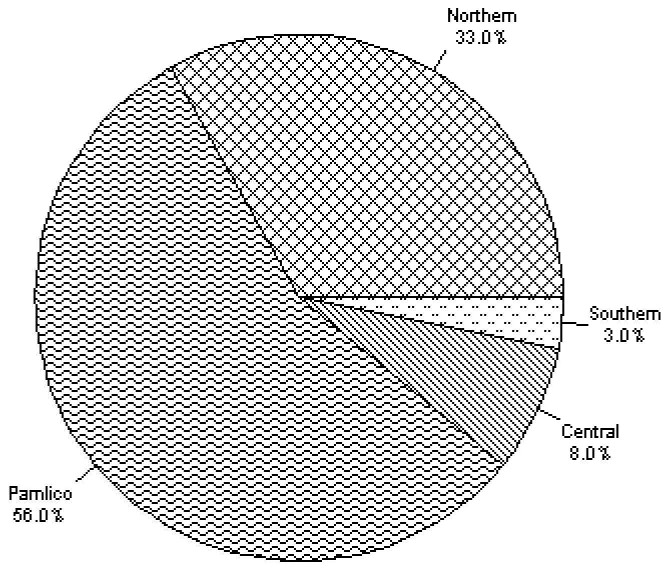

Figure 6.8. Acreages of North Carolina coastal waters by region.

The 2001 survey provided statistics that characterize the gear and effort generated by RCGL shrimp trawlers (Table 6.4). These statistics are based on data collected during 2002 and 2003. These numbers reveal that the typical RCGL shrimper makes four trips a year consisting of 13 tows and most likely uses a trawl with a 22 foot headrope.

Table 6.4. Yearly statistics on trips, tows and trawl headrope size for RCGL users.

	Minimum	Maximum	Mean	Median	Range
Number of trips	1	20	4	3	1 to 8
Number of tows	6	25	13	13	10 to 15
Size of headrope	10	26	22	24	20 to 25

7. ECONOMIC STATUS

7.1 COMMERCIAL FISHERY

7.1.1 Harvesting sector

7.1.1.1 Ex-vessel value and price

DMF began collecting commercial value statistics in 1972. The trip ticket program began in 1994 and it was mandated that all commercial landings be reported to DMF. Reporting the value of the landing continues to remain optional. It is useful in economic analyses to tie the value of annual landings back to an established baseline to control for the effects of inflation. Changes in landings values from year to year since 1972 can be more clearly understood after removing the influence of changing dollar values.

The annual inflated value of shrimp landings typically has been volatile with large changes between years. The lowest inflated value was $3.5 million in 1972. The highest inflated value was $25.4 million in 2000. Relatively speaking, 1981 represented a 69% drop in the value of landings from 1980. However, the fishery rebounded in 1982 with a 210% increase in the inflated value of landings over 1981. The value of the fishery dropped by 53% in 2001 from the record high 2000 value. In 2002 the value increased 54% over the 2001 value, but still considerably lower than 2000. The inflated value hit a 20 year low in 2003, dropping 40% over the previous years value (see Figure 7.1).

Consumer Price Index (CPI) inflation-adjusted figures (deflated to the value of a dollar in 1972) typically show less volatility. Nonetheless, significant volatility from year to year can be seen in the landings values from 1978 to 1987. With a few exceptions, the total deflated value of landings has hovered around the $4 – 5 million from 1972 until 2000. The deflated value of annual landings has been in an overall downward trend in recent years. The deflated value of landings in 2003 was less than $2.5 million, lower than any year in over 30 years. Changes in annual values can largely be attributed to three major causes; pounds landed, price per pound received by fishermen, and in recent years, the impacts of imports. The recent history of imports and their impact on the price of shrimp is further discussed in section 7.1.1.6 of this document.

The average inflated price per pound paid to the fisherman generally rose between 1972 and 1982 (Figure 7.2), rising from a low of $.64 in 1972 to $2.34 in 1982. From 1983 through 1994, the price per pound fluctuated between a high of $2.61 in 1994 and a low of $1.73 in 1991. From 1994 to 2000, the price per pound averaged just below $2.50 per pound. However, since 2000, the inflated price per pound paid to fishermen dropped to a low of $1.77 in 2003.

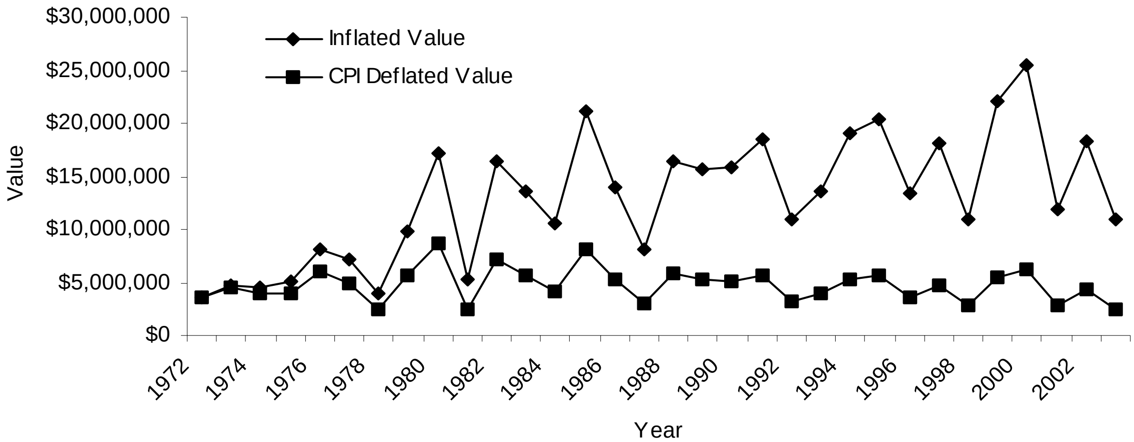

Figure 7.1. Value of shrimp landings in North Carolina, 1972 – 2003 (DMF Trip Ticket Program).

Beginning in 1992 the US Department of Labor began tracking a Producer Price Index (PPI) for unprocessed shrimp. Figure 7.2 shows how the PPI has tracked against the actual price paid per pound to fishermen relative to the initial 1992 value. Years in which the PPI value is above the 1992 value show relative increases. However, in 2002 and 2003, the last two years for which data are available, the value of shrimp per pound was approximately 25% less than the 1992 value. These trends mirror those reported by Maiolo (2004).

The trend in price per pound received by fishermen becomes clearer when one takes into account the impact of inflation. The CPI shows that with the exception of 1972 and 1974, the average deflated price of shrimp was nearly $1.00 per pound until 1982. However, since 1983 there has been a trend towards decline in the average value per pound. The lowest value of $.40 in 2003 is 37% lower than the deflated price received in 1972, and represents the lowest price received per pound in over 30 years.

Supply and demand largely determine the price per pound paid to shrimp fishermen. Farm raised imports, mostly from Asia and Latin America, have increased to meet increasing demand and, indeed, appear to have fostered it. Following the poor domestic harvest years of the late seventies and early eighties, imports had increased from fairly modest levels to 341 million pounds in 1983, 500 million in 1989 and 1990 and 759 pounds in 2000 (Maiolo 2004). The impact of imports has been especially hard on shrimp fishermen since 2001. In that year, price per pound dropped 24% over the previous year. In 2002, the price dropped an additional 32% over the 2001 price received by fishermen. A small gain was realized in 2003 when the price per pound increased by about 13% over the 2002 price. Nonetheless, the PPI deflated price per pound of shrimp went from $2.70 in 2000 down to $1.44 in 2002. It only recovered to $1.63 in 2003, only 60% of the value in 2000. The price per pound reduction received by fishermen since 2000 can largely be attributed to the impact of imports. A record one billion, one hundred and forty million pounds were imported in 2004.

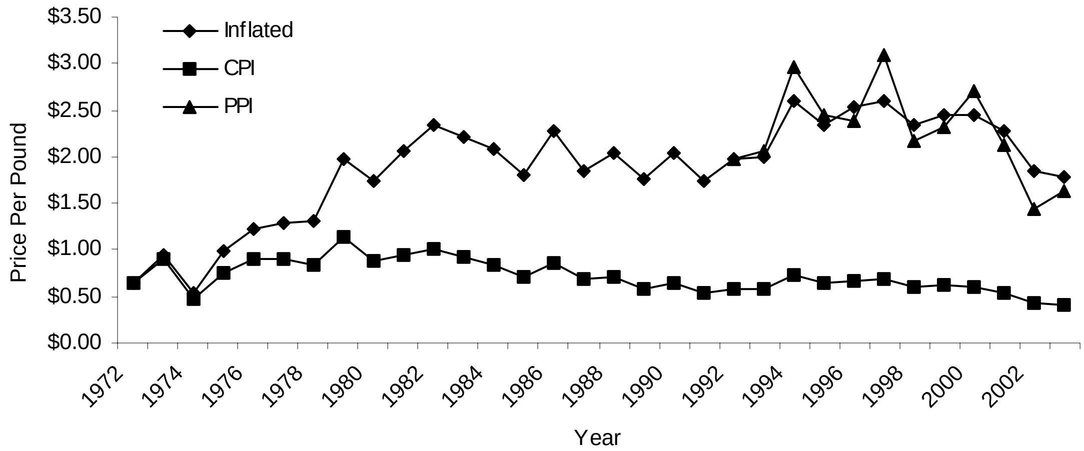

Figure 7.2. Average price per pound of shrimp landings in North Carolina, 1972 – 2003 (DMF Trip Ticket Program).

Table 7.1 show a summary of the data presented in section 7.1.1.1 indicating by year, the number of pounds of shrimp landed, inflated values (indexed to 1972), the CPI deflated value, inflated price per pound, CPI deflated price per pound, the PPI price per pound, and the rate of change from one year to the next for all years in which data were available since 1972.

7.1.1.2 Gear

From 1994 through 2003, 96% to 97% of all shrimp were caught using trawls. An additional 3-4% were caught using channel nets and less than 1% in other gears (Figure 7.3).

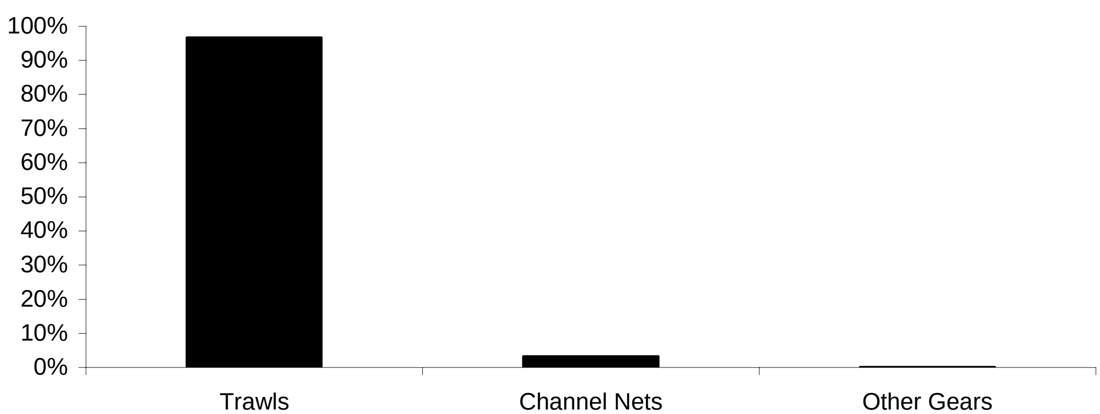

Figure 7.3. Percent of landings by gear used to harvest shrimp in all North Carolina waters, 1994 – 2003 (DMF Trip Ticket Program).

Table 7.1. Detail values of pounds landed, total value, deflate value, price per pound, and percent change from year to year for shrimp landed in North Carolina, 1972 – 2003 (DMF Trip Ticket Program).

Year	Pounds Landed	% Change Pounds	Inflated Value	Conversion	CPI Deflated Value	% Change Value	Inflated Price per Pound	CPI Price per Pound	% Change per Pound	PPI for Shrimp	% PPI Change
1972	5,563,261	---	$3,549,492	1.0000	$3,549,492	---	$0.64	$0.64	---		
1973	5,003,417	-10%	$4,738,223	0.9414	$4,460,759	26%	$0.95	$0.89	40%		
1974	8,440,203	69%	$4,606,363	0.8479	$3,905,598	-12%	$0.55	$0.46	-48%		
1975	5,163,610	-39%	$5,053,944	0.7770	$3,926,670	1%	$0.98	$0.76	64%		
1976	6,642,713	29%	$8,171,394	0.7346	$6,002,887	53%	$1.23	$0.90	19%		
1977	5,600,329	-16%	$7,239,080	0.6898	$4,993,293	-17%	$1.29	$0.89	-1%		
1978	2,960,762	-47%	$3,883,836	0.6411	$2,489,944	-50%	$1.31	$0.84	-6%		
1979	4,941,240	67%	$9,728,917	0.5758	$5,601,498	125%	$1.97	$1.13	35%		
1980	9,823,490	99%	$17,184,994	0.5073	$8,717,630	56%	$1.75	$0.89	-22%		
1981	2,557,426	-74%	$5,295,209	0.4598	$2,434,981	-72%	$2.07	$0.95	7%		
1982	7,027,164	175%	$16,411,472	0.4332	$7,108,803	192%	$2.34	$1.01	6%		
1983	6,114,099	-13%	$13,564,106	0.4197	$5,692,567	-20%	$2.22	$0.93	-8%		
1984	5,036,749	-18%	$10,475,665	0.4023	$4,214,464	-26%	$2.08	$0.84	-10%		
1985	11,676,679	132%	$21,124,922	0.3885	$8,206,522	95%	$1.81	$0.70	-16%		
1986	6,134,774	-47%	$13,903,999	0.3814	$5,302,803	-35%	$2.27	$0.86	23%		
1987	4,413,078	-28%	$8,155,548	0.3680	$3,000,897	-43%	$1.85	$0.68	-21%		
1988	8,110,777	84%	$16,486,042	0.3533	$5,825,161	94%	$2.03	$0.72	6%		
1989	8,922,807	10%	$15,620,305	0.3371	$5,265,554	-10%	$1.75	$0.59	-18%		
1990	7,801,605	-13%	$15,838,593	0.3198	$5,065,441	-4%	$2.03	$0.65	10%		
1991	10,731,041	38%	$18,578,905	0.3069	$5,701,896	13%	$1.73	$0.53	-18%		
1992	5,495,811	-49%	$10,859,113	0.2979	$3,235,288	-43%	$1.98	$0.59	11%	$1.98	---
1993	6,778,762	23%	$13,590,460	0.2893	$3,931,358	22%	$2.00	$0.58	-1%	$2.05	4%
1994	7,294,043	8%	$19,001,297	0.2821	$5,359,340	36%	$2.61	$0.73	27%	$2.96	44%
1995	8,669,398	19%	$20,319,177	0.2743	$5,573,108	4%	$2.34	$0.64	-13%	$2.45	-17%
1996	5,271,731	-39%	$13,378,358	0.2664	$3,564,151	-36%	$2.54	$0.68	5%	$2.38	-3%
1997	6,988,825	33%	$18,203,356	0.2604	$4,740,812	33%	$2.60	$0.68	0%	$3.08	30%
1998	4,636,343	-34%	$10,858,872	0.2564	$2,784,668	-41%	$2.34	$0.60	-11%	$2.17	-30%
1999	9,004,430	94%	$22,095,815	0.2509	$5,543,848	99%	$2.45	$0.62	3%	$2.33	7%
2000	10,334,915	15%	$25,400,172	0.2427	$6,165,663	11%	$2.46	$0.60	-3%	$2.70	16%
2001	5,254,214	-49%	$11,906,335	0.2360	$2,810,191	-54%	$2.27	$0.53	-10%	$2.12	-21%
2002	9,969,026	90%	$18,364,776	0.2324	$4,267,080	52%	$1.84	$0.43	-20%	$1.44	-32%
2003	6,167,371	-38%	$10,945,676	0.2272	$2,486,572	-42%	$1.77	$0.40	-6%	$1.62	13%

Table 7.2 shows the number of pounds landed, the total value, and the price per pound for each of the gears listed in Figure 7.3 by year from 1994 – 2003. Inflated values refer to the actual dollar amount paid by fish dealers to shrimp fishermen. The deflated values referred to in this table refer to the PPI values for unprocessed shrimp.

Trawls were the primary gears used to land shrimp in every year. Trawls brought in the highest price per pound in most years. The difference in price per pound was as much as $.46 in 1999 and as little as $.07 per pound in 2000.

Table 7.2. Pounds, price per pound, and total value of shrimp landings by gear in all North Carolina waters, 1994 – 2003 (DMF Trip Ticket Program).

Year	Gear	Pounds	Inflated Value	Deflated Value	Price/Lb	Deflated Price/Lb
1994	Trawls	7,091,538	$18,572,279	$18,572,279	$2.62	$2.62
	Channel Net	186,029	$403,636	$403,636	$2.17	$2.17
	Other Gears	8,780	$21,303	$21,303	$2.43	$2.43
1995	Trawls	8,350,411	$19,657,278	$20,567,752	$2.35	$2.46
	Channel Net	273,092	$569,050	$595,407	$2.08	$2.18
	Other Gears	45,426	$92,447	$96,729	$2.04	$2.13
1996	Trawls	5,057,320	$12,901,194	$12,105,402	$2.55	$2.39
	Channel Net	199,915	$457,279	$429,072	$2.29	$2.15
	Other Gears	4,247	$9,824	$9,218	$2.31	$2.17
1997	Trawls	6,793,752	$17,734,939	$20,999,375	$2.61	$3.09
	Channel Net	191,188	$459,801	$544,435	$2.40	$2.85
	Other Gears	3,302	$8,034	$9,512	$2.43	$2.88
1998	Trawls	4,450,334	$10,451,933	$9,694,151	$2.35	$2.18
	Channel Net	181,917	$399,736	$370,754	$2.20	$2.04
	Other Gears	2,939	$6,049	$5,610	$2.06	$1.91
1999	Trawls	8,711,223	$21,512,340	$20,406,424	$2.47	$2.34
	Channel Net	284,443	$571,531	$542,150	$2.01	$1.91
	Other Gears	8,542	$11,832	$11,224	$1.39	$1.31
2000	Trawls	10,069,905	$24,767,058	$27,212,506	$2.46	$2.70
	Channel Net	260,321	$621,456	$682,818	$2.39	$2.62
	Other Gears	4,689	$11,658	$12,809	$2.49	$2.73
2001	Trawls	5,065,311	$11,503,607	$10,780,745	$2.27	$2.13
	Channel Net	185,567	$395,288	$370,449	$2.13	$2.00
	Other Gears	3,253	$7,318	$6,858	$2.25	$2.11
2002	Trawls	9,713,944	$17,914,881	$14,014,164	$1.84	$1.44
	Channel Net	250,656	$436,803	$341,695	$1.74	$1.36
	Other Gears	4,417	$13,080	$10,232	$2.96	$2.32
2003	Trawls	5,909,728	$10,514,436	$9,622,889	$1.78	$1.63
	Channel Net	255,892	$420,269	$384,633	$1.64	$1.50
	Other Gears	1,751	$10,971	$10,040	$6.27	$5.74

7.1.1.3 Water bodies

The majority of inshore shrimp are landed from the Pamlico and Core sounds. In every year since 1994 with the exception of 1998, Pamlico Sound landed the greatest amount of shrimp in terms of pounds and value compared to all other trip ticket water bodies. On average from 1994 through 2003, 50% of all shrimp landed in NC came from Pamlico Sound alone. All trip ticket water bodies south of the Albemarle Sound showed some landings in at least most of the years. Pamlico and Core sounds along with ocean landings south of Cape Hatteras each account for over $1 million in landings each year.

Table 7.3 shows shrimp landings for all water bodies that had at least 5,000 pounds landed. Waterbodies that are listed and show no landings for a given year does not mean that waterbody had no landings. It may mean the waterbody did not meet the 5,000-pound threshold for that year. Also, the names of water bodies and how they are used has changed over time. For example, Inland waterway was separated into Inland Waterway – Brunswick and Inland Waterway – Onslow in 2003. Ocean landings were separated into landings north and south of Cape Hatteras. Wherever it was possible, landings using old waterbody names were recoded in this analysis to indicate the current waterbody designation.

7.1.1.4 Participants and trips

DMF began a new licensing system in 1999. This new system allows for easier identification of specific fishermen with their individual landings by species and the number of trips taken where a given species was landed. Table 7.4 shows the number of participants in the shrimp fishery by year and the ex-vessel value of their landings.

The number of fishermen who participate in the fishery seems to follow the abundance of shrimp or when fishermen are receiving a good price. This indicates that at least some fishermen are able to rely on other species or other work when shrimping is not as lucrative. The years 1999 and 2000 saw the greatest number of participants in the fishery at over 900. Yet 2003 had the least number of participants with only 594.

On average, in the five years from 1999 through 2003, nearly half of all fishermen who caught shrimp had ex-vessel landings values less than $5,000. The percentage of fishermen who landed ex-vessel values of between $35,000 and $50,000 remained fairly constant at about 10% of all participants. The percentage of fishermen who had ex-vessel landings values between $50,001 and $75,000 in a given year showed a slight increasing trend among participants. However, there is great variability among years as to the percentage of fishermen who are able to land more than $75,000 ex-vessel value of shrimp.

Table 7.3. Pounds and value of shrimp landed from North Carolina water bodies from 1994 – 2003 (DMF Trip Ticket Program).

	Year							
	1994		1995		1996		1997	
Water body	Pounds	Ex-Vessel Value	Pounds	Ex-Vessel Value	Pounds	Ex-Vessel Value	Pounds	Ex-Vessel Value
Bay River	20,051	$54,588	10,021	$19,981	6,052	$14,231	16,409	$40,222
Bogue Sound	23,344	$49,666	34,345	$65,683	45,689	$92,875	17,009	$33,178
Cape Fear River	149,791	$302,890	114,261	$186,102	80,380	$189,553	138,424	$273,720
Core Sound	864,599	$1,837,495	1,069,258	$2,272,494	738,396	$1,690,725	636,805	$1,423,443
Croatan Sound	7,701	$17,963	13,768	$36,115	6,590	$18,242	12,539	$32,248
Masonboro Sound	---	---	---	---	5,973	$12,699	5,715	$10,681
Ocean 0-3 mi, N of Cape Hatteras	---	---	55,686	$168,765	13,318	$31,018	21,710	$66,132
Ocean 0-3 mi, S of Cape Hatteras	---	---	337,606	$862,315	1,232,910	$3,177,581	1,030,217	$2,618,096
Ocean >3 mi, N of Cape Hatteras	---	---	---	---	16,546	$46,974	7,028	$20,066
Ocean >3 mi, S of Cape Hatteras	---	---	---	---	180,351	$475,194	205,008	$571,463
Ocean less than 3 miles	1,372,958	$3,621,439	1,478,122	$3,190,108	329,751	$788,445	243,964	$643,107
Ocean more than 3 miles	277,855	$763,765	303,217	$846,978	49,752	$139,195	32,609	$89,451
Neuse River	115,689	$320,348	114,705	$284,780	111,098	$311,250	164,538	$441,101
New River	103,078	$284,059	274,212	$689,719	148,264	$420,146	244,360	$636,979
Newport River	166,828	$311,459	275,058	$386,857	125,092	$270,483	213,818	$424,616
Pamlico River	47,621	$133,354	34,756	$86,079	23,078	$64,410	39,793	$116,922
Pamlico Sound	3,861,499	$10,720,672	4,096,435	$10,313,455	1,934,512	$5,147,780	3,722,785	$10,230,968
Stump Sound	8,553	$21,719	25,546	$47,773	27,088	$65,610	29,139	$65,943
Topsail Sound	29,485	$71,715	59,202	$139,414	21,898	$47,900	22,508	$54,216
White Oak River	45,019	$83,167	39,311	$47,476	23,825	$46,005	12,986	$24,578
North River/Back Sound	127,327	$257,580	196,322	$417,171	56,511	$132,456	92,489	$224,554
Roanoke Sound	14,776	$30,690	5,632	$12,482	7,811	$19,305	8,568	$21,619
Inland Waterway - Brunswick	20,377	$36,999	47,264	$80,186	41,431	$74,062	31,182	$61,262
Inland Waterway - Onslow	30,559	$68,141	63,147	$111,917	43,199	$97,621	35,493	$71,044

Table 7.3 (cont.) Pounds and value of shrimp landed from North Carolina water bodies from 1994 – 2003 (DMF Trip Ticket Program).

	Year							
	1998		1999		2000		2001	
Water body	Pounds	Ex-Vessel Value	Pounds	Ex-Vessel Value	Pounds	Ex-Vessel Value	Pounds	Ex-Vessel Value
Bay River	---	---	27,913	$69,034	35,348	$78,462	5,935	$13,383
Bogue Sound	41,849	$70,963	48,220	$94,783	23,875	$38,287	9,906	$13,483
Cape Fear River	82,592	$150,219	118,742	$215,260	46,058	$79,358	17,850	$51,736
Core Sound	547,488	$991,399	884,330	$1,598,475	464,917	$901,322	431,489	$839,705
Croatan Sound	---	---	3,793	$8,370	40,989	$96,493	---	---
Ocean 0-3 mi, N of Cape Hatteras	---	---	6,638	$21,241	36,319	$98,856	---	---
Ocean 0-3 mi, S of Cape Hatteras	1,493,238	$3,696,510	2,468,260	$668,902	1,397,907	$3,565,806	1,157,075	$2,296,261
Ocean >3 mi, N of Cape Hatteras	14,516	$42,551	51,502	$174,186	29,997	$84,160	---	---
Ocean >3 mi, S of Cape Hatteras	380,907	$1,002,549	236,725	$584,197	133,048	$349,046	100,069	$206,999
Ocean less than 3 miles	344,408	$811,075	67,420	$214,004	---	---	---	---
Ocean more than 3 miles	18,602	$47,937	5,007	$17,816	---	---	---	---
Neuse River	83,765	$177,305	216,922	$485,133	210,970	$471,183	19,942	$43,962
New River	259,274	$661,700	271,883	$626,671	483,739	$1,351,747	189,084	$430,682
Newport River	71,793	$126,691	307,504	$456,164	240,583	$304,929	176,502	$241,288
Pamlico River	14,664	$37,043	43,794	$120,732	44,710	$109,849	20,203	$43,487
Pamlico Sound	1,115,961	$2,720,959	3,876,339	$10,191,283	6,708,334	$17,185,783	2,890,943	$7,334,297
Shallotte River	---	---	---	---	---	---	6,123	$11,180
Stump Sound	16,038	$36,094	20,522	$38,276	21,888	$45,129	11,795	$26,149
Topsail Sound	36,579	$73,701	72,561	$134,762	39,152	$84,958	21,888	$35,849
White Oak River	23,582	$37,844	37,984	$36,346	62,164	$55,993	62,361	$75,326
North River/Back Sound	27,391	$53,045	160,649	$193,871	216,045	$309,502	71,739	$133,631
Roanoke Sound	---	---	---	---	7,298	$15,732	---	---
Pungo River	---	---	7,029	$19,554	6,926	$17,482	6,887	$11,814
Inland Waterway - Brunswick	23,951	$42,742	21,913	$41,129	38,487	$60,556	19,450	$35,254
Inland Waterway -Onslow	30,818	$61,108	44,593	$77,669	40,976	$87,833	32,088	$55,937

Table 7.3 (cont.) Pounds and value of shrimp landed from North Carolina water bodies from 1994 – 2003 (DMF Trip Ticket Program).

	Year			
	2002		2003	
Water body	Pounds	Ex-Vessel Value	Pounds	Ex-Vessel Value
Bay River	14,070	$19,787	---	---
Bogue Sound	31,389	$55,013	127,781	$155,212
Cape Fear River	82,868	$109,384	101,428	$162,548
Core Sound	783,852	$1,235,756	821,174	$1,392,239
Croatan Sound	10,010	$18,063	---	---
Masonboro Sound	---	---	6,561	$7,473
Ocean 0-3 mi, S of Cape Hatteras	1,288,291	$2,438,720	2,008,504	$3,365,084
Ocean >3 mi, N of Cape Hatteras	21,337	$38,855	---	---
Ocean >3 mi, S of Cape Hatteras	60,109	$137,491	242,477	$413,615
Neuse River	213,697	$373,058	102,366	$166,627
New River	428,783	$871,912	230,381	$454,378
Newport River	292,696	$289,219	142,654	$190,706
Pamlico River	102,459	$176,545	11,934	$25,129
Pamlico Sound	6,147,806	$11,977,356	2,023,826	$4,115,221
Stump Sound	48,099	$84,230	25,010	$37,392
Topsail Sound	14,383	$22,975	43,141	$69,255
White Oak River	137,397	$128,142	52,052	$49,960
North River/Back Sound	186,314	$212,358	117,353	$175,649
Roanoke Sound	31,342	$57,581	---	---
Pungo River	7,870	$14,036	---	---
Inland Waterway - Brunswick	25,332	$38,907	31,005	$50,432
Inland Waterway - Onslow	32,947	$53,059	66,857	$94,797

Table 7.4. Number of participants in the shrimp fishery by value of landings and year in North Carolina, 1999 – 2003. (DMF Trip Ticket Program).

	Year					
	1999	2000	2001	2002	2003	Total
$1 - $1,000	273	272	199	189	112	1,045
% within year	30%	29%	28%	24%	19%	26%
$1,001 - $5,000	198	170	153	176	148	845
% within year	21%	18%	21%	22%	25%	21%
$5,001 - $10,000	120	120	103	91	89	523
% within year	13%	13%	14%	12%	15%	13%
$10,001 - $20,000	78	76	61	92	62	369
% within year	8%	8%	9%	12%	10%	9%
$20,001 - $35,000	36	39	41	36	40	192
% within year	4%	4%	6%	5%	7%	5%
$35,001 - $50,000	79	96	84	76	76	411
% within year	9%	10%	12%	10%	13%	10%
$50,001 - $75,000	44	42	44	50	45	225
% within year	5%	5%	6%	6%	8%	6%
> $75,000	94	112	32	76	22	336
% within year	10%	12%	4%	10%	4%	9%
Total participants	922	927	717	786	594	
% change	---	1%	-23%	10%	-24%	

Table 7.5 shows the number of fisherman and the number of trips they took in which they landed shrimp for the years 1999 through 2003. From 1999 through 2003 an average of 12% of all participants only had one trip with shrimp landings. An average of 65% of all persons reporting shrimp landings had 20 or fewer trips in a given year. Only 17% of all fishermen reported taking 41 or more trips per year. Again, abundance of shrimp, prices received for the catch, and weather events such as hurricanes greatly affect the number of trips a fisherman might make.

Table 7.5. Number of participants and the number of trips taken that landed shrimp in North Carolina, 1999 – 2003 (DMF Trip Ticket Program).

	Year					
	1999	2000	2001	2002	2003	Total
1 Trip	121	117	94	80	57	469
% within year	13%	13%	13%	10%	10%	12%
2 - 10 Trips	328	309	245	256	181	1,319
% within year	36%	33%	34%	33%	30%	33%
11 - 20 Trips	173	180	158	163	123	797
% within year	19%	19%	22%	21%	21%	20%
21 - 30 Trips	102	128	85	96	67	478
% within year	11%	14%	12%	12%	11%	12%
31 - 40 Trips	47	59	35	51	43	235
% within year	5%	6%	5%	6%	7%	6%
41 - 50 Trips	36	39	28	34	34	171
% within year	4%	4%	4%	4%	6%	4%
51 - 60 Trips	32	22	21	24	27	126
% within year	3%	2%	3%	3%	5%	3%
61 - 70 Trips	25	25	17	17	21	105
% within year	3%	3%	2%	2%	4%	3%
71 - 80 Trips	18	13	8	23	16	78
% within year	2%	1%	1%	3%	3%	2%
81 - 90 Trips	12	17	7	13	12	61
% within year	1%	2%	1%	2%	2%	2%
91 – 100 Trips	7	7	11	9	6	40
% within year	1%	1%	2%	1%	1%	1%
More than 100 Trips	21	11	8	20	7	67
% within year	2%	1%	1%	3%	1%	2%
Total	922	927	717	786	594	3,946

In North Carolina, licensed commercial fishermen are allowed only to sell their catch to licensed fish dealers. Figure 7.4 shows the number of North Carolina fish dealers who purchased shrimp from licensed fishermen each year from 1999 through 2003. There is a fair amount of change in the number of dealers purchasing shrimp from year to year with a low of 225 in 2001 to a high of 284 in 2002. The annual differences are due largely to availability of local shrimp as well as availability and price of imported processed or frozen shrimp.

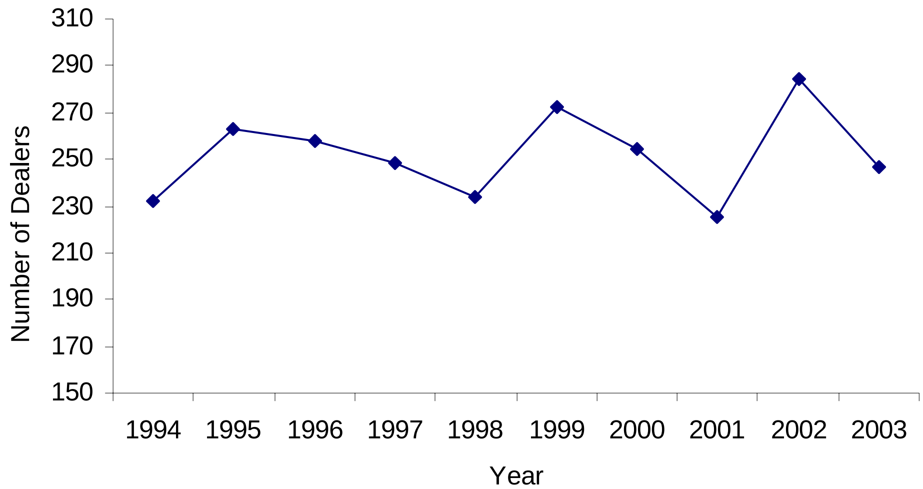

Figure 7.4. Number of dealers who purchased shrimp from 1994 to 2003 (DMF Trip Ticket Program).

Table 7.6 shows the number of fish dealers who purchased specific amounts of shrimp in a given year. An average of 9% of dealers purchase fewer than 100 pounds of shrimp in a given year. All told, about 35% of dealers purchase 1,000 or fewer pounds of shrimp a year. About 23% of dealers purchase more than 20,000 pounds of shrimp from fishermen. Only 9% purchase more than 100,000 pounds of shrimp.

7.1.1.5 Processing

Some dealers will go so far as to head shrimp for customers, but the majority of shrimp are sold heads on. Shrimp that cannot be sold fresh are frozen and sold that way. A few dealers sell shrimp to be processed into other consumable products such as frozen breaded shrimp, however, there are no shrimp processors currently operating in North Carolina.

7.1.1.6 Marketing and distribution

Fish dealers sell shrimp to other dealers, restaurateurs, retail outlets and directly to the consumer. There is no specific information available as to how much North Carolina shrimp is sold through each of these venues.

According to the US Department of Commerce (2003) there was a 3.7 pound per capita consumption of shrimp by Americans in 2002. This represented an all-time record amount of shrimp consumed. The North Carolina State Demographics (2004) website indicates that there were 8,196,195 residents of North Carolina in July of 2002.

Table 7.6. Pounds of shrimp purchased by North Carolina fish dealers from North Carolina fishermen, 1994 – 2003 (DMF Trip Ticket Program). * Denotes confidential data. Data are included with the preceding category.

	Year										
Pounds	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Total
Less than 100 lbs.	17	27	22	22	26	28	28	23	23	20	236
% within year	7%	10%	9%	9%	11%	10%	11%	10%	8%	8%	9%
101 - 500 lbs.	38	35	50	30	36	56	47	40	47	25	404
% within year	16%	13%	19%	12%	15%	21%	19%	18%	17%	10%	16%
501 - 1,000 lbs.	26	25	21	30	30	23	21	24	31	23	254
% within year	11%	10%	8%	12%	13%	8%	8%	11%	11%	9%	10%
1,001 - 2,000 lbs.	19	30	28	32	26	31	26	22	41	39	294
% within year	8%	11%	11%	13%	11%	11%	10%	10%	14%	16%	12%
2,001 - 5,000 lbs.	31	36	43	36	32	35	36	34	39	36	358
% within year	13%	14%	17%	15%	14%	13%	14%	15%	14%	15%	14%
5,001 - 10,000 lbs.	19	21	19	17	16	17	16	19	23	29	196
% within year	8%	8%	7%	7%	7%	6%	6%	8%	8%	12%	8%
10,001 - 20,000 lbs.	17	21	17	22	14	15	18	13	21	18	176
% within year	7%	8%	7%	9%	6%	6%	7%	6%	7%	7%	7%
20,001 - 35,000 lbs.	12	8	11	8	12	11	11	10	12	13	108
% within year	5%	3%	4%	3%	5%	4%	4%	4%	4%	5%	4%
35,001 - 50,000 lbs.	9	7	18	11	13	6	5	5	5	10	89
% within year	4%	3%	7%	4%	6%	2%	2%	2%	2%	4%	4%
50,001 - 75,000 lbs.	13	9	6	12	8	7	6	9	6	7	83
% within year	6%	3%	2%	5%	3%	3%	2%	4%	2%	3%	3%
75,001 - 100,000 lbs.	9	18	9	6	8	8	9	8	3	5	83
% within year	4%	7%	3%	2%	3%	3%	4%	4%	1%	2%	3%
100,001 - 150,000 lbs.	10	9	5	10	8	17	10	11	11	8	99
% within year	4%	3%	2%	4%	3%	625%	4%	5%	4%	3%	4%
150,001 - 200,000 lbs.	3	7	5	5	*	10	5	4	8	8	55
% within Year	1%	3%	2%	2%	*	4%	2%	2%	3%	3%	2%
More than 200,000 lbs.	9	10	4	7	5	8	16	3	14	6	82
% within year	4%	4%	2%	3%	2%	3%	6%	1%	5%	2%	3%
Total	232	263	258	248	234	272	254	225	284	247	
percent change		13%	-2%	-4%	-6%	16%	-7%	-11%	26%	-13%	

These two numbers estimate that over 30 million pounds of shrimp were consumed by North Carolina residents in 2002, over three times the number of pounds actually landed from North Carolina waters. Even if all shrimp caught in North Carolina remained in the state, it would only supply one third of the state's consumption needs. There is a large reliance on shrimp imported into North Carolina from other states, and foreign countries. Thus it appears imports represent a two edged sword. On the one hand, they have increased the supply, and also demand because of the effect on price. On the other hand, the effect on price has greatly diminished the economic returns to domestic fishermen. One result is that some fishermen look for more land based work. In other cases, wives take full time jobs to supplement their husband's income so they can continue shrimping (Maiolo 2004).

Concerned about the rising tide of imports, a group of shrimping industry individuals from the Gulf and South Atlantic formed the Southern Shrimp Alliance (SSA), made up of the shrimp producing states from North Carolina through Texas. The SSA hired two firms: one to do the research for possible trade action, and the other for lobbying.

The SSA decided to file petitions with the Federal government alleging several countries had been dumping shrimp on the US market at below cost. SSA filed trade action against 6 countries, and the petition was filed on December 31, 2003. Preliminary antidumping duties were imposed by the US Department of Commerce in July of 2004. The duties ranged from 3.4% to 67.8% on companies from the countries of Brazil, Ecuador, India, and Thailand. Additionally, The Commerce Department found that shrimp from China and Vietnam were dumped on US markets at a rate of up to 113% below cost (NCFA 2004).

Additionally, the lobbying efforts of SSA helped to persuade the United States Congress in 2003 to set aside $35 million to offset the economic losses suffered by shrimp fishermen from southeastern states. North Carolina received $4.9 million of the total. Of the total, $4.1 million was sent directly to fishermen based on their percent total of 2002 landings. An additional $200,000 was used by DMF to cover the costs of administering the program.

As part of the Federal shrimp economic assistance program of 2003, approximately $600,000 (13.3%) of the shrimp economic assistance Federal aid was given to the North Carolina Department of Agriculture (NCDA) to develop a three-year marketing program for marketing wild-caught North Carolina shrimp. The money was used to market North Carolina wild caught shrimp in trade and consumer publications, billboards, in-store consumer awareness, and recipe cards. Wild caught shrimp are also being marketed through the NCDA's "Freshness from North Carolina Waters" seafood promotion program.

7.1.1.7 Economic impact of commercial fishery

Table 7.7 shows the economic impact of commercial fishing for shrimp in North Carolina to the state's overall economy. These impacts were calculated using the number of persons harvesting shrimp and the value of those landings (IMPLAN, 2000). The numbers provided are to be considered an underestimate of the total impact because there are no North Carolina specific data available that accurately describe the business-to-business cash flow between commercial fishermen and those who provide services to them. However, the impacts do include the added value to the economy by commercial fishermen based on their spending just from the money they received for the annual catch of shrimp. The multiplier shown for each year is a mathematical representation of the additional value of the shrimp as it moves through North Carolina's economy. Once the shrimp leave North Carolina, it no longer has a direct impact on the economy of North Carolina, although it will have impact elsewhere. The annual impact of shrimp on the North Carolina economy is approximately $18.9 to $42.5 million in the years 2000 to 2003.

Table 7.7. Economic impact of the commercial shrimp fishery in North Carolina, 1999 – 2003 (IMPLAN, 2000).

Year	Ex-vessel Value	NC Economic Impact
1999	$22,095,815	$36,955,204
2000	$25,400,172	$42,481,502
2001	$11,906,335	$19,488,601
2002	$18,364,776	$30,059,482
2003	$10,945,676	$18,934,449

In 2003, shrimp landings accounted for about 15% of all the pounds and 20.5% of the total value of shellfish landed in North Carolina. When all finfish are added in, shrimp accounted for 4.4% of all the pounds and 12.6% of the total value of seafood landed in North Carolina.

7.1.2 Recreational fishery economics

There are two survey programs in North Carolina that collect data from recreational fishermen. The Marine Recreational Fisheries Statistics Survey (MRFSS) collects data from anglers and includes ocean landings 0 – 3 miles from the coast and inside waters from south of the Albemarle Sound to the South Carolina border. The DMF also collects data from recreational fishermen who are licensed to use limited amounts of commercial gear.

7.1.2.1 Marine Recreational Fisheries Statistics Survey (MRFSS)

MRFSS captures catch and angler participation data for finfish only. No data from any shellfish species are collected. However, some anglers may catch limited amounts of shrimp for bait using a cast net. There are no data on the economic value of this practice. The Saltwater Fishing License (SFL) legislation recently passed by the NC General Assembly will provide a sampling frame of these individuals for future research. Additionally, there are live shrimp bait dealers that operate in the fall as live shrimp have become a popular bait among spotted seatrout fishermen. This live bait market has grown considerably, as a result, over the past 10 years.

7.1.2.2 Recreational use of commercial gear (RCGL)

Along with the heavy participation of part time commercial fishermen in the shrimp industry, the recreational use of commercial gear has had a long and contentious history. Prior to the Fisheries Reform At of 1997, there was a growing number of participants in both user categories resulting in increased competition in the shrimp fishery. In 2002, the DMF began interviewing recreational fishermen who have purchased a license that allows them to use limited amounts of commercial gear. These fishermen are prohibited from selling their catch as it is intended solely for personal use. The RCGL holder surveys do not specifically determine the final disposition of the shrimp landed by these anglers. However, it is presumed they use the shrimp primarily for personal consumption.

Table 7.8 gives an indication of the direct economic impact of the recreational shrimp fishery by RCGL fishermen in 2003. The data are separated by those who made overnight trips as opposed to those who made day trips. In the case of the shrimp trawl fishery, the majority of fishing does occur at night. A day trip is one in which a person left their home specifically for one fishing trip and then returned to their regular residence once the fishing activity was completed. An overnight trip is defined as one in which the fishermen spent a longer period of time away from home.

Table 7.8. Economic impact of RCGL fishing trips for shrimp in 2003 (DMF RCGL Survey Program).

	Overnight Trips	Day Trips
Avg. # of nights	2.83	
Avg. # of miles traveled	132.75	58.78
Avg. # of people on the trip	3.87	2.98
% of people on trips who fished	88%	91%
Avg. cost of lodging/night	$18.00	
Avg. cost of food/trip	$53.30	$21.73
Avg. cost of ice/trip	$11.64	$6.07
Avg. cost of fuel & oil/trip	$65.42	$25.96

The economic figures are based on an expansion of the actual values reported by RCGL fishermen and are considered the best available estimates. The direct economic impacts described below are those that can be attributed only to shrimp landings by these fishermen. In some instances, the fishermen and the non-fishers who accompanied them, engaged in other, non-fishing activities. The total expenditures were adjusted based on the average proportion of people on the trip who actually engaged in fishing activity.

The expenditures shown in table 7.8 relate to the overall proportion of shrimp landed. Other species were typically caught and kept along with the shrimp. The economic impact was based on the percent of shrimp in the total pounds of all species kept by the fishermen on any given trip where shrimp were landed. The total pounds of shrimp landed were 50,961 pounds out of a total 60,752 pounds landed and kept. Shrimp accounted for 84% of the total catch on trips in which shrimp were landed.

Expenditures by those who made overnight trips tend to be greater when compared to day trips because of the increased costs of lodging and meals. An average overnight trip lasted approximately 3 days and resulted in total expenditures of $226.10 attributable to shrimp landings. The total direct economic impact of overnight RCGL trips for just shrimp in 2003 was $316,120. The average expenditures for day trip fishermen were approximately $73.17 attributable to shrimp landings. The total economic impact of shrimp caught on day trips for was $113,565. The total combined economic impact of all RCGL trips for shrimp in 2003 was approximately $429,685.

7.1.2.3 Other Recreational Fisheries

Some people use cast nets to catch shrimp for personal consumption in addition to those who use cast nets to land shrimp for bait. Again, currently there are no data on these landings or their economic impacts. Landings and economic data collection will be possible once the SFL is implemented.

8. SOCIOECONOMIC CHARACTERISTICS

8.1 Social Importance of the Fishery

8.1.1 Commercial fishermen

There are two primary sources of recent data or accounts available that help to explain the social importance of the commercial fishery. First is a book published on the shrimp industry in North Carolina, Hard Times and a Nickel a Bucket: Struggle and survival in North Carolina's shrimp industry (Maiolo 2004). Secondly, researchers at the DMF have been conducting in-depth socioeconomic interviews with commercial fishermen since 2001 (Cheuvront 2002; 2003). More than 900 fishermen have been interviewed to date. In these nearly identical surveys, 182 fishermen who identified themselves as shrimp fishermen were interviewed. However, at the time of this report, similar interviews had not yet been completed with shrimp fishermen north of Core Sound. Those data will be available for future analyses.

8.1.1.1 Historical importance

Elsewhere in this document is a history of the commercial shrimp fishery in North Carolina. The DMF surveys asked the fishermen for their opinion as to how historically important they think commercial fishing is to their community. On a scale of one to ten, with one being not at all important to ten being extremely important, the average rating across all 182 persons interviewed was 9.6, indicating almost universal agreement that fishing has been historically important to their community. However, when asked how much does their community support commercial fishing now (using the same 10-point scale), the rating was 8.1, indicating they largely feel supported.

8.1.1.2 Community reliance on the commercial fishery

North Carolina coastal communities rely significantly less on commercial fishing now than in the past (Maiolo 2004). This is the result of the development of the communities as multiple use zones, with retirement, light industry, recreation, and tourism becoming the dominant domains of the local economies. Fewer and fewer native born residents make a full time living as fishermen like those in previous generations. Cheuvront (2002; 2003) found the among Core Sound fishermen and south of that location, the average fisherman earned about 76% of his income from commercial fishing. More specifically Cheuvront found that just under half (48%) were totally reliant on fishing for their incomes. This compares with data gathered in the late 1980s where nearly all full time fishermen captains were committed to fishing for nearly all (95%) of their incomes (Maiolo 2004).

The 182 shrimp fishermen came from 38 separate communities in five southeastern North Carolina counties (Carteret, Onslow, Pender, New Hanover, and Brunswick). Table 8.1 shows the communities that had the greatest number of shrimp fishermen who participated in the survey. The largest number of fishermen in the surveys who fished for shrimp came from Sneads Ferry, followed by Harkers Island, Atlantic, Beaufort, and Cedar Island, all communities known to have sizable shrimp fleets.

Table 8.1. Most frequently cited communities where shrimp fishermen live (Cheuvront, 2002; 2003).

Community	Percent of Respondents
Sneads Ferry	12.6%
Harkers Island	9.9%
Atlantic	6.6%
Beaufort	4.9%
Cedar Island	4.9%
Davis	4.4%
Morehead City	4.4%
Hampstead	3.8%
Otway	3.8%
Sea Level	3.8%
Wilmington	3.8%

Studies in the 1970s and eighties revealed that shrimp fishermen engage in a variety of both land and water based activities. Fishing activities required moving from one target species to another as opportunities prevailed, even though shrimping involved most of the effort throughout the year (Maiolo 2004). Cheuvront (2002; 2003) found that shrimp fishermen continue to engage in a variety of capture activities throughout the year. Like most of North Carolina's commercial fishermen, these fishermen tend to diversify the species they target, gears they use, and water bodies they fish. Shrimp constituted an average of 59% of the fishing income earned by these fishermen. Table 8.2 shows the preference for other species targeted and the average percent of fishing income earned by those who the 182 shrimp fishermen who participated in the surveys. Clams (*Mercenaria mercenaria*) were cited by 45% of the fishermen as another species they target. Of those who also land clams, they earn an average of 33% of their income from clams. Other species frequently targets by these fishermen included oysters (*Crassostrea virginica*), striped mullet (*Mugil cephalus*), spot (*Leiostomus xanthurus*), blue crabs (*Callinectes sapidus*), and flounder (*Paralichthys spp.*). Shrimp fishermen targeted scallops (*Argopecten irradians*), Atlantic croaker (*Micropogonias undulatus*), and weakfish (*Cynoscion regalis*) less often.

Table 8.2. Prevalent species targeted by shrimp fishermen (Cheuvront, 2002;2003)

Species	Percent who land	Percent income
Shrimp	100%	59%
Clams	45%	33%
Oysters	32%	19%
Striped mullet	21%	31%
Spot	19%	25%
Blue crabs	14%	44%
Flounder	14%	28%
Scallops	6%	10%
Atlantic croaker	3%	7%
Weakfish	2%	18%

8.1.1.3 Perceived conflicts

There are largely two kinds of conflicts that have been measured, those between commercial fishermen and those between commercial fishermen and others who use the water. Conflicts between the users of the public resource are not uncommon, as no one individual actually owns any part of the water, yet all citizens own the water and its resources. Conflicts tend to be reported more frequently as the demand for use of the resource increases.

Extensive competition, and often ill will between the full timers, part timers, and recreational fishermen, characterized the shrimp fishery according to research conducted in the seventies and eighties. At that time the competition was most intense in the estuaries in July, when shrimping was at its peak. The part timers and recreational users viewed ownership of the resource as much theirs as that of the full timers (Maiolo 2004).

One of the purposes of the Fishery Reform Act was to address the intense and often uncontrolled competition and conflict between and among the user groups, and recent data indicate there has been some success in this area. The majority of the shrimp fishermen interviewed by Cheuvront (2002; 2003) reported not having any conflicts with other commercial fishermen in the past year (70%). Six percent of the fishermen reported having daily or more than 20 conflicts with other commercial fishermen in the past year (see Figure 8.1).

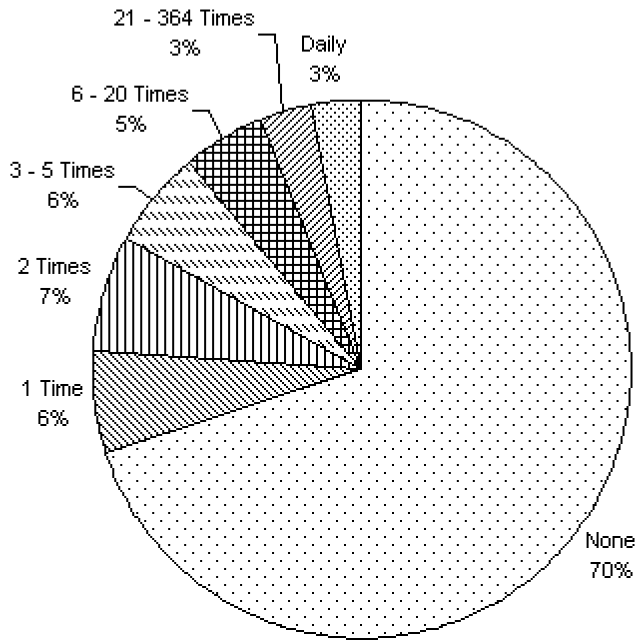

Figure 8.1. Frequency of conflict experiences with other commercial fishermen in the past year (Cheuvront 2002; 2003)

Slightly fewer (66%) of the fishermen interviewed by Cheuvront (2002; 2003) reported not having any negative experiences with recreational fishermen. The number who had frequent conflicts with recreational fishermen was the same as the number who had conflicts with commercial fishermen (Figure 8.2).

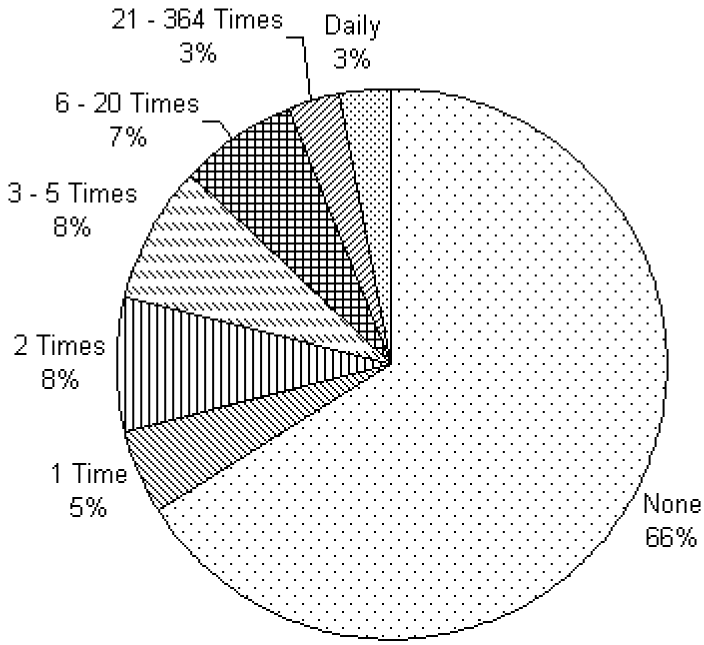

Figure 8.2. Frequency of conflict experiences with recreational fishermen in the past year (Cheuvront 2002; 2003)

Over a third of the fishermen interviewed (35%) reported having negative experiences with state regulations (Figure 8.3). The DMF Marine Patrol is responsible for enforcing the rules and proclamations governing marine resources. The DMF also has the authority to open and close shrimp seasons in areas where fishermen may catch shrimp. Twenty two percent of the fishermen interviewed say they have daily negative experiences with state regulations.

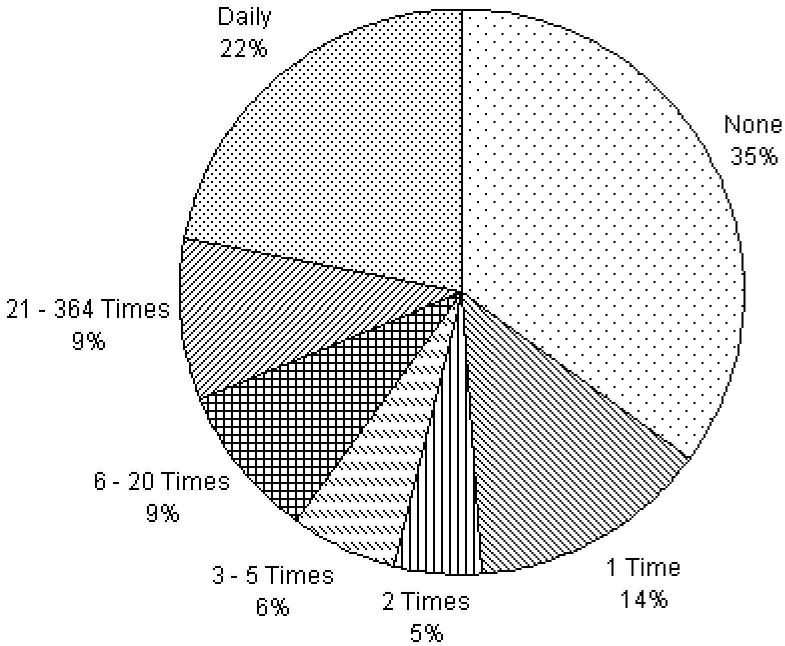

Figure 8.3. Frequency of negative experiences with state regulations in the past year (Cheuvront 2002; 2003).

Shrimping that occurs off the coast in the Exclusive Economic Zone (from 3 to 200 miles) is governed by Federal regulations. The South Atlantic Fishery Management Council is currently developing Amendment 6 of its management plan for shrimp in the ocean. A significant amount of shrimp landed in North Carolina is from trawlers that work these waters. Many fishermen who land shrimp never work these waters. Consequently, when asked about negative experiences with federal regulations, 58% say they have not had any negative interactions with federal regulations in the past year. Nonetheless, 26% indicated fairly frequent or daily negative interactions (Figure 8.4).

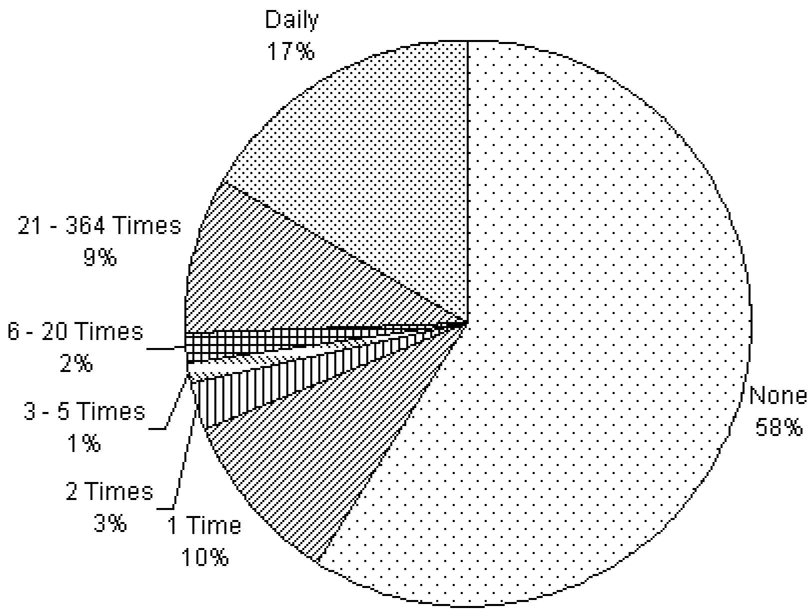

Figure 8.4. Frequency of negative experiences with federal regulations in the past year (Cheuvront, 2002; 2003)

Maiolo (2004) reported that because many commercial fishermen feel it is their inherent right to sell what they can catch, they frequently are in favor of regulatory actions that limit the activities of fishermen other than themselves. However, not all conflicts are resolved by relying on governmental regulatory agencies. In some areas of the state there is potential for conflicts between shrimp channel net fishermen and shrimp trawl fishermen. It is worth noting that off of Harkers Island in Carteret County, the channel net and trawl fishermen have a solution that works for all concerned. Channel netters stay far enough away from each other so that each is still able to land a reasonable catch. Channel netters carry lights that allow them to signal trawlers as to where they are working. Also the channel netters pull up their net anchors after each fishing trip. Although not mandated by outside regulatory authorities, actions such as these allow the channel netters and trawl fishermen to work in the same area and minimize conflicts (Maiolo 2004).

8.1.1.4 Perception of important issues

The fishermen interviewed by Cheuvront (2002; 2003) were asked to state the business issues they found to be the most important they were currently facing. The most important issue to these fishermen was the need to keep up with rules and proclamations. Not surprising, these fishermen stated that low prices for seafood was a very important issue, followed closely by a feeling that there are too many imports. Table 8.3 lists the eight most commonly cited issues facing these fishermen.

Table 8.3. Fishing related issues considered most important to shrimp fishermen (Cheuvront, 2002; 2003)

Ranking	Issue
1	Keeping up with rules and proclamations
2	Low prices for seafood
3	Imported seafood
4	Overfishing
5	Business costs
6	Too many areas are off limits to fishing
7	Too many regulations overall
8	Outside competition

8.2 Recreational fishery

All data regarding the social importance of the fishery come from the first annual survey of RCGL fishermen conducted in 2001. In-depth socioeconomic data will be collected from this user group every three to five years.

8.2.1 Historical importance

North Carolina has a long history of fishermen using commercial gear for recreational purposes. The RCGL license was put into effect in 1999 as a result of the Fisheries Reform Act of 1997. Prior to that, recreational fishermen who wished to use commercial gear purchased a commercial vessel license, but did not sell their catch. The RCGL fishermen who reported landing shrimp stated that they had been fishing commercial gear on average for 20 years. It is likely that using shrimp trawls for personal harvest has been occurring ever since commercial fisherman have been harvesting shrimp using trawls.

8.2.2 Community reliance on the recreational fishery

There are no data available to indicate the level of community reliance on the recreational shrimp fishery.

8.2.3 Perceived conflicts

Thirty-five percent of the RCGL fishermen felt that there was too much fishing gear in the water where they fish. An additional 17% weren't sure if there was too much gear in the areas where they fish. The remaining 48% felt that there wasn't too much gear in the water.

Over 73% of all RCGL fishermen who land shrimp say they do not have any conflicts with commercial fishermen. Nearly 90% of them stated they do not have conflicts with recreational anglers.

8.2.4 Perception of important issues

RCGL fishermen were asked for their opinions about two issues they find to be important. Of those who land shrimp, 73% agreed with the statement that they ought to be allowed to use more commercial gear. An additional 13% disagreed indicating they felt they were allowed to use plenty of gear, while 14% indicated they were not sure whether they should be allowed to use more gear.

8.3 Demographic Characteristics

8.3.1 Commercial fishermen

Table 8.4 shows a summary of the demographic characteristics of the 182 shrimp fishermen interviewed by Cheuvront (2002; 2003). Nearly all of the shrimp fishermen were white males. They averaged 45 years old and had over 25 years fishing experience. The average shrimp fisherman was currently married and had a high school diploma or less education. Approximately 37% of the fishermen had incomes of $15,000 to $30,000. Another 29.7% had total household incomes of $30,001 to $50,000.

Approximately 64% of the fishermen interviewed said they fished all year long. Of those who didn't fish all year, fishing activity was lowest from January through March. The peak fishing participation months for these fishermen were May through November. Seventy-seven percent of the fishermen indicated that fishing was their sole source of income. Of those who had other sources of income, the most frequently cited sources of additional income included carpentry, machinery mechanic, government, and retirement pensions.

Nearly 96% of the fishermen owned their fishing operation as a sole proprietorship. The average boat was 28.47 ft. long, was 10 years old and had a current market value of just under $26,000. The average shrimp fisherman (including full and part time) earned just under $11,720 profit from all of their fishing activities. They averaged $96.85 for routine fishing trip costs (fuel, ice, groceries, etc.). They averaged nearly $13,250 in annual fixed business costs (new equipment, repairs, business loan payments, etc.).

Table 8.4. Demographic characteristics of shrimp fishermen (Cheuvront, 2002; 2003).

Variable n = 182	Category Values	Average or percent
Years Fishing		25.4
Age		45.2
Gender		
	Male	98.4%
	Female	1.6%
Race		
	White	98.9%
	Hispanic	0.6%
	Black	0.6%
Education Level		
	Less than HS	36.8%
	HS Grad	46.2%
	Some College	11.0%
	College Graduate	6.0%
Marital Status		
	Married	78.0%
	Divorced	10.4%
	Widowed	1.1%
	Never Married	0.5%
	Separated	9.9%
Total Household Income		
	Less than $15,000	12.1%
	$15,001 - $30,000	37.4%
	$30,001 - $50,000	29.7%
	$50,001 - $75,000	12.1%
	More than $75,000	13.2%
	Refused to answer	7.6%

8.3.2 Recreational fishermen

The average RCGL holder who targeted shrimp was 51.4 years old and 76% were born in North Carolina (Table 8.5). The vast majority were males. Most of these fishermen had at least some college education and had total household incomes of greater than $30,000 per year. On average they had been using commercial gear for nearly 20 years.

Table 8.5. Sociodemographic data of RCGL holders who targeted shrimp in 2001. (DMF RCGL Survey Program).

Variable	Category Values	Sample Size	Average/ Percent
Years Experience Fishing Commercial Gear		324	19.8
Born in NC		323	76%
Age		320	
	<16 years	1	0%
	17 to 25	5	2%
	26 to 40	63	20%
	41 to 60	164	51%
	>60 years	87	27%
Marital Status		318	
	Married	281	88%
	Divorced	17	5%
	Widowed	3	1%
	Separated	3	1%
	Never Married	14	4%
Ethnic Group		319	
	Hispanic/Latino	1	0%
	Caucasian/White	299	94%
	African-American/Black	2	1%
	Native American	17	5%
Gender		318	
	Male	307	97%
	Female	11	3%
Education		316	
	< High School	38	12%
	High School Diploma	76	24%
	Some College	131	41%
	College Diploma	7	2%
Total Household Income		299	
	< $5,000	2	1%
	$5,000 tp $15,000	9	3%
	$15,001 to $30,000	48	16%
	$30,001 to $50,000	80	27%
	$50,001 to $75,000	85	28%
	$75,001 to $100,000	37	12%
	> $100,000	38	13%

8.4 Research Recommendations

Once the Saltwater Fishing License (SFL) is established, research ought to be undertaken to determine the extent of non-RCGL recreational harvest that is occurring. This group primarily is those who use cast nets to take shrimp either for bait or personal consumption.

8.5 Definitions and Acronyms

Commercial Fishing – Fishing in which fish harvested, either in whole or in part, are intended to enter commerce or enter commerce through sale, barter or trade. Since 1999, a commercial fisherman in North Carolina is required to have a license issued by the North Carolina Division of Marine Fisheries (DMF) and is allowed only to sell to a licensed dealer.

CPI (Consumer Price Index) – The CPI measures the price paid by consumers for a fixed group of goods and services. Changes in the CPI over time constitute a common measure of inflation.

Deflated (Inflation-adjusted) price and value – Inflation is a general upward price movement of goods and services in an economy, usually as measured by the Consumer Price Index (CPI). Ex-vessel prices and values can be adjusted (deflated) according to the CPI to remove the effects of inflation so that the value of a dollar remains the same across years. Inflation adjusted values allow for easier understanding and analysis of changes in values. Some products allow for a Producer Price Index (PPI). The PPI measures inflation in wholesale goods. It is considered a more reliable indicator than CPI because it is related to a specific product or group of products. The PPI is related to the CPI in that PPI is considered a precursor to CPI because fluctuations in production costs are usually associated with general measures of inflation.

Fishing Trip – A period of time over which fishing occurs. The time spent fishing includes configuring, deploying, and retrieving gear, clearing animals from the gear, and storing, releasing or discarding catch. When watercraft are used, a fishing trip also includes the time spent traveling to and from fishing areas or locales and ends when the vessel offloads product at sea or returns to the shore. When fishing from shore or man-made structures, a fishing trip may include travel between different fishing sites within a 24-hour period.

Inflated (Ex-vessel) price and value - The total landed dollar amount of a given species (or species landing condition and market category). Example: 100 lbs. of shrimp at a PRICE of $1.50 per pound will have a VALUE of $150. These values represent the amounts paid to a fisherman by a seafood dealer.

MRFSS – Marine Recreational Fisheries Statistical Survey

DMF – North Carolina Division of Marine Fisheries

PPI (Producer Price Index) – The PPI is a price index that measures the average level of producers' prices for a given product or group of products. Because it reflects the costs of getting specific products to the market, and price to consumers is based in part on producer costs, it is considered a good economic indicator of the rate of inflation for the specified products.

RCGL – Recreational Commercial Gear License

Recreational Fishing – A recreational fishing trip is any trip for the purpose of recreation from which none of the catch is sold or bartered. This includes trips with effort but no catch. Fishermen who wish to use limited amounts of commercial fishing gear in joint and coastal waters under DMF jurisdiction are required to have a Recreational Commercial Gear License (RCGL).
SFL – Saltwater Fishing License
SSA – Southern Shrimp Alliance

9. ENVIRONMENTAL FACTORS

9.1 Habitat

Penaeid shrimp utilize a system of interdependent habitats throughout their life cycle. Brown, white, and pink shrimp utilize similar habitats with minor differences in substrate and salinity preferences. Environmental preferences (salinity, temperature, oxygen, substrate) were described in the Life History section. The slightly different preferences in bottom substrate and salinity affect their general position in the estuary and ocean. Each habitat provides ecological services that aid in maintaining and enhancing shrimp stock sustainability, and also influences the functioning of the ecosystem overall. Protecting the integrity of the entire system is therefore necessary to manage this species. Although ecosystem protection is of vital importance to penaeid shrimp, it may be difficult to detect a cause and effect relationship between habitat protection/enhancement and shrimp stock condition due to the large natural variation in environmental conditions in North Carolina, and the relatively short life cycle of penaeid shrimp.

The South Atlantic Fisheries Management Council (SAFMC) designated inshore estuarine nursery areas, offshore marine habitats used for spawning and growth to maturity, and all connecting waterbodies as Essential Fish Habitat for penaeid shrimp (SAFMC 1998). Inshore nursery areas listed by SAFMC included wetlands, submerged aquatic vegetation (SAV), and subtidal and intertidal non-vegetated bottom (soft bottom). Designated Habitat Areas of Particular Concern (HAPC) for penaeid shrimp include all coastal inlets, all state designated nursery habitats used by shrimp, and state-identified overwintering areas. In North Carolina, specific HAPC includes SAV and estuarine shorelines. In areas lacking SAV, marsh with shell hash and mud bottoms, and adjoining bottoms are of particular concern (SAFMC 1998).

Water column

Adult shrimp spawn offshore in ocean waters. Brown and pink shrimp spawn in deep water over the continental shelf, while white shrimp remain nearshore in relatively shallow water (SAFMC 1993). Adult shrimp are demersal oriented in all life stages, except as larvae and post-larvae. Larvae and post-larvae depend on ocean currents to be transported through inlets into estuarine nursery grounds. Inlets are critical bottlenecks through which shrimp and many other ocean-spawned larvae must pass to complete their life cycle (Hettler and Barker 1993). Inlets accessing Pamlico Sound are limited in number and therefore are particularly important to recruitment into Pamlico Sound and its tributaries. The time of spawning varies with species, with brown shrimp spawning earliest in winter and early spring, and white and pink shrimp spawning in late spring and early summer (Table 9.1). Shrimp are transported by water circulation throughout the estuary and back into the ocean. Water quality in estuarine waters affects viability of shrimp populations.

Table 9.1. Spawning seasons for Penaeid shrimp species in North Carolina (Pattilo et al. 1997).

Species	Spawning season
Brown shrimp	Feb-Apr
Pink shrimp	Apr-Jul
White shrimp	May-Jul

Wetlands

Wetlands are defined by federal regulations [40 CFR 230.3(t)] and EMC rules [15A NCAC 2B .0202(71)] as areas that are inundated or saturated by an accumulation of surface or groundwater at a frequency and duration sufficient to support, under normal conditions, a prevalence of vegetation typically adapted for life in saturated soil conditions. Estuarine wetlands, which include salt and brackish marsh and estuarine shrub/scrub, generally occurs along the edge of estuaries and sounds. Riverine wetlands, which includes freshwater marshes, bottomlands hardwood forest and swamp forest, generally occurs in low-salinity to fresh water along streams, creeks, and rivers. It is estimated that over 95% of commercially harvested finfish and invertebrates in the United States are wetland dependent, a strong indication of their high habitat value (Feierabend and Zelanzy 1987).

The combination of shallow water and thick vegetation provides excellent nursery and foraging habitat for juvenile shrimp and many other fish species (Graff and Middleton 2003). Shallow wetlands also provide refuge from large fish predators and a safe corridor for migration to other habitats within the system (Rozas and Odum 1987; Mitsch and Gosselink 1993). Riparian wetlands are also highly effective and well recognized for their ability to trap and filter pollutants from upland runoff, and store, spread, and slow stormwater runoff prior to entering surface waters (Mitsch and Gosselink 1993).

Primary production in salt/brackish marshes is converted into shrimp production in two ways. Wetland plants decay into detritus, which accumulates in the wetlands and adjacent soft bottom areas and is a food source for shrimp and other small organisms. Also, nutrients from the broken down organic matter support growth of benthic microalgae on, between, and near wetland vegetation (Peterson and Howarth 1987). Productivity in riverine forested wetlands in North Carolina is reported to be lower than in estuarine marsh (Brinson 1977). It is estimated that 45% of salt marsh production is exported to the estuarine system in the form of detritus, dissolved organic matter, and transient fish, including shrimp (Teal 1962).

Shrimp are considered critically linked to marsh edge habitat (SAFMC 1998; Clark et al. 2004). Studies in Texas estuaries have documented that juvenile brown shrimp and white shrimp were more abundant along the salt/brackish marsh edge than in shell bottom, SAV, soft bottom, or inner marsh (Minello 1999; Rozas and Zimmerman 2000). Turner (1977) found a positive relationship between commercial yields of penaeid shrimp and the area of intertidal vegetation present at multiple estuarine locations. This suggests that preserving existing coastal wetlands and restoring former wetlands, where possible, would be directly beneficial to shrimp populations and harvest.

Coastal wetlands were mapped by DCM in 1994 and are shown in Figures 9.1 a-c, along with distribution of juvenile shrimp. Riparian wetlands covered 7% of the land in coastal river basins, and riverine forested wetlands were the most abundant type. The Cape Fear, Neuse, and Albemarle river basins have the largest acreage of riparian wetlands, primarily riverine wetlands. Pamlico, Core, and Bogue sounds, and estuaries south of Bogue Sound, have the highest percentages of estuarine wetlands. The largest acreage of salt/brackish marsh is in the Pamlico Sound region.

Distribution, size, and abundance of shrimp are monitored in the juvenile fish sampling program (Program 120) and the shrimp sampling program (Program 510). The distribution and abundance of juvenile brown, white, and pink shrimp in estuarine waters can be seen in Figures 9.1 a-c. The sampling gear of the two programs differs slightly, but results are shown together to spatially depict general distribution patterns. The majority of shrimp are collected in close proximity to shallow wetland systems. Brown shrimp are widely distributed throughout North Carolina's estuaries in both low and high salinity areas, and support relatively higher concentrations in the Neuse tributaries, Core Sound, Stump Sound, and Intracoastal Waterway in Brunswick County. White shrimp abundance is most concentrated in the Cape Fear River estuary, Brunswick County estuaries, New River, and tributaries along the western shoreline of Pamlico Sound, north of the Tar-Pamlico River. Pink shrimp occur in relatively lower concentrations along the western shoreline of Pamlico Sound, Bogue Sound, New River, lower Cape Fear River, and Intracoastal Waterway in Brunswick County. However, current DMF sampling locations do not target the primary nursery grounds of pink shrimp, and therefore, may not accurately represent juvenile pink shrimp distribution and abundance.

It is estimated that as much as 34-50% of North Carolina's original wetland coverage has been lost, primarily due to ditching, channelization, and filling for agriculture and development (Dahl 1990; DWQ 2000). According to the North Carolina Division of Water Quality (DWQ 2000), approximately 88% of salt/brackish marsh, 81-88% of riverine forested wetlands, and 48% of pocosins remain. From the early 1800s to the early 1900s, ditching and draining for agriculture accounted for the majority of wetland losses (Heath 1975). From 1950 to the 1990s, conversion of wetlands to managed forest and agriculture accounted for 53% and 42%, respectively, with commercial and residential development activities responsible for the remaining 5% (Bales and Newcomb 1996). Since 1990, losses from agriculture and forestry decreased, but losses from development increased. The primary threats to wetland habitat today are dredging, filling, and hydrological alterations associated with development. Although the rate of wetland loss has slowed, losses continue to occur. Mitigation for permitted losses and voluntary restoration efforts in some areas have partially offset some recent losses.

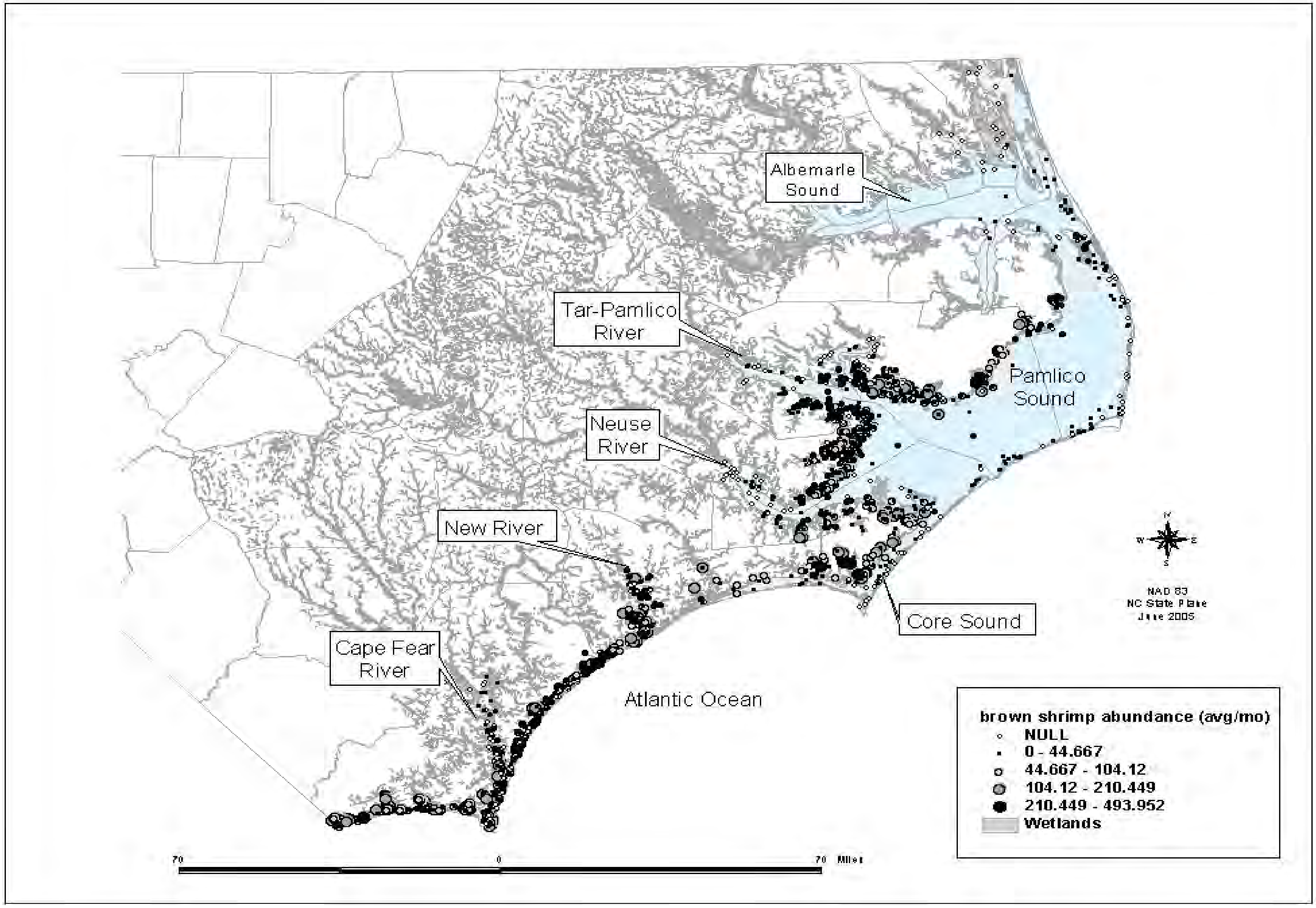

Figure 9.1a. Distribution of riparian wetlands and juvenile brown shrimp abundance from DMF juvenile fish and shrimp sampling programs, 1978-2003.

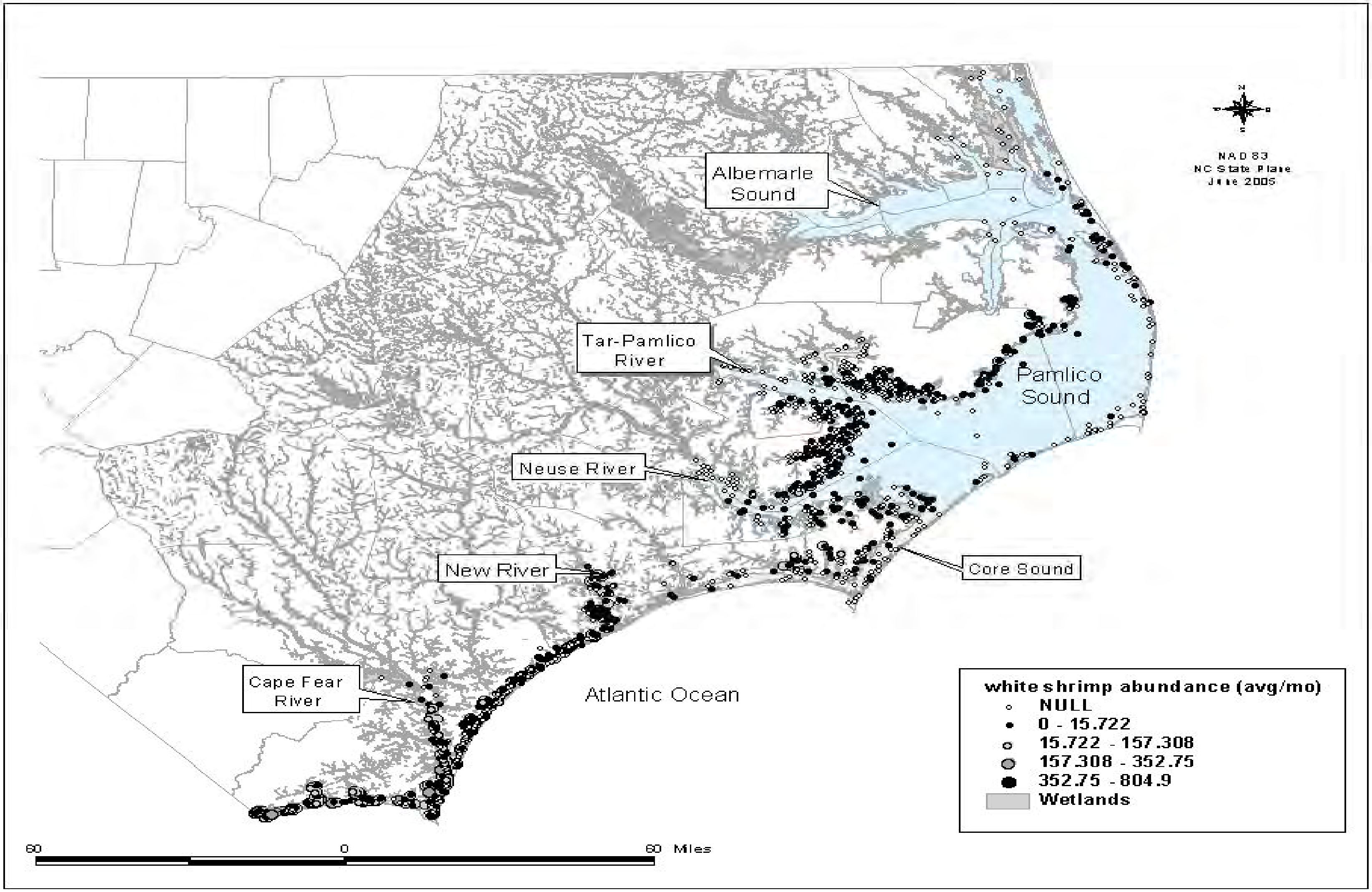

Figure 9.1b. Distribution of riparian wetlands and juvenile white shrimp abundance from DMF juvenile fish and shrimp sampling programs, 1978-2003.

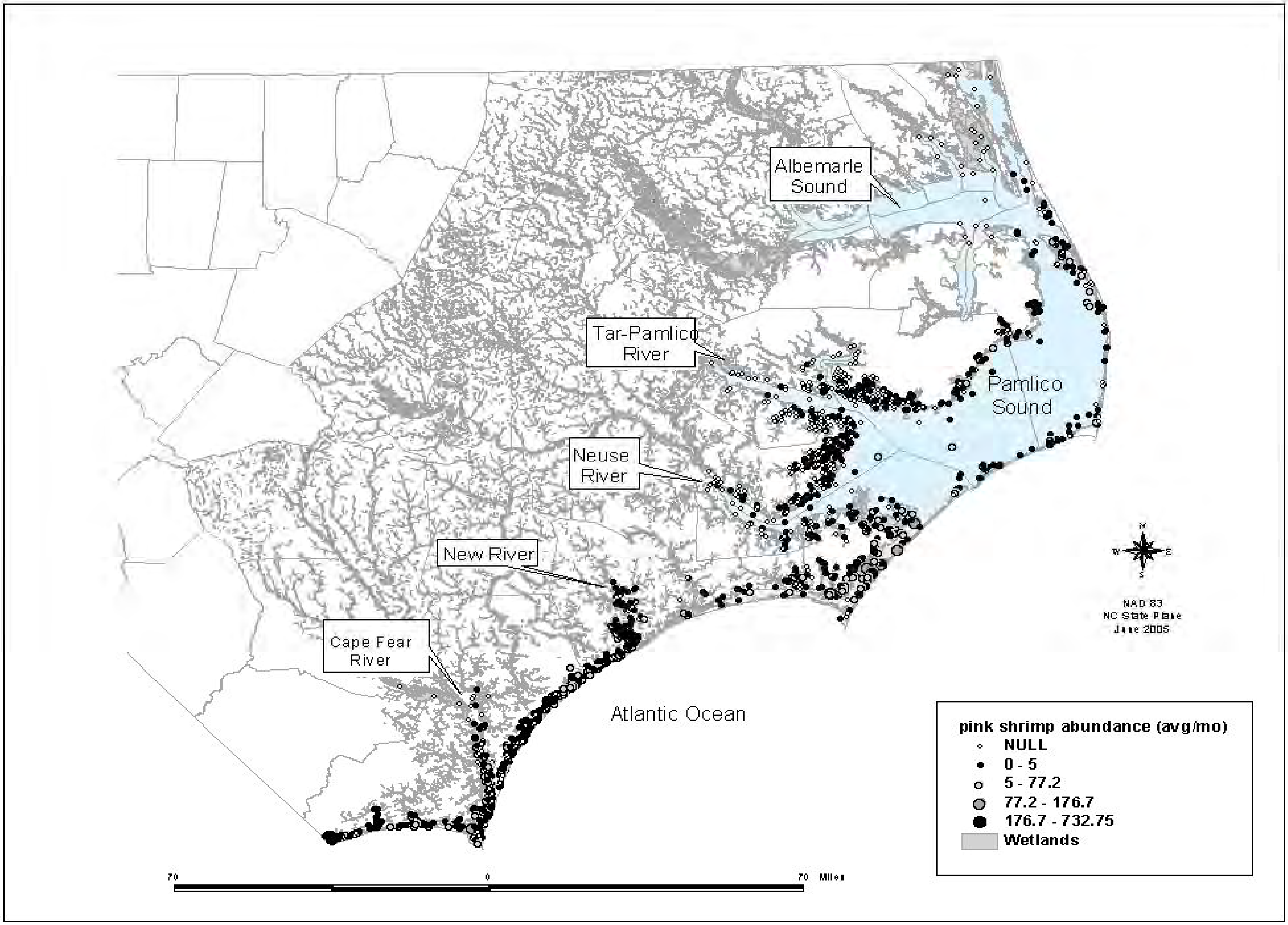

Figure 9.1c. Distribution of riparian wetlands and juvenile pink shrimp abundance from DMF juvenile fish and shrimp sampling programs, 1978-2003.

One activity that has a cumulative impact on wetlands is estuarine shoreline stabilization. Hardened estuarine shorelines cause gradual, long-term wetland loss by limiting sediment inputs needed for maintenance and expansion of wetlands, and by blocking landward migration as sea level rises. Garbisch et al. (1973) showed that marsh vegetation waterward of bulkheads experienced a 63% post-construction mortality due to stress from increased turbulence and scour resulting from vertical hardened structures. Scouring action at the toe of bulkheads also deepened the adjacent water, thus reducing or eliminating intertidal habitat. The added turbulence at the base of bulkheads and deepened water depth prevents vegetation from reestablishing after construction (Knutson 1977). Several studies have found that abundance of shrimp and other organisms adjacent to bulkheaded shorelines was much less than what occurred adjacent to unaltered naturally vegetated shorelines (80-300% less) (Mock 1966; Gilmore and Trent 1974; Peterson et al. 2000). The difference was attributed to lower abundance of organic detritus and small benthic invertebrates, deeper water, and less intertidal vegetation.

Ongoing initiatives such as wetland restoration, land acquisition and preservation, and agricultural cost-share BMPs (Best Management Practices) need to be enhanced. There should also be additional initiatives implemented to protect and enhance wetland habitat. The many fishery and water quality functions provided by wetlands make their preservation and restoration along North Carolina’s coast a high priority for protection of all coastal fish habitats.

Soft bottom

Soft bottom habitat is unconsolidated, unvegetated sediment that occurs in freshwater, estuarine, and marine systems. Sediment composition varies with geomorphology and location within the system and may be a factor in juvenile shrimp distribution. Juvenile white shrimp prefer shallow muddy substrate. In contrast, juvenile brown shrimp prefer peat and muddy bottoms but also occur where the bottom is composed of sand, silt, clay, or shell fragments (SAFMC 1993). Although soft bottom habitat is defined as “unvegetated” and lacks visible structural habitat, the surface sediments support an abundance of microscopic plants (benthic microalgae) and numerous burrowing animals hidden below the surface.

Soft bottom plays a very important role in the ecology of estuarine ecosystems as a storage reservoir of nutrients, chemicals and microbes. Biogeochemical processing and recycling establishes a filter to trap and reprocess natural and human-induced nutrients and toxic substances or release them into the water column (Matoura and Woodward 1983), allowing chemicals to pass quickly or over several seasonal cycles through the estuary (Uncles et al. 1988). Soft bottom also provides a rich food base for juvenile and adult shrimp due to the numerous plants and animals living on and in the sediment (Peterson and Peterson 1979; Currin et al. 1995). At different life stages, shrimp feed on various organisms in bottom sediments, including microfauna such as protozoans, meiofauna, such as nematodes and copepods, and macrofauna such as amphipods, polychaetes, and other crustaceans (Peterson and Peterson 1979). Once shrimp enter ocean waters, they continue foraging on subtidal bottom, particularly on muddier bottom. Although there is little structure to hide behind, shrimp can find refuge from predators by remaining on very shallow flats that predators cannot access or by burrowing beneath soft bottom during the day, and actively foraging and moving at night (Peterson and Peterson 1979; Ross and Epperly 1985).

Soft bottom also plays a key role as a nursery area for shrimp. Primary nursery areas for juvenile brown, white, and to a lesser extent pink shrimp, include shallow soft bottom habitat, usually adjacent to wetlands (Noble and Monroe 1991). Most larval settlement occurs in the uppermost portion of shallow creek systems. Areas that have been documented to consistently support large numbers of juvenile shrimp and other species have been designated by the MFC as Primary Nursery Areas (Figure 9.2a-b). For 1990-2003, data from DMF's ongoing juvenile fish monitoring program indicate that brown shrimp is one of the most abundant species found along the entire coast, along with spot, Atlantic croaker, pinfish, bay anchovy, blue crab, silver perch, and Atlantic menhaden. In the southern portion of the coast, white shrimp were also among the most abundant species (DMF, unpub. data). During 1990-2003, a total of 178 species was collected from juvenile sampling stations (DMF, unpub. data). Consequently, protection of these areas is a high priority for shrimp management, as well as other species.

The loss of structured habitats, such as SAV and shell bottom, over time, has most likely led to gains in the amount of soft bottom habitat, but it may be of lower quality in some areas if toxins have accumulated in the sediment. Activities that lead to the deepening, loss, or chemical contamination of shallow and intertidal habitat are the greatest threat to this habitat. Refer to the water quality section for more information on chemical contamination of bottom sediments.

Soft bottom habitat may be affected by marina and dock facilities through alteration of the shoreline configuration, circulation patterns, and subsequently, changes in bottom sediment characteristics (Wendt et al. 1990). Because benthic microalgae, an important component of primary production in soft bottom habitat, are light-dependent, bottom sediments in dredged marinas will have reduced light availability due to the deeper water depth and shading from docking structures. A study estimating macroalgae and microalgae productivity before and after construction of a marina in Long Island Sound found that microalgae production on soft bottom would decline by 48% post-construction and macroalgae production would decline by 17% (Ianuzzi et al. 1996). However, the authors concluded that some of this loss would be offset by additional microalgal production on hard structures in the marina. Operation of a marina can also affect productivity of the soft bottom community due to introduction of heavy metals, hydrocarbons, and bacteria (Chmura and Ross 1978; Marcus and Stokes 1985; Voudrias and Smith 1986). Heavy metals and hydrocarbons are toxic to many soft bottom dwelling invertebrates and benthic feeding fish (Weis and Weis 1989). Dissolved oxygen (DO) may become depleted or below optimum thresholds in dredged marina basins and channels. A North Carolina marina study found significantly lower DO concentrations (less than 5.0 mg/l) inside some marinas compared to samples from outside marinas (DEHNR 1990). Cumulatively, docks may also negatively impact shrimp populations (Sanger and Holland 2002). Research is needed to better assess the impacts of multiple docks on shrimp and other species.

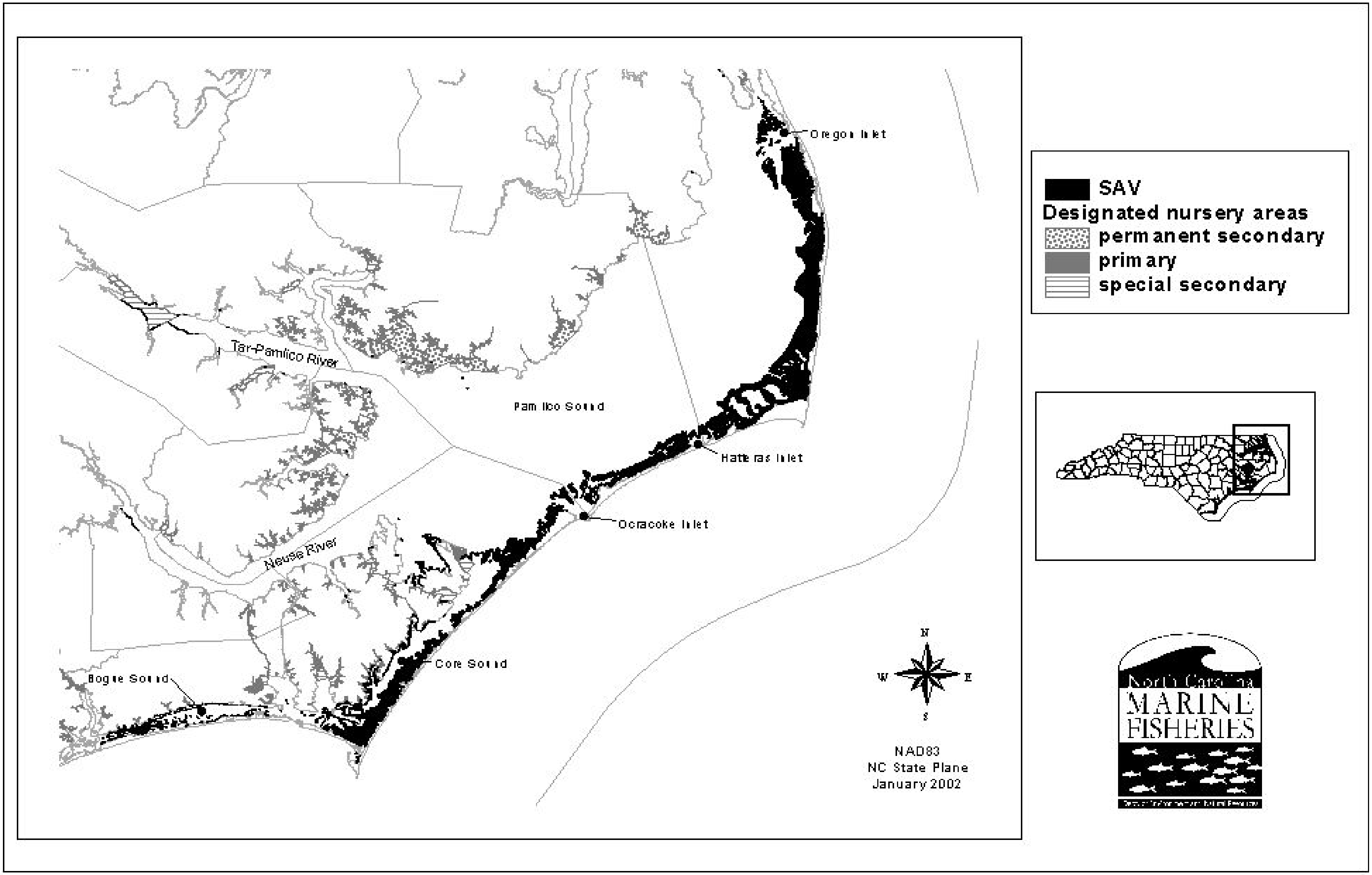

Figure 9.2a. Shrimp nursery areas, including MFC designated nursery areas and SAV beds, northern coast of NC.

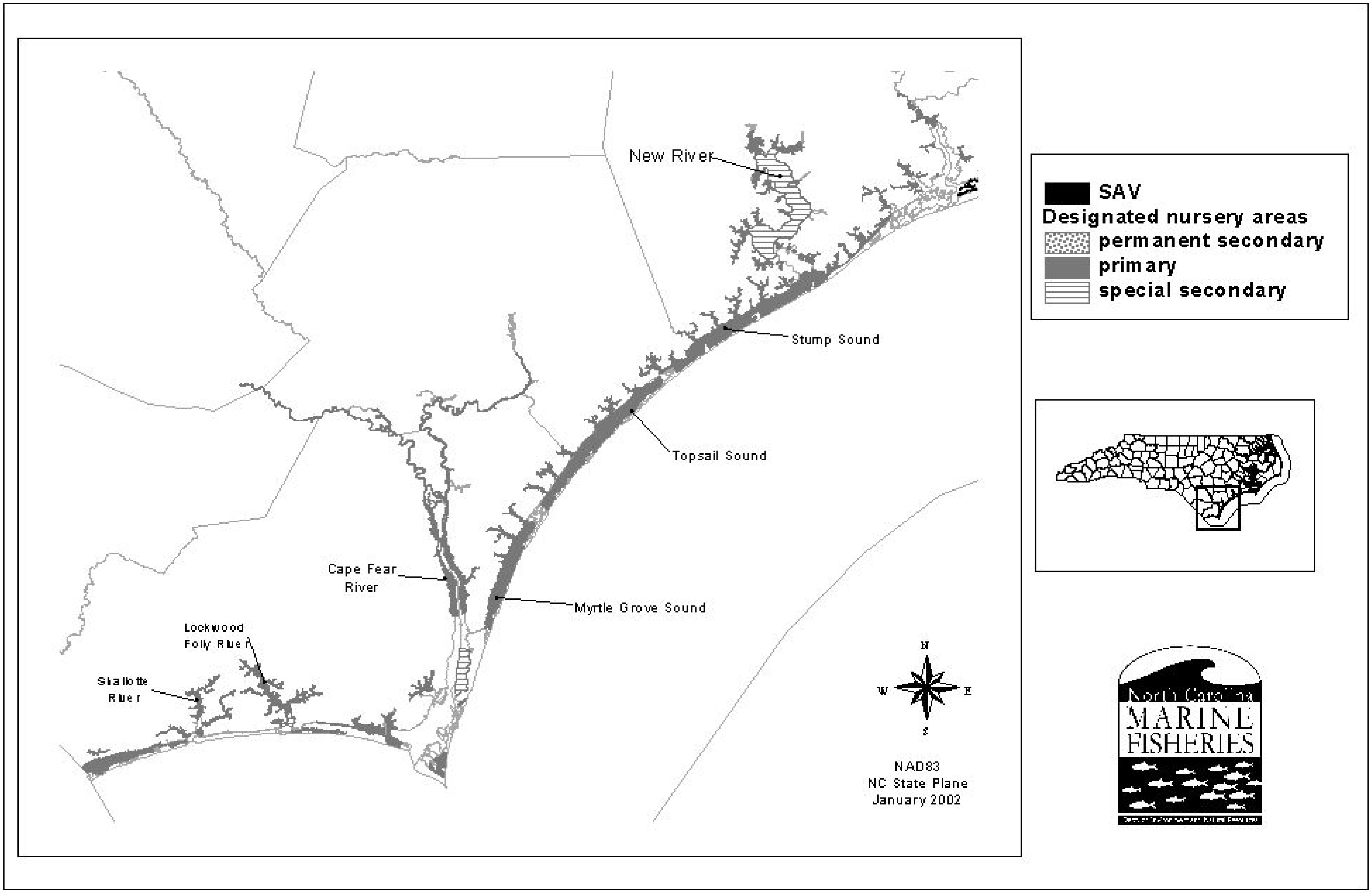

Figure 9.2b. Shrimp nursery areas, including MFC designated nursery areas and SAV beds, southern coast of NC.

In addition to impacting wetlands, estuarine shoreline stabilization can degrade soft bottom habitat by reducing or eliminating the intertidal zone, deepening shallow soft bottom habitat, or contaminating sediment from leaching of toxic preservatives from wood structures (Weis et al. 1998). Multiple studies have shown that the diversity and abundance of invertebrates and juvenile fish over soft bottom are reduced adjacent to bulkheaded areas (Mock 1966; Ellifrit et al. 1972; Gilmore and Trent 1974; O'Rear 1983; Byrne 1995; Peterson et al. 2000; Waters and Thomas 2001). Beach nourishment along ocean shorelines can alter the sediment composition of nearshore soft bottom to a condition less favorable for shrimp or result in a temporary reduction in food availability (Hackney et al. 1996). Local fishermen have noted a shift in shrimp distribution to waters further offshore at Carolina Beach and Wrightsville Beach, where storm damage reduction projects have been ongoing for many years. This change may be associated with a shift in sediment composition from muddy to sandy substrate.

While MFC rules are designed to minimize commercial fishing gear impacts to fisheries habitat, these restrictions primarily focus on restricting the use of highly destructive bottom disturbing gear from most structural habitats such as oyster or SAV beds. Soft bottom habitat, because of its low structure and dynamic nature, has historically been considered the most appropriate location to use bottom disturbing gear. Existing fishery rules that restrict bottom disturbing gears in soft bottom habitat include prohibition of trawls, dredges, and long haul seines in PNAs, [15A NCAC 3N .0104] and prohibition of trawls, or mechanical shellfish gear in crab spawning sanctuaries [15A NCAC 3L .0205] in the five northern-most inlets of North Carolina during the blue crab spawning season (March-August).

Fishing gears documented to have the greatest potential to damage or degrade soft bottom or other habitats are dredges, followed by trawls (DeAlteris et al. 1999; Collie et al. 2000). Bottom trawling is used more extensively than dredging on soft bottom habitat in both estuarine and coastal ocean waters. Shrimp trawling accounts for the majority of bottom trawling effort in North Carolina. The effect of bottom trawls on soft bottom and other habitats is discussed separately in an issue paper (Effects of shrimp trawling on habitat).

Various types of dredges used on soft bottom habitat in North Carolina cause similar bottom disturbance: crab dredges, oyster dredges, and hydraulic clam dredges. Because of the gears' teeth, crab and oyster dredges can dig deep into the sediment and cause extensive sediment disturbance. Mechanical methods for the taking of crabs is prohibited in designated Crab Spawning Sanctuaries from March through August. Although the amount of fishing effort is low, this gear is documented to cause significant damage (DeAlteris et al. 1999; Collie et al. 2000).

Hydraulic clam dredging, as well as clam "kicking", a specialized type of trawl, creates trenches and mounds of discarded material in soft bottom habitat, redistributing and resuspending sediment (Adkins et al. 1983). Water jets from the hydraulic dredge can penetrate 18 inches into bottom sediments, and uproot any biotic structure present (Godcharles 1971). Dredge tracks can remain present from a few days to more than one year, and recolonization by vegetation can take months to begin. Recruitment of clams and other benthic invertebrates does not appear to be affected by hydraulic dredging (Godcharles 1971). Because of the severe impacts to habitats, both hydraulic clam dredging and clam kicking are restricted to open sand and mud bottoms, usually deeper waters, including areas frequently dredged as navigational channels. Overwintering pink or white shrimp could potentially be affected by this activity, although they usually overwinter in shallow vegetated areas. However, Freeman (1988) examined the effects of clam kicking on pink shrimp in Core Sound and found no significant differences in mean CPUE between an area opened to mechanical harvest and an area closed to mechanical harvest.

SAV

Submerged aquatic vegetation (SAV) is bottom that is recurrently vegetated by submerged, rooted vascular plants (roots, rhizomes, leaves, stems, or propagules), as well as temporarily unvegetated areas between vegetated patches (Street et al. 2005). Submerged aquatic vegetation occurs in both subtidal and intertidal zones and may be colonized by estuarine species, such as eelgrass (*Zostera marina*), shoalgrass (*Halodule wrightii*), or widgeon grass (*Ruppia maritima*) or freshwater species, such as wild celery (*Vallisneria americana*) and sago pondweed (*Potamogeton pectinatus*). Under MFC rules, SAV is a Critical Habitat Area [MFC rule 15A NCAC 03I .0100 (b)(20)].

SAV enhances the ecosystem by stabilizing and trapping sediment, reducing wave energy and cycling nutrients within the system (Thayer et al. 1984). The three-dimensional structure provides a surface for small plants and animals to attach to and provides a safe refuge and foraging area for a large number of juvenile fish and invertebrates (SAFMC 1998). Beds of SAV also produce large quantities of organic matter, which supports a complex food base for numerous fish and other organisms (Thayer et al. 1984). Similar to wetlands, the structure of SAV grass blades provides an excellent nursery area and enhances safe corridor between habitats, reducing predation (Micheli and Peterson 1999). While white shrimp may utilize freshwater SAV to some extent, brown and pink shrimp primarily utilize estuarine SAV because of salinity preferences.

Many important commercial and recreational fishery species use SAV as a nursery (Thayer et al.1984). The blades of SAV provide protection and food for post-larvae and juvenile shrimp. Of the three penaeid shrimp species, SAV is particularly critical as a nursery area for pink shrimp (Murphey and Fonseca 1995). Juvenile pink shrimp abundance was greater in estuarine SAV beds compared to soft bottom, marsh edge, or shell bottom (Minello 1999). Brown shrimp also utilize SAV to some extent. Data from Texas estuaries suggest that brown shrimp show greater preference for SAV rather than marsh edge where both habitats occur (Clark et al. 2004). The configuration of a grass bed may also be a factor in juvenile and adult shrimp distribution (Murphey and Fonseca 1995). The juvenile fish abundance maps (Figures 9.1a-c) underestimate the use of high salinity SAV by brown and pink shrimp, due to the low number of sampling stations in those locations. Additional sampling in SAV is needed to better assess the relationship of SAV condition and spatial changes to shrimp enhancement.

Several studies in North Carolina have shown that shrimp abundance was greater on SAV beds than on oyster beds (Ellis et al. 1996) or unvegetated soft bottom (Murphey and Fonseca 1995). These studies showed similar trends for other species as well. In Florida Bay, changes in animal abundances were compared between the 1980s and 1990s when significant loss of SAV occurred (Matheson et al. 1999). A decrease in SAV coverage appeared to result in a decrease in abundance of small fish and invertebrates that live within the seagrass canopy (such as shrimp and pipefish), while larger demersal predatory fish (such as toadfish and sharks) increased. Similarly, increases in SAV density were characterized by significant increases in crustaceans. In another study in Florida Bay, reductions in pink shrimp abundance were greater in seagrass die-off areas than in nearby undamaged or recovering areas (Roblee and DiDomenico 1992).

The presence of SAV may be the reason pink shrimp can overwinter in temperate North Carolina and thus supports North Carolina’s spring pink shrimp harvest (T. Murphey, DMF, pers.

com. 2003). From 1983-1989 average pink shrimp landings comprised 30% of North Carolina's total shrimp landings and from 1999-2003 average pink shrimp landings comprised 3% of total shrimp landings (DMF, unpub. data). In contrast, in South Carolina and Georgia, where no SAV is present, pink shrimp comprise a negligible portion of the shrimp landings. The location of SAV beds in North Carolina is shown in Figure 9.2a-b, along with wetland dominated, MFC designated nursery areas.

The amount of SAV in North Carolina was estimated to be between 134,000 and 200,000 acres around 1990 (Orth et al. 1990; Ferguson and Wood 1994). However the current spatial distribution and acreage of SAV may be somewhat different since some areas that historically supported SAV were not mapped, and changes may have occurred since the original mapping. Along the Atlantic coast, North Carolina supports more SAV than any other state, except for Florida. The majority of SAV occurs in eastern Pamlico Sound and Core Sound in high salinity waters (Figure 9.2a-b). Because light is the primary limiting factor affecting its distribution, SAV is restricted to relatively shallow waters, usually less than 1 m in depth.

Historical accounts indicate that there have been large-scale losses of SAV in North Carolina's low salinity tributaries on the mainland side of Pamlico Sound and along much of the shoreline of western Albemarle Sound (North Carolina Sea Grant 1997; J. Hawkins, DMF, pers. com, 2003) while the high salinity grass beds to the east appear relatively stable (Ferguson and Wood 1994). Loss of low salinity SAV habitat could negatively affect white or brown shrimp. Impacts to high salinity SAV beds could be especially detrimental to pink shrimp. Protection, enhancement, and restoration of this habitat are high priorities for sustained shrimp populations.

The greatest threat to SAV is large-scale nutrient enrichment and sediment loading, which increases turbidity, reduces light penetration, and subsequently impacts SAV growth, survival, and productivity (Goldsborough and Kemp 1988; Kenworthy and Haunert 1991; Funderburk et al. 1991; Stevenson et al. 1993). Catastrophic losses of seagrass beds have been correlated with these water quality problems in other states in the past (Twilley et al. 1985; Orth et al. 1986; Durako 1994). Nutrient enrichment and/or increased sediment loads impact SAV growth, survival, and productivity by increasing chronic turbidity in the water column from suspended sediment or phytoplankton associated with algal blooms. Also, sediment, epiphytes, or drift algae can cover the surface of blades (Dennison et al. 1993; SAFMC 1998; Fonseca et al. 1998). Elevated nitrogen concentrations have also been shown to be toxic to eelgrass (Burkholder et al. 1992). In North Carolina, most of the low salinity areas that have experienced large reductions in SAV coverage (Tar-Pamlico River and Neuse River) are also designated Nutrient Sensitive Waters. Once SAV is lost, increased turbidity and sediment destabilization can result in accelerated shoreline erosion and make recolonization more difficult (Durako 1994; Fonseca 1996). Therefore prevention of any additional SAV loss through water quality maintenance and improvement is a high priority for shrimp management.

Increased sediment and nutrient loading in the water column can enter coastal waters from point source discharges, nonpoint stormwater runoff, or resuspension of bottom sediments. Specific sources that contribute to increased sediment loading include construction activities, unpaved roads, road construction, golf courses, uncontrolled urban runoff, mining, silviculture, row crop agriculture, and livestock operations (DWQ 2000). Urbanization can increase the flow and velocity of stormwater runoff, which in turn leads to increased stream bank erosion. Stream bank erosion is a significant source of sediment loading (DWQ 2000). Specific sources that contribute to increased nutrient loading include agricultural and urban runoff, wastewater treatment plants, forestry activities, and atmospheric deposition. Nutrients in point source discharges are primarily from human waste and industrial processes. The primary contributors of nutrients from non-point sources are fertilizer and animal wastes (DWQ 2000).

In addition to effects from water quality degradation, SAV can be removed or damaged by water-based activities. Dredging for navigational channels, marinas, or infrastructure such as bridges, submarine pipelines, or cables can result in large, direct losses of SAV. Docks constructed over SAV can cause immediate loss during construction or gradual loss due to shading effects. Several studies in Florida have shown that SAV was significantly reduced or eliminated under and around docks that were less than 5.5 ft about mean high water or where light received was less than 14% of the surface light availability (Loflin 1995; Shafer 1999). In addition to direct damage from docks and marinas, indirect damage to SAV can result from boating activity associated with these structures. Shoals and other shallow bottoms supporting SAV may become scarred as boating activity to and from the docking areas increases. Boat wakes can destabilize and erode SAV beds, or resuspend sediment, reducing light penetration. As additional docks and marinas are constructed along the coast, the potential for boating-related damage increases.

Along the southeast coast of Florida, there are stringent standards for dock construction to minimize impacts to SAV, including dock height above the water, minimum water depth, and maximum square footage. In North Carolina, the depth of water at the dock end is not considered in Coastal Resource Commission (CRC) rules. To minimize shading effects to wetland plants, CRC rules require a dock height of at least three feet (0.91 m) above the wetland substrate, and a pier width of no greater than six feet (1.83 m) [CRC rule 15A NCAC 07H.0208 (6)]. However, there is no requirement for height above the water surface. Results from Connell and Murphey (2004) indicate that current dock designs over SAV beds in North Carolina result in a reduction in SAV coverage and density. Dock criteria should be evaluated by CRC to determine if existing requirements are adequate for SAV survival and growth and what changes would be needed to allow adequate light beneath docks. The permit requirements for docks and piers may need to be changed accordingly.

Several bottom disturbing fishing gears have the potential to destroy or damage SAV. The DMF issued a report on shrimp and crab trawling impacts (DMF 1999). Also, the Fisheries Moratorium Steering Committee's Habitat Subcommittee identified specific habitat impacts from various commercial and recreational fishing gears used in North Carolina waters, and made recommendations to minimize such impacts (MSC 1996). The Fisheries Moratorium Steering Committee presented the summary of findings to the Joint Legislative Commission on Seafood and Aquaculture of the General Assembly. Fishing gear found to be potentially damaging to SAV is listed in Table 9.2.

Table 9.2. Fishing gears used in North Carolina identified as potentially damaging to submerged aquatic vegetation habitat. [Source: MSC 1996]

Severe damage	Moderate damage	Low damage or unsure
Oyster dredge	Crab trawl	Long haul seine
Crab dredge	Clam Tongs	Otter trawl
Hydraulic clam dredge		Clam hand rake
Clam trawl (kicking)		Bay scallop dredge (very little)
Bull rake		

Damage from fishing gear varies in severity. Hand gear, such as bull rakes and large oyster tongs, can uproot SAV and cause substantial damage, but generally to smaller areas than mechanical gears (Thayer et al. 1984). Current MFC rules prohibit use of rakes more than twelve inches wide or weighing more than six pounds SAV [MFC rule 15A NCAC 03K.0304 (a)(2)]. Use of hand rakes and clamming by hand are allowed.

Mobile gear, such as long haul seines or bottom trawls, can shear or cut the blades of SAV, or uproot plants without major disruption of the sediment (ASMFC 2000). Shearing of above-ground plant biomass does not necessarily result in mortality of SAV, but productivity is reduced since energy is diverted to replace the damaged plant tissue, and the nursery and refuge functions are reduced in the absence of structure. Other fishing practices can cause severe disruption of the sediment and damage the roots of SAV. Gears that disturb the sediment and below-ground plant structures, like toothed dredges, heavy trawls, and boat propellers, may cause total loss of SAV in the affected area, requiring extensive time to recover (ASMFC 2000). SAV can also be buried by excessive sedimentation associated with trawling, dredging, and propeller wash. High turbidity from use of bottom-disturbing fishing gear can reduce water clarity, affecting SAV growth, productivity, and in some cases, survival (ASMFC 2000).

All toothed dredges can cause severe damage when pulled through SAV. Because oyster dredges, crab dredges, and hydraulic clam dredges severely impact bottom structure, there are strict limits on their use in North Carolina. Use of crab dredges is restricted to an area in northern Pamlico Sound southwest of Oregon Inlet [MFC rule 15A NCAC 03R.0109] that excludes SAV beds. Use of oyster dredges is currently restricted to parts of Pamlico Sound and its tributaries (Figure 9.3a-c). The majority of high salinity SAV occurs in areas where mechanical methods for oyster harvesting are prohibited. However, brackish and freshwater SAV in western Pamlico Sound is generally unprotected from dredging, except in PNAs and SNAs. Submerged aquatic vegetation will not be able to recolonize areas that historically supported SAV if they continue to be dredged. Oyster dredging should be prohibited from some shallow waters along the Albemarle-Pamlico shoreline that historically supported SAV, to allow for restoration and expansion of SAV in those areas.

Clam kicking can also severely impact SAV since substrate is displaced by propeller backwash (Guthrie and Lewis 1982). Peterson and Howarth (1987) found that clam kicking significantly reduced plant biomass in eelgrass and shoalgrass beds. It is likely that SAV was damaged by kicking in the past since this technique has been used in North Carolina for over 60 years, effort was high in areas known to support SAV (Carteret County), and kicking vessels tended to operate in shallow waters (Guthrie and Lewis 1982). Because of the severe disturbance to the bottom, clam kicking is restricted to sandy bottom, in waters more than 10 ft deep, in Core and Pamlico sounds, and Newport, North, New, and White Oak rivers. The fishery is managed intensively, with strong enforcement to prevent clam kicking outside the designated areas. Much of the designated mechanical clamming areas have SAV in close proximity to them, so vessels that fish illegally outside the open areas may severely impact SAV. Turbidity generated by clam kicking may also affect adjacent SAV beds. High salinity SAV species are more likely to be impacted by mechanical clamming practices due to the location of the fishery.

Bay scallop dredges, in contrast to oyster and crab dredges, cause less severe damage to SAV because they are smaller [not over 50 lb (22.68 kg)] and have no teeth. They are intended to glide along the substrate surface, taking bay scallops lying on the surface within SAV beds. Most damage observed by DMF staff has not been from the dredge, but from propeller scarring while pulling the dredge, particularly when the season opening coincides with low tide (T. Murphey, DMF, pers. com., 2002). To reduce SAV impacts, DMF allows hand harvest methods for bay scallops early in the season, followed by proclamations to open scallop dredging later in the season, starting on a high tide. This management practice minimizes damage to SAV from propeller scarring by dredging vessels (T. Murphey, DMF, pers. com., 2002).

Fishery restrictions already exist for most of the gears used in North Carolina that are potentially damaging to SAV. Additional law enforcement may be needed to enforce buffers around SAVs. In addition, the boundaries of areas where dredging or trawling is allowed should be evaluated and adjusted, if necessary, to adequately protect all SAV beds and provide a buffer of unvegetated area to reduce turbidity impacts. Because of the location and magnitude of fishing effort and SAV beds, it appears that trawling in Core and Bogue sounds has the greatest potential for significant fishing gear impacts on existing SAV beds. The effect of trawling on habitat is discussed in a separate issue paper (Section 10.1.3).

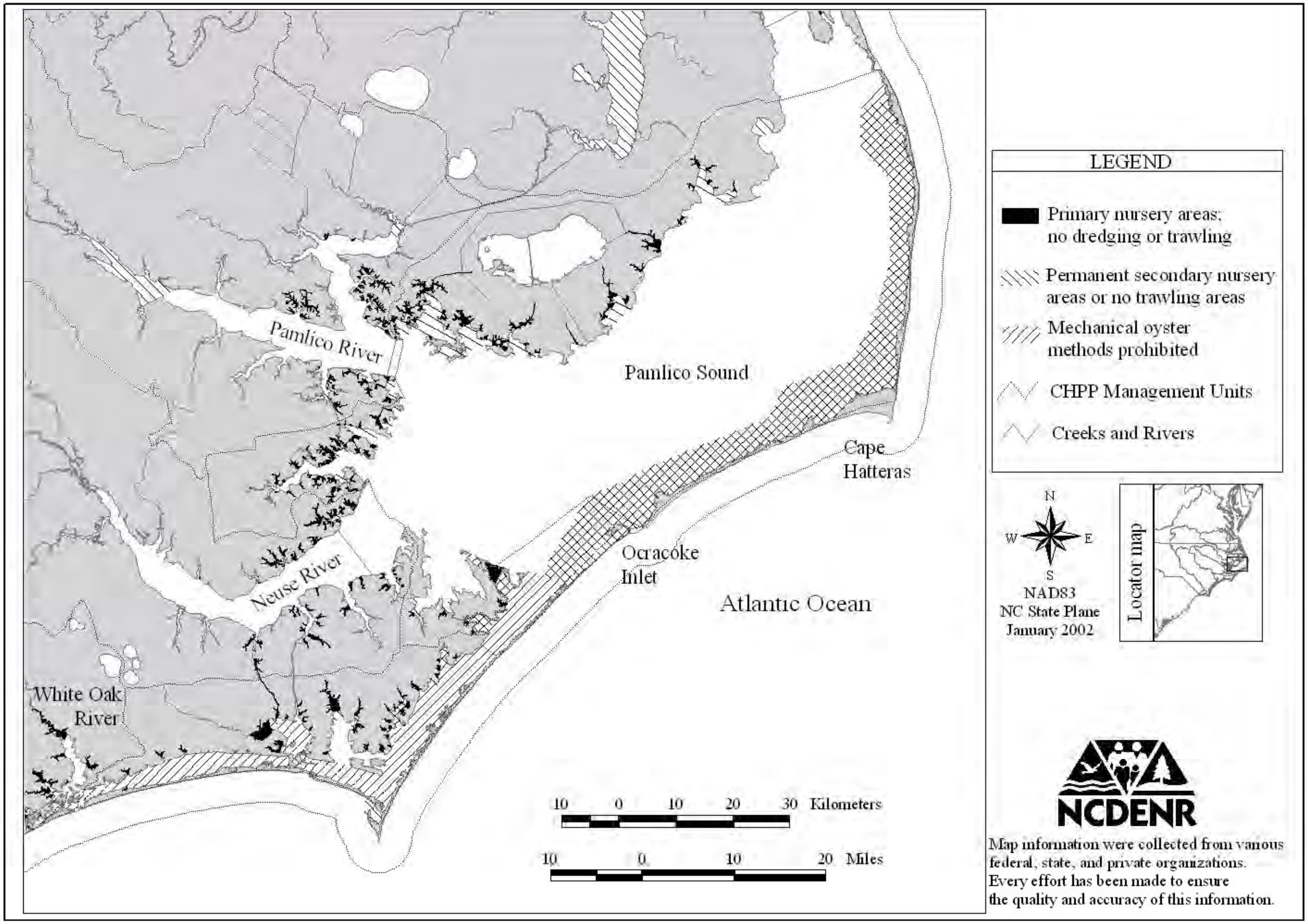

Figure 9.3a. Areas where mechanical oyster gears and bottom trawling are prohibited in the Pamlico Sound system.

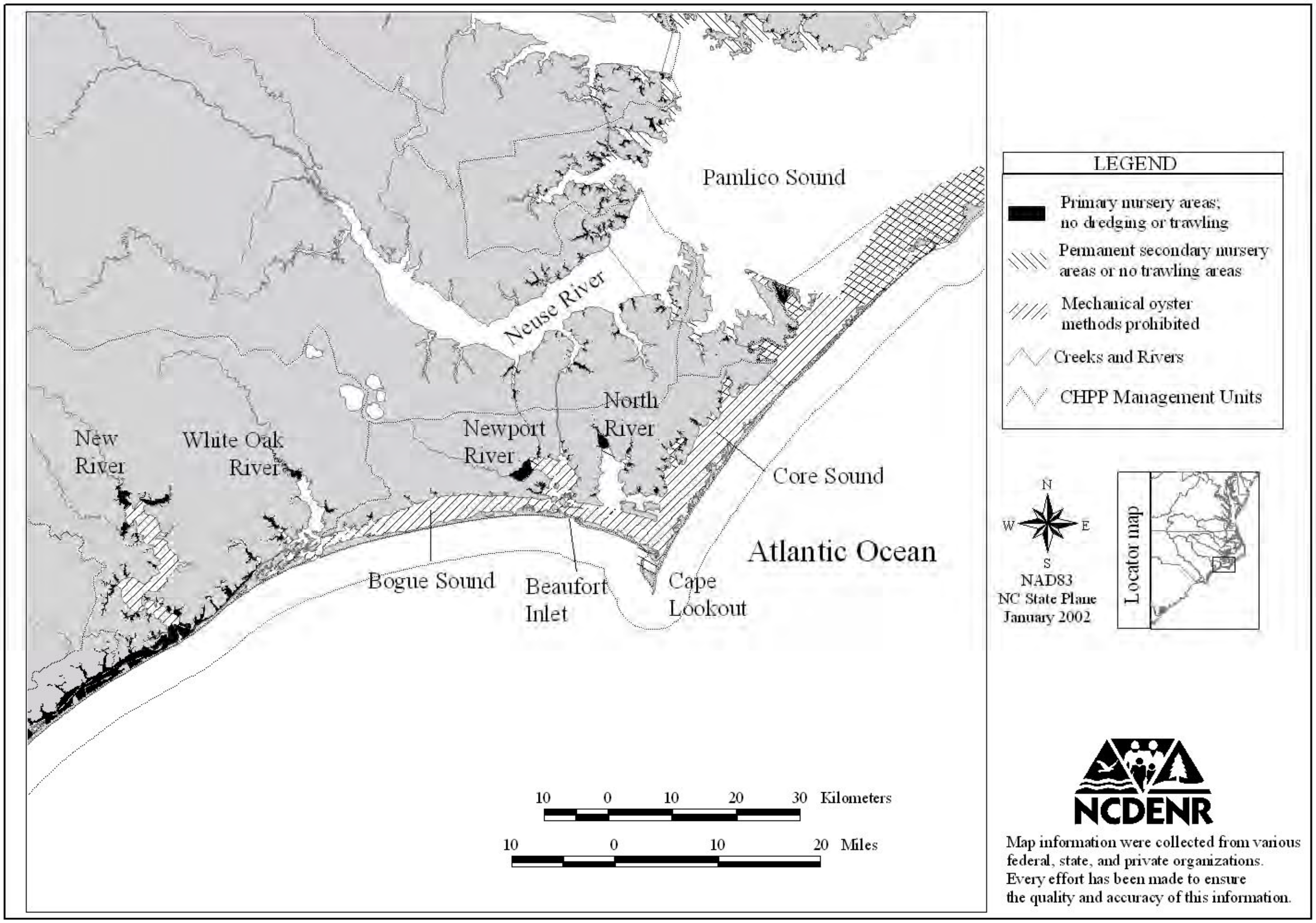

Figure 9.3b. Areas where mechanical oyster gears and bottom trawling are prohibited in central coastal areas.

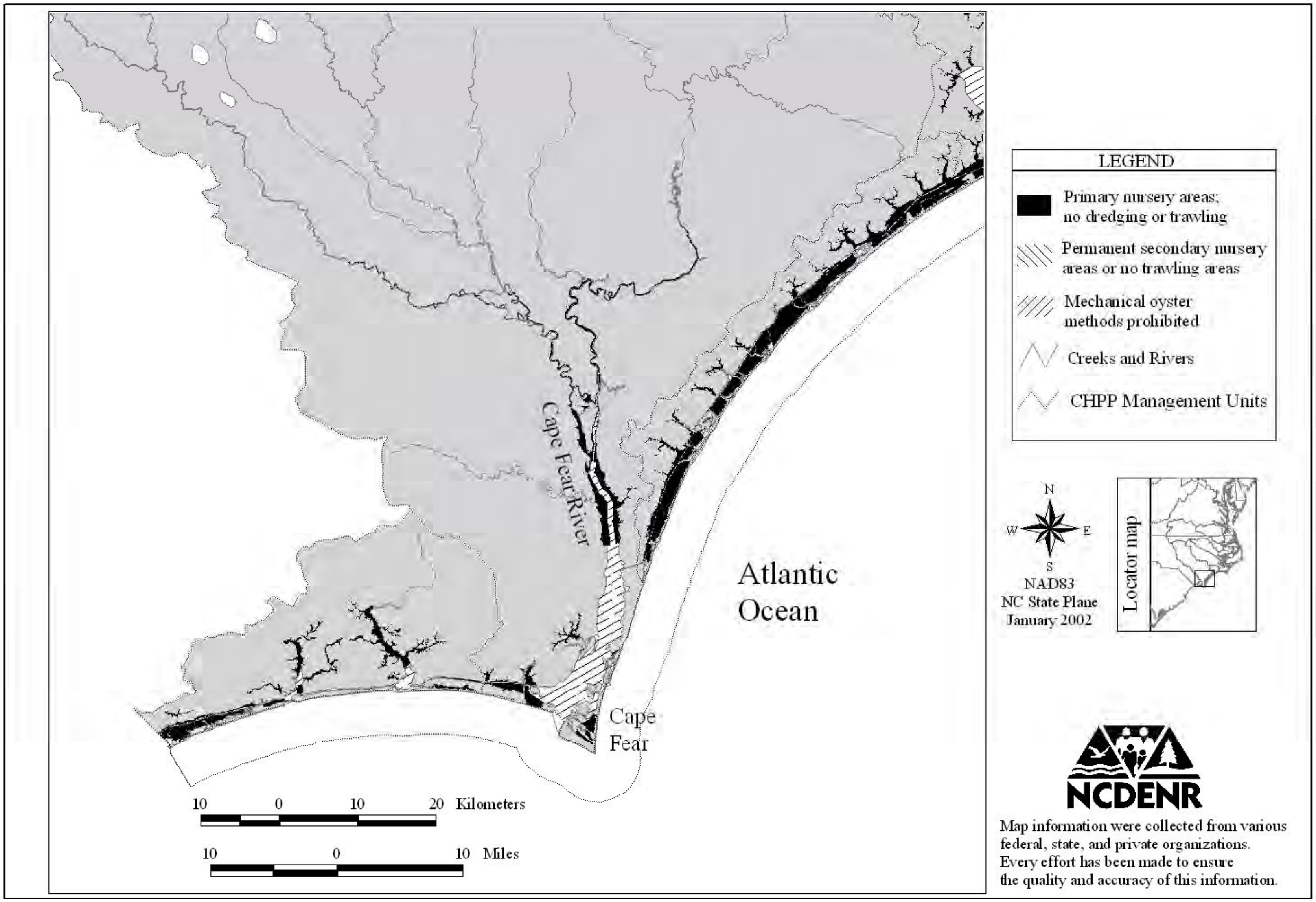

Figure 9.3c. Areas where mechanical oyster gears and bottom trawling are prohibited in southern central coastal areas.

Shell bottom

Shell bottom habitat is estuarine intertidal or subtidal bottom having concentrations of shell, including living or dead oysters (*Crassostrea virginica*), hard clams (*Mercenaria mercenaria*), or other shellfish (Street et al. 2005). In the 1990s, fisheries management agencies began to formally recognize shell bottom habitat as critical to fisheries production. The North Carolina Marine Fisheries Commission (MFC), South Atlantic Fishery Management Council (SAFMC), and Atlantic States Marine Fisheries Commission (ASMFC) all recognize the importance of shell bottom.

Common terms used to describe shell bottom habitats in North Carolina are "oyster beds," "oyster rocks," "oyster reefs," "oyster bars," and "shell hash." Shell hash is a mixture of sand or mud with gravel and/or unconsolidated broken shell (clam, oyster, scallop, and/or other shellfish). Shell bottom is enhanced in some areas by the addition of cultch material. Cultch material (hard material to which oysters attach) can consist of oyster, clam, or scallop shells; gravel or marl; or other hard materials. Cultch exists naturally, as shell hash and oyster rocks. DMF's Shellfish Rehabilitation Program staff also plant cultch to enhance and restore estuarine shell bottom for oyster and hard clams.

Shell bottom is both intertidal and subtidal, and can consist of fringing or patch reefs (Coen et al. 1999). Intertidal oyster reefs in the central and southern estuarine systems may only be a few oysters thick. However, subtidal oyster mounds in Pamlico Sound may have been several meters tall (Lenihan and Peterson 1998). In North Carolina, oysters attach to and accumulate on existing oyster beds, other shell, outcroppings of fossil shell beds, exposed *Spartina* roots, pilings, and rip-rap (DMF 2001). Intertidal oyster reefs in North Carolina may occur along the edges and points of salt marsh, between salt marsh and seagrass beds, or as isolated reef features, away from other structure (Grabowski et al. 2000).

Shell bottom provides many important functions that enhance the health of the entire ecosystem for fishery and non-fishery species. Oysters filter sediment and pollutants from the water column, enhancing water quality and improving conditions for SAV growth (Coen and Luckenbach 1998). The hard multi-faceted shell structure aids in reducing wave energy, stabilizing sediment, and reducing shoreline erosion (Lowery and Paynter 2002). Oysters, like SAV and benthic microalgae, facilitate storage and cycling of nutrients. This process reduces the likelihood of coastal eutrophication and its detrimental effects on fish and fisheries. Oyster beds also increase shoreline complexity, modify circulation patterns, and enhance fish use of marsh edge habitat (Grabowski et al. 2000).

The complex three-dimensional structure provides protective cover for juvenile and adult shrimp. The shell structure also provides an area for small plant and invertebrate attachment, which shrimp may feed on or hide among (Meyer et al. 1996; Lenihan and Peterson 1998; Coen et al 1999). However, predatory finfish around the reefs feed, in part, on penaeid shrimp (Grabowski et al. 2000). Fringing shell bottom or shell hash also serves as a nearshore corridor between habitats such as salt marsh and SAV, which shrimp also utilize (Coen et al. 1999; Micheli and Peterson 1999).

Brown, white, and pink shrimp have been documented to utilize shell bottom habitat in South Carolina and Texas estuaries (Coen and Luckenbach 1998; Zimmerman et al. 1989), although shell bottom does not appear to be the preferred habitat, compared to salt marsh edge or SAV (Minello 1999). In North Carolina, some studies indicate use of oyster beds by pink, white, and brown shrimp (Meyer et al. 1996; Grabowski et al. 2000; Lenihan et al. 2001).

Analysis of these studies in Peterson et al. (2003) concluded that pink, white, and brown shrimp were not recruitment or growth enhanced by the presence of shell bottom. In sounds and the lower portions of estuaries where SAV is not present, shell bottom may be more critical to penaeid shrimp. In addition, the ecosystem benefits provided by the habitat would still indirectly enhance shrimp populations.

Oysters are found along a majority of the North Carolina coast from extreme southeastern Albemarle Sound to the estuaries of the southern part of the state to the South Carolina border (DMF 2001). Oyster reefs occur at varying distances up North Carolina's estuaries, depending upon salinity, substrate, and flow regimes. In the wind-driven Pamlico Sound system north of Cape Lookout, oyster reefs consist overwhelmingly of subtidal beds. South of Cape Lookout, subtidal rocks also occur in the New, Newport, and White Oak rivers (DMF 2001). Extensive intertidal oyster rocks occur in North Carolina's southern estuaries, where the lunar tidal ranges are higher. Substantial shell hash is present in New River, eastern Bogue Sound, and along the edges of many streams and channels, such as portions of the Atlantic Intracoastal Waterway (ICW) in the southern coastal area. In the Albemarle-Pamlico estuary, oysters are concentrated in the lower portion of Pamlico Sound tributaries, along the western shore of Pamlico Sound, and to a lesser extent, behind the Outer Banks (Epperly and Ross 1986).

The current distribution of shell bottom is much less than what historically occurred (Newell 1988). Mechanical harvesting of oysters (oyster dredging) was the primary and initial cause of habitat loss (DMF 2001). Most shell bottom losses have been to subtidal beds in Pamlico Sound, where DMF has also found declines in oyster recruitment. Although mechanical harvesting of oysters has been greatly restricted, reefs have not recovered, possibly due to stress from water quality degradation and increased occurrence of disease (Dermo, MSX) (DMF 2001). Oyster dredging removes oysters and reduces the vertical profile of oyster rocks, increasing the susceptibility of remaining shell bottom at that location to low DO and possible mortality (Lenihan and Peterson 1998; Lenihan et al. 1999). Although commercial oyster dredging has been greatly reduced, current activities continue to reduce and degrade a habitat that is utilized by shrimp. Hand harvest methods for oysters and clams can also be destructive, but on a much smaller scale. Other bottom disturbing fishing gears, such as trawls, prevent the re-establishment of oyster reefs within their historic range.

Other causes of shell bottom losses include dredging for navigation channels or marina basins. These activities can physically remove or damage existing shell bottom or result in turbidity that clogs oyster gills or covers sediment completely. Hydrologic modifications in the Neuse and Pamlico rivers have decreased salinity in the downstream portions of those rivers and resulted in a downstream displacement of oysters since the 1940s (Jones and Sholar 1981). While drainage for agriculture has changed little in recent years, drainage for urban/suburban development is increasing steadily.

9.2 Water Quality

Adequate water quality is necessary to maintain the chemical properties of the water column that are needed by shrimp, as well as sustain SAV, shell bottom, and soft bottom habitats that support shrimp. Human activities that degrade water quality or alter water flow can negatively impact shrimp growth or survival. For example if salinity or DO concentrations are altered beyond the known preferences of shrimp, shrimp distribution or growth rates may be affected. Toxins can be assimilated into shrimp tissue and alter growth and reproduction. The most common causes of water quality use support impairment in North Carolina's coastal river basins are excessive sediment loading and low DO (DWQ 2000). Hydrological modifications, low DO and toxin contamination are probably the greatest water quality concerns for penaeid shrimp.

Hydrological modifications

Hydrological modifications occur when streams and creeks are channelized (deepened and straightened), dredged, or ditched to improve drainage of adjacent lands or for navigation (North Carolina Sea Grant 1997), and often result in increased runoff. Runoff from agriculture, urban/suburban development, and transportation infrastructure carries sediment, nutrient, and toxic chemical pollutants (DWQ 2000). Sediment, the number one pollutant of waterways in the United States, clogs oyster gills and buries shells (Coen et al. 1999). Excess nutrients can fuel algal blooms and low DO events, and in turn, cause mortality of benthic organisms on deep, subtidal shell bottom (Lenihan and Peterson 1998). Heavy metals, petroleum products, pesticides, and other toxic chemicals in the runoff can kill sensitive oyster larvae (Wendt et al. 1990; Funderburk et al. 1991).

Channelized streams are often deeper, with more extreme flows, less woody debris and less variable depth than natural streams. These changes primarily affect smaller species and early life stages that use shallow stream margins, since these areas are reduced with channelization. Channelization potentially affects shrimp in several ways. By removing the meanders of the channel and increasing the slope of the shoreline, water velocities in the altered stream are higher and erosion of the shoreline and sediment loading increases. In many channelized streams, storm flows are confined primarily to the main channel rather than passing through wetlands and achieving some filtration of pollutants, deposition of sediment, and water storage. In addition, the natural woody vegetation along the sides of the stream is often removed in the process of channelization. Consequently, loading and movement of sediment and other nonpoint source pollutants are often greater in channelized sections than natural streams, which can have negative impacts on water quality and therefore fish habitat (White 1996; EPA 2001). Nutrient concentrations, particularly for nitrogen and phosphorus, may increase with channelization. Elevated water velocities can also deter or prevent movement of adult and juvenile fish. In addition, spoil banks created by dredge disposal along the shoreline prevents shrimp from accessing adjacent wetlands.

Several studies have found that the size, number, and species diversity of fish in channelized streams are reduced and the fisheries associated with them are less productive than those associated with unchannelized reaches of streams (Tarplee et al. 1971; Hawkins 1980; Schoof 1980). Pate and Jones (1981) compared nursery areas that were altered and unaltered by channelization and found that brown shrimp, spot, croaker, southern flounder, and blue crab were more abundant in nursery habitats with no man-made drainage. They attributed this reduction in organisms to the unstable salinity conditions that occurred in areas adjacent to channelized systems following moderate to heavy rainfall (>1 inch/24 hr).

Low oxygen

Adequate supply of DO is critical to survival of benthic invertebrates and fish. Low-oxygen conditions (hypoxia) can occur naturally in a system from flushing of swamp waters, which characteristically have low DO, or from stratification of the water column due to wind, temperature, and salinity conditions. However, low-oxygen conditions can also be fueled by increased stormwater runoff carrying nutrients and oxygen-consuming wastes, which result in excessive oxygen demand in the water column or sediment. Algal blooms deplete the water column of DO as respiration from the dense concentrations of plants consumes oxygen at night (DWQ 2000). Dissolved oxygen can be further depleted as bacteria use oxygen to decompose the algae's organic material. Algal blooms may occur naturally in coastal waters or occur with greater frequency or intensity upon inputs of nutrients. Dissolved oxygen depletion in the water column occurs most often in summer. Warmer water holds less DO and increases microbial decomposition. In addition, warmer water, calm winds, and reduced freshwater inflow in the summer reduce mixing and aeration of water. The stratified bottom layer of water is prevented from receiving oxygenated surface waters and rapidly becomes depleted of oxygen. Shallow water estuaries with less frequent flushing often develop persistent stratification and bottom-water hypoxia that can last for weeks to months (Tenore 1972). Low oxygen events in coastal waters of the United States are becoming more frequent, larger in extent, and longer lasting due to increasing eutrophication (Cooper and Brush 1991; Breitberg 1992; Lenihan and Peterson 1998).

In freshwater streams, DWQ water quality (use support) data indicate low DO as a major cause of impairment in the Neuse River basin (132 mi), Chowan River basin (46 mi), Pasquotank River basin (40 mi), Roanoke River basin (24 mi), Tar-Pamlico River basin (13 mi), and White Oak River basin (8 mi) (DWQ 2000). In estuarine waters, low DO was a major source of impairment in the Cape Fear (5,000 acres) and the Pasquotank river basins (1,125 acres). In the Neuse River, recent estimates suggest that up to 30-50% of the estuarine bottom during summer is unsuitable habitat due to hypoxia (Seldberg et al. 2001; Eby and Crowder 2002). Since shrimp live on the bottom in estuaries where hypoxia and anoxia (no oxygen) have been reported to occur, the species may be negatively affected by low oxygen events.

Brown shrimp and some other organisms are capable of detecting and avoiding waters with low oxygen concentrations (Wannamaker and Rice 2000). Where shrimp had access to water with 4 or 2 mg/l DO rather than 1 mg/l DO, shrimp strongly preferred and moved to the higher oxygenated waters. Migration of benthic organisms from hypoxic or anoxic waters can lead to high densities of organisms in oxygenated areas, increased competition, and increased predation by opportunistic predators (Eby and Crowder 2002; Seldberg et al. 2001). Although fish have the ability to migrate away from hypoxic areas and seek refuge in shallower oxygenated waters, wind-driven circulation can rapidly transport the hypoxic bottom-water into shallow waters, so that fish cannot escape (Paerl et al. 1998). The Neuse, Tar-Pamlico and Cape Fear river basins had the largest numbers of reported fish kills in North Carolina, from 1996 to 2001 (DWQ 2001), with low DO being a common cause. However, the absence of shrimp in recent reported fish kills (DWQ 2001) suggests that shrimp may successfully avoid lethal anoxic waters.

Although direct mortality does not appear to be a significant factor for shrimp, prolonged periods of hypoxia could stress and negatively impact penaeid shrimp and significantly alter the estuarine system. Studies on white shrimp found that growth rates of white shrimp were reduced in waters having less than 3.5 mg/l DO, feeding was affected in waters 2-3 mg/l DO, and oxygen uptake was reduced by 50-70% in 2 mg/l DO (Gray et al. 2002). When a benthic community is severely depleted by a low oxygen event, ecological successional patterns of the benthos are altered (Luettich et al. 1999). The various successional stages may affect or benefit different benthic feeders to differing extents. For example, early successional communities composed of very small, shallow-burrowing opportunists (capitellid worms) and meiofauna may favor small species, such as penaeid shrimp and larval and juvenile croaker and red drum, but not provide food for large adult fish species. Partially recovered benthic communities consisting of polychaetes and small juvenile clams could benefit demersal species like spot, croaker and blue crabs. A fully recovered community with deep burrowing polychaetes and large clams might benefit adult spot and hogchoker, but not shrimp (Luettich et al. 1999).

While hypoxia and anoxia can occur naturally, they can also be attributed, in part, to anthropogenic changes in the system, including excess nutrient and organic loading from waste discharges, nonpoint runoff, streambank erosion, and sedimentation (Schueler 1997). Oxygen depletion in the water column was positively correlated with accumulation of organic material in the sediments (Luettich et al. 1999). Several studies have indicated that the frequency, duration, and spatial extent of low oxygen events have increased over the years due to increasing eutrophication of coastal waters from human and animal waste discharges, greater fertilizer use, loss of wetlands, and increased atmospheric nitrogen deposition (Cooper and Brush 1991; Dyer and Orth 1994; Paerl et al. 1995; Buzzelli et al. 2002). More information is needed to understand consequences on the estuarine food web and to what extent anoxia affects the soft bottom community. Efforts are needed to reduce anthropogenic nutrient loading, particularly in systems that have a history of hypoxia and anoxia.

Toxins

While toxins can fluctuate between the sediment and water column, concentrations of toxic chemicals tend to accumulate in sediments at concentrations several orders of magnitude greater than in overlying waters (Kwon and Lee 2001). The bioavailability and transport of a chemical depends on the form of the chemical incorporated into the sediments, the feeding habits and condition of aquatic organisms, and the physical and chemical conditions of the environment. Toxic chemicals can become active in soft bottom sediment or overlying waters through several mechanisms, including resuspension from natural weather events or human activities, such as dredging and trawling.

Toxins in sediments or the water column can affect benthic invertebrates by inhibiting or altering reproduction or growth, or causing mortality in some situations (Weis and Weis 1989). Early life stages are most vulnerable to toxins (Funderburk et al. 1991). Because macroinvertebrate diversity significantly declines with increasing sediment contamination, food resources for benthic feeders, like shrimp, may be limited in highly contaminated areas (Weis et al. 1998; Brown et al. 2000; Dauer et al. 2000). While the survival of some aquatic organisms is affected by toxins, other organisms survive and bioaccumulate the chemicals to toxic levels, passing them along in the food chain. Multiple studies have shown clear connections between concentrations of toxins in sediments and those in benthic feeding fish and invertebrates (Kirby et al. 2001; Marburger et al. 2002). Heavy metal contamination of sediments has been documented to result in elevated trace metal concentrations in shrimp, striped mullet, oysters, and flounder (Kirby et al. 2001; Livingstone 2001).

There is some information available on the effect of certain toxic chemicals on different shrimp species. A study on the effect of copper, a common chemical associated with marinas, on a penaeid sprimp (*Metapenaeus dobsoni*) found that shrimp were tolerant to low concentrations of copper (0.05 mg Cu 1 super (-1)). However shrimp growth was significantly reduced when exposed to higher concentrations (0.15 mg Cu 1 super (-1)) (Manisseri and Menon 2001). Cellular damage to the hepatopancreas also occurred to shrimp exposed to 50-150 ppb Cu (Manisseri and Menon 1995). Another study examined mercury concentrations in both shrimp and blue crab, and found that blue crabs collected in the field with pink shrimp had higher mercury concentrations. The lower levels found in pink shrimp were attributed to shorter residence times in the contaminated area, differences in feeding habits, and the ability to excrete mercury somewhat faster (Evans et al. 2000).

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

Because low concentrations of heavy metals in the water column can be easily incorporated into fine-grained sediment, chemicals can accumulate in the sediment to toxic levels and be resuspended into the water column (Riggs et al. 1991). Studies have shown that fine-grained sediments are the primary reservoir for heavy metals, particularly organic rich muds (ORM) (Riggs et al. 1991). Since organic rich muds are the most extensive sediment type in North Carolina's estuaries, and since many primary nursery areas are composed of ORM, resuspension of contaminated ORM sediments in PNAs is of particular concern.

The extent of sediment contamination in North Carolina coastal waters is not well known. Sediment sampling is not conducted by the DWQ since there are no sediment standards in the state. Studies examining sediment contamination at sites in North Carolina soft bottom areas have found various levels of contamination. The EPA Environmental Monitoring and Assessment Program surveyed 165 sites within North Carolina's sounds and rivers during 1994-1997 to evaluate condition of bottom sediments (Hackney et al. 1998). Highest contamination levels occurred in low salinity areas with low flushing and high river discharge. Benthic populations were dominated by tolerant opportunistic species and benthic communities had low species richness. Laboratory bioassays showed that sediments from many sites were toxic to biological organisms. However, because of the low sample size, frequency of sampling, and the confounding effects of hypoxia in areas sampled, results from this study may not accurately assess the condition of North Carolina sediments (C. Currin, NOAA, pers. com., 2003).

Concentrations of heavy metals in the Neuse and Pamlico estuaries have been assessed (Riggs et al. 1989; Riggs et al. 1991). In the Neuse River, surface sediments contained elevated levels of several heavy metals, including zinc, copper, lead, and arsenic. Furthermore, 17 areas between New Bern and the mouth of the river were identified as "contaminated areas of concern". The contaminated sites were primarily attributed to permitted municipal and industrial treatment plant discharges. Marinas were also found to contribute substantial amounts of copper and variable amounts of zinc and lead. Nonpoint sources were more difficult to evaluate. In the Pamlico River, heavy metal contamination was less severe, although arsenic, cobalt, and titanium exceeded the levels found in the Neuse River. These studies suggest that sediment contamination in some estuarine areas especially those where both organic rich mud and waste water discharges are present, may be significant and could affect fish populations and the base of their food chain. To better determine if contaminated sediment is a significant threat to shrimp habitat, the distribution and concentration of heavy metals and other toxic contaminants in freshwater and estuarine sediments need to be adequately assessed and areas of greatest concern need to be identified. Continued minimization of point and nonpoint sources of toxic contaminants is vital for protection of the entire ecosystem.

Parasites and Disease

Diseases and parasites in penaeid shrimps come in the forms of viruses, bacteria, fungi, protozoa, flatworms and nematodes. Disease ranks second only to predation and mass kills of natural populations in the Gulf and South Atlantic (Couch 1978) in shrimp mortality. The *Baculovirus* infects larval and adult shrimp and is associated with mortality, especially in larval shrimp. The effect of bacteria on mortality is unclear, however *Vibrio, Beneckea*, and *Leucothrix* are associated with disease in penaeid shrimps. Several types of fungi can be very destructive to tissue of larval shrimp. There are several types of protozoa that are parasitic and commensal and include Microsporidia which cause the condition commonly known as "cotton shrimp" and Ciliatea which causes black gill disease. Flatworms and nematodes can also be found in muscles and viscera of penaeid shrimp (Couch 1978).

Cotton disease is widespread and is found in all three species of shrimp on the South Atlantic and Gulf coasts. There are several species of *Microsporidia* that infects the tail muscle of the shrimp, as well as the organs and tissues with masses of spores. These spores cause the white discoloration of muscle giving infected shrimp a cotton or paper-white color. This parasite kills shrimp. A typical catch of wild shrimp contains a few infected individuals, which are usually discarded.

Black gill disease results from infection by a single-celled protozoan called a Ciliatea (SC DNR 2002). It attaches itself to a thin area around the gills of the shrimp's shell. This attachment either causes structural damage or erodes a hole through the shell, causing inflammation. The black pigmentation of the gill results from an immune response to the inflammation. The infestation of black gill disease does not result in any noticeable mortality in the wild and appear to attach in mass when shrimp are stressed (SC DNR 2002).

Several penaeid shrimp viruses may be carried by imports from Asia and South America as well as from expanding aquaculture. These viruses enter processing facilities and aquaculture facilities through infected brood stock, contaminated feed, infected transport containers or by migratory birds. These viruses may infect our three species of native shrimp but there is little information on the presence of exotic shrimp viruses in populations of our native shrimp in North Carolina. There are currently no aquaculture facilities for shrimp in the state though there were two permitted facilities in 2003.

9.3 Habitat and Water Quality Protection

MFC Authority

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

Although MFC's primary responsibilities are management of fisheries (seasons, size and bag limits, licensing, etc.), the MFC also has authority to comment on State permit applications that may have an effect on marine and estuarine resources or water quality, regulate placement of fishing gear, develop and improve mariculture, and regulate location and utilization of artificial reefs. MFC authority is found at G.S. 143B-289.51 and 289.52. As discussed previously, the MFC prohibits certain bottom-disturbing gears from areas supporting SAV, shell bottom, or juvenile fish populations to protect these resources.

Authority of Other Agencies

Several divisions within the North Carolina Department of Environment and Natural Resources are responsible for providing technical and financial assistance, planning, permitting, certification, monitoring, and regulatory activities that have a direct or indirect impact on coastal water quality and habitat. The North Carolina Division of Coastal Management (DCM) is responsible for development permits along the estuarine shoreline in 20 coastal counties. Wetland development activity throughout North Carolina is permitted through the United States Army Corps of Engineers (COE) and the North Carolina Division of Water Quality (DWQ; 401-certification program). The DWQ permits and regulates discharges to surface waters, and monitors water quality throughout the state. DWQ has established a water quality classification and standards program for "best usage" to promote protection of surface water supply watersheds, high quality waters, ecosystem functions, and the protection of unique and special pristine waters with outstanding resource values. Classifications, particularly for High Quality Waters (HQW), Outstanding Resource Waters (ORW), Nutrient Sensitive Waters (NSW) and Water Supply (WS) waters, outline protective management strategies aimed at controlling point and nonpoint source pollution. Various federal and state agencies, including DMF, evaluate projects proposed for permitting and provide comments and recommendations to the DCM, DWQ, and COE on potential habitat and water quality impacts. Various public agencies (state and federal) and private groups acquire and manage natural areas as parks, refuges, reserves, or protected lands, which helps to protect adjacent public trust estuarine water quality.

Coastal Habitat Protection Plans

The Fisheries Reform Act of 1997 (FRA 1997) mandated the Department of Environment and Natural Resources (DENR) to prepare a Coastal Habitat Protection Plan (CHPP -- G. S. 143B-279.8). The legislative goal for the CHPP is long-term enhancement of the coastal fisheries associated with coastal habitats and provides a framework for management actions to protect and restore habitats critical to North Carolina's coastal fishery resources. The Coastal Resources Commission, Environmental Management Commission, and the Marine Fisheries Commission must each approve and implement the plan for it to be effective. These three Commissions have regulatory jurisdiction over the coastal resources, water, and marine fishery resources. The CHPP was approved in December 2004 and an implementation plan is to be developed by July 2005. Actions taken by all three commissions pertaining to the coastal area, including rule making, are to comply, "to the maximum extent practicable" with the plans. The CHPP will help to ensure consistent actions among these three commissions as well as their supporting Department of Environment and Natural Resources agencies and will be reviewed every five years.

The CHPP describes and documents the use of habitats by species supporting coastal fisheries, status of these habitats, and the impacts of human activities and natural events on those habitats. Fish habitat is defined as freshwater, estuarine, and marine areas that support juvenile and adult populations of economically important fish, shellfish, and crustacean species (commercial and recreational), as well as forage species important in the food chain (Street et al. 2005). Fish habitat also includes land areas that are adjacent to, and periodically flooded by riverine and coastal waters. Six fish habitats are discussed and designated based on distinctive physical properties, ecological functions, and habitat requirements for living components of the habitat: wetlands, submerged aquatic vegetation (SAV), soft bottom, shell bottom, ocean hard bottom, and water column.

The CHPP recommends that some areas of fish habitat be designated as "Strategic

Habitat Areas" (SHAs). Strategic Habitat Areas are defined as specific locations of individual fish habitat or systems of habitat that have been identified to provide critical habitat functions or that are particularly at risk due to imminent threats, vulnerability or rarity. While all fish habitats are necessary for sustaining viable fish populations, some areas may be especially important to fish viability and productivity. Protection of these areas would therefore be a high priority (Street et al. 2005). The process of identifying and designating SHAs was initiated in 2005. See Section 10 for recommended habitat and water quality actions.

10. PRINCIPAL ISSUES AND MANAGEMENT OPTIONS

A summary of the major issues and management options identified during the development of the FMP are contained in this section. Each issue is briefly described along with potential management options, recommended strategies, and actions to be taken by the MFC, DMF, and others. An in-depth discussion of habitat and water quality is found in Section 9 (Environmental Factors), while the remaining issues are discussed in Section 12 (Appendices).

10.1 ISSUES

10.1.1 Habitat

10.1.1.1 Issue/ Purpose

Protect, enhance, and restore habitats utilized by shrimp.

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

10.1.1.2 Management Options

1. No regulatory action.
2. MFC rule changes to protect additional critical habitats for shrimp.
3. Rule changes by other agencies (North Carolina Coastal Resources Commission, North Carolina Environmental Management Commission, and others) to protect critical habitats for shrimp and water quality.

Option two would require rule changes by the MFC.

10.1.1.3 Recommended Management Strategy

Habitat protection, conservation, and restoration are essential to accomplish the goal and objectives of this plan. The MFC, North Carolina Coastal Resources Commission (CRC), and North Carolina Environmental Management Commission (EMC) should adopt rules to protect critical habitats for shrimp as outlined in the Coastal Habitat Protection Plan (CHPP). The Department of Environment and Natural Resources (DENR) should develop a strategy to fully support the CHPPs process with additional staff and funding. The MFC and DMF should continue to comment on activities that may impact aquatic habitats and work with permitting agencies to minimize impacts and promote restoration and research. Research must be conducted to investigate the impacts of trawling on various habitats.

A strategy should be developed and adopted by the MFC and DENR to accomplish the actions outlined in Section 10.1.1.4. These strategies would address objectives 3, and 6 of this plan.

10.1.1.4 Actions

Actions 2, 3, 4, 5, 11, 12, and 13 would need to be implemented through the cooperative efforts of the N.C. General Assembly and several divisions within the Department of Environment and Natural Resources. The involvement of federal agencies and increased funding (state and federal) may be necessary to accomplish these actions.

Strategic Habitat Areas

Action 1: Identify and delineate Strategic Habitat Areas that will enhance protection of penaeid shrimp.

Wetlands

Action 2: Prevent loss of any additional riparian wetlands through the permitting process, land acquisition, or land use planning.

Action 3: Accelerate restoration of wetlands to enhance nursery habitat for shrimp and improve water quality.

Action 4: Increase use of effective vegetated upland and wetland buffers along coastal streams and rivers to enhance wetlands and improve water quality.

Action 5: Minimize wetland losses to estuarine shoreline stabilization by:

- o Revising CRC estuarine and public trust shoreline stabilization rules using best available information.
- o Incorporating estuarine erosion rates in siting criteria for shoreline development and stabilization measures.
- o Developing and promoting incentives for use of alternatives to vertical shoreline stabilization measures.

Soft bottom

Action 6: Protect shallow soft bottom habitat in areas that are highly utilized as shrimp nursery or foraging grounds.

Action 7: Assess the distribution, concentration, and threat of heavy metals and other toxic contaminants in freshwater and estuarine sediments and identify the areas of greatest concern to focus water quality improvement efforts.

Action 8: Evaluate the effects of clam kicking and crab dredging on soft bottom habitat and shrimp.

Submerged Aquatic Vegetation (SAV)

Action 9: Completely map all low and high salinity SAV in North Carolina.

Action 10: Expand nursery sampling to include high and low salinity SAV beds to adequately evaluate their use by penaeid shrimp and other species, and trends in those species.

Action 11: Reduce nutrient and sediment loading in the Albemarle-Pamlico system, particularly the Neuse and Tar-Pamlico rivers, to levels that will support SAV, using regulatory and non-regulatory actions.

Action 12: Evaluate dock criteria to determine if existing requirements are adequate for SAV survival and growth and modify accordingly.

Action 13: Develop and implement a comprehensive coastal marina and dock management plan and policy to minimize impacts to SAV, shell bottom, soft bottom, and water quality.

Action 14: Expand areas where dredging and trawling is not allowed to allow some recovery of SAV and shell bottom where those habitats historically occurred.

Action 15: Seek additional resources to enhance enforcement of and compliance with bottom disturbing gear restrictions that protect SAV and other habitats utilized by shrimp.

Shell bottom

Action 16: Accelerate restoration of oyster sanctuaries.

Action 17: Conduct research to evaluate the role of shell hash and shell bottom for penaeid shrimp recruitment or other ecological functions, particularly where SAV is absent.

10.1.2 Water Quality

10.1.2.1 Issue/ Purpose

Protect, enhance, and restore estuarine water quality.

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

10.1.2.2 Management Options

The MFC has no regulatory authority over water quality impacts. The MFC and DMF should highlight problem areas and advise other regulatory agencies (EMC, Division of Water Quality, Division of Environmental Health – Shellfish Sanitation, Division of Land Resources, US Army Corps of Engineers, and local governments) on preferred options and potential solutions.

10.1.2.3 Recommended Management Strategy

The MFC and DMF should continue to comment on activities (state, federal, and local permits) that may impact estuarine water quality and work with permitting agencies to minimize impacts. Additionally, the MFC and DMF should solicit and support Fishery Resource Grant (FRG) projects that may provide information necessary for protection, management, and restoration of water quality. Water quality standards should be based on the assimilative capacity of, and impacts to, the entire system. Several plans for water quality management have recommended strategies that need to be implemented to improve water quality. A strategy should be developed and adopted by the MFC and DENR to accomplish the actions outlined in Section 10.1.2.4, and to assure that recommendations of existing and future water quality plans are addressed in a timely manner. The DENR should develop a strategy to fully support the CHPPs process with additional staff and funding. Water quality protection and restoration are essential to accomplish the goal and objectives of this plan. This strategy would address objectives 3 and 6 of this plan.

10.1.2.4 Actions

Actions would need to be implemented through the cooperative efforts of the N.C. General Assembly and several divisions within the Department of Environment and Natural Resources. The involvement of federal agencies and funding (state and federal) will be necessary to accomplish these actions.

Action 1: Improve methods to reduce sediment and nutrient pollution from construction sites, agriculture, and forestry.

Action 2: Increase on-site infiltration of stormwater through voluntary or regulatory measures.

Action 3: Provide more incentives for low-impact development.

Action 4: Reduce impervious surfaces where feasible and reduce the maximum amount of impervious surfaces allowed in the absence of engineered stormwater controls.

Action 5: Current Phase II stormwater rules should be implemented and modified if found to be ineffective.

10.1.3 MANAGEMENT OF TRAWLING FOR HABITAT PROTECTION

10.1.3.1 Issue/ Purpose How does North Carolina manage estuarine trawling to minimize effects on habitat?

Shrimp trawling is a bottom disturbing fishing activity and affects hard bottom, shell bottom, submerged aquatic vegetation and soft bottom habitats where it occurs. These critical habitats provide commercially and recreationally valuable fish species with food resources, living space, and protection from predators during part of or all of their life cycle. Trawling alters these habitats by reducing structure, changing sediment size and distribution, and increasing turbidity. This in turn affects ecosystem processes such as growth of primary producers (algae and plants), nutrient regeneration, growth of secondary producers (organisms that consume other organisms), and the character of the feeding relationships of organisms within the ecosystem (the food web).

10.1.3.2 Management Options

1. Status Quo
2. Partition trawling activities from fixed gear activities
3. Decrease the amount of area open to shrimp trawling harvest
4. Modify trawl gear
5. Establish a reduced trawling season
6. Rotate trawling in existing sites
7. Use only stationary fishing gear
8. Close all trawling
9. Re-examine habitats needing protection and modify rules

10.1.3.3 Recommended Management Strategy

See area specific recommendations and action items for habitat and water quality and research recommendations. These strategies would address objectives 3 and 6 of this plan. The actions in Section 10.1.3.4 need to be implemented to accomplish these strategies.

10.1.3.4 Actions

Action 1: Implement area specific recommendations.
Action 2: Conduct necessary research.

10.1.4 SHRIMP TRAWL BYCATCH

10.1.4.1 Issue/ Purpose Bycatch in the shrimp trawl fishery.

Over the last few years, bycatch has become one of the more controversial topics in fisheries management both in the United States and around the world (Alverson et al. 1994; Crowder and Murawski 1998). In spite of increased public awareness, greater management agency scrutiny, and significant research efforts, many basic issues remain unresolved. Only recently has the term bycatch been defined in any standard manner, and important information on the magnitude of bycatch is severely lacking for many fisheries. Given this situation, it is not surprising that little is known of the impacts of bycatch on specific fisheries, fish populations, and marine communities. However, this lack of basic information has not dulled the public's interest and may, in fact, catalyze such concerns. As a result, recent public policy dictates that bycatch be either eliminated or reduced to insignificant levels (Crowder and Murawski 1998). As perhaps the prime example of the new policy positions, the re-authorized Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) contains a National Standard (#9) requiring bycatch minimization (USDOC 1996). National Standard 9 states: "Conservation and management measures shall, to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch." Additionally, in1991 the North Carolina Marine Fisheries Commission (MFC) adopted a policy directing the Division of Marine Fisheries (DMF) to establish the goal of reducing bycatch losses to the absolute minimum and to consciously incorporate that goal into all its, management considerations (Murray et. al. 1991).

10.1.4.2 Management Options

1. No rule change
2. Gear modifications
3. Catch Restrictions
4. Harvest seasons
5. Time restrictions
6. Area restrictions
7. Limited entry
8. Ban shrimp trawling

10.1.4.3 Recommended Management Strategy

See area specific recommendations and bycatch research recommendations in Appendix 3. This strategy would meet objectives 1, 2, and 6 of this plan. The actions in Section 10.1.4.4 need to be implemented to accomplish these strategies.

10.1.4.4 Actions

Action 1: Effort data needs to be collected to provide estimates based on actual time fished (or number of tows), rather than number of trips.
Action 2: Characterization work (shrimp) needs to be conducted across all strata (for example; season, areas, vessel type, and dominant species).
Action 3: Obtain mortality (immediate and post harvest) estimates of culled, active and passive, bycatch.
Action 4: Develop standard protocol for bycatch estimations.
Action 5: Continue to develop and test methods to reduce bycatch in the commercial and recreational shrimp trawl fisheries.
Action 6: Continue to develop and test alternate gears for shrimp harvest.
Action 7: Implement area specific recommendations.

10.1.5 SOUTHERN FLOUNDER BYCATCH IN THE INSHORE SHRIMP TRAWL FISHERY

10.1.5.1 Issue/ Purpose

Southern flounder bycatch in the inshore shrimp trawl fishery.

Bycatch of southern flounder were a topic of concern for the Southern Flounder Advisory

Committee. Bycatch characterization studies indicate that bycatch reduction devices currently in place are not effective for reducing southern flounder bycatch. The Southern flounder Advisory Committee recommended that Shrimp Advisory Committee address the issue of discard of sublegal southern flounder in the shrimp trawl fishery within the Shrimp FMP.

10.1.5.2 Management Options

1. No rule change
2. Gear modifications
3. Catch Restrictions
4. Harvest seasons
5. Time restrictions
6. Area restrictions
7. Limited entry
8. Ban shrimp trawling

10.1.5.3 Recommended Management Strategy

See area specific recommendations and research recommendations in Appendix 3. This strategy would meet objectives 1, 2, and 6 of this plan. The actions in Section 10.1.5.4 need to be implemented to accomplish these strategies.

10.1.5.4 Actions

Action 1: Effort data needs to be collected to provide estimates based on actual time fished (or number of tows), rather than number of trips.
Action 2: Characterization work (shrimp) needs to be conducted across all strata (for example; season, areas, vessel type, and dominant species).
Action 3: Obtain mortality (immediate and post harvest) estimates of culled, active and passive, bycatch.
Action 4: Develop standard protocol for bycatch estimations.
Action 5: Continue to develop and test methods to reduce bycatch in the commercial and recreational shrimp trawl fisheries.
Action 6: Continue to develop and test alternate gears for shrimp harvest.
Action 7: Implement area specific recommendations.

10.1.6 SHRIMP MANAGEMENT BY SIZE IN NORTH CAROLINA ESTUARIES

10.1.6.1 Issue/ Purpose At what shrimp size should waterbodies be opened to shrimp trawling?

Shrimp area openings and closures are based primarily on the size of most of the shrimp present in an area determined by extensive DMF sampling. Other factors considered in a decision to open or close an area include biological, environmental, economic and social issues in an “optimum utilization” scheme. The social aspects of management are addressed by evaluating the subjective knowledge of experienced DMF field personnel, shrimp fishermen, dealers, and others associated with the industry. When personal preferences or circumstances cloud this information, the size of the shrimp and the number of juvenile finfish in the samples assume the greatest weight in the decision.

10.1.6.2 Management Options

1. Status quo, with specific target size for openings: Pamlico Sound to White Oak River-26-30
2. Keep all areas closed that are currently intensively managed areas
3. Set dates for opening and closing areas each year
4. Management by strict minimum count rule
5. Restrict the size or number of shrimp trawls per vessel in inside waters
6. Close inside shrimping

10.1.6.3 Recommended Management Strategy

See area specific recommendations. This strategy would meet objectives 1, 2, 4, 5, and 6 of this plan. The actions in Section 10.1.6.4 need to be implemented to accomplish these strategies.

10.1.6.4 Actions

Action 1: Implement area specific recommendations.

10.1.7 SHRIMP POUND NET SETS (Shrimp Traps)

10.1.7.1 Issue/ Purpose

What is the appropriate definition and allowable use of shrimp traps?

In 2003, the DMF became aware of the emergence of a new form of shrimp pot/trap with wings. These traps are constructed of 5/8" rigid hardware cloth and have two V-shaped wings to direct the shrimp into the traps. These wings can be up to 50 feet in length and the distance between the ends of the wings is approximately 80 feet. The traps are most successful when set during a flood tide with one of the wings against a bulkhead or marsh shoreline. The devices are staked or anchored in place. The ends of the wings face away from the direction of the tide flow when deployed.

The proliferation of these shrimp traps in the relatively confined waters of the Southern District caused concern due to interference with traditional uses of the waters for shrimp trawling and navigation. The solution adopted to prevent this possible problem was to designate these shrimp traps as shrimp pound net sets. This designation requires a permit that is only available to applicants that have a Standard or Retired Commercial Fishing License (SCFL). After the proposed sets are marked and the application is completed, there is a 20-day public comment period, during which the public has an opportunity to see where the nets are proposed and comment on activities that the set would possibly interfere with. The pound net designation has had the desired effect of preventing the rapid and uncontrolled growth of these devices. Four applications in the Southern District have been denied by the Director and three additional pound net application packages have been sent out as of August 19, 2004.

10.1.7.2 Management Options

1. Status Quo
2. Define a scaled-down "recreational" version of this device in MFC Rule and add it to a list of "recreational" commercial gear in 15A NCAC 3O .0302.

10.1.7.3 Recommended Management Strategy

Investigate the use of shrimp traps as RCGL gear including size, and location restrictions. This strategy would meet objectives 1, 2, 3, 4, 5, and 6 of this plan. The actions in Section 10.1.7.4 need to be implemented to accomplish these strategies.

10.1.7.4 Actions

Action 1: Continue to develop and test alternate gears (shrimp traps) for shrimp harvest.
Action 2: Define a scaled-down "recreational" version of this device in MFC Rule and add it to a list of "recreational" commercial gear in 15A NCAC 3O .0302.
Action 3: Investigate the use of shrimp traps as RCGL gear including size, and location restrictions.

10.1.8 MANAGEMENT OF FIXED GEAR IN THE INSHORE SHRIMP FISHERY

10.1.8.1 Issue/ Purpose

Management of Channel nets.

The use of fixed gear to harvest shrimp in areas that are closed to the use of mobile gears (trawls, skimmers, seines and butterfly nets) is a common practice in the areas between Harkers Island and Topsail Inlet. The primary fixed gear used to catch shrimp in these areas is a channel net. While channel nets are allowed in areas closed to trawling, insufficient tidal current throughout much of southeastern North Carolina limits their use to only a small portion of these closed areas.

10.1.8.2 Management Options

1) Status quo
2) Restrict use to areas and times available to mobile gears

10.1.8.3 Recommended Management Strategy

Areas upstream of the Highway 172 bridge over New River and those north of the Highway 50 swing bridge in Surf City would open to channel nets when they open to mobile gears. No part of a channel net set will be allowed in the marked navigation channel from New River Inlet to the Intracoastal Waterway. This strategy would meet objectives 4, and 5 of this plan. The actions in Section 10.1.8.4 need to be implemented to accomplish these strategies.

10.1.8.4 Actions

Action 1: Issue a proclamation to close these areas to channel netting.

10.1.9 THE RECREATIONAL SHRIMP TRAWL FISHERY IN NORTH CAROLINA

10.1.9.1 Issue/ Purpose

The harvest of Penaid shrimp using the Recreational Commercial Gear License.

Shrimp are harvested recreationally throughout the state by otter trawls, seines, shrimp pots and cast nets. No license is required to use cast nets and they are allowed in all areas.

There is a 100 shrimp per person limit in those areas closed to other methods of shrimping.

Otter trawls, seines, and shrimp pots require a Recreational Commercial Gear License (RCGL) for their use and can be used in areas open to those gears. The RCGL limits the size of the gear to a 26 foot head rope for trawls, a 100 foot seine and five shrimp pots.

The DMF conducted surveys of RCGL holders in 2002 and 2003 concerning their use of this license. RCGL use of seine and shrimp pots is negligible (<0.2%).

RCGL trawlers landed 101,595 lbs of shrimp in 2002 and 47,511 lbs in 2003, a 53% reduction. A substantial reduction in harvest also occurred in the commercial fishery where landings decreased 38% year to year. RCGL landings represented only 1.0% of total commercial landings in 2002 and 0.7% in 2003. Commensurate with the year to year decline in RCGL shrimp landings and license sales, there was also a significant decline in the effort or number of trawling trips between 2002 and 2003. There were 5,373 trawling trips in 2002 as opposed to only 2,646 trips in 2003, a decrease of 51%.

The MFC has received two petitions for rulemaking since 2002 to limit the RCGL take of shrimp to no more than a 32 quart cooler and to restrict trawling by RCGL trawlers to Friday and Saturday and for 12 hours immediately following the opening of an area. The petitions were submitted to address the illegal sale of shrimp. The MFC denied those because enforcement concerns were addressed through present criminal and civil statutory authority. Additionally, the four regional committees recommended denial and there was a scarcity of data (at the time) on shrimp harvest by RCGL holders.

10.1.9.2 Management Options

1. Status quo (26’ headrope, no catch limits)
2. Impose limits on the amount of shrimp a RCGL license holder may possess
3. Prohibit trawls as an allowable gear under RCGL license
4. Area restrictions under RCGL license
5. Gear Restrictions (headrope size, mesh size)
6. Seasonal / Daily - Weekly Restrictions

10.1.9.3 Recommended Management Strategy

A 48 quart heads-on (30 quarts heads-off) maximum limit on RCGL harvest (two limits if more than one license holder is on vessel). Allow use of skimmer trawls as RCGL gear with a total headrope less than 26 feet. This strategy would meet objectives 1, 2, 3, and 5 of this plan. The actions in Section 10.1.9.4 need to be implemented to accomplish these strategies.

10.1.9.4 Actions

Action 1: Modify rule 03O .0302 by adding section (7) that allows the recreational use of skimmer trawls.

Action 2: Modify rule 03O .0303 by adding sections (e) and (f) that limits shrimp catch to 48 quarts by RCGL holders (two limits if more than one license holder is on vessel).

10.1.10 GEAR SIZE RESTRICTIONS

10.1.10.1 Issue/ Purpose Gear Size Restrictions

The size of gear allowed in the shrimp fishery has been the subject of debate particularly with respect to trawls. There are size limits on channel nets and on trawls utilized for the recreational harvest of shrimp but no restriction on the size of trawls used in the commercial shrimp fishery. Many fishermen feel that there should be a maximum limit placed on the size of trawls particularly in some of the smaller water bodies. They cite unfairness in allowing larger vessels into these areas especially on opening days when many boats crowd into an area. The feeling is that these operations take most of the shrimp, rendering areas unproductive for several days, and then leave to fish in more open waters unworkable by the smaller vessels. In addition to fairness the reduction in bycatch and decreased affect on the habitat are reasons given for a net size limit.

10.1.10.2 Management Options

1) Status quo
2) Restrict the size of gear used in the shrimp fishery.

10.1.10.3 Recommended Management Strategy

Implement a 90 foot total headrope limit for all internal waters of North Carolina except Pamlico Sound and portions of the Neuse and Pamlico Rivers. This strategy would meet objectives 1, 2, 3, 4 and 5 of this plan. The actions in Section 10.1.10.4 need to be implemented to accomplish these strategies.

10.1.10.4 Actions

Action 1: Modify rule 03L .0103 by adding sections (c) and (d) and rule 03R .0114 to implement the 90 foot total headrope limit for all internal waters of North Carolina except Pamlico Sound and portions of the Neuse and Pamlico Rivers.

10.1.11 SHRIMP MANAGEMENT IN NEW RIVER ABOVE THE HIGHWAY 172 BRIDGE

10.1.11.1 Issue/ Purpose Shrimp Management in New River.

The waters upstream of the Highway 172 bridge were designated by rule as a Special Secondary Nursery Area (SSNA) in 1996. The areas of the SSNA that are impacted by the trawling opening include the river above the bridge up to the marked closure line running from Grey's Point to the opposite side of the river. Trawling in any of the tributary creeks is prohibited. The river consists mostly of shallow bays with the exception of the marked navigation channel. Bottom types range from sand and sand/mud to live shell bottom. DMF actively manages eight Shellfish Management Areas (SMAs) in this portion of New River.

The increasing use of skimmers in the New River SSNA has positive implications for the resource in terms of minimizing waste/bycatch and disturbance to the bottom. Additionally, the trip ticket harvest data indicate this gear is more effective catching the target species than conventional otter trawls. A skimmer trawl study conducted by Sea Grant found skimmers much more effective on white shrimp than otter trawls in water less than 12 feet (most all of the water above the bridge in New River) and in some cases outfished otter trawls as much as 5-to-1.

Unlike otter trawls, the tailbag in skimmers is emptied while fishing is still underway. Consequently, the bag is emptied much more frequently, leading to significant increases in survivability of most all finfish species (Coale, et al. 1994). The majority of shrimp openings in the New River SSNA are for white shrimp since by late summer most of the brown shrimp have already emigrated.

10.1.11.2 Management Options

1. Status quo (potential opening dates set by rule and determined by sampling)
2. Prohibit otter trawls (not skimmers) as an allowable gear in New River SSNA
3. Establish timeline when otter trawls would be prohibited
4. Prohibit all trawlers and skimmers in New River SSNA
5. Net size restrictions in New River SSNA
6. Status quo but with reduction in days of week trawling allowed (Tues,Thur)

10.1.11.3 Recommended Management Strategy

Prohibit otter trawls after a four year phase in period to allow those who wish to convert to skimmers to do so. This strategy would meet objectives 1, 2, 3, 4, and 5 of this plan. The actions in Section 10.1.11.4 need to be implemented to accomplish these strategies.

10.1.11.4 Actions

Action 1: Phase out the use of otter trawls in New River after four years.

10.1.12 SHRIMP MANAGEMENT IN CHADWICK BAY

10.1.12.1 Issue/ Purpose

Shrimp Management in Chadwick Bay.

Chadwick Bay is a small high salinity waterbody encompassing 841 acres located just south of the mouth of New River and adjacent to the IWW and the New River Inlet. The southern portion of the bay is classified as a Primary Nursery Area (PNA) characterized by shallow water depth (< 5 feet) and a sandy mud substrate with patches of submerged aquatic vegetation (SAV). Fullard Creek is the major tributary of Chadwick Bay and minor tributaries include Charles Creek and Bumps Creek. The upper portion of Fullard and all of Charles Creek and Bumps Creek are designated by DMF as PNAs. Although the lower portion of Fullard Creek is not currently classified as a nursery area, it is not opened to shrimping because of the abundance of juvenile finfish. The remainder of Chadwick Bay is opened by proclamation to shrimping when the shrimp reach a harvestable size (30-40 heads-on count). The area that may open to shrimping is approximately 132 acres or 16% of the waterbody. The bottoms in the open shrimping area lacks SAV and are sandier, a little deeper than the PNAs, but still supports large numbers of juvenile and sub-adult finfish.

DMF has utilized two different strategies in managing Chadwick Bay. In some years when brown shrimp are abundant and large, the bay is opened in July along with the White Oak River, Queen’s Creek and Bear Creek. In other years when brown shrimp are less abundant, a Chadwick Bay shrimp opening on white shrimp may occur in August or September in conjunction with the openings in New River and/or Stump Sound.

The Chadwick Bay shrimp fishery is primarily conducted with trawls, although, in recent years, the use of skimmers has increased in the commercial portion of the fishery. The bay is frequently shrimped by Recreational Commercial Gear License holders, especially on opening days.

10.1.12.2 Management Options

1) Status quo (potential opening dates set by rule and determined by sampling)
2) Prohibit otter trawls (not skimmers) as an allowable gear in Chadwick Bay
3) Establish timeline when otter trawls would be prohibited
4) Prohibit all trawlers and skimmers in Chadwick Bay
5) Net size restrictions in Chadwick Bay
6) Status Quo but with reduction in days of week trawling allowed (Tues,Thur)

10.1.12.3 Recommended Management Strategy

Status quo (potential opening dates set by rule and determined by sampling) and initiate sampling to investigate if Chadwick Bay functions as a Special Secondary Nursery Area. This strategy would meet objectives 1, 2, 3, 4, and 5 of this plan. The actions in Section 10.1.12.4 need to be implemented to accomplish these strategies.

10.1.12.4 Actions

Action 1: Initiate sampling to investigate if Chadwick Bay functions as a Special Secondary Nursery Area.

10.1.13 SHRIMP MANAGEMENT IN THE INTRACOASTAL WATERWAY AND SOUNDS FROM NEW RIVER TO RICH'S INLET

10.1.13.1 Issue/ Purpose

Shrimp Management in the Intracoastal waterway and sounds from New River to Rich's inlet.

The estuarine waters of the IWW channel and the adjacent sounds and bays between New River Inlet and Rich's Inlet are managed as a single waterbody by the DMF. A section of this waterbody bounded by Marker #17 to the north and the Surf City swing bridge to the south is designated as SSNA. SSNA status (15A NCAC 03R.0105) makes it unlawful to use trawl nets in these waters except that the Fisheries Director may, by proclamation, open any portion of this area to shrimp or crab trawling from August 16 through May 14. Management rationale for this rule included minimizing bycatch by delaying the trawl opening date to reduce the finfish bycatch and to reduce user conflicts. Historical data (since 1972) collected by DMF indicates these waters support large aggregations of commercially important finfish as well as shellfish and crustaceans.

Bottom types range from mud and muddy/sand in the IWW to mostly sand near the inlets. The shallow waters of Topsail Sound and some of the estuarine areas around New River Inlet contain patches of SAV.

There are active clam and oyster fisheries in the entire area. Hand harvest for oysters and clams take place in the shallow areas throughout these waters on both public bottom and leased areas, while mechanical harvest of clams is allowed in the IWW from New River to south of the Surf City bridge ("BC" Marker). DMF maintains Shellfish Management Areas throughout the area, all of which are located in waters closed to shrimping with mobile gears. DMF and the Coastal Federation have collaborated to begin construction of oyster sanctuaries in Stump

Sound.

The typical management cycle for these waters is; the IWW north of Marker #17, the IWW south of the Surf City swing bridge and Banks Channel in Topsail Sound remain open during the entire year unless unusually high rainfall amounts or overcrowded nursery areas force large numbers of small shrimp into them prematurely. Waters in the SSNA, with the exception of the middle portion of the SSNA, are typically opened sometime after August 15. The middle portion of the SSNA from Marker #45 to the Highway 210-50 highrise bridge usually remains closed until late in the season because of the abundance of small shrimp.

The fishing is dominated by small boats that trawl, float net and skim in the main channel of the IWW and in a 100- foot strip on the side of the IWW that is open from Marker #49 to Marker #105. Channel nets are set outside of the marked channel from Marker #15 at New River to just south of the Surf City bridge and in Topsail Sound. Banks Channel serves as a migration route for emigrating shrimp and gears used there includes trawls, skimmers and most recently shrimp traps.

10.1.13.2 Management Options

1. Status quo (potential opening dates set by rule and determined by sampling)
2. Prohibit otter trawls (not skimmers) as an allowable gear in Stump/Topsail Sound
3. Establish timeline when otter trawls would be prohibited
4. Prohibit all trawlers and skimmers in Topsail/Stump Sound
5. Net or vessel size restrictions
6. Status Quo but with reduction in days of week trawling allowed (Tues,Thur)

10.1.13.3 Recommended Management Strategy

No changes to the current management strategy (potential opening dates set by rule and determined by sampling) is recommended. This strategy would meet objectives 1, 2, 3, 4, and 5 of this plan.

10.1.13.4 Actions

No new actions are required.

10.1.14 SHRIMP MANAGEMENT IN THE INTRACOASTAL WATERWAY AND SOUNDS, RICH'S INLET TO CAROLINA BEACH

10.1.14.1 Issue/ Purpose

Shrimp Management in the Intracoastal waterway and sounds, Rich's inlet to Carolina Beach.

The estuarine waters of the IWW channel and adjacent sounds between Rich's Inlet and Carolina Beach stretch over 21 miles and include four inlets separating four barrier islands, three of which (Figure 8, Wrightsville, Carolina Beach) are heavily developed. These waters are bordered on the north by Rich's Inlet and to the south by the Carolina Beach Yacht Basin (CBYB). The largest inlet is Masonboro Inlet and it is located approximately in the center of these estuaries where it separates Wrightsville Beach from Masonboro Island.

Bottom types are primarily sand throughout the area with the exception of more soft muddy substrates in the sounds and portions of the IWW. Submerged aquatic vegetation (SAV) is limited to a few patches in the shallow sound areas. There are active oyster, clam, and crab fisheries throughout the area. These fisheries are prosecuted in the sounds and along the edges of the IWW. The waters contain a few shellfish leases and DMF maintains six SMA's from Hewletts Creek north to Rich's Inlet. In addition, DMF and the Coastal Federation have collaborated on construction of an oyster sanctuary in the mouth of Hewlett's Creek. Closed shellfish areas are abundant and include all or portions of creeks on the mainland side of the IWW as well as most of the Wrightsville Beach area and buffers around numerous marinas.

Most all of these areas receive very minimum shrimping effort with little or no impact on shellfish resources. Exceptions are a section of the IWW in Myrtle Grove Sound (Williams landing) and the CBYB. Additionally, some of the channels around Wrightsville Beach also receive shrimping effort at various times during a typical year. Both commercial and recreational shrimpers utilize these waters.

The William's Landing area has been difficult to manage because the shrimp often migrate before reaching larger sizes (30-40 count, heads-on) except in the fall. In some years, large concentrations of algae (*Grassilaria* and *Ulva, spp*) prevent the use of trawls until the shrimp grow to an acceptable count while in other years there has been harvest of small shrimp. The CBYB is opened and closed based on the size of shrimp present. Channels around Wrightsville Beach remain open to allow harvest of shrimp migrating to the ocean. The area of the IWW from the Wrightsville Beach Drawbridge to Marker # 105 at Green's Channel always remains open to shrimping but historically, has received little effort from commercial or recreational fisherman.

10.1.14.2 Management Options

1. Status quo (potential opening dates set by proclamation and determined by sampling)
2. Modify existing management strategy as needed to address concerns
3. Prohibit all trawling

10.1.14.3 Recommended Management Strategy

Close IWW to trawling from Marker # 105 to Wrightsville Beach drawbridge. Manage trawling in the IWW from Marker #139 to Marker # 146 as if it were a Special Secondary Nursery Area. This strategy would meet objectives 1, 2, 3, 4, and 5 of this plan. The actions in Section 10.1.14.4 needs to be implemented to accomplish these strategies.

10.1.14.4 Actions

Action 1: Modify rule 03R .0106 by adding section (9) which closes the IWW from Marker # 105 to the Wrightsville Beach Drawbridge.

Action 2: Issue proclamations to manage the IWW from Marker # 139 to Marker # 146 as a Special Secondary Nursery area.

10.1.15 SHRIMP MANAGEMENT IN THE CAPE FEAR RIVER COMPLEX

10.1.15.1 Issue/ Purpose

Shrimp Management in the Cape Fear River Complex.

The waters of the Cape Fear River, the Basin, Second Bay, Buzzard's Bay (the Bays) and Bald Head, Cape and Bay Creeks (the Creeks) are part of the Cape Fear estuarine system. The area in the Cape Fear that is open to shrimping is dredged on a regular basis for navigation purposes. The river is managed on the size of shrimp and various parts of the River are opened and closed based on the DMF's samples.

The bays south of Fort Fisher known as the Basin or First Bay, Second Bay and Buzzard's Bay have been managed as a unit with openings and closings based on the DMF's samples. New Inlet drained these areas but closed after a series of hurricanes in the late 1990's and circulation is now through the Cape Fear. Since the inlet closing, DMF has observed a shift in the biological character of these waters towards more of a nursery area. Consequently, the size of the shrimp tends to remain small and the waters have not opened since 2001.

The Bald Head Creeks are usually opened in late June or early July based on the size of shrimp. Areas opened include the lower portions of the Creeks. The fishery is prosecuted by small skiffs. However, due to a lack of effort over the last few years, these creeks have not been opened since 2002.

10.1.15.2 Management Options

1) Status quo (potential opening dates set by proclamation and determined by sampling)
2) Status quo for the main river but establish no trawling areas in the bays south of Fort Fisher and the Bald Head creeks
3) Prohibit all trawling in Cape Fear

10.1.15.3 Recommended Management Strategy

Status quo (potential opening dates set by rule and determined by sampling) for the main river and establish no trawling areas in the bays south of Fort Fisher and the Bald Head creeks. This strategy would meet objectives 1, 2, 3, 4, and 5 of this plan. The actions in Section 10.1.15.4 need to be implemented to accomplish these strategies.

10.1.15.4 Actions

Action 1: Modify rule 03R .0106 by adding section (10) which closes the Bays adjacent to the Cape Fear River to trawling.

Action 2: Modify rule 03R .0106 by adding sections (11 and 12) which close Cape and Bald Head Creeks to trawling.

10.1.16 SHRIMP MANAGEMENT IN BRUNSWICK COUNTY

10.1.16.1 Issue/ Purpose Shrimp Management in Brunswick County.

The Brunswick County coastline stretches for approximately 33 miles and is bound by the Cape Fear River Inlet on the east end and by the Little River Inlet on the west end. Four barrier islands, all of which are densely developed, are separated by five inlets along the coastline.

The IWW in Brunswick County is managed based on the size and abundance of the shrimp taken in the DMF's samples. The area is usually open until the beginning of June when it is closed because of small brown shrimp. In most years, portions may be opened in late June or early July to allow harvest of brown shrimp and then closed in late July or early August when small white shrimp recruit to the area. Occasionally, small white shrimp may appear before the brown shrimp reach a harvestable size, thus delaying an opening until the whites are harvestable, usually in September but sometimes as late as November. Principle harvest areas are behind Oak Island, from the Holden Beach bridge to Shallotte River and from the Ocean Isle beach bridge to the Sunset Beach bridge.

The IWW channel from the Sunset Beach bridge to the South Carolina State Line and the Calabash River are rarely opened to trawling because of the abundance of small shrimp. The area from Sunset Beach bridge to Calabash River is usually opened toward the end of the season so that the shrimp won't be "lost" to South Carolina.

The channels that connect the IWW with the Atlantic Ocean usually remain open during the entire year to allow harvest of shrimp that are migrating to the ocean. In rare instances of very heavy rainfall, these channels may be closed. The areas include Elizabeth River, Dutchman Creek, Montgomery Slough, Jink's Creek and Bonaparte Creek. Trawling in Montgomery Slough and the Elizabeth River has become the subject of discussion amongst shrimpers as well as the public because of concerns about bycatch as well as interference with navigation.

Eastern Channel, located behind Ocean Isle Beach, is a shallow channel (less than 1 meter at mean low tide) that connects the IWW at Marker 93 to Jink's Creek. These waters have not been opened to harvest in the last 15 years.

The Shallotte River was opened and closed to shrimp trawling based on size and abundance until 1998. However, DMF sampling has shown that shrimp rarely reach large sizes and the head-on counts remain greater than 60 during most of the season. Consequently, the last time DMF opened Shallotte River was a span of time in 1998 between July 8 and September 9. There is a small channel net fishery (<3 participants) that has operated in Shallotte River sporadically during 1994-2003. The confidentiality policy of the DMF Trip Ticket Program prevents disclosure of these data.

10.1.16.2 Management Options

1. Status quo (potential opening dates set by proclamation and determined by sampling)
2. Modify existing management strategy as needed: (Prohibit commercial and recreational shrimping, except for cast nets, as in MFC Rule 3L.0104).
3. Prohibit all trawling

10.1.16.3 Recommended Management Strategy

No changes to the current management strategy (potential opening dates set by proclamation and determined by sampling) is recommended. This strategy would meet objectives 1, 2, 3, 4, and 5 of this plan.

10.1.16.4 Actions

No new action is required.

10.1.17 SHRIMP MANAGEMENT IN CORE SOUND

10.1.17.1 Issue/ Purpose

Shrimp Management in Core Sound.

The banks side of Core Sound north of Drum Inlet is a shallow sand bottom area with patches of SAVs. This shallow water/SAV habitat in Core Sound south of Drum Inlet and in southern Pamlico Sound from Wainwright Island north to Oregon Inlet is protected from shrimp trawling and mechanical clam harvest by different methods. The Wainwright Island to Oregon Inlet zone along the banks is designated as a no trawl area. The area from Drum Inlet south to Cape Lookout is also a no trawl area.

The tributaries of Core Sound on the mainland side are designated as Special Secondary Nursery Areas (SSNA). They include Jarrett Bay, Brett Bay, Nelson Bay, Thorofare Bay-Barry Bay and Cedar Island Bay. These bays can be opened after August 16th when shrimp reach a harvestable size and fish abundance is at relatively lower levels. Historically these openings have been coordinated whenever possible with the October opening of Newport River to diffuse effort, even though they can now be opened as early as mid-August.

10.1.17.2 Management Options

1. Status quo (potential to open up to PNA line when shrimp size sufficient)
2. Prohibit all shrimp trawlers in SSNAs of Core Sound
3. Status quo (Core Sound banks side opened)
4. Close grassbed areas on the banks side of northern Core Sound

10.1.17.3 Recommended Management Strategy

Make banks side north of Drum Inlet to Wainwright Island a Trawl Net Prohibited Area. This strategy would meet objectives 1, 2, 3, 4, and 5 of this plan. The actions in Section 10.1.17.4 need to be implemented to accomplish these strategies.

10.1.17.4 Actions

Action 1: Modify rule 03R .0106 by modifying section (1) to include the area from Drum Inlet to Wainwright Island as a Trawl Net Prohibited area.

10.1.18 SHRIMP MANAGEMENT IN THE NEWPORT RIVER

10.1.18.1 Issue/ Purpose

Shrimp Management in the Newport River.

The Newport River is relatively small estuary of about 63 square miles located north of Morehead City in Carteret County. Its average depth is three feet with maximum depth in natural channels of six feet and 40 feet in the dredged channels near the State Port. The western portion of Newport River has bottoms composed of silts, clays and oyster rocks and the eastern part is composed of firm sand bottom. The river has a long history of disagreements concerning where the proper location of the shrimp line should be. During the long period of conflict that peaked in the mid-1980s, the line would be moved three or four times a season in response to political lobbying and shrimp size variation.

Shrimp harvest generally begins in June when there are pink shrimp present and can continue into November when white shrimp are abundant. Although the conflict over the location of the line has greatly decreased in recent years, Newport River is still the source of controversy at times in the fall. The primary conflict is between the full-time commercial fishermen, who generally want a line downstream where the bigger shrimp will migrate to them when they reach a marketable size, and the part-time fishermen, who want a line farther upstream to access the shrimp in shallower water, harvest the majority of them, and return to jobs or hunting season.

10.1.18.2 Management Options

1. Status quo (potential to open to PNA line when shrimp size sufficient)
2. Establish timeline when otter trawls would be prohibited
3. Implement permanent line at Penn Point-Hardesty Farm line
4. Prohibit all shrimp trawlers in Newport River

10.1.18.3 Recommended Management Strategy

Implement permanent Penn Point-Hardesty Farms line. This strategy would meet objectives 1, 2, 3, 4, and 5 of this plan. The actions in Section 10.1.18.4 need to be implemented to accomplish these strategies.

10.1.18.4 Actions

Action 1: Modify rule 03R .0106 by adding section (7) to implement a permanent Penn Point-Hardesty Farms line in Newport River upstream of which is close dto trawling.

10.1.19 SHRIMP MANAGEMENT IN BOGUE SOUND AND NORTH RIVER

10.1.19.1 Issue/ Purpose

Shrimp Management in Bouge Sound and North River.

Bogue Sound is located in Carteret County and lies between the State Port in Morehead City to the east and the town of Emerald Isle to the west. The sound is closed to trawling north of the IWW on the mainland side because of SAV and some shellfish beds. The tributaries of Broad, Gales, Jumping Run, and Saunders creeks are designated Primary Nursery Areas. The closure of the mainland side of the ICW serves as a buffer zone to the PNAs and shrimp are harvested from the ICW as they are migrating toward the inlets (Beaufort and Bogue). There have been requests to open the northern side of the ICW, particularly around Broad Creek when white shrimp are abundant. These requests usually come from skimmer trawl fishermen who have problems fishing in the waterway.

There is also a rectangular section of Bogue Sound in the western portion that is closed to trawling in order to protect seagrass beds with bay scallops which are located there. Most of Bogue Sound outside of the IWW is too shallow to trawl in, but there is a channel on the banks side that runs along the village of Salter Path and one that runs along Pine Knoll Shores that are trawled.

North River is located west of Beaufort and east of Harkers Island. It also has a history of line moving disputes between a downstream line at Long Point line and an upstream line called the Oyster House line. Both lines were established to protect small brown shrimp in the early summer (Long Point line) and small white shrimp in the fall (Oyster House line). The source of conflict was the appropriate time to open trawling up to the Oyster House line. Concerns with opening the area too late include the shrimp running on a northeast wind as well as running on rain and/or full or new moon because of its close proximity to Beaufort Inlet.

10.1.19.2 Management Options

1. Status quo (opening dates determined by shrimp size)
2. Establish a timeline when otter trawls would be prohibited in Bogue Sound
3. Prohibit all otter trawls and skimmer trawls in Bogue Sound

10.1.19.3 Recommended Management Strategy

No changes to the current management strategy (opening dates determined by shrimp size) is recommended. This strategy would meet objectives 1, 2, 3, 4, and 5 of this plan.

10.1.19.4 Actions

No new action is needed.

10.1.20 SHRIMP MANAGEMENT IN THE WHITE OAK RIVER

10.1.20.1 Issue/ Purpose Shrimp Management in the White Oak River.

White Oak River is located on the Onslow/Carteret County line and has the town of Swansboro at its mouth. Due to the presence of oyster rocks and shoals, there are only a few places that are able to be trawled in the White Oak. They are Hills Bay below Jones Island, the mouth of Pettiford Creek, the Turnstake, Cahoon's Slough above Jones Island, and the Gator Gap upstream near Bluff Point.

The river is closed at the Highway 24 Bridge with the issuance of the first shrimp proclamation in early June. Sampling for opening White Oak River generally begins around the end of June because of the tendency for shrimp there to migrate out before they "normally should". Historically, the DMF has opened White Oak between July 10 and July 20. For years, the river was opened to the Gator Gap where the river widens near Bluff Point. Small shrimp were often forced across that line and the DMF has tried alternative line locations with varying success that allow for shrimping in the lower portion of the river while protecting small brown and white shrimp upstream. Adjusting the line is difficult due to the amount of oyster rocks in the river. Shrimpers like to tow on the line, therefore placement of the line over oyster rock can lead to habitat destruction of those rocks.

Issues that must be considered in the management of this river besides shrimp size are weather conditions and lunar stage. Early northerly winds with a lot of rain or a hurricane can force the small shrimp to run before the normal opening dates. A full or new moon on top of that may also cause the DMF to open on a smaller count so they can be caught.

Occasionally, shrimp will not reach a 45-55 count but will remain at a small size throughout the season. In this case, the DMF may open on a smaller count. The river may or may not close due to small white shrimp. Over the past few years, once the river has been open, a closure for small whites has not been needed as the two species seem to segregate within the river very well with small whites staying up the river above the closure line in the lower salinities while the larger brown shrimp have moved down in the open area. However, when there is good sign of small white shrimp, the river has been closed in September.

With the bridge being the closure line, there is no shrimp trawling allowed in White Oak River when it is closed. If the shrimp leave before the river is opened, then the only fishermen who benefit are a few channel net fishermen and maybe ocean trawlers. Options have been considered to leave the river closed at all times to protect the oyster rocks, but that is inconsistent with permitting mechanical clam harvest up to the Turnstake and does not allow trawlers to catch the shrimp at all.

10.1.20.2 Management Options

1. Status quo (opening dates determined by shrimp size)
2. Establish a "permanent" line from the Turnstake downstream to allow harvest when shrimp begin to migrate
3. Establish a timeline when otter trawls would be prohibited in White Oak River
4. Prohibit all otter trawls and skimmer trawls in White Oak River

10.1.20.3 Recommended Management Strategy

Straighten the Hancock Point area line for ease of enforcement. However, the line shall not be placed upstream of the Hancock Point area for protection of oyster rocks and small shrimp. This strategy would meet objectives 1, 2, 3, 4, and 5 of this plan. The action in Section 10.1.20.4 needs to be implemented to accomplish these strategies.

10.1.20.4 Actions

Action 1: Modify rule 03R .0106 by adding section (8) to implement a permanent line in White Oak River upstream of which is closed to trawling.

10.1.21 SHRIMP MANAGEMENT IN NEUSE RIVER

10.1.21.1 Issue/ Purpose

Shrimp Management in the Neuse River.

The Neuse River is one of the state's larger rivers and separates Pamlico County to the north from Craven and Carteret counties to the south. The river is one mile wide at New Bern and five miles wide near its mouth, with depths in that stretch ranging from 12 to 23 feet. Although shrimp and crab trawling are technically permitted from New Bern downstream to the Pamlico Sound (except when closed due to small shrimp size), shrimp are only found as far upstream as Slocum Creek. The majority of the Neuse tributaries are designated primary (2,835 acres), secondary (2,358 acres), or special secondary (963 acres) nursery areas. Shrimp generally grow in these nursery areas during the early spring and begin migrating out of them and into the river proper in July. Once in the river, they migrate around Cedar Island into Core Sound, or down Adams and Clubfoot creeks toward Beaufort Inlet to the ocean.

Neuse River ranks third in the state behind Pamlico and Core sounds in shrimp trawl landings. From 1994 to 2003 landings have ranged from 19,942 pounds to 216,922 pounds and averaged 135,369 pounds. Value of shrimp catches during those years ranged from $43,989 to $471,504 and averaged $ 304,502. Of the commercial landings in Neuse River from 1994 through 2003, 95.72% were harvested by shrimp trawls, 3.84% by skimmer nets, and 0.25% by channel nets. During that period, 4,542 trawl trips were made by 824 licensees for an average of 452 trips per year by 82 participants.

10.1.21.2 Management Options

1. Status quo (potential to close and open when shrimp are of sufficient size)

2. Implement closure of Neuse River and Adams Creek with initial June proclamation and open in mid July when the majority of the shrimp reach 30-35 count (heads on)
3. Prohibit all shrimp trawlers in Neuse River and tributaries
4. Prohibit shrimp and crab trawling (Prohibited Trawling Area) upstream of a line from Wilkinson Point to Cherry Point

10.1.21.3 Recommended Management Strategy

Restrict total headrope to 90 feet upstream of a line between Windmill Point at Oriental and Winthrop Point at Adams Creek. Never open above Wilkinson Point to Cherry Point to reduce overall trawling impact on river bottom and crabs and finfish. This strategy would meet objectives 1, 2, 3, 4, and 5 of this plan. The actions in Section 10.1.21.4 need to be implemented to accomplish these strategies.

10.1.21.4 Actions

Action 1: Modify Rule 3R 0.006 (7) TRAWL NETS PROHIBITED, to close waters to shrimp trawling above Wilkinson Point to Cherry Point.

Action 2: Modify Rule 3L 0.0103 PROHIBITED NETS AND MESH SIZES, to restrict total headrope to 90 feet upstream of a line between Windmill Point at Oriental and Winthrop Point at Adams Creek.

10.1.22 SHRIMP MANAGEMENT IN BAY RIVER

10.1.22.1 Issue/ Purpose

Shrimp Management in Bay River.

Bay River is a tributary of Pamlico Sound, located in Pamlico County, between the Pamlico and Neuse rivers. The main bottom type in Bay River is soft mud, with patches of hard sand bottom. The shallow waters of the feeder creeks and bays contain patches of submerged aquatic vegetation (wild celery, and widgeongrass). Trawling (shrimp and crab) is only allowed in the main stem of the river. All feeder creeks and bays are classified as either Nursery Areas (Primary or Secondary) or no trawl areas.

Bay River accounts for 0.2% of the total statewide shrimp production. Average annual shrimp landings are 13,917 pounds, with an average dockside value of $31,562. Ninety-seven percent of the shrimp landed from Bay River are caught by shrimp trawls.

10.1.22.2 Management Options

1. Status quo (potential to close and open when shrimp are of sufficient size)
2. Harvest Season (Month (s), or Month (s)/Day (s) closures)
   a) Implement closure of Bay River with initial June proclamation and open in mid July (based on predetermined heads-on count).
   b) Implement split season for commercial and RCGL shrimpers (same as # 2 above except open to RCGL harvest 1 or 2 weeks prior to commercial opening)
   c) Open in July (based on predetermined heads-on count or pre determined date) and close to shrimp trawling in mid to late August
3. Area Closures
   a) Prohibit all shrimp trawlers in Bay River
   b) Close portions of the river to shrimp trawl harvest.
4. Regulate Means and Methods (gear and vessel)

a) Implement headrope size limit on shrimp trawlers working in Bay River
 + Allows for all size classes of vessels to work
b) Increase tailbag mesh size.
c) Implement maximum vessel length restriction on shrimp trawlers working in Bay River

10.1.22.3 Recommended Management Strategy

Open in July and close to shrimp trawling in mid to late August. Implement 90 foot headrope size limit on shrimp trawlers working in Bay River. This strategy would meet objectives 1, 2, 3, 4, and 5 of this plan. The actions in Section 10.1.22.4 need to be implemented to accomplish these strategies.

10.1.22.4 Actions

Action 1: Modify existing proclamations to open and close based on count size and abundance.
Action 2: Modify Rule 3L 0.0103 PROHIBITED NETS AND MESH SIZES, to restrict total headrope to 90 feet upstream of a line between Maw Point and Bay River Point

10.1.23 SHRIMP MANAGEMENT IN THE PAMLICO RIVER

10.1.23.1 Issue/ Purpose Shrimp Management in the Pamlico River.

The Pamlico River is a tributary of Pamlico Sound. The main bottom type is soft mud, with patches of hard sand bottom in waters less than six feet deep. The shallow waters of the feeder creeks and bays contain patches of submerged aquatic vegetation (wild celery, and widgeongrass).

Trawling (shrimp and crab) is only allowed in the main stem of the river. All feeder creeks and bays are classified as either Nursery Areas (Primary, Secondary, Special Secondary) or Inland Waters all of which are closed to trawling. Overall this system is approximately 82,705 acres in size. 76,516 acres are under DMF jurisdiction. 1,414 acres are classified as Primary Nursery areas, 11,231 acres as Secondary Nursery areas, 2,736 acres as Special Secondary Nursery areas, and 1,184 acres of no trawl areas. Seventy-nine percent of the water under DMF jurisdiction is open to trawling.

Pamlico River accounts for 0.6% of the total statewide shrimp production. Average annual shrimp landings are 38,301 pounds, with an average dockside value of $91,355. Ninety-eight percent of the shrimp landed from the Pamlico River are caught by shrimp trawls (1994 – 2003 Trip ticket Data). Other gears with reported shrimp landings are; skimmer trawls (0.96%), crab trawls (0.49%), crab pots (0.14%), seines (0.06%), and sink gill net (0.02%).

10.1.23.2 Management Options

1. Status quo (potential to close and open when shrimp are of sufficient size)
2. Harvest Season (Month (s), or Month (s)/Day (s) closures)
   a) Implement closure of Pamlico River with initial June proclamation and open in mid July (based on predetermined heads-on count).
   b) Implement split season for commercial and RCGL shrimpers (same as # 2 above except open to RCGL harvest 1 or 2 weeks prior to commercial opening)

c) Open in July (based on predetermined heads-on count or pre determined date) and close to shrimp trawling in mid to late August

3. Area Closures
   a) Prohibit all shrimp trawlers in Pamlico River
   b) Close portions of the river to shrimp trawl harvest.
4. Regulate Means and Methods (gear and vessel)
   a) Implement headrope size limit on shrimp trawlers working in Pamlico River
   b) Increase tailbag mesh size.
   c) Implement maximum vessel length restriction on shrimp trawlers working in Pamlico River

10.1.23.3 Recommended Management Strategy

Open in July and close to shrimp trawling in August (July 7 through August 7). All waters upstream of a line from Wades Point to Goose Creek will be closed to shrimp trawling and implement a 90 feet maximum combined headrope length in the open portion of the Pamlico River (upstream of a line from Pamlico Point to Willow Point). This strategy would meet objectives 1, 2, 3, 4, and 5 of this plan. The actions in Section 10.1.23.4 need to be implemented to accomplish these strategies.

10.1.23.4 Actions

Action 1: Modify Rule 3L 0.0103 PROHIBITED NETS AND MESH SIZES, to restrict total headrope to 90 feet upstream of a line between Pamlico Point and Willow Point.

Action 2: Modify Rule 3R 0.006 (7) TRAWL NETS PROHIBITED, to close waters to trawling upstream of a line between Wades Point and Goose Creek.

10.1.24 SHRIMP MANAGEMENT IN PUNGO RIVER

10.1.24.1 Issue/ Purpose

Shrimp Management in the Pungo River.

The Pungo River is a tributary of Pamlico Sound. The main bottom type is soft mud, with patches of hard sand bottom. The shallow waters of the feeder creeks contain patches of submerged aquatic vegetation (wild celery, eel grass, and widgeongrass).

Trawling (shrimp and crab) is only allowed in the main stem of the river. All feeder creeks are classified as either Nursery Areas (Primary, Secondary, Special Secondary) or Inland waters all of which are closed to trawling. Overall the Pungo River is approximately 32,741 acres in size. Of that 25,530 acres are open to trawling. The remainder is either nursery areas (4,361 acres) or inland waters (3,850 acres) all of which is closed to trawling. Other commercial fisheries in the Pungo River include crab pot, crab trawl, gill net, eel potting, pound netting, and long-haul.

The Pungo River accounts for 0.05% of the total statewide shrimp production. Average annual shrimp landings are 3,862 pounds, with an average dockside value of $8,565. Ninety-nine percent of the shrimp landed from Pungo River are caught by shrimp trawls (1996 – 2003 Trip ticket Data). The remaining shrimp landings were reported from crab pots, and dip nets.

10.1.24.2 Management Options

1. Status quo (potential to close and open when shrimp are of sufficient size)

2. Harvest Season (Month (s), or Month (s)/Day (s) closures)
    a) Implement closure of Pungo River with initial June proclamation and open in mid July (based on predetermined heads-on count).
    b) Implement split season for commercial and RCGL shrimpers (same as # 2 above except open to RCGL harvest 1 or 2 weeks prior to commercial opening)
    c) Open in July (based on predetermined heads-on count or pre determined date) and close to shrimp trawling in mid to late August
3. Area Closures
    a) Prohibit all shrimp trawlers in Pungo River
    b) Close portions of the river to shrimp trawl harvest.
4. Regulate Means and Methods (gear and vessel)
    a) Implement headrope size limit on shrimp trawlers working in Pungo River
    b) Increase tailbag mesh size.
    c) Implement maximum vessel length restriction on shrimp trawlers working in Pungo River

10.1.24.3 Recommended Management Strategy

All waters upstream of a line from Wades Point to Abels Bay will be closed to shrimp trawling. This strategy would meet objectives 1, 2, 3, 4, and 5 of this plan. The action in Section 10.1.24.4 needs to be implemented to accomplish this strategy.

10.1.24.4 Actions

Action 1: Modify Rule 3R 0.006 (7) TRAWL NETS PROHIBITED, to close waters to trawling upstream of a line between Wades Point and Abels Bay (DMF option).

10.1.25 SHRIMP MANAGEMENT IN THE ATLANTIC OCEAN

10.1.25.1 Issue/ Purpose Shrimp Management in the Atlantic Ocean.

North Carolina’s coastline on the Atlantic Ocean is comprised of barrier islands that stretch approximately 484 kilometers. Shoals extending perpendicular from shore accompany capes and inlets along North Carolina’s coastal ocean. On average, 24% of shrimp landed in North Carolina are harvested from these nearshore (< 3 miles) ocean waters. Near-shore hardbottom areas, dense concentrations of marine algae, artificial reefs and shipwrecks limit the amount of trawlable bottom available to commercial fishers.

Since shrimp that migrate from the estuaries are usually large, the DMF does not actively manage the ocean waters. However, during the past few years and exclusively off the Brunswick county coast, DMF has been requested by the fishermen to take a more active role in the management of the ocean shrimp fishery. These requests were precipitated as result of the heavy hurricane or tropical storm induced rains that have impacted southeastern North Carolina with regularity since the mid 1990s. Fresh water from these heavy rains dramatically reduces salinities in the estuaries causing the shrimp to prematurely migrate from the estuaries into the ocean. When this occurs, DMF generally closes the impacted ocean and estuarine waters. With the exception of 2001, closures of this nature have occurred each year during the period 1999-2003.

An average of 221 vessels landed shrimp from the ocean during 1994-2003.

10.1.25.2 Management Options

1. Status quo (potential opening dates set by proclamation and determined by sampling)
2. Allow night-time trawling off Brunswick County.
3. Prohibit weekend trawling off Brunswick County
4. Prohibit all trawling

10.1.25.3 Recommended Management Strategy

Status quo (potential opening dates set by proclamation and determined by sampling). This strategy would meet objectives 1, 2, 3, 4, and 5 of this plan.

10.1.25.4 Actions

No new action is required.

10.1.26 SHRIMP MANAGEMENT IN PAMLICO SOUND

10.1.26.1 Issue/ Purpose Shrimp Management in Pamlico Sound.

The Pamlico Sound system extends from Oregon Inlet south to Core Sound. Salinity varies from 25 - 30 ppt near the three inlets to near zero in the upper tributaries. Two large river systems (Neuse and Tar-Pamlico) provide the major fresh water inputs. The average depth of the sound is 16 ft. Numerous small creeks and bays surround Pamlico Sound. The Sound is divided into two basins east and west of Bluff Shoal. Extensive low salinity *Juncus* marshes border the sound and many of the tributary bays and creeks. Significant SAV beds occur in the sound, with high salinity species (e.g., eel grass) along the shoals behind the Outer Banks in the east and low salinity species (e.g., widgeon grass, wild celery) along some of the western shores. There are diurnal tides of 2 - 3 ft near the three inlets, but virtually no lunar tides away from the inlet areas. However, wind tides exceeding 2 ft regularly occur during storms.

Trawling (shrimp and crab) is only allowed in the main portion of the sound. All feeder creeks and bays are classified as either Nursery Areas (Primary, Secondary, Special Secondary) or no trawl areas all of which are closed to trawling (Map 2). Overall this system is approximately 1,129,577 acres in size. 1,088,258 acres are under DMF jurisdiction (coastal and joint waters). 5,400 acres are classified as Primary Nursery areas, 30,184 acres as Secondary Nursery areas, 1,916 acres as Special Secondary Nursery areas, and 172,128 acres of no trawl areas. Seventy-nine percent of the water under DMF jurisdiction is open to trawling. Other commercial fisheries in Pamlico Sound include crab pot, crab trawl, crab dredging, oyster dredging, clam kicking, gill net, pound netting, and long-haul. Over the last 11 years, portions of western Pamlico Sound (Mouth's of Rose, Spencer, SwanQuater, and Juniper bay's) have been closed six times to shrimp trawling.

Pamlico Sound accounts for 51% of the total statewide shrimp production. Average annual shrimp landings are 3,637,844 pounds, with an average dockside value of $8,993,767. Ninety-nine percent of the shrimp landed from the Pamlico Sound are caught by shrimp trawls (1994 – 2003 Trip ticket Data). Other gears with reported shrimp landings are; channel net (0.01%) skimmer trawls (0.03%), and crab trawls (0.03%).

10.1.26.2 Management Options

1. Status quo (potential to close and open when shrimp are of sufficient size)
2. Harvest Season (Month (s), or Month (s)/Day (s) closures)
   a) Implement closure of Pamlico Sound with initial June proclamation and open in mid July (based on predetermined heads-on count).
   b) Implement split season for commercial and RCGL shrimpers (same as # 2 above except open to RCGL harvest 1 or 2 weeks prior to commercial opening)
   c) Open in July (based on predetermined heads-on count or pre determined date) and close to shrimp trawling in mid to late August
3. Area Closures
   a) Prohibit all shrimp trawlers in Pamlico Sound
   b) Close portions of the river to shrimp trawl harvest.
4. Regulate Means and Methods (gear and vessel)
   a) Implement headrope size limit on shrimp trawlers working in Pamlico Sound
   b) Increase tailbag mesh size.
   c) Implement maximum vessel length restriction on shrimp trawlers working in Pamlico Sound

10.1.26.3 Recommended Management Strategy

Status quo, potential to close and open when shrimp are of sufficient size. This strategy would meet objectives 1, 2, 3, 4, and 5 of this plan.

10.1.26.4 Actions

No new action is required.

10.1.27 SHRIMP MANAGEMENT IN ROANOKE SOUND

10.1.27.1 Issue/ Purpose

Shrimp Management in the Roanoke Sound.

Roanoke Sound system extends from Oregon Inlet north, along the east side of Roanoke Island to Albemarle Sound. Trawling (shrimp and crab) is only allowed in the main portion of the sound. With the exception of Outer Broad Creek, all feeder creeks and bays are classified as either Nursery Areas (Primary, Secondary, Special Secondary) or no trawl areas, all of which are closed to trawling. This system is approximately 21,168 acres in size. One hundred sixty seven acres are classified as Primary Nursery areas, 168 acres as Secondary Nursery areas, and 468 acres as Special Secondary Nursery areas. The majority of the shrimp trawling in Roanoke Sound occurs in Roanoke channel, Outer Broad Creek, and the Wanchese Channel. Special secondary nursery areas of Outer Shallowbag Bay, and Kitty Hawk Bay-Buzzard Bay, are also popular, when open. Other commercial fisheries in Roanoke Sound include crab pot, crab trawl, gill net, pound netting, fyke net and long-haul.

Roanoke Sound accounts for 0.11% of the total statewide shrimp production. Average annual shrimp landings are 7,959 pounds, with an average dockside value of $16,514. Ninety-five percent of the shrimp landed from the Roanoke Sound are caught by shrimp trawls (1994 – 2003 Trip ticket Data). Other gears with reported shrimp landings are crab pots (3.09%), peeler pots (1.45%), and crab trawls (0.02%).

10.1.27.2 Management Options

1. Status quo (potential to close and open when shrimp are of sufficient size)
2. Harvest Season (Month (s), or Month (s)/Day (s) closures)
   a) Implement closure of Roanoke Sound with initial June proclamation and open in mid July (based on predetermined heads-on count).
   b) Implement split season for commercial and RCGL shrimpers (same as # 2 above except open to RCGL harvest 1 or 2 weeks prior to commercial opening)
   c) Open in July (based on predetermined heads-on count or pre determined date) and close to shrimp trawling in mid to late August
3. Area Closures
   a) Prohibit all shrimp trawlers in Roanoke Sound
   b) Close portions of the Sound to shrimp trawl harvest.
4. Regulate Means and Methods (gear and vessel)
   a) Implement headrope size limit on shrimp trawlers working in Roanoke Sound
   b) Increase tailbag mesh size.
   c) Implement maximum vessel length restriction on shrimp trawlers working in Roanoke Sound

10.1.27.3 Recommended Management Strategy

Status quo, potential to close and open when shrimp are of sufficient size. This strategy would meet objectives 1, 2, 3, 4, and 5 of this plan.

10.1.27.4 Actions

No new action is needed.

10.1.28 SHRIMP MANAGEMENT IN CROATAN SOUND

10.1.28.1 Issue/ Purpose

Shrimp Management in the Croatan Sound.

Croatan Sound is bound by Pamlico Sound to the south, extends along the west side of Roanoke Island, to Albemarle Sound to the North This system is approximately 26,272 acres in size. There is one nursery areas in Croatan Sound, Spencers Creek, which is closed to trawling. Additionally, one hundred and thirty five acres are classified as inland areas and are closed to trawling. The majority of the shrimp trawling in Croatan Sound occurs in deep holes and sloughs. Other commercial fisheries in Croatan Sound include crab pot, crab trawl, gill net, and pound netting,

Croatan Sound accounts for 0.14% of the total statewide shrimp production. Average annual shrimp landings are 9,605 pounds, with an average dockside value of $23,067. Ninety-eight percent of the shrimp landed from the Croatan Sound are caught by shrimp trawls (1994 – 2003 Trip ticket Data). Other gears with reported shrimp landings are crab pots (1.3%), and crab trawls (0.1%).

10.1.28.2 Management Options

1. Status quo (potential to close and open when shrimp are of sufficient size)
2. Harvest Season (Month (s), or Month (s)/Day (s) closures)
   a) Implement closure of Croatan Sound with initial June proclamation and open in

mid July (based on predetermined heads-on count).
b) Implement split season for commercial and RCGL shrimpers (same as # 2 above except open to RCGL harvest 1 or 2 weeks prior to commercial opening)
c) Open in July (based on predetermined heads-on count or pre determined date) and close to shrimp trawling in mid to late August

3. Area Closures
   a) Prohibit all shrimp trawlers in Croatan Sound
   b) Close portions of the Sound to shrimp trawl harvest.
4. Regulate Means and Methods (gear and vessel)
   a) Implement headrope size limit on shrimp trawlers working in Croatan Sound
   b) Increase tailbag mesh size.
   c) Implement maximum vessel length restriction on shrimp trawlers working in Croatan Sound

10.1.28.3 Recommended Management Strategy

Status quo, potential to close and open when shrimp are of sufficient size. This strategy would meet objectives 1, 2, 3, 4, and 5 of this plan.

10.1.28.4 Actions

No new action is needed.

10.2 SUMMARY OF MANAGEMENT ACTIONS

10.2.1 Rules (new, modifications, or technical changes)

See Appendix 28 for proposed rules.

10.2.2 Legislative Action

No legislative action is required.

10.2.3 Processes

1. Identify and delineate Strategic Habitat Areas (shallow soft bottom, low and high salinity SAV, and shell bottom) that will enhance protection of penaeid shrimp.
2. Prevent loss of any additional riparian wetlands through the permitting process, land acquisition, or land use planning.
3. Accelerate restoration of wetlands to enhance nursery habitat for shrimp and improve water quality.
4. Increase use of effective vegetated upland and wetland buffers along coastal streams and rivers to enhance wetlands and improve water quality.
5. Minimize wetland losses to estuarine shoreline stabilization by:
   I. Revising CRC estuarine and public trust shoreline stabilization rules using best available information.
   II. Incorporating estuarine erosion rates in siting criteria for shoreline development and stabilization measures.
   III. Developing and promoting incentives for use of alternatives to vertical shoreline stabilization measures.

6. Protect shallow soft bottom habitat in areas that are highly utilized as shrimp nursery or foraging grounds.
7. Assess the distribution, concentration, and threat of heavy metals and other toxic contaminants in freshwater and estuarine sediments and identify the areas of greatest concern to focus water quality improvement efforts.
8. Evaluate the effects of clam kicking and crab dredging on soft bottom habitat and shrimp.
9. Completely map all low and high salinity SAV in North Carolina.
10. Expand nursery sampling to include high and low salinity SAV beds to adequately evaluate their use by penaeid shrimp and other species, and trends in those species.
11. Reduce nutrient and sediment loading in the Albemarle-Pamlico system, particularly the Neuse and Tar-Pamlico rivers, to levels that will support SAV, using regulatory and non-regulatory actions.
12 Evaluate dock criteria to determine if existing requirements are adequate for SAV survival and growth and modify accordingly.
13. Develop and implement a comprehensive coastal marina and dock management plan and policy to minimize impacts to SAV, shell bottom, soft bottom, and water quality.
14. Expand areas where dredging and trawling is not allowed to allow some recovery of SAV and shell bottom where those habitats historically occurred.
15. Seek additional resources to enhance enforcement of and compliance with bottom disturbing gear restrictions that protect SAV and other habitats utilized by shrimp.
16 Accelerate restoration of oyster sanctuaries.
17. Conduct research to evaluate the role of shell hash and shell bottom for penaeid shrimp recruitment or other ecological functions, particularly where SAV is absent.
18. Improve methods to reduce sediment and nutrient pollution from construction sites, agriculture, and forestry.
19. Increase on-site infiltration of stormwater through voluntary or regulatory measures.
20. Provide more incentives for low-impact development.
21. Reduce impervious surfaces where feasible and reduce the maximum amount of impervious surfaces allowed in the absence of engineered stormwater controls.
22. Current Phase II stormwater rules should be implemented and modified if found to be ineffective.

10.2.4 Management Related Research (not ranked in order of priority)

1. Bycatch characterization work needs to be conducted across all strata (for example; season, areas, vessel type, and dominant species).

2. Obtain mortality (immediate and post harvest) estimates of culled, active and passive, bycatch.

3. Develop standard protocol for bycatch estimations.

4. Continue to develop and test methods to reduce bycatch in the commercial and recreational shrimp trawl fisheries.

5. Continue to develop and test alternate gears (shrimp traps) for shrimp harvest.

6. Initiate sampling to investigate if Chadwick Bay functions as a Special Secondary Nursery Area

10.2.5 Biological Research Needs (not ranked in order of priority)

1. Define and quantify the intensity, duration and spatial scale of trawling effort in NC estuaries.

2. Map and quantify the habitat structure and sediment types in North Carolina estuaries.

3. Determine the effects of trawling on sediment size distribution and organic carbon content.

4. Determine the effect of trawling on water quality and primary productivity.

5. Determine the physical effects of currents, storms, animal activities, etc. on sediment disturbances and compare to mobile fishing gear effects.

6. Determine the effects trawling and recovery time of benthic community structure in different habitat types

7. Determine the effects of trawling on secondary productivity and how it affects local pathways of food energy transfer.

10.2.6 Social and Economic Research Needs (ranked in order of priority)

1. Determine the extent of non-RCGL recreational shrimp harvest that is occurring. This group primarily is those who use cast nets to take shrimp either for bait or personal consumption.

10.2.7 Data Needs

1. Effort data needs to be collected to provide estimates based on actual time fished (or number of tows), rather than number of trips.

2. Develop standard protocol for bycatch estimations.

10.2.8 Education

1. Encourage research and education to improve the understanding and management of the shrimp resource.

10.2.9 Rule Changes other agencies

Various sections of State government will need to implement rule changes to accomplish the process outlined in Section 10.2.3.

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12. APPENDICES

12.1 Appendix 1 SUMMARY OF SHRIMP REGULATIONS FROM OTHER STATES

	SOUTH CAROLINA	GEORGIA	FLORIDA
ADMINISTRATIVE ORGANIZATION	Department of Natural Resources Marine Division PO BOX 12559 Charleston SC 29422 (843) 953-9300	Department of Natural resources, Coastal Resources Division (912) 264-7218	Florida Fish and Wildlife Conservation Commission (850) 487-0554
LICENSES	**Resident:** Commercial license $25 Shrimp, fish, and crab trawling $125 Cast netting over bait $25 Channel net $250/net **Non-resident:** Commercial license $300 Shrimp, fish, and crab trawling $300 Cast netting over bait $500	**Resident**: Commercial fishing boat $50 for the first 18', and $3 for each foot or fraction over 18'. Commercial fishing license $12 required for every person engaged in commercial fishing. Sport bait shrimping $5 Commercial bait shrimping $25 **Non-resident:** Commercial fishing boat $25 over the cost to a resident. Commercial fishing license $118.00 Sport bait shrimping $75 Commercial bait shrimping $150	**Resident:** Saltwater products licenses Individual $50 Boat $100 Live bait shrimping and noncommercial food shrimping: Permit required, no fee except for certain counties, see fees listed under restrictions. **Non-resident:** Saltwater products licenses Individual $200 Boat $400 Alien Saltwater products licenses Individual $300 Boat $600
RESTRICTIONS	~Unlawful to trawl for crabs with a net or bag with a mesh of less than 4", and chafing gear of any sort must be confined to not more than one-half the circumference of the tailbag. ~The department may open or close areas of the states waters lying seaward of the trawling boundaries to crab trawling from December to March. ~A crab trawling permit is required. ~Finfish caught incidental to shrimp and crab trawling must meet minimum size limits. ~Shrimp trawlers may retain blue crabs caught incidental to shrimp trawling from June 1 to November 13. ~Shrimp trawling is allowed from 0500 to 2100 hrs from Opening Day through August 31. ~Shrimp trawling is allowed from 0600 to 2000 hrs from September 1 through October 31. ~Shrimp trawling is allowed 0600 to 1900 from November 1 until the end of the season. ~Certain Sounds and Bays closed to trawling at all times. Channel Nets ~Sixty channel net licenses are issued each year. ~Season is from September 1 to December 15 for no more than 90 days. ~Channel nets may not be set within 200' of each other or within 400' of the centerline of any marked navigation channel. **Recreational Shrimping** ~Cast nets, seines (40' max), and drop nets are allowed. ~Catch limit is 48 quarts heads on or 29 quarts heads off/ Person or boat. **Cast Netting Over Bait** ~Sixty day season between Septembeer 1and November 15. ~Catch limit is 48 quarts heads on, 29 quarts heads off. ~license is required.	~Finfish caught incidental to legal shrimp andcrab trawling must meet minimum size limits. ~Sounds permanently closed to shrimping from January 1 through August 31. The Sounds (Cumberland, St. Andrews, St. Simons, Sapelo, Wassaw and Ossabaw) may be opened to shrimping at the Commissioner's discretion. These Sounds can be opened to crab trawling from January through March. ~It is illegal to trawl for shrimp or crabs between the hours of 2000 and 0500. No trawling permitted in Sounds between 8:00 p.m. Saturday and 5:00 a.m. Monday. ~Crab trawl mesh size must be of at least 4" stretch mesh. ~Blue crabs caught while shrimp trawling may be kept and sold. **Bait-shrimping:** ~Sport bait shrimpers may not possess at any time more than 2 quarts of shrimp, no more than1/2 pint of which may be dead, and may not take more than 4 quarts in a 24 hour period. When two or more people are on the boat these numbers are doubled. ~Bait shrimping is only permitted in the tidal rivers and creeks, these areas are closed to food shrimp trawling. ~The legal hours for bait-shrimping are one half hour before official sunrise to one half hour after official sunset. ~Sport bait shrimp nets maximum size 10' headrope and footrope. ~Commercial bait shrimp nets are limited to a max. of 20' for headrope and 25' for footrope. ~Unlawful for a commercial bait-shrimper to have on board any boat more than 50 quarts of shrimp at any one time with no more than 10% of these shrimp may be dead. **Cast Netting** -Commercial cast netting limited to 200 licenses -Cast netting over bait is prohibited -48 quart limit heads-on for recreational cast netting	~Legal size 47 (or less) shrimp per pound (heads-on), or 70 count tails. * Except in certain areas, there is no size restrictions. ~Recreational shrimping is allowed by seines, cast nets, dip nets and shrimp trapsand is limited to 5 gallons/person or boat. ~Unlawful to trawl for shrimp at night in any county whose coastal boundary borders solely on the Atlantic Ocean, except during the monthsof June, July and August. ~Finfish caught incidental to trawling may be kept in both the commercial and recreational fisheries. Flounder is limited to 200 pounds. ~Size and creel limits and seasons must be observed. ~No more than 200 pounds of blue crabs caught while shrimp trawling may be kept and sold. ~Live bait shrimp boats must be equipped with live bait shrimp tanks. ~Live bait shrimpers may not have more than 5 gallons of dead shrimp per day. **Shrimp regulations for Clay, Duval, Nassau,Putnam, Flagler, and St. Johns Counties:** ~Trawling for live or dead shrimp is limited to daylight hours. ~The taking of dead shrimp is not allowed onSaturday, Sunday, or legal state holidays. ~No trawling permitted within 100 yards of the shoreline. ~See attached regulations for gear restrictions (Northeast region) ~$250 fee for live bait production in these Counties. ~$250 fee for dead shrimp production in these Counties. ~Trawling for dead shrimp in these five counties and the other five counties that make up the East Coast Shrimp bed is prohibited from April 1 and June 1. Noncommercial trawling in the St. Johns River $50 **Tampa Bay:** ~$250 resident; $1,000 non-resident

	ALABAMA	MISSISSIPPI	LOUISIANA
ADMINISTRATIVE ORGANIZATION	Department of Conservation and Natural Resources, Marine Resources Division. (205) 861-2882	Department of Marine Resources 1141 Bay View Ave. Biloxi Ms. 39530 (228) 374-5000	Department of Wildlife and Fisheries (225) 765-2800
LICENSES	**Resident:** Shrimp boat less than 30' $50 30-40' $75 Over 45' $100 Commercial crab $50 (needed to sell crabs caught in shrimp trawls). Live bait shrimp dealer 1 boat or truck $51 Live bait shrimp dealer 2 boats or trucks $101 Recreational shrimping (food and bait) $15 **Non-resident:** A non-resident will be charged the same fee for a license as a Alabama resident would be charged for a license in that state.	**Resident:** Shrimp boat license. Recreational $15 Under 30' $60 30' to 45' $85 Over 45 $110 Commercial crab $75 (needed to sell crabs caught in shrimp trawls). **Non-resident:** A non-resident will be charged the same fee for a license as a Mississippi resident would be charged for a license in that state.	**Resident:** Commercial fisherman's license $55 (per person) Vessel license $15; shrimp trawl, skimmer and butterfly nets $25 per trawl Recreational: Basic fishing $5.50; saltwater $5.50; shrimp trawl (up to 16') $25 100 pounds?day. Shrimp trawl 16' – 25' $80 250 pounds/day. **Non-resident**: Commercial fishing license $460 (per person) Vessel license $60; shrimp trawl, skimmer and butterfly nets $100 per gear in use. Recreational: Basic fishing $31, Saltwater fishing $36 shrimp trawl $100.
RESTRICTIONS	~The taking, catching or attempting to take or catch shrimp by trawl, seine, cast net, or any means whatsoever for any purpose is prohibited in the designated Shrimp Nursery Areas. ~It is unlawful for any person to drag any net, seine or trawl over any public oyster reef or private oyster grounds in the State. **Commercial shrimping:** ~Legal size 68 (or less) shrimp per pound (heads-on). ~Season set by regulation ~Total combined headrope length (maximum of 2 nets) is 50 feet for trawls in inside waters. ~Some areas closed to commercial and recreational shrimping permanently. ~Finfish caught incidental to trawling may be kept in both the commercial and recreational fisheries. ~Size and creel limits and seasons must be observed. ~Blue crabs caught while shrimp trawling may be kept and sold as long as the vessels has a valid commercial crab license. **Recreational shrimping (food and bait):** ~Exclusive bait shrimping areas perm-anently closed to commercial shrimping. ~Licensed recreational shrimp boats may take bait shrimp during the closed commercial season only from areas designated by law as exclusive bait shrimping areas. ~Other areas season set by regulation ~Legal size 68 (or less) shrimp per pound (heads-on). ~Catch limit of 5 gallons (heads-on) per person per day in waters open to commercial shrimping, except for the areas open year round - limits are one gallon of shrimp (heads-on), per boat per day. ~Trawl headrope not to exceed 16' **Live bait Shrimp dealers:** ~Limited to one trawl per boat not to exceed 16' headrope and 22' leadline. ~No closed season ~Cannot trawl in permanently closed areas. ~Can not have more than 15 lb of dead shrimp on the boat at any time. ~Tow time limit 20 minutes.	~It is unlawful to use any single trawl net which measures more than 50 feet along the headrope [max. of 2 nets, 50 feet total width;(i.e. 2 @ 25')] ~Shrimp smaller in size than 68-count are not to be taken. ~No restrictions on headropes south of barrier islands in Mississippi Sound. ~Trawl nets in the Mississippi Sound are limited to 2 nets, with max. headrope length of 25' each. ~Except by special order of the Commission, trawling is not permitted in any area within 1/2 mile of the mainland nor within any Bay, except by live-bait dealers. ~With the exception of pipeline canal, there is no trawling permitted in bayous. ~The area south of the intercoastal waterway will be closed to trawling after April 30. ~Areas north of the intercoastal waterway will be closed to trawling after sunset on December 31. ~Closed areas will open to trawling when the Division has determined that shrimp have reached legal size. ~Recreational limit, one trawl 16' or less. ~Finfish caught incidental to trawling may be kept in both the commercial and recreational fisheries with appropriate license. ~Size and creel limits and seasons must be observed. ~Blue crabs caught while shrimp trawling may be kept and sold as long as the vessels has a valid commercial crab license. ~Live -bait shrimping limited to 25 minute tows. ~Live-bait shrimpers must use trawls smaller than 16' except in areas west of Bayou Caddy trawls less than 25' may be used. ~Fish caught while live-bait trawling may be kept and sold for chum. ~Only 30 pounds of dead shrimp are permitted on board a live-bait boat.	~Inshore shrimp seasons are set yearly based on biological and technical data. The spring season usually runs from mid May to July. The fall season usually begins in mid August and lasts until December. ~No size limit during the spring season nor is there any size limit on brown shrimp or seabobs taken during any open season. White shrimp are limited to 100 heads-on count. ~Trawls cannot have a mesh size less than 1-1/4" stretched during the spring shrimp season. ~Trawls cannot have a mesh size less than 1-1/2" stretched during the fall shrimp season. ~Restrictions on night time trawling in some areas. ~Portions of some waters closed to trawling. ~Trawls less than 16' may be used for recreational purposes. ~Recreational shrimpers are limited to 100 lbs. (heads-on) of shrimp per boat. ~Finfish caught incidental to trawling may be kept in both the commercial and recreational fisheries. ~Size and creel limits and seasons must be observed. ~Five percent of each species of commercial fish by number may be smaller than the legal limit. ~Blue crabs caught while shrimp trawling may be kept and sold. ~Inshore trawling - Restrictions: one net - 50' max. headrope length. two nets - 25' max. haedrope length per net, with doors no larger than 6'x34" per net; or, for two nets which are connected in the center, no more than two inner sled doors, and no more than two outer doors with a max. size of 8'x40", plus one test net - 16' max. headrope length. ~In State outside waters (from beach to 3 miles offshore), 130' max. headrope and 165' max lead line length. ~Offshore territorial waters, up to four trawl nets may be used of any size, plus one test net.

TEXAS

TEXAS (cont.)

ADMINISTRATIVE ORGANIZATION

Parks and Wildlife Department, Coastal Fisheries Branch
(512) 389-4800
1-800-792-1112

LICENSES

Resident commercial:
General Commercial $24 (per person) only need if landing finfish and crabs caught while shrimping.
Commercial finfish $360 (needed to sell fish caught while shrimping)
Bay shrimp boat $348
Bait shrimp boat $348

Resident recreational:
Sport fishing $23
Saltwater stamp $10
Bait shrimp tag $35

Non-resident commercial:
General Commercial $180 (per person) only need if landing finfish and crabs caught while shrimping.
Commercial finfish $1440 (needed to sell fish caught while shrimping)
Bay shrimp boat $750
Bait shrimp boat $750

Non-resident recreational:
Sport fishing $50
Saltwater stamp $10
Bait shrimp tag $35

RESTRICTIONS

~Unlawful to head shrimp aboard a boat in inside waters.
~Unlawful to retain a catch of finfish exceeding 50% of the total trawl catch by weight of aquatic products including shrimp.
~Size and creel limits and seasons must be observed.
~Blue crabs caught while shrimp trawling may be kept and sold.
~Spring open season May 15 through July 15.
~Legal hours for shrimp during the spring season are 30 minutes before sunrise to 1400 hrs.
~No more than 600 lb of any size whole shrimp may be taken per day during the spring season.
~Mesh size must not be smaller than 6-1/2" over 5 stretched meshes.
~Fall open season August 15 through November30.
~Legal shrimp hours are 30 minutes before sunrise to 30 minutes after sunset.
~Bag and possession limits are not restricted.
~August 15 through October 31, the legal shrimp count is 50 heads on per pound.
~Mesh size must not be smaller than 8-3/4" over 5 stretched meshes.
~Winter open season February 1 through April 15 in Major Bays south of the Colorado River.
~No bag limit. Legal shrimping hours 30 minutes before sunset until 30 minutes after sunrise.
~Mesh size must not be smaller than 6-1/2" over 5 stretched meshes.
~Commercial bait-shrimping is permitted year round in bait Bays and nursery areas (when permitted under a nursery area shrimping authorization). Daily catch is 200 pound whole shrimp of which 50% must be alive (except from Aug. 16 through November 14).
~Mesh size must not be smaller than 6-1/2" over 5 stretched meshes.

Recreational shrimping:
~Only 1 trawl per boat is allowed. Must have a bait-shrimp tag in possession. Trawl net must not be greater than 20 feet in width between doors. Mesh size must not be smaller than 8-3/4" over 5 stretched meshes. Trawl doors can be no larger than 15 by 30 inches or 450 square inches each. When shrimping for food may only shrimp during the spring and fall seasons. Only 15 pounds of shrimp per person per day permitted.
~From August 15 through March 31 bait shrimping is permitted from 30 minutes before sunrise to 30 minutes after sunset. From April 1 through August 14, bait shrimping is permitted from 30 minutes before sunrise to 1400 hours. Catch limit of 2 quarts per person or 4 quarts per boat.
~Unlawful to retain a catch of finfish exceeding 50% of the total trawl catch by weight of aquatic products including shrimp.

12.2 Appendix 2 MANAGEMENT OF TRAWLING FOR HABITAT PROTECTION

I. ISSUE

How does North Carolina manage estuarine trawling to minimize effects on habitat?

II. BACKGROUND

Otter trawls are used to harvest shrimp from both North Carolina's estuarine waters and territorial ocean waters. These trawls are conical nets towed behind vessels that are kept open by water pressure on otter boards or doors that are attached at the forward edges of the nets. Developed in Europe over 100 years ago, otter trawls were brought to North Carolina in 1912. Shrimp trawling began in the Southport area and spread northward. Vessels and nets grew in size and sophistication over the years. Today, approximately 79 percent of shrimp trawl trips occur in estuarine waters. Pamlico and Core/Bogue Sounds account for the 62 percent of these trips. Ocean shrimp trawling occurs mainly offshore of Onslow through Brunswick counties, with the southern most area producing the greatest share of ocean harvest (Street et al. 2005).

Numerous studies have been conducted on the effects of mobile fishing gear on the benthos. These studies include effects of gear such as scallop dredges, oyster dredges, hydraulic clam dredges and clam trawls, beam trawls and otter trawls. The impacts of these different gears have been studied on habitat types ranging from flat sand and mud bottoms to structured habitats such as piled boulders, live bottom, seagrass, kelp beds and coral reefs (Dorsey and Pederson 1998; Auster 1998). These studies have shown that mobile fishing gear reduces habitat complexity by smoothing the bottom and removing structures provided by different benthic fauna. Benthic populations that provide food are also removed (Dorsey and Pederson 1998).

Rate of recovery for areas that are disturbed by bottom fishing gears are dependent on the habitat type. Those areas of stable habitats such as hard bottom, inhabited by low mobility, long-lived and slow growing species have the slowest recovery rates while those habitats that are constantly disturbed, inhabited by fast growing, short-lived species are much quicker to recover. These latter areas tend to be populated by opportunistic species that can recolonize quickly. Examples of these types of habitats are shallow sandy environments that are constantly disturbed by storm events, and high tidal flow (NRC 2002).

Shrimp trawling is a bottom disturbing fishing gear and affects hard bottom, shell bottom, submerged aquatic vegetation and soft bottom habitats where it occurs. These critical habitats provide commercially and recreationally valuable fish species with food resources, living space, and protection from predators during part of or all of their life cycle. Trawling alters these habitats by reducing structure, changing sediment size and distribution, and increasing turbidity. This in turn affects ecosystem processes such as growth of primary producers (algae and plants), nutrient regeneration, growth of secondary producers (organisms that consume other organisms), and the character of the feeding relationships of organisms within the ecosystem (the food web).

Studies of the ecological impacts of trawling indicate that the magnitude of trawling disturbance to bottom communities is highly variable, ranging from no apparent effect, to the complete elimination of some species and coincident long-term changes in the benthic community. The ecological effect of trawling depends upon site-specific characteristics of the ecosystem such as bottom type (sand, mud, shell, grass bed, reef, etc.), water depth, type of animal community (small vs. large sized species, short-lived vs. long-lived species; mobile vs. immobile species), type of fishing trawl employed, and the intensity and duration of trawling and natural disturbances.

Trawl Effects on Hard Bottom

Hard bottom refers to coral communities that occur in temperate, subtropical and tropical oceans as well as exposed areas of rock or consolidated sediments. Manmade structures such as artificial reefs, wrecks and jetties are included in the hard bottom classification. Natural hard bottom varies from flat, smooth surfaces to scarped ledges with vertical, sloped, or stepped relief (Street et al. 2005). Bottom topography and bottom temperatures are the most important factors in the types of habitat and are strongly influenced by the Gulf Stream (SAMFC 1998). Exposed rock outcrops are colonized by algae, sponges, soft coral, hard coral, bryozoans, polychaete worms, and tunicates and support a large diversity of fish and invertebrate species, including economically important snappers and groupers (Street et al. 2005; SAFMC 1998).

Hard bottom habitats are the most structurally complex habitats because of high vertical relief, varying sizes of interstitial spaces and crevices, as well as attached fauna, such as sponges, bryozoans and other sessile organisms providing additional complexity. VanDolah et al. (1987) studied the effects of a research trawl over hard bottom areas and the damage to several sponge and coral species. This study was done off the coast of Georgia where they compared the density of sponges in an area trawled one time to an untrawled area. There was immediate damage to all of the sponges they were targeting, however significant reduction of only the barrel sponges were observed. One year after trawling, sponge abundance had increased to pre-trawl densities with damage no longer detected. However, it should be noted that this was after one pass made with a trawl with a roller-rig design (VanDolah et al. 1987; SAFMC 1998). Roller rig trawls are generally considered to be less damaging than conventional bottom trawls. In a review of different studies on the impacts of bottom disturbing gears, by Watling and Norse (1998) there were numerous results demonstrating the impacts to bryozoan beds, overturned boulders, reduced sponge cover, as well as changes in diversity of different benthic communities.

Trawling Effects on Shell Bottom

The NC Coastal Habitat Protection Plan defines shell bottom as an estuarine intertidal or subtidal bottom composed of surface shell concentrations of living or dead oysters, hard clams, and other shellfish (Street et al. 2005). These oyster rocks form by the accumulation of shells and oysters over the course of many years. This habitat is critical for the settlement of larval oysters, and therefore, the condition of these shell habitats affects oyster stock abundance. The South Atlantic Fishery Management Council (SAFMC) considers shell bottom essential fish habitat (EFH) for red and black drum, striped bass, sheepshead, weakfish, spotted seatrout, summer and southern flounder. Shell bottom has a stabilizing effect on erosional processes and may modify current and tidal flow. It provides a hard substrate required as habitat for sessile filter feeding organisms and serves as cover for small fish and invertebrates.

The more complex the habitat structure, the more susceptible the habitat is to disturbance by mobile bottom fishing gear (Auster 1998). Shell bottom is a fairly complex habitat that is affected by both oyster dredges and otter trawls. Lenihan (1998) found that oyster dredges reduced the vertical relief of subtidal oyster reefs causing several negative habitat impacts. These impacts were the scatterings of shell and oysters into less suitable substrates, and destabilizing the reef structure causing an increase in vulnerability to damage by storms. Dredging reduces the small interstitial spaces that function as refuge and foraging areas for juvenile fish. Trawling over oyster reefs has a similar affect by disturbing the structure of the reefs, reducing and scattering the upper layers of shell with the movement of trawl doors or chain as the gear is fished over the structure (DMF 2001; Street 2004). The Blue Ribbon Advisory Council on Oysters (BRACO) (1995) concluded that trawling had a significant negative impact on live shell bottom habitat. With the understanding of the economic value of the shrimp fishery by the BRACO, they proposed the establishment of an experiment to test whether shrimping could be made more compatible with oyster habitat preservation in the Albemarle/Pamlico system. It was also proposed by the BRACO to establish trawling restrictions in conjunction with shell cultch planting of some oyster reefs in a sufficiently large area so as to test whether income from shrimping can still be maintained despite the spatial displacement of the shrimping fleet and whether that protection from trawl damage enhances and sustains oyster production of those protected reefs.

Trawl Effects on Submerged Aquatic Vegetation (SAV)

Submerged Aquatic Vegetation (SAV) is a fish habitat dominated by one or more species of underwater vascular plants and is defined by the North Carolina Marine Fisheries Commission (MFC) as those habitats in public trust and estuarine waters vegetated with one or more species of submerged vegetation such as eel grass (*Zostera marina*), shoalgrass (*Halodule wrightii*) and widgeon grass (*Ruppia maritima*). SAVs occur in both subtidal and intertidal zones and may be patchy or continuous meadows. In patchy areas, bottom between the patches is also considered habitat. SAV habitat is important to the life cycle of many organisms including red drum, spotted seatrout, snapper/grouper, bay scallops, and peneaid shrimp by providing refuge, forage and spawning location as well as a nursery area. SAVs provide important ecosystem functions such as structural complexity, sediment and shoreline stabilization, primary productivity, and nutrient cycling.

There are two types of SAV communities. There is the high salinity estuarine type that include the three species listed above and lower salinity freshwater SAVs such as wild celery (*Vallisneria americana*), bushy pondweed (*Najas guadalupensis*) redhead grass (*Potamogeton perfoliatus*) and sago pondweed (*P. pectinatus*). These species are found in the coastal riverine systems and are more diverse than the high salinity SAVs.

There are several bottom disturbing fishing gears that have the potential to destroy or damage SAV. Shearing of blades, seeds and/or flowers, uprooting, as well as burial are injuries to SAV caused by fishing gears such as the otter trawl. Turbidity, which may cause a reduction in light for photosynthesis is also a concern. Below ground impacts are also a great concern, however, these impacts result more from digging gears such as clam rakes and dredges and are probably minimal from trawls (Street et al. 2005; (ASMFC 2000).

Impacts from trawling over SAV may occur from the sweep of the net and the digging of the trawl doors into the sediment (ASMFC 2000). It is estimated that the maximum cutting depth for otter trawl doors ranges between about an inch and a foot (2.54-30.48 cm) when used in depths over about 100 ft (30.48) (ASMFC 2000), although such deep water does not occur in North Carolina's estuaries. Cutting depth variation is due to differences in gear weight, bottom hardness and towing warp to depth ratios (a measure of the force of the gear). Trawl doors were found to penetrate the bottom more than the rest of the gear (ASMFC 2000). In the Gulf region, it has been noted that trawling by larger vessels in deep water (2-3 m) through SAV resulted in edges of SAV ripped up and observed masses of SAV floating on the surface following the opening of shrimp season. It was also noted that shallow SAV beds were not affected by trawling except during high tides when beds were more accessible (Eleuterius 1987).

Overall, there are few specific studies addressing effects of trawling over SAVs, however, the knowledge from studies in other bottoms and habitat types may be intuitively applied to what the effects of trawling over SAVs may be. These effects include leaf shearing and uprooting in areas that are heavily trawled, resulting in the loss of blades and shoots which in turn reduces the complexity and coverage of SAV beds. Turbidity effects, especially in areas of low energy where sediment types tend to be mud/silt can reduce light levels needed for photosynthesis.

Trawl Effects on Soft Bottom

The Coastal Habitat Protection Plan defines soft bottom as unconsolidated, unvegetated sediment that occurs in freshwater, estuarine and marine systems. It is found in both subtidal and intertidal zones and can be characterized by geomorphology (the shape and size of the system), sediment type, water depth, hydrography and salinity (Street et al. 2005).

As with other habitats, damage from bottom-disturbing fishing gear varies with gear type, and habitat complexity. Soft bottom habitats have been considered the most appropriate bottom to use bottom-disturbing gear because of its lack of structure and complexity. However, the degree to which bottom trawls disturb the sediment surface depends on the sediment type and the gear itself. As mentioned earlier, different parts of the gear have different effects on habitat as well as tow speed and net configuration. However the depth of penetration by any part of the gear is always greater in muddy substrate as compared to sandy substrate (DMF 1999).

Trawling in sandy and muddy areas causes resuspension of bottom sediments. Besides the resulting turbidity, grain size of the sediment as it settles back to the bottom can be altered. This is because the coarser sand grains settle out faster than the finer mud/silt/clay sediment grains along with organics important for deposit feeding infauna. Tidal transport of fine-grained sediments can alter the sediment composition by increasing average grain size of the trawled bottom (DMF 1999). Areas of shallow sandy substrate located in places of high energy or tidal flow are regularly disturbed be natural physical processes. These areas recover quickly. Therefore, disturbances by trawling in the same type of area would also recover quickly, while those areas that are deep and muddy with little natural disturbances are slow to recover from physical processes as well as by trawling disturbances (DeAlteris et al. 1999). Schwinghamer et al. (1998) found that trawling in a sandy bottom area on the Grand Banks caused measurable changes to top sediments and habitat structure (mound, tubes, and burrows) but recovered in a year. They also noted less organic material in the trawled area versus the untrawled area where sediments had a “hummocky, mottled” appearance.

Palanques et al. (2001) studied the impacts of trawling in a muddy low-energy environment 30-40 m deep. Side scan sonar showed trawl door tracks were present after one year. Sediment thickness was reduced by 2-3 cm by the net. Turbidity increased gradually beginning with turbidity close to the seabed followed by progressively resuspended particles becoming mixed several meters above the bottom leading to an increase in turbidity after 24 hours. Within 4-5 days, turbidity had increased even more with suspended sediments representing 10% of the total amount of sediment disturbed by trawling.

In North Carolina, Corbett et al. (2004) conducted a study on the impact of trawling on the water column in South Creek, a tributary of the Pamlico River. This shallow water soft bottom creek was trawled in an upstream area and a downstream area for 45 minutes back and forth on six sampling occasions over a two-year period. These areas along with two untrawled areas were monitored for a minimum of two days before and after trawling. It was found that sediment resuspension from wind over a large fetch was similar to trawling while trawling was the dominant force when wind direction was over a small fetch.

Churchill (1998) discusses modeling sediment resuspension in an area called the “Mud Patch” located on the New England shelf. The model included information such as resuspension rates by trawls, estimates of rates of settlement of sediment and NMFS trawling activity records in the region. He then modeled resuspension of sediments by currents with data of near-bottom currents, surface wave motions and near-bottom sediment concentrations. Results from these models in this area showed that the overall impact of trawling on sediment resuspension was a function of depth. As depth increased, resuspension was less influenced by current and more influenced by trawling, at least in the wintertime in the “Mud Patch”.

Ecological Impacts of Trawling

Significant changes in habitat can cause changes in community structure by altering species composition and productivity. These include changes in abundances and diversity of the benthic and epibenthic community, changes in the geochemical structure of the water column resulting from turbidity, and release of nitrogen and phosphorus, among others, effecting primary productivity. All of these changes can result in the alteration of food webs and bringing the system full circle back to effects on species abundance and diversity.

It has been found that in areas of repeated trawling, there are community shifts from species that are large and slow growing toward dominance by fast growing species that are small-bodied (Kaiser et al. 2002; NRC 2002). Trawling removes huge amounts of biomass by removing species that are being targeted. Some of those species being removed may also act as predators. The removal of targeted species results in changes of species composition as well as changes in biomass and production. This results in an overall lower productivity because of the removal of the high biomass species. Other non-targeted species suffer various degrees of mortality and displacement by trawling. These species act as prey items as well as add to the characteristics of the habitat by reworking the sediments, burrowing, creating depressions, mounds etc (McConnaughey et al. 2000; Kaiser et al. 2002). This new community structure will become permanent as fauna readapt to the trawling disturbance (Kaiser et al. 2002).

Cahoon et al. (1998) looked at the impacts from trawling on soft-bottom organisms in primary nursery areas located in Rose Bay, Pungo Creek and South Creek in North Carolina. These primary nursery areas are closed to trawling. They found no significant effect on the biomass of benthic microalgae, no consistent effect on the abundance of demersal zooplankton (nematodes), and a slight but non-significant effect on the abundances of benthic macrofauna (polychaetes and *Macoma* clams). When they compared trawled to untrawled areas located in the Pamlico River, an area that is opened to trawling, they found significantly higher benthic microalgal biomass in the untrawled areas. There were no significant differences in abundance of demersal zooplankton (nematodes) but higher abundances of benthic macrofauna (polychaetes and *Macoma* clams) in trawled locations than at untrawled locations. They concluded that these shallow soft-bottom habitats experience frequent wind, wave, and storm disturbances that are probably similar to disturbance caused by trawling. However, they caution that the frequency and intensity of trawling can overcome the resilience of these organisms.

Besides changes in community structure, there are also concerns about effects of the geochemistry of the water column from trawling. Increased turbidity, nutrients and heavy metal contamination can result from trawling disturbing the bottom. Increased turbidity can reduce the maximum depth of light penetration effecting photosynthesis by SAVs and algae. Increased turbidity can affect foraging success of visual predators as well as impede the function of feeding and respiratory structures. Filter feeding species such as the Atlantic menhaden, bay anchovy and Atlantic silverside are much more sensitive to turbidity than the more demersal feeding species such as spot. Extreme concentrations of nitrogen and phosphorus in the water column may stimulate algal blooms, ultimately leading to eutrophication or nutrient enrichment (Pilskaln et al. 1998). Although such blooms may benefit herbivorous zooplankton and organisms of higher trophic level, the resultant decomposition of the algae, the increased nighttime respiration by algae still alive, and the additional nitrogenous waste excreted by their consumers may deplete the dissolved oxygen levels. The probability of fish kills is also increased under such conditions. However, the volume and spatial extent of nutrients resuspended in the water column by bottom-disturbing gear such as trawls are relatively minor compared to the nutrient inputs associated with non-point pollutant sources such as agriculture (DMF 1999; Street et al. 2005). Nonetheless, bottom sediments have the ability to store a variety of heavy metals and toxic compounds that may be released into the water following the physical disturbance of benthic sediments (DMF 1999).

III. CURRENT AUTHORITY

<u>North Carolina Fisheries Rules for Coastal Waters</u>
15A NCAC 3J .0104 TRAWL NETS
Prohibits trawl nets in specific areas
15A NCAC 3K .0103 SHELLFISH OR SEED MANAGEMENT AREAS
Prohibits trawl nets in shellfish or seed management areas
15A NCAC 3L .0101 SEASON
Gives Director Proclamation authority to open shrimp season in various waters
15A NCAC 3N .0104 PROHIBITED GEAR, PRIMARY NURSERY AREAS
Prohibits trawl nets in primary nursery areas
15A NCAC 3N .0105 PROHIBITED GEAR, SECONDARY NURSERY AREAS
Prohibits trawl nets in secondary nursery areas
15A NCAC 3O .0211 PROTECTION OF PRIVATE SHELLFISH INTEREST
Prohibits trawl nets on shellfish lease or franchise
15A NCAC 3R .0103 PRIMARY NURSERY AREAS
Delineates primary nursery areas
15A NCAC 3R .0104 PERMANENT SECONDARY NURSERY AREAS
Delineates secondary nursery areas
15A NCAC 3R .0105 SPECIAL SECONDARY NURSERY AREAS
Delineates special secondary nursery areas
15A NCAC 3R .0106 TRAWL NETS PROHIBITED
Delineates other areas where trawl nets are prohibited

IV. DISCUSSION

North Carolina’s estuarine system is over two million acres and is the largest of any state on the Atlantic coast. Features such as the amount of open water area, amount of coastline, depth, tides, bottom types, sea grass, and shoreline orientation makes it unique. North Carolina's estuaries consist of 92 percent open water while only 8 percent are wetlands. It has over 3,000 miles of estuarine coastline compared to only 300 miles of ocean coastline. It is a shallow system averaging 12 feet in depth. Tidal amplitude ranges from zero in the northern area to five feet in the southern area. Oyster reefs are found more subtidally in the northern area and more intertidally in the south. There are marine SAVs located along the Outer Banks, in Core Sound and Bogue Sound. Several species of brackish and freshwater SAVs are found on the mainland side of Albemarle Sound, Pamlico Sound and Currituck Sound. Unvegetated sand and mud make up the majority of the estuarine bottom, dependent on tide and wind current influence (DMF 1999; DMF 2004).

The DMF's management of trawling has focused mainly on the protection of juvenile finfish and shellfish but has also achieved habitat protection at the same time. In 1969, the North Carolina General assembly enacted Chapter 1101, 1969 Session Laws, directing the DMF to conduct a study of the fisheries resources of the coastal areas. The DMF conducted several studies from 1970 through 1976 resulting in the identification of estuarine areas that consistently supported populations of juvenile shrimp, crab, flounder, croaker, spot and menhaden. From these studies the Marine Fisheries Commission adopted regulations in 1977 to protect these nursery areas and defined them by rule. There are presently three types of nursery areas. These are Primary Nursery Areas (PNAs), Secondary Nursery Areas (SNAs) and Special Secondary Nursery Areas (SSNAs).

Primary nursery areas are defined as those areas in the estuarine system where initial post larval development takes place. They are normally located in the uppermost sections of a system where populations are very early juveniles. There are a little more than 80,000 acres of PNAs. Secondary nursery areas are those areas where later juvenile development takes place. Populations are usually composed of developing sub-adults of similar size that have migrated from a primary nursery area to the lower portions of creeks and bays. Approximately 35,000 areas of estuarine waters are SNAs. Special secondary nursery areas are located downstream from primaries in areas near open waters and sounds of high salinities. Most are located in Core Sound. These areas may be opened to trawling in the fall when shrimp have reached a certain size and are ready to move out. There are around 31,000 acres of SSNAs. These areas total 147,000 acres closed to trawling. Other areas closed to trawling by rule are the Albemarle Sound, designated SAVs, posted oyster rocks, shellfish management areas, and shellfish leases. Thirty-two thousand acres are closed because of military activity and an additional 32,000 acres are closed by proclamation. All of these closures add up to over one million acres or 48% of estuarine waters are closed to trawling (Figure 1) (DMF 1999).

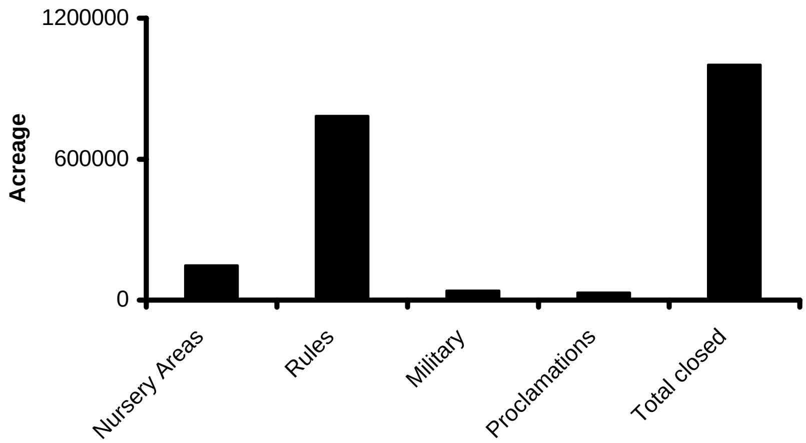

Figure 1. Acreage of closed areas in estuarine waters of North Carolina (DMF 1999)

There are additional ways to manage habitat that is critical to the life histories of our fish and shellfish. Total closure of the estuarine waters to trawling would conserve those inshore habitats but at the loss of approximately 70% of the state’s shrimp landings, as well as a portion of blue crab landings. Rotation of fishing areas similar to rotation management of mechanical clam harvest areas is one possibility. This would allow recovery time of one area while another area is being fished. However, this can concentrate effort spatially and may do more damage to the area that is open because of increased frequency and intensity. Modifying trawling gear such as running a tickler chain through a PVC pipe or adding rollers to the sweep of the net may minimize effects to the bottom in some areas. Partitioning areas between trawlers and stationary gear may decrease the amount of area affected by trawling but may result in more user conflict, concentrate effort and possibly a decrease in CPUE. Allowing only stationary gear such as the shrimp pound or shrimp trap is another option, however, time is needed to design and test the feasibility of such use. Shortening the time an area is open would decrease impacts and allow a longer time for recovery. Closing more area to shrimping, especially where there may be significant impacts in places such as White Oak River, Newport River and other places where oyster rocks are abundant and oyster restoration efforts exist, may be an additional consideration in the management of trawling and its effects on habitat.

Current knowledge of fishing gear impacts indicates that shrimp-trawling gear can have habitat impacts, dependent on the structure and complexity of the habitat, energy regime, depth and sediment type. These impacts can be severe in highly structured, deep, low-energy environments and minimal in unconsolidated sandy shallow high-energy environments. Our current management of the shrimp trawl/crab trawl fishery by prohibiting the use of trawl nets in shellfish and seed management areas, shellfish leases and franchises, primary nursery areas, secondary nursery areas, SAVs as well as other areas described in rule and in proclamation minimizes bottom disturbing effects of trawling in those habitats more vulnerable to the effects of trawling.

V. MANAGEMENT OPTIONS/IMPACTS

1. Status Quo

   + No additional regulation
   - Unknown impacts on habitat function along with possible impacts on species diversity of benthic fauna

2. Partition trawling activities from fixed gear activities

   + Decrease in the amount of habitat affected by trawling
   + Possible decrease in bycatch
   - Larger number of trawlers in a reduced area could increase impacts to benthos
   - Larger number of fixed gear in a reduced area could increase navigation hazards and decrease CPUE

3. Decrease the amount of area open to shrimp trawling harvest

   + Decrease in amount of habitat affected by shrimp trawling
   + Possible decrease in bycatch
   - Larger number of boats in a reduced area could increase impacts on benthos

4. Modify trawl gear

   + Minimize effects on habitat by trawl gear
   + Encourage gear research
   - Increase in cost to fishermen to change gear over

5. Establish a reduced trawling season

   + Shorter amount of time habitat is impacted
   + Longer amount of time habitat can recover
   - Reduced income for fishermen

6. Rotate trawling in existing sites

   + Decrease amount of habitat affected by trawling at one time
   + Ability for closed portions of area to recover from harvest impacts
   - Larger number of boats in a reduced area could increase impacts on benthos

7. Use only stationary fishing gear

+ Decrease impacts to habitat
+ May decrease bycatch
- Time needed to design, test, and evaluate different stationary gear
- Increase cost for fishermen to make gear changes
- Decrease in landings and income as fishermen learn how to use gear
- Possible increase in conflict
- Increase in navigational hazards

8. Close all trawling

+ No further impacts by harvest gear on benthos
+ Decrease in bycatch
- Loss of income to trawlers

9. Re-examine habitats needing protection and modify rules

+ Manage according to current studies and mapping datat
+ Decrease impacts to critical habitats
- May decrease traditional trawling areas

VI. RESEARCH NEEDS

- Define and quantify the intensity, duration and spatial scale of trawling effort in NC estuaries.
- Map and quantify the habitat structure and sediment types in North Carolina estuaries.
- Determine the effects of trawling on sediment size distribution and organic carbon content.
- Determine the effect of trawling on water quality and primary productivity.
- Determine the physical effects of currents, storms, animal activities, etc. on sediment disturbances and compare to mobile fishing gear effects.
- Determine the effects trawling and recovery time of benthic community structure in different habitat types
- Determine the effects of trawling on secondary productivity and how it affects local pathways of food energy transfer.

RECOMMENDATION:

AC, DMF and MFC recommendations: Investigate the use of shrimp traps as RCGL gear including size restrictions and location.

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12.3 Appendix 3 SHRIMP TRAWL BYCATCH

I. Issue:

Bycatch in the shrimp trawl fishery.

II. Background:

Over the last few years, bycatch has become one of the more controversial topics in fisheries management both in the United States and around the world (Alverson et al. 1994; Crowder and Murawski 1998). In spite of increased public awareness, greater management scrutiny, and significant research efforts, many basic issues remain unresolved. Only recently has the term bycatch been defined in any standard manner, and important information on the magnitude of bycatch is severely lacking for many fisheries. Given this situation, it is not surprising that little is known of the impacts of bycatch on specific fisheries, fish populations, and marine communities. However, this lack of basic information has not dulled the public's interest and may, in fact, catalyze such concerns. As a result, recent public policy dictates that bycatch be either eliminated or reduced to insignificant levels (Crowder and Murawski 1998). As perhaps the prime example of the new policy positions, the re-authorized Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) contains a National Standard (#9) requiring bycatch minimization (USDOC 1996). National Standard 9 states: "Conservation and management measures shall, to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch." Additionally, in1991 the North Carolina Marine Fisheries Commission (MFC) adopted a policy directing the Division of Marine Fisheries (DMF) to establish the goal of reducing bycatch losses to the absolute minimum and to consciously incorporate that goal into all it's, management considerations (Murrary et al. 1991).

Bycatch is defined by the Atlantic States Marine Fisheries Commission (ASMFC) as "the portion of a catch taken incidentally to the targeted catch because of non-selectivity of the fishing gear to either species or size differences" (ASMFC 1994). In the MSFCMA, bycatch is defined as "fish which are harvested in a fishery, but which are not sold or kept for personal use" (USDOC 1996). Bycatch can be divided into two components: incidental catch and discarded catch. Incidental catch refers to retained catch of non-targeted species. Discarded catch is that portion of the catch returned to the sea as a result of economic, legal, or personal considerations. The biological significance of bycatch can be judged from a number of different perspectives, including those of the populations (e.g. of a particular species), of the fishery or fisheries that target or otherwise encounter the species, and of the general biological community (Murawksi 1995).

During the late 80's the DMF initiated gear testing to reduce bycatch in the shrimp trawl fishery (Pearce et al. 1988, and Holland 1988). Due to growing concern over bycatch in shrimp trawl fisheries the MSFCMA was amended in 1990 to include bycatch research. Congress mandated that the U.S. Secretary of Commerce conduct a three year research program to assess the impact of the incidental harvest by the shrimp trawl fishery on fishery resources in the South Atlantic and the Gulf of Mexico areas. The National Marine Fisheries Service (NMFS), along with the Gulf and South Atlantic Fisheries Development Foundation (GSAFDF), began a cooperative bycatch research program to: (1) update and expand bycatch estimates temporally and spatially; (2) identify, develop and evaluate gear options for reducing bycatch; (3) develop an information transfer and education program on bycatch; and (4) develop and operate a standardized data management system for centralized dissemination and access

(NMFS 1995). Starting in 1992, observers were placed aboard cooperating vessels to characterize bycatch and to test BRDs during normal commercial shrimp trawling.

While it is becoming increasingly apparent to scientists, natural resource managers, and much of the general public that bycatch is an important issue that must be addressed, characterizing the nature and extent of bycatch has proven extremely difficult. These difficulties are generally attributed to inadequate monitoring of many pertinent characteristics, including actual bycatch levels, effort of the directed fishery, distribution of the bycatch species, and the mortality rate of the discarded species. The problem is exacerbated by the patchy distribution of effort and juvenile finfish in both time and space. The amount of bycatch in a particular trip is usually very skewed, with many tows having some bycatch and very few tows with high bycatch. Additionally, available effort data are often inadequate. Although research indicates that tow duration is often a significant factor when estimating bycatch losses, the DMF and most other agencies typically record effort data by trip without any accompanying information on tow duration or the number of tows made during a trip. Mortality of bycatch captured in trawls varies considerably, not only by species, but also in response to factors such as water temperature, tow time, fishing location, and gear configuration.

The lack of reliable discard estimates has not stopped researchers from investigating assessment impacts, but it has prevented increases in precision. Most assessments address the range of bycatch estimates through sensitivity analyses by comparing basic assessment results over the range of bycatch estimates and assumptions. If none of the results seem plausible, the assessment may proceed without the bycatch estimates included but with the caveat that results may be biased or contain additional uncertainties due to unknown levels of missing catch.

III. DISCUSSION:

<u>Bycatch Characterization</u>

Incidental Catch:

Total annual landings in the North Carolina shrimp trawl fishery has averaged 7.3 million pounds, ranging from 4.9 to 9.9 million pounds (DMF Trip Ticket data 1994-2003; Table 1). Shrimp (brown, pink, and white) account for 92% of the total landings followed by finfish (4%), crabs [4% (blue, stone, and horseshoe crabs)] and Mollusks [0.45% (conchs/welks, squid, octopus, and clams)]. Ninety-two percent of the total shrimp trawl landings come from three areas; Pamlico Sound (53%), Atlantic Ocean (28%), and Core Sound [11% (Table 2)]. In the Atlantic Ocean 87% of the landings are reported within three miles of the shoreline and 74% are caught south of Cape Hatteras (Table 3). The period of June through November accounts for 92% of the total landings (Table 4).

On average 323,902 pounds of finfish are landed annually by shrimp trawls (Table 1). Five groups; sea mullet [whiting, and kingfish 38%, 124,547 pounds), flounder [summer and southern (18%, 58,933 pounds), spot (17%, 56,606 pounds), Atlantic croaker (8%, 25,373 pounds) and weakfish (5%, 15,560 pounds), account for 87% of the finfish landings (Table 5). Ninety-six percent of these landings are reported from two areas, the ocean and Pamlico Sound (Table 2). The ocean accounts for 85% of the croaker, 66% of the sea mullet, and 54% of the spot landed from shrimp trawls (Table 6). Pamlico Sound accounts for 61% of the flounder and 89% of the weakfish landings for this gear. The peak months for finfish landings from shrimp trawls are in October (23%) and November (20%), with the period of August through December accounting for 80% of all finfish landings (Table 4). The peak month for sea mullet landings from shrimp trawls is November (32%), while the period from July through December accounts for 82% of the landings (Table 7). Seventy-four percent of the flounder are landed from July through November, with September accounting for 23% of the landings. The period of August through November accounts for 95% of the spot landings, with October accounting for 44% of the landings. Seventy percent of the Atlantic croaker are landed in December, and 94% are landed from September through January. Weakfish landings peak in August, while 92% of the landings occur from July through November. Total annual value of finfish landings from shrimp trawls by species, waterbody, and month are given in Tables 8, 9, and 10.

Since 1994, annual crab (blue, horseshoe, and stone) landings by shrimp trawls have averaged 262,460 pounds (Table 1). Blue crabs account for over 99% of the shrimp trawl crab landings followed by horseshoe (0.11%), and stone crabs [<0.01% (Table 11)]. Core (57%) and Pamlico (28%) sounds account for 86% of the blue crabs and 100%, 1% and 99% respectively, of the horseshoe crabs landed by shrimp trawls (Table 12). Eighty percent of the blue crabs are landed from April through August (Table 13). While 98% of the horseshoe crab landings occur from November through January. Total annual value of crabs landing from shrimp trawls by species, waterbody, and month are given in Tables 14, 15, and 16.

Mollusk (squid, octopus, Conchs, and clams) landings from shrimp trawls have averaged 15,090 pounds per year (Table 1). Average squid landings are 15,320 pounds and account for over 99% of the Mollusk landing (Table 17). Octopus (0.62%) conchs (0.49%), hard clam meats (< 0.01%), and blood clams (< 0.01%) are the other Mollusks landed by this gear. Eighty percent of the squid and 96% of the octopus are landed from the ocean (Table 18). Core Sound accounts for 80% of the conch landings. Squid landings from shrimp trawls have been reported from every month, however 92% of the landings occur from May through December (Table 18). Octopus landings peak in November (59%), while 87% of the conchs are harvested from March through May (Table 19). Total annual value of Mollusk landing from shrimp trawls by species, waterbody, and month are given in Tables 20, 21, and 22.

Discarded Catch:

In the South Atlantic more than 150 taxa have been identified in shrimp trawl catches, and the average overall catch rate was about 57.33 pounds per hour (Nance 1998). Finfish made-up 54% of the catch by weight, shrimp 18%, other invertebrates 18%, and the remaining 13% was composed of crustacean (Table 23). Seasonal distribution of finfish bycatch in the south Atlantic indicates that the highest percentage by weight occurs in the summer, while numerically finfish bycatch is highest in the spring (Table 24). The top ten species by weight were: cannonball jelly (14%), white shrimp, spot, and Atlantic menhaden each at 9%, brown shrimp and other jellyfish at 6% each, Atlantic croaker contributes 6%, southern kingfish, and blue crab each at 4%, and star drum at 3%.

In the Gulf of Mexico over 450 taxa were identified in shrimp trawls (Nance 1998). The average hourly catch was approximately 59 pounds per hour of towing. Finfish made-up 67% of the catch by weight, shrimp 16%, crustacean 13%, and the remaining 4% was composed of other invertebrates (Table 23). Seasonally, finfish bycatch was highest, by weight, in the fall (Table 25). The 10 most abundant species by weight were: longspined porgy (15%), brown shrimp (9%), Atlantic croaker (9%), inshore lizardfish (6%), pink shrimp (3%), gulf butterfish, and lesser blue crab, white shrimp, longspined swimming crab, and brown rock shrimp each comprising 2% of the catch.

Although a detailed characterization study of bycatch in the shrimp trawl fishery has not been conducted for North Carolina waters, preliminary investigations were conducted in 1995 (Diamond-Tissue 1999) and 1999 (Johnson 2003). Diamond-Tissue's (1999) 1995 characterization study examined 52 tows conducted over 15 trips. Sampled boats had one or two nets, and all nets contained the required Turtle Excluder Device (TED) and bycatch reduction device (BRD). A total of 92 different species, including 66 species of finfish, 10 species of crabs, and 13 other invertebrates were identified. For all areas combined, market-size penaeid shrimp made up 44.3% of the organisms by number and 30.8% by weight (Tables 26 and 27). The top finfish species by number were star drum, Atlantic croaker, weakfish, and spot, while Atlantic croaker, weakfish, spot, and star drum were the top finfish species by weight. Samples from Pamlico Sound (n=16 tows) and the Cape Fear River (n=24 tows) were collected monthly from July through October 1995. Additionally, four tows were sampled in Core Sound in August 1995, and eight tows were examined off Carolina Beach during July and August. In Pamlico Sound, 38 species were identified in the catches, 37 were identified in Core Sound, and 50 species were identified in Cape Fear River. Market-size penaeid shrimp were the top species in terms of both numbers (Table 26) and weight for all areas combined, as well as for all individual areas by number, and all areas by weight except Core Sound (Table 27). The composition of finfish in the bycatch varied by area, with Atlantic croaker, spot, and weakfish accounting for 53% of the total catch by number and 56% by weight in Pamlico Sound. In Core Sound, pigfish, spot, and Atlantic croaker were the most abundant finfish species in terms of number and weight. Star drum, weakfish, and Atlantic croaker were the most abundant species in the Cape Fear River.

Johnson (2003) quantified the catch of shrimp trawlers working in Core Sound (n=46 tows) and the Neuse River (n=8 tows) during the summers of 1999 and 2000. Overall, blue crabs accounted for 26% by weight of the total combined catch (Table 28). Spot accounted for 17% of the total catch and 40% of the total finfish bycatch (Table 29). Core Sound catches were dominated by invertebrates, crabs, and shrimp, which accounted for 71% of the total catch (Table 28). Three species of finfish; spot (48%), Atlantic croaker (13%), and pinfish (12%) accounted for 73% of the finfish bycatch from this area (Table 29). In the Neuse River, invertebrates made up 24% of the sampled catches (Table 28). Atlantic croaker (44%), and spot (33%) accounted for 77% of the finfish bycatch (Table 29).

In 1950 sampling was conducted aboard commercial shrimp trawlers working in Core and Pamlico sounds (Roelofs 1950). Although only total weights were reported for shrimp and finfish, Roelofs (1950) indicated that for Core Sound "85 to 90% of the fish taken were croakers and spot, with croaker predominating; while in late August, hogfish, pinfish and other trash species increased until they made up over 50 per cent of the catch". Seven tows were sampled in Pamlico Sound during September of 1950. Atlantic croaker comprised 73% of the finfish taken, with spot and trout each accounting for 10% (Roelofs 1950).

Numerous gear evaluation studies have been conducted in North Carolina waters (McKenna and Monaghan 1993; Coale et al. 1994; Murray et al. 1995; and McKenna et al. 1996). However, this data should not be used for characterization analysis since these studies are often relegated to times of low shrimp catch rates, and as such, the bycatch data are not representative of times when shrimp catch rates are higher. For example the fish to shrimp ratio for gear studies conducted in 1994 (McKenna et al. 1996) was 5.5 to 1, while characterization studies conducted in 1995 by Diamond-Tissue (1999) found the fish to shrimp ratio to be 1.6 to 1. While these data should not be used for characterization analysis, catches can provide information on species and sizes of species vulnerable to shrimp trawls. In a 1949 shrimp trawl tailbag mesh study conducted in Pamlico Sound 24 species of fish were observed in the catches (Roelofs 1950). Three species, Atlantic croaker (69%), spot (21%), and sea trout (4%)

made up 94% of the finfish bycatch by number (Roelofs 1950). Diamond-Tissue (1999) data shows that these three species still make up the bulk of the finfish bycatch in this area (Table 26).

One way of presenting and expanding bycatch data is by using the ratio of finfish to shrimp (F:S). For the Gulf of Mexico the finfish to shrimp ratio was 5.3:1, and for the South Atlantic it was 4.5:1 (Nance 1998). Reported F:S ratios for North Carolina are 1.5:1 (Roelofs 1950), 1.6:1 (Diamond-Tissue 1999) and 1.2 to 1 (Johnson 2003). However, Diamond-Tissue (1999) demonstrated the need for a standard protocol for bycatch estimations. Expansion techniques based on either the F:S ratio or the average species weight per tow (CPUE) resulted in bycatch estimates that differed greatly and were not consistent among areas or species. Estimated bycatch and coefficients of variation were generally greater with the F:S method than with the CPUE method, but both techniques produced estimates with large confidence intervals when sample sizes were small. Using known trip ticket shrimp landings as a check of potential bias, the CPUE method produced an overestimate of about 25%. Peuser (1996) indicates that, in spite of greatly increased observer sampling and analytical effort, problems such as varying trip definitions and small sample sizes continue to hamper efforts to precisely estimate the magnitude of bycatch. Before bycatch estimates can be used in stock assessments, it is necessary to convert total numbers to numbers at age and to expand estimates from known strata to unknown strata so that the entire fishing area is encompassed.

The Diamond-Tissue (1999) characterization study is the most extensive evaluation of bycatch in a North Carolina fishery. For the sole purpose of comparing methodology, bycatch quantities were estimated for each area and the total state for selected species. However, limited sample sizes and incomplete strata coverage resulted in excessive confidence intervals that prevent meaningful interpretation of the overall bycatch estimates. Diamond-Tissue concluded that the best way to obtain unbiased estimates of bycatch is through an observer program based on randomly observed trips. A stratified random sampling design based on five geographic regions and four shrimp seasons would be optimal. Based on initial estimates of variance, a minimum of 60 trips per strata is needed to narrow the confidence intervals to one-half of their current range.

Biological Implications of Bycatch

Evaluating the biological impacts of bycatch is a two stage process. First, the bycatch must be characterized in both magnitude and nature. Second, information obtained from characterization efforts must be applied to population and ecosystem models to evaluate potential impacts at those levels. Although, by definition, bycatch can include both incidental and discarded catch, much of the current concern is directed toward discarded animals. This concern is largely due to a general perception that discarded bycatch is a waste of natural resources and leads to overfishing (Crowder and Murawski 1998). Beyond the obvious impacts on discarded individuals, there are also potential population and ecosystem level effects (Alverson et al. 1994, Crowder and Murawski 1998). Kept bycatch has biological impacts also, but since it is accounted for as catch such impacts are encompassed in harvest strategies.

The first phase of characterization starts at the level of an individual animal. Discarded individuals suffer one of two immediate alternative fates: survival or death. Further, initial survival may still lead to chronic effects, such as delayed mortality, reduced growth, and interrupted maturation. Discarded animals are also vulnerable to increased predation, as shown by numerous observations of live discarded animals being preyed upon by birds, marine mammals, and finfishes. If this initial predation is avoided, the animals must still seek shelter and return to their normal environments, all the while exposed to the risk of predation (Murawski 1995).

While discarding is generally thought of in an active sense, most fishing gears are designed to provide some degree of passive discarding. In trawling, mesh sizes are selected by choice or mandated by regulation to prevent the harvest of small sized animals and it is generally assumed that animals escaping through the mesh survive. But the possibility remains that not all survive, resulting in some level of unobserved mortality. This unobserved mortality is a difficult issue for both managers and scientists because, if it occurs, the actual reduction in bycatch and thus mortality is lessened (Chopin and Arimoto 1995). Furthermore, since gear escapees can not be counted by conventional fishery observer programs, they cannot be monitored or included in stock assessment calculations. Chopin and Arimoto (1995) suggest that escapee mortality should be considered if gear-based measures are used as a primary management tool.

When viewed at the population level, the first instinct of many observers is to assume that discarding adversely impacts populations or stocks. Such ideas lead to the widely held belief that discarding, especially when the magnitude in pounds or numbers is large, contributes to overfishing and the decline of many stocks. Unfortunately, few hypothesis about population-level impacts have been tested (Crowder and Murawski 1998). Regardless, just as large levels of discarding do not necessarily lead to significant biological impacts, it can not be assumed that minimal discarding has only minor effects (Alverson et al. 1994). Discard impacts can only be determined through proper data collection and analytical investigations. Studies conducted to-date suggest that discarding has harmed some stocks, while others seem unaffected. For example, discarding has been implicated in the decline of Gulf of Maine groundfish, Atlantic croaker in the Gulf of Mexico, and scup and black seabass in the Mid-Atlantic (Alverson et al. 1994, ASMFC 1996a, ASMFC 1996b). Conversely, sizable discarding of redfish in the Northwest Atlantic and pollock, cod, and sablefish in the Northeast Pacific represents only a fraction of the total mortality of these species and is not believed to have a significant adverse impact on population abundance (Alverson et al. 1994).

The magnitude of discarding should not be the only concern when examining population-level impacts such effects are also related to the size or life-stage of the discarded animal. If discards are immature or below the size for optimum yield, both yield-per-recruit and spawning potential may be adversely impacted (Crowder and Murawski 1998). In other words, it is commonly known that harvesting fish before they mature and spawn can lead to recruitment overfishing and can impair a stock’s ability to sustain itself. Also, harvesting a fish before it reaches some optimal size can lead to growth overfishing and reduced overall yield from the fishery. These principles are unavoidable consequences of exploitation that can occur whether the fish are harvested or discarded. According to Amendment 3 to the weakfish FMP, discard losses in the South Atlantic shrimp trawl fishery significantly increased mortality of age 0 and 1 weakfish, and both yield and spawning potential could be increased if these age classes were protected (ASMFC 1996c).

In addition to impacts on individuals and populations, it is suspected that discarding can also alter entire communities. Community effects are still largely unknown, but in theory they could be significant. For instance, if an abundant species that dominates a community is removed by harvest while another species is discarded and survives, the community could eventually change to the extent that the discarded species becomes the dominant species in the ecosystem (Murawski 1995). If the newly dominant species is of less value, either ecologically or economically, both the ecosystem and the fishing economy could suffer. It is thought that such species-specific exploitation could be more damaging to the productivity of an ecosystem than exploitation of the entire community. However, such effects remain largely speculative as there has been little research on community-level effects.

Bycatch Impacts on Stock Assessment and Prediction

Any population is a dynamic entity that will fluctuate in abundance as members enter and members leave. In a simplified example of a fish population, the entering members (or recruits) are the fish born each year and the leaving members are those removed by natural mortality and harvest (or catch). However, as indicated previously, bycatch can result in largely unknown levels of additional removals from the population. Most quantitative stock assessment techniques involve statistical analysis of catch data and, thus, require an accurate record of the entire catch to reliably estimate stock parameters such as recruitment, abundance, and selectivity. Since these parameters are crucial to forecasts of future stock conditions, any error or bias in them will lead to additional uncertainty in the predictions.

Very little discard information was available in the past, so it was often assumed that discarding was a constant that could be largely ignored without causing any serious bias in assessment results (Murawski 1995). This trend is changing with the availability of additional research suggesting that while discarding may be constant in some fisheries, it is quite variable in many others. The challenge now lies in determining whether the additional precision gained by including discard losses justifies the expense and effort of collecting the data (Alverson et al. 1994). Since the impacts of overlooked bycatch on assessment results will vary from fishery to fishery, each case must be evaluated separately, and at least some characteristics of the bycatch must be determined.

In the most basic sense, discarded bycatch causes an underestimate of the total catch and evaluating how an assessment model responds to such an underestimate is fairly simple. It is known that responses vary among analytical techniques and depend on such factors as the age distribution of the discarded fish, the magnitude of harvest to discards, the variability and predictability of discard rates, relative year class strength, and the exploitation patterns of the involved fisheries (Alverson et al. 1994; Murawski 1995). Much of this knowledge is intuitive, and stems from understanding the interactions between input data (catch) and model outputs such as stock size and fishing mortality. Still lacking at this time are adequate bycatch estimates that could support the transition from generalized to quantitative responses. For example, if the discarded bycatch is composed of young fish, and the actual removal of young fish from the population is more than that indicated by the available data then this portion of the total catch is underestimated. How does this affect perceptions of stock status? In generalized terms, omitting the discard data from the analysis will underestimate recruitment and, to a lesser extent, mortality rates at age. If the discarded bycatch is older fish, both numbers at age and recruitment will be underestimated and thus overall stock biomass will be underestimated as well. Quantitative responses are desirable and certainly feasible, but they require some estimate of the magnitude of the discarded bycatch.

Just as with stock status estimates, how discards will affect stock predictions depends on several factors, including the type of predictions being considered, variability and predictability of discard characteristics, and fishery selectivity (Alverson et al. 1994). In all situations, if discard rates can not be predicted, then the fishery predictions will contain additional error. Short-term yield forecasts are robust if discarding and fishery selectivity are constant and predictable, but if discarding represents varying proportions of the total catch, these predictions may be impacted significantly. The impact will likely be expressed as additional uncertainty rather than as a bias (Alverson et al. 1994, Murawski 1995). According to Alverson (1994) and Murawski (1995), long-term forecasts such as equilibrium yield and spawning biomass per recruit analyses require inclusion of all sources of mortality and thus are very sensitive to discard effects. Even constant discard rates influence long-term predictions when the exploitation pattern of a fishery changes, a point that can have important consequences when contemplating changes in size or mesh restrictions.

The lack of reliable discard estimates has not stopped researchers from investigating assessment impacts, but it has prevented increases in precision. Exploration of such sources as the SEAMAP database and the NMFS vessel logbook entries has provided a wide range of discard estimates for a number of fish stocks. Most assessments address the range of bycatch estimates through sensitivity analyses by comparing basic assessment results over the range of bycatch estimates and assumptions. Those preparing or reviewing the estimates must decide which scenario seems most likely. If none of the results seem plausible, the assessment may proceed without the bycatch estimates included but with the caveat that results may be biased or contain additional uncertainty due to unknown levels of missing catch.

Unlike in the past, it is no longer acceptable to assume discards represent an unimportant removal from a stock. Under certain circumstances, discarding can and does impose uncertainty and potential bias on both estimates of current stock status and predictions of future stock conditions. This bias and error can make proper management even more difficult. While qualitative analyses of discard impacts are readily available at this time, providing the quantitative estimates that are necessary to improving stock assessments will require significant additional research and monitoring. Further, due to the extreme variation of discard characteristics, such efforts must be directed to specific fisheries and areas and must represent a long-term commitment.

Assessments of Target and Non-target Species

Target Species:

Shrimp Status

All three species of shrimp are essentially annual crops. Population size is regulated by environmental conditions. While fishing reduces the population size over the season, fishing is not believed to have any impact on subsequent year class strength unless the spawning stock has been reduced below some unknown minimum threshold level by unfavorable environmental conditions. Estimates of population size are not available, but since the fishery is considered to operate at or near maximum levels, annual landings are probably a good indication of relative abundance. Annual variations in catch are presumed to be due to a combination of prevailing environmental conditions and fishing effort.

Because of high fecundity and migratory behavior, the three shrimp species are all capable of rebounding from a very low population size in one year to a large population size in the next, provided environmental conditions are favorable. Landings over the last thirty or forty years have remained fairly stable while fishing pressure has increased dramatically. Fluctuations in abundance resulting from changes in environmental conditions will continue to occur. Perhaps the most serious threat to the stocks is loss of habitat due to pollution or physical alteration. Especially vulnerable and critical to shrimp production is the salt marsh (for white and brown shrimp) and estuarine seagrass habitat (especially for pink shrimp) which comprise the nursery areas for juvenile shrimp. In general, shrimp stocks of all three species in

North Carolina are considered healthy.

Non-Target Species:

Although many species are caught as bycatch in the estuarine shrimp trawl fishery, four species, blue crab, Atlantic croaker, spot, and weakfish have, since the first studies were conducted in the 1950s and continuing to the present, accounted for the bulk of the bycatch. The bycatch of southern flounder (*Paralichthys lethostigma*) is of concern due to it's overfished status. Because these five species and many other species of commercially and recreationally important finfish spend a portion of their lives in estuarine waters, bycatch in North Carolina's estuarine shrimp trawl fisheries, mainly ages 0 and 1, may have the potential to impact the stocks of these species. Natural mortality at these stages is high; however, it is believed that bycatch may adversely increase overall mortality potential. Possible impacts from this increased mortality include reducing spawning stock potential and reduced yields to the fisheries (West et al.1994). Due to the magnitude of the bycatch of these species and their importance to other commercial and recreational fisheries, a brief summary of their stock status is presented below.

Blue Crab Status

Significantly reduced landings of hard blue crabs during 2000 - 2002, following the historically record high landings observed during 1996 - 1999, has caused increased industry concern for the health of the resource and fishery. NC State University (NCSU) researchers have estimated maximum sustainable yield (MSY) for blue crabs to be between 38 and 46 million pounds per year (Eggleston et al. 2004). However, it is felt that these MSY estimates are not valid based on data and modeling limitations and the significant influence of environmental variables on the population. Because of data and modeling limitations, the MSY estimates should be used as a guideline to the long-term potential of the fishery rather than as strict targets. The model results do indicate that the blue crab stock is currently at a low biomass level and current fishing pressure exceeds that required to produce MSY, leading to reduced yield (Eggleston et al. 2004). None of the assessment results suggest that the high landings from the late 1990s would be sustainable. Stock size may be influenced by a number of factors, including habitat availability, natural events and cycles, harvest pressure, changes in stream flows, and water quality. Preliminary examination of fishery-independent catch-per-unit-effort data (1978-2003) for juveniles (crabs less than 121 mm carapace width) suggests that, despite variability in abundance, there is no general downward or upward trend in recruitment. These data indicate that a cautionary approach must be taken in the management of this species.

The bycatch of blue crabs in the shrimp trawl fishery is of concern due to the mortality (immediate and delayed) and physical injury of culled individuals. In a study of post-harvest mortality and physical injury to trawl and pot-caught crabs, McKenna and Camp (1992) found the incidence of physical injury to those crabs was similar; that is, the appendages were the most frequently damaged area. The chelipeds (pincher appendages) were the most frequently damaged appendage for both gear types; crab pot-crabs showed a greater loss than did trawl-caught crabs, 52% and 33%, respectfully. There were no differences between the survival rates of damaged crabs and undamaged crabs. These findings are in agreement with those of Smith and Howell (1987), who found the appendages were the most frequently damaged structure in pot and trawl-caught American lobsters in Long Island Sound, N.Y. Additionally, Wassenberg and Hill (1989) found that 99% of the trawl-induced damage to sand crabs was restricted to the appendages.

The only observed cases of immediate mortality in crab-trawl-caught crabs occurred in June (McKenna and Camp 1992). During this trip, a large number of paper shell and soft crabs were killed in the trawling process. These findings agree with those of other investigators who found that immediate mortality in trawl-caught crustaceans was almost entirely limited to soft or paper stage individuals (Smith and Howell 1987; Wassenberg and Hill 1989).

Factors affecting the level of delayed mortality in crustaceans are temperature, exposure time, amount and level of physical injury, and total catch biomass (Smith and Howell 1987; Wassenberg and Hill 1989). Overall survival rates for trawl-caught crabs was 64%, while 93% of the crab-pot crabs survived (McKenna and Camp 1992). The effects of temperature were readily apparent; survival rates for trawl-caught crabs during the winter months were 74%, while the individuals caught in June had a 20% survival rate.

Weakfish Status

The FMP for weakfish was adopted in 1985 by the ASMFC. The FMP was amended in 1991, 1994, 1996, and most recently by Amendment #4 in 2002. The Weakfish Management Board of the ASMFC oversees development of the plan. Weakfish are a major component of the haul seine, flynet, pound net, gill net, and hook and line fisheries from New York through North Carolina. A quantitative stock assessment through 1998 was conducted by the Weakfish Technical Committee and was favorably reviewed by the Stock Assessment Review Committees in Wood's Hole, Massachusetts. This assessment suggests that the target reduction in fishing mortality rate has been achieved and that the age structure of the population is improving. Amendment #4 to the FMP is designed to manage the recovered fishery and similar to Amendment #3 has specific restrictions including: Bycatch Reduction Devices for shrimp trawls and escape panels in long haul seines, 12 inch commercial minimum size limit for all but estuarine pound net and long haul seine fisheries (seasonal 10 inch size limit), minimum mesh sizes for gill nets and trawls, and a recreational bag and size limit (currently 7 fish at 12 inches). In addition, North Carolina is still required to maintain a closure of the area south of Cape Hatteras to flynets. One major change in Amendment #4 was an increase in the bycatch allowance for commercial fisheries from 150 pounds to 300 pounds provided that there is at least equal poundage of other species on board the vessel. In North Carolina this bycatch provision applies to gears used that do not meet the minimum mesh size requirements of Amendment #4 designed to prevent weakfish bycatch.

The 1996 stock assessment for weakfish represents one of the few examples of use of specific bycatch information in the stock assessment process. Vaughan et al. (1991) ran analyses based on different multipliers (0.0, 0.25, 0.50, 1.0) of weakfish to shrimp landings. They made the assumption that bycatch was proportional to shrimp landings and that this ratio was constant over time. However, these proportions are variable depending on location and time of year. Generally, weakfish to shrimp ratios in weight appear to range from 0.1:1 to 0.5:1.

Based on Vaughan et al. (1991), VPAs for 1982-1987 with natural mortality M=0.3 and without bycatch estimates, fishing mortality estimates (F) for age 0 were very small (around .015), while those for age 1 were much larger and increasing. However, estimates of fishing mortality at age-0 and age-1 increased values with increasing bycatch multipliers. For example, at the lowest bycatch multiplier (.25) the estimate of F_{age} ranged from 0.3 to 0.7, a much higher value than the F=.015 in the initial analysis. Initial yield-per-recruit estimates without bycatch showed almost no gain from raising the age at entry from age 0.25 to 1, but moderate gains from age 1 to age 2 and from age 2 to age 3. However, when the bycatch multipliers entered the analysis, a significant reduction in estimated yield-per-recruit was found, and a significant gain was demonstrated from raising the age at entry from age 0 to age 1 and from age 1 to age 2. There were moderate gains from raising the age at entry from age 2 to age 3. Maximum spawning stock potential (without bycatch) showed small declines, but when the bycatch multipliers were introduced, significant reductions were estimated. The 0.25 multiplier showed a small but significant gain in spawning stock potential when the age at entry was raised from age 0 to age 1 and even higher gains from increasing the age at entry to age 2.

The assumptions made in Vaughn et al. (1991) created the effect that trends in weakfish discards reflected shrimp harvest, in other words, the more shrimp caught, the more weakfish discarded. Another assumption that may be applied to weakfish stock estimates is to consider bycatch of weakfish as a function of weakfish abundance and shrimp fishing effort, but not shrimp catch. Gibson (1994) used shrimp trawl effort rather than shrimp catch and produced new estimates of weakfish bycatch in the shrimp trawl fishery. Gibson (1994) found nearly 90% of weakfish discards were age-0 fish; however, these estimates were imprecise. Discard numbers were 50% higher on average compared to a later assessment by Vaughan (1994 in Gibson 1994) showing opposite trends. Fishing mortality rates were slightly higher than Vaughan's method and agreed with the trends in spawning stock biomass and the decline in recruitment strength. Though these estimates are still uncertain, they may be sounder than past assessments.

Weakfish are managed under this plan as a single stock throughout their coastal range. All states from Massachusetts to Florida and the Potomac River Fisheries Commission have a declared interest in the Weakfish FMP. Responsibility for the FMP is assigned to the ASMFC Weakfish Management Board, Plan Review Team, Technical Committee, Stock Assessment Sub-Committee and Advisory Panel.

Based on data through 2000, weakfish are currently not overfished with fishing mortality below the target and SSB above the target. A new assessment is currently under development and will include data through 2003.

A weakfish stock assessment of data through 1998 was conducted in 1999 and reviewed by the Stock Assessment Review Committee for peer review at the 30th Northeast Regional Stock Assessment Workshop (NMFS 2000). This report indicated that weakfish were "at a high level of abundance and subject to low fishing mortality rates." This assessment was updated in 2002 with data through 2000. Much of the language below was taken from this updated assessment (Kahn 2002).

Virtual population analysis was used to estimate fishing mortality and stock size (ADAPT VPA in FACT, Northeast Fishery Science Center; Gavaris 1988; Conser and Powers 1990). This is a type of analysis that uses data on the number of fish caught at various ages or lengths to estimate fishing mortality as well as numbers of spawning individuals in a population. The most recent stock assessment update conducted with data through 2000 indicates that the management measures put in place in Amendment 3 resulted in positive trends for the weakfish population. The absolute magnitude of impact should be viewed with caution given the uncertainty of the fishing mortality and spawning stock biomass estimates for the most recent year of the assessment, which is often the case with these final year estimates. Once more data is added to the assessment the fishing mortality is expected to rise and the spawning stock biomass is expected to decrease.

This assessment indicates that weakfish are at a high level of abundance and fishing mortality appears to be low. Recent history of the coast-wide stock shows that spawning stock biomass (total weight of fish in a stock that are old enough to spawn) estimates were low from 1982 through 1985. High recruitment of age one weakfish in 1985-1987 produced a brief increase in biomass. By 1989, biomass had again declined and remained low through 1993. Since then, biomass has been building to higher levels. While the exact level of bias in the most recent estimates is unknown, the current level of SSB is well above the threshold level in Amendment 4 of 14,400 MT.

Estimates of fishing mortality (the rate fish are being removed by human activity) range from a high in 1994 of 2.52 to a low of in 2000 of 0.12. Since 1995, estimates of F have been below the Amendment 3 target of 0.50. The 2000 estimate of 0.12 could be underestimated. Despite this bias, the corrected value would still be below the fishing mortality target of 0.31 in Amendment 4 and far below the proposed fishing mortality threshold of 0.50. In 1982, the estimate of the proportion of age 6+ fish was 1.0% of the total. By 1990, this had shrunk to only 0.3% of the total number of weakfish. This proportion has been increasing in recent years to the level of 6.8% of the total in 2001.

Atlantic Croaker Status

The Atlantic croaker stock status was upgraded to viable in 2004 (Stock Status 2004). The CPUEs for Atlantic croaker increased greatly in the ocean trawl and sink gill net fisheries, and the size and age distributions shifted to older, larger fish. Some of the increase is attributable to increased fishing effort on Atlantic croaker in the ocean because of harvest restrictions placed on weakfish during this period. Comparable increases did not take place in the estuarine long haul seine and sciaenid pound net fisheries, which continue to show a decline in the harvest of Atlantic croaker. Reduced landings of Atlantic croaker in estuarine waters may be due, in part, to changes in the traditional estuarine fisheries in response to weakfish size limits imposed during 1992. However, the decreases could also signal some environmental or other problems affecting the estuarine system. The magnitude of the catches in the ocean has caused the overall commercial CPUE to rise incrementally since 1992. A significant upward trend was not seen in the recreational harvest, which is primarily an estuarine fishery.

The peer-reviewed stock assessment was completed by ASMFC Technical Committee and accepted by the South Atlantic State/Federal Fisheries Management Board in August 2004 (ASMFC 2003 and ASMFC 2004). The development of Amendment 1 will begin in October 2004 to incorporate the information from the latest stock assessment and peer review, and revise the plan to comply with the mandate of the Atlantic Coastal Fisheries Cooperative Management Act. It was determined the stock is not overfished and overfishing is not occurring in the Mid-Atlantic region (North Carolina and north). The stock assessment shows both fishing mortality and spawning stock biomass for the Mid-Atlantic region exhibiting a cyclical trend over the time series. The Atlantic croaker stock status for the South Atlantic region (South Carolina and south) is unknown at this time. The South Atlantic region makes up a relatively small component of the total stock biomass. Recent fishing pressure (2002) is below the target MSY and the spawning stock biomass is well above the target level. Shrimp trawl bycatch was not included in the final model due to the uncertainty of the bycatch data. Model runs were completed including shrimp trawl bycatch to show the effects this fishery has on the stock even with the limited data. Sensitivity analysis evaluating the inclusion and non-inclusion of shrimp bycatch estimates, indicate that SSB_{msy} estimates are sensitive to the inclusion of Atlantic croaker caught as shrimp bycatch. However, increased SSB_{msy} estimates are also accompanied by higher total SSB estimates. The ratio of SSB_{2002}:SSB_{msy} when preliminary estimates of shrimp bycatch is included indicates that the stock is unlikely to be below the threshold estimates. Also, biomass reference points from the simulation runs including shrimp trawl bycatch indicated higher SSB_{msy} values and the lower estimates of SSB_{2002}:SSB_{msy} than those obtained for the base model. The range of estimates for F_{msy} (~0.4) was similar to the base model (~ 0.39). SSB_{msy} estimates from the simulation ranged from 48,000-67,000 MT with a median of 56,467 MT and were much higher than those for the base run (28,932 MT).

Diamond-Tissue (1999b) showed that by separating Atlantic croaker into different life history stages, she could examine the effects on the population of mortality at different life stages. This approach provides some insight into population changes that may be caused by bycatch. She used a stage-within age based matrix model. In this type of model, a stage-based model of the first year of life was combined with an age-based model of adults. The first year (age 0) was divided into six stages separated by biologically significant events based on major changes of morphology or habitat. Within each life stage model, she examined the population growth rate, the stable age distribution, and the elasticity (sensitivity) of the population to increases and decreases of mortality in each life stage. In order to determine elasticity of the population, baseline matrices were constructed from published and unpublished data on the life history of Atlantic croaker. Of all the data examined, only late-stage juvenile and adult mortality rates were shown to be affected anthropomorphically (fishing mortality). She then examined the trade-offs between regulating directed fisheries for adults and regulating fisheries that cause mortality on late juveniles. These simulations varied mortality from the baseline values established from data in the literature.

In the Atlantic and the Gulf of Mexico areas, the baseline model showed 99% of the population to be in the first year of life. The elasticity analyses showed that croaker were more sensitive to survival during age 0 than other age classes. In both regions, croaker were more sensitive to changes in fertility of age-1 fish (the age of first full reproduction) than fertility in any other year. In the analyses of other life stages, the south Atlantic population was more sensitive to fecundity than the Gulf population, but both populations were most sensitive to mortality in the oceanic larval stage than in any other stage.

By altering the late stage juvenile mortality from 10% to 200% of the baseline rate while keeping adult mortality constant, Gulf population growth rates decreased. Changing the adult mortality rates yielded similar effects. If juvenile or adult mortality was decreased, population growth rates increased. In the south Atlantic, the model was much more reactive to change. As in the Gulf, changing the mortality rate from 10% to 200% of the baseline caused population growth rates to decrease. Changing the adult mortality rate had a much larger effect on population growth rates.

Diamond-Tissue's (1999b) model results indicate that bycatch mortality at the estimated levels is not the most important factor affecting Atlantic croaker populations in the Gulf of Mexico or in the south Atlantic areas, although it can have a large negative impact on population growth rates. Both populations were most sensitive to mortality during the ocean's larval stage, followed by mortality of estuarine larvae and adults in the Gulf, and by early juvenile and adult mortality in the Atlantic. Bycatch mortality would have to be 2.5 times higher in the Gulf of Mexico and about 3.5 times higher in the south Atlantic for bycatch mortality to be the most important factor affecting population growth rate. Simulations showed that reducing late juvenile mortality by 1% and adult mortality by 3% of the baseline would stabilize the Atlantic population.

Spot Status

A formal coastwise spot stock assessment has not been conducted. The DMF has classified the status of spot stocks as viable in North Carolina (DMF 2004). The ASMFC Fishery Management Plan (FMP) for spot, adopted in 1987 included the states from Delaware through Florida. Spot is a short-lived species and fluctuations in landings aren't uncommon (Mercer 1987). Concerns addressed in the 1987 FMP included growth overfishing, as indicated by the dominance of unmarketable fish being landed, especially in the shrimp trawl and flynet fisheries, but also in the sciaenid pound net and long haul seine fisheries. North Carolina has addressed these concerns. North Carolina has tested bycatch reduction devices in the shrimp trawl fishery and achieved finfish reductions of 50-70% with little loss of shrimp. Finfish reduction devices have been required in all shrimp trawls since the fall of 1992 (15A NCAC 3J.0104) and escape panels have been required (since April 1999) in the bunt nets of long haul seines in an area south and west of Bluff Shoals in the Pamlico Sound (15A NCAC 03J.0109). The North Carolina Marine Fisheries Commission modified this rule in August 2003 to include more specific wording on installation and placement of the culling panels. Additionally, in the North Carolina flynet fishery, where a large portion of the spot catch occurs, there is a requirement for a minimum tailbag mesh of 3 1/2 inch diamond or 3 inch square. Furthermore, the state of North Carolina has banned flynet fishing in waters south of Cape Hatteras. The 2004 review of the spot FMP includes prioritized research and monitoring recommendations for the Atlantic states to consider.

Southern Flounder Status

Based on the 2004 stock assessment, the southern flounder stock is overfished and has been for at least the past decade. North Carolina lands 96% of the southern flounder caught in southeastern United States commercial fisheries. North Carolina landings increased dramatically during the 1990s as they replaced summer flounder as the leading flounder landed in North Carolina. According to a draft stock assessment report, southern flounder appear to be fully-to-over-exploited in North Carolina and the rest of the southeastern United States. Preliminary results indicate that the fishing mortality rate for females was close to F_{max}, and the spawning potential ratio for females was between 15% and 20% for the years 1988 to 1997. Since the stock is comprised of primarily 1 and 2 year-old fish, stock status is dependent on annual recruitment.

The southern flounder fishery is largely dependent on incoming recruitment. The 2004 stock status catch-at-age indicated extremely high exploitation of age-1 and age-2 southern flounder (57% and 38% respectively), that is a concern since only 59% of age-1 and 79% of age-2 female southern flounder are sexually mature. With the addition of 1.0 million age 0-2 fish from the shrimp trawl bycatch, exploitation of juvenile southern flounder is more pronounced (19%, 52%, and 26% respectively). The current fishing mortality rate for southern flounder is 1.91 (representing an 85% removal rate), which retains approximately 5.4% of the maximum spawning stock biomass, well below the percentage of spawning stock necessary to sustain most stocks. In such a suppressed stock scenario, it is unclear what specific impacts shrimp trawl bycatch has on the overall stock status of southern flounder. However, the cumulative impacts of low spawning stock biomass and low recruitment abundance are of concern within the southern flounder fishery and efforts to increase both are needed.

Summary

While the bycatch of these species has been a concern to managers since the 1950's only recently has the affect of bycatch mortality been examined, and only for three species, weakfish, southern flounder, and Atlantic croaker. This is due in large part to the lack of adequate assessment data for these and most other species. The bycatch of weakfish in the shrimp trawl fishery has been identified as a major source of mortality for this species. Through the use of BRD's and other management measures this mortality has been reduced and the stock is showing signs of improvement. The bycatch mortality of Atlantic croaker may need to be 3.5 times higher to be the most important factor affecting population growth rate for this species. It is unclear what specific impacts shrimp trawl bycatch has on the overall stock status of southern flounder given this species suppressed stock scenario. These analyses show the importance of combining adequate assessment data with the appropriate management measures to insure healthy stocks.

Obtaining unbiased and precise estimates of bycatch clearly represents a significant technical and financial challenge. However, for many target and non-target trawl species, these data may be critical to determining exploitation status and the effectiveness of management measures. The importance of discard estimates to a given species will depend on the magnitude of the discards, the fraction of the total catch represented by discards, and the variability in discard losses over time (Murawski 1995). Because of the unique nature of North Carolina's estuarine habitats and the fact that bycatch rates vary by fishery, season, and area, North Carolina can not depend on research efforts of the NMFS or other states in addressing bycatch losses.

While the effect that shrimp trawl bycatch has on finfish stocks is unknown, the reduction or elimination of the bycatch has a number of important implications. The reduction of fishing mortality on juvenile finfish stocks might result in more individuals recruiting into the commercial and recreational fisheries. From the commercial fisherman's perspective, less time will be spent culling the catch, fuel savings might be realized due to lower biomass in the nets, and the quality of shrimp catch should be improved. Methods and management options to reduce bycatch are discussed below.

Gear Modifications

Tailbag Mesh Size

Trawl minimum mesh size regulations are the principal method used to regulate fishing mortality on fish stocks (Smolowitz 1983). The control of net selectivity is the preferred management tool in lieu of other more stringent regulations such as temporal and spatial closures, quotas, or limited entry. The underlying principle of mesh size regulations is that undersized fish will escape from the tailbag, survive, and become part of the future spawning biomass. Recent studies on the survival of fish escaping from tailbags (Main and Sangster 1988, J.T. DeAlteris, Univ. Rhode Island, Pers. Comm., Simpson 1990) support the use of minimum mesh sizes as a means of reducing fishing mortality on juvenile fish.

In 1949 Roelofs (1950) tested three tailbag sizes (2", 2 ¼", and 2 ½") in Pamlico Sound. Reduction rates were reported for spot, Atlantic croaker, and shrimp. Reduction rates for spot were 12.2% (2"), 42.8% (2 ¼"), and 50.5% (2 ½"). Atlantic croaker reductions were 24.8% (2"), 59% (2 ¼"), and 38% (2 ½"). Overall shrimp reduction rates were 5.6% (2"), 14.9% (2 ¼"), and 9.2% (2 ½"). In all cases, reduction rates were influenced by the size of the fish and shrimp.

The DMF conducted some preliminary tests on diamond tailbag mesh size in 1991, and square mesh tailbags in 2000. The two tailbags tested in 1991 were 1 5/8" stretched mesh

(13/16" bar), and 2" stretched mesh (1" bar) tested against a 1 ½" standard stretched mesh tailbag. In 2000 a 1 ½" stretched square mesh tailbag was tested against a 1 ½" stretched mesh diamond tailbag. Results of the 1991 tests indicated that there was no apparent difference between the catches in the control net and the 1 5/8" tailbag (Table 30). Tests with the 2" stretched mesh tailbag did show a difference between catch rates of spot (-46%), Atlantic croaker (-22%), total fish (-37%) and total catch [-18% (Table 31)]. However as was the case with the 1 5/8" tailbag not enough tows were made to test for significance differences. Tests conducted in 2000 with the 1 ½" square mesh tailbag showed a significant reduction in the catch of young of the year (YOY) weakfish (-51%), and bay wiff [-32% (Table 32)].

Bycatch Reduction Devices

During the 1980's the DMF and NMFS conducted studies on shrimp retention rates for various Turtle Excluder Devices [TED's (1985 - 1986 DMF unpublished data, and 1988 - 1989 NMFS unpublished data)], and started work on identifying means to reduce finfish bycatch in the shrimp trawl fishery (Pearce et al. 1988, and Holland 1988). In 1991 Amendment 1 to the Weakfish Fishery Management Plan (FMP) was adopted. This amendment recommended that South Atlantic states implement programs to reduce bycatch mortality of weakfish in their shrimp trawl fisheries by 40% by January 1, 1994. Based on results obtained during development work in 1990 and 1991 on DMF research vessels and operational testing conducted aboard a commercial trawler in 1992, the DMF required all shrimp trawlers working in state waters to equip their nets with functional fish excluders in October 1992. However North Carolina was the only state that required finfish excluders. On October 20, 1994 Amendment 2 of the weakfish FMP was passed. This amendment required all South Atlantic states (NC-FL) to implement management measures to achieve the 40% reduction in bycatch of weakfish in the shrimp trawl fisheries by the start of the 1996 shrimping season.

Starting in 1992 DMF staff has worked with fishermen and used its own research vessel to test many different BRD's in a variety of waterbodies, seasons, and under various tidal and environmental conditions. The goal of the testing was to find devices, which maximized finfish reduction, minimized shrimp loss and meet the requirements of Amendments 1 and 2 of the weakfish FMP. Florida Fish Excluders [FFE's (Figure 1)] are currently being utilized by over 80% of the shrimp trawlers in the state (close to 100% for recreational shrimpers). The effectiveness of this gear in reducing weakfish and other fish species is a function of the size of the FFE opening and the placement of the gear in the tailbag of the trawl. A minimum opening of 5 1/2" X 6 1/2" is required for the reduction of weakfish at the mandated level (Table 33). Placement in the tailbag is a function of the distance the gear is placed from the tailbag tie-off and general location in the net (top, side, or bottom). The distance from the tailbag tie-off is expressed as a ratio, BRD length/tailbag length. Where BRD length is equal to the distance from the tailbag tie-off to the opening of the FFE, and tailbag length is the length of the tailbag from the tie-off rings to the beginning of the tailbag (excluding any extension). To obtain a 40% value in weakfish reduction this ratio cannot exceed 0.68 (Tables 34-36). Data collected during the development of FFE's indicated that maximum reduction of weakfish was obtained when the FFE was placed 15 meshes to the side of the tailbag (Tables 37 and 38).

The large mesh extended funnel [LMEF (Figure 2)] is constructed from three sections of webbing. The forward piece is 62 meshes long, 120 meshes in circumference, 1 5/8" stretch mesh, #30 nylon twine. The center is made of 8" stretched mesh, 4 mm polyethylene, hung on the square. This section is 5 meshes long and 23 meshes in circumference. The rear section is similar to the first section except that it's 232 meshes long. A single hoop, constructed of 1/2" diameter plastic coated towing cable is sewn into the rear section of webbing, 4 meshes aft of the 8" webbing. This hoop is 30" in diameter. An accelerator funnel, constructed of 1 ½”, #24 depth stretched and heat set polyethylene webbing is attached to the forward section of small webbing. The funnel extends back past the 8" webbing and is reattached 4 meshes behind the hoop. Only 7 meshes on top and 7 meshes on the bottom are attached in the rear section. This device showed good potential in its ability to retain shrimp and exclude weakfish and other fish species (Table 39). Overall this gear showed a -2% reduction in shrimp weight. Significant reduction in the weight of spot (-71%), whiting (-45%), Atlantic croaker (-63%), bluefish (-32%), weakfish (-50%), and total finfish (-55%) was observed with this gear.

During the summer of 1995, a series of tests with a modified large mesh funnel excluder [MLMFE (Figure 3)] was conducted using the R/V Carolina Coast. This device consists of an extension of 4" stretched mesh, #60 nylon, hung on the square (50 meshes in circumference and 12 meshes long. Hoops of ½” combination cable are attached to both ends of the 4" extension. An accelerator funnel made of 1 7/8" stretched mesh, #15 nylon, runs through the 4" escapement webbing into the tailbag (15 meshes beyond the escapement webbing). The aft end of the funnel is pulled tight by bungie cord attached at the top and bottom of the funnels end. The accelerator funnel is constructed from two pieces of webbing, 49 meshes (points) at the large end, 30 meshes long and cut on a 2 to 1 taper. The device was installed immediately behind the TED (mini-super shooter). Shrimp catches were reduced by 12% in the MLMEF equipped net. Significant reductions in total finfish (-24%), and total catch (-23%) weight was also observed. Since there was no reduction in weakfish weight, the accelerator funnel was modified in an attempt to increase reduction rates. The original funnel was replaced with an accelerator funnel, constructed of ½”, #24 depth stretched and heat set polyethylene webbing cut on a 1 to 1 taper. This device was tested in Brunswick County in late August 1995. Significant reductions in the weight of weakfish (-58%), spot (-71%), and Atlantic croaker (-36%) were observed in the test net (Table 40).

From 1995 through 1996 gear development work continued using state funds. New designs developed by a local fisherman were examined for their ability to reduce weakfish. Designs tested were a 6" and 8" PVC excluder [“Sea Eagle” (Figure 4)]. The 6” “Sea Eagle” was tested 40 meshes above the tailbag tie-off at the top of the tailbag. Total catch weights and reduction rates for all species collected in the control and test nets are given in Table 41. Since the 6” “Sea Eagle” did not meet the minimum weakfish reduction requirement, tests were conducted with an 8” version of the device. Work with the 8” “Sea Eagle” showed that the weight of shrimp -4.77%, weakfish -57.80%, spot -53.39%, Atlantic croaker -56.70%, and total finfish -54.33% were significantly reduced with this gear.

In 1996, the MFC approved four BRD’s for use in shrimp trawls. Proclamation SH-9-97, effective September 1, 1997, required shrimp trawlers to be equipped with one of the following approved designs: 1) a Florida fish excluder (FFE) measuring at least 5 1/2" x 6 1/2" (inside measurement) positioned no more than 19 meshes from the top centerline of the tailbag and located no more than 65% up from the tailbag tie-off; 2) a large mesh funnel [8 or 10 inches stretched mesh; 3) a modified large mesh funnel excluder; or 4) a circular excluder constructed of PVC material measuring at least eight inches in diameter, positioned no more than 15 meshes from the top centerline and located no more than 38% up from the tailbag tie-off.

Although BRD testing has continued in North Carolina, by the DMF and projects funded by NC Sea Grant Fisheries Resource Grants, and other South Atlantic states no new devices have been identified that meet the weakfish reduction requirements. The preferred alternative for the certification of new BRD’s in draft Amendment #6 (2004) to the FMP for the Shrimp Fishery of the South Atlantic Region recommends that for a new BRD to be certified, it must be statistically shown that the device can reduce the total weight of finfish by at least 30%. This will allow more flexible testing of BRD's, and allow the South Atlantic Council to achieve an ecosystem approach in fisheries management. If this new requirement is adopted there is a strong potential for new BRD's to be developed that have greater bycatch reduction rates then those currently in use.

When the BRD requirements were adopted by the MFC, recreational and commercial shrimpers were considered as a single group. With the passage of the Recreational Commercial Gear License (RCGL) in 1997, recreational shrimpers are limited to a single shrimp trawl with a maximum headrope length of 26 feet and are prohibited from using mechanical retrieval methods. When testing FFE's, work was conducted aboard commercial trawlers with tow times of 60 minutes or longer. Since most RCGL holders have shorter tow times (20 minutes or less) FFE's placed 65% up from the tailbag tie-off most likely do not maximize finfish reduction. Additionally, gear testing conducted by the DMF in 1986 on the effects of light vs. heavy footrope chains on 20 foot trawls showed that bycatch of flounder, and crabs was higher in a heavily chained net while there was no difference in shrimp catches. To better reduce bycatch in RCGL shrimp trawls FFE's should be tested closer to the tailbag tie-off, and specific requirements for footrope chains should be examined.

Alternate Gears

The development of species specific gears such as shrimp pots and cast nets could reduce finfish bycatch, minimize environmental concerns and conflicts with other fisheries, and could be more cost-effective than trawling. Even if these gears are ineffective in catching commercial quantities of shrimp, their use by recreational fishermen could result in a significant decrease in finfish bycatch.

Shrimp pots are currently being used in Pacific Northwest to harvest the British Columbia prawn (*Pandalus platyceros*) and in Maine to harvest northern shrimp [(*P. borealis*) Boutillier and Sloan 1987, and Philip Averill, Maine DMR, Pers. Comm.]. Various attempts have been made to develop a pot to capture Penaeid shrimp in North Carolina, however, all have proven to be ineffective (Jim Bahen, UNC Sea Grant, pers. comm.; DMF unpublished data 1990; McKenna and Clark 1993). In 2003, the DMF became aware of the emergence of a new form of shrimp pot/trap with wings. These traps are constructed of 5/8" rigid hardware cloth and have two V-shaped wings to direct the shrimp into the traps. These wings can be up to 50 feet in length and the distance between the ends of the wings is approximately 80 feet. The traps are most successful when set during a flood tide with one of the wings against a bulkhead or marsh shoreline. The devices are staked or anchored in place. The ends of the wings face away from the direction of the tide flow when deployed.

The use of cast nets to harvest shrimp is a popular technique used by recreational fishermen in South Carolina and Georgia (Theiling 1988; Williams 1990). This method is used primarily on white shrimp, but may also be effective in capturing brown shrimp. In shrimp baiting, a series of poles are pushed into the bottom of shallow tidal waters. Bait balls, made from fish meal and mud, are placed at a known distance around the poles. Casting with multi- or mono-filament nets begins within minutes after baiting. Catches generally range from 30 to 41 quarts (headson) of shrimp per night (Theiling 1988). The harvest of white shrimp by cast netters in South Carolina accounted for 40% of the total white shrimp landings in 1990 (David Whitaker, S.C. Wild. Mar. Res. Per. Com.). This recreational fishery occurs largely at night in the shallow, peripheral waters of the estuaries. On a limited basis, cast netting for white shrimp occurs in the southern portion of North Carolina and in the Core and Bogue sound areas. As is the case in South Carolina, most of the activity in North Carolina is restricted to shallow tidal creeks. No known cast netting activity occurs in the Pamlico Sound complex. Tests conducted in this area indicated that cast nets were a ineffective means of harvest (McKenna and Clark 1993). This system has a low tidal range with circulation that is dominated by wind-driven currents. This lack of tidal influence could affect shrimp behavior in terms of movement and feeding activity, thus making them less susceptible to baiting.

Catch Restrictions

Catch restrictions have been used by fisheries managers to maintain fish stocks, extend fishing seasons, allocate resources, and reduce bycatch. In North Carolina this method is being used to reduce the targeting of marketable finfish with shrimp trawls. From December 1 through February 28 It is unlawful to use trawl nets in internal waters to take more than 500 pounds of finfish and from March 1 through November 30 no more than 1,000 pounds of finfish may be taken (15A NCAC 3J .0104 (a) (1)). Additionally, in the Atlantic Ocean it is unlawful to possess finfish caught incidental to shrimp trawling from December 1 through March 31 unless the weight of the combined catch of shrimp and crabs exceeds the weight of finfish, except that 300 pounds of kingfish may be taken south of Bouge Inlet (15A NCAC 3J .0202 (5 (a) (b)).

Harvest Seasons

Harvest Seasons have been used to reduce bycatch by relegating fishing activity to times of maximum target species abundance, or by limiting activity during times of high bycatch. Currently shrimp trawling is permitted all year in North Carolina. If a specific species stock assessment indicated that measures need to be taken to reduce either the incidental or discarded catch in the shrimp trawl fishery of that species the following questions should be addressed:

1) How will seasons be determined?
   a) Overall?
   b) Area?

2) What criteria will be used to set seasons?
   a) Base on historic average landings?
   b) Maximum value?

3) Will allowances be made for variable conditions?
   a) Water temperature?
   b) Salinity?

The type of information presented in Tables 1 through 22 would provide information to answer the first two questions, while environmental data collected by the various resource agencies could be used to address the third question.

Time Restrictions

Trawl time restrictions can reduce bycatch of non-target species. In North Carolina it is unlawful to trawl for shrimp in the Atlantic Ocean off Brunswick County, from one hour after sunset to one hour before sunrise. This management measure was implemented in large part to reduce the bycatch of finfish in this gear. Ingraham (2003) examined this question by conducting a study of shrimp and finfish catch rates (day vs. night) in state waters from Topsail Inlet to Little River Inlet. Data from the study showed that finfish bycatch was higher at night than during the day. Of the nine commercially important finfish species caught, southern flounder, spot, Atlantic croaker, and southern kingfish catch rates were significantly higher at night. The catch of shrimp did not vary significantly between nighttime and daytime trawling, although catches were slightly higher during the day.

Area Restrictions

Area restrictions for trawling have been used to deal with allocation, resource, habitat, and safety issues in North Carolina. During the late 80's trawling was prohibited in Albemarle Sound and its tributaries (15A NCAC 3J .0104 (b) (3)). This action was implemented to protect the flounder gill net fishery in this area (allocation issue). Since 1978 over 147,000 acres of estuarine nursery areas have been closed to trawling to protect juvenile fish and crustaceans. MFC rule 3N .0102 (a) defines Nursery Areas "as those areas in which for reasons such as food, cover, bottom type, salinity, temperature and other factors, young fish and crustaceans spend the major portion of the initial growing season." There are approximately 80,000 acres of Primary Nurseries, 35,500 acres of Secondary Nursery areas, and 31,000 of special Secondary Nursery areas. Primary and Secondary Nursery areas are permanently closed to trawling, while Special Secondary Nursery areas can only be opened to trawling by proclamation from August 16 through May 15. In the mid 90' s the sea grass beds along the Outer Banks were closed to trawling to protect this critical habitat. Over 39,000 acres of military target areas are also closed to trawling for safety reasons. North Carolina has 2,147,000 acres of estuarine surface waters with just over 1,000,000 acres (46%) closed to trawling.

Limited Entry

Limited entry methods of management restrict access to a fishery. Capping and/ or reducing fishing effort can protect the biological viability of a species and the economic integrity of the fishery. The species is protected by preventing overfishing and depletion of the stocks. While the fishery is enhanced by reducing costs and increasing earnings, effectively increasing efficiency. Other benefits of limited entry programs include an incentive to conserve, more efficient management, bycatch minimization, and habitat protection. However, piecemeal implementation of limited entry programs can easily displace fishing effort from one fishery to create new problems in other areas and fisheries (Buck 1995). For bycatch reduction, limited entry systems are often used in conjunction with other management measures, such as quotas or trip limits to achieve management objectives.

IV. Current Authority:

- ♦ It is unlawful to use trawl nets for the taking of finfish in internal waters, except that it shall be permissible to take or possess finfish incidental to crab or shrimp trawling in accordance with the following limitations: it is unlawful to possess more than 500 pounds of finfish from December 1 through February 28 and 1,000 pounds of finfish from March 1 through November 30. 15A NCAC 3J .0104 (a) (1)
- ♦ It is unlawful to use trawl nets from December 1 through February 28 from one hour after sunset to one before sunrise in portions of the Pungo, Pamlico, Bay, Neuse, and New rivers. 15A NCAC 3J .0104 (b) (5) (A) (B) 8 (D) (E)
- ♦ It is unlawful to use trawls within one-half mile of the ocean beach between the Virginia line and Oregon Inlet. 15A NCAC 3J .0202 (2)

- ♦ From December 1 through March 31 it is unlawful to possess finfish caught incidental to crab or shrimp trawling in the Atlantic Ocean unless the weight of the combined catch of shrimp and crabs exceeds the weight of finfish; except that trawlers working south of Bogue Inlet may keep up to 300 pounds of kingfish, regardless of their finfish or crab catch weight. 15A NCAC 3J .0202 (5) (a) (b)
- ♦ It is unlawful to use trawl nets in Albemarle Sound and its tributaries. 15A NCAC 3J .0104 (b) (3)
- ♦ It is unlawful to use any trawl net in any primary or secondary nursery area. 15A NCAC 3N .0104 and 3N .0105 (a)
- ♦ Special secondary nursery areas may be opened to shrimp and crab trawling from August 16 through May 14. 15A NCAC 3N .0105 (b)
- ♦ The Director may by proclamation, require bycatch reduction devices or codend modifications in trawl nets to reduce the catch of finfish that do not meet size limits or are unmarketable as individual foodfish by reason of size. 15A NCAC 3J .0104 (d)
- ♦ It is unlawful to use shrimp trawls in all waters west of a line beginning at the southeastern tip of Baldhead Island 33° 50' 29" N - 77° 57' 28" W running 173° (M) to a point in the Atlantic Ocean 33° 46' 16" N - 77° 56' 24" W from one hour after sunset to one hour before sunrise. 15A NCAC 3J .0202 (8)

V. Management Options/Impacts

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

1. No rule change.
   - \+ No new regulations.
   - \- Continued biological concerns with finfish and sublegal crab bycatch.
   - \- Continued spacial conflicts.

2. Gear modifications.
   - \+ Reduce bycatch.
   - \+ Possibly increase numbers of bycatch species by delaying age at entry into the fishery.
   - \- Potential economic burden on fishermen (loss of shrimp and incidental catch).

3. Catch Restrictions
   - \+ Reduce bycatch of incidental catch.
   - \+ Possibly increase numbers of bycatch species by delaying age at entry into the fishery.
   - \- Potential economic burden on fishermen (loss of shrimp and incidental catch).

4. Harvest seasons.
   - \+ Reduce bycatch mortality.
   - \+ Potential decrease in effort.
   - \+ Reduce/eliminate conflicts with other commercial fisheries (crab trawl and crab potters).
   - \+ More efficient law enforcement.
   - \- Potential economic burden on fishermen.

5. Time restrictions.
    + Reduce bycatch mortality.
    + Potential decrease in effort.
    + Reduce/eliminate conflicts (crab trawl and crab potters).
    - Potential economic burden on fishermen.

6. Area restrictions.
    + Reduce bycatch mortality.
    + Protect critical habitats.
    + Reduce effort.
    + Reduce/eliminate user conflicts.
    - Potential economic burden on fishermen (reduction in catch).
    - Increased law enforcement duties.

7. Limited entry.
    + Reduce bycatch mortality.
    + Potential decrease in effort.
    + Reduce/eliminate conflicts.
    + More efficient law enforcement.
    + Potential economic windfall to fishermen in fishery.
    - Potential economic burden to fishermen left out of the fishery.

8. Ban shrimp trawling.
    + Eliminate trawl bycatch mortality.
    + Reduce user conflicts.
    - Economic hardship for trawlers.

Options two through four and six would require rule changes by the MFC.
AC and DMF recommendations: See area specific recommendations and research needs.

VI. Research Needs:

(1). Effort data need's to be collected to provide estimates based on actual time fished (or number of tows), rather than number of trips.

(2). Characterization work (shrimp) needs to be conducted across all strata (for example; season, areas, vessel type, and dominant species).

(3). Obtain mortality (immediate and post harvest) estimates of culled, active and passive, bycatch.

(4). Develop standard protocol for bycatch estimations.

(5). Continue to develop and test methods to reduce bycatch in the commercial and recreational shrimp trawl fisheries.

(6). Continue to develop and test alternate gears for shrimp harvest.

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Table 1. Percent Shrimp trawl landings (lbs)* of major market groups for North Carolina, 1994-2003.

	Shrimp		Fish		Crabs		Mollusk		Total
Year	Pounds	% of total	Pounds	% of total	Pounds	% of total	Pounds	% of total	Pounds
1994	6,890,373	89.46	391,671	5.09	394,817	5.13	25,096	0.33	7,701,957
1995	7,903,366	90.83	555,834	6.39	203,379	2.34	38,252	0.44	8,700,832
1996	4,874,276	85.83	530,604	9.34	265,166	4.67	9,225	0.16	5,679,271
1997	6,451,239	91.51	317,716	4.51	264,609	3.75	16,008	0.23	7,049,572
1998	4,270,740	85.62	197,277	3.95	508,457	10.19	11,574	0.23	4,988,048
1999	8,108,209	92.34	411,973	4.69	247,198	2.82	13,063	0.15	8,780,443
2000	9,442,710	94.90	320,997	3.23	169,906	1.71	16,449	0.17	9,950,063
2001	4,749,564	93.86	141,304	2.79	161,169	3.18	8,256	0.16	5,060,293
2002	8,879,703	95.90	229,236	2.48	143,367	1.55	7,481	0.08	9,259,787
2003	5,432,418	92.85	142,410	2.43	266,528	4.56	9,687	0.17	5,851,042
Average	6,700,260	91.31	323,902	4.49	262,460	3.99	15,509	0.21	7,302,131

*Single gear Trip Tickets

Table 2. Percent Shrimp trawl landings (lbs)* of major market groups in North Carolina, 1994-2003.

Area	Shrimp	Fish	Crabs	Mollusk	Total
Pamlico Sound	54.24	40.74	28.41	15.33	52.63
Ocean**	27.99	54.80	0.36	79.20	28.30
Core Sound	9.38	1.88	57.26	0.85	10.75
Neuse River	1.93	0.51	9.12	0.23	2.13
Inland Waterway***	1.57	0.43	0.55	2.90	1.48
Cape Fear River	1.36	0.44	0.12	0.23	1.27
New River	1.23	0.76	1.23	0.72	1.20
Newport River	0.61	0.02	0.17	0.09	0.56
Pamlico River	0.56	0.19	0.33	0.05	0.54
North River	0.39	0.05	0.23	0.25	0.37
Bay River	0.20	0.04	0.50	0.01	0.20
White Oak River	0.22	0.03	0.00	0.04	0.20
Croatan Sound	0.14	0.08	1.13	0.00	0.18
Roanoke Sound	0.11	0.04	0.52	0.00	0.12
Pungo River	0.05	0.00	0.06	0.00	0.04
Shallotte River	0.02	0.00	0.00	0.09	0.02
Lockwood Folly	0.00	0.00	0.00	0.00	0.00
Unknown	0.00	0.00	0.00	0.00	0.00
Total	100	100	100	100	100

*Single gear Trip Tickets

**Ocean includes six sub-areas see Table 3.

***Inland Waterway includes; all portions of the Inland waterway south of Morehead City, and Topsail, Stump, Masonboro and Bouge sounds.

Table 3. Percent landings (lbs) for the major market groups landed* by shrimp trawls in the Atlantic Ocean: 1994-2003.

Ocean subareas	Shrimp	Fish	Crabs	Mollusk	Total
<3 mi, N of Cape Hatteras	0.72	1.72	0.62	3.01	0.82
>3 mi, N of Cape Hatteras	0.76	0.51	0.94	0.12	0.74
<3 mi, S of Cape Hatteras	66.16	62.11	45.73	50.99	65.71
>3 mi, S of Cape Hatteras	8.29	10.12	6.50	5.50	8.43
Less than 3 miles	20.41	19.37	34.14	31.99	20.39
More than 3 miles	3.65	6.16	12.07	8.38	3.90
Total	100	100	100	100	100

*Single gear Trip Tickets

Table 4. Percent landings (lbs) by month for the major market groups landed* by shrimp trawls: all waters combined in North Carolina: 1994-2003.

Month	Shrimp	Fish	Crabs	Mollusk	Total
January	0.48	1.55	0.42	1.42	0.53
February	0.20	1.64	0.24	2.37	0.27
March	0.29	2.38	1.86	0.72	0.44
April	0.74	1.32	9.41	3.00	1.08
May	2.68	2.56	17.72	7.89	3.22
June	8.44	3.54	20.36	10.16	8.66
July	26.73	7.45	21.75	8.79	25.66
August	20.52	11.30	10.83	9.42	19.74
September	15.27	13.80	4.84	6.02	14.81
October	15.08	22.58	5.02	16.46	15.06
November	7.51	20.30	5.70	24.47	8.05
December	2.05	11.58	1.85	9.27	2.48
Total	100	100	100	100	100

*Single gear Trip Tickets

Table 5. Yearly finfish landings (lbs)* from shrimp trawls all North Carolina Waters combined.

	Year												Percent
Species	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Total	Average	of total
Sea mullet	93,292	220,610	132,953	105,149	78,843	231,075	154,700	47,414	113,574	67,859	1,245,471	124,547	38.45
Flounders	131,262	74,068	70,687	63,457	39,143	68,648	38,810	30,419	48,581	24,257	589,332	58,933	18.19
Spot	57,835	78,795	72,924	76,050	43,493	45,351	80,608	43,176	33,947	33,884	566,064	56,606	17.48
Croaker	14,305	18,642	190,251	15,695	1,857	6,956	1,129	2,254	1,661	994	253,743	25,374	7.83
Weakfish	47,406	40,269	18,492	13,786	5,014	17,304	7,190	1,793	2,983	1,360	155,596	15,560	4.80
Fish, Mixed	23,940	33,449	7,419	11,564	10,936	8,254	10,184	7,070	6,496	6,445	125,755	12,576	3.88
Butterfish	8,712	50,625	18,905	7,142	6,657	10,167	7,347	2,316	6,925	1,638	120,432	12,043	3.72
Harvestfish	1,722	6,658	4,077	4,813	3,199	8,627	5,327	2,040	2,534	1,234	40,230	4,023	1.24
Sheepshead	4,206	4,326	3,155	3,265	2,749	4,366	4,911	1,811	4,315	2,622	35,723	3,572	1.10
Spanish mackerel	850	3,287	2,273	5,043	1,911	2,271	1,439	497	1,175	164	18,909	1,891	0.58
Puffer	702	2,397	1,739	2,214	53	3,782	2,844	177	352	3	14,262	1,426	0.44
Hogfish	2,123	1,781	2,208	2,512	1,538	832	1,097	717	632	815	14,254	1,425	0.44
Black drum	35	8,499	440	32	43	638	331	132	2,374	154	12,677	1,268	0.39
Spadefish	241	1,792	820	1,567	76	1,643	443	400	1,665	7	8,654	865	0.27
Bluefish	879	1,284	1,411	1,907	223	440	676	227	299	59	7,405	740	0.23
Cutlassfish	573	1,552	92	359	359	226	1,369	27	4	289	4,850	485	0.15
Spiny dogfish	N/R	3,600	N/R	N/R	N/R	N/R	1,000	N/R	N/R	N/R	4,600	460	0.14
Sharks	184	906	346	858	733	N/R	546	102	6	N/R	3,681	368	0.11
Pompano	124	588	264	170	175	64	106	715	1,126	288	3,619	362	0.11
Triggerfish	1,927	1	37	121	8	N/R	N/R	N/R	9	N/R	2,103	210	0.06
Black sea bass	79	13	1,741	68	13	35	2	1	N/R	N/R	1,951	195	0.06
Cobia	183	246	103	268	93	N/R	19	N/R	N/R	35	945	95	0.03
Menhaden bait	104	25	N/R	300	N/R	227	N/R	N/R	230	40	926	93	0.03
False albacore	73	7	N/R	793	N/R	N/R	N/R	N/R	N/R	N/R	873	87	0.03
Bait	96	97	32	2	N/R	8	130	N/R	165	236	766	77	0.02
Mullets	44	258	61	68	N/R	12	43	9	66	1	562	56	0.02
Speckled trout	150	279	1	5	5	33	35	6	12	N/R	525	53	0.02
King mackerel	123	71	18	56	100	7	61	N/R	58	25	520	52	0.02
Conger eel	N/R	N/R	N/R	N/R	11	485	N/R	N/R	7	N/R	503	50	0.02
Snowy grouper	N/R	442	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	442	44	0.01
Angelfish	17	178	40	69	10	124	N/R	N/R	N/R	N/R	438	44	0.01
Hakes	N/R	326	32	N/R	N/R	50	N/R	N/R	N/R	N/R	408	41	0.01
Monkfish	66	20	40	272	N/R	N/R	4	N/R	N/R	N/R	402	40	0.01
Snapper	N/R	400	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	400	40	0.01
Blacktip shark	N/R	N/R	N/R	N/R	N/R	N/R	392	N/R	N/R	N/R	392	39	0.01
Red drum	100	49	4	N/R	5	191	10	N/R	29	N/R	387	39	0.01
Porgies	157	69	15	N/R	N/R	N/R	N/R	N/R	N/R	N/R	241	24	0.01
Eels	N/R	N/R	N/R	37	N/R	5	147	N/R	N/R	N/R	189	19	0.01
Oyster toad	N/R	N/R	N/R	N/R	N/R	138	5	N/R	N/R	N/R	143	14	0.00
Angel shark	N/R	58	N/R	7	N/R	N/R	72	N/R	N/R	N/R	137	14	0.00
Strawberry bass	46	28	2	11	5	3	16	N/R	N/R	N/R	111	11	0.00
Skates	N/R	62	N/R	N/R	27	N/R	N/R	N/R	N/R	N/R	89	9	0.00
Smooth dogfish	N/R	N/R	N/R	60	N/R	N/R	N/R	N/R	N/R	N/R	60	6	0.00
Yellow perch	57	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	57	6	0.00
Pinfish	26	20	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	46	5	0.00
Whitebone porgy	18	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	18	2	0.00
Tautog	11	5	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	16	2	0.00
Minnows	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	13	N/R	13	1	0.00

Table 5. Continued

Species	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Total	Average	Percent of total
	Year												
African pompano	N/R	N/R	11	N/R	N/R	N/R	N/R	N/R	N/R	N/R	11	1	0.00
Cod	N/R	11	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	11	1	0.00
Crevalle jack	N/R	10	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	10	1	0.00
Hog snapper	N/R	10	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	10	1	0.00
Boston mackerel	N/R	N/R	N/R	N/R	N/R	10	N/R	N/R	N/R	N/R	10	1	0.00
Spottail pinfish	N/R	3	6	N/R	N/R	N/R	N/R	N/R	N/R	N/R	9	1	0.00
Catfish	2	6	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	8	1	0.00
Shad	N/R	5	N/R	N/R	N/R	N/R	3	N/R	N/R	N/R	8	1	0.00
Grouper, mixed	N/R	N/R	8	N/R	N/R	N/R	N/R	N/R	N/R	N/R	8	1	0.00
White perch	N/R	4	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	4	0	0.00
Jolthead porgy	N/R	N/R	N/R	N/R	N/R	2	2	N/R	N/R	N/R	4	0	0.00
Grunts	N/R	N/R	N/R	N/R	N/R	N/R	N/R	3	N/R	N/R	3	0	0.00
Margate/Porgies	N/R	3	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	3	0	0.00
Scups	N/R	2	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	2	0	0.00
Perch, sand	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	1	1	0	0.00
Permit	1	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	1	0	0.00
Rock sea bass	N/R	1	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	1	0	0.00
Total	391,671	555,834	530,604	317,716	197,277	411,973	320,997	141,304	229,236	142,410	3,239,022	323,902	100

*Single gear Trip Tickets

Table 6. Total shrimp trawl landings (lbs)* of top five finfish groups by waterbody, 1994 – 2003 landings combined.

	Species											
	Sea Mullet		Flounders		Spot		Croaker		Weakfish		Total	
Area	Pounds	Percent	Pounds	Percent	Pounds	Percent	Pounds	Percent	Pounds	Percent	Pounds	Percent
Ocean**	829,825	66.63	189,769	32.20	305,342	53.94	216,793	85.44	12,175	7.82	1,553,904	55.30
Pamlico Sound	390,572	31.36	360,464	61.16	229,863	40.61	33,982	13.39	137,707	88.50	1,152,587	41.01
Core Sound	13,904	1.12	15,207	2.58	5,570	0.98	357	0.14	2,114	1.36	37,151	1.32
New River	2,019	0.16	7,438	1.26	10,654	1.88	1,133	0.45	45	0.03	21,289	0.76
Neuse River	4,330	0.35	4,446	0.75	2,882	0.51	379	0.15	1,626	1.04	13,661	0.49
Inland Waterway***	1,251	0.10	3,187	0.54	7,040	1.24	381	0.15	78	0.05	11,936	0.42
Cape Fear River	1,696	0.14	4,241	0.72	1,809	0.32	266	0.10	130	0.08	8,142	0.29
Pamlico River	1,411	0.11	2,484	0.42	505	0.09	92	0.04	405	0.26	4,897	0.17
Croatan Sound	47	0.00	441	0.07	1,027	0.18	108	0.04	440	0.28	2,063	0.07
North River	61	0.00	125	0.02	624	0.11	154	0.06	304	0.20	1,269	0.05
Bay River	192	0.02	365	0.06	92	0.02	53	0.02	453	0.29	1,155	0.04
Roanoke Sound	15	0.00	448	0.08	387	0.07	28	0.01	97	0.06	975	0.03
White Oak River	123	0.01	603	0.10	107	0.02		0.00		0.00	833	0.03
Newport River	25	0.00	89	0.02	38	0.01	16	0.01	23	0.01	191	0.01
Shallotte River		0.00	17	0.00	126	0.02		0.00		0.00	143	0.01
Pungo River		0.00	10	0.00		0.00	2	0.00		0.00	12	0.00
Total	1,245,471	100	589,332	100	566,064	100	253,743	100	155,596	100	2,810,206	100

*Single gear Trip Tickets

**Ocean includes six sub-areas see Table 3.

***Inland Waterway includes; all portions of the Inland waterway south of Morehead City, and Topsail, Stump, Masonboro and Bouge sounds.

Table 7. Monthly landings (lbs)* of top five finfish groups, 1994 – 2003 landings combined.

	Species					
Month	Sea Mullet	Flounders	Spot	Croaker	Weakfish	Total
January	2.40	0.83	0.00	3.82	0.18	1.59
February	3.95	0.42	0.00	0.00	0.26	1.86
March	4.30	1.17	0.10	0.39	0.38	2.23
April	1.83	2.48	0.08	0.15	0.22	1.37
May	1.88	5.28	0.24	0.12	1.45	2.08
June	3.33	6.89	0.45	0.23	2.64	3.18
July	7.78	9.65	3.52	1.52	16.51	7.23
August	10.48	12.25	10.44	3.47	25.80	11.06
September	5.54	23.01	23.89	6.26	16.57	13.58
October	17.45	22.51	44.34	7.00	18.64	23.05
November	32.23	11.38	16.35	6.98	14.33	21.39
December	8.83	4.15	0.58	70.06	3.01	11.39
Total	100	100	100	100	100	100

*Single gear Trip Tickets

Table 8. Yearly finfish value from shrimp trawls* all North Carolina Waters combined; 1994-2003.

	Year												%
Species	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Total	Average	of total
Sea Mullet	$71,573	$154,022	$119,910	$106,922	$82,656	$237,126	$146,535	$48,457	$110,545	$67,181	$1,144,927	$114,493	42.83
Flounders	$204,262	$124,377	$120,117	$117,541	$67,324	$114,303	$65,978	$48,329	$68,231	$38,522	$968,984	$96,898	36.25
Spot	$19,549	$24,426	$27,591	$33,424	$18,263	$20,524	$32,997	$18,096	$14,474	$14,320	$223,663	$22,366	8.37
Croaker	$3,992	$5,036	$61,516	$7,121	$887	$2,190	$352	$631	$334	$228	$82,288	$8,229	3.08
Weakfish	$20,938	$17,199	$8,964	$6,088	$2,288	$8,445	$3,701	$876	$1,577	$809	$70,884	$7,088	2.65
Butterfish	$2,815	$21,769	$8,507	$3,214	$2,859	$4,913	$3,380	$1,181	$3,132	$1,016	$52,785	$5,278	1.97
Fish, Mixed	$5,985	$6,355	$5,564	$3,122	$3,171	$2,470	$5,194	$2,898	$1,840	$1,611	$38,212	$3,821	1.43
Harvestfish	$1,033	$6,259	$2,976	$3,706	$2,468	$5,970	$4,102	$1,672	$1,712	$1,111	$31,008	$3,101	1.16
Sheepshead	$1,135	$1,514	$1,009	$1,306	$907	$1,424	$1,768	$652	$1,570	$918	$12,204	$1,220	0.46
Spanish Mackerel	$342	$1,676	$1,571	$2,703	$1,083	$1,261	$1,068	$318	$934	$131	$11,087	$1,109	0.41
Puffer	$246	$784	$463	$718	$20	$1,724	$936	$81	$156	$1	$5,129	$513	0.19
Black Sea Bass	$102	$8	$3,961	$114	$12	$41	$2	$1			$4,242	$424	0.16
Cutlassfish	$287	$546	$136	$193	$557	$144	$1,248	$276	$54	$656	$4,096	$410	0.15
Pompano	$126	$442	$150	$75	$209	$79	$129	$493	$1,581	$429	$3,714	$371	0.14
Black Drum	$6	$2,210	$101	$9	$12	$160	$86	$38	$528	$38	$3,188	$319	0.12
Hogfish	$423	$298	$437	$552	$333	$192	$242	$172	$150	$220	$3,021	$302	0.11
Spadefish	$41	$358	$197	$360	$26	$457	$124	$112	$336	$1	$2,013	$201	0.08
Bluefish	$194	$318	$295	$504	$51	$94	$193	$51	$63	$14	$1,777	$178	0.07
Triggerfish	$1,330	$1	$28	$91	$6				$8		$1,463	$146	0.05
Sharks	$464	$213	$83	$202	$169		$115	$27	$1		$1,272	$127	0.05
Cobia	$201	$301	$112	$323	$109		$26			$46	$1,118	$112	0.04
Snowy Grouper		$796									$796	$80	0.03
Spiny Dogfish		$576					$170				$746	$75	0.03
King Mackerel	$149	$105	$30	$77	$144	$11	$71		$68	$41	$695	$69	0.03
Snapper		$620									$620	$62	0.02
Speckled Trout	$173	$304	$1	$6	$6	$38	$42	$8	$15		$593	$59	0.02

Table 8. Continued

Species	Year 1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Total	Average	% of total
Red Drum	$72	$44	$4		$5	$203	$11		$32		$371	$37	0.01
Eels				$94		$7	$204				$305	$31	0.01
Mullets	$25	$140	$29	$31		$6	$17	$5	$27	$0	$279	$28	0.01
Angelfish	$7	$77	$10	$30	$10	$124					$258	$26	0.01
Monkfish	$23	$25	$24	$131			$6				$210	$21	0.01
False Albacore	$11	$1		$174							$187	$19	0.01
Conger Eel					$4	$161			$3		$167	$17	0.01
Minnows									$104		$104	$10	0.00
Menhaden Bait	$8	$2		$27		$23			$34	$4	$98	$10	0.00
Blacktip Shark							$92				$92	$9	0.00
Hakes		$65	$9			$14					$88	$9	0.00
Porgies	$50	$26	$8								$84	$8	0.00
Bait	$5	$8	$3	$0		$1	$20		$12	$9	$58	$6	0.00
Yellow Perch	$46										$46	$5	0.00
Strawberry Bass	$13	$8	$1	$3	$1	$2	$8				$35	$4	0.00
Angel Shark		$15		$1			$7				$22	$2	0.00
Oyster Toad						$21	$1				$21	$2	0.00
Skates		$15			$5						$20	$2	0.00
African Pompano			$16								$16	$2	0.00
Grouper, Mixed			$15								$15	$2	0.00
Whitebone Porgy	$10										$10	$1	0.00
Pinfish	$5	$4									$9	$1	0.00
Smooth Dogfish				$8							$8	$1	0.00
Shad		$4					$2				$6	$1	0.00
Cod		$5									$5	$1	0.00
Tautog	$3	$1									$5	$0	0.00
Spottail Pinfish		$1	$3								$5	$0	0.00
Jolthead Porgy						$1	$1				$3	$0	0.00
Catfish	$0	$2									$3	$0	0.00
Hog Snapper		$3									$3	$0	0.00
Crevalle Jack		$2									$2	$0	0.00
Grunts								$2			$2	$0	0.00
White Perch		$2									$2	$0	0.00
Margate/Porgies		$2									$2	$0	0.00
Boston Mackerel						$1					$1	$0	0.00
Scups		$1									$1	$0	0.00
Sand Perch										$1	$1	$0	0.00
Rock Sea Bass		$0									$0	$0	0.00
Permit	$0										$0	$0	0.00
Total	335,646	370,966	363,840	288,869	183,586	402,128	268,825	124,377	207,522	127,306	2,673,067	267,307	100

*Single gear Trip Tickets

Table 9. Total value of finfish landings from shrimp trawls by waterbody, 1994 – 2003 landings combined.

	Year												%
Area	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Total	Average	of total
Ocean**	$102,447	$175,070	$211,953	$129,625	$110,947	$257,482	$157,304	$51,432	$91,115	$79,299	$1,366,674	$136,667	51.13
Pamlico Sound	$217,912	$175,600	$137,326	$144,577	$63,999	$132,593	$98,193	$68,181	$109,084	$41,308	$1,188,772	$118,877	44.47
Core Sound	$6,108	$11,520	$3,646	$6,938	$3,618	$3,252	$4,297	$3,136	$2,114	$2,815	$47,444	$4,744	1.77
New River	$1,496	$3,792	$1,113	$1,677	$1,631	$2,190	$4,552	$728	$1,910	$1,240	$20,329	$2,033	0.76
Neuse River	$1,192	$1,138	$4,854	$2,782	$897	$2,559	$684		$1,092	$255	$15,453	$1,545	0.58
Cape Fear River	$3,150	$1,624	$1,563	$267	$1,225	$695	$1,114	$196	$1,015	$636	$11,485	$1,148	0.43
Inland Waterway***	$1,041	$672	$690	$1,107	$757	$2,688	$1,531	$403	$257	$1,053	$10,198	$1,020	0.38
Pamlico River	$603	$1,141	$1,689	$1,379	$266	$420	$134	$210	$340	$137	$6,320	$632	0.24
Croatan Sound	$36	$52	$284	$247	$140	$157	$652	$66	$101	$18	$1,754	$175	0.07
White Oak River	$133		$356		$24		$92	$3	$97	$433	$1,137	$114	0.04
Roanoke Sound	$383	$13	$158	$80	$9	$13	$9		$387	$2	$1,052	$105	0.04
Bay River	$648	$16	$90	$156	$4	$45	$50	$1		$33	$1,045	$104	0.04
North River	$397	$247	$87	$10	$60			$4		$3	$808	$81	0.03
Newport River	$99	$61	$32	$3		$34	$209	$13	$4	$46	$502	$50	0.02
Shallotte River		$19		$17	$9		$4			$30	$79	$8	0.00
Pungo River				$5				$4	$7		$15	$2	0.00
Total	$335,646	$370,966	$363,840	$288,869	$183,586	$402,128	$268,825	$124,377	$207,522	$127,306	$2,673,067	$267,307	100

*Single gear Trip Tickets
**Ocean includes six sub-areas see Table 3.
***Inland Waterway includes; all portions of the Inland waterway south of Morehead City, and Topsail, Stump, Masonboro and Bouge sounds.

Table 10. Total monthly value of finfish landings from shrimp trawls*, 1994 – 2003 landings combined

	Year												%
Month	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Total	Average	of total
January	$850	$2,638	$3,821	$10,474	$408	$2,031	$21,469	$106	$288	$103	$42,189	$4,219	1.58
February	$1,933	$31,966	$17	$2,336		$2,056	$1,645		$461		$40,415	$4,041	1.51
March	$2,614	$13,955	$23,244	$12,185	$367	$5,634	$1,311	$65	$842	$1,382	$61,599	$6,160	2.30
April	$11,443	$8,297	$1,613	$9,434	$935	$4,585	$2,966	$1,477	$3,196	$2,034	$45,979	$4,598	1.72
May	$17,578	$7,753	$6,251	$13,557	$5,673	$6,713	$4,617	$3,260	$12,465	$3,986	$81,853	$8,185	3.06
June	$18,583	$12,360	$12,356	$14,977	$10,136	$12,080	$7,577	$4,250	$19,891	$4,100	$116,312	$11,631	4.35
July	$36,604	$25,264	$28,413	$20,689	$13,800	$22,777	$15,529	$20,043	$17,060	$18,392	$218,571	$21,857	8.18
August	$56,801	$26,227	$63,860	$45,063	$12,570	$23,601	$14,233	$26,306	$15,503	$24,337	$308,501	$30,850	11.54
September	$82,499	$53,935	$43,850	$49,276	$24,550	$48,742	$36,562	$18,448	$14,695	$14,249	$386,805	$38,681	14.47
October	$66,095	$52,447	$60,757	$67,715	$55,839	$71,962	$95,384	$33,099	$53,416	$30,247	$586,963	$58,696	21.96
November	$34,893	$72,114	$56,985	$37,480	$50,008	$145,425	$66,759	$14,036	$67,379	$26,420	$571,499	$57,150	21.38
December	$5,753	$64,009	$62,673	$5,683	$9,299	$56,524	$773	$3,287	$2,325	$2,055	$212,381	$21,238	7.95
Total	$335,646	$370,966	$363,840	$288,869	$183,586	$402,128	$268,825	$124,377	$207,522	$127,306	$2,673,067	$267,307	100

*Single gear Trip Tickets

Table 11. Yearly crab landings (lbs)* from shrimp trawls all North Carolina Waters combined.

	Blue crabs		Horseshoe crabs		Stone crabs		Total	
Year	Pounds	Percent	Pounds	Percent	Pounds	Percent	Pounds	Percent
1994	394,815	100.00			2	0.00	394,817	100
1995	203,339	99.98	40	0.02			203,379	100
1996	265,156	100.00			10	0.00	265,166	100
1997	264,495	99.96	105	0.04	9	0.00	264,609	100
1998	506,822	99.68	1,635	0.32			508,457	100
1999	246,501	99.72	696	0.28	1	0.00	247,198	100
2000	169,906	100.00					169,906	100
2001	161,167	100.00			2	0.00	161,169	100
2002	142,913	99.68	447	0.31	7	0.00	143,367	100
2003	266,520	100.00			8	0.00	266,528	100
Total	2,621,635	99.89	2,923	0.11	39	0.00	2,624,597	100
Average	262,164		292		4		262,460	

*Single gear Trip Tickets

Table 12. Shrimp trawl crab landings (lbs)* by waterbody, 1994 – 2003 data combined.

	Species											
	Blue crabs			Horseshoe crabs			Stone crabs			Total		
Area	Pounds	Percent	Average	Pounds	Percent	Average	Pounds	Percent	Average	Pounds	Percent	Average
Core Sound	1,502,750	57.32	150,275	40	1.37	4				1,502,790	57.26	150,279
Pamlico Sound	742,855	28.34	74,286	2,883	98.63	288				745,738	28.41	74,574
Neuse River	239,432	9.13	23,943							239,432	9.12	23,943
New River	32,198	1.23	3,220				7	18.18	1	32,205	1.23	3,220
Croatan Sound	29,739	1.13	2,974							29,739	1.13	2,974
Inland Waterway***	14,502	0.55	1,450				29	75.32	3	14,531	0.55	1,453
Roanoke Sound	13,640	0.52	1,364							13,640	0.52	1,364
Bay River	13,234	0.50	1,323							13,234	0.50	1,323
Ocean**	9,535	0.36	954							9,535	0.36	954
Pamlico River	8,542	0.33	854							8,542	0.33	854
North River	6,125	0.23	612							6,125	0.23	612
Newport River	4,341	0.17	434							4,341	0.17	434
Cape Fear River	3,087	0.12	309							3,087	0.12	309
Pungo River	1,504	0.06	150							1,504	0.06	150
White Oak River	82	0.00	8				3	6.49	0	84	0.00	8
Unknown	54	0.00	5							54	0.00	5
Shallotte River	17	0.00	2							17	0.00	2
Total	2,621,635	100	262,164	2,923	100	292	39	100	4	2,624,597	100	262,460

*Single gear Trip Tickets

**Ocean includes six sub-areas see Table 3.

***Inland Waterway includes; all portions of the Inland waterway south of Morehead City, and Topsail, Stump, Masonboro and Bouge sounds.

Table 13. Monthly shrimp trawl crab landings (lbs)*, 1994 – 2003 data combined.

	Species											
	Blue crabs			Horseshoe crabs			Stone crabs			Total		
Month	Pounds	Percent	Average	Pounds	Percent	Average	Pounds	Percent	Average	Pounds	Percent	Average
January	10,890	0.42	1,089	222	7.59	22				11,112	0.42	1,111
February	6,281	0.24	628							6,281	0.24	628
March	48,807	1.86	4,881							48,807	1.86	4,881
April	247,050	9.42	24,705							247,050	9.41	24,705
May	465,108	17.74	46,511				8	19.48	1	465,115	17.72	46,512
June	534,459	20.39	53,446				7	18.52	1	534,466	20.36	53,447
July	570,767	21.77	57,077				12	30.88	1	570,779	21.75	57,078
August	284,270	10.84	28,427	40	1.37	4	8	19.77	1	284,317	10.83	28,432
September	126,912	4.84	12,691							126,912	4.84	12,691
October	131,688	5.02	13,169				4	11.35	0	131,692	5.02	13,169
November	147,746	5.64	14,775	1,794	61.38	179				149,540	5.70	14,954
December	47,657	1.82	4,766	867	29.66	87				48,524	1.85	4,852
Total	2,621,635	100	262,164	2,923	100	292	39	100	4	2,624,597	100	262,460

*Single gear Trip Tickets

Table 14. Yearly crab value from shrimp trawls* all North Carolina Waters combined; 1994-2003.

	Species			
Year	Blue crabs	Horseshoe crabs	Stone crabs	Total
1994	$182,093		$4	$182,096
1995	$122,993	$5		$122,998
1996	$138,869		$24	$138,893
1997	$157,541	$12	$19	$157,573
1998	$284,724	$245		$284,970
1999	$137,970	$104	$2	$138,077
2000	$122,776			$122,776
2001	$105,612		$5	$105,618
2002	$83,011	$89	$16	$83,116
2003	$168,566		$20	$168,586
Total	$1,504,156	$457	$90	$1,504,703
Average	$150,416	$46	$9	$150,470
Percent of total	99.96	0.03	0.01	100.00

*Single gear Trip Tickets

Table 15. Total value of crab landings* from shrimp trawls by waterbody, 1994 – 2003 landings combined.

	Species			
Area	Blue crabs	Horseshoe crabs	Stone crabs	Total
Core Sound	$821,772	$5		$821,777
Pamlico Sound	$406,616	$451		$407,067
Neuse River	$170,380			$170,380
Croatan Sound	$29,550			$29,550
New River	$21,768		$18	$21,786
Roanoke Sound	$13,171			$13,171
Inland Waterway	$11,720		$67	$11,787
Bay River	$9,171			$9,171
Ocean	$5,508			$5,508
Pamlico River	$5,458			$5,458
North River	$3,438			$3,438
Newport River	$2,634			$2,634
Cape Fear River	$1,906			$1,906
Pungo River	$941			$941
White Oak River	$57		$6	$63
Unknown	$40			$40
Shallotte River	$27			$27
Total	$1,504,156	$457	$90	$1,504,703
Average	$150,415.63	$45.65	$9.04	$150,470.31
Percent of total	99.96	0.03	0.01	100.00

*Single gear Trip Tickets
**Ocean includes six sub-areas see Table 3.
***Inland Waterway includes; all portions of the Inland waterway south of Morehead City, and Topsail, Stump, Masonboro and Bouge sounds.

Table 16. Total monthly value of crab landings from shrimp trawls*, 1994 – 2003 landings combined.

	Species			
Month	Blue crabs	Horseshoe crabs	Stone crabs	Total
January	$6,364	$33		$6,397
February	$3,693			$3,693
March	$27,446			$27,446
April	$135,108			$135,108
May	$259,005		$18	$259,023
June	$300,354		$16	$300,369
July	$340,668		$29	$340,697
August	$186,014	$5	$17	$186,037
September	$72,572			$72,572
October	$71,196		$11	$71,206
November	$78,117	$266		$78,383
December	$23,619	$152		$23,772
Total	$1,504,156	$457	$90	$1,504,703
Average	$150,415.63	$45.65	$9.04	$150,470.31
Percent of total	99.96	0.03	0.01	100.00

*Single gear Trip Tickets

Table 17. Yearly Mollusk* landings (lbs)** from shrimp trawls all North Carolina Waters combined.

	Squid		Octopus		Conchs		Total	
Year	Pounds	Percent	Pounds	Percent	Pounds	Percent	Pounds	Percent
1994	24,804	98.84	183	0.73	79	0.31	25,096	16.18
1995	37,813	98.85	105	0.27	202	0.53	38,252	24.66
1996	9,047	98.07	138	1.49	40	0.43	9,225	5.95
1997	15,825	98.86	11	0.07	172	1.08	16,008	10.32
1998	11,246	97.17	180	1.55	148	1.28	11,574	7.46
1999	12,836	98.26	181	1.39	46	0.35	13,063	8.42
2000	16,349	99.40	27	0.16	73	0.44	16,449	10.61
2001	8,247	99.90	9	0.10		0.00	8,256	5.32
2002	7,376	98.59	106	1.41		0.00	7,481	4.82
2003	9,660	99.72	20	0.21	7	0.07	9,687	6.25
Total	153,203	98.78	957	0.62	767	0.49	155,090	100
Average	15,320		96		77		15,509	

*15.75 lbs of blood clams, and 146 lbs of hard clam meats also landed, specific data confidential.
**Single gear Trip Tickets

Table 18. Shrimp trawl Mollusk* landings (lbs)** by waterbody, 1994 – 2003 data combined.

	Species											
	Squid			Octopus			Conchs			Total		
Area	Pounds	Percent	Average	Pounds	Percent	Average	Pounds	Percent	Average	Pounds	Percent	Average
Ocean***	121,900	79.57	12,190	917	95.82	92	19	2.45	2	122,836	79.29	12,284
Pamlico Sound	23,713	15.48	2,371	37	3.87	4	29	3.83	3	23,780	15.35	2,378
Inland Waterway****	4,491	2.93	449				1	0.07	0	4,491	2.90	449
Core Sound	578	0.38	58				613	79.88	61	1,191	0.77	119
New River	1,077	0.70	108	3	0.31	0				1,080	0.70	108
North River	279	0.18	28				106	13.77	11	385	0.25	39
Cape Fear River	359	0.23	36							359	0.23	36
Neuse River	354	0.23	35							354	0.23	35
Shallotte River	145	0.09	15							145	0.09	15
Newport River	133	0.09	13							133	0.09	13
Pamlico River	85	0.06	9							85	0.05	9
White Oak River	70	0.05	7							70	0.04	7
Bay River	18	0.01	2							18	0.01	2
Total	153,203	100	15,320	957	100	96	767	100	77	154,927	100	15,493

*15.75 lbs of blood clams, and 146 lbs of hard clam meats also landed, specific data confidential.

**Single gear Trip Tickets

***Ocean includes six sub-areas see Table 3.

****Inland Waterway includes; all portions of the Inland waterway south of Morehead City, and Topsail, Stump, Masonboro and Bouge sounds.

Table 19. Monthly shrimp trawl Mollusk* landings (lbs)**, 1994 – 2003 data combined.

	Species											
	Squid			Octopus			Conchs			Total		
Month	Pounds	Percent	Average	Pounds	Percent	Average	Pounds	Percent	Average	Pounds	Percent	Average
January	2,191	1.43	219	13	1.36	1		0.00	0	2,204	1.42	220
February	3,668	2.39	367		0.00	0	5	0.65	0	3,673	2.37	367
March	837	0.55	84	20	2.09	2	257	33.51	26	1,114	0.72	111
April	4,400	2.87	440	13	1.36	1	244	31.76	24	4,657	3.01	466
May	12,068	7.88	1,207	8	0.84	1	165	21.47	16	12,241	7.90	1,224
June	15,573	10.16	1,557	1	0.10	0	73	9.50	7	15,647	10.10	1,565
July	13,614	8.89	1,361		0.00	0	0	0.04	0	13,614	8.79	1,361
August	14,531	9.48	1,453	37	3.87	4	4	0.52	0	14,572	9.41	1,457
September	9,307	6.07	931	23	2.35	2	7	0.95	1	9,337	6.03	934
October	25,444	16.61	2,544	87	9.09	9	0	0.06	0	25,532	16.48	2,553
November	37,390	24.41	3,739	566	59.10	57	0	0.06	0	37,956	24.50	3,796
December	14,180	9.26	1,418	190	19.85	19	11	1.48	1	14,382	9.28	1,438
Total	153,203	100	15,320	957	100	96	767	100	77	154,927	100	15,493

*15.75 lbs of blood clams, and 146 lbs of hard clam meats also landed, specific data confidential.
**Single gear Trip Tickets

Table 20. Yearly Mollusk value from shrimp trawls*, all North Carolina waters combined; 1994 – 2003.

Year	Species: Squid	Octopus	Conchs	Total
1994	$7,937	$170	$57	$8,165
1995	$15,401	$118	$127	$15,646
1996	$4,378	$157	$40	$4,575
1997	$8,117	$13	$174	$8,304
1998	$6,489	$228	$121	$6,839
1999	$7,147	$248	$33	$7,427
2000	$9,284	$33	$51	$9,368
2001	$4,865	$11		$4,875
2002	$4,972	$125		$5,097
2003	$5,313	$25	$6	$5,344
Total	$73,903	$1,127	$610	$75,640
Average	$7,390	$113	$61	$7,564
Percent of total	97.70	1.49	0.81	100

*Single gear Trip Tickets

Table 21. Total value of Mollusk landings* from shrimp trawls by waterbody. 1994 – 2003 landings combined.

Area	Species: Squid	Octopus	Conchs	Total
Ocean**	$60,170	$1,081	$15	$61,267
Pamlico Sound	$10,020	$42	$19	$10,081
Inland Waterway***	$2,280		$0	$2,280
Core Sound	$220		$506	$726
New River	$521	$3		$525
North River	$145		$70	$215
Cape Fear River	$172			$172
Neuse River	$162			$162
Shallotte River	$86			$86
Newport River	$56			$56
White Oak River	$35			$35
Pamlico River	$27			$27
Bay River	$9			$9
Total	$73,903	$1,127	$610	$75,640
Average	$7,390	$113	$61	$7,564
Percent of total	97.70	1.49	0.81	100

*Single gear Trip Tickets

**Ocean includes six sub-areas see Table 3.

***Inland Waterway includes; all portions of the Inland waterway south of Morehead City, and
Topsail, Stump, Masonboro and Bouge sounds.

Table 22. Total monthly value of Mollusk landings from shrimp trawls*, 1994 – 2003 landings combined.

	Species			
Month	Squid	Octopus	Conchs	Total
January	$1,169	$18		$1,187
February	$1,815		$4	$1,819
March	$383	$19	$187	$588
April	$1,933	$12	$180	$2,125
May	$5,595	$8	$161	$5,764
June	$7,704	$1	$59	$7,765
July	$7,157		$0	$7,157
August	$7,581	$42	$3	$7,626
September	$4,721	$26	$5	$4,752
October	$12,390	$90	$0	$12,481
November	$17,740	$671	$1	$18,412
December	$5,715	$240	$10	$5,964
Total	$73,903	$1,127	$610	$75,640
Average	$7,390	$113	$61	$7,564
Percent of total	97.70	1.49	0.81	100

*Single gear Trip Tickets

Table 23. Overall composition* of bycatch in the south Atlantic and Gulf of Mexico shrimp trawl fishery.

	South Atlantic		Gulf of Mexico	
Group	Percent by weight	Percent by number	Percent by weight	Percent by number
Shrimp	18	23	16	29
Fish	51	54	67	50
Crustacean	13	12	13	17
Invertebrates	18	11	4	4

*Data from 1998 National Marine Fisheries Service report to Congress.

Table 24. Seasonal catch composition of bycatch in the south Atlantic shrimp trawl fishery*.

	Weight			Number		
Group	Spring	Summer	Fall	Spring	Summer	Fall
Shrimp	37	15	18	11	26	17
Fish	44	58	44	65	58	44
Crustacean	9	14	14	21	14	9
Invertebrates	9	13	25	3	3	30

*Data from 1998 National Marine Fisheries Service report to Congress.

Table 25. Seasonal catch composition of bycatch in the Gulf of Mexico shrimp trawl fishery*.

	Weight			Number		
Group	Spring	Summer	Fall	Spring	Summer	Fall
Shrimp	16	18	15	28	29	30
Fish	66	62	72	46	51	51
Crustacean	15	15	10	21	16	16
Invertebrates	3	5	30	5	4	3

*Data from 1998 National Marine Fisheries Service report to Congress.

Table 26. Catch composition (top ten species) by number for shrimp trawls, all areas combined, and by area (from Diamond-Tissue 1999).

Area	Rank	Species	Total number	Percent of total number	Frequency of occurrence
All areas combined					
	1	Market penaeid shrimp	112,974	44.3	52
n=52 tows	2	Star drum	28,316	11.1	26
(15 trips)	3	Atlantic croaker	27,199	10.7	50
	4	Weakfish	22,538	8.8	48
	5	Spot	13,204	5.2	41
	6	Squid	6,807	2.7	30
	7	Lesser blue crab	6,432	2.5	19
	8	Pink shrimp	5,176	2.0	40
	9	Blue crab	4,332	1.7	22
	10	Pigfish	2,670	1.0	13
				90.0	
Pamlico Sound					
	1	Market penaeid shrimp	13,671	28.9	16
n=16 tows	2	Atlantic croaker	12,046	25.5	16
(5 trips)	3	Spot	8,043	17.0	16
	4	Weakfish	5,047	10.7	15
	5	Blue crab	2,023	4.3	14
	6	Jellyfish	1,586	3.4	6

Table 26. Continued

Area	Rank	Species	Total number	Percent of total number	Frequency of occurrence
	7	Silver perch	884	1.9	8
	8	Summer flounder	656	1.4	11
	9	Hogchoker	489	1.0	12
	10	Brown shrimp	392	0.8	6
				94.9	
Core Sound					
	1	Market penaeid shrimp	4,694	20.4	4
n=4 tows	2	Lesser blue crab	4,578	19.9	4
(2 trips)	3	Pink shrimp	3,753	16.3	5
	4	Pigfish	2,342	10.2	4
	5	Spot	1,757	7.6	4
	6	Atlantic croaker	1,541	6.7	3
	7	Mojarra	599	2.6	4
	8	Pinfish	564	2.4	4
	9	Mantis shrimp	456	2.0	4
	10	Blue crab	344	1.5	4
				89.7	
Cape Fear River					
	1	Market penaeid shrimp	83,937	54.8	24
n=24 tows	2	Star drum	28,170	18.4	23
(5 trips)	3	Weakfish	15,992	10.4	24
	4	Atlantic croaker	11,438	7.5	23
	5	Squid	2,243	1.5	16
	6	Spot	1,286	0.8	14
	7	Blue crab	1,274	0.8	16
	8	Pink shrimp	1,226	0.8	13
	9	Bay anchovy	1,202	0.8	18

Table 26. Continued

Area	Rank	Species	Total number	Percent of total number	Frequency of occurrence
	10	Hog choker	1,080	0.7	15
				96.6	

Listing for pink or brown shrimp indicates less than market size.

Table 27. Catch composition (top ten species) by weight for shrimp trawls, all areas combined, and by area (from Diamond-Tissue 1999).

Area	Rank	Species	Total weight (lbs.)	Percent of total weight	Frequency of occurrence
All areas combined	1	Market penaeid shrimp	2,983.0	34.2	52
n=52 tows	2	Atlantic croaker	1,1620.	13.3	50
(15 trips)	3	Weakfish	978.0	11.2	48
	4	Spot	707.0	8.1	41
	5	Blue crab	569.0	6.5	40
	6	Lesser blue crab	260.8	3.0	19
	7	Star drum	229.1	2.6	26
	8	Atlantic cutlassfish	216.1	2.5	17
	9	Squid	153.0	1.8	30
	10	Yellowfin menhaden	108.2	1.2	8
				84.4	
Pamlico Sound	1	Market penaeid shrimp	634.5	22.4	16
n=16 tows	2	Weakfish	582.7	20.5	15
(5 trips)	3	Atlantic croaker	545.6	19.2	16
	4	Spot	457.9	16.2	16
	5	Blue crab	253.7	9.0	14
	6	Silver perch	84.0	3.0	8
	7	Summer flounder	70.8	2.5	11
	8	Atlantic menhaden	45.2	1.6	5
	9	Jellyfish	44.8	1.6	6

Table 27. Continued

Area	Rank	Species	Total weight (lbs.)	Percent of total weight	Frequency of occurrence
	10	Hogchoker	26.9	0.9	12
				96.9	
Core Sound	1	Lesser blue crab	227.7	25	4
n=4 tows	2	Penaeid shrimp	190.0	20.8	4
(2 trips)	3	Atlantic croaker	131.0	14.3	3
	4	Spot	73.0	8.0	4
	5	Pigfish	67.0	7.4	4
	6	Pink shrimp	36.4	4.0	4
	7	Blue crab	35.7	3.9	4
	8	Inshore lizardfish	24.9	2.7	3
	9	Pinfish	24.5	2.7	4
	10	Mantis shrimp	21.4	2.3	4
				91.1	
Cape Fear River	1	Market penaeid shrimp	1,910.9	51.2	24
n=24 tows	2	Weakfish	350.0	9.4	24
(5 trips)	3	Atlantic croaker	264.0	7.1	23
	4	Star drum	228.0	6.1	23
	5	Blue crab	190.0	5.1	16
	6	Atlantic cutlassfish	160.1	4.3	9
	7	Yellowfin menhaden	100.1	2.7	5
	8	Pinfish	26.5	1.6	8
	9	Atlantic menhaden	50.3	1.3	6
	10	Atlantic stingray	48.7	1.3	7
				90.2	

Note Listing for pink or brown shrimp indicates less than market size.

Table 28. Catch composition (top ten) by weight for shrimp trawls, all areas combined, and by area (Johnson 2003).

Area	Rank	Species	Total weight (lbs)	Percent of total catch	Frequency of occurrence
All areas combined	1	Blue Crabs	2,757	26.29	54
	2	Shrimp	2,092	19.95	54
n=54 tows	3	Spot	1,796	17.13	54
	4	Croaker	1,286	12.26	51
	5	Invertebrates (Other)	1,155	11.01	53
	6	Other Fish (Undivided, etc.)	366	3.49	32
	7	Pinfish	358	3.41	43
	8	Pigfish	117	1.12	23
	9	Menhaden	106	1.01	12
	10	Flounder, Other or Unspecified	73	0.70	21
				96.37	
Core Sound	1	Blue Crabs	2,416	32.76	46
	2	Shrimp	1,738	23.56	46
n=46	3	Invertebrates (Other)	1,088	14.76	45
	4	Spot	1,013	13.74	46
	5	Croaker	265	3.59	43
	6	Pinfish	255	3.46	39
	7	Other Fish (Undivided, etc.)	216	2.93	26
	8	Pigfish	116	1.57	22
	9	Summer flounder	39	0.52	20
	10	Silversides	31	0.42	26
				97.32	
Neuse River	1	Croaker	1,021	32.82	8
	2	Spot	783	25.15	8
n=8	3	Shrimp	354	11.37	8
	4	Blue Crabs	341	10.94	8
	5	Other Fish (Undivided, etc.)	150	4.82	6
	6	Pinfish	103	3.30	4
	7	Menhaden	95	3.05	4
	8	Invertebrates (Other)	67	2.14	8
	9	Flounder, Other or Unspecified	53	1.70	5
	10	Unknown drum species	50	1.60	3
				96.91	

Table 29. Finfish catch composition (top ten) by weight for shrimp trawls, all areas combined, and by area (Johnson 2003).

Area	Rank	Species	Total weight (lbs)	% of total catch	Frequency of occurrence
All areas combined	1	Spot	1,796	40.23	54
	2	Croaker	1,286	28.81	51
n=52 tows	3	Other Fish (Undivided, etc.)	366	8.20	32
	4	Pinfish	358	8.01	43
	5	Pigfish	117	2.62	23
	6	Menhaden	106	2.37	12
	7	Flounder, Other or Unspecified	73	1.65	21
	8	Unknown drum species	51	1.15	5
	9	Summer flounder	39	0.86	20
	10	Silversides	36	0.81	29
				94.72	
Core Sound	1	Spot	1,013	47.95	46
	2	Croaker	265	12.53	43
n=46	3	Pinfish	255	12.07	39
	4	Other Fish (Undivided, etc.)	216	10.21	26
	5	Pigfish	116	5.49	22
	6	Summer flounder	39	1.83	20
	7	Silversides	31	1.48	26
	8	Cusk-eel	27	1.27	6
	9	Flounder, Other or Unspecified	21	0.98	16
	10	Bluefish	14	0.65	13
				94.46	
Neuse River	1	Croaker	1,021	43.45	8
	2	Spot	783	33.30	8
n=8	3	Other Fish (Undivided, etc.)	150	6.38	6
	4	Pinfish	103	4.37	4
	5	Menhaden	95	4.04	4
	6	Flounder, Other or Unspecified	53	2.25	5
	7	Unknown drum species	50	2.12	3
	8	Mackeral	30	1.26	4
	9	Cutlassfish	22	0.92	2
	10	SilverPerch	11	0.45	2
				98.53	

Table 30. Results of 1 ½" vs. 1 5/8" stretched mesh diamond tailbags tested in Pamlico Sound, July 1991.

	Total weight (lbs)		
n=5	Control	Experimental	Percent difference
Spot	148.46	166.63	12.24
Atlantic croaker	81.65	79.51	-2.62
Summer flounder	6.24	6.48	3.89
Southern flounder	2.56	1.28	-50
Weakfish	5.51	8.45	53.2
Market fish	18.19	20.73	13.94
Miscellaneous fish	23.75	32.88	38.44
Total fish	286.36	315.93	10.33
Crabs	143.33	164.27	14.62
Brown shrimp	11.36	11.03	-2.91
Pink shrimp	5.16	6.02	16.67
Total shrimp	16.52	17.04	3.2
Total	446.20	497.25	11.44

Table 31. Results of 1 ½" vs. 2" stretched mesh diamond tailbags tested in Pamlico Sound, July 1991.

	Total weight (lbs)		
n=5	Control	Experimental	Percent difference
Spot	156.78	84.85	-45.88
Atlantic croaker	46.55	36.23	-22.17
Summer flounder	8.80	6.64	-24.56
Southern flounder	0.24	0.77	218.18
Weakfish	0.68	0.20	-70.97
Market fish	7.19	7.74	7.67
Miscellaneous fish	33.76	22.60	-33.05
Total fish	254.02	159.00	-37.4
Crabs	147.74	168.68	14.18
Brown shrimp	2.56	3.13	22.41
Pink shrimp	1.21	0.90	-25.45
Total shrimp	3.77	4.04	7.02
Total	405.52	331.72	-18.2

Table 32. Results of 1 ½” diamond vs. 1 ½” square, stretched mesh tailbags tested in Pamlico Sound, 2000.

	Total weight (lbs)			
	Control	Experimental	Percent difference	P(T<=t)
Atlantic croaker	556.2	576.61	3.67	0.42
Spot	126.63	116.08	-8.33	0.40
Harvest fish	6.22	7.16	15.07	0.50
Spanish mackerel	0.21	0	-100	0.23
Butterfish	1.32	0.54	-59.28	0.35
Silver perch	1.49	1.17	-21.53	0.76
Blue fish	0.99	1.16	16.78	0.17
Southern flounder	19.82	10.45	-47.28	0.13
Summer flounder	7.99	5.41	-32.3	0.47
Bay wiff	5.94	4.02	-32.41	0.01*
Striped searobin	0.43	0.53	23.22	0.80
Pinfish	5.16	2.61	-49.47	0.10
Tounge fish	0	0.16		0.34
Inshore lizzard fish	1.51	0.33	-78.31	0.07
Cutlassfish	0.43	0	-100	0.34
Hogchoker	0.91	1.75	91.96	0.34
Atlantic Stingray	2.17	0	-100	
Menhaden	0	0.98		
Weakfish YOY	19.64	9.61	-51.04	0.01*
Weakfish	25.31	29.59	16.88	0.28
Blue crab	719.93	726.66	0.93	0.88
Brown shrimp	99.14	96.34	-2.82	0.60
Jellyfish	46.42	43.23	-6.86	0.63
Total fish	737.44	728.95	-1.15	0.80
Total catch	1,647.87	1,634.38	-0.82	0.82

*significant difference at the P<=0.05 level or less

Table 33. Results of experimental tows with FFE designs (escapment opening GE 6½" x 5½"), tested aboard commercial trawlers in North Carolina, 1992 and 1994.

	Total weight (kg)			
n=165	Control	Experimental	Percent difference	P(T<=t)
Brown, white & pink shrimp	1,808.28	1,663.58	-8	0.00*
Crabs, lobsters & other shrimp	2,823.60	2,545.72	-9.84	0.00*
Other invertebrates	376.16	327.18	-13.02	0.31
Sharks (all species)	10.45	2.5	-76.09	
Skate and rays	124.45	110.41	-11.28	0.25
Atlantic bumper	16.14	0.15	-99.06	0.40
Spot	1,497.00	745.34	-50.21	0.00*
Snapper (other)	0.09	0	-100	
Lane snapper	0.95	0	-100	
Kingfish	49.22	30.18	-38.67	0.00*
Atlantic croaker	2,810.17	1,277.42	-54.54	0.00*
Southern flounder	80.49	46.77	-41.89	0.00*
Summer flounder	89.85	90.28	0.48	0.93
Bluefish	34.14	15.32	-55.14	0.13
King mackerel	0.38	0.21	-45.57	0.08
Spanish mackerel	31.37	20.3	-35.3	0.26
Longspine porgy	0.23	0.3	33.04	
Cutlassfish	6.02	13.6	125.87	0.11
Other finfish-grouped	1,321.96	1,147.25	-13.22	0.06
Harvestfish	16.32	12.56	-23.04	0.14
Hogchoker	5.83	7.04	20.7	0.17
Weakfish (YOY)	133.36	40.93	-69.31	0.00*
Weakfish	314.63	167.33	-46.82	0.01*
Total weakfish	447.99	208.25	-53.52	0.00*
Total finfish	15,339.04	9,030.63	-41.13	0.00*
Miscellaneous	2,766.28	2,633.70	-4.79	0.46
Total catch	22,850.60	15,977.85	-30.08	0.00*

*significant difference at the P<=0.05 level or less

Table 34. Results of experimental tows with FFE designs (escapment opening Ge 6½" X 5½", and ratio 0.4-0.5), tested aboard commercial trawlers in North Carolina, 1992 and 1994.

	Total weight (kg)			
n=64	Control	Experimental	Percent difference	P(T<=t)
Brown, white & pink shrimp	688.68	633.03	-8.08	0.01*
Crabs, lobsters & other shrimp	1,568.41	1,418.71	-9.54	0.02*
Other invertebrates	96.27	111.45	15.77	0.72
Skate and rays	34.32	50.67	47.64	0.96
Atlantic bumper	0.15	0.05	-66.51	
Spot	760.28	291.58	-61.65	0.00*
Snapper (other)	0.09	0	-100	
Lane snapper	0.95	0	-100	
Kingfish	15.8	5.8	-63.3	0.12
Atlantic croaker	1,335.43	539.39	-59.61	0.00*
Southern flounder	46.84	17.73	-62.14	0.00*
Summer flounder	36.76	36.05	-1.93	0.59
Bluefish	0.83	0	-100	
Spanish mackerel	18.43	4.98	-72.99	0.24
Cutlassfish	3.78	8.57	126.73	0.38
Other finfish-grouped	609.38	575.77	-5.51	0.56
Harvestfish	6.54	2.75	-58.02	0.02*
Hogchoker	0.33	0.2	-38.22	
Weakfish (YOY)	127.12	36.27	-71.47	0.00*
Weakfish	90.24	20.43	-77.36	0.01*
Total weakfish	217.36	56.7	-73.91	0.00*
Total finfish	7,883.77	4,103.49	-47.95	0.00*
Miscellaneous	975.48	842.02	-13.68	0.06
Total catch	11,208.10	7,104.20	-36.62	0.00*

*significant difference at the P<=0.05 level or less

Table 35. Results of experimental tows with FFE designs (escapment opening Ge 6½" X 5½", and ratio 0.5-0.6), tested aboard commercial trawlers in North Carolina, 1992 and 1994.

	Total weight (kg)			
n=31	Control	Experimental	Percent difference	P(T<=t)
Brown, white & pink shrimp	388.85	343.7	-11.61	0.04*
Crabs, lobsters & other shrimp	309.6	256.74	-17.07	0.01*
Other invertebrates	43.17	31.76	-26.43	0.10
Sharks (all species)	10.45	2.5	-76.09	
Skate and rays	90.13	59.74	-33.71	0.05*
Atlantic bumper	15.99	0.1	-99.36	0.40
Spot	292.45	113.25	-61.28	0.04*
Kingfish	31.92	16.63	-47.91	0.00*
Atlantic croaker	478.16	130.86	-72.63	0.01*
Southern flounder	9.08	9.79	7.85	0.72
Summer flounder	22.93	18.8	-17.99	0.52
Bluefish	19.69	4.4	-77.64	0.17
King mackerel	0.38	0.21	-45.57	0.08
Spanish mackerel	3.34	6.26	87.28	0.87
Longspine porgy	0.23	0.3	33.04	
Cutlassfish	2.24	4.12	83.43	0.30
Other finfish-grouped	155.79	113.22	-27.32	0.10
Harvestfish	2.24	1.33	-40.7	
Hogchoker	5.05	3.8	-24.91	0.10
Weakfish (YOY)	6.1	4.58	-24.86	0.18
Weakfish	32.38	12.18	-62.38	0.37
Total weakfish	38.48	16.76	-56.45	0.22
Total finfish	2,334.06	1,038.57	-55.5	0.00*
Miscellaneous	619.52	623.53	0.65	0.99
Total catch	3,527.20	2,154.85	-38.91	0.00*

*significant difference at the P<=0.05 level or less

Table 36. Results of experimental tows with FFE designs (escapment opening Ge 6½" X 5½", and ratio 0.6-0.65), tested aboard commercial trawlers in North Carolina, 1992 and 1994.

	Total weight (kg)			
n=34	Control	Experimental	Percent difference	P(T<=t)
Brown, white & pink shrimp	449.65	427.5	-4.93	0.00*
Crabs, lobsters & other shrimp	692	610	-11.85	0.01*
Other invertebrates	19.5	26.5	35.9	
Spot	272.76	203.33	-25.46	0.04*
Kingfish	0.53	7.23	1,270.23	
Atlantic croaker	333.77	217.36	-34.88	0.08
Summer flounder	19.99	25.77	28.92	0.10
Spanish mackerel	8.89	8.52	-4.18	
Other finfish-grouped	79.99	65.03	-18.7	0.23
Harvestfish	7.54	8.48	12.56	0.69
Hogchoker	0.45	3.04	580.79	
Weakfish	74.09	37.23	-49.75	0.44
Total finfish	3,500.50	2,728.50	-22.05	0.00*
Miscellaneous	899.5	913.5	1.56	0.91
Total catch	5,508.90	4,656.50	-15.47	0.00*

*significant difference at the P<=0.05 level or less

Table 37. Results of experimental tows with FFE designs (escapement opening >= 5½" X 6½", placed 15 meshes to the side), tested aboard commercial trawlers in North Carolina, 1992 and 1994.

	Total weight (kg)			
n=118*	Control	Experimental	Percent difference	P(T<=t)
Brown, white & pink shrimp	1,424.88	1,311.63	-7.95	0.00**
Crabs, lobsters & other shrimp	2,420.53	2,186.46	-9.67	0.00**
Other invertebrates	133.04	146.32	9.98	0.83
Sharks (all species)	10.45	2.5	-76.09	
Skate and rays	124.45	110.41	-11.28	0.25
Atlantic bumper	0.73	0.15	-79.04	0.40
Spot	1,247.01	632.14	-49.31	0.00**
Snapper (other)	0.09	0	-100	
Lane snapper	0.95	0	-100	
Kingfish	48.25	23.35	-51.61	0.00**
Atlantic croaker	1,930.65	870.66	-54.9	0.00**
Southern flounder	55.17	24.8	-55.05	0.00**
Summer flounder	77.17	75.96	-1.57	0.89
Bluefish	33.29	15.32	-53.99	0.13
King mackerel	0.38	0.21	-45.57	0.08
Spanish mackerel	30.67	19.76	-35.57	0.27
Longspine porgy	0.23	0.3	33.04	
Cutlassfish	6.02	12.68	110.59	0.11
Other finfish-grouped	1,237.65	1,102.91	-10.89	0.11
Harvestfish	16.32	12.56	-23.04	0.14
Hogchoker	0.78	4.05	421.62	
Weakfish (YOY)	133.36	40.93	-69.31	0.00**
Weakfish	188.87	65.11	-65.53	0.03**
Total weakfish	322.23	106.03	-67.1	0.00**
Total finfish	12,910.49	7,808.80	-39.52	0.00**
Miscellaneous	2,227.28	2,129.20	-4.4	0.58
Total catch	18,891.45	13,388.95	-29.13	0.00**

* 118 tows examined for shrimp, 111 for total finfish, crabs, and miscellaneous
and 58 tows for target finfish

**significant difference at the P<=0.05 level or less

Table 38. Results of experimental tows with FFE designs (escapement opening >= 5½" X 6½", placed 30 meshes to the side), tested aboard commercial trawlers in North Carolina, 1992 and 1994.

	Total weight (kg)			
n=17*	Control	Experimental	Percent difference	P(T<=t)
Brown, white & pink shrimp	293.75	275.25	-6.30	0.12
Crabs, lobsters & other shrimp	290.50	231.50	-20.31	0.00**
Other invertebrates	41.00	37.50	-8.54	0.38
Atlantic bumper	15.41	0.0	-100.00	
Spot	151.05	51.12	-66.16	0.03**
Kingfish	0.00	6.31		
Atlantic croaker	236.34	37.43	-84.16	0.00**
Southern flounder	1.44	3.20	121.88	
Summer flounder	10.85	10.98	1.13	0.98
Other finfish-grouped	50.01	23.75	-52.52	0.24
Hogchoker	5.05	2.99	-40.84	0.10
Weakfish	7.84	4.73	-39.63	
Total finfish	1,506.00	648.25	-56.96	0.00**
Miscellaneous	539	504.5	-6.4	0.16
Total catch	2,632.25	1,667.50	-36.65	0.00**

* 17 tows examined for shrimp, 15 for total finfish, crabs, and miscellaneous and 4 tows for target finfish

**significant difference at the P<=0.05 level or less

Table 39. Results of experimental tows with the large mesh extended funnel tested in Pamlico Sound North Carolina, 1994.

	Total weight (kg)			
n=36	Control	Experimental	Percent difference	P(T<=t)
Brown, white & pink shrimp	263.70	258.25	-2.07	0.54
Crabs, lobsters & other shrimp	353.39	400.68	13.38	0.17
Other invertebrates	350.34	456.57	30.32	0.24
Skate and rays	5.51	0.00	-100.00	
Spot	668.11	191.05	-71.40	0.00*
Kingfish	26.16	14.38	-45.04	0.03*
Atlantic croaker	1612.29	595.06	-63.09	0.00*
Southern flounder	69.94	61.10	-12.64	0.50
Summer flounder	109.72	123.37	12.43	0.19
Bluefish	26.20	17.78	-32.11	0.05*
Spanish mackerel	2.51	0.42	-83.30	
Cutlassfish	1.19	0.70	-41.00	
Other finfish-grouped	554.89	372.71	-32.83	0.00*
Spotted seatrout	0.00	0.29		
Weakfish (YOY)	277.47	160.68	-42.09	0.00*
Weakfish	88.80	21.22	-76.11	0.00*
Total weakfish	366.28	181.90	-50.34	0.00*
Total finfish	3442.78	1558.76	-54.72	0.00*
Miscellaneous	24.17	33.79	39.83	0.08
Total catch	4434.38	2708.05	-38.93	0.00*

*significant difference at the P<=0.05 level or less

Table 40. Results of experimental tows with the modified large mesh funnel excluder conducted in Brunswick County North Carolina, August 1995.

n=10	Total weight (kg) Control	Experimental	Percent difference	P(T<=t)
Brown, white & pink shrimp	10.57	9.74	-7.90	0.49
Crabs, lobsters & other shrimp	17.50	12.65	-27.71	0.01 *
Other invertebrates	10.40	10.00	-3.85	0.46
Spot	57.35	16.40	-71.40	0.00 *
Atlantic croaker	167.70	107.40	-35.96	0.00 *
Other finfish-grouped	139.00	124.10	-10.72	0.11
Weakfish	16.00	6.80	-57.50	0.01 *
Total finfish	380.05	254.70	-32.98	0.00 *
Miscellaneous	29.60	36.75	24.16	0.50
Total catch	448.12	323.84	-27.73	0.00 *

*significant difference at the p<=0.05 level or less

Table 41. Results of experimental tows with a 6" "Sea Eagle" tested in Bay River North Carolina 1997.

	Total (kg)		Percent
n=33	Control	"Sea Eagle"	difference
Shrimp	187.80	175.45	-6.58
Southern flounder	29.55	24.15	-18.27
Spot	316.20	203.60	-35.61
Atlantic croaker	169.50	107.00	-36.87
Weakfish wgt.	67.30	41.65	-38.11
Weakfish #'s	1,158.00	820.00	-29.19
Southern kingfish	8.05	2.45	-69.57
Bluefish	5.80	1.40	-75.86
Sea Robin	0.60	0.00	-100.00
Hogchoker	0.30	0.00	-100.00
Atlantic menhaden	3.95	0.35	-91.14
Oyster toadfish	0.30	0.00	-100.00
Pinfish	5.85	4.25	-27.35
Pigfish	0.50	0.50	0.00
Harvestfish	1.00	0.60	-40.00
Inshore Lizzardfish	37.90	1.75	-95.38
Gizzard shad	0.50	0.00	-100.00
Atlantic thread herring	2.05	0.70	-65.85
Spanish mackerel wgt.	0.05	0.00	-100.00
Spanish mackerel #'s	2.00	0.00	-100.00
Sand perch	12.85	9.15	-28.79
Crabs & inverts.	336.70	331.40	-1.57
Jellyfish	104.40	100.30	-3.93
Miscellaneous	22.40	18.60	-16.96
Total finfish	662.25	397.55	-39.97
Total catch	1,313.55	1,023.30	-22.10

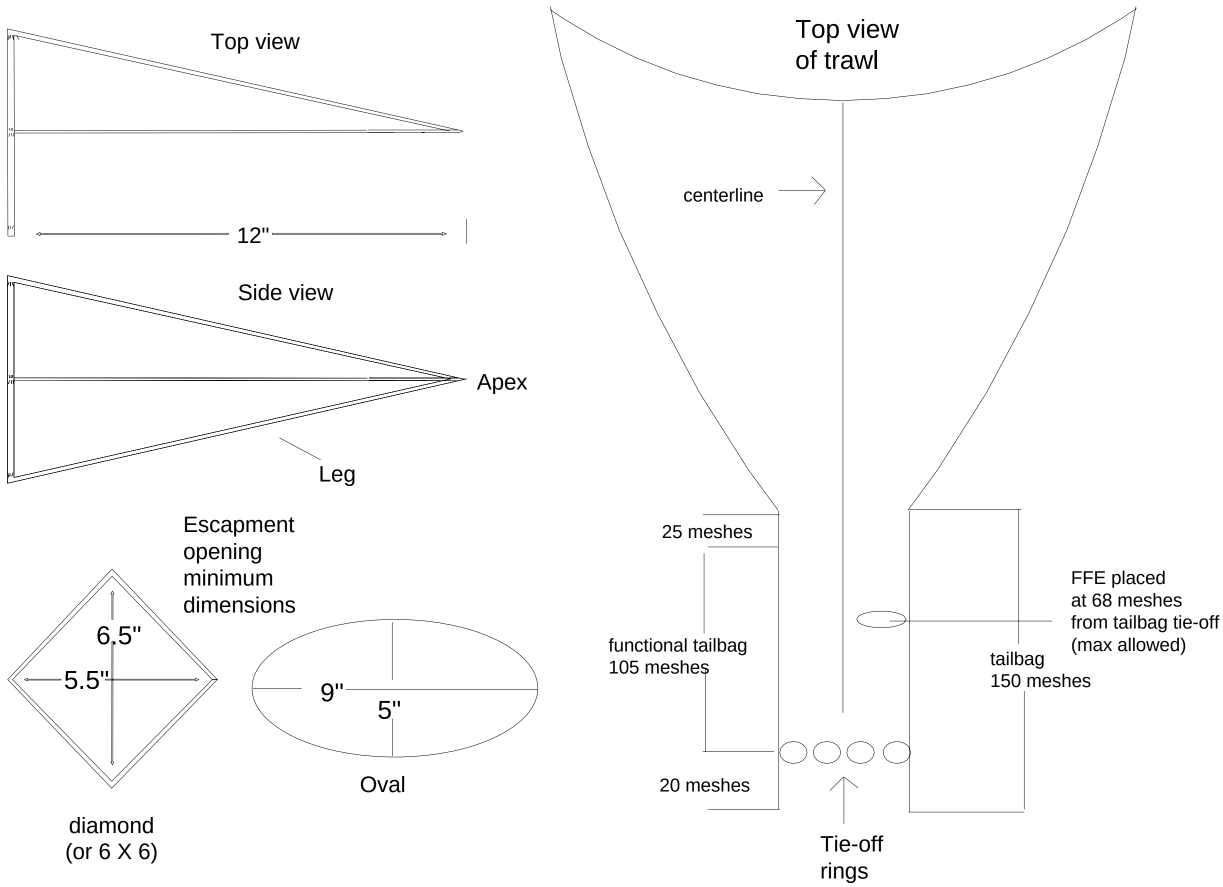

Figure 1. Diagram of Florida Fish Excluder (FFE) tested in North Carolina waters.

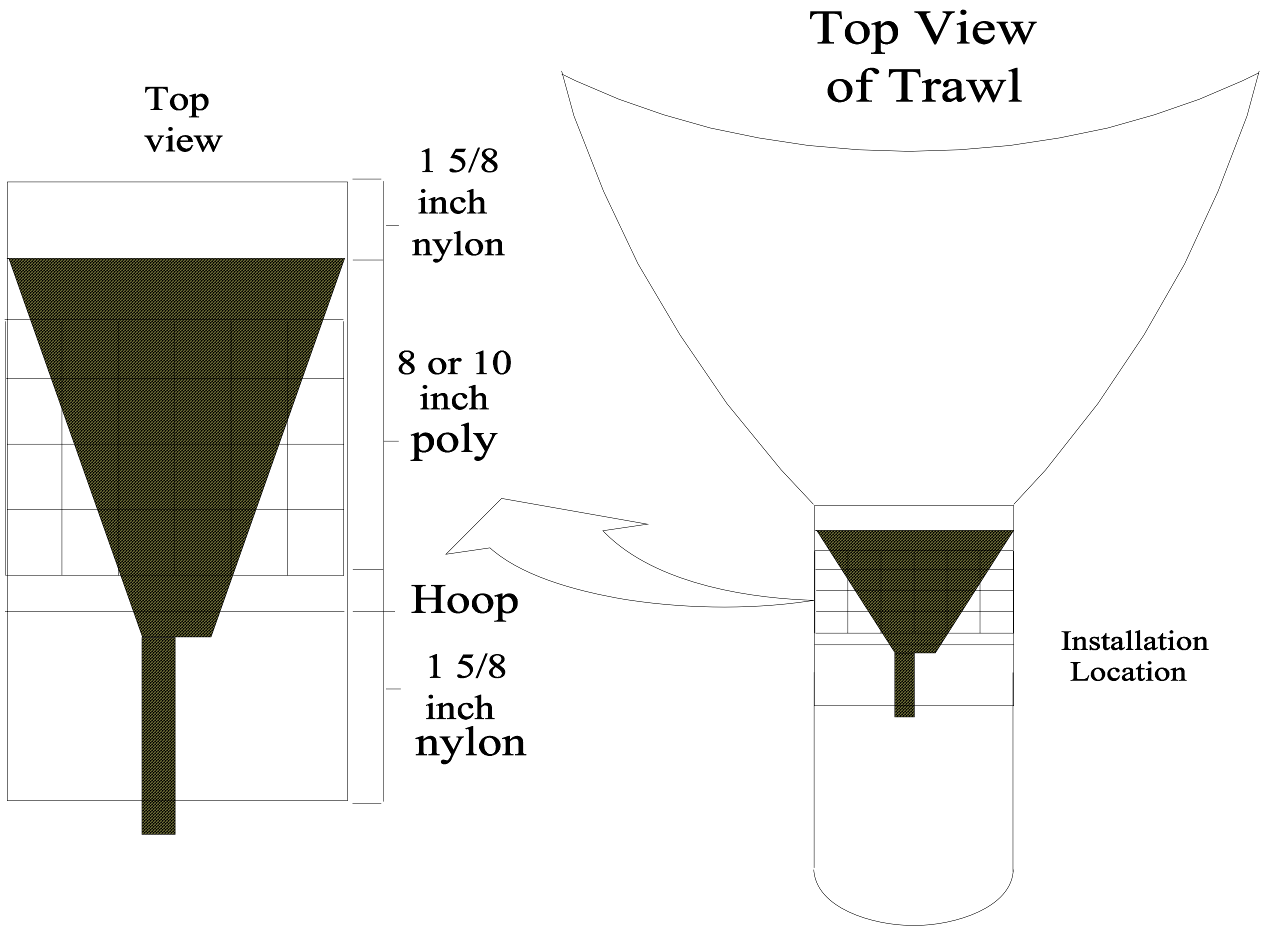

Figure 2. Diagram of large mesh extended funnel BRD (LMEF) tested in North Carolina.

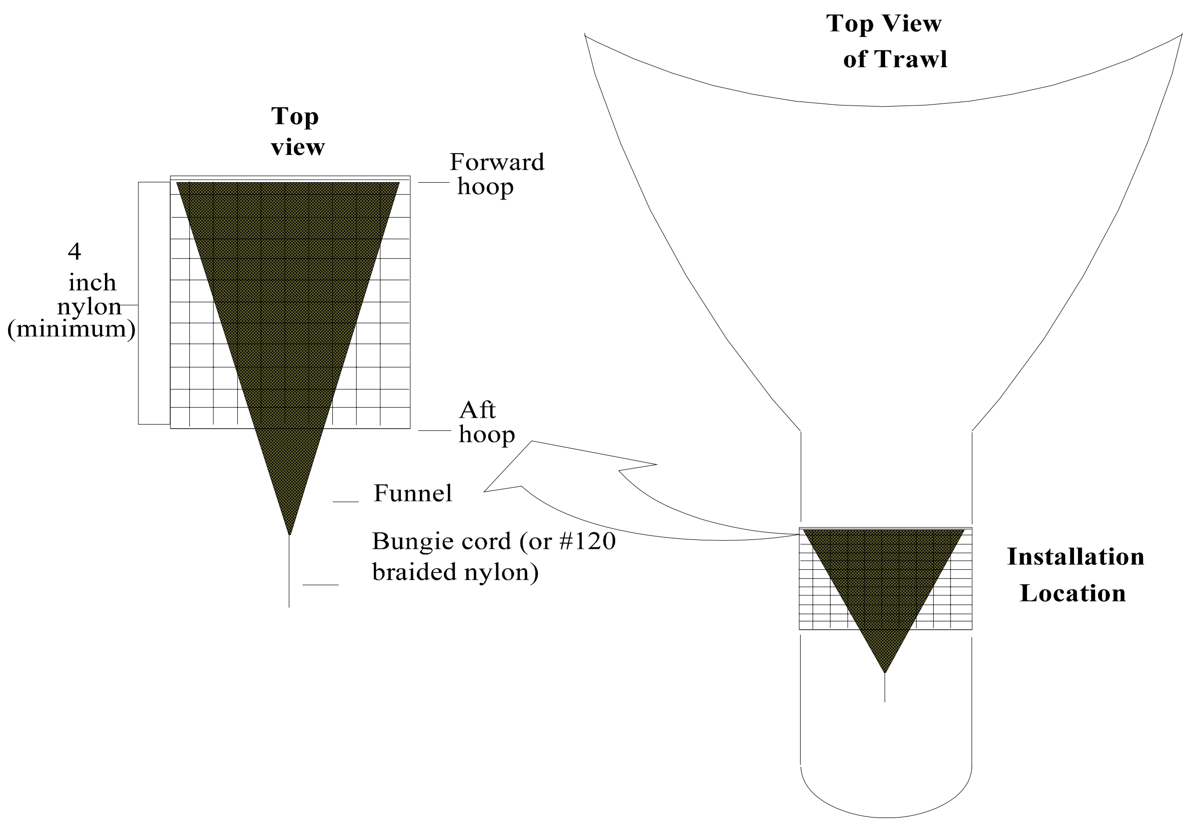

Figure 3. Diagram of modified large mesh funnel excluder (LMFE) tested in North Carolina.

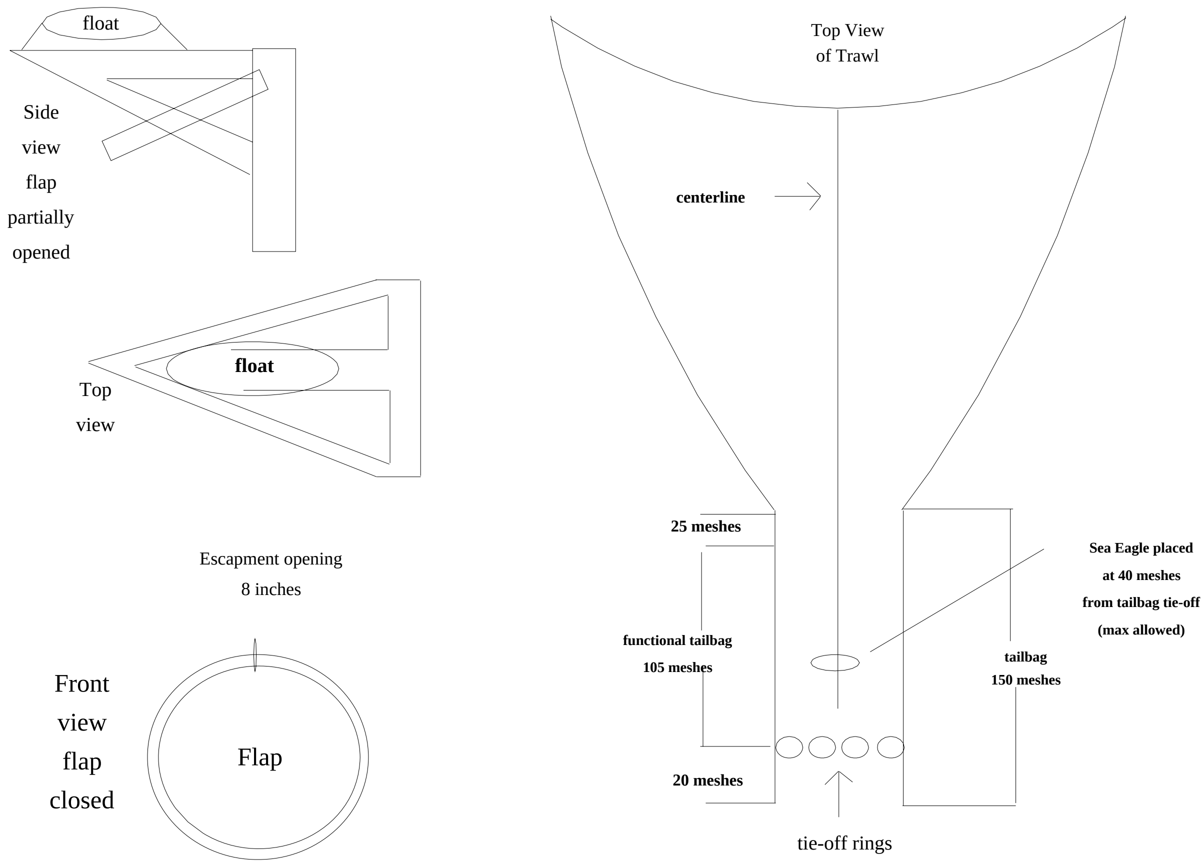

Figure 4. Diagram of “Sea Eagle” fish excluder tested in North Carolina.

12.4 Appendix 4. SOUTHERN FLOUNDER BYCATCH IN THE INSHORE SHRIMP TRAWL FISHERY

I. Issue:

Southern flounder bycatch in the inshore shrimp trawl fishery.

II. Background:

Bycatch of southern flounder was a topic of concern for the Southern Flounder Advisory Committee. Bycatch characterization studies indicate that bycatch reduction devices currently in place are not effective for reducing southern flounder bycatch (Table 1). The Southern flounder Advisory Committee recommended that Shrimp Advisory Committee address the issue of discard of sublegal southern flounder in the shrimp trawl fishery within the Shrimp Fishery Management Plan (FMP).

Table 1. The size range and mean size in millimeters of southern and summer flounder taken in shrimp trawls during BRD testing in 1995 (n = the number of fish sampled) (McKenna et al. 1996).

	Croatan Sound		Pamlico Sound		Core Sound		New River		Cape Fear	
	Control	BRD	Control	BRD	Control	BRD	Control	BRD	Control	BRD
Southern flounder (n)	**3**	**1**	**441**	**441**	**55**	**71**	**170**	**127**	**37**	**96**
Range (mm)	196-354	155	94-447	89-378	102-322	90-358	88-414	103-337	114-396	74-419
Mean (mm)	300	155	163	161	214	220	220	227	231	190
Summer flounder (n)	**138**	**111**	**195**	**283**	**594**	**476**	**84**	**72**	**188**	**231**
Range (mm)	101-278	83-325	110-313	110-310	45-332	65-331	137-346	92-341	77-351	90-420
Mean (mm)	145	140	196	196	130	132	235	235	158	163

III. Discussion

Based on the 2004 stock assessment, the southern flounder stock is overfished and has been for at least the past decade. North Carolina lands 96% of the southern flounder caught in southeastern United States commercial fisheries. North Carolina landings increased dramatically during the 1990s as they replaced summer flounder as the leading flounder landed in North Carolina. According to a stock assessment report, southern flounder appear to be fully-to-over-exploited in North Carolina and the rest of the southeastern United States.

The southern flounder fishery is largely dependent on incoming recruitment. The 2004 stock status catch-at-age indicated extremely high exploitation of age-1 and age-2 southern flounder (57% and 38% respectively), that is a concern since only 59% of age-1 and 79% of age-2 female southern flounder are sexually mature. The current fishing mortality rate for southern flounder is 1.91 (representing an 85% removal rate), which retains approximately 5.4% of the maximum spawning stock biomass, well below the percentage of spawning stock necessary to sustain most stocks.

Shrimp Trawl Bycatch

In the absence of quantifiable observer data, DMF utilized the Pamlico Sound trawl survey (Program 195) as a proxy for estimating shrimp trawl bycatch of southern flounder. The trawl survey utilizes comparable gears and operates during the same periods of time as the shrimp trawl fishery.

Mean catch-at-length by year, from 1991-2002, were provided and converted into catch-at-age for comparable analysis within the defined parameters of the southern flounder stock assessment (SA) (Table 2) (Grist 2003). The bycatch catch-at-age were added to the original southern flounder catch-at-age utilized in the SFSA and compared (Figure 1). A catch curve analysis and a Virtual Population Analysis (VPA) were conducted to compare the original southern flounder SA results with results that included the shrimp trawl bycatch catch-at-age.

Table 2. Southern flounder bycatch catch-at-age.

	Age							
Year	0	1	2	3	4	5	6	7
1991	705,675	670,504	284	0	0	0	0	0
1992	505,106	577,673	10,254	0	0	0	0	0
1993	668,281	352,862	8,710	6,485	0	0	0	0
1994	838,333	520,245	11,934	121	121	0	0	0
1995	901,136	677,671	13,417	0	0	0	0	0
1996	570,626	168,662	3,556	0	0	0	0	0
1997	710,106	577,395	1,901	0	0	543	0	0
1998	177,849	374,264	14,390	0	0	0	0	0
1999	913,981	240,672	5,314	0	0	0	0	0
2000	803,845	315,111	0	0	0	0	0	0
2001	284,981	158,799	6,526	0	0	0	0	0
2002	448,562	292,798	6,651	0	0	0	0	0

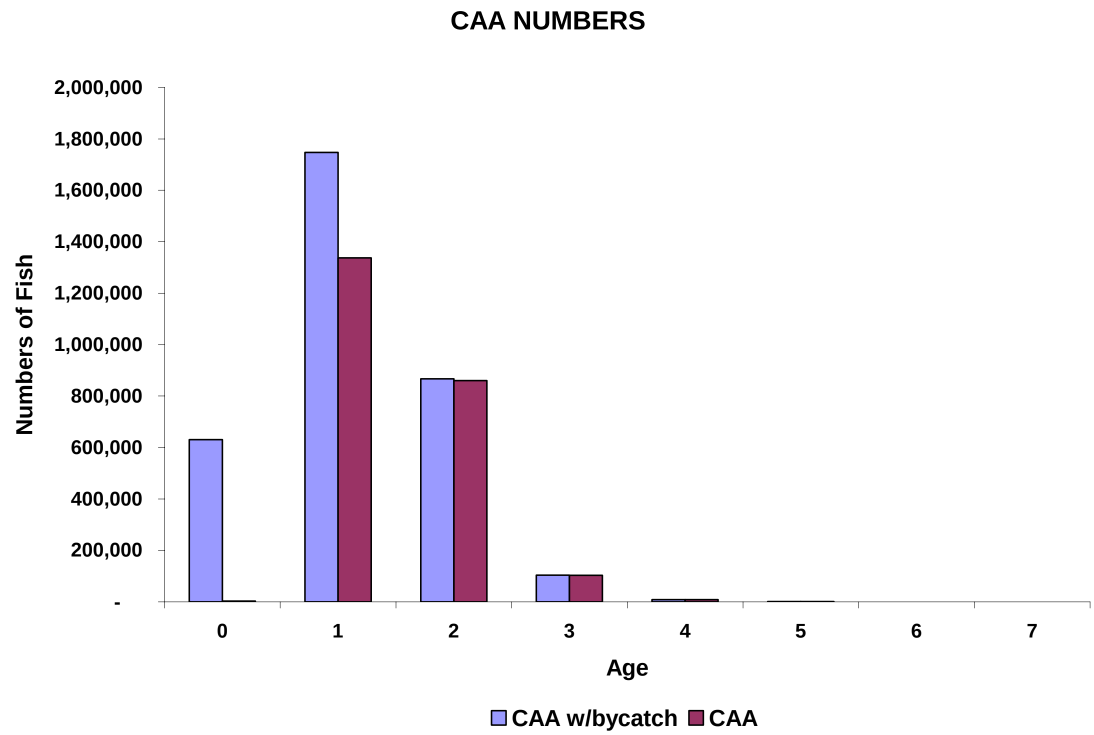

Figure 1. Original southern flounder catch-at-age versus catch-at-age including shrimp trawl bycatch catch-at-age.

Catch Curve Analysis

Initial estimates of total mortality (Z, or fishing + natural mortality) were obtained through catch curve analysis. A catch curve is a basic approach to analyzing catch-at-age wherein a linear regression is fit to the declining limb of log transformed catch-at-age data. (Ricker 1958, Ricker 1975, Hilborn and Waters 1992).

Catch curve analysis was conducted for ages 1-6. The original southern flounder catch curve analysis suggested that total mortality averaged 2.30 from 1991-2002, with the estimated fishing mortality rate equal to 1.89 and a fishing exploitation rate of 85%. When the shrimp trawl bycatch estimates were added to the original catch-at-age, the average total mortality from 1991-2002 for southern flounder increased to 2.75, with the estimate fishing mortality rate equal to 2.35 and a fishing exploitation rate of 90% (Figure 2).

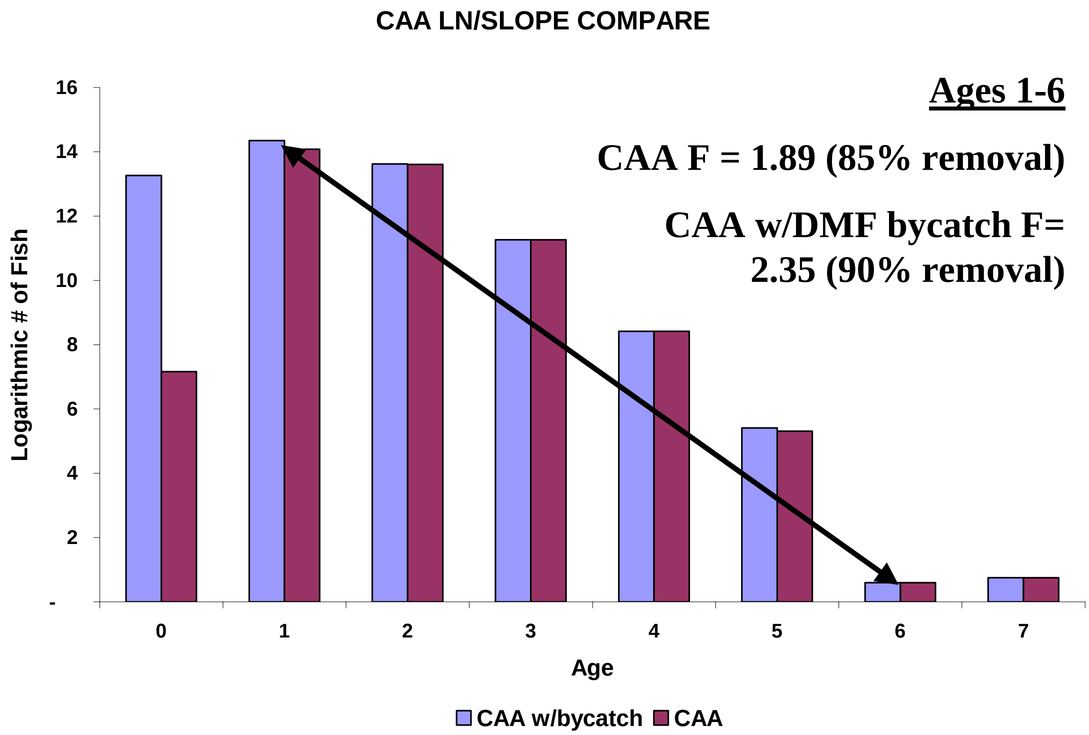

Figure 2. Comparison of catch curve analysis for southern flounder with and without shrimp trawl bycatch catch-at-age.

Virtual Population Analysis

VPA/ADAPT uses Virtual Population Analysis (VPA) combined with non-linear least squares minimization of residuals using the Levenburg-Marquardt algorithm. The VPA is a technique for reconstructing historical population size based on observed catch, an estimated natural mortality rate and estimated terminal year abundance (Gavaris 1988, Conser and Powers 1990). No error is assumed to occur in the CAA estimates. The VPA is calibrated with survey indices of abundance to improve population estimates in the final years. Confidence intervals and bias estimates are provided by 1000 bootstrap iterations.

The original VPA analysis for southern flounder estimated the fishing mortality at 1.91 ages 2-5, with a range of 1.69-2.89, and a fishing exploitation rate of 85%. When the shrimp trawl bycatch catch-at-age was added to the original dataset, the fishing mortality rate did not change. With shrimp trawl bycatch data, the VPA fishing mortality rate of 1.90, with a range of 1.68-2.95, and a fishing exploitation rate of 85%.

Age-Structure Analysis

Catch curve analysis and VPA are exacting quantitative analysis of stock status, and both have indicated minimal to no differences in the affects upon the high exploitation rate of southern flounder through the fishery. An additional analysis of population-at-age distributions under current and proposed management strategies also confirms this analysis. A theoretical stock distribution, based on known and proposed fishing mortality rates by age, and examining both the original and bycatch inclusive catch-at-ages, also depicts how under the current suppressed stock scenario, shrimp trawl bycatch impacts are unclear. In the absence of fishing (Figure 3), only natural mortality (M=0.4) has any cumulative affect upon the southern flounder population, and the age structure is distributed naturally from young to old. Under the current fishing scenario, with or without bycatch, the age structure is severely truncated, with very few age 3+ fish, and high exploitation of age-1 and age-2 fish. Under the target fishing mortality goals set forth by the southern flounder FMP, the age distribution allows for more older fish in the population. With age-3 representing 100% maturity-at-age for females, this target distribution if vital for the rehabilitation of the fishery. However, it should be noted that under both the current and target fishing scenarios, current models show very little difference when shrimp trawl bycatch is included in the calculations.

With the addition of approximately 1.0 million age 0-2 fish from the shrimp trawl bycatch, exploitation of juvenile southern flounder is more pronounced (19%, 52%, and 26% respectively). However, in such a suppressed stock scenario, it is unclear what specific impacts shrimp trawl bycatch has on the overall stock status of southern flounder at this time.

Theoretical Stock Distribution Examples

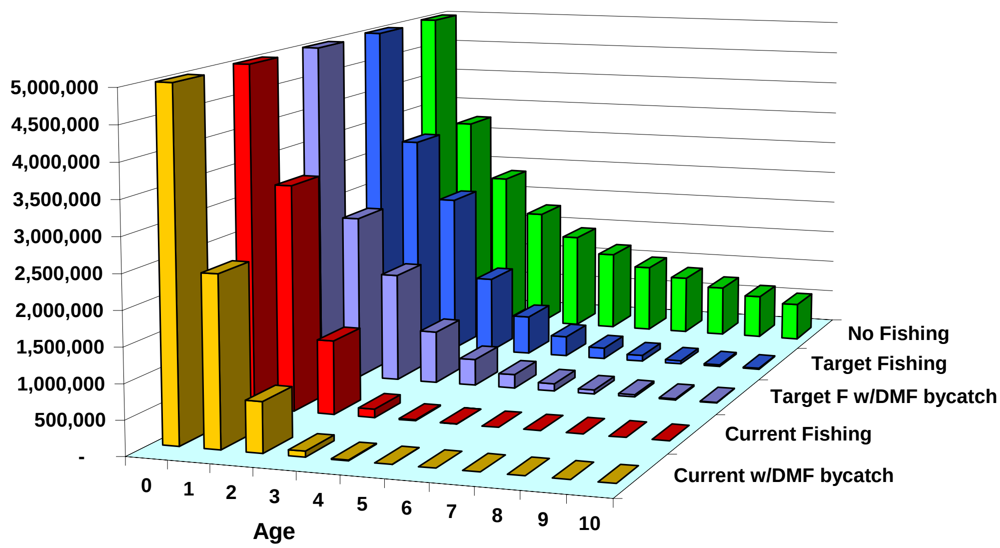

Figure 3. Theoretical population-at-age distributions for southern flounder under no fishing, target fishing (with and without bycatch), and current fishing (with and without bycatch).

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12.5 Appendix 5. SHRIMP MANAGEMENT BY SIZE IN NORTH CAROLINA ESTUARIES

I. Issue:

At what shrimp size should waterbodies be opened to shrimp trawling?

II. Background:

Shrimp management in North Carolina has evolved from early biological work done in the mid 1960s. At that time, studies were conducted on the behavior of our three species of shrimp (pink, brown and white), their growth rates, mortality and migration, habitat preferences, and salinity and temperature tolerances.

A major step in the evolution of management came in 1978 with the designation of Primary and Secondary Nursery Areas. These are the shallow bays and tributaries with low salinities, muddy bottoms and detritus where the shrimp spend their post-larval and juvenile development. In these shallow waters, food is abundant, salinities and temperatures are optimal, and there are few predators. No trawling is allowed in primary and secondary nursery areas to allow the shrimp to grow to harvestable size with as little man-made disturbance as possible. A Special Secondary Nursery Area designation originated in the 1980s to protect the shrimp during the majority of the season and allow harvest toward the end, when shrimp are of harvestable size and juvenile fish have migrated out of the bays. Other management measures that have been implemented include the 1 ½ inch minimum mesh size in shrimp trawls, no trawling areas in the Outer Banks seagrass beds, military restricted areas, and weekend closures from 9:00 p.m. on Friday nights to 5:00 p.m. on Sunday nights, among others.

The Director has proclamation authority to open and close in the estuaries and the Atlantic Ocean based on size and environmental conditions. The Director may, by proclamation, open any or all of the special secondary nursery areas, or portion thereof, to shrimp or crab trawling from August 16 through May 14, subject to the provisions of 15A NCAC 03L .0100 and .0200 (general shrimp and crab trawl rules). This flexibility in opening and closing shrimp areas is a valuable management tool, but it makes managers subject to the lobbying efforts of the various user groups.

III. Discussion:

Shrimp area openings and closures are based primarily on the size of most of the shrimp present in an area determined by extensive DMF sampling. Other factors considered in a decision to open or close an area include biological, environmental, economic and social issues in an "optimum utilization" scheme. The social aspects of management are addressed by evaluating the subjective knowledge of experienced DMF field personnel, shrimp fishermen, dealers, and others associated with the industry. When personal preferences or circumstances cloud this information, the size of the shrimp and the number of juvenile finfish in the samples assume the greatest weight in the decision.

Although highly variable, the density of shrimp in the nursery areas during the spring as well as weather conditions in the critical spring nursery months determine the number and size of shrimp in the different waterbodies. Overcrowding, with its associated competition for food and space cause the shrimp to migrate downstream earlier than they normally would and wind and rainfall compound the problem. At times when this occurs, the event is over before a closure can take effect or we already have the line at the point downstream at which a marketable and enforceable line can be established.

Shrimp management varies from the northern portion of the state to the southern part because of species behavior and differences among geographic areas as well as preferences of the user groups. In the Roanoke Island area, which is the northernmost range for NC shrimp, the management of special secondary nursery areas is based more on the protection of juvenile finfish than on the harvest of shrimp. Sampling is conducted to insure that the small fish have left the bays and, if shrimp are present, the area is opened. Abundant shrimp in the northern part of the state is such a rare occurrence that nearly any size is considered harvestable, and by August 16, they are usually of sufficient size.

The target size of shrimp in the majority of the Central District is 26-30 or 27-35 count (per pound heads on). In White Oak River, where shrimp do not reach that size before migrating, openings are considered when the majority of the sampled shrimp reach about 45-50 count.

Shrimp in the southern part of the state, with no extensive bays and sounds to develop in, begin to migrate at a smaller size. The waters of Onslow, Pender, New Hanover, and Brunswick counties that are available for opening to trawling are typically located either in or landward of the Intracoastal Waterway (ICW), which runs the entire length of all four counties' coastlines. Portions of these narrow waters may remain closed only at some times of the year or not open at all, depending on the size of the shrimp observed in the DMF's samples. Target opening size in Brunswick and portions of New Hanover counties is 40-50 count (heads on). In Onslow and parts of Pender County, sampling has shown that a 20-30 count target size can be achieved before migration occurs. Channels that connect the ICW with the Atlantic Ocean have been left open to allow some harvest of shrimp as they migrate from closed areas to the ocean. Trawling in these migration routes has become the subject of discussion among shrimpers as well as the public because of concerns about bycatch of other species as well as interference with navigation. One migration route that has been the subject of recent controversy is the channel leading to Blue Water Point Marina in Brunswick County.

Consideration must be given to the entire range of users, from the 15' outboard in the shallow water sounds and river tributaries to the 85' ocean trawler. In most cases, 100 pounds of 45 count (heads on) shrimp would be much more valuable if permitted to grow to 16-20s, even factoring in the mortality suffered in the meantime. Even this statement has its exception in the spring pink shrimp fishery in the North River area of Carteret County when those 45 count shrimp bring up to $2.50 per pound. Managing for 16-20 sized shrimp would eliminate the majority of the shrimp fleet and leave the catch to larger trawlers in Pamlico Sound and the ocean and to some channel netters. Thus far the management strategy has been to allocate some of the public resource to all groups. All of these groups call and visit during the season and complain when they feel that they are not getting their fair portion.

Attempts have been made to limit the frequent movement of shrimp lines by meeting with the fishermen, discussing the problems, and seeking answers acceptable to the majority of them, while offering reasonable protection for the small shrimp. For example, a meeting was held at Harkers Island in 1997 about a possible solution to North River shrimp line and by unanimous choice, a "permanent" line was agreed to and implemented. The line works well, unless there are tremendous numbers of shrimp, which causes smaller ones to spill over into the open area. Still the shrimp are marketable and provide income to the fishermen, particularly the early summer pink shrimp. Newport River has settled into a fairly predictable pattern of working the Penn Point-Hardesty Farm line until late fall when an opening to the Turtle Rock occurs.

Closing an area in mid-season usually results in a “grand opening” later. Areas like Adams Creek, Newport or North River may have up to 200 boats, regardless of the number of shrimp there may or may not be. This large number of vessels operating in confined waterbodies results in dangerous navigational situations. Fish kills following shrimp openings in New River and Bay River in recent years have brought attention to trawling impacts. The detrimental effects of these openings to the bottom and juvenile fish in the area make it very desirable to avoid them whenever possible.

In conclusion, North Carolina shrimp management has evolved into a fairly routine series of openings and closures over the past few years. Designation of primary and secondary nursery areas and negotiated “permanent” lines in some waterbodies like North River have eliminated the need to open and close anything. Unusual weather events or the occurrence of unusually high numbers of small shrimp will occasionally force closures of normally opened areas like a portion of Neuse River or the ocean south of Cape Fear. Target sizes for opening have evolved: 26-30 count from Pamlico Sound to White Oak River; 45-50 count in the White Oak River; 20-30 count in New River and parts of Pender County; and 40-50 count in Brunswick and parts of New Hanover counties. At the present time modal groups are used and some shrimp are larger and some smaller than our target. Openings based on these target sizes have addressed the variability within the state of boat sizes and size preferences of the user groups, geographical differences in the shrimp size at migration, weather events, and socio-economic conditions.

IV. Current Rule:

V. Management Option/Impacts:

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

1. Status quo, **with specific target size for openings**: Pamlico Sound to White Oak River-26-30 count; White Oak River-45-50 count; New River and parts of Pender County-20-30 count; Brunswick and parts of New Hanover counties-40-50 count.
   + Flexibility in reacting to variable conditions (excessive rainfall, early migration)
   + Access to resource by a variety of users
   + Minimize harvest of small shrimp and bycatch
   - Open areas highly dynamic (size and number of shrimp change quickly)
   - Potential for larger shrimp to leave with smaller shrimp remaining.
   - Labor intensive and expensive to sample
   - Difficult to keep public abreast of opening and closing dates
   - Necessitates “grand openings”

2. Keep all areas closed that are currently intensively managed areas
   + Prevent harvest of smaller shrimp
   + Reduce bycatch
   + Public better informed
   - Increases effort in areas that remain open
   - Elimination of niche markets developed over the years (bait)

3. Set dates for opening and closing areas each year
+ Grand opening dates predetermined
+ Satisfy fishermen who disagree with DMF openings
+ Better utilization of staff time
+ Public better informed
- Lose flexibility of management by proclamation
- Excessive harvest of small shrimp or shrimp gone when opened

4. Management by strict minimum count rule
+ Possible reduction in harvest of small shrimp
+ May increase price for shrimp that are landed
- Poses enforcement problem
- Wastage due to high-grading
- Counts may vary widely in the same geographic area
- May eliminate most inside shrimping
- Difficult to keep public abreast of openings/closings

5. Restrict the size or number of shrimp trawls per vessel in inside waters
+ May reduce bycatch
+ May reduce user conflicts
Reduces possibility of large “ocean” trawlers working inside
+ May reduce habitat disturbances caused by larger trawlers
- Reduce inside shrimp catch

6. Close inside shrimping
+ Reduction of small shrimp harvest
+ Eliminate inside bycatch from shrimp trawls
+ Decrease navigational and fixed vs. mobile gear conflicts in inside waters
- Loss of large portion of shrimp fishery
- Loss of income to commercial fishermen and dealers
- Impossible to assess benefit of bycatch reduction on fish stocks with current data
- Loss of recreational use of shrimp resource

Recommendations:

AC, DMF and MFC Recommendations: See area specific recommendations.

12.6 Appendix 6. SHRIMP POUND NET SETS (Shrimp Traps)

I. Issue:

What is the appropriate definition and allowable use of the relatively new shrimp traps which are made of hardware cloth, have V-shaped wings, and are presently used in the southern part of the state?

II. Background:

There are two existing shrimp pound nets in East Thorofare Bay, a tributary of Core Sound in Carteret County. These have been permitted since approximately 1995. They have leads approximately 100 yards in length and a pound of 1 ½" stretched mesh. Copper-treated nylon webbing is used for the wings and pounds. These "traditional" pound nets are used commercially to catch primarily brown shrimp in July and August.

Last year, the DMF became aware of the emergence of a new form of shrimp pot/trap with wings. These traps are constructed of 5/8" rigid hardware cloth and have two V-shaped wings to direct the shrimp into the traps. These wings can be up to 50 feet in length and the distance between the ends of the wings is approximately 80 feet. The traps are most successful when set during a flood tide with one of the wings against a bulkhead or marsh shoreline. The devices are staked or anchored in place. The ends of the wings face away from the direction of the tide flow when deployed.

The proliferation of these shrimp traps in the relatively confined waters of the Southern District caused concern due to interference with traditional uses of the waters for shrimp trawling and navigation. The solution adopted to prevent this possible problem was to designate these shrimp traps as shrimp pound net sets. This designation requires a permit that is only available to applicants that have a Standard or Retired Commercial Fishing License (SCFL). After the proposed sets are marked and the application is completed, there is a 20 day public comment period, during which the public has an opportunity to see where the nets are proposed and comment on activities that the set would possibly interfere with. The pound net designation has had the desired effect of preventing the rapid and uncontrolled growth of these devices. Four applications in the Southern District have been denied by the Director and three additional pound net application packages have been sent out as of August 19, 2004.

The Shrimp Fishery Management Plan Advisory Committee has been given a presentation on these devices at one of their meetings. The devices are very efficient if placed in a productive area with the proper tidal flow. There is very little bycatch involved, it can be released alive, and small shrimp are able to escape through the meshes. Several of the AC members and staff have expressed the need to examine the possibility of using this (or a scaled down version of this gear) as a recreational shrimp harvest gear and a possible alternative to Recreational Commercial Gear shrimp trawls. There is evidence that a smaller version of the shrimp trap (perhaps as small as 10 to 20 feet long in total) is very effective.

Under the present MFC Rules, the gear is a shrimp pound net and, by virtue of that definition, several obstructions exist to the use of that gear as a "recreational" gear. The applicant must have a SCFL. The pound nets must not interfere with traditional uses like shrimp trawling and gill netting as well as navigation. In the confined waters of the south, where space is at a premium, these conditions are very limiting. Also, our present pound net set rules require a 1000 yard distance between new pound nets. If several nets were to be applied for along a certain bulkhead or shoreline, only one or two could be approved. These devices are often used in front of waterfront houses by their owners in congested areas with houses lining the entire bank. In addition, gill nets cannot be set within 200 yards of a functional pound net, so this will either prevent many sets from being permitted (existing uses), or prevent gill nets from being set in the vicinity of the sets.

Therefore, the immediate problem of preventing the uncontrolled proliferation of these devices has been dealt with, but if this effective, non-bottom disturbing, no bycatch producing gear is to be allowed, how should it be modified, what should we call it and where should it be used?

III. Discussion:

The person who gave the presentation to the Shrimp AC on these devices said that, although he used a trap with a distance between the ends of the wings or 80 feet, a smaller version of this device 10 feet long is effective in catching shrimp. There are two components of the use of this gear; recreational and commercial. The gear is now considered commercial and is not included in the list of noncommercial gear that appears in Rule 15A NCAC 03I .0101 (b)(1). An option for allowing recreational use is to begin an effort to define a scaled-down version of the existing traps that could be used with a Recreational Commercial Gear License (RCGL). This definition would include the maximum dimensions, mesh size, marking requirements, and attendance requirements. The MFC would be asked to add this gear to the list of allowable RCGL devices and one trap per license could be allowed for recreational uses.

Any shrimp trap whose dimensions exceeded the parameters specified in the definition would be considered a shrimp pound net set and be subject to the requirements of the Pound Net Set Rule, including permitting, SCFL requirement for eligibility and the public notice period. To address the problems of a 1000 yard minimum distance between sets and the prohibition of gill nets within 200 yards of active pound nets, the shrimp traps could be exempted from those requirements in the Pound Net Set Rule. The locations of the sets would be determined by tidal flow.

In order to come up with a comprehensive definition of shrimp traps, their dimensions, proper mesh sizes, etc., research should be conducted on how and where these devices function and what requirements are appropriate for their recreational use. By adopting the concept, the MFC could adopt rules when that research is completed without waiting for the revision of the Shrimp FMP in five years.

IV. Current Authority:

15A NCAC 3J .0107 Pound Net Sets
15A NCAC 3J .0301(l) It is unlawful to use pots with leads or leaders to take shrimp. For the purposes of this Rule, leads or leaders are defined as any fixed or stationary net or device to direct fish into any gear used to capture fish. Any device with leads or leaders used to capture fish is not a pot.
15A NCAC 3I .0101 (b) (29) Pound Net Set. A fish trap consisting of a holding pen, one or more enclosures, lead or leaders, and stakes or anchors used to support such trap. The lead(s), enclosures, and holding pen are not conical, nor are they supported by hoops or frames.
15A NCAC 3I .0101 (b) (2) Fixed or stationary net. A net anchored or staked to the bottom, or some structure attached to the bottom, at both ends of the net.
15A NCAC 3J .0103 (d) (1) It is unlawful to use gill nets within 200 yards of any pound net with

lead and pound or heart in use.

V. Management Options:

1. Status Quo
   + controlled growth and placement
   + reduced interference with traditional uses
   + permitted devices uniformly marked
   - “recreational” use discouraged
   - no gill netting within 200 yards
   - 1,000 yard minimum distance between pound nets

2. Define a scaled-down “recreational” version of this device in MFC Rule and add it to a list of “recreational” commercial gear in 15A NCAC 3O .0302.
   + allows recreational use of device in manner in which it is presently used
   + requires no Pound Net Set Permit (May require new Saltwater Fishing License)
   - unrestricted use and interference with traditional uses
   - disputes over setting “upcurrent” of someone

Recommendations:

AC, DMF and MFC Recommendations: Investigate the use of shrimp traps as RCGL gear including size restrictions and location.

12.7 Appendix 7. MANAGEMENT OF FIXED GEAR IN THE INSHORE SHRIMP FISHERY

I. Issue:

Management of Channel nets

II. Background:

The use of fixed gear to harvest shrimp in areas that are closed to the use of mobile gears (trawls, skimmers, seines and butterfly nets) is a common practice in the areas between Harker's Island and Topsail Inlet. The primary fixed gear used to catch shrimp in these areas is a channel net. While channel nets are allowed in areas closed to trawling, insufficient tidal current throughout much of southeastern North Carolina limits their use to only a small portion of these closed areas.

User conflicts between channel netters and mobile gear users have developed over the years. Mobile gear fishermen have complained about channel nets being allowed in closed areas as well as being allowed to fish during the weekend trawl closure. Channel netters counter that they are not able to work every day since they must have a period of ebbing tide during the night. Spatial competition for the "best sets" among channel net fishermen is another conflict that the Division of Marine Fisheries (DMF) has dealt with over the years. This fishery is regulated by proclamation and some areas in the Cape Fear, New River and the Intracoastal Waterway (ICWW) have been closed to address user conflicts and navigational issues in these waters.

Historically, channel nets have contributed almost all (>99%) of the fixed gear shrimp landings in North Carolina. During the period 1972-2003, landings fluctuated from a low of 21,113 lbs in 1977 to a high of 596,511 lbs in 1980 (Figure 1). Landings have been more consistent in the past ten years, ranging from a low of 181,915 lbs in 1998 to 284, 257 lbs in 1999 and comprising 4.4% of the total inshore shrimp landings. Other gears that harvested less than 10% of the inside shrimp landings (1994-2003) include skimmer trawls, gill nets and shrimp pots (Figure 2). Otter trawls dominated inside shrimp landings during 1994-2003 accounting for approximately 88% of the landings.

The majority of the shrimp harvested with channel nets are captured and landed in Carteret, Onslow and Pender counties. Between 1994-2003, these three counties contributed 91-99% of the total channel net landings with ten-year means of 35, 54 and 6% respectively.

Shrimp is an annual crop and the relative abundance in any given year appears to dictate the effort/trips in the fishery. Effort in the channel net fishery is categorized here by the number of trips and participants in the fishery since 1994 (Figure 3). There has been a decline in participants in this fishery since 1994 from188 participants in the fishery during 1995to only 88 participants in 2003, a 53% reduction. Channel net landings were queried for participants who landed more 2000 lbs. An average of 32 participants harvested 73% of the channel net landings between 1994-2003 (Table 1).

Blue crabs are a marketable bycatch component of the channel net fishery. Concern over channel netters targeting blue crabs prompted the Marine Fisheries Commission to enact regulations limiting the harvest of blue crabs to 50 percent of the total weight of the combined shrimp and crab catch or 300 pounds, whichever is greater. This new rule will become effective in 2005.

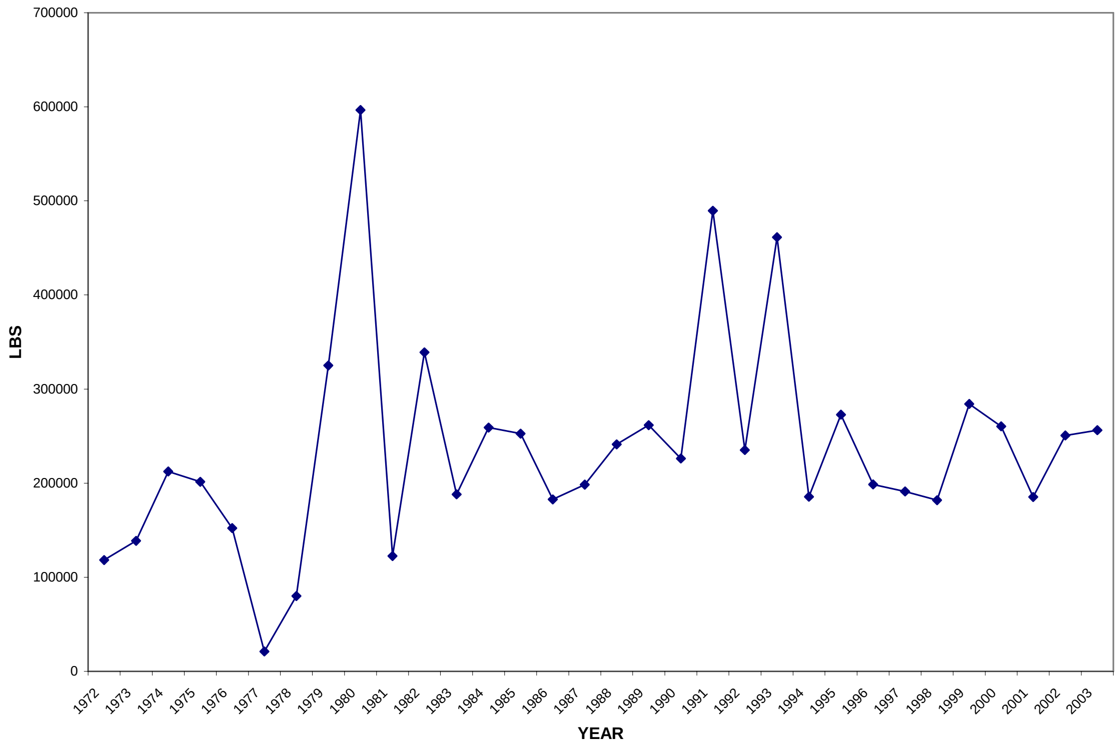


Figure 1. Channel net landings 1972-2003 (courtesy of the DMF trip ticket program)

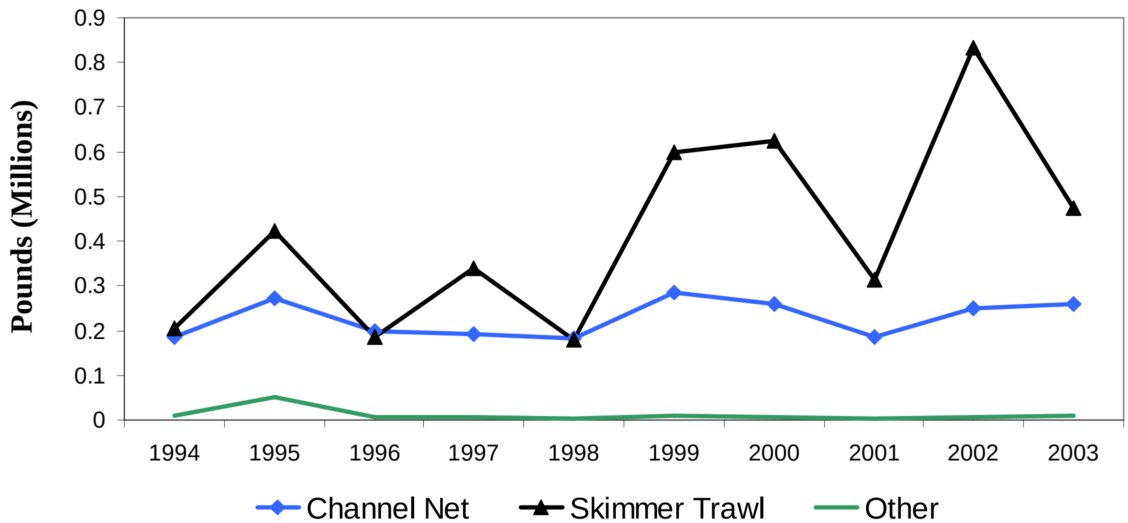


Figure 2. Inside landings from gears other than shrimp trawls (courtesy of the DMF trip ticket program).

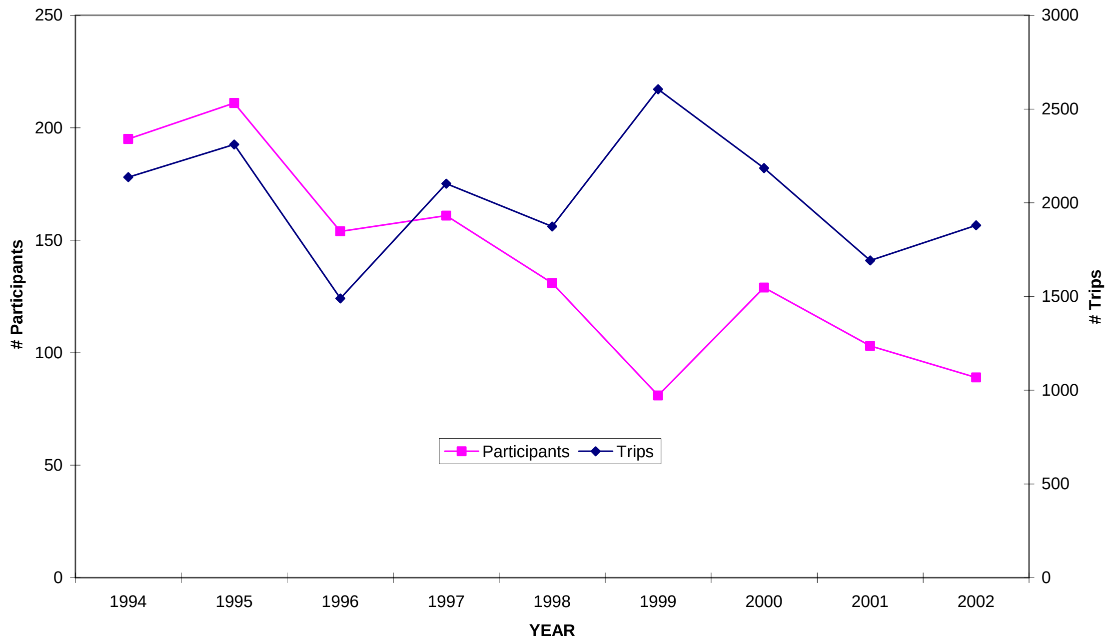


Figure 3. Effort in the channel net fishery, 1994-2003 (courtesy of the DMF trip ticket program.

Table 1. Participants landing at least 2,000 lbs of shrimp in channel nets (courtesy of the DMF trip ticket program).

Year	Participants	Pounds	Percent of total	Trips	Value
1994	29	125,832	66.8%	1,333	$273,882
1995	35	214,820	77.6%	1,688	$453,722
1996	30	154,570	75.9%	938	$350,779
1997	29	135,384	68.5%	1,392	$327,547
1998	21	136,859	74.0%	1,260	$306,860
1999	40	238,709	79.1%	2,104	$489,999
2000	36	224,314	74.4%	1,758	$552,413
2001	28	148,957	56.0%	1,160	$320,282
2002	34	218,164	69.7%	1,569	$386,299
2003	36	220,482	85.0%	1,371	$360,728

III. Discussion:

Fishermen in Onslow and Pender counties who utilize channel nets to harvest shrimp typically return to the same set night after night. The majority of fishermen leave their anchors and marking buoy in place throughout the season. Anchors for each set are strategically located so the fishermen can fish as close to the ICWW channel as possible and still be conform to current regulations (3J .0106 (a) (3-4). DMF does not require these sets to be permitted, nor is there a minimum distance requirement between sets. The problem with minimum distance requirements is that the distance between sets may or may not affect the catching ability of one channel net relative to another one. Rather, it is more related to current, bottom topography, and the contour of the channel. Conflicts between users as well as navigational issues that have arisen in the past have been dealt with on an as needed basis with DMF staff taking on the role of mediator. During the 1990's until 2004, DMF has exercised proclamation authority in four instances to mitigate navigational and or user conflicts. The DMF also attempted to control user conflict by permitting channel nets in New River. This effort was unsuccessful because it was considered limited entry to restrict the number of permits. The problems have improved in the last few years and the DMF feels that the necessary tools are in place to manage this segment of the fishery.

Under current regulations, with the exception of the Cape Fear River, channel net fishermen have been allowed to work in areas that are closed to shrimp trawling. The DMF has received negative comments about this practice even though the closed areas in which there is enough current to allow channel nets to fish effectively is limited. Channel nets generally catch larger shrimp that are migrating to the ocean from the estuary and the capture of large amounts of unmarketable shrimp is rare. An exception to this would be the Cape Fear River, where the over exploitation of small shrimp with channel net gear necessitated a proclamation restricting channel nets in closed trawling areas The use of channel nets has been permitted during the weekend trawl closure to allow the harvest of shrimp that are migrating to the ocean, a percentage of which would not be harvested by trawlers.

IV. Current Authority:

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)

3J .0106 – CHANNEL NETS
3L.0102 – WEEKEND SHRIMPING PROHIBITED
3L.0103 – PROHIBITED NETS AND MESH SIZES

V. Management Options/Impacts

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

1) Status quo
+ Allows flexibility to deal with problems as they arise.
+ Passive gear has less by-catch and bottom disturbance associated with its use.
- Conflicts with other user groups.
- Interference with navigation.

2) Restrict use to areas and times available to mobile gears
+ Would treat everyone the same.
- Increased user conflicts
- Decreased area for fixed gear users by rule
- Decreased fishing time available for fixed gears

Recommendations:

AC and MFC Recommendation: The Advisory Committee concurred with the DMF's recommendation on the closure of areas to fixed gear. They also recommended that no part of a channel net set be allowed in the marked navigation channel from New River Inlet to the Intracoastal Waterway.

DMF Recommendation: The DMF recommends that the closed areas up-current of areas open to mobile gears be restricted to use of fixed gears south of Highway 58 bridge. This would involve channel nets sets upstream of the Highway 172 bridge over New River and those north of the Highway 50 swing bridge in Surf City. These areas would open when they are opened to mobile gears. The DMF proposes no rule change and would do this by proclamation.

12.8 Appendix 8. THE RECREATIONAL SHRIMP TRAWL FISHERY IN NORTH CAROLINA

I. Issue:

The harvest of *Penaid* shrimp using the Recreational Commercial Gear License

II. Background:

On August 14, 1997, the Fisheries Reform Act was signed into law. One aspect of this law was the creation of the Recreational Commercial Fishing License (RCGL). According to the Fisheries Moratorium Steering Committee (MSC), a group that provided the recommendations for the FRA, the purpose of creating this license was to: (1) allow individuals and families who have traditionally accessed the State's public trust fishery with commercial gear to supply themselves with fresh seafood; (2) limit the effort that may be expended by this class of fishermen both individually and as a group; and (3) implement the principle that all persons who harvest state public trust resources pay for that privilege by investing in coastal fisheries conservation and management (Moratorium Steering Committee, 1996). DMF began selling this license July 1, 1999.

The MSC also recommended that the North Carolina Marine Fisheries Commission (MFC) be authorized to establish specific gear limits with "standing advisory committees" and those limits could vary by region. The MFC should be required to re-examine and revise the gear limitations on a recurring basis. The MSC further recommended that the RCGL be restricted to the use of the following gears and amounts during the period final gear limitation rules are being developed by the MFC: one – 100 yds of gill net; 2) five crab/fish pots and 3) a single trawl with a headrope less than or equal to 25 ft. These limits were meant to serve as the starting point for the MFC rule development on RCGL gear and were the result of extensive public input and deliberation by the MSC.

The FRA provided that the MFC: 1) shall adopt rules authorizing the use of a limited amount of commercial fishing equipment or gear for recreational fishing under a RCGL (G.S.113-173(c); 2) may authorize the limited use of waters commercial gear on a uniform basis in all coastal fishing waters or may vary the limited use of commercial gear within specified areas of the coastal fishing waters; and 3) shall periodically evaluate and revise the authorized use of commercial gear for recreational fishing. The MFC deliberated on those measures at their December 10-11, 1999 meeting in Kill Devil Hills, NC. The DMF's recommendation was one trawl net, 26 ft headrope. However, several commissioners expressed reservations over DMF's recommendation. Commissioners Phillips, Nifong, and Moffit expressed concerns with shrimp trawls being used recreationally. Commissioners Fickling and Clem recommended that the shrimp trawls used recreationally be phased out instead of cut off completely. Chairman Johnson recommended a 26-ft net with nonmechanical retrieval and a five-year phase-out (minutes MFC meeting, Dec 10-11). The rule (3O .0302 (2)) that was passed by the MFC reads as follows: One shrimp trawl with a headrope not exceeding 26 feet in length per vessel. Mechanical methods for retrieving the trawl are not authorized for recreational purposes, including but not limited to, hand winches and block and tackle.

In 1998 the DMF completed a survey of persons that had commercial fishing licenses, but did not sell their harvest. The goal of the survey was to provide data on potential RCGL users. Six thousand three hundred forty eight licensees were sent surveys. Survey results indicated 20% of the persons used shrimp trawls, the average size was a < 26 ft headrope, and the nets ranged in size from 15 to 75 ft. Shrimp trawls were most commonly used in the Neuse River and the southern part of NC. Shrimp was the fourth ranked species taken recreationally with commercial gear, ranking behind spot, flounder and blue crabs. Fishermen used shrimp trawls an average of 6 to 16 days, depending on the area.

The MFC has received two petitions for rulemaking since 2002 to limit the RCGL take of shrimp to no more than a 32 quart cooler and to restrict trawling by RCGL trawlers to Friday and Saturday and for 12 hours immediately following the opening of an area. The petitions were submitted to address the illegal sale of shrimp. The MFC denied those because enforcement concerns were addressed through present criminal and civil statutory authority. Additionally, the four regional committees recommended denial and there was a scarcity of data (at the time) on shrimp harvest by RCGL holders.

After the RGCL was passed in 1999 and until March 2002, fishery managers knew how many RCGLs had been sold, but had no data on the amount of seafood harvested, what gear they used and where they fished. This changed in March 2002 when two independent surveys were initiated by DMF to collect data from the RCGL user group. The first survey was a census of the 2001 RCGL population with the objective of obtaining baseline data on the social and economic characteristics of the RCGL community. Data collected included information on target species, waterbodies fished, gears fished, seasonality of species, and fishing effort. The second survey was a monthly survey with an objective of collecting data that could be used to estimate monthly catches and effort of major species of finfish and shellfish caught by RCGL holders. Monthly, in 2002 and 2003, 30% of the RCGL population was mailed surveys. Response rates from these surveys ranged between 23 and 44 %. Data obtained from these responses were then extrapolated to the entire population to generate estimates. All data and analyses referenced in this issue paper from this point on were derived from these two surveys.

III. Discussion

The majority of RCGL license holders are located in the coastal and coastal plain counties of North Carolina (Figure 1) although there is representation from almost every county in the state.

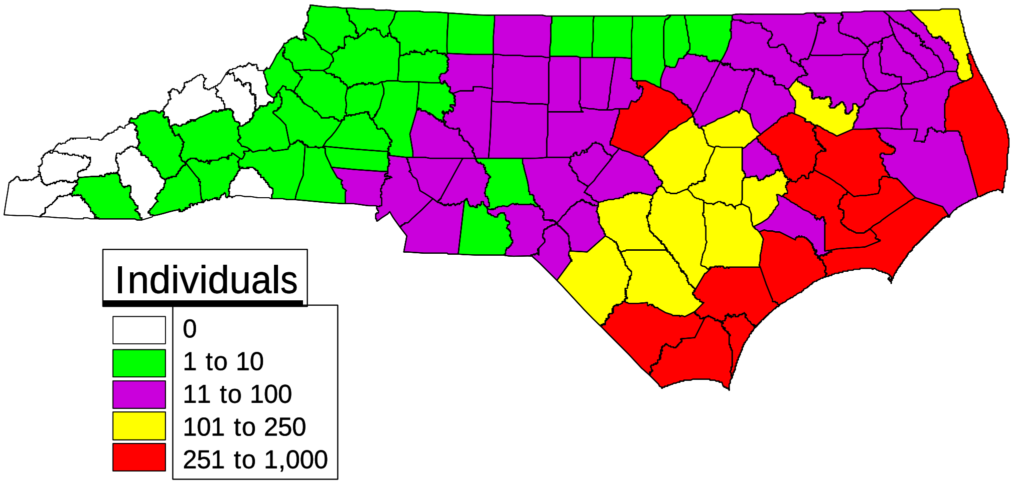


Figure 1. Density of RCGL license holders in North Carolina.

The number and the months RCGL licenses were sold in 2001 and 2002 are similar. Since the license expires a year from the date sold, the number of licenses outstanding during any one month of the year fluctuates. Licenses issued decreased significantly in 2003 (Figure 2). The peak in license sales evident during the spring and summer of 2001 and 2002 never materialized in 2003, resulting in a lower number of licenses outstanding. The reason for this decrease is not clearly understood but might reflect weakness in the general economy.

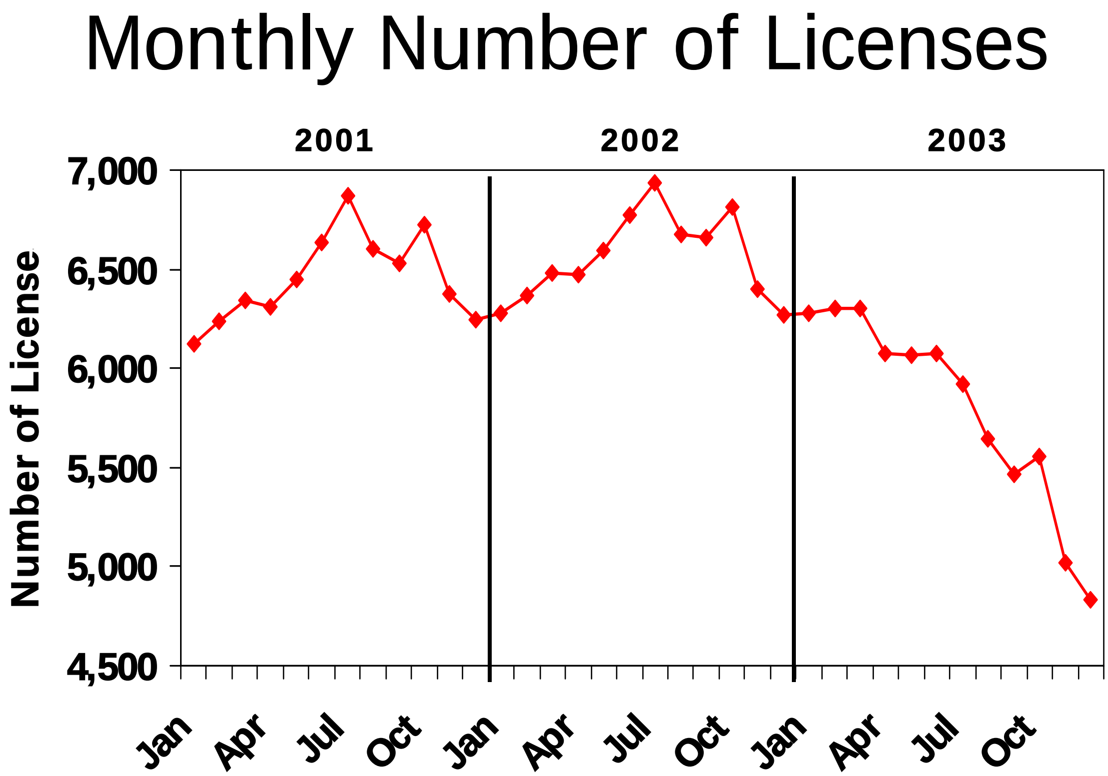


Figure 2. Outstanding RCGL licenses by month and year 2001-03.

RCGL trawlers landed 101,595 lbs of shrimp in 2002 and 47,511 lbs in 2003, a 53% reduction. A substantial reduction in harvest also occurred in the commercial fishery where landings decreased 38% year to year. RCGL landings represented only 1.0% of total commercial landings in 2002 and 0.7% in 2003. Commensurate with the year to year decline in RCGL shrimp landings and license sales, there was also a significant decline in the effort or number of trawling trips between 2002 and 2003. There were 5,373 trawling trips in 2002 as opposed to only 2,646 trips in 2003, a decrease of 51%. Other gears harvesting shrimp included seines and shrimp pots but the amounts harvested with these gears were negligible [<0.2% (DMF, Statistics program)].

For comparison purposes, the coastline of the state was divided into four regions. These regions are defined in Figure 3.

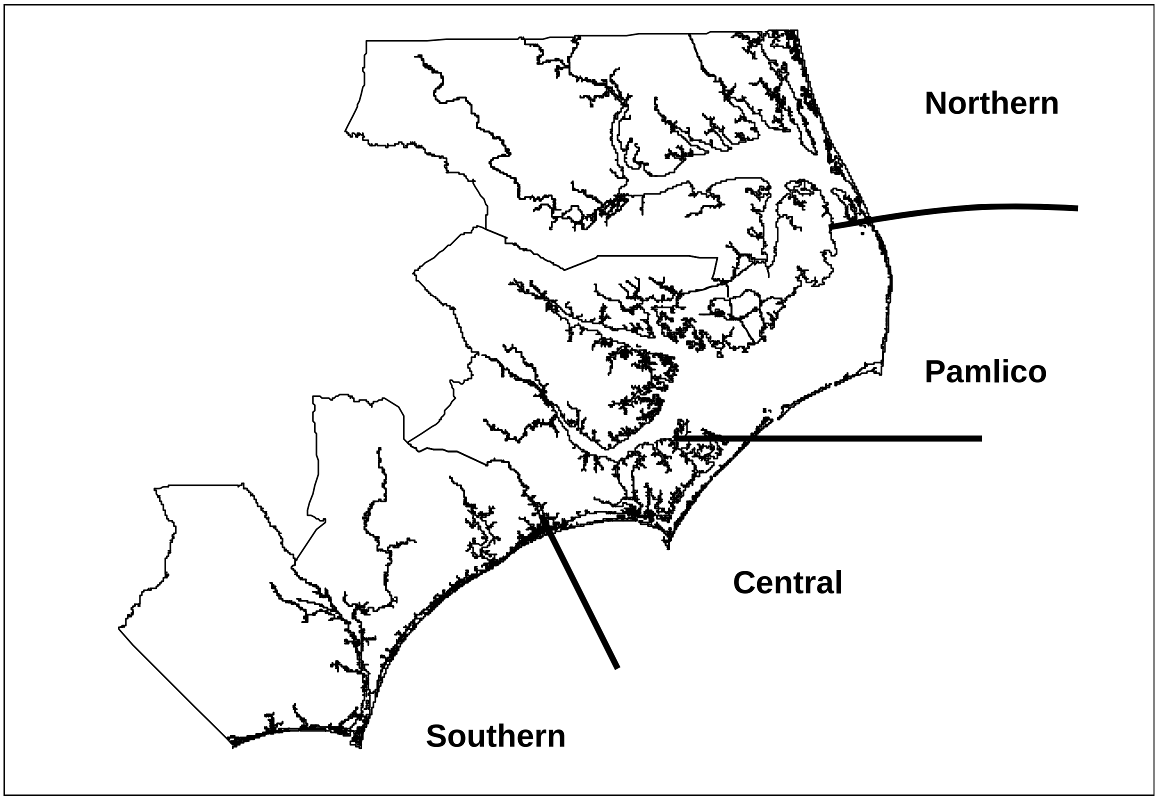


Figure 3. Regions used to describe distribution of RCGLs.

The amount of trips and landings relative to the four coastal regions were similar in 2002 and 2003 (Figure 4). The Pamlico region had the highest proportion of landings and effort/trips followed by the Southern region. Landings and effort showed little change in either of these areas between 2002 and 2003. In the Northern area, effort increased from 15 to 20% and landings increased from 8 to 18%. Both effort and landings decreased between years in the Central region, from 19 to 11% and 19 to 09% respectively.

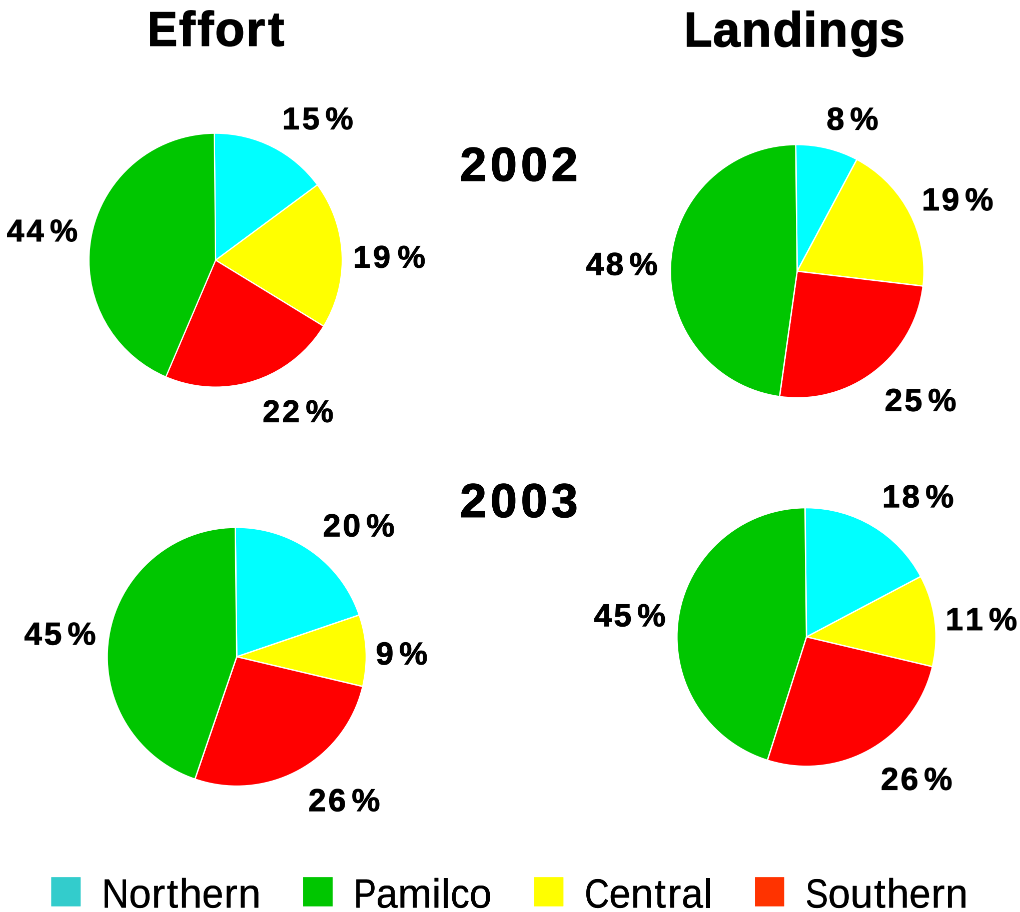


Figure 4. Distribution of Effort and Landings in North Carolina.

Acreages of estuarine waters where RCGL harvesting activities occur are different across the Northern, Pamlico, Central, and Southern regions (Figure 5). The Southern area has just for 3% of the total waters but averaged 25.5% of the RCGL shrimp harvest in 2002-03. The Pamlico area, with 56% of the acreage, had the highest shrimp harvest with an average of 46.5% during 2002-03. The Central Area has 8% of the total acreage and averaged 15% of the landings in 2002-03. The Northern area has the second highest acreage (33%) and the lowest average landings (13%) over 2002-03.

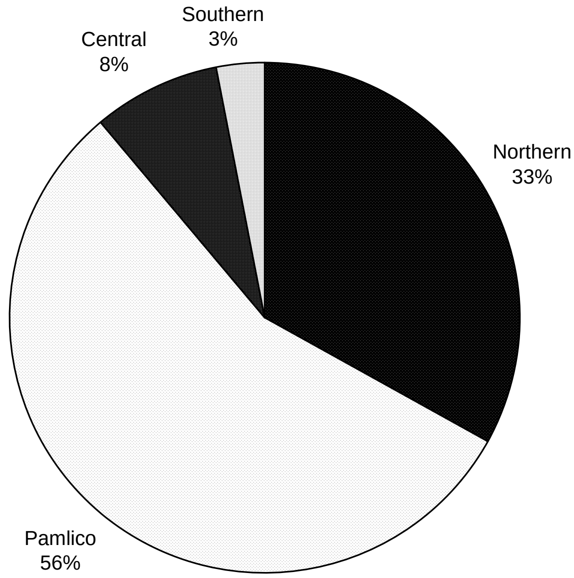


Figure 5. Acreages of coastal waters by region.

The 2001 survey provided statistics that characterize the gear and effort generated by RCGL shrimp trawlers (Table 1). These statistics are based on data collected during 2002 and 2003. These numbers reveal that the typical RCGL shrimper makes 4 trips a year consisting of 13 tows and most likely uses a trawl with a 22 foot headrope.

Based on 2002 survey results, after shrimp, blue crab (15, 417 lbs) and flounder (1,565 lbs) were the primary species caught in RCGL trawls that were kept. The dominant discarded species were blue crab, flounder, spot and croaker.

Table 1. Yearly statistics on trips, tows, and trawl headrope size for RCGL users.

	Minimum	Maximum	Mean	Median	Typical
Number of trips	1	20	4	3	1 to 8
Number of tows	6	25	13	13	10 to 15
Size of headrope (ft)	10	26	22	24	20 to 25

These results presented for the years 2001-03 identify the number of RCGL holders and attempt to quantify the impacts these license holders may be having on shrimp stocks. As mentioned earlier, when the MFC decided to include shrimp trawls as an allowable gear under the RCGL license, it was with reservations by a few commissioners. Now that the license has been in effect for almost 5 years and characterization data is available, it may be prudent to examine this issue again.

IV. Current Authority

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)

3L .0100 – SEASON
3L .0102 – WEEKEND SHRIMPING PROHIBITED
3L .0103 – PROHIBITED NETS AND MESH SIZES
3L .0104 – UNLAWFUL TO USE OR TAKE
3O .0301 – ELIGIBILITY FOR RECREATIONAL COMMERCIAL GEAR LICENSE
3O .0302 – AUTHORIZED GEAR
G.S. 113-173 – RECREATIONAL COMMERCIAL GEAR LICENSE

V. Management Options/Impacts

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

1) Status quo (26' headrope, no catch limits)
   + No further restrictions on the use of shrimp trawls by RCGL license holders, No regulatory action
   - Does not address exploitation concerns

2) Impose limits on the amount of shrimp a RCGL license holder may possess
   + Reduce potential of illegal sales
   + May reduce user conflicts
   + Potential reduction in bycatch/effort
   - May increase waste by encouraging high grading
   - Possible law enforcement issues

3) Prohibit trawls as an allowable gear under RCGL license
   + Reduce user conflicts
   + Reduce bycatch/effort
   + Decrease in amount of bottom disturbing gear
   + Increase demand for commercially caught shrimp
   - No more shrimp for personal consumption, except cast nets & seines
   - Loss of revenue for gear suppliers
   - Potential for increase in illegal shrimping activities

4) Area restrictions under RCGL license
   + Regional conflicts may be addressed
   + High grading not an issue
   + Limit bottom disturbing devices in certain areas
   - May concentrate more RCGL shrimpers in less area

5) Gear Restrictions (headrope size, mesh size)
   + Reduction in bycatch/effort
   + Reduce user conflict (less entanglement)
   + Keeps traditional revenue stream for netmakers
   - Effort may increase to account for decrease in gear size

6) Seasonal / Daily - Weekly Restrictions
   - + Reduce effort/bycatch
   - + Reduce user conflicts
   - + Still allow limited recreational shrimp fishery
   - \- May effect revenue stream of netmakers
   - \- Less choice about when one can shrimp

Recommendations:

AC Recommendation: Status quo and allow use of skimmer trawls as RCGL gear with a total headrope less than 26 feet.

DMF and MFC Recommendation: Status quo with a 48 quart cooler heads on maximum limit on RCGL harvest (two limits if more than license holder is on vessel). Allow use of skimmer trawls as RCGL gear with a total headrope less than 26 feet.

12.9 Appendix 9. SHRIMP MANAGEMENT BY AREA IN NORTH CAROLINA

Historically, the DMF of Marine Fisheries (DMF) has used a number of criteria to determine if trawling should be allowed in estuarine waters. These criteria include habitat issues such as aquatic vegetation, water depth and bottom types; shrimp size and abundance; economic and social factors; user conflicts; and by-catch issues.

DMF has utilized rules and proclamations to manage trawling in internal coastal waters. The intention of these rules and proclamations has been to allow the harvest of shrimp and crabs in estuarine waters but prohibit directed finfish trawling. Openings and closings of specific areas are based primarily on the size of the shrimp.

The closure of nursery areas and the protection of sea grass beds through rules, and proclamations are designed to minimize the bottom-disturbing effects of trawling (see habitat section of FMP). Trawling is limited primarily to the large bodies of waters such as the rivers and sounds. Shoals, wrecks, obstructions, oyster rocks, and algal and bryozoan growth make some of this open water area inaccessible to trawls. There are also areas opened to shrimping that receive very little effort because shrimp abundance is low.

Shellfish management areas (SMAs) are another critical habitat where trawling is prohibited (15A NCAC 03N.0104 and 0105.03J.0103). Although these regulations protect physical damage by trawls to the substrate, bottom-disturbing gear used adjacent to the SMAs impacts oyster reefs indirectly by re-suspending sediment. As sediment disperses away from the disturbance and settles to the bottom, it can bury oyster larvae, adults, or shell, deterring successful recruitment of larvae due to lack of an exposed hard substrate (Coen, et al. 1999). Additionally, excessive sedimentation can also harm shellfish by clogging gills, increasing survival time of pathogenic bacteria, or increasing ingestion of non-food particles (SAMFC 1998).

DMF conducts a regular sampling program to monitor shrimp size and abundance and takes appropriate action based on the samples. Waters eligible to be opened to trawling may also be closed if the size of the shrimp is too small. Closures of this nature are primarily influenced by economics since small shrimp have little value and if there is no market, the resource is wasted. Affected areas include those where shrimp size changes predictably based on annual cycles and environmental conditions as well as those areas where the habitat has changed in response to physical changes such as inlet closures and shoaling. Waters have also been closed in order to reduce or eliminate conflicts with other users and traditional uses such as navigation. These would include closure of crab pot areas and navigation channels where shrimping activity has been problematic.

To reduce finfish bycatch the DMF utilizes Special Secondary Nursery Areas (SSNA). This rule (15A NCAC 03R .0105) makes it unlawful to use trawl nets in these waters, except that the Fisheries Director may, by proclamation, open any portion of this area to shrimp or crab trawling from August 16 through May 14. Management rationale for this rule included minimizing waste by delaying the trawl opening date to reduce the finfish bycatch and to ensure catches of larger shrimp. Historical data (since 1972) collected by DMF indicates these waters support large aggregations of commercially important finfish as well as shellfish and crustaceans.

A criteria that has not been applied to decisions on trawling areas is the suitability of the area for use of alternative gears. The Shrimp Advisory Committee (AC) has discussed this subject on several occasions as it relates to channel nets, skimmers and shrimp traps.

In addition to restricting trawling to suitable habitats, DMF requires bycatch reduction devices (BRDs) to be installed in specific tailbag locations in order to reduce the incidental catch of juvenile finfish. The strategy of DMF has been to protect the sensitive nursery areas and critical habitats while working to reduce bycatch as much as possible (see issue paper on bycatch).

DMF has applied these criteria to determine which areas to allow trawling activity in the past. The following papers will apply these variables to assess the suitability of areas that are currently opened to trawling and whether to make any changes to them.

Shrimp Management in the Southern Area (Inside waters)

DMF has been managing the shrimp harvest since the early 1970's. In 1977, based on sampling conducted over a number of years the DMF designated nursery areas (both primary and secondary) throughout the State that were closed to all bottom disturbing gear, including shrimp trawls. Many of these nursery areas are in the southern part of the State and include those areas that are most biologically sensitive to trawling. Additional areas were closed in the 1980s in reaction to an increase in fishing effort. Time and area closures were the only tools available to deal with the increase in effort. The net result of all these closures is that approximately one-third of the waters in Onslow, Pender, New Hanover and Brunswick counties can be opened to shrimp trawling. However, portions of these waters may remain closed or not be open at all depending on the size of shrimp observed in DMF's samples. While this strategy helps protect these areas, it forces the fishery to operate in a smaller area thus increasing user conflicts.

The areas that can be opened to shrimping are typically located either in or landward of the Intracoastal Waterway (IWW) which runs the entire length of the Onslow, Pender, New Hanover and Brunswick counties coastline. The heads-on counts used to determine whether to open an area vary by area based on historical sampling which indicates at what size shrimp tend to migrate from different water bodies. In Brunswick and portions of New Hanover counties, where shrimp migrate at smaller sizes, DMF attempts to open on a 40-50 count shrimp. In Onslow and parts of Pender counties, sampling has shown that a 20-30 count can be attained before migration occurs. Channels that connect the IWW with the Atlantic Ocean are normally left open at all times to allow some harvest of shrimp as they migrate from closed areas to the ocean. Trawling in these migration routes has become the subject of discussion amongst shrimpers as well as the public because of concerns about bycatch as well as interference with navigation.

Shrimp Management in the Central District

Management of shrimping in the Central District takes place from the White Oak River on the Onslow/Carteret County line to Core Sound in Carteret County. The Central District also manages the south side of the Neuse River in Craven County. Areas that are open and closed to shrimping through proclamation include: the White Oak River, Newport River, West Bay/Long Bay, several Core Sound tributaries as well as Adams Creek, South River and the mouth of Clubfoot Creek, located on the south side of the Neuse River.

As with the Pamlico district area, the DMF issues a proclamation during the first week of June showing shrimp lines for the beginning of the season. This proclamation establishes closures in White Oak River, Newport River, Jarrett Bay and the West Bay-Long Bay and Thorofare Bay areas. This proclamation also designates closures of the Special Secondary Nursery Areas (SSNA) located in Core Sound. Once this proclamation is issued, the DMF begins sampling areas for openings. The DMF conducts nighttime sampling in both the closed portion and the open portion of a waterbody with a small 20-foot otter trawl with ½ inch bar mesh in the body and ¼ inch bar mesh in the tailbag. Tow times are between 5 minutes and 20 minutes. Shrimp are counted and a subset of the sample is measured to determine sizes or counts. Salinities and water temperatures are also recorded. Target counts vary dependent on the waterbody. In most areas a “harvestable size” ranges from 26-30 count to 31-35 count (heads on). In an area like the White Oak River, where shrimp do not grow very large, the count is around 45-55. Based on this sampling, lines may be moved by proclamation to protect small shrimp until they are large enough to harvest.

White Oak River

Recreational shrimpers as well as a few commercial shrimpers use the White Oak River. Shrimp from there supply a market for bait shrimp. Sampling for opening White Oak River generally begins around the end of June. Several stations are checked, usually in early morning hours before sunrise. Cahoon Slough and the Turnstake stations usually have a good representation of what is coming down the river. The DMF typically opens White Oak around the middle portion of July, usually between July 10 and July 20. The river may or may not close due to small white shrimp. Over the past few years, once the river has been open, a closure for small whites has not been needed as the two species seem to segregate within the river very well with small whites staying up the creek above the closure line in the lower salinities while the larger brown shrimp have moved down in the open area. However, when there is good sign of small white shrimp, the river has been closed in September. The line has also been adjusted to allow for shrimping in the lower portion of the river while protecting small whites that have spilled over the normal closure line. Issues that must be considered in the management of this river besides shrimp size are weather conditions and lunar stage. An early northeast wind with a lot of rain or a hurricane can force the small shrimp to run before the normal opening dates. A full moon on top of that may also cause the DMF to open on a smaller count. Occasionally, shrimp will not reach a 45-55 count but will remain at a small size throughout the season. In this case, the DMF will open on a smaller count. Adjusting the line is also difficult due to the amount of oyster rocks in the creek. Shrimpers like to tow on the line, therefore placement of the line over oyster rock can lead to habitat destruction of those rocks.

Bogue Sound

Bogue Sound for the most part has permanent closure lines. The sound is closed to trawling on the north or mainland side of the Intercoastal Waterway (ICW) and in a portion of the western part of the sound. These areas remain closed because of the nature of the bottom. The area along the northern side of the ICW acts as a nursery area and also boarders several primary nursery areas. Seagrass beds with bay scallops are located in the closed portion of the western part of Bogue. There have been requests made to open the western side of the ICW, particularly around Broad Creek. These request usually come from skimmer trawl fishermen who have problems fishing in the waterway. So far, the DMF has not opened this area because it functions as a nursery area for shrimp and other species.

Newport River

Newport River lines that have been used in the recent past are the Hardesty Farm line; the White Rock line and the Turtle Rock line. The Hardesty Farm line is the lowest line in the river and is usually established in June. The White Rock line delineates the special secondary nursery area and the Turtle Rock line delineates the primary nursery area and is the highest line the DMF may use to open the river to trawling. Over the past several years, the White Rock line has not been used. This line is harder to trawl because of the shallowness of the northern portion of the line as well as the proximity of shellfish management areas and private leases. However this line exists for those times when fishermen with smaller boats want to get further up in the shallow water where the larger boats are unable to work. The Hardesty Farm line seems to work very well because of its location in deeper water allowing the larger boats to trawl the whole line instead of just part of the line as with the White Rock line. This line also has fewer impacts to shell bottom. Typically the river will open all the way up to the Turtle Rock line in October with all the other special secondary nursery areas that are located in Core Sound.

North River

North River also has a long and interesting shrimp line history. This river was managed with two lines for years. These were the Long Point line and the Oyster House line. Both lines were established to protect small browns in the early summer (Long Point line) and small whites in the fall (Oyster House line). The point of contention with these lines was when to open up to the Oyster House line. Concerns with opening the area too late include the shrimp running on a northeast wind as well as running on rain and/or full or new moon. In June of 1997 a public meeting was held to discuss permanent lines in North River. It was agreed to move the Wards Creek line downstream to the mouth of the creek and move the Long Point line upstream to the next point north. These lines offered deeper water, more shelter to work in a northeast wind and would provide an adequate buffer for both brown and white shrimp. The location of these lines do allow for small brown shrimp to be caught at the beginning of the season, and we get complaints about this. The old line at Long Point has been used a couple of times since the implementation of the permanent line concept because of pressure to close by fishermen because of the small browns in the area. However once the proclamation was issued, there was pressure from fishermen to honor the new permanent line. Now the DMF continues to keep this line as a closure line unless unusual conditions such as in 2003 where high amounts of rainfall displaced small shrimp into open areas causing the DMF to close all of North River as well as the Straits.

Jarrett Bay

The DMF also manages Jarrett Bay under different strategies. Over the past several years (since 2001) Jarrett Bay is closed to the range markers in early June and is opened to the chimney line in July. This is to protect small shrimp in the bay until they are big enough for harvest. In the past, the DMF has opened Jarrett Bay to the chimney line in June because of pressure from fishermen out of the Marshallberg area. These fishermen say this line is easier to tow and they can keep the shrimp from moving out of the bay. Only half of the range marker line can be towed and there is more algae outside of the bay creating a lot of fouling of nets. Jarrett Bay also has a special secondary nursery area that allows it to be opened to the bridge.

Other Special Secondary Nursery Areas

Prior to August 1, 2004, these SSNAs would be opened to trawling no earlier than October 15th because they were also trawl prohibited areas. A rule change removing these areas from the Trawl Nets Prohibited Rule will allow these areas to be opened between August 16th and May 14th allowing for harvest of pink shrimp in the spring and for the harvesting any remaining shrimp in the late fall.

In the West Bay Area:
West Thorofare Bay
Long Bay - Ditch Bay
Turnagain Bay
Core Sound Area:
Cedar Island Bay
Thorofare Bay-Barry Bay
Nelson Bay
Brett Bay

South Side of Neuse River

South River, Adams Creek and the outer portion of Clubfoot Creek typically stay open unless all of Neuse River is closed. Adams Creek and Clubfoot are popular areas for the recreational shrimper to fish because they are small waterbodies with protection from bad weather. South River typically has very few shrimp but is a popular crab trawl area. The DMF tries not to close these areas because of concerns of grand openings. These result in a large number of small and large boats in a small waterbody. This concentration of effort on opening day increases finfish bycatch and discards, vessel conflict and decreases the amount of shrimp available after the opening.

Shrimp Management in the Pamlico/Hyde County Area

The DMF has been managing the shrimp harvest since the early 1970s. DMF sampling of the tributaries of the major rivers resulted in the designation of nursery areas throughout the state that were subsequently closed in 1977 to the use of all bottom-disturbing gear, including shrimp trawls. These lines have constituted the shrimp closure lines in the Central portion of the state and, for the most part, do not change.

The notable exceptions to this rule of thumb have been Bay River, the mouths of the Hyde County bays, and Adams Creek and Neuse River. In years when shrimp occur in great numbers, they compete for space and food and spill out into the open trawl areas because the closed nursery areas cannot contain them. Also, heavy rainfall and strong northerly winds during the month of June will cause the shrimp to move out of the closed areas seeking higher salinity. The DMF's response to finding the small shrimp in these open trawling areas has been to close them by proclamation (intensively managed areas) in to protect the shrimp until they reach "harvestable size". This harvestable size has been the source of controversy for over twenty years.

Typically, the annual shrimp management process begins when the DMF issues a proclamation during the first week of June that shows the location of shrimp closures lines that the season begins with. As sampling dictates, lines may be moved downstream by proclamation to protect small shrimp until they are large enough to harvest. The DMF uses a small 20 foot otter trawl with 1/2 inch mesh in the body and 1/4 inch mesh in the tailbag. This small trawl is used to determine the size structure of all the shrimp and fish in the waterbody, so that the impacts will be known. The target "harvestable size" is in the neighborhood of 26-30 count or 31-35 count (heads on). When sampling indicates that the majority of the shrimp in a closed area have reached this target size, the area is opened by proclamation.

In the past, the DMF has been reluctant to close larger bodies of water like Neuse and Bay rivers or migration routes like Adams Creek. Occasionally, shrimp will be driven out of the creeks from Oriental to the mouth of the Neuse River, and from the tributaries of Bay River. When shrimp size dictates that these areas, particularly Neuse River, be closed, the closure line itself has been at issue. Closing the entire river has been done as an extreme measure and a line following channel markers running from offshore Oriental to Maw Point has been used with mixed success in the past. Usually, this enables the larger boats to run along that line and catch small shrimp to the exclusion of the smaller boats. Smaller recreational boats are not able to work in more open and unsheltered waters and the harvestable shrimp size desired by some "recreational" fishermen before opening is smaller than the size desired by commercial interests. For example, a 41-45 count shrimp may be more suitable to some and they want to see areas opened when that size is achieved.

"Grand openings" are also a problem with area closures. They result in a massive concentration of all types of boats in a very confined area like Adams Creek or Bay River. This increases finfish bycatch and discard because of the increased effort, increases conflict between vessels, and decreases the amount of shrimp available after the opening as opposed to a gradual migration out of a closed area over time when the shrimp themselves are ready to run. Opening times are sometimes at issue. A Sunday evening opening is convenient for Marine Patrol as far as marking the area. More odd times such as Monday at noon tend to diffuse the number of boats present at once for a "grand opening" as they gradually show up to fish.

An issue with the dynamic nature of the opening and closing of the intensively managed areas is keeping the public informed. Immediately after an area is closed, calls begin to ask when it will open again. Proclamations require 48 hours notice and fishermen need more time than that to plan their activities.

Finally, the areas of the Central District are generally closed to "shrimping and crab trawling". This closes the waterbodies to all gear for catching shrimp, including seines. South River is open to trawling year round since it rarely contains shrimp but does support a crab trawl fishery.

12.10 Appendix 10. SHRIMP MANAGEMENT IN NEW RIVER ABOVE THE HIGHWAY 172 BRIDGE

The waters upstream of the Highway 172 Bridge (Map 1) were designated by rule as a Special Secondary Nursery Area (SSNA) in 1996. The areas of the SSNA that are impacted by the trawling opening include the river above the bridge up to the marked closure line running from Grey's Point to the opposite side of the river. Trawling in any of the tributary creeks is prohibited. The river consists mostly of shallow bays with the exception of the marked navigation channel. Bottom types range from sand and sand/mud to live shell bottom. DMF actively manages eight Shellfish management areas (SMAs) in this portion of New River.

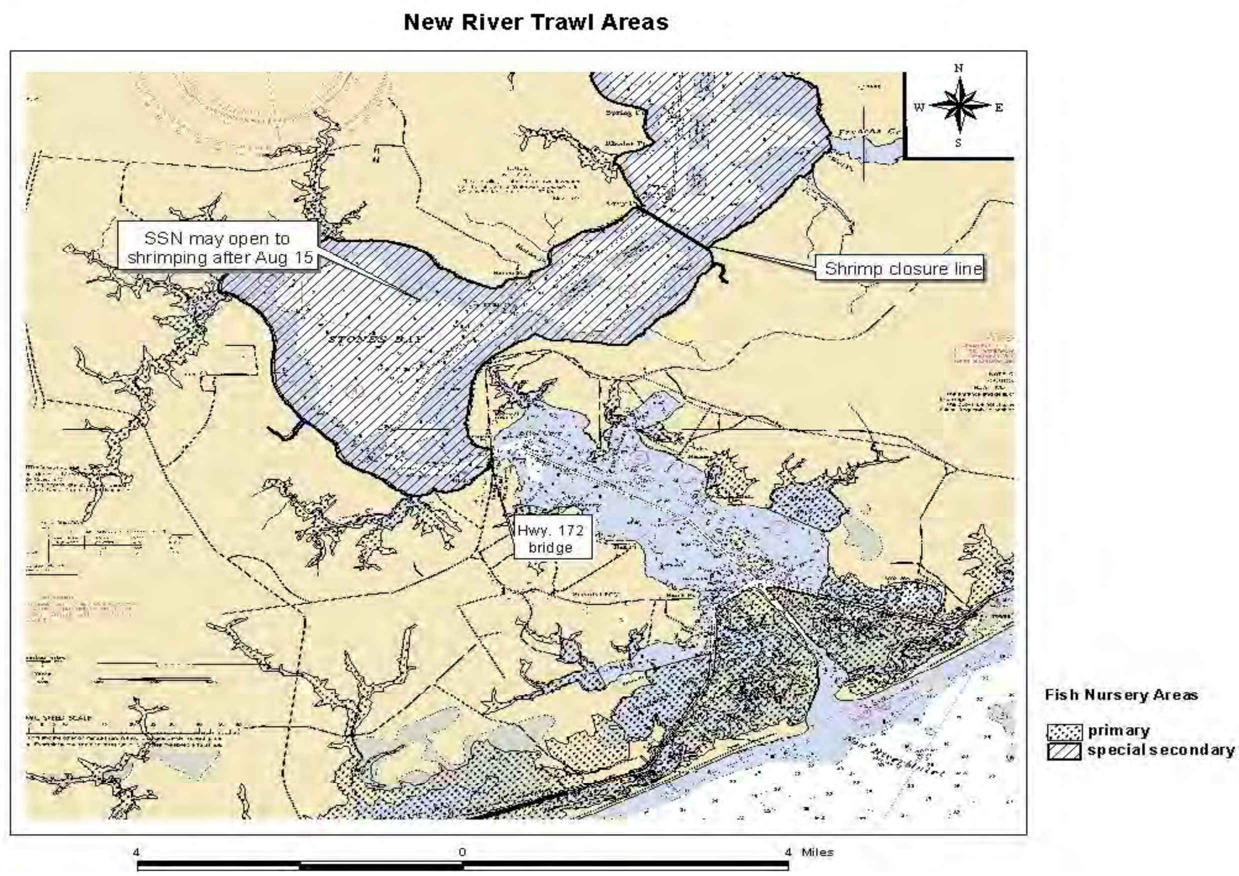
Data from Table 1 were extracted from the DMF Trip Ticket Program and were used to describe the commercial shrimp fishery in New River from 1994-2003. Landed bycatch by gear was calculated and ratios (in pounds) of marketable bycatch relative to shrimp were calculated for the three main gears: channel nets, otter trawls, skimmers and for the various miscellaneous gears (cast nets, gill nets, etc). Marketable bycatch from the skimmers is consistently lower than with the other gears. Marketable bycatch landings in channel nets were also low, with the exception of 2000-2002 when significant amounts of blue crabs were landed in this fishery. During this three-year period, ratios of pounds of shrimp per pound of marketable bycatch in the channel nets were 4, 2, and 3: 1 respectively. Of course, these bycatch ratios apply only to the portion of bycatch retained and sold.

Discarded bycatch is much more difficult to quantify because of the lack of data in most areas. However, during 2003 and 2004, DMF staff sampled the study area for shrimp management purposes utilizing a 25-foot, 4-seam otter trawl. This gear was not equipped with a turtle excluder or a finfish excluder. Catches were separated into four categories: commercial finfish, non-commercial finfish, invertebrates, and shrimp. Each component was weighed and bycatch percentages were derived for each year (Figure. 1). All tows were conducted prior to the shrimp opening and tow times ranged from 2 to 10 minutes. The primary objective of the sampling was to determine if the shrimp were large enough to warrant an opening but the weights of all the biomass components were recorded. Finfish accounted for approximately 50% of the total biomass in each year with shrimp representing 30% of the weight in 2003 and 40% in 2004. Invertebrates constituted 18% of the weights in 2003 and 14% in 2004.

The number of trips by the major gears indicates an increase in effort for channel nets and skimmers and a decrease in trawling effort (Figure. 2). Channel nets are primarily fished in the waters below the Highway 172 Bridge while trawling and skimmer effort is focused more in the SSNA located above the bridge. Channel nets show the most consistency in the mean number of pounds harvested per trip while skimmers and trawls show similar year- to-year fluctuations but skimmers generally harvest more shrimp per trip (Figure. 3). Landings from skimmers have shown a marked increase since 1994 reflecting the increased popularity of this gear, especially in the capture of white shrimp during the late summer and early fall (Figure. 4). However, the variability of catches between all the gears is expected and is a result of the year class strength.

The numbers of participants in the otter trawl fishery and how many trips each participant conducted were analyzed for the 5-year period, 1998-2003 (Figure. 5). Most of the effort was by participants who made only 1 or 2 trips. The number of people making between 3 and 10 trips ranged from 57 in the year 2000 to 16 during 2003. In the 11-20 trips category, 1999 had the highest number of participants (14) while 2001 and 2003 both had only 3 participants. The trip ticket data indicates that, except for 2002, over 50% of the participants in a given year made only one or two trips in the otter trawl fishery between 1994 and 2003.

The increasing use of skimmers in the New River SSNA has positive implications for the resource in terms of minimizing waste/bycatch and disturbance to the bottom. Additionally, the trip ticket harvest data indicate this gear is more effective catching the target species than conventional otter trawls. A skimmer trawl study conducted by Sea Grant found skimmers much more effective on white shrimp than otter trawls in water less than 12 feet (most all of the water above the bridge in New River) and in some cases outfished otter trawls as much as 5-to-1. Unlike otter trawls, the tail bag in skimmers is emptied while fishing is still underway. Consequently, the bag is emptied much more frequently, leading to significant increases in survivability of most all finfish species (Coale, et al. 1994). The majority of shrimp openings in the New River SSNA are for white shrimp since by late summer most of the brown shrimp have already emigrated.



Map 1. New River.

Table 1. Catch and effort data on shrimp and landed bycatch, by gear type, New River, 1994-2003 (courtesy of DMF trip ticket program).

Channel Net	Participants	Trips	Shrimp/lbs	Sold bycatch-lbs	Mean catch/trip lbs	Ratio of Shrimp to sold bycatch
2003	36	819	100667	1685	123	60
2002	41	1244	163831	61907	132	3
2001	45	1084	137595	79793	127	2
2000	51	1366	163109	38998	119	4
1999	69	1410	124727	4444	88	28
1998	42	828	80714	428	97	189
1997	58	1111	86610	3065	78	28
1996	68	574	62590	1894	109	33
1995	70	839	87536	1435	104	61
1994	74	529	47556	747	90	64

Otter trawls	Participants	Trips	Shrimp	Sold bycatch-lbs	Mean catch/trip lbs	Ratio of Shrimp to sold bycatch
2003	67	243	39264	5612	162	7.0
2002	77	436	91652	4710	210	19.5
2001	71	184	14926	4389	81	3.4
2000	160	600	163640	7479	273	21.9
1999	176	743	77956	4537	105	17.2
1998	128	546	109034	4875	200	22.4
1997	130	798	79788	3721	100	21.4
1996	146	497	42113	3941	85	10.7
1995	232	1161	152285	17559	131	8.7
1994	183	793	53787	7115	68	7.6

Skimmer	Participants	Trips	Shrimp	Sold bycatch-lbs	Mean catch/trip lbs	Ratio of Shrimp to sold bycatch
2003	57	550	89780	1356	163	66
2002	52	815	173091	1701	212	102
2001	46	305	36043	1879	118	19
2000	78	601	155949	2508	259	62
1999	71	439	68813	222	157	310
1998	51	285	69396	13	243	5338
1997	45	332	75029	188	226	400
1996	38	210	42677	267	203	160
1995	26	81	21554	0	266	0
1994	5	12	1468	7	122	226

Other	Participants	Trips	Shrimp	Sold bycatch-lbs	Mean catch/trip lbs	Ratio of Shrimp to sold bycatch
2003	5	16	670	27	42	25
2002	5	5	209	184	42	1
2001	7	9	519	819	58	1
2000	12	18	1041	827	58	1
1999	5	10	387	553	39	1
1998	3	6	130	442	22	0
1997	15	51	2934	4394	58	1
1996	14	20	884	1528	44	1
1995	30	160	12837	11043	80	1
1994	2	2	267	426	133	1

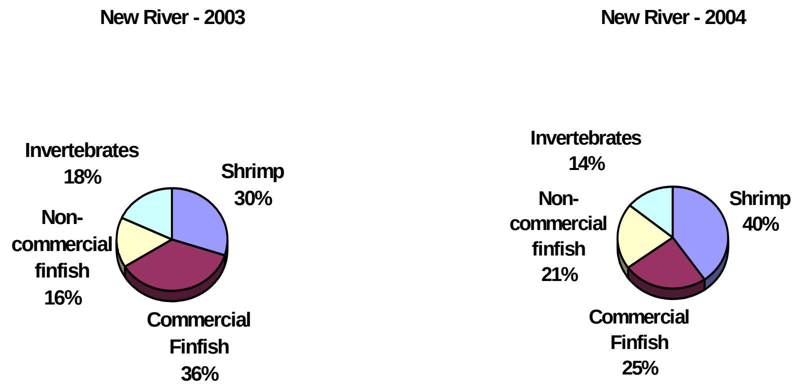


Figure 1. Percent weight in pounds of trawl biomass in New River 2003-2004.

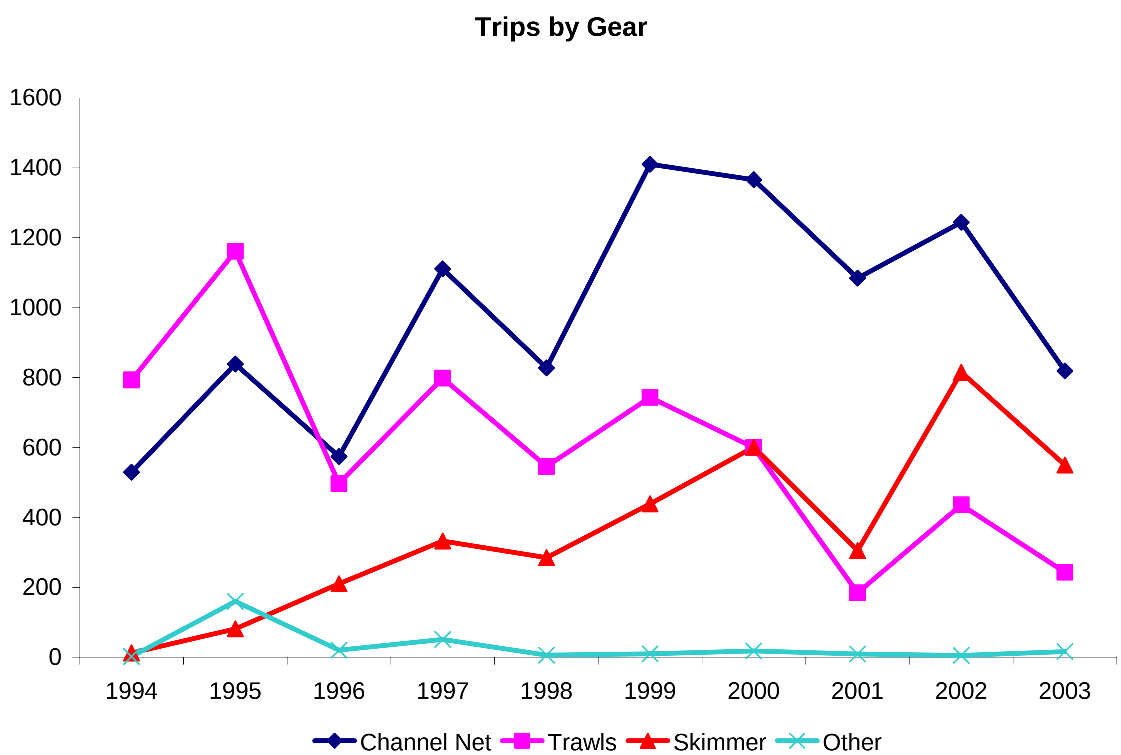


Figure 2. Trips by gear in New River, 1994-2003.

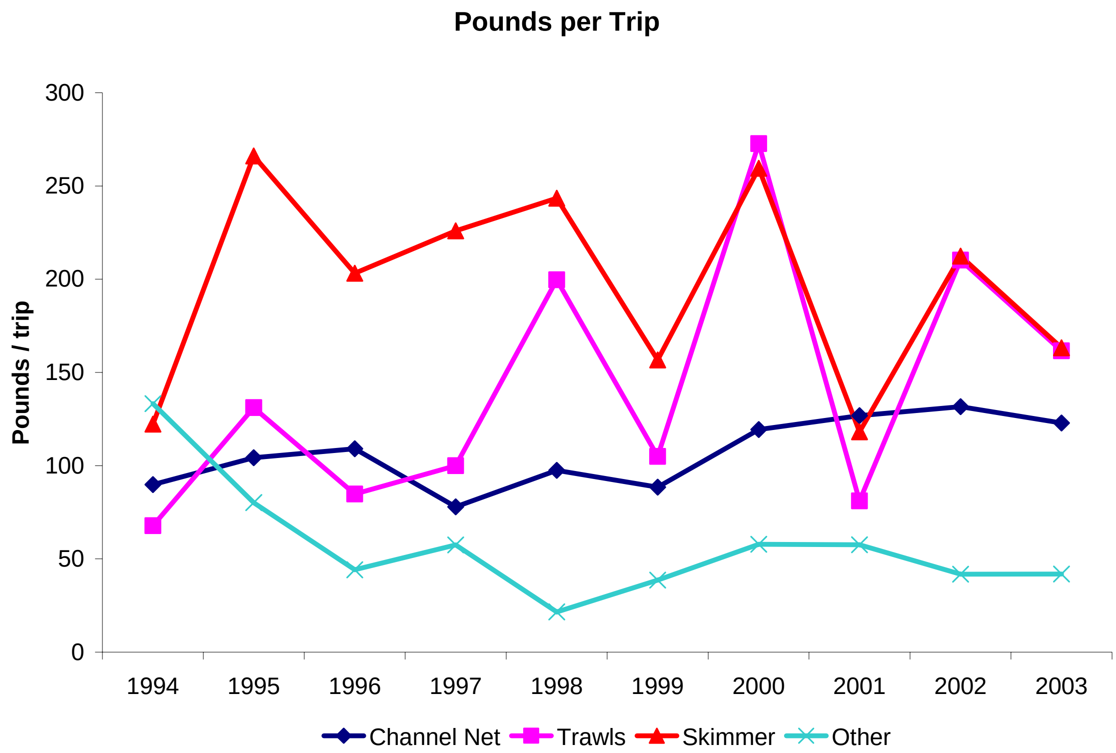


Figure 3. Mean catch in pounds per trip by gear, 1994-2003.

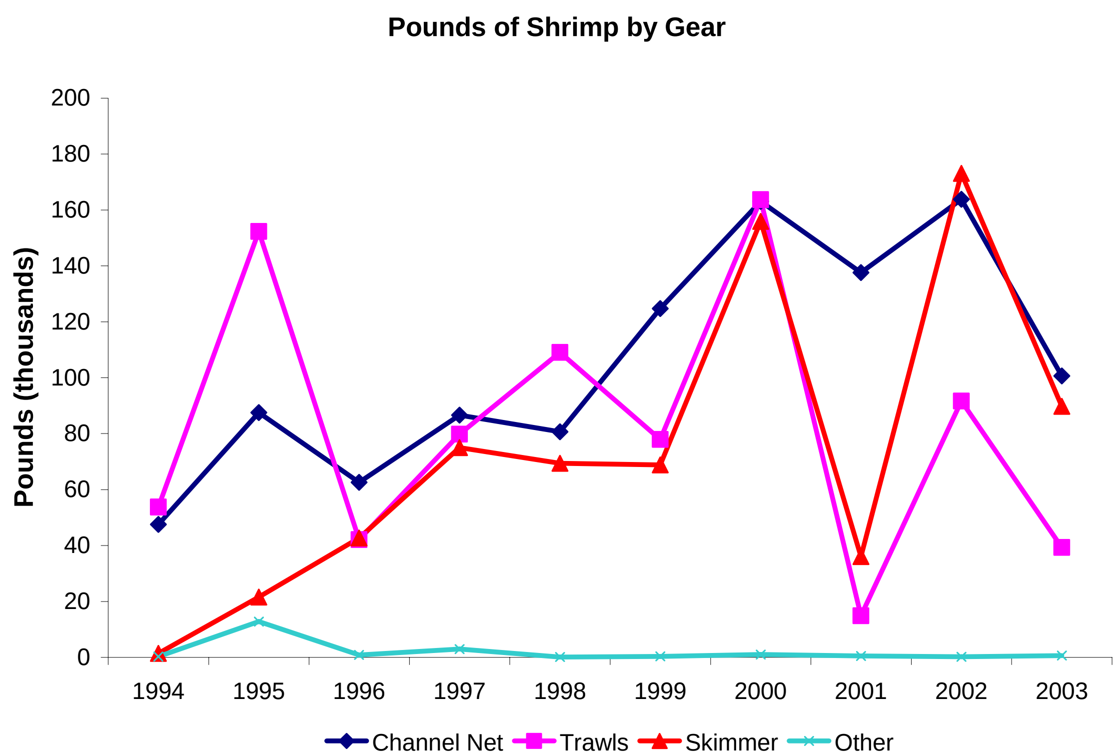


Figure 4. Total catch in pounds by gear, New River, 1994-2003.

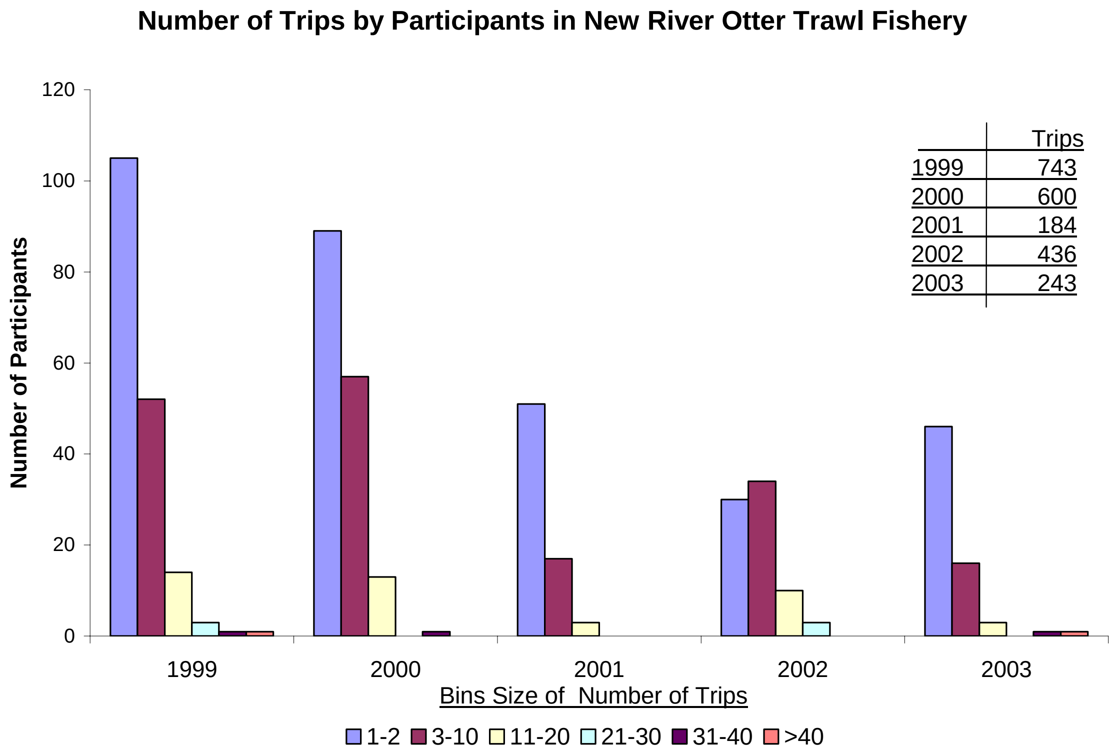


Figure 5. Number of trips by participants, by year in New River otter trawl fishery.

Management Options/Impacts

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

1. Status quo (potential opening dates set by rule and determined by sampling)
   + No need for further rulemaking on the use of shrimp trawls in the SSNA
   - Does not address perceived excessive finfish mortalities
   - Does not encourage use of more environmentally friendly gear
   - No remedy for indirect shellfish impacts

2. Prohibit otter trawls (not skimmers) as an allowable gear in New River SSNA
   + Benefit to existing Shellfish management areas
   + Encourage the use of a more efficient gear for harvesting white shrimp
   + Reduction in waste/fish kills especially on opening day
   - Eliminates part of a traditional Sneads Ferry fishery in this SSNA
   - Difficult to catch shrimp in a few deep-water spots
   - Financial hardship on trawlers who would likely convert to skimmers

3. Establish timeline when otter trawls would be prohibited
   + More time for fishermen to adopt to change
   + Possible decreased financial hardship
   - No immediate remedy for waste/fish kills on opening day
   - No immediate benefits to SMAs

4. Prohibit all trawlers and skimmers in New River SSNA
   + Bycatch issue completely eliminated
   + Potential for healthier shellfish/finfish stocks
   - Eliminates potential lucrative opening days for fishermen
   - Some loss of traditional shrimp harvest in New River
   - Eliminates traditional Sneads Ferry fishery in this SSNA

5. Net size restrictions in New River SSNA
   + Still allows prosecution of traditional fishery in SSNA
   + May cut down on waste/fish kills especially on opening day
   + Fishermen more able to harvest brown shrimp and white shrimp that move to deeper water within the SSNA
   - Still have indirect impacts on shellfish
   - Increases in effort/tow times might offset bycatch savings

6. Status Quo but with reduction in days of week trawling allowed (Tues,Thur)
   + Allows traditional fishing
   + Reduction in waste/fish kills
   + Longer season, more sustainable prices
   + No time necessary to adopt to gear change
   - Indirect impact on SMAs
   - Still have waste/fish kill issues

Recommendations

AC Recommendation: Status quo

DMF Recommendation: Prohibit otter trawls after a two year phase in period to allow those who wish to convert to skimmers to do so. Also recommend that the MFC pursue changes to allow skimmers less than 26 feet as a RCGL gear.

MFC Recommendation: Prohibit otter trawls after a four year phase in period to allow those who wish to convert to skimmers to do so.

Literature Cited

Coale, J.S., R. A. Rulifson, J. D. Murray, and R. Hines. Comparisons of shrimp catch and bycatch between a skimmer trawl and an otter trawl in the North Carolina inshore shrimp fishery. North American Journal of Fisheries Management 14: 751-768.

12.11 Appendix 11. SHRIMP MANAGEMENT IN CHADWICK BAY

Chadwick Bay (see Map 1) is a small high salinity waterbody encompassing 841 acres located just south of the mouth of New River and adjacent to the IWW and the New River Inlet. The southern portion of the bay is classified as a Primary Nursery Area (PNA) characterized by shallow water depth (< 5 feet) and a sandy mud substrate with patches of submerged aquatic vegetation (SAV). Fullard Creek is the major tributary of Chadwick Bay and minor tributaries include Charles Creek and Bumps Creek. The upper portion of Fullard and all of Charles Creek and Bumps Creek are designated by DMF as PNAs. Although the lower portion of Fullard Creek is not currently classified as a nursery area, it is not opened to shrimping because of the abundance of juvenile finfish. The remainder of Chadwick Bay is opened by proclamation to shrimping when the shrimp reach a harvestable size (30-40 heads-on count). The area that may open to shrimping is approximately 132 acres or 16% of the waterbody. The bottoms in the open shrimping area lacks SAV and are sandier, a little deeper than the PNAs, but still supports large numbers of juvenile and sub-adult finfish.

DMF has utilized two different strategies in managing Chadwick Bay. In some years when brown shrimp are abundant and large, the bay is opened in July along with the White Oak River, Queen's Creek and Bear Creek. In other years when brown shrimp are less abundant, a Chadwick Bay shrimp opening on white shrimp may occur in August or September in conjunction with the openings in New River and/or Stump Sound.

The Chadwick Bay shrimp fishery is primarily conducted with trawls, although, in recent years, the use of skimmers has increased in the commercial portion of the fishery. The bay is frequently shrimped by Recreational Commercial Gear License holders, especially on opening days.

Other fisheries prosecuted in Chadwick bay include clamming, gill netting, crabbing and oystering. Oysters and clams are harvested from public and leased areas in the tributaries and the bay adjacent to the shrimping area. There is also a small bay scallop fishery in years when they are plentiful. It is impossible to quantify the seafood landings that are harvested in Chadwick Bay since it is not listed on DMF trip tickets.

The amount of bycatch discarded from trawling operations in Chadwick Bay is difficult to quantify due to a lack of dependent data from this area. However, during the summers of 2003 and 2004, DMF staff sampled Chadwick Bay on four different occasions for shrimp management purposes utilizing a 25-foot, 4-seam otter trawl, or a 20-foot flat otter trawl. These gears were not equipped with turtle excluders or finfish excluders. All tows were conducted prior to the shrimp opening and tow times ranged from 2 to 5 minutes. These catches were separated into four categories: commercial finfish, non-commercial finfish, invertebrates, and shrimp. The weights (in pounds) of each component were summed and bycatch percentages were calculated as a percent of the total catch from all four trips (Figure 1). Finfish accounted for approximately 50% of the total biomass in each year with shrimp representing 30% of the weight in 2003 and 40% in 2004. Invertebrates constituted 18% of the weights in 2003 and 14% in 2004.

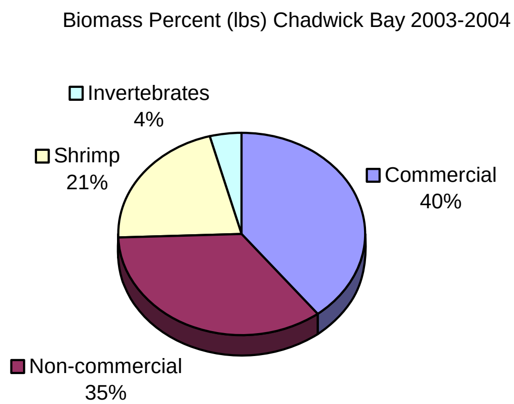


Figure 1. Percent weight in pounds of trawl biomass in Chadwick Bay, 2003-2004.

Samples were also collected by DMF staff in Chadwick Bay during May and June of 1999-2001 using a 10 ft trawl with a ¼ inch body and a 1/8 inch tailbag. Tow times using this gear were 1 minute in duration. Samples were taken in lower Fullard Creek (Map 1, hatched area) which is not classified PNA, nor included within the boundaries of the open shrimping area. On the same day, for comparison purposes, samples were also collected in the upper reaches of Fullard Creek, which is classified as a PNA. Catch per unit effort (CPUE) for the commercial species (spot, southern flounder, Atlantic menhaden, Atlantic croaker, weakfish, silver perch, pigfish, brown, white and pink shrimp) captured at the PNA station are compared with CPUEs from the non-nursery area (Table 1). Catches of these species are similar and indicate that the non-nursery area should be classified as PNA. Furthermore, the commercial finfish that were present in the sampling of the open shrimp area are probably the same fish, shrimp and invertebrates that were captured in the spring PNA sampling. Although, DMF has classified most of these species as healthy, there is the potential for substantial fish mortalities during commercial shrimping operations in Chadwick Bay.

Management Options/Impacts

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

1) Status quo (potential opening dates set by rule and determined by sampling)
+ No need for further rulemaking on the use of shrimp trawls in the SSNA
- Does not address perceived excessive finfish mortalities
- Does not encourage use of more environmentally friendly gear
- No remedy for indirect shellfish impacts

2) Prohibit otter trawls (not skimmers) as an allowable gear in Chadwick Bay
+ Benefit to Shellfish
+ Encourage the use of a more efficient gear for harvesting shrimp
+ Reduction in waste/fish kills especially on opening day
- Eliminates a traditional Chadwick Bay fishery
- Financial hardship on trawlers who would likely convert to skimmers

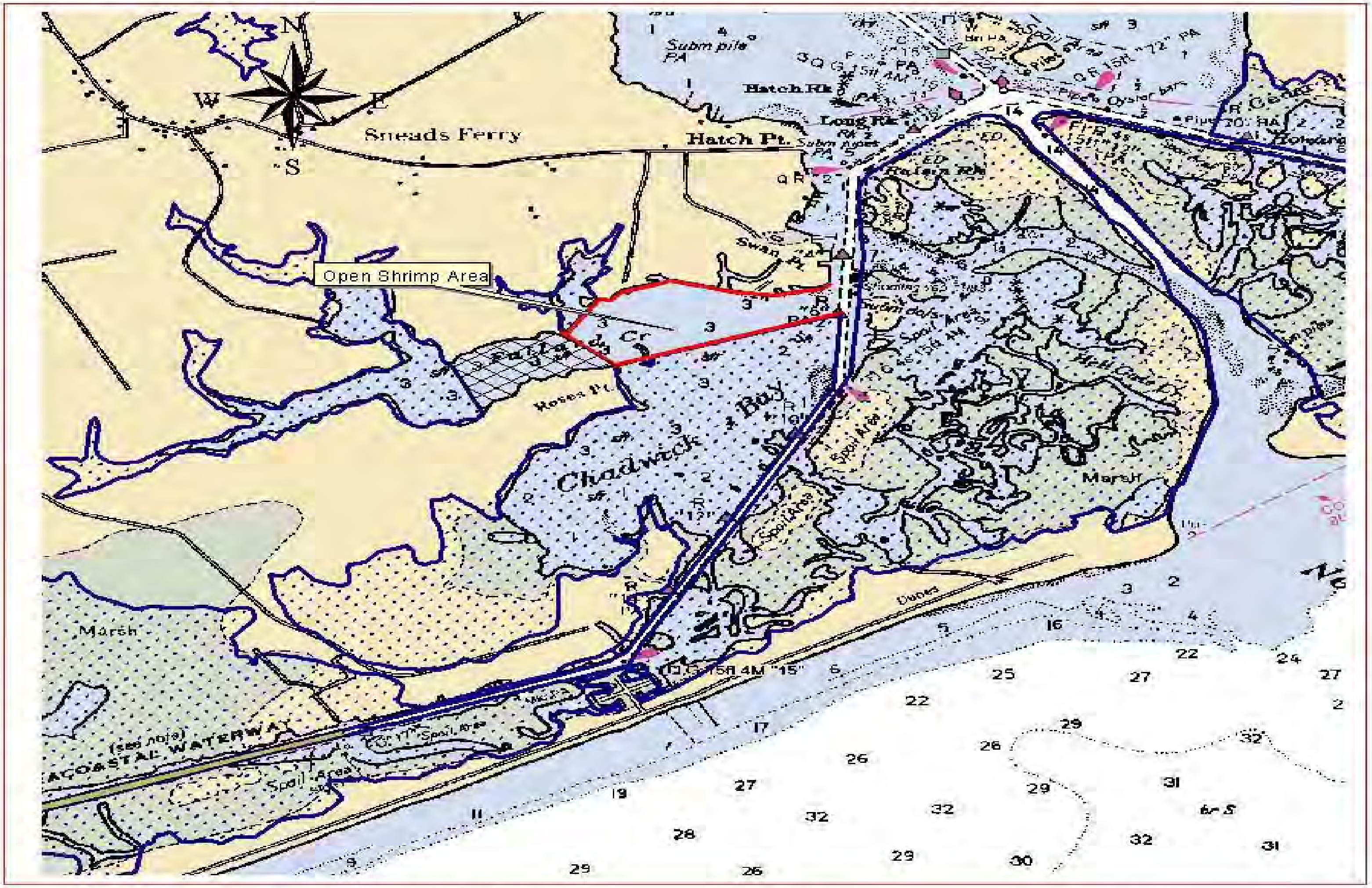
3) Establish timeline when otter trawls would be prohibited
+ More time for fishermen to adopt to change
+ Possible decreased financial hardship
- No immediate remedy for waste/fish kills on opening day
- No immediate benefits to shellfish

4) Prohibit all trawlers and skimmers in Chadwick Bay
+ Bycatch issue completely eliminated
+ Potential for healthier shellfish/finfish stocks
- Eliminates potential lucrative opening days for fishermen
- Some loss of traditional shrimp harvest in Chadwick Bay
- Eliminates traditional Sneads Ferry fishery
- Increase pressure on adjacent areas open to trawling

5) Net size restrictions in Chadwick Bay
+ Still allows prosecution of traditional fishery
+ May cut down on waste/fish kills especially on opening day
- Still have indirect impacts on shellfish
- Increases in effort/tow times might offset bycatch savings

6) Status Quo but with reduction in days of week trawling allowed (Tues,Thur)
+ Allows traditional fishing
+ Reduction in waste/fish kills
+ Longer season, more sustainable prices
+ No time necessary to adopt to gear change
- Still have indirect impact on SMAs
- Still have waste/fish kill issues

AC, DMF, and MFC Recommendation: Status quo and initiate sampling to investigate if Chadwick Bay functions as a Special Secondary Nursery Area.



Map 1. Chadwick Bay

Table 1. Catch per unit effort for Chadwick Bay, PNA and Non-PNA stations, May-June 1999-2001.

	Chadwick Bay PNA	Chadwick Bay Non-PNA
Spot	159.7	193.5
Croaker	16.0	3.5
Southern flounder	3.2	0.7
Weakfish	0.2	0.0
Summer flounder	0.2	0.0
Silver Perch	0.0	0.5
Pigfish	0.0	5.0
Brown shrimp	76.3	40.3
White shrimp	0.3	0.0
Pink shrimp	0.0	1.2
Blue crab	5.2	1.0
Pinfish	141.8	188.8
Bay anchovy	31.0	23.2
Bay whiff	3.0	0.0
Blackcheek tonguefish	0.0	0.7
Inshore lizardfish	0.5	0.2
False blue crab	0.2	0.2
Spotfin mojarra	3.8	0.7
Green goby	0.8	0.0
Naked goby	0.0	0.3
Squid	0.2	0.0

12.12 Appendix 12. SHRIMP MANAGEMENT IN THE INTRACOASTAL WATERWAY AND SOUNDS FROM NEW RIVER TO RICH'S INLET

The estuarine waters of the IWW channel and the adjacent sounds and bays between New River Inlet and Rich's Inlet are managed as a single waterbody by the DMF. A section of this waterbody bounded by Marker #17 to the North and the Surf City Swing Bridge to the south is designated as SSNA. SSNA status (15A NCAC 03R.0105) makes it unlawful to use trawl nets in these waters except that the Fisheries Director may, by proclamation, open any portion of this area to shrimp or crab trawling from August 16 through May 14. Management rationale for this rule included minimizing bycatch by delaying the trawl opening date to reduce the finfish bycatch and to reduce user conflicts. Historical data (since 1972) collected by DMF indicates these waters support large aggregations of commercially important finfish as well as shellfish and crustaceans.

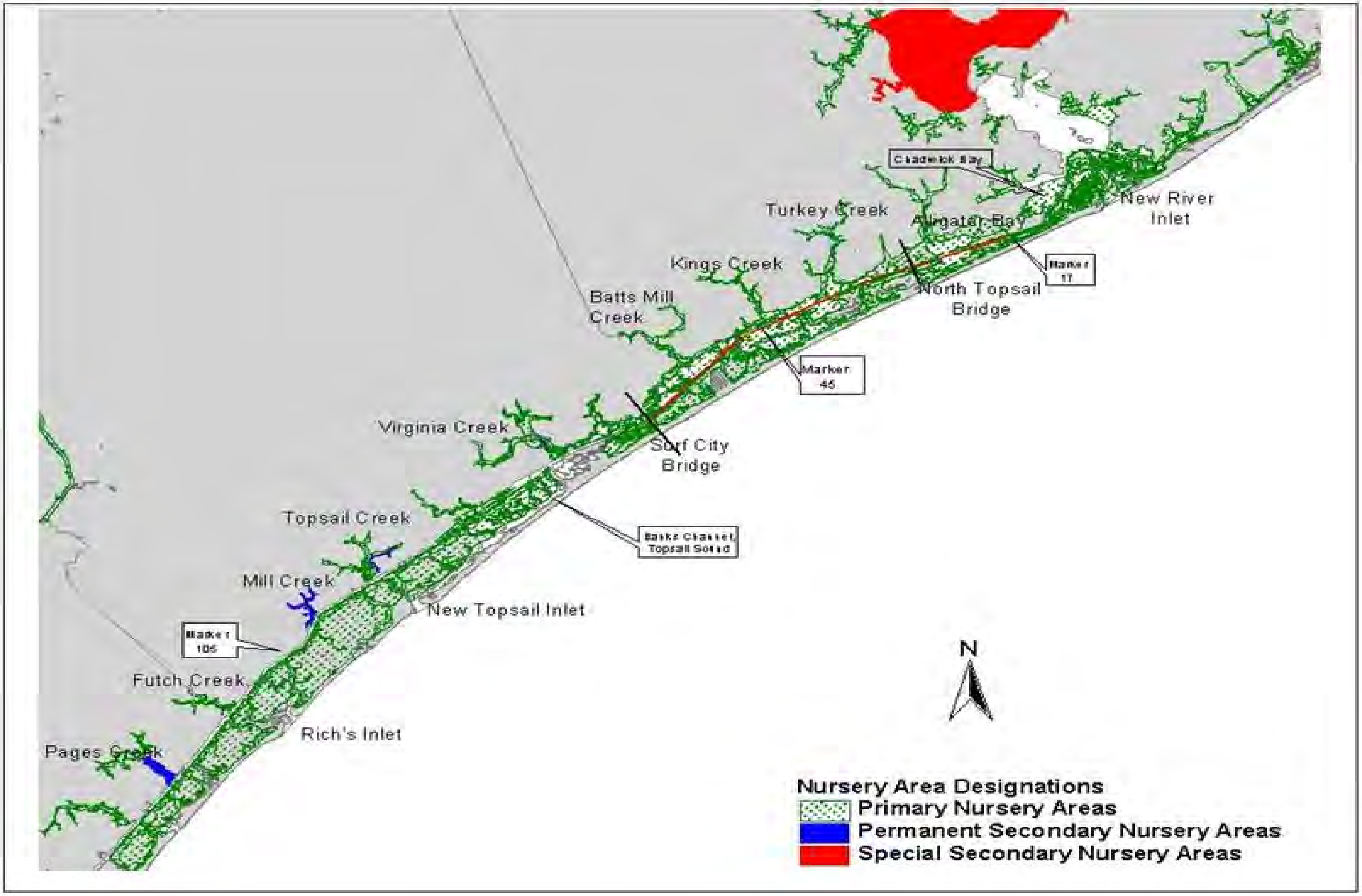
Bottom types range from mud and muddy/sand in the IWW to mostly sand near the inlets. The shallow waters of Topsail Sound and some of the estuarine areas around New River Inlet contain patches of SAV.

There are active clam and oyster fisheries in the entire area. Hand harvest for oysters and clams take place in the shallow areas throughout these waters on both public bottom and leased areas, while mechanical harvest of clams is allowed in the IWW from New River to south of the Surf City Bridge ("BC" Marker). DMF maintains Shellfish Management Areas throughout the area, all of which are located in waters closed to shrimping with mobile gears. DMF and the Coastal Federation have collaborated to begin construction of oyster sanctuaries in Stump Sound.

The typical management cycle for these waters is; the IWW north of Marker #17, the IWW south of the Surf City Swing Bridge and Banks Channel in Topsail Sound remain open during the entire year unless unusually high rainfall amounts or overcrowded nursery areas force large numbers of small shrimp into them prematurely. Waters in the SSNA, with the exception of the middle portion of the SSNA are typically opened sometime after August 15. The middle portion of the SSNA from Marker #45 to the Highway 210-50 Highrise Bridge usually remains closed until late in the season because of the abundance of small shrimp.

The fishing is dominated by small boats that trawl, float net, and skim in the main channel of the IWW and in a 100- foot strip on the side of the IWW that is open from Marker #49 to Marker #105. Channel nets are set outside of the marked channel from Marker #15 at New River to just south of the Surf City Bridge and in Topsail Sound. Banks Channel serves as a migration route for emigrating shrimp and gears used there includes trawls, skimmers and most recently shrimp traps. The use of shrimp traps in Topsail Sound has been discussed in a previous issue paper.

Data from the DMF Trip Ticket Program (Figure. 1) are used to compare the commercial shrimp fishery in Topsail/Stump Sound relative to other waterbodies in the state during the 10-year period, 1994-2003. The waterbodies were ranked according to their contribution in total pounds of shrimp landed. The Topsail/Stump Sound area is ranked seventh, contributing 1,015,148 lbs of shrimp during 1994-2003.



Map 1. New River Inlet to Rich's Inlet.

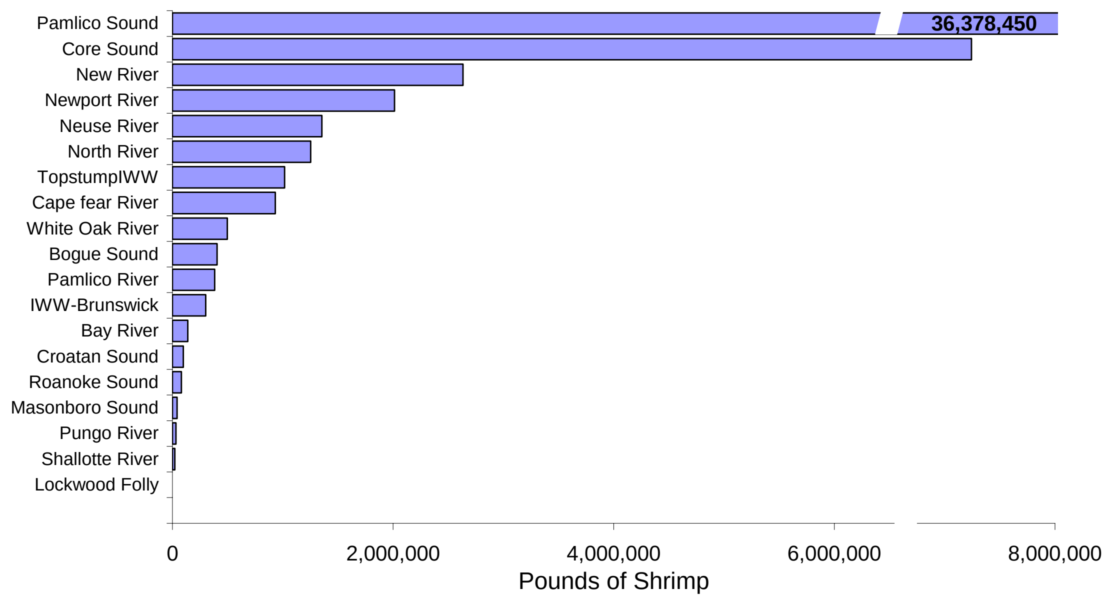


Figure 1. Total pounds of shrimp harvested by all gears in major North Carolina waterbodies between 1994-2003 (courtesy NC Trip Ticket Program).

In most years, otter trawls harvest the largest amount of shrimp in the Topsail/Stump Sound waterbody (Figure 2). However, in 1999 and 2003, channel net landings exceeded trawl landings. Skimmer landings have increased since 1997 and were greater than trawl landings in 2002.

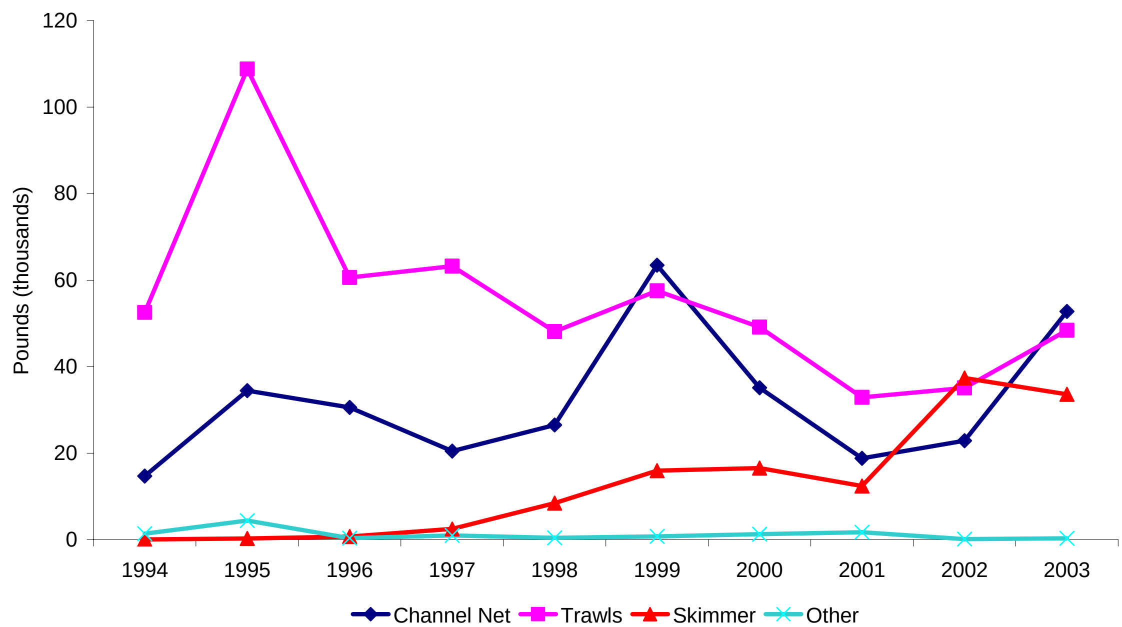


Figure 2. Total catch in pounds, by gear, Topsail / Stump Sound, 1994 –2003.

Trip ticket program data were examined for trends in the different fisheries on an annual basis (Table 1). Landed bycatch by gear was calculated and ratios (in pounds) of shrimp to marketable bycatch were calculated for: channel nets, otter trawls, skimmers and for the various miscellaneous gears (cast nets, gill nets, etc.). Ratios are stated in pounds of shrimp to one pound of marketable bycatch.

Ratios in the otter trawls fluctuate the least on a year to year basis, ranging from 30.4 lbs of shrimp to each pound of sold bycatch in 1999 (30.4**:** 1) to 72.6**:** 1 in 2001. Landed bycatch in skimmers is small and ranges from zero pounds landed in 7 out of the 10 years to 77 lbs landed in 2001. Thus, in skimmers, the ratio of shrimp to a pound of landed bycatch is very high. Bycatch ratios in channel nets fluctuated, ranging from 6.0**:** 1 in 1999 to 1,453.3**:** 1 in 2003.

The number of trips by the major gears (Table 1, Figure 3) indicates that otter trawls are the dominant gear used in this waterbody followed by channel nets and skimmers. Effort in the skimmer fishery has been increasing, especially in 2002 and 2003, where for the first time, in 2002, there were more skimmer trips than channel net trips.

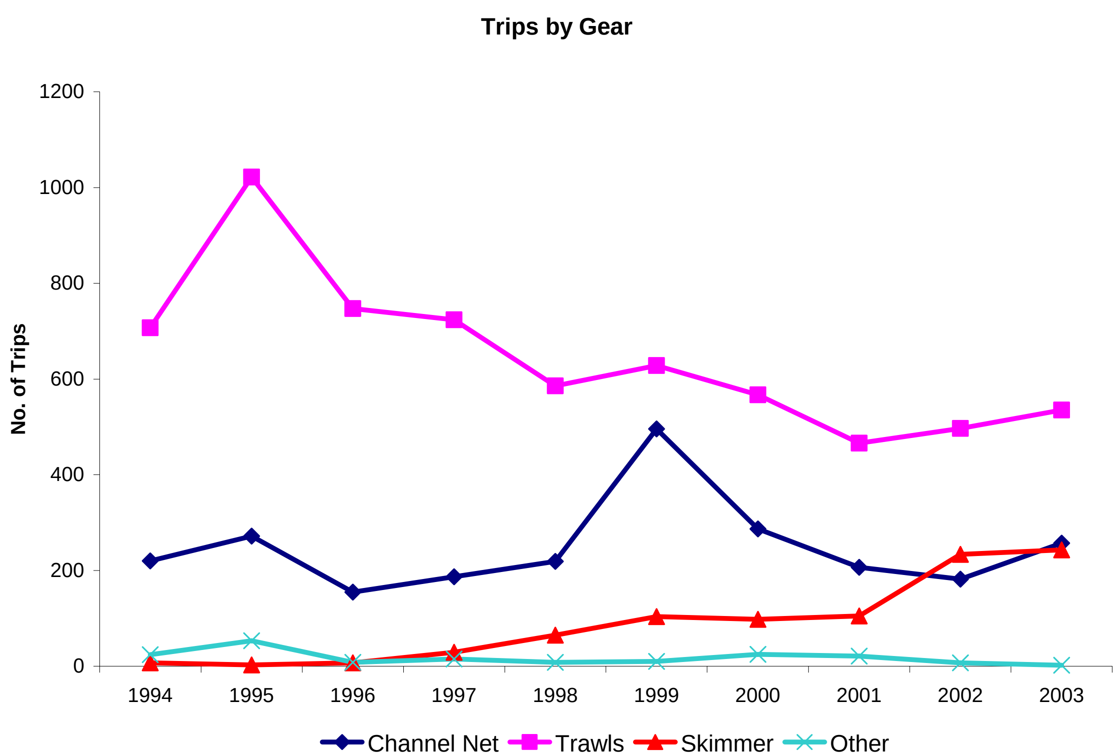


Figure 3. Trips by gear, Topsail/Stump Sound, 1994-2003.

Table 1. Catch and effort data on shrimp and landed bycatch, by gear type, Topsail/Stump Sound, 1994-2003.

Gear	Year	Participants	Trips	Shrimp/lbs	Sold bycatch/lbs	Mean catch/trip	Ratio of shrimp to sold bycatch
Cannel Net	1994	30	220	14,676	80	66.7	183.5
	1995	48	272	34,430	1,214	126.6	28.4
	1996	40	155	30,543	93	197.1	328.4
	1997	36	187	20,457	683	109.4	30.0
	1998	28	219	26,487	1011	120.9	26.2
	1999	57	496	63,459	10,608	127.9	6.0
	2000	28	287	35,113	669	122.3	52.5
	2001	37	207	18,793	324	90.8	58.0
	2002	17	182	22,875	70	125.7	326.8
	2003	22	257	52,754	36	205.3	1,465.4
OtterTrawls	1994	372	707	52,520	1,303	74.3	40.3
	1995	483	1,022	108,833	1,647	106.5	66.1
	1996	263	747	60,601	888	81.1	68.2
	1997	260	724	63,238	994	87.3	63.6
	1998	230	586	48,100	922	82.1	52.2
	1999	235	628	57,524	793	91.6	72.5
	2000	287	567	49,113	1,357	86.6	36.2
	2001	176	466	32,873	700	70.5	47.0
	2002	174	497	35,070	1154	70.6	30.4
	2003	240	535	48,366	1,229	90.4	39.4
Skimmer	1994	<3	<3	*	*	*	*
	1995	<3	<3	*	*	*	*
	1996	5	7	721	0	103.0	721.0
	1997	10	29	2,480	0	85.5	2,479.5
	1998	14	65	8,440	1	129.9	8,440.4
	1999	26	104	15,957	8	153.4	1,994.6
	2000	22	98	16,534	0	168.7	16,533.8
	2001	22	105	12,404	77	118.1	161.1
	2002	24	234	37,369	0	159.7	37,369.0
	2003	24	243	33,615	0	138.3	33,615.0
Other	1994	12	30	1,375	666	45.8	2.1
	1995	22	53	4,373	515	82.5	8.5
	1996	4	8	320	35	40.0	9.1
	1997	9	15	965	246	64.3	3.9
	1998	5	8	406	5	50.7	81.1
	1999	8	10	737	18	73.7	40.9
	2000	8	25	1,256	318	50.2	3.9
	2001	9	21	1,701	391	81.0	4.3
	2002	3	7	115	0	16.4	115.0
	2003	<3	<3	*	*	*	*

Otter trawls fluctuated the least in the mean number of pounds harvested per trip (Table 1, Figure 4) and skimmers averaged more pounds per trip than trawls in every year since 1997. Catches per trip in channel nets fluctuated, ranging from 67 lbs in 1997 to 205 lbs in 2003. From 1995-1997 and again in 2003, channel nets had the highest landings per trip of the major gears.

Catches from other gear includes butterfly nets, cast nets and sink gill nets. Although the mean shrimp catch for "other" gear was high in 2003, this number was based on just a few trips. The number of trips from "other" gear was less than or equal to 30 for every year but 1995 when there were 53 trips.

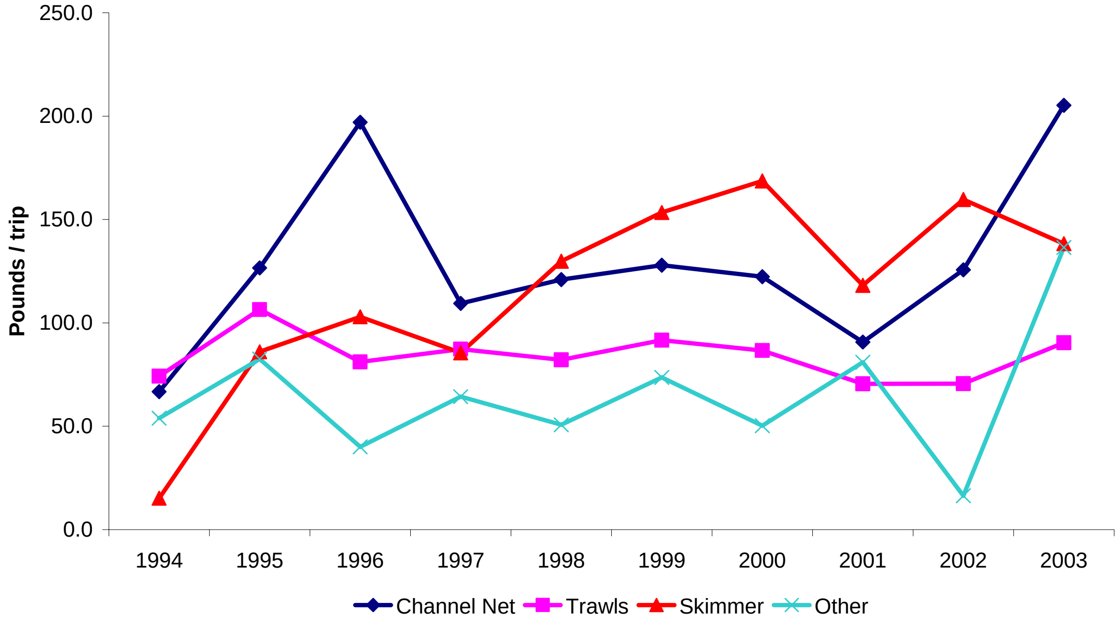


Figure 4. Mean catch in pounds per trip by gear, Topsail/Stump Sound, 1994-2003.

Discarded bycatch is much more difficult to quantify because of the lack of data from specific waterbodies. However, during 2003 and 2004, DMF staff sampled the study area for shrimp management purposes utilizing a 25-foot, 4-seam otter trawl or a 20-foot 2-seam flat trawl. Both trawls had a ¾ inch mesh body (bar) and a ¼ inch mesh tailbag. DMF trawls do not contain turtle or fish excluding devices. Catches were separated into four categories: commercial finfish, non-commercial finfish, invertebrates, and shrimp. Each component was weighed and bycatch percentages were derived for all the catches combined (N=16) for both years (Figure 5). All tows were conducted prior to the shrimp opening and tow times ranged from 2 to 10 minutes. By weight, commercial finfish accounted for 24% of the total biomass, non-commercial, 12%, shrimp 59% and invertebrates 5%.

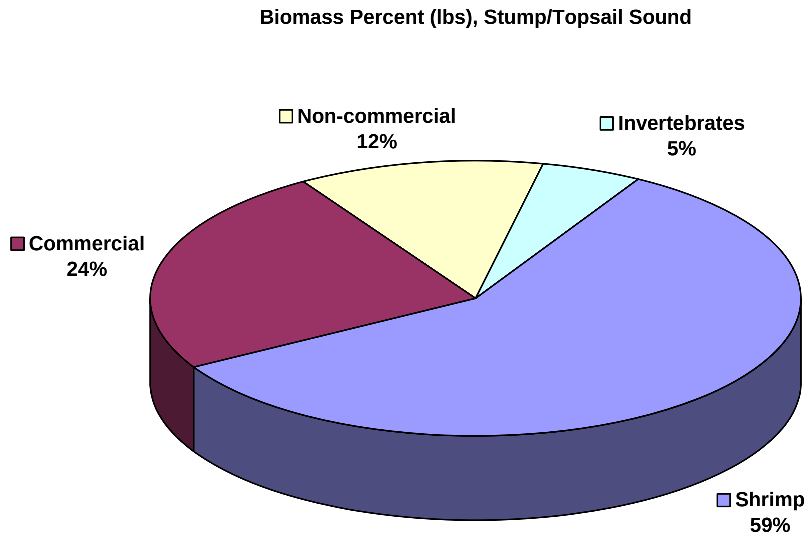


Figure 5. Percent weight in pounds of trawl biomass in Topsail/Stump Sound, 2003-2004.

Management Options/Impacts

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

1) Status quo (potential opening dates set by rule and determined by sampling)
+ No need for further rulemaking on the use of shrimp trawls in the SSNA
- Does not address perceived excessive finfish mortalities
- Does not encourage use of more environmentally friendly gear
- No remedy for indirect shellfish impacts

2) Prohibit otter trawls (not skimmers) as an allowable gear in Stump/Topsail Sound
+ Benefit to Shellfish
+ Encourage the use of a more efficient gear for harvesting white shrimp
+ Reduction in waste/fish kills especially on opening day
- Eliminates portion of traditional fishery
- Financial hardship on trawlers who might convert to skimmers

3) Establish timeline when otter trawls would be prohibited
+ More time for fishermen to adopt to change
+ Possible decreased financial hardship
- No immediate remedy for waste/fish kills on opening day
- No immediate benefits to shellfish

4) Prohibit all trawlers and skimmers in Topsail/Stump Sound
+ Bycatch issue completely eliminated
+ Potential for healthier shellfish/finfish stocks
- Loss of significant shrimp landings to that region
- Eliminates traditional fishery
- Increase pressure on adjacent areas open to trawling

5) Net or vessel size restrictions
+ Still allows prosecution of traditional fishery
+ May cut down on waste/fish kills especially on opening day
- May still have indirect impacts on shellfish
- Increases in effort/tow times might offset bycatch savings

6) Status Quo but with reduction in days of week trawling allowed (Tues,Thur)
+ Allows traditional fishing
+ Reduction in waste/fish kills
+ Longer season, more sustainable prices
+ No time necessary to adopt to gear change
- Still have indirect impact on shellfish
- Still have waste/fish kill issues

AC, DMF, and MFC Recommendation: Status Quo

12.13 Appendix 13. SHRIMP MANAGEMENT IN THE INTRACOASTAL WATERWAY AND SOUNDS, RICH'S INLET TO CAROLINA BEACH

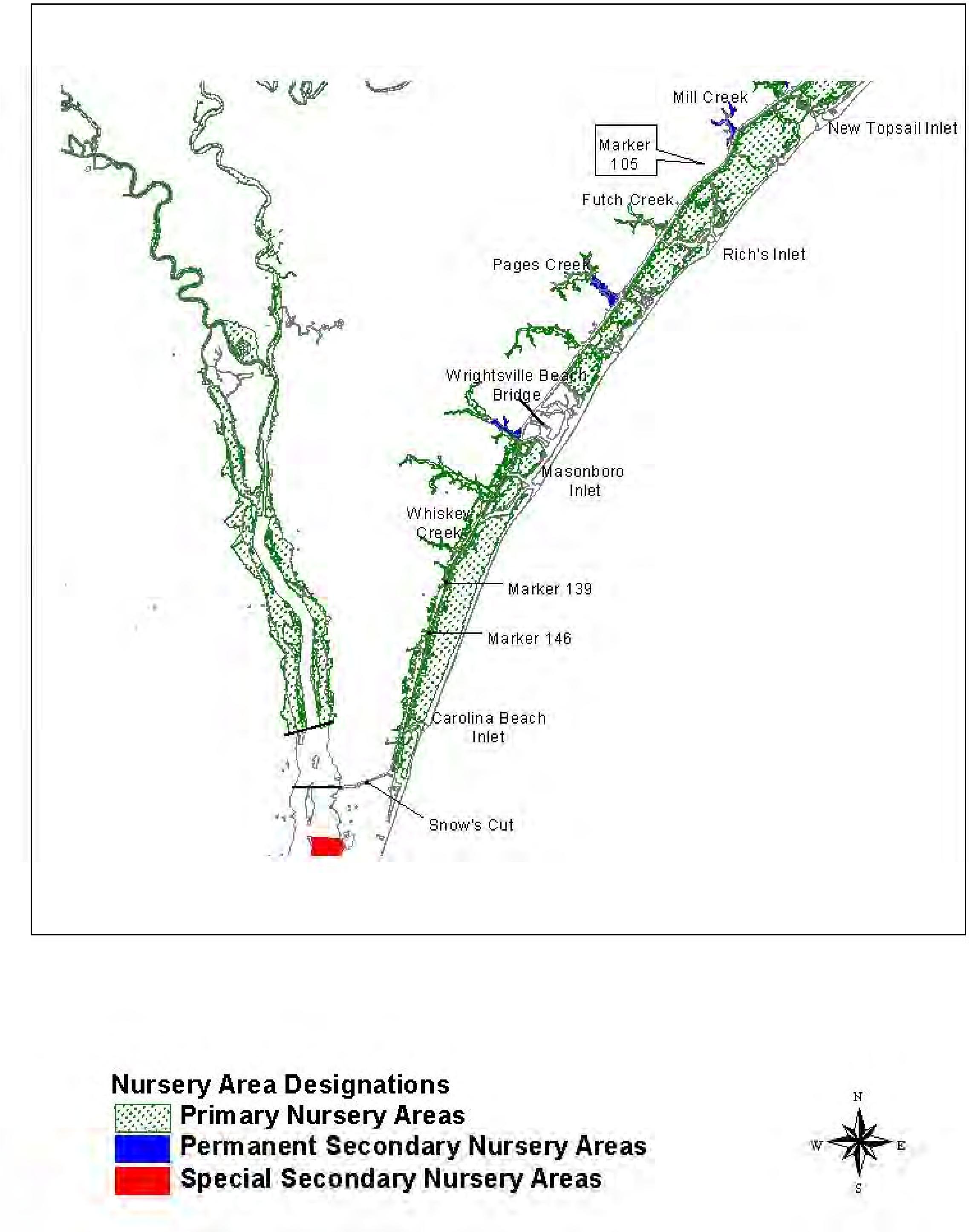
The estuarine waters of the IWW channel and adjacent sounds between Rich's Inlet and Carolina Beach stretch over 21 miles and include 4 inlets separating four barrier islands, three of which (Figure 8, Wrightsville, Carolina Beach) are heavily developed (Map 1). These waters are bordered on the north by Rich's Inlet and to the south by the Carolina Beach Yacht Basin. The largest inlet is Masonboro Inlet and it is located approximately in the center of these estuaries where it separates Wrightsville Beach from Masonboro Island.

Bottom types are primarily sand throughout the area with the exception of more soft muddy substrates in the sounds and portions of the IWW. Submerged Aquatic Vegetation (SAV) is limited to a few patches in the shallow sound areas. There are active oyster, clam, and crab fisheries throughout the area. These fisheries are prosecuted in the sounds and along the edges of the ICW. The waters contain a few shellfish leases and DMF maintains six Shellfish Management Areas from Hewletts Creek north to Rich's Inlet. In addition, DMF and the Coastal Federation have collaborated on construction of an oyster sanctuary in the mouth of Hewlett's Creek. Closed shellfish areas are abundant and include all or portions of creeks on the mainland side of the IWW as well as most of the Wrightsville Beach area and buffers around numerous marinas.

Most all of these areas receive minimal shrimping effort with little or no impact on shellfish resources. Exceptions are a section of the IWW in Myrtle Grove Sound (Williams landing) and the Carolina Beach Yacht Basin (CBYB). Additionally, some of the channels around Wrightsville Beach also receive shrimping effort at various times during a typical year. Both commercial and recreational shrimpers utilize these waters.

The William's Landing area has been difficult to manage because the shrimp often migrate before reaching larger sizes (30-40 count, heads-on) except in the fall. In some years, large concentrations of algae (*Grassilaria and Ulva, spp*) prevent the use of trawls until the shrimp grow to an acceptable count while in other years there has been harvest of small shrimp. The CBYB is opened and closed based on the size of shrimp present. Channels around Wrightsville Beach remain open to allow harvest of shrimp migrating to the ocean. The area of the IWW from the Wrightsville Beach Drawbridge to Marker # 105 at Green's Channel always remains open to shrimping but historically, has received little effort from commercial or recreational fisherman.

Shrimp landings were combined from the different waterbodies for the years 1994-2003 and charted relative to their statewide contribution (Figure 1). In relation to the other waterbodies, the Masonboro Sound waterbody has not been a significant contributor to landings. During 1994-2003 trawl landings ranged from 6,369 lbs. in 2003 to 1,515 lbs. in 2001 (Table 1, Figure 2) with an average of 4,097 lbs. Greater than 97% of the harvest was captured by otter trawls, with the last 4 years indicating a 100% harvest from otter trawls. The amount of sold bycatch relative to shrimp is quantified in the table and although higher than other areas examined in southeastern N.C., is insignificant from a total poundage standpoint. Most of the vessels harvesting shrimp in this waterbody are small (less than 25 feet) and pull only one net. The number of participants has been decreasing and only 10 users were documented in each year during 2000-2003 (Table 1).



Map 1. New Topsail Inlet to Carolina Beach Yacht Basin.

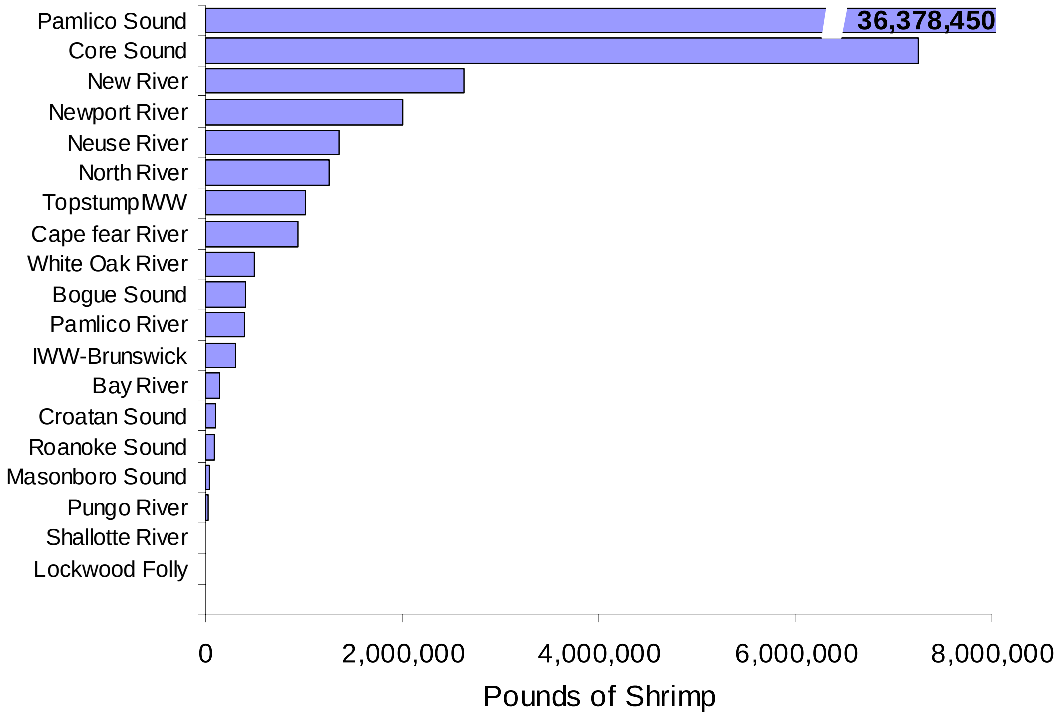


Figure 1. Contribution in total pounds of shrimp captured during 1994-2003.

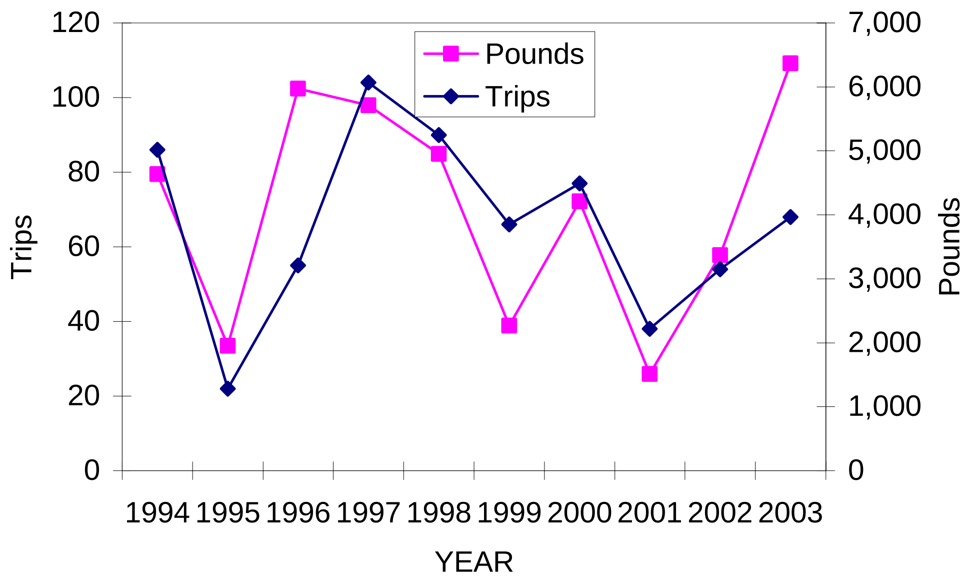


Figure 2. Total pounds and trips in the Masonboro Sound trawl fishery, 1994-2003.

Table 1. Trip ticket data from Masonboro Sound.

Year	License	Trips	Shrimp/lbs	Sold bycatch in pounds	Mean catch per trip	Ratio of shrimp to sold bycatch	Percent from otter trawls
1994	38	86	4,638	153	54	30.24	100.00%
1995	12	22	1,952	9	89	216.83	100.00%
1996	24	55	5,973	1,089	109	5.49	100.00%
1997	13	104	5,715	255	55	22.39	100.00%
1998	11	90	4,954	360	55	13.77	99.87%
1999	14	66	2,266	440	34	5.15	100.00%
2000	6	77	4,212	156	55	27.06	100.00%
2001	10	38	1,514	28	40	54.08	100.00%
2002	10	54	3,372	255	62	13.22	99.96%
2003	10	68	6,369	334	94	19.08	97.07%

The mean catch per trip (Table 1, Figure 3) has ranged between 34 lbs. in 1999 to 109 lbs. in 1996. The average catch per trip during the ten years 1994-2003 was 65 pounds.

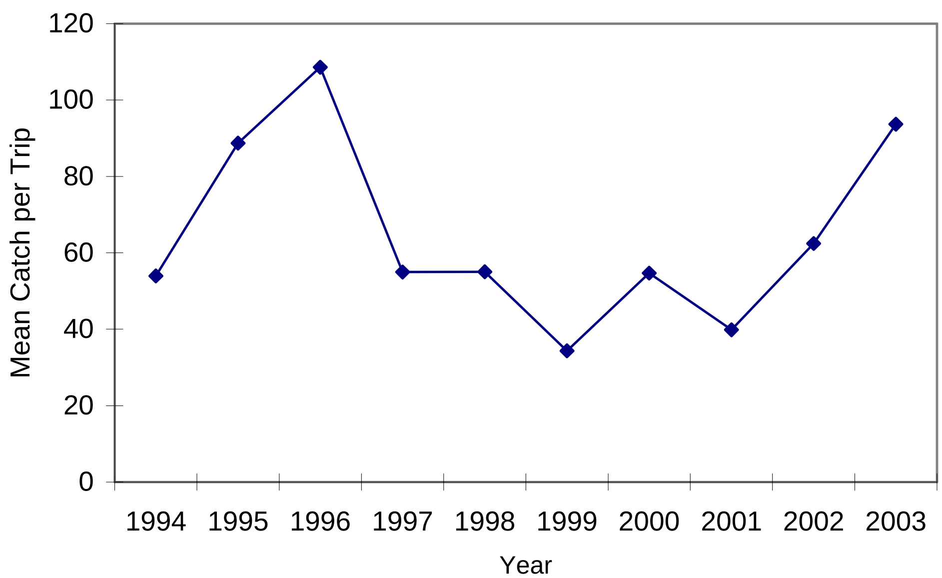


Figure 3. Mean catch per trip, in the trawl fishery, Masonboro Sound, 1994-2003.

The size (counts) of shrimp landed is recorded on DMF trip ticket data. These data were extracted from the DMF database for the Masonboro Sound waterbody during 1994-2003 and plotted relative to the number of trips where a particular size shrimp was landed (Figure 4). The peak modal size was 41/45 count shrimp, representing 122 trips.

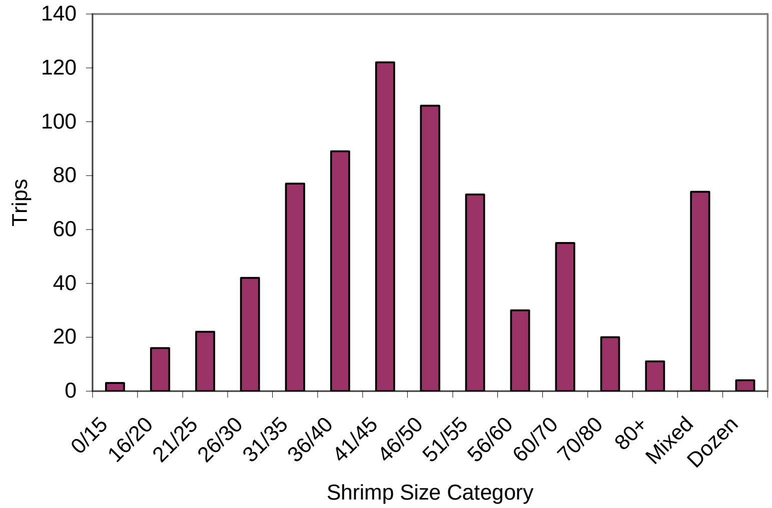


Figure 4. Frequency of trips by heads-on count size, Masonboro Sound, 1994-2003

Preliminary bycatch results from a recently completed (2004) Fishery Resource Grant (Logothetis, pers. comm.) provide information on the bycatch associated with commercial trawling in the Williams Landing portion of the IWW. Based on 12 trips and 22 tows conducted between May and October of 2003 the ratio of bycatch to shrimp was 0.7**:** 1. In other words, for every 0.7 lb. of bycatch captured there was 1 lb of shrimp captured. This ratio of bycatch was the second lowest of all the study areas with the Cape Fear River being the lowest at 0.38**:** 1. The mean counts of shrimp captured by the investigators during August, September and October was 87, 67.5 and 72 respectively. These numbers were based on 2 trips in August, 4 in September and 1 in October. Other areas sampled were located in Brunswick, Onslow and Pender counties. All tows were made with a commercial 50 foot two seam otter trawl outfitted with turtle and fish excluder devices.

Management Options/Impacts

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

1) Status quo (potential opening dates set by proclamation and determined by sampling)
+ Flexibility in dealing with variety of conditions
+ No need for further rulemaking
- Does not address harvest of small shrimp or waste/bycatch
- Sometimes necessitates "grand openings'

2) Modify existing management strategy as needed to address concerns
+ Harvest of more marketable shrimp
+ Potential reduction in waste/bycatch
- More regulations
- Modifications to strategy may not have intended effect
- Possible reduction of harvest

3) Prohibit all trawling
+ Possible benefit to finfish stocks
+ Eliminates navigational conflicts
+ No harvest of small shrimp by trawlers
- Eliminates traditional trawl fishery in some areas
- Financial hardship on some shrimpers

AC, DMF and MFC Recommendation: Close IWW to trawling from Marker # 105 to Wrightsville Beach drawbridge. Manage trawling in the IWW from Marker #139 to Marker # 146 as if it were a Special Secondary Nursery Area.

12.14 Appendix 14. SHRIMP MANAGEMENT IN THE CAPE FEAR RIVER COMPLEX

The waters of the Cape Fear River, the Basin, Second Bay, Buzzard's Bay (the Bays) and Bald Head, Cape and Bay Creeks (the Creeks) are part of the Cape Fear estuarine system (Map 1). Bottom types range from sand near the inlet and creek mouths to mud in some of the bays and channels near Snow's Cut. There are active clam and oyster fisheries in the bays, creeks and the river upstream to the Fort Fisher Ferry Terminal. These fisheries occur primarily by hand and in shallow water though there are tong and bull rake clam fisheries in the deeper areas. In some of the deeper areas of the Cape Fear, clam and shrimp fisheries co-exist. There are active crab pot and gillnet fisheries throughout the entire estuary. Map 1 illustrates the locations of the Primary, Secondary and Special Secondary Nursery Areas in the Cape Fear River.

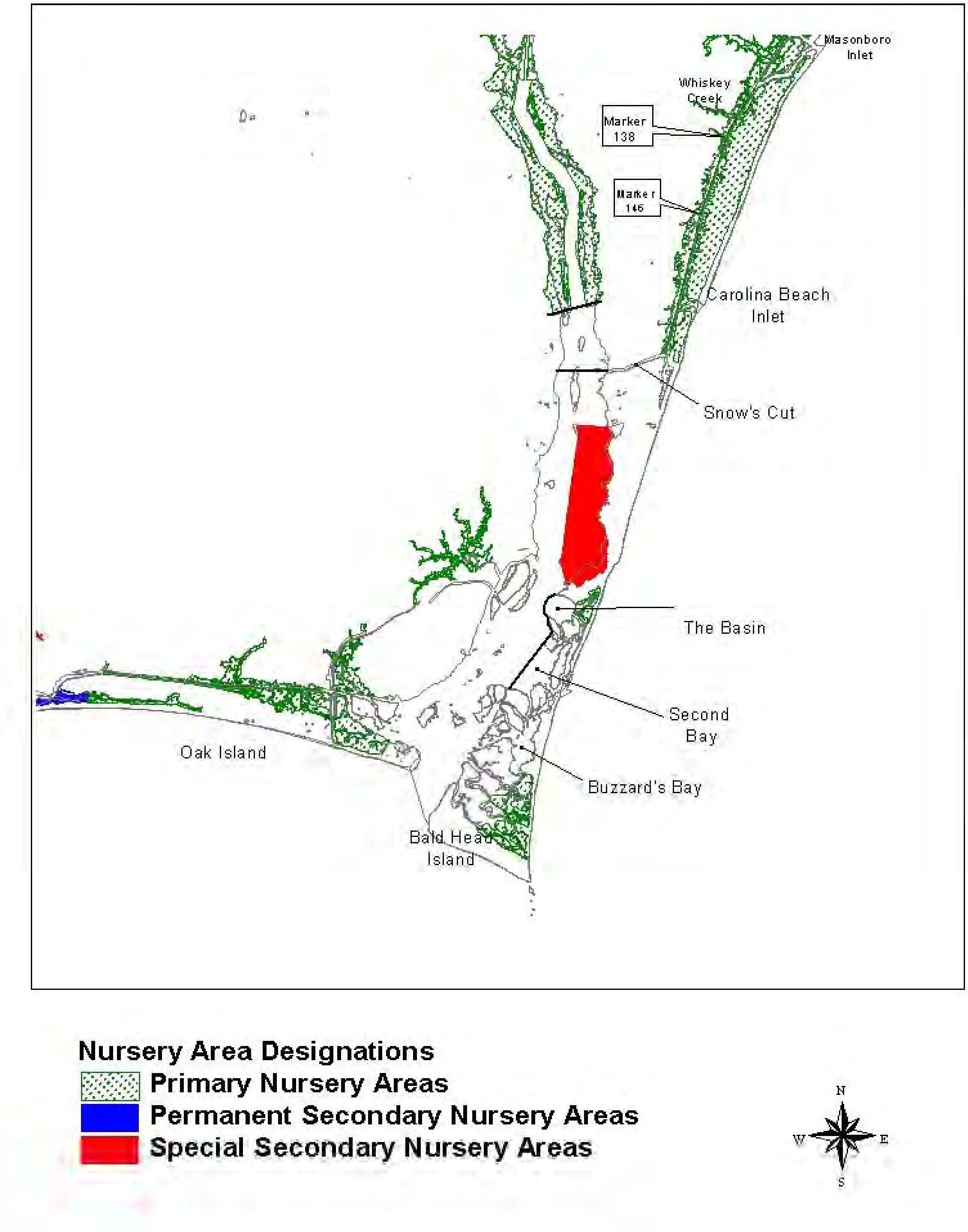
The area in the Cape Fear that is open to shrimping is dredged on a regular basis for navigation purposes. The river is managed on the size of shrimp and various parts of the River are opened and closed based on the DMF's samples. The upstream line was placed at Snow's Cut for many years because of the abundance of small shrimp above this line. The line was moved upstream 3 years ago based on larger shrimp being present at that location. The River has not been closed for the last two years because when small shrimp were in the open areas the participants have chosen not to harvest them.

The bays south of Fort Fisher known as the Basin or First Bay, Second Bay and Buzzard's Bay have been managed as a unit with openings and closings based on the DMF's samples. New Inlet drained these areas but closed after a series of hurricanes in the late 1990's and circulation is now through the Cape Fear. Since the inlet closing, DMF has observed a shift in the biological character of these waters towards more of a nursery area. Consequently, the size of the shrimp tends to remain small and the waters have not opened since 2001.

The Bald Head Creeks are usually opened in late June or early July based on the size of shrimp. Areas opened include the lower portions of the Creeks. The fishery is prosecuted by small skiffs. However, due to a lack of effort over the last few years, these creeks have not been opened since 2002.

Trawling trips in the Cape Fear are usually day trips and fishery operations are performed primarily from small boats although vessels up to 50 feet may work in the channels of the Cape Fear. There are no other mobile gears used but there has been some use of channel nets in the past. During 1999-2003, greater than 99% of the shrimp landings were captured with otter trawls (Table 1).

Shrimp landings were combined from the different estuarine waterbodies for the years 1994-2003 and charted relative to their statewide contribution (Figure 1). During the 10-year period in the Cape Fear, a total of 990,446 lbs were harvested, an average of 99,044 pounds per year. Over 98% of these landings were from otter trawls. The trawling effort has dropped significantly in recent years and now the main channels of the Cape Fear River support all the effort (Table 1, Figure 2). The number of trawling participants has declined from 81 in 1994 to 23 in 2003. The number of participants working in the river averaged 25 during the five-year period 1999-2003. Ratios of shrimp to the amount of bycatch sold are high indicating that shrimp dominate the catches.



Map 1. Cape Fear River.

Table 1. Trip ticket data from the otter trawl fishery, Cape Fear River.

Year	License	Trips	Shrimp/lbs	Sold bycatch in pounds	Mean catch per trip	Ratio of shrimp to sold bycatch	Percent from otter trawls
1994	81	837	145,350	4,988	173.7	29.1	97.0%
1995	43	434	111,384	2,252	256.6	49.5	97.5%
1996	50	379	76,283	2,958	201.3	25.8	94.9%
1997	46	529	134,857	442	254.9	305.1	97.4%
1998	35	365	75,465	1,626	206.8	46.4	91.4%
1999	42	439	118,407	996	269.7	118.9	99.7%
2000	19	255	45,600	1,558	178.8	29.3	99.0%
2001	18	206	17,839	269	86.6	66.3	99.9%
2002	25	322	82,845	1,631	257.3	50.8	100.0%
2003	23	301	101,416	1,048	336.9	96.7	100.0%

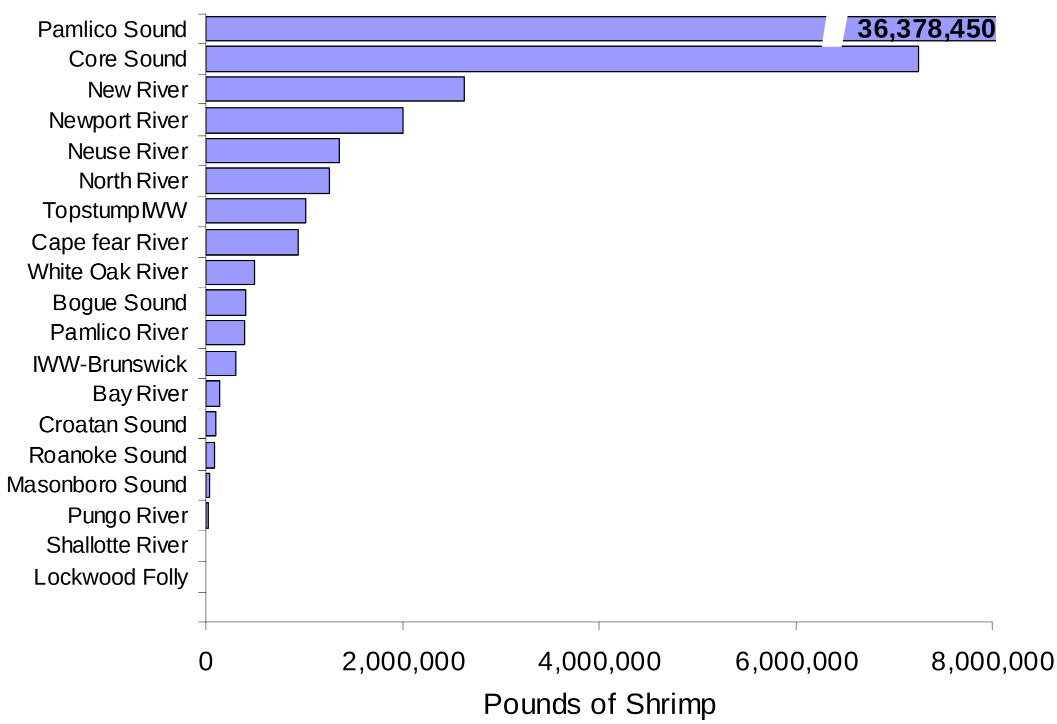


Figure 1. Total pounds of shrimp harvested by all gears in major North Carolina waterbodies, 1994-2003.

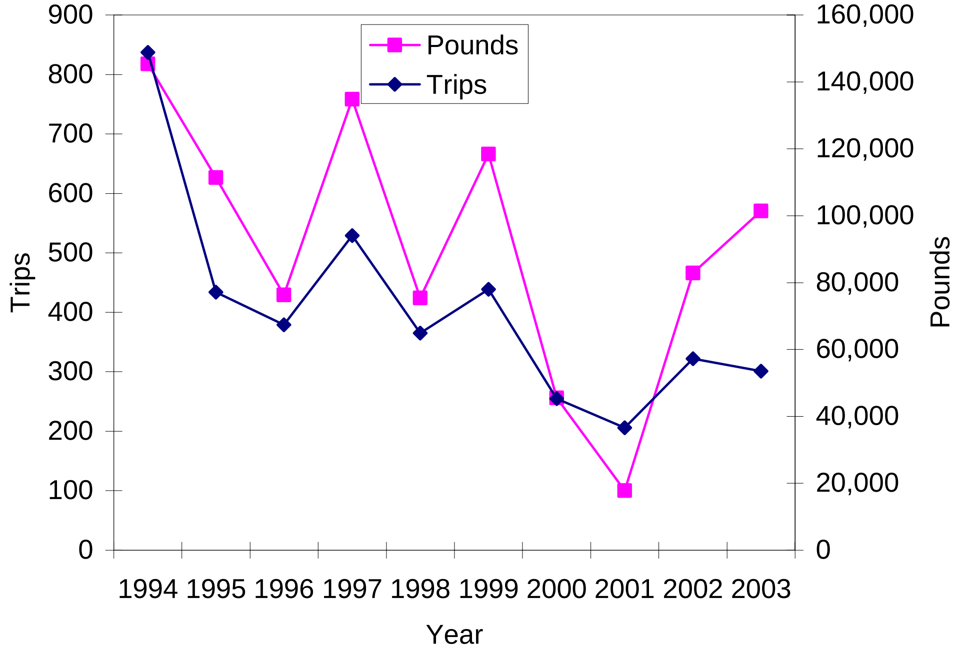


Figure 2. Total pounds and trips by year in the otter trawl fishery, Cape Fear River, 1994-2003.

Except for 2001, when the total harvest from trawls (17,839 lbs.) was 73,106 lbs less than the 10- year average, mean catches per trip have not fluctuated much (Table 1, Figure 2). Mean catches averaged 222 lbs over the 10-year period (Figure 3).

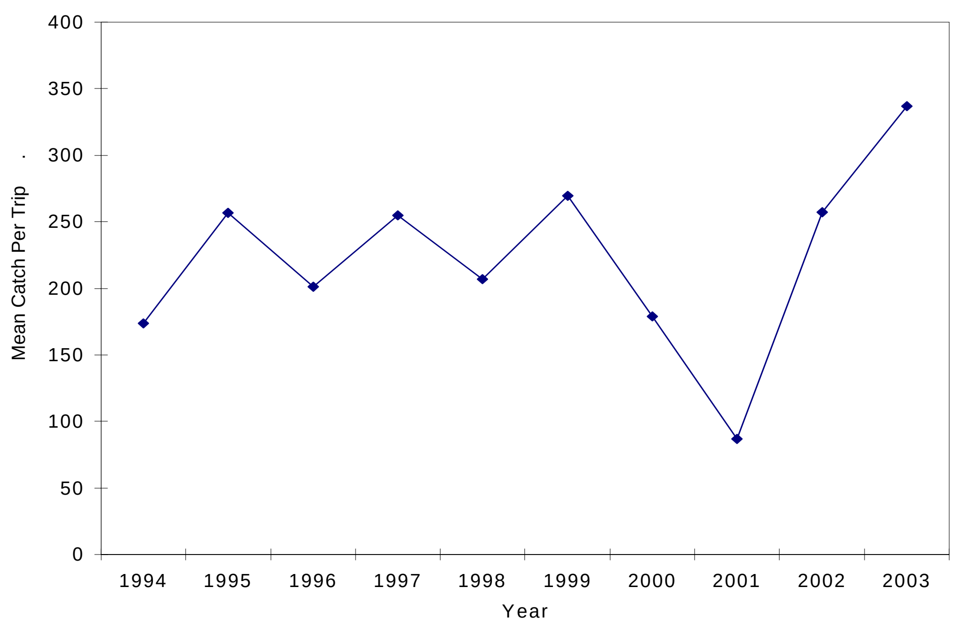


Figure 3. Mean catch in pounds, per trip, otter trawls, Cape Fear River, 1994-2003.

Preliminary bycatch results from a recently completed FRG (Logothetis, pers. comm.) provide some data on the bycatch associated with commercial trawling in the Cape Fear River. Based on 25 trips and 50 tows conducted between April and November of 2003, the ratio of bycatch to shrimp was 0.38**:** 1. In other words, for every 0.38 lb. of bycatch captured there was 1 lb of shrimp captured. This ratio of bycatch was the lowest of any of the study areas, which also included waters in Brunswick, New Hanover, Pender and Onslow counties. The mean counts of shrimp by month were calculated for the Cape Fear River based on1 tow in August, 5 tows in September, 18 tows in October and 10 tows in November. Counts averaged 122 in August, 96 in September, 60 in October and 41 in November. All tows were conducted with a commercial 50-foot two-seam otter trawl outfitted with turtle and fish excluder devices.

Management Options/Impacts

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

1) Status quo (potential opening dates set by proclamation and determined by sampling)
+ Flexibility in dealing with variety of conditions
+ No need for further rulemaking
- Does not address harvest of small shrimp or waste/bycatch in some areas
- Sometimes necessitates “grand openings”

2) Status quo for the main river but establish no trawling areas in the bays south of Fort Fisher and the Baldhead creeks
+ Harvest of more marketable shrimp
+ Potential reduction in waste/bycatch
- More regulations
- Modifications to strategy may not have intended effect
- Possible reduction of harvest

3) Prohibit all trawling in Cape Fear
+ Possible benefit to finfish
+ Eliminates any navigational conflicts
+ No harvest of small shrimp by trawlers
- Eliminates traditional trawl fishery in some areas
- Financial hardship on some shrimpers

AC Recommendation: Status Quo.

DMF, and MFC Recommendation: Status quo for the main river but establish no trawling areas in the bays south of Fort Fisher and the Bald Head creeks.

12.15 Appendix 15. SHRIMP MANAGEMENT IN BRUNSWICK COUNTY

The Brunswick County coastline stretches for approximately 33 miles and is bound by the Cape Fear River Inlet on the east end and by the Little River Inlet on the west end. Four barrier islands, all of which are densely developed, are separated by five inlets along the coastline. Bird Island, located near the South Carolina state line is the smallest of the barrier islands and the only one not commercially developed. It was previously separated from Sunset Beach by Mad Inlet but natural processes have closed the Inlet. Between the barrier islands and the Intracoastal Waterway (IWW), there are many acres of estuarine waters with numerous creeks and three small rivers (Lockwood Folly, Shallotte and Calabash) on the mainland side of the IWW. Areas classified as Primary, Secondary or Special Secondary nursery areas are shown on Map 1 and Map 2. Nursery area designations protect these sensitive ecosystems from bottom disturbing gear.

Except for the dredged channel of the IWW, the CP&L Discharge canal, Lockwood Folly River, Calabash River and the inlet channels, the system is shallow and mostly intertidal due to strong lunar tides. The bottom types range from shell bottoms to soft mud substrates in nursery areas and the coastal wetlands are home to many intertidal oyster reefs. Dredged areas contain bottom types that are variable mixes of mud and sand. Submerged aquatic vegetation has not been documented in Brunswick County. Habitat is probably more impacted by the maintenance dredging of the IWW and coastal development than by shrimp trawling activities.

Other than shrimping, significant commercial fisheries that occur in these waters include clamming, oystering, crabbing, and gill netting. The DMF actively manages 8 Shellfish Management Areas (SMAs) in Brunswick County. These SMAs are located in the Shallotte and Lockwood Folly Rivers and on the ocean side of the IWW in Jinks Creek. There are extensive areas closed to shellfishing throughout the county especially around Southport, the west end of Long Beach, in Lockwood Folly and Shallotte Rivers and behind Ocean Isle and Sunset Beaches.

The IWW in Brunswick County is managed based on the size and abundance of the shrimp taken in the DMF's samples. The area is usually open until the beginning of June when it is closed because of small brown shrimp. In most years, portions may be opened in late June or early July to allow harvest of brown shrimp and then closed in late July or early August when small white shrimp recruit to the area. Occasionally, small white shrimp may appear before the brown shrimp reach a harvestable size, thus delaying an opening until the whites are harvestable, usually in September but sometimes as late as November. Principle harvest areas are behind Oak Island, from the Holden Beach Bridge to Shallotte River and from the Ocean Isle Beach Bridge to the Sunset Beach Bridge.

The IWW channel from the Sunset Beach Bridge to the South Carolina State Line and the Calabash River are rarely opened to trawling because of the abundance of small shrimp. Data from the sampling conducted by DMF show a consistent pattern in the area from the Sunset Beach Bridge to Calabash River (Figure 1). Samples were taken with either a 20-foot flat trawl or a 25-foot 4-seam trawl with a 1.50 inch stretched mesh body and a 0.50-inch tailbag. Neither net is outfitted with turtle or fish excluder devices. Prior to the brown shrimp reaching harvestable size in late June or early July, small white shrimp begin recruiting to the waters. This results in a situation where larger

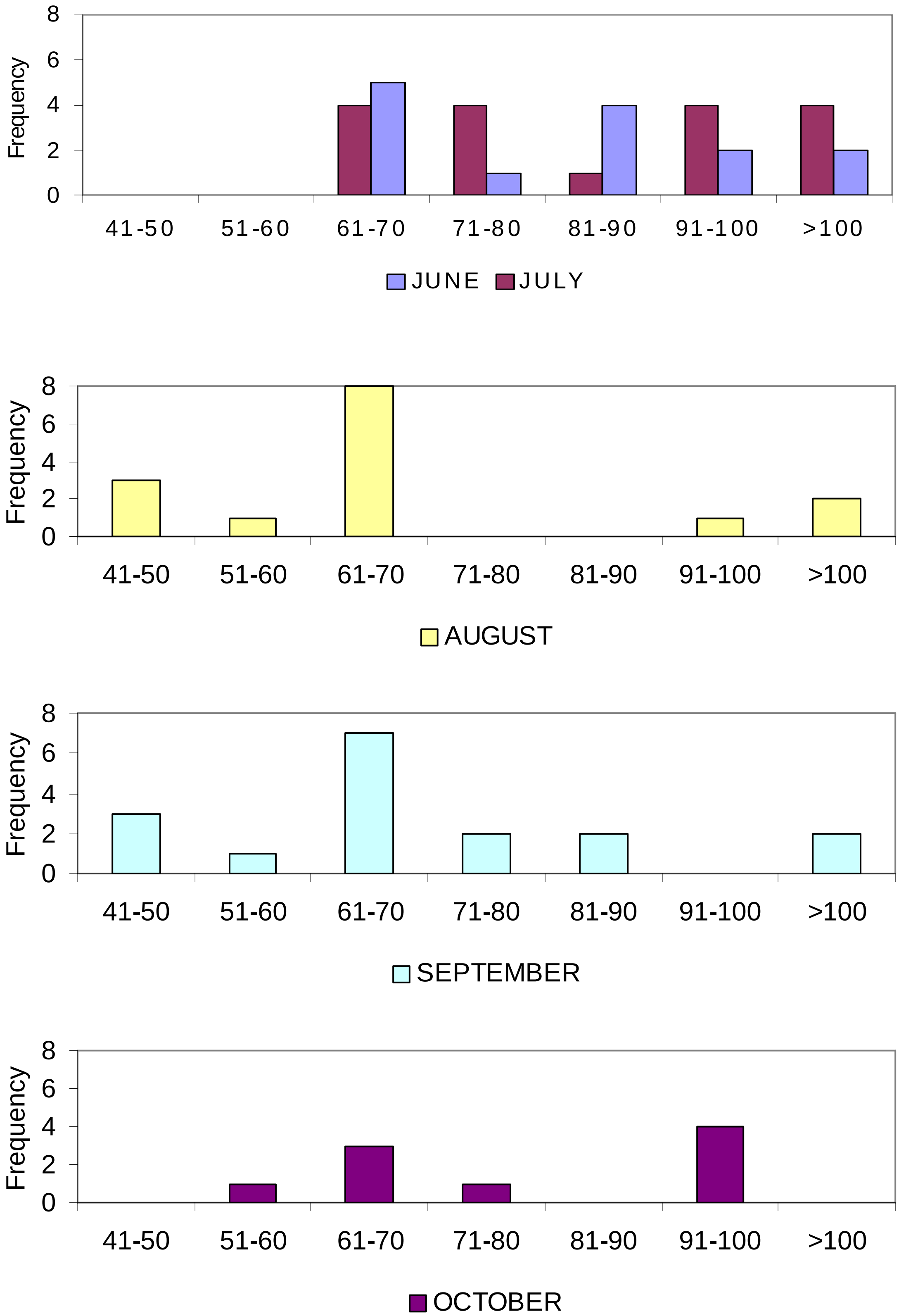


Figure 1. Frequency of trips grouped by head-on counts of shrimp caught in DMF sampling in the IWW west of Sunset Beach Bridge and Calabash River.

brown shrimp (40-50 count) are mixed with smaller white shrimp (>100 count) bringing the overall count to >60 count. As the brown shrimp migrate from the area and more whites recruit, the counts rise to the 80-90 count range and remain there through most of the summer and fall. The population may occasionally reach a harvestable size but larger shrimp migrate quickly to the ocean leaving smaller shrimp. The area from Sunset Beach Bridge to Calabash River is usually opened toward the end of the season so that the shrimp won't be "lost" to South Carolina.

The channels that connect the IWW with the Atlantic Ocean usually remain open during the entire year to allow harvest of shrimp that are migrating to the ocean. In rare instances of very heavy rainfall, these channels may be closed. The areas include Elizabeth River, Dutchman Creek, Montgomery Slough, Jink's Creek and Bonaparte Creek. Trawling in Montgomery Slough and the Elizabeth River has become the subject of discussion amongst shrimpers as well as the public because of concerns about bycatch as well as interference with navigation.

Eastern Channel, located behind Ocean Isle Beach, is a shallow channel (less than 1 meter at mean low tide) that connects the IWW at Marker 93 to Jink's Creek. Data collected by DMF have indicated a change toward smaller shrimp over the last 10 years. Prior to the 1980s, this area was opened by managers to allow the harvest of brown shrimp in late June to early July. This opening would be followed by a closure in August, followed by an opening for white shrimp in September and October. However, due to environmental changes, the shrimp now seldom reach harvestable size before they migrate. The changes in habitat are attributable to the deposition of a large shoal at the junction of Eastern Channel and Jink's Creek and the subsequent shoaling of Eastern Channel with the cumulative effect of shallower water and a sandier substrate. These changes have resulted in the waters not being opened to harvest in the last 15 years. There has been no effort with other gears in this area.

The Shallotte River was opened and closed to shrimp trawling based on size and abundance until 1998. However, DMF sampling has shown that shrimp rarely reach large sizes and the head-on counts remain greater than 60 during most of the season. Consequently, the last time DMF opened Shallotte River was a span of time in 1998 between July 8 and September 9. There is a small channel net fishery (<3 participants) that has operated in Shallotte River sporadically during 1994-2003. The confidentiality policy of the DMF Trip Ticket Program prevents disclosure of these data.

Shrimp landings were combined from the different waterbodies for the years 1994-2003 and charted relative to their statewide contribution (Figure 2). In relation to the other waterbodies, the IWW in Brunswick County (excluding Shallotte and Lockwood Folly rivers) ranked 12th out of 19 waterbodies. Shallotte and Lockwood Folly Rivers both had minimal landings ranking 18th and 19th in the state, respectively.

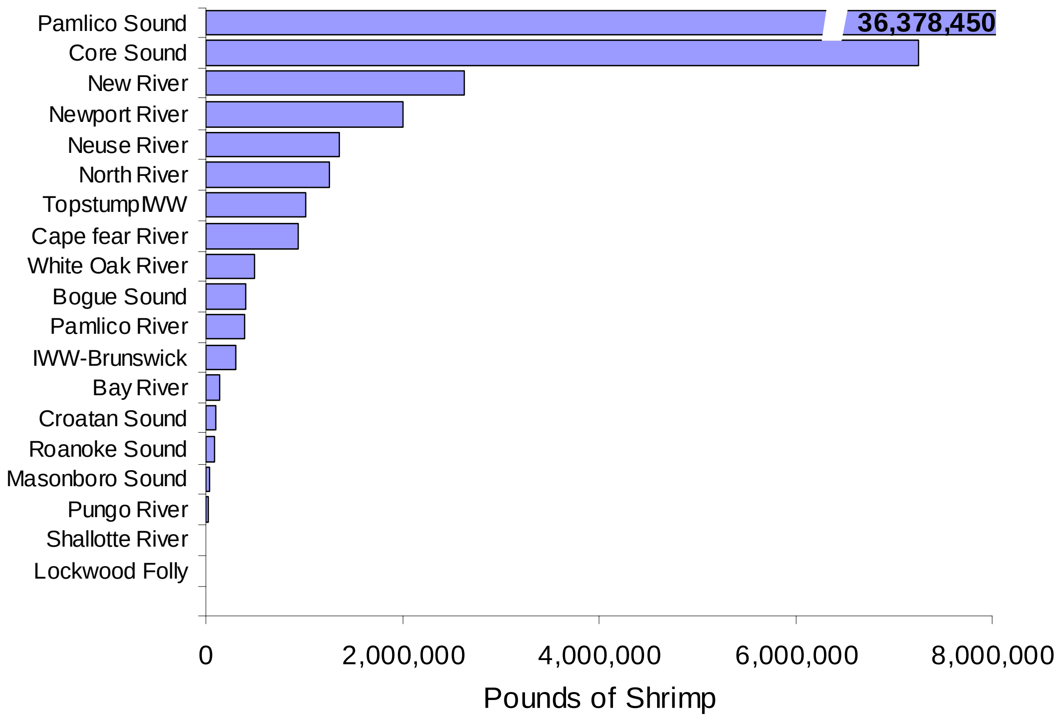


Figure 2. Contribution in total pounds of shrimp captured during 1994-2003.

Data from Table 1 were extracted from the DMF Trip Ticket Program and were used to describe the trawl fishery in Brunswick County from 1994-2003. For this analysis, the landings from otter trawls in the Brunswick County IWW were pooled with trawl landings from Shallotte and Lockwood Folly rivers. During 1994-2003, trawl landings ranged from 22,138 lbs. in 1999 to 48,141 lbs. in 1995 (Table 1, Figure 3) with an average of 30,701.8 lbs. The percent of the catch from otter trawls ranged from 91% in 2003 to 99.1% in 1994. On average, 95.5% of landings in Brunswick County were harvested with otter trawls. Other gears landing shrimp include a small number of channel netters in Shallotte River and a small cast net fishery.

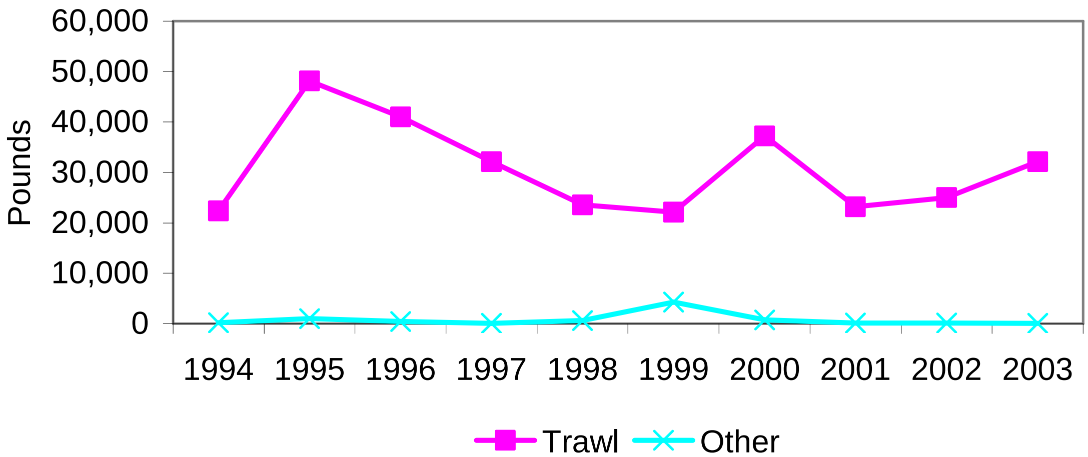


Figure 3. Pounds of shrimp captured by gear, Brunswick County 1994-2003.

The number of participants has been decreasing and only 38 users were documented in

2003, a decrease of 68% from a high of 118 participants in 1996 (Table 1, Figure 4). The number of trips has been decreasing, falling from over 500 trips in 1994-1996, to between 250-322 trips during 1999-2003 (Table 1, Figure 5). The mean catch has varied over time, fluctuating between 41 lbs. and 116 lbs. per trip.

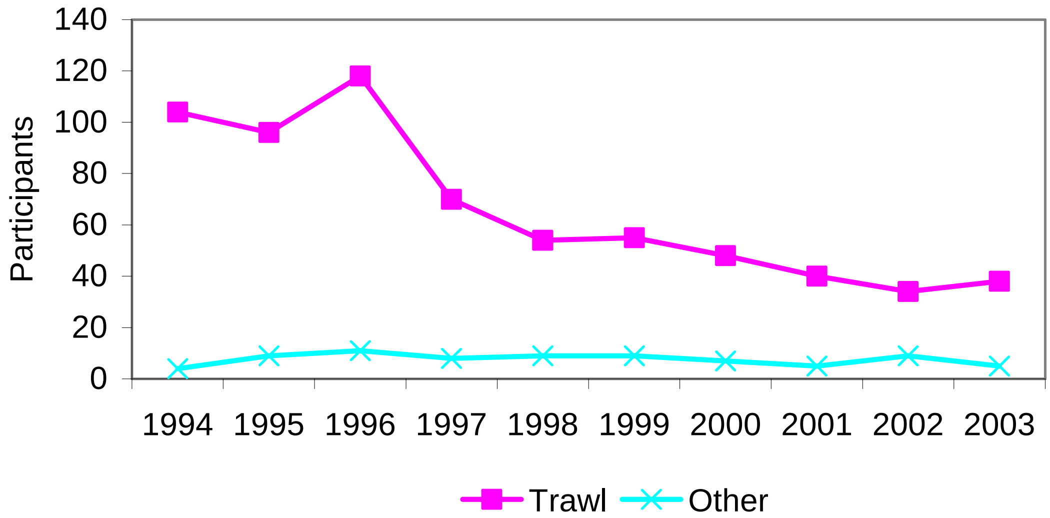


Figure 4. Participants in Brunswick County trawl fishery, 1994-2003.

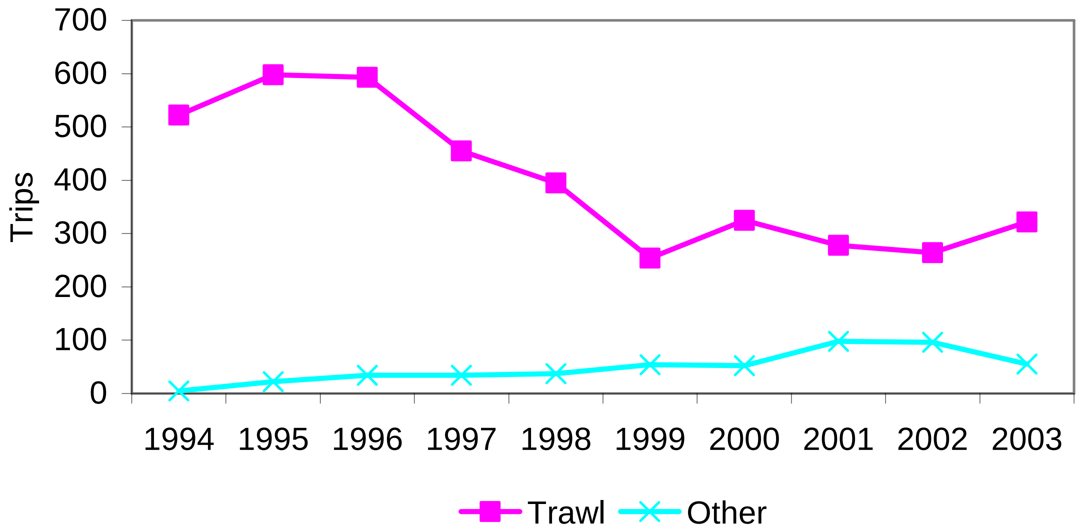


Figure 5. Trips by gear, Brunswick County 1994-2003.

Landed bycatch by gear was calculated and ratios (in pounds) of marketable bycatch to shrimp were determined. The ratios were low ranging from 1:32.9 in 2002 to 1:13.0 in 2003. Discarded bycatch is much more difficult to quantify because of the lack of data in most areas. However, during 2003 and 2004, DMF staff sampled the study area for shrimp management purposes utilizing either a 20-ft, 2-seam otter trawl or a 25-foot, 4-seam otter trawl. Neither net was equipped with a bycatch reduction device or a turtle excluder. Catches were separated into four categories: commercial finfish, non-commercial finfish, invertebrates, and shrimp. Weights of each component were summed from all samples and bycatch percentages were derived for each year (Figure 6). The majority of the tows were conducted prior to the shrimp opening and tow times ranged from 1 to 10 minutes. The primary objective of the sampling was to determine if the shrimp were large enough to warrant an opening but the weights of all the biomass components were recorded. Finfish accounted for 17% of the catch in 2003 and 19% in 2004, while invertebrates (mostly crabs and squid) represented 5% in 2003 and 10% in 2004. Shrimp dominated the catches by weight representing over 70% in both years.

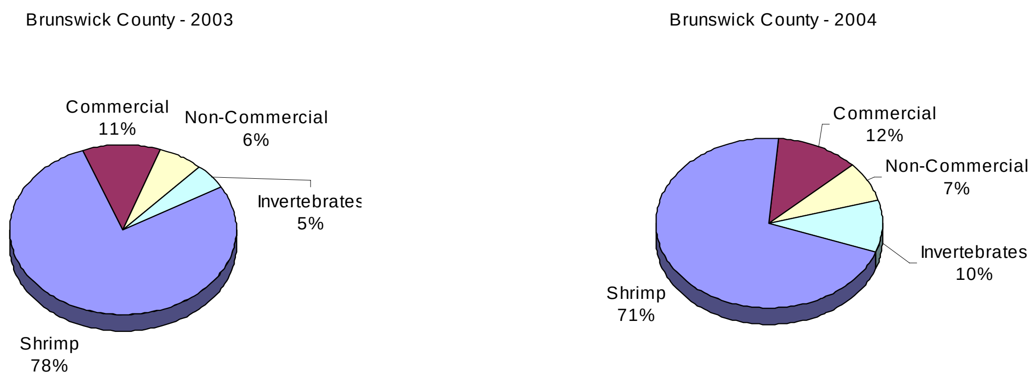


Figure 6. Percent weight in pounds of trawl biomass in IWW Brunswick County 2003-2004. There were 69 and 67 sampling trips from 2003 and 2004, respectively.

Preliminary bycatch results from a recently completed (2004) Fishery Resource Grant (Logothetis, pers. comm.) provide information on the bycatch associated with commercial trawling in the Brunswick County IWW. Based on 20 trips and 46 tows conducted between April and October of 2003 the ratio of bycatch to shrimp was 1.55 **:** 1. What this means is that for 1.55 lb. of bycatch captured there was 1 lb. of shrimp captured. This ratio of bycatch was ranked third lowest of all the study areas with the Cape Fear River being the lowest at 0.38 **:** 1, followed by New Hanover County at 0.70 **:** 1. All tows were made with a commercial 50-foot, 2-seam otter trawl outfitted with turtle and fish excluder devices.

Management Options/Impacts

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

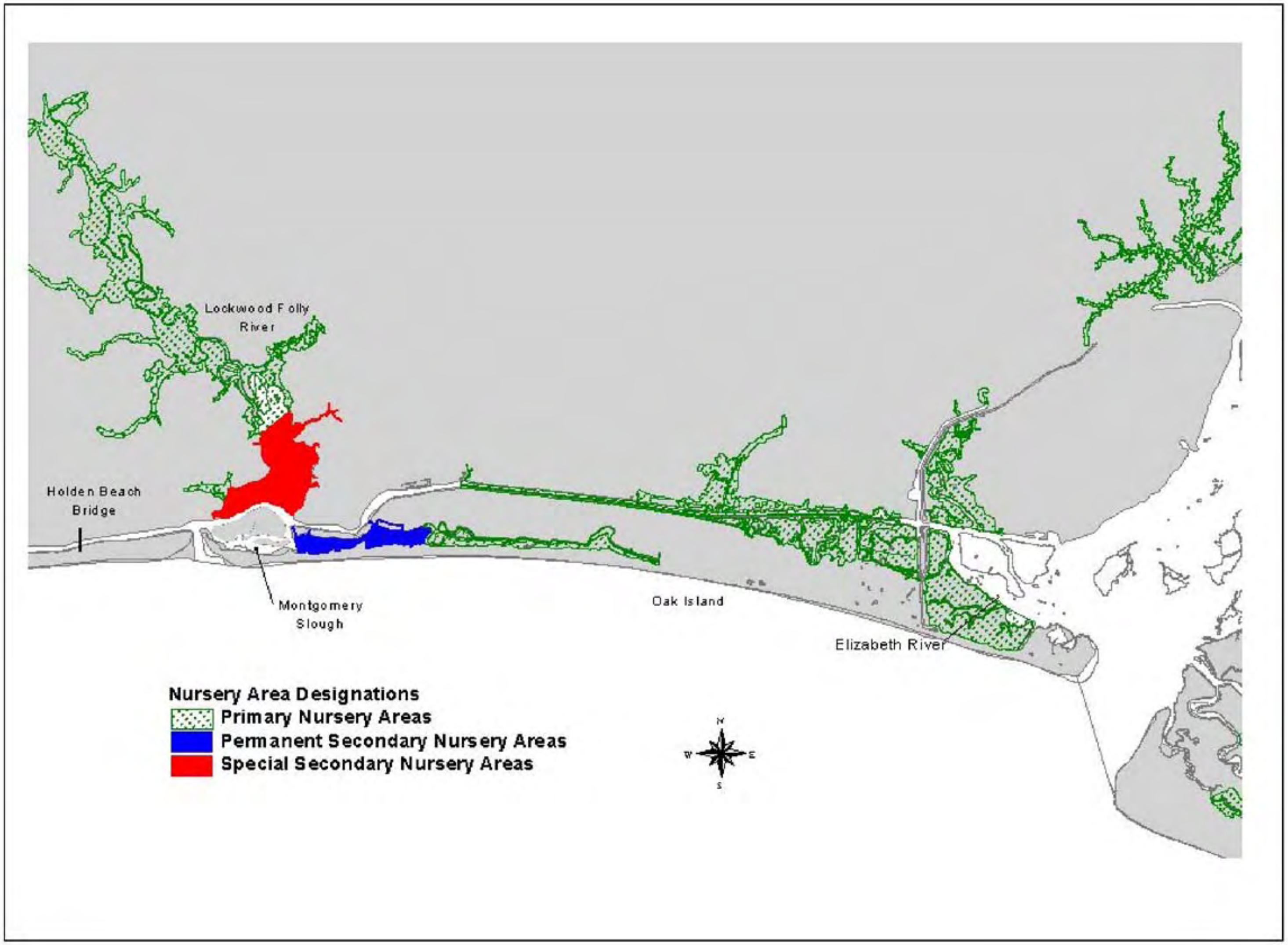
1. Status quo (potential opening dates set by proclamation and determined by sampling)
   + Flexibility in dealing with variety of conditions
   + No need for further rulemaking
   - Does not address harvest of small shrimp or waste/bycatch
   - Sometimes necessitates “grand openings’

2. Modify existing management strategy as needed:
   Prohibit commercial and recreational shrimping, except for cast nets, as in MFC rule 3L.0104, in the following areas.
   i. The Intracoastal Waterway from the Sunset Beach Bridge to South Carolina and lower Calabash River
   ii. All areas of Eastern channel that could potentially open under current rules.
   iii. All areas in Shallotte River that could potentially open under current rules
   + Harvest of more marketable shrimp
   + Potential reduction in waste/bycatch
   + More and larger shrimp escape to the ocean in lower Brunswick County
   - More regulations
   - Possible reduction of harvest
   - Loss of shrimp to South Carolina fishermen
   - Loss of shrimp on bait market

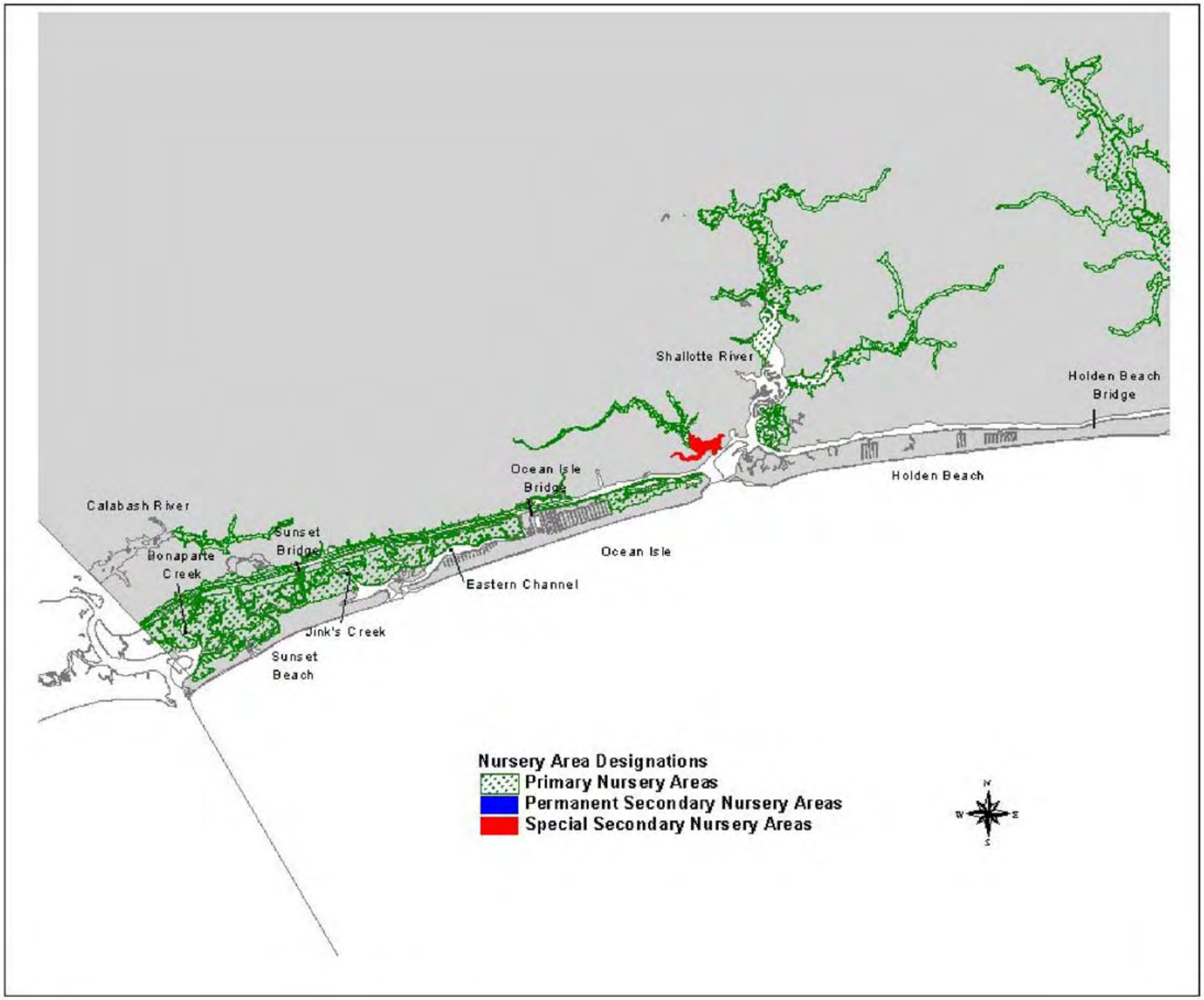
3. Prohibit all trawling
   + Possible benefit to finfish stocks
   + Eliminates navigational conflicts
   + No harvest of small shrimp by inshore trawlers
   - Eliminates traditional trawl fishery in some areas
   - Financial hardship on some shrimpers

AC and MFC Recommendation: Status quo

DMF Recommendation: Prohibit commercial and recreational shrimping, except for cast nets, in the Intracoastal Waterway from the Sunset Beach Bridge to South Carolina, lower Calabash River, Eastern Channel and Shallotte River.



Map 1. IWW from Cape Fear River to Holden Beach.



Map 2. IWW Holden Beach Bridge to South Carolina.

Table 1. Catch and Effort data on shrimp and bycatch harvest from Brunswick County (DMF Trip Ticket).

Trawls	Participants	Trips	Shrimp lbs	Sold Bycatch	Mean Catch per Trip	Ratio of Shrimp to Sold Bycatch	% Catch from Otter Trawls
2003	38	322	32161.2	2469.2	99.9	13.0	91.0
2002	34	264	25034.2	759.2	94.8	33.0	91.7
2001	40	278	23202.9	1257.9	83.5	18.4	91.0
2000	48	325	37260.4	2801.4	114.6	13.3	96.9
1999	55	254	22138.5	850.0	87.2	26.0	83.8
1998	54	395	23572.5	1161.9	59.7	20.3	95.1
1997	70	455	32111.8	862.6	70.6	37.2	95.5
1996	118	593	41035.9	1564.7	69.2	26.2	98.0
1995	96	598	48141.3	1862.1	80.5	25.9	97.8
1994	104	522	22359.9	1191.0	42.8	18.8	99.1
Other							
2003	5	55	74.0	95.4	1.3	0.8	
2002	9	96	125.5	899.9	1.3	0.1	
2001	5	98	106.5	413.5	1.1	0.3	
2000	7	52	785.6	1247.4	15.1	0.6	
1999	9	54	4288.6	881.4	79.4	4.9	
1998	9	37	599.4	56.6	16.2	10.6	
1997	8	34	59.7	728.0	1.8	0.1	
1996	11	34	439.2	808.0	12.9	0.5	
1995	9	22	982.7	2790.8	44.7	0.4	
1994	4	5	210.2	68.5	42.0	3.1	

12.16 Appendix 16. SHRIMP MANAGEMENT IN CORE SOUND

The banks side of Core Sound north of Drum Inlet is a shallow sand bottom area with patches of submerged aquatic vegetation (SAVs). This shallow water/SAV habitat in Core Sound south of Drum Inlet and in southern Pamlico Sound from Wainwright Island north to Oregon Inlet is protected from shrimp trawling and mechanical clam harvest by different methods. The Wainwright Island to Oregon Inlet zone along the banks is designated as a no trawl area. The area from Drum Inlet south to Cape Lookout is closed to shrimp trawling by proclamation.

The tributaries of Core Sound on the mainland side are designated as Special Secondary Nursery Areas (SSNA). They include Jarrett Bay, Brett Bay, Nelson Bay, Thorofare Bay-Barry Bay and Cedar Island Bay. These bays can be opened after August 16th when shrimp reach a harvestable size and fish abundance is at relatively lower levels. These openings are coordinated whenever possible with the October opening of Newport River to diffuse effort, even though they can now be opened as early as mid-August.

SAV is a fish habitat dominated by one or more species of underwater vascular plants and is defined by the North Carolina Marine Fisheries Commission as those habitats in public trust and estuarine waters vegetated with one or more species of submerged vegetation such as eel grass (*Zostera marina*), shoalgrass (*Halodule wrightii*) and widgeon grass (*Ruppia maritima*). SAVs occur in both subtidal and intertidal zones and may be patchy or continuous meadows. In patchy areas, bottom between the patches is also considered habitat. SAV habitat is important to the life cycle of many organisms including red drum, spotted seatrout, snapper/grouper, bay scallops, and peneaid shrimp by providing refuge, forage and spawning location as well as a nursery area. SAVs provide important ecosystem functions such as structural complexity, sediment and shoreline stabilization, primary productivity, and nutrient cycling.

The amount of SAV in North Carolina was estimated to be between 134,000 and 200,000 acres around 1990 (Orth et al. 1990; Ferguson and Wood 1994). The majority of SAV occurs in eastern Pamlico Sound and Core Sound in high salinity waters. Because light is the primary limiting factor affecting its distribution, SAV is restricted to relatively shallow waters, usually less than 1 m in depth. However, the current spatial distribution and acreage of SAV may be somewhat different and changes may have occurred since the original mapping since grass beds advance and recede over suitable habitat. Along the Atlantic coast, North Carolina supports more SAV than any other state except Florida.

Overall, there are few specific studies addressing effects of trawling over SAVs, however, the knowledge from studies in other bottoms and habitat types may be intuitively applied to what the effects of trawling over SAVs may be. These effects include leaf shearing and uprooting in areas that are heavily trawled, resulting in the loss of blades and shoots which in turn reduces the complexity and coverage of SAV beds. Turbidity effects, especially in areas of low energy where sediment types tend to be mud/silt can reduce light levels needed for photosynthesis.

Impacts from trawling over SAV may occur from the sweep of the net and the digging of the trawl doors into the sediment (ASMFC 2000). In the Gulf region, it has been noted that trawling by larger vessels in deep water (2-3 m) through SAV resulted in edges of SAV ripped up and observed masses of SAV floating on the surface following the opening of shrimp season. It was also noted that shallow SAV beds were not affected by trawling except during high tides when beds were more accessible (Eleuterius 1987).

The DMF proposes to close the banks side of Core Sound north of Drum Inlet by proclamation or extending the No Trawl area south from Wainwright Island. The affected area is too shallow to be trawled and is off limits to mechanical clam harvest, so its more formalized protection will not impact present use much.

One of the DMF's draft Coastal Habitat Protection Plan implementation tasks is to look at the present management of bottom disturbing gear and map where these activities overlap with sensitive habitat. Modification of these lines, where they exist, is to be examined. Another task is to modify shrimp trawling areas through the ongoing Shrimp Fishery Management Plan process to restrict trawling over or immediately adjacent to shell bottom, SAV, or nursery areas and maintain an adequate buffer. These tasks are also being considered as we think about criteria for management of shrimp trawling areas and where we have inconsistencies, like northern Core Sound, this is an opportunity to correct them.

The catches of shrimp in Core Sound after the late October openings of the SSNAs have comprised between 1.1% and 4.7% of the total Core Sound landings since the year 2000. Although the SSNA waterbodies are included in the Core Sound total and cannot be separated, it is apparent that in most years, October signals the end of shrimping. If the Core Sound SSNAs were to be closed, there is still and opportunity to catch the shrimp in Core Sound proper, but trawling would be largely be limited to the channel only.

Management Options/Impacts

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

1) Status quo (potential to open up to PNA line when shrimp size sufficient)
+ Flexibility in reacting to variable conditions (excessive rainfall, early migration)
+ No need for further rulemaking
- Does not minimize harvest of small shrimp and bycatch
- Does not encourage the use of more environmentally friendly gear
- Does not prevent damage to shellfish plantings, natural rocks and leases
- Labor intensive and expensive to sample
- Necessitates “grand openings”

2) Prohibit all shrimp trawlers in SSNAs of Core Sound
+ Bycatch issue completely eliminated
+ Potential for healthier shellfish/finfish stocks
+ Protection of SAVs present
+ Decrease navigational and fixed vs. mobile gear conflicts in inside waters
- Eliminates potentially lucrative opening day for fishermen
- Much less “downstream” area to catch shrimp before they migrate to ocean
- Loss of income to commercial fishermen and dealers
- Loss of recreational use of shrimp resource

3) Status quo (Core Sound banks side opened)
+ Does not eliminate bottom that may be trawled by small trawlers
- Does not protect SAV
- Does not protect species using SAV

4) Close grassbed areas on the bank side of northern Core Sound
+ protects additional habitat areas
+ protects species utilizing SAV
- May eliminate bottom trawled by small trawlers

AC, DMF, and MFC Recommendation: Make banks side north of Drum Inlet to Wainwright Island a Trawl Net Prohibited Area (Option 4).

12.17 Appendix 17. SHRIMP MANAGEMENT IN THE NEWPORT RIVER

The Newport River is relatively small estuary of about 63 square miles located north of Morehead City in Carteret County. Its average depth is three feet with maximum depth in natural channels of six feet and 40 feet in the dredged channels near the State Port. The western portion of Newport River has bottoms composed of silts, clays and oyster rocks and the eastern part is composed of firm sand bottom. The river has a long history of disagreements concerning where the proper location of the shrimp line should be. During the long period of conflict that peaked in the mid-1980s, the line would be moved three or four times a season in response to political lobbying and shrimp size variation.

Shrimp harvest generally begins in June when there are pink shrimp present and can continue into November when white shrimp are abundant. Although the conflict over the location of the line has greatly decreased in recent years, Newport River is still the source of controversy at times in the fall. The primary conflict is between the full-time commercial fishermen, who generally want a line downstream where the bigger shrimp will migrate to them when they reach a marketable size, and the part-time fishermen, who want a line farther upstream to access the shrimp in shallower water, harvest the majority of them, and return to jobs or hunting season. Landings after the October opening dates for the years 2000 through 2003 ranged from 3.4% of total Newport River landings to 25.5%. The line has moved back and forth among four lines since 1968, when the line was at the Cross Rock.

The western half of the Newport River has been the target of significant shellfish management efforts over the past 30 years. Natural oyster rocks extend from the Cross Rock in the western part of the river through White Rock at the mouth of Harlowe Creek. They also exist along the shores of Newport River Marshes and the entrance to Core Creek. The DMF has planted approximately 133,000 bushels of cultch material in the western portion of Newport River since 1987 (and more prior to that). Several designated Shellfish Management Areas (SMAs) have been created for the purpose of expanding the natural rocks like Flat Rock, White Rock, Turtle Rock and the Bullseye Rock. Surf clam shells proved to be an effective cultch material for the protection of clam spat along the White Rock line and elsewhere.

There are two concentrations of shellfish bottom leases in the Newport River; one in the central part of the river from Oyster Creek west to Mill Creek, and the other along the eastern shore of the river between Russell and Ware creeks. At the present time, there are about 55 active leases consisting of about 325 acres of bottom. This acreage represents approximately 10% of the state’s total leased bottom.

In recent years, the line has been located from Penn Point to the boat ramp at Hardesty Farms subdivision. This line has been a successful one in that it protects the smaller shrimp that move out of Harlowe Creek in the early summer and provides a buffer when the abundance of juvenile shrimp, heavy rainfall or strong northerly winds move the shrimp downstream of their normal location. The Penn Point-White Rock line is favored by smaller trawlers who can operate in the shallow waters at the mouth of Harlowe Creek. The Penn Point-Hardesty Farm line is longer and deeper providing more maneuvering room for the trawlers.

The Primary Nursery Area (PNA) line presently runs from Lawton Point through the Bullseye Rock to the north shore and from there to the line form Harlowe Creek south to Penn Point is designated a Special Secondary Nursery Area (SSNA). Nursery area sampling records indicate that spot, croaker, brown shrimp, blue crab and southern flounder are the top species captured. The SSNA designation allows shrimp trawling to occur after August 16 each year and the river is generally opened to the PNA line in mid-October, in conjunction with the Core Sound SSNA tributaries. This causes problems between leaseholders and trawlers because the leases are often trawled over causing the cultch material and oyster resources on them to be covered in sediment, particularly on a rising tide. A rule making it unlawful to trawl over properly marked leases was enacted in 1992 and the DMF's Shellfish Management Areas are marked as adequately as possible in October, but violations still occur. Frequent complaints arise from shellfishermen when the area is opened to trawling.

There are no seagrass beds in Newport River except a small bed east of Phillips Island off the Intracoastal Waterway. Mechanical clam harvest has been allowed in the eastern half of the Newport River and the mouth of Core Creek since 1979 or before.

As is the trend elsewhere in Carteret and Onslow counties, there is a move toward the use of skimmer trawls in Newport River. Shrimp landings from skimmer trawls over the period 1994-2003 have averaged 76.83%, while otter trawls have averaged 20.28% of the total during that period. Although originally used for white shrimp, the Newport River fishermen have become adept at capturing brown shrimp successfully with skimmer trawls too. Total landings of all shrimp by all gears in the Newport River since 1994 have ranged from 71,793 lb to 307,504 lb and averaged 201,206 lb. The number of trips averaged 1042 per year during that period.

Proponents of trawling above the Penn Point-Hardesty Farms line in October cite the lack of growth of remaining shrimp due to falling water temperatures and the need to stir up sedimentation by trawling to remove silt from the upper river. They claim that stirring the bottom removes silt (at least at ebbing tides), keeps it oxygenated (or alive), and exposes old oyster rocks and plantings to new spat set the following spring.

A Sea Grant funded Duke University Marine Lab Study by Kirby-Smith and Costlow (1996) states that the Newport River has filled in 16 inches over the past 81 years and rates averaged 2/10 inch per year with a maximum of ½ inch per year during the 1990s. This rate exceeds the present rate of sea level rise. Therefore, it seems that trawling will ultimately have little effect on the natural process of filling of the river.

Management Option/Impacts

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

1) Status quo (potential to open to PNA line when shrimp size sufficient)
    + Flexibility in reacting to variable conditions (excessive rainfall, early migration)
    + Access to resource by a variety of users
    + No need for further rulemaking on the use of trawls in the SSNA
    - Does not minimize harvest of small shrimp and bycatch
    - Does not prevent damage to shellfish plantings, natural rocks and leases
    - Labor intensive and expensive to sample
    - Necessitates "grand openings"

2) Establish timeline when otter trawls would be prohibited
    + More time for fishermen to adapt to change
    + Possible decreased financial hardship
    + Trend already to skimmer use
    - No immediate remedy for waste/fish kills on opening day
    - No immediate benefits to SMAs and leases
    - Trend already to skimmer use

3) Implement permanent line at Penn Point-Hardesty Farm line
    + Eliminates grand openings
    + Protection of shellfish plantings, natural oyster rocks and leases
    + Longer and deeper line for less congestion when trawling
    - Lose flexibility of management by proclamation

4) Prohibit all shrimp trawlers in Newport River
    + Bycatch issue completely eliminated
    + Potential for healthier shellfish/finfish stocks
    + Protection of leases and SMAs
    + Decrease navigational and fixed vs. mobile gear conflicts in inside waters
    - Eliminates potentially lucrative opening day for fishermen
    - No "downstream" area to catch shrimp before they migrate to ocean
    - Loss of income to commercial fishermen and dealers
    - Loss of recreational use of shrimp resource
    - Inconsistent with allowance of mechanical clam harvest

AC, DMF, and MFC Recommendation: Implement permanent Penn Point-Hardesty Farms line (Option 3)

12.18 Appendix 18. SHRIMP MANAGEMENT IN BOGUE SOUND AND NORTH RIVER

Bogue Sound is located in Carteret County and lies between the State Port in Morehead City to the east and the town of Emerald Isle to the west. The sound is closed to trawling north of the Intracoastal Waterway (ICW) on the mainland side because of SAV and some shellfish beds. The tributaries of Broad, Gales, Jumping Run, and Saunders creeks are designated Primary Nursery Areas. The closure of the mainland side of the ICW serves as a buffer zone to the PNAs and shrimp are harvested from the ICW as they are migrating toward the inlets (Beaufort and Bogue). There have been requests to open the northern side of the ICW, particularly around Broad Creek when white shrimp are abundant. These requests usually come from skimmer trawl fishermen who have problems fishing in the waterway.

There is also a triangular section of Bogue Sound in the western portion that is closed to trawling in order to protect seagrass beds with bay scallops which are located there. Most of Bogue Sound outside of the ICW is too shallow to trawl in, bit there is a channel on the banks side that runs along the village of Salter Path and one that runs along Pine Knoll Shores that are trawled.

Shrimp landings in Bogue Sound from 1994 to 2003 have ranged from 9,906 pounds to 127,781 pounds and averaged 40,340 pounds. Value of shrimp catches during those years ranged from $13,484 to $155,164 and averaged $66,896. The Bogue Sound shrimp trawl fishery is important to the local Broad Creek and Salter Path area shrimpers and a very popular recreational (RCGL) shrimping location. Of the commercial landings from 1994 through 2003, 41.47% were harvested by shrimp trawls, 36.73% by skimmer nets, and 21.54% by channel nets. During that period, trips made ranged from 24-217 and averaged 130 a year.

Management Option/Impacts

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

1) Status quo (opening dates determined by shrimp size)
   + Flexibility in reacting to variable conditions (excessive rainfall, early migration)
   + Access to resource by a variety of users
   + No need for further rulemaking
   - Does not minimize harvest of small shrimp and bycatch
   - Does not encourage the use of more environmentally friendly gear
   - Does not prevent damage to shellfish plantings, natural rocks and leases
   - Labor intensive and expensive to sample

2) Establish a timeline when otter trawls would be prohibited in Bogue Sound
   + More time for fishermen to adapt to change
   + Possible decreased financial hardship
   - No immediate remedy for waste/fish kills on opening day
   - No immediate benefits to SMAs
   - Eliminates ICW trawling

3) Prohibit all otter trawls and skimmer trawls in Bogue Sound
   + Bycatch issue completely eliminated
   + Potential for healthier shellfish/finfish stocks
   + Decrease navigational and fixed vs. mobile gear conflicts in inside waters

- Eliminates potentially lucrative opening day for fishermen
- No “downstream” area to catch shrimp before they migrate to ocean
- Loss of recreational shrimp fishery
- Loss of income to commercial fishermen and dealers

AC, DMF, and MFC Recommendation: Status quo

North River:

North River is located west of Beaufort and east of Harkers Island. It also has a history of line moving disputes between a downstream line at Long Point line and an upstream line called the Oyster House line. Both lines were established to protect small brown shrimp in the early summer (Long Point line) and small white shrimp in the fall (Oyster House line). The source of conflict was the appropriate time to open trawling up to the Oyster House line. Concerns with opening the area too late include the shrimp running on a northeast wind as well as running on rain and/or full or new moon because of its close proximity to Beaufort Inlet.

In June of 1997, a public meeting was held in Harkers Island to discuss the best way to manage the river for the benefit of the most users, while protecting small shrimp. At that meeting, there was unanimous agreement to move the Wards Creek line downstream to the mouth of the creek and move the Long Point line upstream to the next point north. These lines offered deeper water, more shelter to work in a northeast wind and provided an adequate buffer for both brown and white shrimp. It was agreed that these lines would become “permanent lines” in North River and not moved. During years when shrimp are abundant there is an occasional spillover of shrimp downstream of those lines and on one or two occasions since 1997 when high winds and rainfall amounts have pushed small shrimp below the lines, the Long Point line was temporarily used to protect them. However, once the proclamation was issued, there was pressure from fishermen to honor the permanent line. Now the DMF continues to keep this line as a closure line unless unusual conditions such as in 2003 where high amounts of rainfall displaced small shrimp into open areas causing the DMF to close all of North River as well as the Straits.

The shrimp landings in North River/Back Sound from 1994 to 1999 have ranged from 27,391 pounds to 216,045 pounds and averaged 125,214 pounds. Values during that period ranged from $53,066 to $309,372 and averaged $240,830. The North River landings are combined with those of Back Sound, which confounds things due to the significant numbers of channel net landings in Back Sound.

Of the commercial catch in North River/Back Sound between 1994 and 2003, 66.23% of it was caught using skimmer nets, 21.05% was captured by shrimp trawls, and 12.54% was caught with channel nets. Number of trips ranged from 40 to 524 and average 186 per year.

Management Option/Impacts

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

1) Status quo (negotiated “permanent line”)
   + Known, unchanging line that offers working area protected from northerly winds)
   + Access to resource by a variety of users
   + No need for further rulemaking

+ Prevents damage to shellfish leases and natural oyster rocks
- Does not minimize harvest of small shrimp and bycatch
- Does not encourage the use of more environmentally friendly gear

2) Prohibit all otter trawls and skimmer trawls in North River
+ Bycatch issue completely eliminated
+ Potential for healthier shellfish/finfish stocks
+ Decrease navigational and fixed vs. mobile gear conflicts in inside waters
- No "downstream" area to catch shrimp before they migrate to ocean
- Loss of recreational shrimp fishery
- Loss of income to commercial fishermen and dealers

AC, DMF, and MFC Recommendation: Status quo

12.19 Appendix 19. SHRIMP MANAGEMENT IN THE WHITE OAK RIVER

White Oak River is located on the Onslow/Carteret County line and has the town of Swansboro at its mouth. The Highway 24 bridge and causeway system has effectively altered the normal tidal flow and shoals have been formed in its southern portions as the flood tide sediment settles out. Flow out of the river during ebb tide is largely confined to the western side of the river along the Swansboro side. The river has a deep channel up to and past Jones Island and then narrows about halfway up to a small natural channel whose buoys are maintained by the Wildlife Resources Commission. There are many oyster rocks in the lower half of the river, but due to overcrowding, lack of sufficient flow and food, very few oysters reach the three inch minimum size for harvest. More oyster rocks are found upstream which grow larger, but sources of pollution have caused the river to be closed to shellfish harvest north of Hancock Point. There are a few clumps of seagrass in Hills Bay and clams are found in the shell beds in the lower half of the river.

The White Oak commercial shrimp landings have declined from 45,019 lbs. in 1994 to 8,690 lbs. in 2003. A total of 802 trips was taken by 180 licensees during that same ten year period. Recreational shrimp trawlers work the White Oak River, especially on opening days. Shrimp from the river have traditionally filled recreational fishermen's freezers and also supplied a market for bait shrimp at the Bogue Banks ocean fishing piers.

Due to the presence of oyster rocks and shoals, there are only a few places that are able to be trawled in the White Oak. They are Hills Bay below Jones Island, the mouth of Pettiford Creek, the Turnstake, Cahoon's Slough above Jones Island, and the Gator Gap upstream near Bluff Point.

The river is closed at the Highway 24 Bridge with the issuance of the first shrimp proclamation in early June. Sampling for opening White Oak River generally begins around the end of June because of the tendency for shrimp there to migrate out before they "normally should". Historically, the DMF has opened White Oak between July 10 and July 20. For years, the river was opened to the Gator Gap where the river widens near Bluff Point. Small shrimp were often forced across that line and the DMF has tried alternative line locations with varying success that allow for shrimping in the lower portion of the river while protecting small brown and white shrimp upstream. Adjusting the line is difficult due to the amount of oyster rocks in the river. Shrimpers like to tow on the line, therefore placement of the line over oyster rock can lead to habitat destruction of those rocks.

Issues that must be considered in the management of this river besides shrimp size are weather conditions and lunar stage. Early northerly winds with a lot of rain or a hurricane can force the small shrimp to run before the normal opening dates. A full or new moon on top of that may also cause the DMF to open on a smaller count so they can be caught.

Occasionally, shrimp will not reach a 45-55 count but will remain at a small size throughout the season. In this case, the DMF may open on a smaller count. The river may or may not close due to small white shrimp. Over the past few years, once the river has been open, a closure for small whites has not been needed as the two species seem to segregate within the river very well with small whites staying up the river above the closure line in the lower salinities while the larger brown shrimp have moved down in the open area. However, when there is good sign of small white shrimp, the river has been closed in September.

With the bridge being the closure line, there is no shrimp trawling allowed in White Oak

River when it is closed. If the shrimp leave before the river is opened, then the only fishermen who benefit are a few channel net fishermen and maybe ocean trawlers. Options have been considered to leave the river closed at all times to protect the oyster rocks, but that is inconsistent with permitting mechanical clam harvest up to the Turnstake and does not allow trawlers to catch the shrimp at all. The mechanical harvest of clams is permitted in the White Oak every other year and is rotated with the New River in a successful strategy to conserve each river's clam resource.

Management Option/Impacts

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

1) Status quo (opening dates determined by shrimp size)
+ Flexibility in reacting to variable conditions (excessive rainfall, early migration)
+ Access to resource by a variety of users
+ No need for further rulemaking
- Does not minimize harvest of small shrimp and bycatch
- Does not encourage the use of more environmentally friendly gear
- Does not prevent damage to shellfish plantings, natural rocks and leases
- Labor intensive and expensive to sample
- Necessitates "grand openings"

2) Establish a "permanent" line from the Turnstake downstream to allow harvest when shrimp begin to migrate
+ Eliminates the all or nothing aspect of White Oak harvest
+ Establishes permanent line that would not change
+ Protects upstream SMAs and natural rocks
+ Eliminates grand openings
- Potential for small shrimp harvest during unusual weather events

3) Establish a timeline when otter trawls would be prohibited in White Oak River
+ More time for fishermen to adapt to change
+ Possible decreased financial hardship
- No immediate remedy for waste/fish kills on opening day
- No immediate benefits to SMAs

4) Prohibit all otter trawls and skimmer trawls in White Oak River
+ Bycatch issue completely eliminated
+ Potential for healthier shellfish/finfish stocks
+ Decrease navigational and fixed vs. mobile gear conflicts in inside waters
- Eliminates potentially lucrative opening day for fishermen
- No "downstream" area to catch shrimp before they migrate to ocean
- Loss of recreational shrimp fishery
- Loss of income to commercial fishermen and dealers

AC Recommendation: Status quo with a recommendation to straighten the Hancock Point area line for ease of enforcement

DMF, and MFC Recommendation: Status quo except that the line shall not be placed upstream of the Hancock Point area for protection of oyster rocks and small shrimp

12.20 Appendix 20. SHRIMP MANAGEMENT IN THE NEUSE RIVER

The Neuse River is one of the state's larger rivers and separates Pamlico County to the north from Craven and Carteret counties to the south. The river is one mile wide at New Bern and five miles wide near its mouth, with depths in that stretch ranging from 12 to 23 feet in the deepest parts. Although shrimp and crab trawling are technically permitted from New Bern downstream to the Pamlico Sound (except when closed due to small shrimp size), shrimp are only found as far upstream as Slocum Creek. The majority of the Neuse tributaries are designated primary (2,835 acres), secondary (2,358 acres), or special secondary (963 acres) nursery areas. Shrimp generally grow in these nursery areas during the early spring and begin migrating out of them and into the river proper in July. Once in the river, they migrate around Cedar Island into Core Sound, or down Adams and Clubfoot creeks toward Beaufort Inlet to the ocean.

There are few seagrass beds that have been mapped in Neuse River. Several established oyster rocks have been located in the in the Neuse River, but are not formally mapped. During the 1980s and 1990s, there were fairly regular fish kills associated with low dissolved oxygen levels in the July-August period in deeper waters when winds were calm and there was little rainfall.

Neuse River ranks third in the state behind Pamlico and Core sounds in shrimp trawl landings. From 1994 to 2003 landings have ranged from 19,942 pounds to 216,922 pounds and averaged 135,369 pounds. Value of shrimp catches during those years ranged from $43,989 to $471,504 and averaged $ 304,502. Of the commercial landings in Neuse River from 1994 through 2003, 95.72% were harvested by shrimp trawls, 3.84% by skimmer nets, and 0.25% by channel nets. During that period, 4,542 trawl trips were made by 824 licensees for an average of 452 trips per year by 82 participants.

For the period from 1994 through 2003, the month of July has produced the most landings. On average, June accounted for 15,1% of the total, July accounted for 49.5%, and August 13.5%. September and October landings represented 10.9% and 7.1% of the grand total. The remaining months accounted for only 3.9% of the total landings (Table 1).

The breakdown of the market grades (heads on per pound) for the months of June, July and August during the 1994 through 2003 period reveal the progression of shrimp growth through the summer. These landings data are taken from trip tickets with landings reported as heads on. In June, 21.66% of the catch was 31-35 count, 20.57% of the catch was 36-40 count and 13.81% of the catch was 26-30 count. The shrimp continue to grow and in July, 34.46% of the catch was 26-30 count, 19.48% was 16-20 count and 16.56% was 31-35 count. In August, 29.53% of the catch was 20-25 count, 19.48% of the catch was 16-20 count, and 12.25% of the catch was 26-30 count.

The Neuse River tributaries, particularly Clubfoot, Adams, Broad creeks and offshore Oriental provide the Recreational Commercial Gear License (RCGL) shrimp trawl fishermen with very important recreational shrimping locations. In 2003, 43% of the reported state RCGL shrimp trips were made in the Neuse River, with 17,134 pounds of shrimp caught.

Table 1. Neuse River monthly shrimp landings 1994-2003.

	Year									
Month	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Jan	0	0	0	0	0	0	0	0	0	0
Feb	0	0	0	0	0	0	0	0	0	0
Mar	0	42	284	0	0	0	0	0	0	0
Apr	0	0	7	10	0	0	0	0	423	0
May	2,131	2,395	59	0	0	293	0	0	6,543	0
Jun	8,457	24,688	7,377	2,786	25,575	15,534	30,596	581	67,432	12,897
Jul	42,900	18,318	67,212	36,562	13,636	156,384	143,645	12,780	89,561	60,587
Aug	17,850	12,803	21,528	62,750	3,187	13,154	14,814	4,300	10,559	18,629
Sep	15,578	18,936	8120	35,133	20,981	24,500	2,448	1,230	8,341	5826
Oct	21,414	19,344	413	17,674	19,241	997	1,414	151	10,354	447
Nov	6,648	12,513	770	3,518	1,130	725	1,117	0	6,564	0
Dec	0	49	673	0	0	0	0	0	30	0
Total	114,978	109,088	106,443	158,433	83,750	211,587	194,034	19,042	199,807	98,386

In past years, the management of the Neuse River has included opening the river in early June and leaving Adams Creek and West Bay opened (Figure 1). In years when shrimp are scarce or of average abundance, the closure lines stay the same the entire year. When there are great numbers of juvenile shrimp in the tributaries, they may move out “early” in search of room and food, or due to heavy rainfall in the critical weeks prior to their reaching harvestable size. During these years, the presence of small shrimp necessitates closures to protect the small shrimp until they reach harvestable size.

South River is currently left opened to trawling. It rarely contains shrimp, but is trawled regularly during the summer months for crabs. Most of Turnagain Bay is a Special Secondary Nursery Area, which opens with the other SSNAs in October.

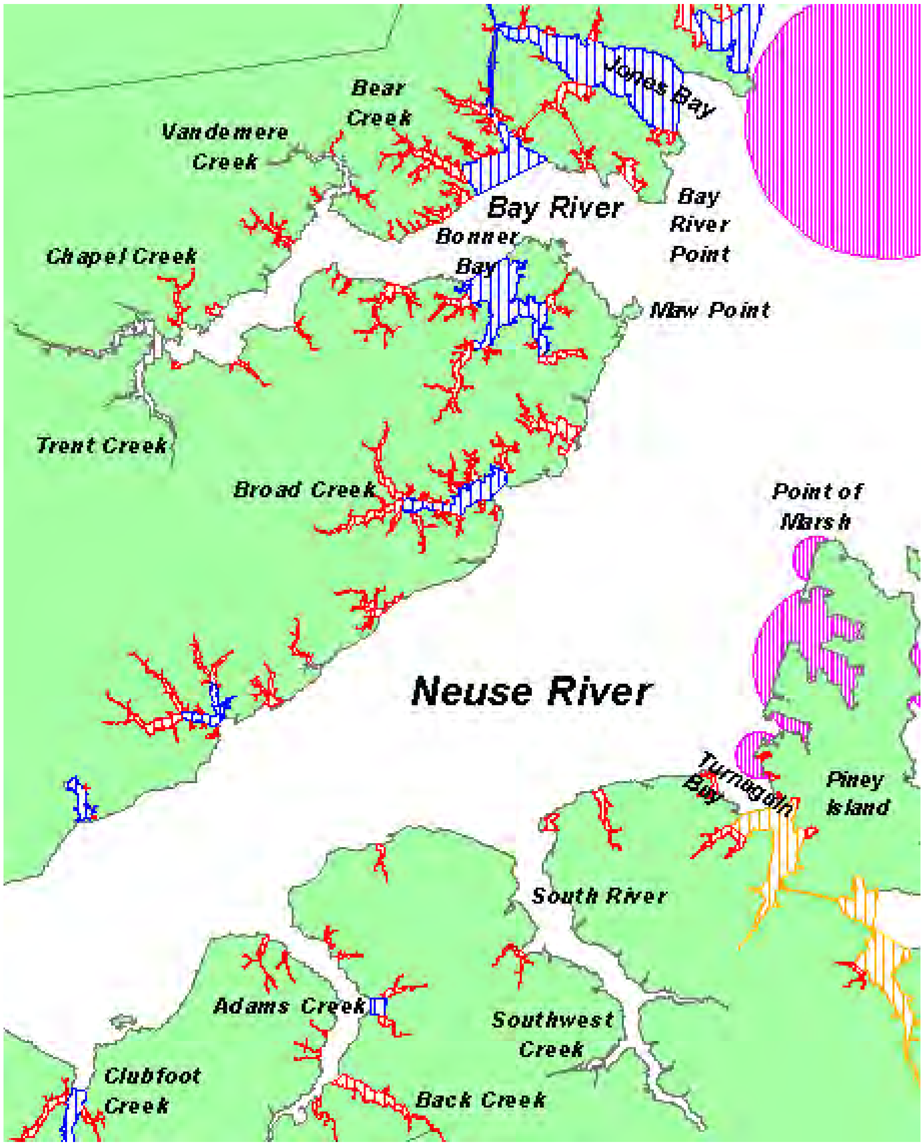


Figure 1. Neuse River open.

In reviewing the past eleven years' proclamations, the shrimp season began with a June opening and did not have to be closed for three years (Figure 1). For six out of the eleven years, after the June opening, tributary creeks had to be closed in mid-June and were reopened in mid-July. In 2001 and 2002, the initial June proclamation had the Neuse River closed to the mouth due to small shrimp present in the normally opened waters at the beginning of the season.

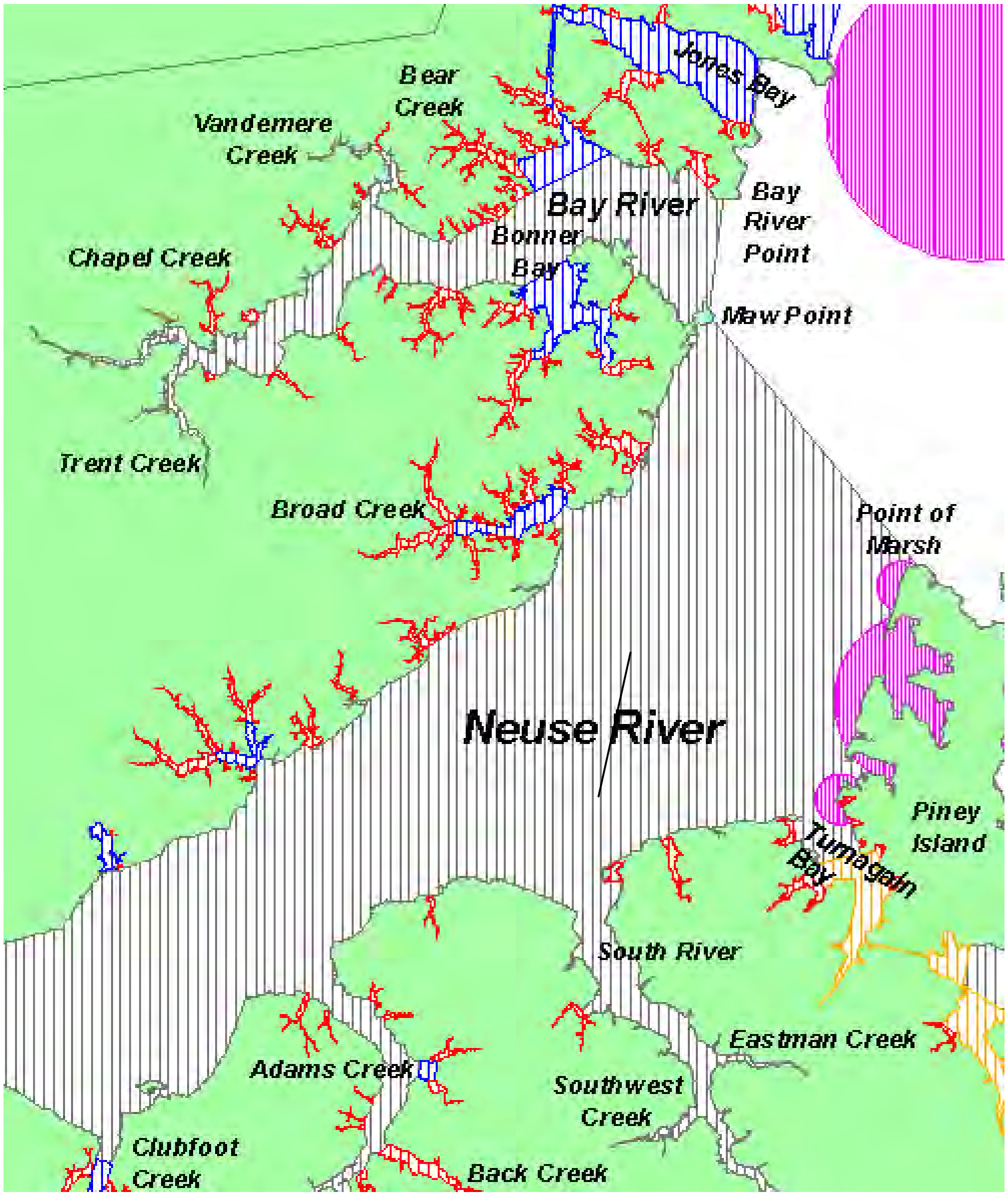


Figure 2. Neuse River closed.

The line that protects small shrimp on the north side of the river runs along the channel markers from Dawson Creek to the mouth of Neuse River. This line was used in 1999 for the first time and again in 2000 when overcrowding, weather, or both forced small shrimp out of the Oriental area creeks and complaints began about catching small shrimp (Figure 3). The line along the channel markers is a difficult line to enforce and often the same size shrimp will be found on the open side of the line as in the closed area. The capture of small shrimp in that area is wasteful and some closure line is warranted.

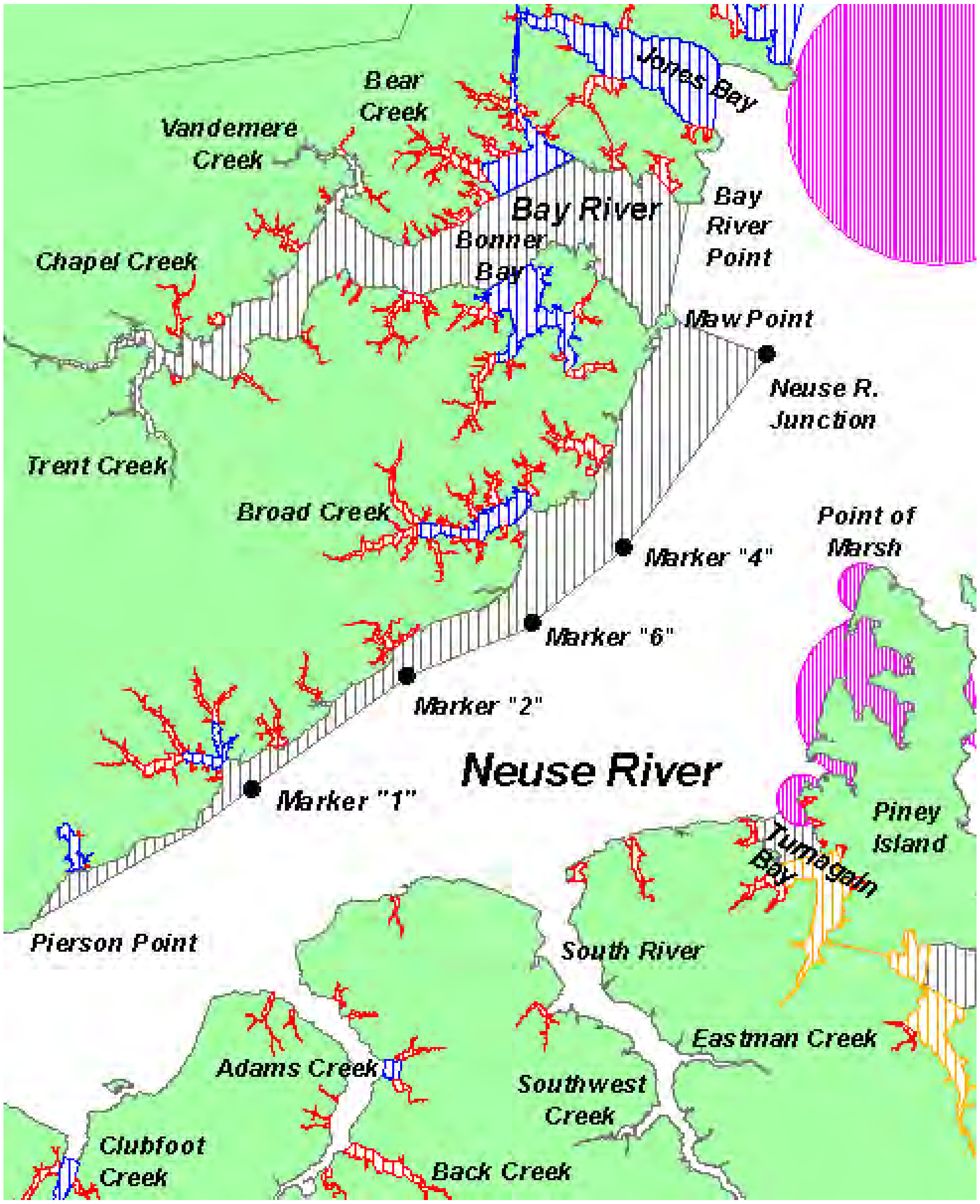


Figure 3. North side of Neuse River closure.

Once closed, either at the channel markers or at the river's mouth, there is always a considerable difference of opinion among the public as to what the appropriate opening size is, with larger commercial boats wanting a larger count and RCGL fishermen being satisfied with 40 or 50 (heads on) count shrimp for their freezers. DMF sampling is conducted to determine the shrimp size and the river has been opened on approximately 30-35 count shrimp in mid-July. When the river, creeks and bays are opened, even though there is a conscious effort to open as many areas as possible together to distribute the fishermen, there is always the grand opening aspect to contend with. For example, as many as 200 boats have been present for past opening days in Adams Creek. This causes navigation hazards in concentrated areas, increases bycatch mortality, and reduces the number of shrimp available for the remainder of the season (catching the majority of them up at one time).

Several changes to blue crab management proposed in the 2004 Blue Crab Fishery

Management Plan update will have indirect benefits to the Neuse River shrimp fishery. The change in designated crab pot areas in most areas of the Neuse River from a distance offshore to the six-foot depth contour and prohibiting trawling within that contour from June through November will greatly decrease shrimp trawling effort in the river, particularly by the smaller commercial vessels and the RCGL fishermen. The same plan proposes to make the minimum mesh size for crab trawls in the western half of Pamlico Sound and its tributaries, including Neuse River, four (4) inches stretched mesh. This should reduce impact on finfish and shrimp. These rules are scheduled to be effective September 1, 2005.

The availability of quantitative bycatch data is lacking in the Neuse River system. Johnson (2003) quantified the catch of shrimp trawlers working in the Neuse River (n=8 tows) during the summers of 1999 and 2000. Overall, invertebrates made up 24% of the sampled catches (Table 2). Atlantic croaker (44%), and spot (33%) accounted for 77% of the finfish bycatch (Table 3). The bycatch of southern flounder in shrimp trawls is of concern given the status of the stock. Figure 4 shows the catch-per-unit-effort (CPUE) of southern flounder captured in the DMF's Pamlico Sound survey. The overall CPUE of southern flounder in the Neuse River is seven fish per tow (1987-2003). The CPUE for the upper and middle section of the river is six per tow and for the lower section, nine southern flounder caught per tow.

Table 2. Catch composition (top ten) by weight for shrimp trawl catches in the Neuse River (Johnson 2003).

Rank	Species	Total weight (lbs)	Percent of total catch	Frequency of occurrence
1	Croaker	1,021	32.82	8
2	Spot	783	25.15	8
3	Shrimp	354	11.37	8
4	Blue crabs	341	10.94	8
5	Other fish (undivided, etc.)	150	4.82	6
6	Pinfish	103	3.30	4
7	Menhaden	95	3.05	4
8	Invertebrates (other)	67	2.14	8
9	Flounder, other or unspecified	53	1.70	5
10	Unknown drum species	50	1.60	3
			96.91	

Table 3. Finfish catch composition (top ten) by weight for shrimp trawl catches in the Neuse River (Johnson 2003).

Rank	Species	Total weight (lbs)	% of total catch	Frequency of occurrence
1	Croaker	1,021	43.45	8
2	Spot	783	33.30	8
3	Other fish (undivided, etc.)	150	6.38	6
4	Pinfish	103	4.37	4
5	Menhaden	95	4.04	4
6	Flounder, other or unspecified	53	2.25	5
7	Unknown drum species	50	2.12	3
8	Mackerel	30	1.26	4
9	Cutlassfish	22	0.92	2
10	Silver perch	11	0.45	2
			98.53	

Management Option/Impacts

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

1. Status quo (potential to close and open when shrimp are of sufficient size)
   + Flexibility in reacting to variable conditions (excessive rainfall, early migration)
   + Access to resource by a variety of users
   + No need for further rulemaking on the use of trawls in the SSNA
   - Does not minimize harvest of small shrimp and bycatch
   - Labor intensive and expensive to sample
   - Sometimes necessitates “grand openings”

2. Implement closure of Neuse River and Adams Creek with initial June proclamation and open in mid July when the majority of the shrimp reach 30-35 count (heads on).
   + Protection of small shrimp and juvenile fish and crabs using bay and creek mouths
   + Potential for larger shrimp when trawling is opened
   - Lose flexibility of management by proclamation
   - Loss of resource to RCGL and smaller commercial trawlers
   - Differing sizes of shrimp in different bays

3. Prohibit all shrimp trawlers in Neuse River and tributaries
   + Bycatch issue completely eliminated
   + Potential for healthier shellfish/finfish stocks
   + Decrease navigational and fixed vs. mobile gear conflicts in inside waters
   - Loss of income to commercial fishermen and dealers
   - Loss of recreational use of shrimp resource

4. Prohibit shrimp and crab trawling (Prohibited Trawling Area) upstream of a line from Wilkinson Point to Cherry Point (Figure 5)
   + Potential reduction in bycatch
   + Less impact to bottom habitat from trawling
   - Potential loss of shrimp during years when they occur upstream of that line

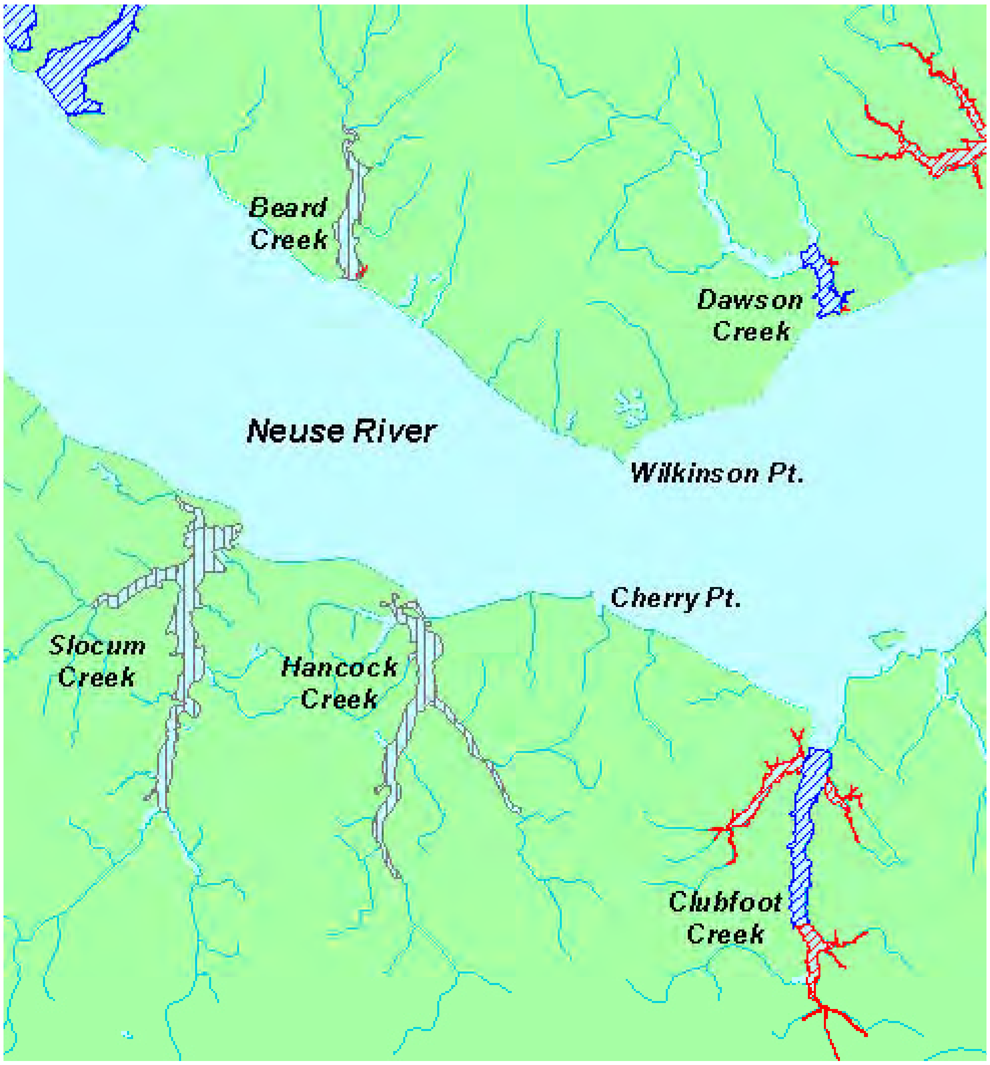


Figure 5. Option 4

AC Recommendation: Open on 26-30 count heads-on count on or after July 7. Restrict total headrope to 90 feet upstream of a line between Windmill Point at Oriental and Winthrop Point at Adams Creek.

DMF Recommendation: Close in mid-June to allow for pink shrimp harvest, open in mid-July to maximize brown shrimp catch (31-35 count) and close in mid-October (or whenever majority of white shrimp have left).
Never open above Wilkinson Point to Cherry Point to reduce overall trawling impact on river bottom and crabs and finfish.

MFC Recommendation: Restrict total headrope to 90 feet upstream of a line between Windmill Point at Oriental and Winthrop Point at Adams Creek**.** Never open above Wilkinson Point to Cherry Point to reduce overall trawling impact on river bottom and crabs and finfish.

12.21 Appendix 21. SHRIMP MANAGEMENT IN BAY RIVER

Bay River is a tributary of Pamlico Sound, located in Pamlico County, between the Pamlico and Neuse rivers (Map 1). The main bottom type in Bay River is soft mud, with patches of hard sand bottom. The shallow waters of the feeder creeks and bays contain patches of submerged aquatic vegetation (wild celery, and widgeongrass).

Trawling (shrimp and crab) is only allowed in the main stem of the river. All feeder creeks and bays are classified as either Nursery Areas (Primary or Secondary) or no trawl areas (Map 2). Other commercial fisheries in Bay River include crab pot, crab trawl, gill net, oyster, and long-haul.

Since 1994 Bay River has been closed five times to protect small shrimp. Most closures occur in mid to late June with openings in mid-July. The river is closed west of a line from Bay Point to Maw Point (Map 2).

Bay River accounts for 0.2% of the total statewide shrimp production. Average annual shrimp landings are 13,917 pounds, with an average dockside value of $31,562. Ninety-seven percent of the shrimp landed from Bay River are caught by shrimp trawls (1994 – 2003 Trip ticket Data). The remaining shrimp landings were reported from skimmer trawls (2.99%), crab pots (0.11%), crab trawls (0.01%), and channel net (0.02%). Landings from crab pots (June), crab trawls (March), and channel nets (August) were reported in 1995, while skimmer trawl landings were reported in July 1999.

Bay River ranks 13th in shrimp landings by shrimp trawls with average landings of 13,481 pounds per year (Figure 1). The average dockside value of these landings is $30,432. In addition to shrimp, an average of 1,453 pounds of marketable bycatch with a dockside value of $1,022 is landed by shrimp trawls from Bay River. The landed bycatch is composed of blue crabs (91%; 1,323 pounds/year), finfish (9%; 127 pounds/year), and mollusks (0.12%; 2 pounds/year). Weakfish are the most common finfish species landed with average annual landings of 45 pounds (Table 1), 95% of which are landed in July (Table 2). Flounder are the second most common finfish species with 36 pounds landed annually. Eighty-three percent of the flounder are landed during July (48%), October (20%), and April [15% (Table 2)].

July accounts for 58% of the shrimp landings from shrimp trawls for Bay River (Tables 2 and 3). The months of June (26%) and August (12%) are the other two main months of shrimp harvest from this system (Figure 2). Tables 4 through 6 and Figure 2 show the percent contribution of daily shrimp landings by market grade for these three months.

The percent contribution of yearly shrimp trawl landings by various sized vessels is given in Table 7. Fifty-one percent of the shrimp trawl landings were harvested by vessels less than 40 feet in length (Table 8). The annual numbers of licenses with shrimp trawl landings for Bay River has average 17 since 1994 (Table 8).

No fishery dependent data is available from shrimp trawls working in Bay River. The DMF conducts a juvenile trawl survey in the nursery areas but no independent trawl surveys are conducted in the river proper. The only bycatch data available from this system is from gear testing conducted in 1996 and 1997. While these data should not be used for characterization analysis, catches can provide information on species composition and sizes of species vulnerable to shrimp trawls. In 148 ninety minute tows conducted in 1996 and 1997 with a 32 foot shrimp trawl spot accounted for 57% of the finfish bycatch. Atlantic croaker was the next most abundant species accounting for 30% of the catch; this was followed by weakfish (6%), miscellaneous finfish species (4%), and southern flounder (3%). Ninety-six percent of the southern flounder captured were sublegal. Data from the DMF's juvenile trawl survey shows that the CPUE of southern flounder in Bay River (CPUE = 4) is comparable to those seen in the Neuse (CPUE = 4), Pamlico (CPUE = 3), and Pungo (CPUE = 4) rivers, and in the Bays of Pamlico County (CPUE = 5). These data suggest that Bay River is an important nursery area for southern flounder. Given the suppressed stock scenario of southern flounder, it is unclear what specific impacts shrimp trawl bycatch has on the overall stock status at this time. However, any reduction in southern flounder fishing mortality, especially directed toward sublegal fish, would benefit the stock.

Management of Bay River should include measures to further minimize southern flounder bycatch while still achieving the overall goal and objectives of this FMP. The goal of the North Carolina Shrimp Fishery Management Plan is to utilize a management strategy that provides adequate resource protection, optimizes the long-term commercial harvest, maximizes social and economic value, provides sufficient opportunity for recreational shrimpers, and considers the needs of all user groups. To achieve this goal, it is recommended that the following objectives be met:

1. Minimize waste and enhance economic value of the shrimp resource by promoting more effective harvesting practices.

2. Minimize harvest of non-target species of finfish and crustaceans and protected, threatened, and endangered species.

3. Promote the protection, restoration, and enhancement of habitats and environmental quality necessary for the enhancing the shrimp resource.

4. Maintain a clear distinction between conservation goals and allocation issues.

5. Reduce conflicts among and within user groups, including non-shrimping user groups and activities.

6. Encourage research and education to improve the understanding and management of the shrimp resource.

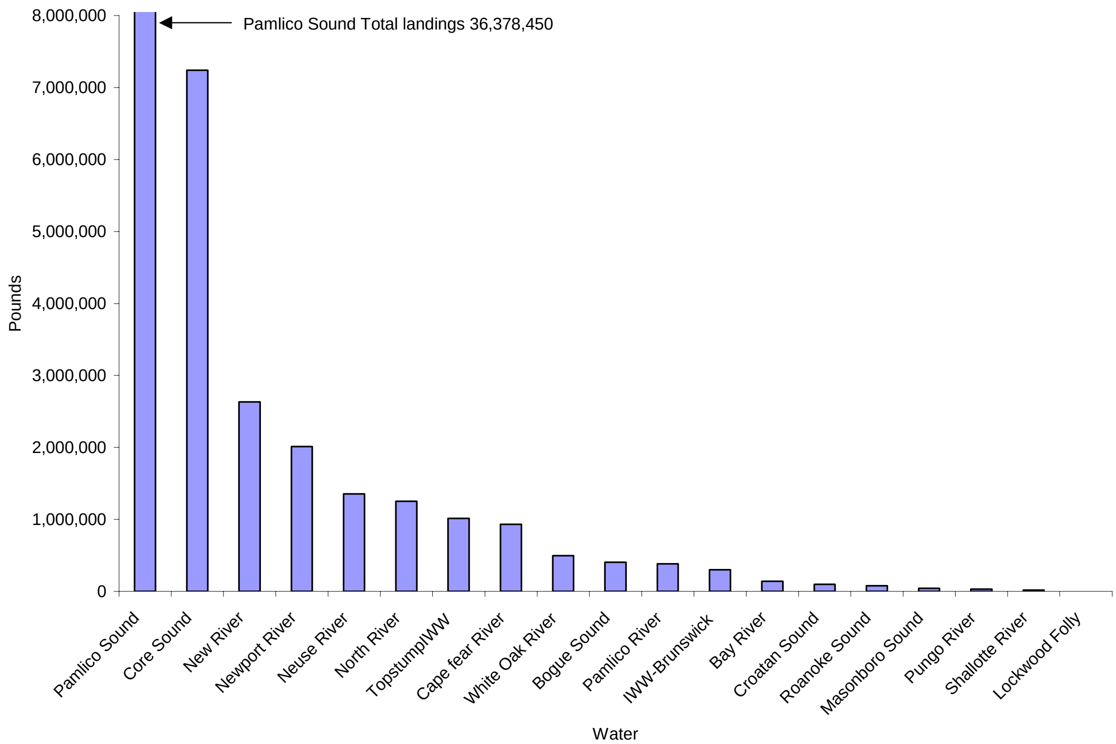


Figure 1. Total pounds of shrimp harvested by shrimp in major North Carolina waterbodies between 1994-2003.

Table 1. Landings (lbs) of finfish from shrimp trawls from Bay River North Carolina; 1994 – 2003.

Species	Total pounds	Average pounds	Percent of total
Weakfish	453	45	35.54%
Flounders	365	36	28.60%
Sea mullet	192	19	15.06%
Spot	92	9	7.22%
Fish, Mixed	70	7	5.49%
Atlantic croaker	53	5	4.16%
Pigfish	19	2	1.49%
Spanish Mackerel	16	2	1.26%
Sheepshead	6	1	0.47%
Harvestfish	4	0.4	0.31%
Butterfish	3	0.3	0.24%
Speckled Trout	2	0.2	0.16%

Table 2. Monthly percent contribution of landed shrimp trawl catch for Bay River North Carolina; 1994 – 2003.

	Month									
Species	April	May	June	July	August	September	October	November	December	Total
Shrimp	0.01%	0.07%	25.60%	58.26%	11.93%	2.11%	1.76%	0.24%	0.01%	100.00%
Blue crab	0.50%	1.53%	18.39%	52.84%	22.51%	2.18%	1.00%	0.85%	0.19%	100.00%
Weakfish	0.00%	0.00%	1.32%	90.29%	1.10%	1.88%	5.41%	0.00%	0.00%	100.00%
Flounders	14.81%	0.00%	10.01%	48.15%	3.70%	1.51%	20.16%	0.55%	1.10%	100.00%
Sea mullet	6.25%	0.00%	7.29%	77.34%	1.56%	4.69%	2.86%	0.00%	0.00%	100.00%
Spot	0.00%	0.00%	63.04%	23.91%	0.00%	7.61%	5.43%	0.00%	0.00%	100.00%
Fish, mixed	0.00%	0.00%	57.14%	11.43%	18.57%	0.00%	12.86%	0.00%	0.00%	100.00%
Atlantic croaker	0.00%	0.00%	35.85%	58.49%	5.66%	0.00%	0.00%	0.00%	0.00%	100.00%
Pigfish	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
Spanish mackerel	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
Sheepshead	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
Harvestfish	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	100.00%
Butterfish	0.00%	0.00%	33.33%	0.00%	0.00%	66.67%	0.00%	0.00%	0.00%	100.00%
Speckled trout	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
Squid	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
Total	0.10%	0.20%	24.89%	57.81%	12.80%	2.12%	1.76%	0.30%	0.03%	100.00%

Table 3. Monthly shrimp landings (lbs), and trips from shrimp trawls from Bay River North Carolina; 1994 – 2003.

Month	Total pounds	Average pounds	Percent of total	Percent of total trips
April	12	1	0.00%	0.16%
May	96	10	0.10%	0.80%
June	34,322	3,432	25.50%	11.90%
July	78,860	7,886	58.50%	44.20%
August	15,998	1,600	11.90%	21.60%
September	2,825	283	2.10%	7.90%
October	2,363	236	1.80%	10.10%
November	325	33	0.20%	3.20%
December	10	1	0.00%	0.20%
Overall	134,811	13,481		

Table 4. Percent contribution of daily June shrimp landings* by market grade for Bay River, 1994 – 2003.

	Market grade									Total	Percent of
Day	20/25	26/30	31/35	36/40	41/45	46/50	51/55	56/60	60/70	pounds	monthly total
10	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	5	0.02
12	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	123	0.47
14	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	198	0.76
17	0.00%	0.00%	0.00%	26.63%	0.00%	0.00%	0.00%	73.37%	0.00%	368	1.41
18	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	16	0.06
19	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	318	1.22
20	0.00%	0.00%	0.00%	73.03%	13.15%	13.82%	0.00%	0.00%	0.00%	1,483	5.67
21	0.00%	0.00%	35.17%	9.34%	9.46%	35.91%	0.00%	0.00%	10.12%	2,590	9.90
22	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	264	1.01
23	0.00%	0.00%	95.52%	0.00%	0.00%	0.00%	0.00%	4.48%	0.00%	1,451	5.55
24	0.00%	0.00%	0.00%	0.00%	16.36%	71.52%	12.12%	0.00%	0.00%	83	0.32
25	0.00%	0.00%	59.31%	32.26%	0.00%	0.00%	0.00%	8.43%	0.00%	1,442	5.51
26	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	46	0.18
27	0.00%	0.00%	76.08%	0.00%	0.00%	22.14%	1.78%	0.00%	0.00%	673	2.57
28	4.81%	9.25%	33.92%	36.23%	0.00%	15.79%	0.00%	0.00%	0.00%	2,724	10.42
29	0.00%	1.26%	0.00%	0.51%	0.00%	96.98%	0.15%	1.10%	0.00%	12,468	47.67
30	0.00%	62.59%	0.00%	11.40%	0.00%	0.00%	3.73%	22.28%	0.00%	1,903	7.28
Total	0.50%	6.12%	17.54%	13.08%	3.13%	53.77%	0.43%	4.42%	1.02%	26,154	100.00

*Only showing heads on landings which represent 76% of the monthly total.

Table 5. Percent contribution of daily July shrimp landings* by market grade for Bay River, 1994 – 2003.

	Market grade												Total	Percent of
Day	16/20	20/25	26/30	31/35	36/40	41/45	46/50	51/55	56/60	60/70	70/80	Mixed	pounds	monthly total
1	0.00%	0.00%	5.18%	0.00%	7.27%	4.19%	83.35%	0.00%	0.00%	0.00%	0.00%	0.00%	811	1.23
2	0.00%	0.00%	23.08%	0.00%	0.00%	0.00%	76.92%	0.00%	0.00%	0.00%	0.00%	0.00%	228	0.34
3	0.00%	0.00%	76.67%	0.00%	10.49%	2.42%	10.41%	0.00%	0.00%	0.00%	0.00%	0.00%	1,239	1.88
4	0.00%	0.00%	1.50%	33.52%	62.94%	0.00%	0.00%	0.00%	2.04%	0.00%	0.00%	0.00%	3,675	5.56
5	0.00%	0.00%	17.51%	11.60%	29.64%	41.25%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1,508	2.28
6	0.00%	0.00%	84.84%	0.00%	15.16%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	244	0.37
7	0.00%	0.00%	16.21%	74.38%	0.00%	9.41%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1,881	2.85
8	0.00%	3.11%	88.37%	3.02%	5.50%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3,475	5.26
9	0.00%	23.56%	15.92%	18.27%	42.24%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1,106	1.67
10	0.00%	1.15%	60.53%	25.51%	12.60%	0.00%	0.00%	0.00%	0.00%	0.22%	0.00%	0.00%	2,270	3.44
11	0.00%	10.96%	54.51%	4.69%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	29.85%	0.00%	1,387	2.10
12	0.00%	54.10%	12.66%	33.23%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1,011	1.53
13	0.00%	84.83%	10.67%	4.49%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	890	1.35
14	0.00%	8.89%	76.01%	10.54%	4.55%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2,789	4.22
15	0.00%	9.81%	45.80%	34.15%	6.83%	0.00%	1.22%	0.00%	2.20%	0.00%	0.00%	0.00%	1,478	2.24
16	0.00%	26.92%	50.66%	17.91%	1.06%	0.71%	1.58%	1.16%	0.00%	0.00%	0.00%	0.00%	9,867	14.94
17	0.00%	19.62%	32.50%	30.58%	15.23%	2.08%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3,130	4.74
18	1.36%	37.86%	53.77%	6.73%	0.27%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	7,337	11.11
19	0.00%	73.42%	18.60%	5.51%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.47%	1,215	1.84
20	0.00%	89.90%	7.72%	0.00%	2.38%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2,940	4.45
21	2.05%	56.90%	35.78%	5.27%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2,921	4.42
22	0.00%	22.03%	54.46%	23.51%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	404	0.61
23	0.92%	73.60%	20.34%	4.22%	0.92%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	4,360	6.60
24	0.00%	14.96%	85.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	254	0.38
25	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	92	0.14
26	3.84%	13.13%	31.16%	51.87%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	937	1.42
27	6.01%	26.11%	31.59%	9.92%	26.37%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	383	0.58
28	1.86%	82.85%	12.80%	0.00%	0.00%	2.49%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2,414	3.66
29	24.40%	43.41%	30.51%	0.87%	0.00%	0.00%	0.59%	0.00%	0.00%	0.00%	0.23%	0.00%	2,193	3.32
30	4.28%	79.00%	10.50%	5.72%	0.00%	0.00%	0.00%	0.49%	0.00%	0.00%	0.00%	0.00%	2,638	3.99
31	13.00%	0.00%	87.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	200	0.30
Unknown	0.00%	81.36%	0.00%	8.87%	0.00%	9.78%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	767	1.16
Total	1.48%	34.38%	37.84%	14.25%	7.53%	1.72%	1.77%	0.19%	0.16%	0.01%	0.63%	0.05%	66,042	100.00

*Only showing heads on landings which represent 80% of the monthly total.

Table 6. Percent contribution of daily August shrimp landings* by market grade for Bay River, 1994 – 2003.

Day	Market grade												Total	Percent of
	16/20	20/25	26/30	31/35	36/40	41/45	46/50	51/55	56/60	60/70	70/80	Mixed	pounds	monthly total
1	23.50%	16.62%	46.43%	13.44%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1,919	14.92
2	14.24%	51.67%	32.27%	0.00%	0.00%	0.00%	1.52%	0.00%	0.00%	0.30%	0.00%	0.00%	660	5.13
3	39.10%	13.91%	24.44%	0.00%	0.00%	22.56%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	532	4.14
4	6.11%	81.87%	8.04%	2.74%	0.62%	0.00%	0.62%	0.00%	0.00%	0.00%	0.00%	0.00%	1,605	12.48
5	87.74%	0.00%	5.22%	0.00%	7.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	881	6.85
6	42.17%	15.06%	42.77%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	166	1.29
7	49.30%	0.00%	16.55%	34.15%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	284	2.21
8	19.18%	62.37%	12.26%	3.04%	3.14%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	954	7.42
9	6.43%	93.57%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	389	3.03
10	51.52%	8.03%	0.00%	6.90%	21.35%	0.00%	0.00%	0.00%	12.20%	0.00%	0.00%	0.00%	623	4.85
11	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	547	4.25
12	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	92	0.72
13	37.40%	58.02%	0.00%	4.58%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	131	1.02
14	0.00%	59.36%	40.64%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	219	1.70
15	11.85%	59.78%	22.59%	5.79%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	363	2.82
16	13.47%	74.21%	8.88%	3.44%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	349	2.71
17	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	146	1.14
18	0.71%	99.29%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1,411	10.97
19	33.62%	66.38%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	235	1.83
20	3.56%	69.33%	20.89%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	6.22%	0.00%	0.00%	225	1.75
21	0.00%	51.95%	0.00%	48.05%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	77	0.60
22	54.10%	0.00%	32.38%	8.61%	4.92%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	244	1.90
23	55.36%	0.00%	33.04%	11.61%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	112	0.87
24	0.00%	0.00%	0.00%	93.55%	0.00%	6.45%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	93	0.72
25	36.13%	16.81%	0.00%	0.00%	47.06%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	119	0.93
27	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	15	0.12
29	60.16%	15.94%	0.00%	0.00%	23.90%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	251	1.95
30	66.44%	0.00%	0.00%	0.00%	33.56%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	146	1.14
31	52.86%	0.00%	0.00%	0.00%	0.00%	31.43%	15.71%	0.00%	0.00%	0.00%	0.00%	0.00%	70	0.54
Total	25.52%	48.34%	15.62%	5.20%	3.20%	1.15%	0.24%	0.00%	0.59%	0.12%	0.00%	0.00%	12,858	100.00

*Only showing heads on landings which represent 80% of the monthly total.

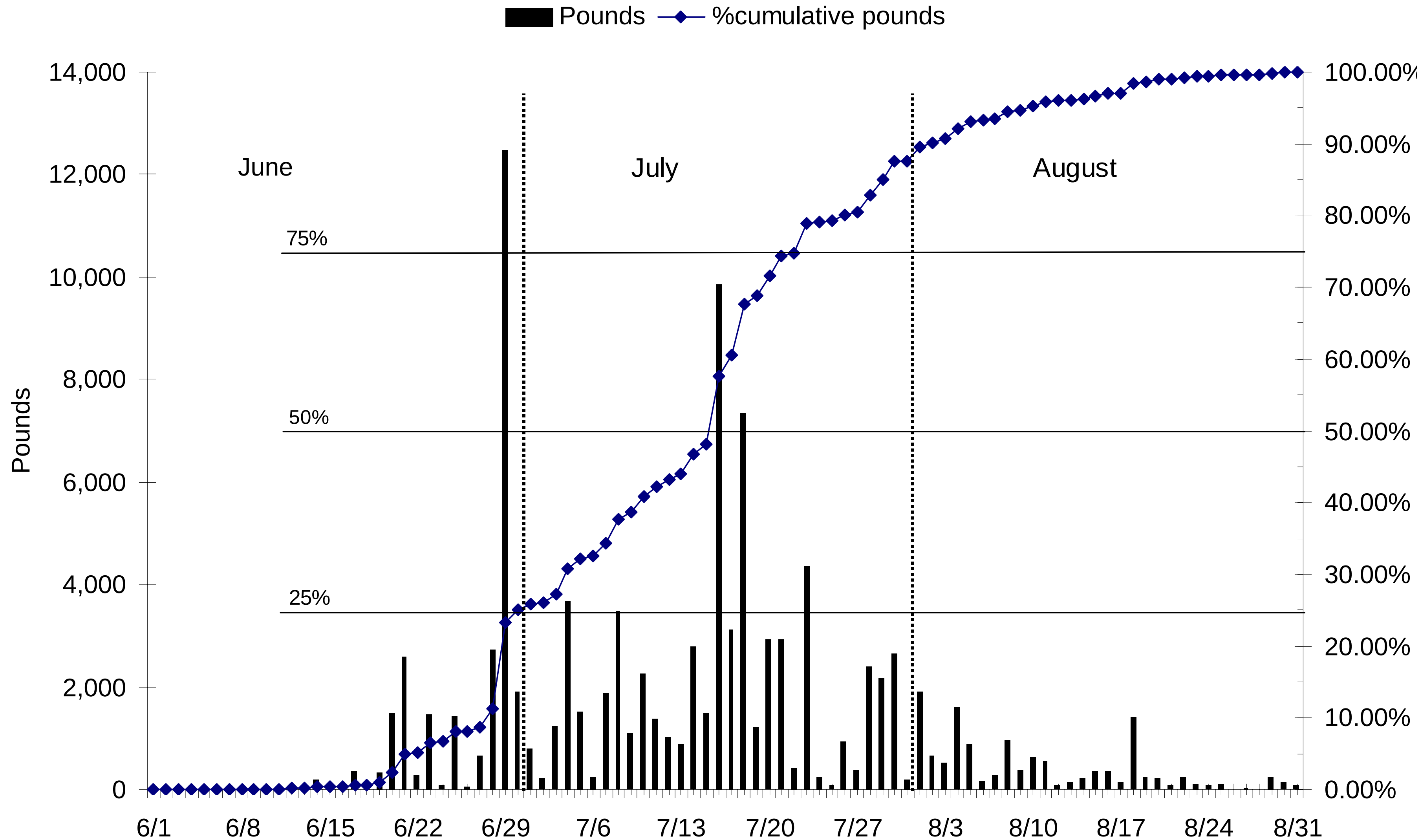


Figure 2. Bay River daily (heads-on lbs and cumulative percent) shrimp trawl landings, 1994 – 2003.

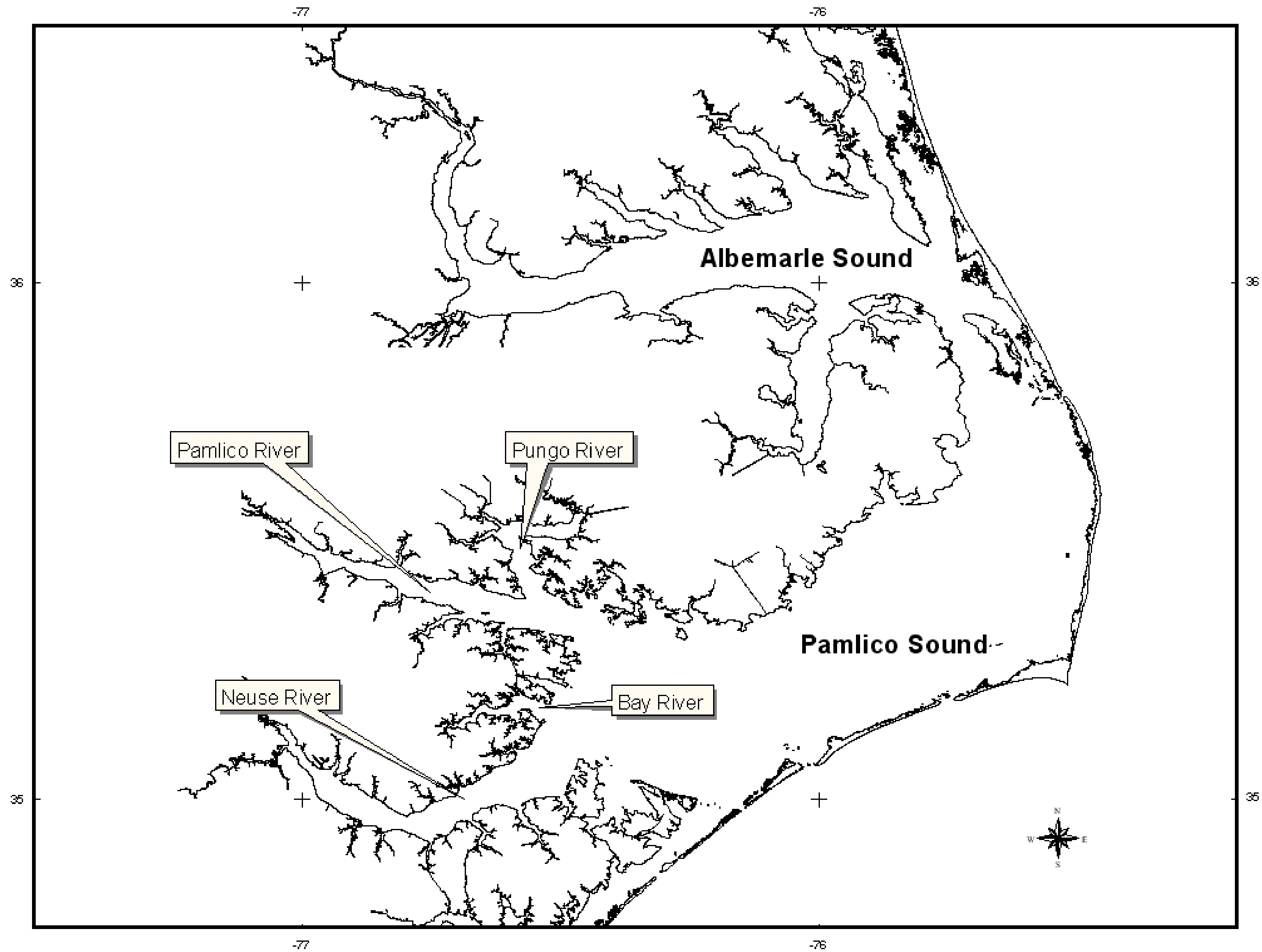
Table 7. Percent contribution of various vessel size classes to total shrimp trawl landings in Bay River; 1994 – 2003.

	Vessel size range											
Year	< 20'	20 - 24'	25 - 29'	30 - 34'	35 - 39'	40 - 44'	45 - 49'	50 - 54'	55 - 59'	> 60'	Unknown	Total
1994	8.20%	1.18%	0.42%	9.31%	27.24%	0.00%	9.71%	0.00%	0.00%	28.30%	15.64%	100.00%
1995	15.05%	0.00%	3.28%	12.13%	10.24%	0.00%	0.00%	0.00%	0.00%	59.30%	0.00%	100.00%
1996	33.47%	2.31%	0.00%	0.00%	17.48%	0.00%	2.05%	0.00%	10.69%	32.84%	1.16%	100.00%
1997	6.96%	0.00%	16.60%	0.00%	24.44%	0.00%	1.26%	30.31%	5.59%	14.84%	0.00%	100.00%
1998	0.00%	4.35%	0.00%	0.00%	83.40%	0.00%	0.00%	0.00%	0.00%	12.25%	0.00%	100.00%
1999	0.76%	0.00%	4.22%	15.51%	10.39%	1.26%	1.20%	0.00%	8.84%	0.00%	57.82%	100.00%
2000	4.51%	3.36%	10.43%	10.00%	22.69%	13.11%	0.00%	2.34%	5.98%	27.59%	0.00%	100.00%
2001	0.00%	2.20%	8.51%	24.59%	61.98%	0.81%	0.00%	0.00%	0.00%	0.00%	1.92%	100.00%
2002	8.05%	2.20%	12.79%	25.76%	32.77%	16.26%	0.00%	0.00%	0.00%	2.17%	0.00%	100.00%
2003	0.00%	1.49%	0.00%	33.63%	0.00%	0.00%	0.00%	0.00%	64.88%	0.00%	0.00%	100.00%
Total	6.82%	1.55%	7.51%	11.90%	23.32%	5.39%	1.90%	4.30%	5.25%	19.40%	12.65%	100.00%

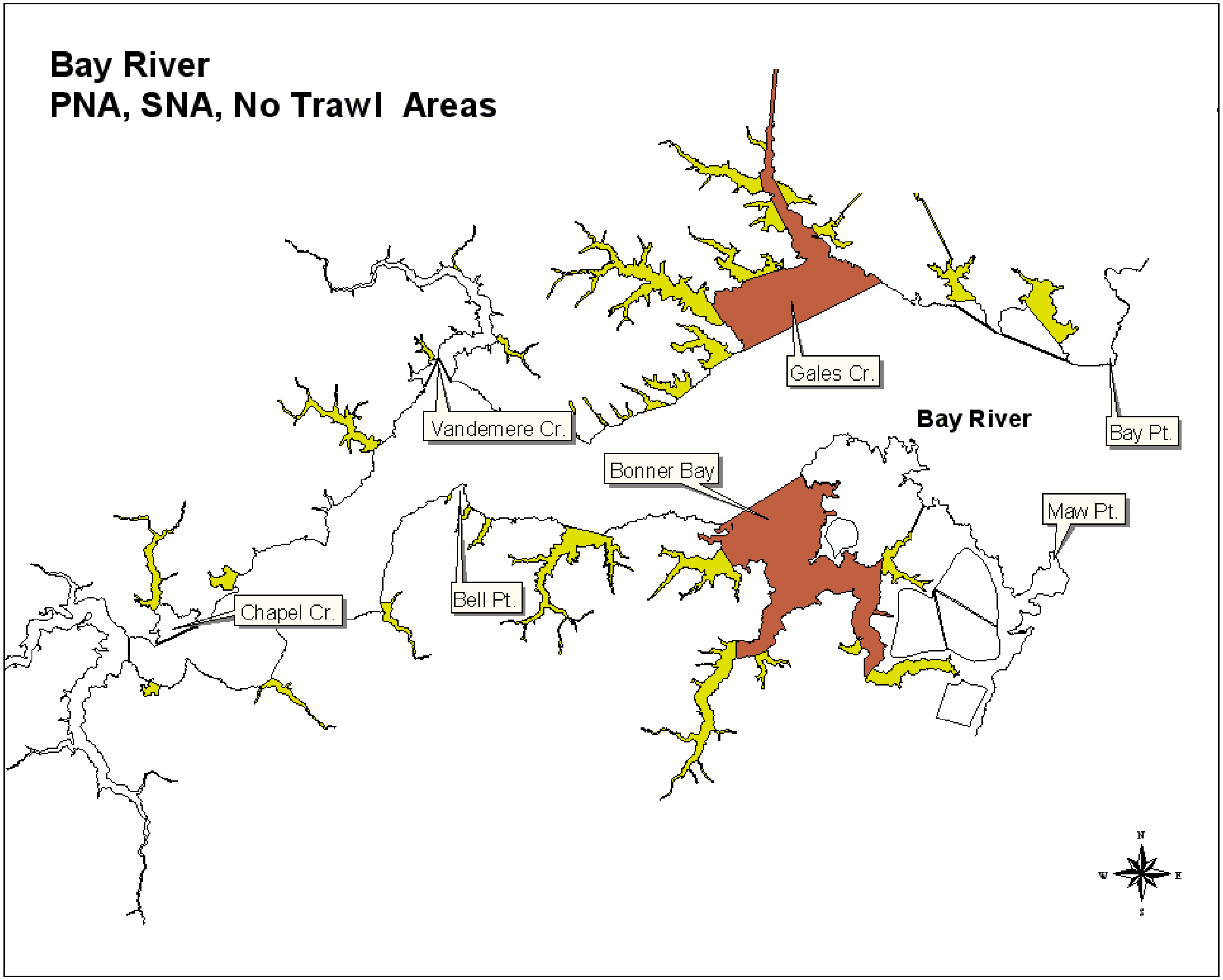
Table 8. Percent contribution of three vessel size groups to yearly shrimp trawl landings in Bay River; 1994 – 2003.

	Vessel size range				Number of
Year	< 20'	20 - 39'	> 40'	Total	licenses
1994	8.20%	38.15%	38.01%	84.36%	19
1995	15.05%	25.65%	59.30%	100.00%	12
1996	33.47%	19.79%	45.58%	98.84%	13
1997	6.96%	41.04%	52.00%	100.00%	15
1998	0.00%	87.75%	12.25%	100.00%	4
1999*	0.76%	30.12%	11.30%	42.18%	27
2000*	4.51%	46.48%	49.02%	100.00%	48
2001*	0.00%	97.27%	0.81%	98.08%	15
2002*	8.05%	73.52%	18.42%	100.00%	16
2003	0.00%	35.12%	64.88%	100.00%	3
Total	6.82%	44.28%	36.25%	87.35%	

*Years that Bay River was closed to shrimping (also closed in 2004).



Map 1. Map of Pamlico and Albemarle sounds North Carolina.



Map 2. Map of Bay River North Carolina.

Management Option/Impacts

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

1. Status quo (potential to close and open when shrimp are of sufficient size)
   + Flexibility in reacting to variable conditions (excessive rainfall, early migration)
   + Access to resource by a variety of users
   - Does not minimize harvest of small shrimp and bycatch
   - Labor intensive and expensive to sample
   - Necessitates "grand openings"

2. Harvest Season (Month (s), or Month (s)/Day (s) closures)
   a) Implement closure of Bay River with initial June proclamation and open in mid July (based on predetermined heads-on count).
      + Eliminates grand openings (if coordinated with other areas)
      + Protection of small shrimp and juvenile fish and crabs.
      + Potential for larger shrimp when trawling is opened
      - Lose flexibility of management by proclamation
      - Loss of resource to RCGL and smaller commercial trawlers

   b) Implement split season for commercial and RCGL shrimpers (same as # 2 above except open to RCGL harvest 1 or 2 weeks prior to commercial opening)
      + Protection of small shrimp and juvenile fish and crabs
      + Allows access to resource by all users
      + Potential for larger shrimp when trawling is opened
      - Lose flexibility of management by proclamation

   c) Open in July (based on predetermined heads-on count or pre determined date) and close to shrimp trawling in mid to late August
      + Eliminates grand openings (if coordinated with other areas)
      + Protection of small shrimp and juvenile fish and crabs
      + Potential for larger shrimp when trawling is opened
      - Lose flexibility of management by proclamation
      - Loss of resource to RCGL and smaller commercial trawlers

3. Area Closures
   a) Prohibit all shrimp trawlers in Bay River
      + Bycatch issue completely eliminated
      + Potential for healthier shellfish/finfish stocks
      + Decrease navigational and fixed vs. mobile gear conflicts in inside waters
      + Allow for harvest of larger count shrimp once they migrate into Pamlico Sound
      - Loss of income to commercial fishermen and dealers
      - Loss of RCGL use of shrimp resource

   b) Close portions of the river to shrimp trawl harvest.
      + Decrease navigational and fixed vs. mobile gear conflicts in closed waters
      + Allow for harvest of larger count shrimp once they migrate into Open areas
      - Loss of income to commercial fishermen and dealers
      - Loss of recreational use of shrimp resource

4. Regulate Means and Methods (gear and vessel)
   a) Implement headrope size limit on shrimp trawlers working in Bay River
      + Allows for all size classes of vessels to work
      + Reduction in bycatch
      - Reduction in fishing power of larger vessels

   b) Increase tailbag mesh size.
      + Reduction in bycatch
      + Catch larger size shrimp
      - Loss of smaller size shrimp
      - Insufficient data on different mesh sizes and shrimp loss and bycatch reduction

   c) Implement maximum vessel length restriction on shrimp trawlers working in Bay River
      + Decrease navigational and fixed vs. mobile gear conflicts in inside waters
      + Reduction in bycatch
      - Loss of income to commercial fishermen and dealers

AC Recommendation: Open on 26-30 heads-on count on or after July 7. Restrict total headrope to 90 feet upstream of a line between Maw Point and Bay River Point.

DMF Recommendation: Open in July (31-35 count) and close to shrimp trawling in mid to late August. Implement 90 foot headrope size limit on shrimp trawlers working in Bay River.

MFC Recommendation: Open in July and close to shrimp trawling in mid to late August. Implement 90 foot headrope size limit on shrimp trawlers working in Bay River.

12.22 Appendix 22. SHRIMP MANAGEMENT IN PAMLICO RIVER

The Pamlico River is a tributary of Pamlico Sound (Map 1). The main bottom type is soft mud, with patches of hard sand bottom in waters less than six feet deep. The shallow waters of the feeder creeks and bays contain patches of submerged aquatic vegetation (wild celery, and widgeongrass).

Trawling (shrimp and crab) is only allowed in the main stem of the river. All feeder creeks and bays are classified as either Nursery Areas (Primary, Secondary, Special Secondary) or Inland waters all of which are closed to trawling (Map 2). Overall this system is approximately 82,705 acres in size. 76,516 acres are under DMF jurisdiction. 1,414 acres are classified as Primary Nursery areas, 11,231 acres as Secondary Nursery areas, 2,736 acres as Special Secondary Nursery areas, and 1,184 acres of no trawl areas. Seventy-nine percent of the water under DMF jurisdiction is open to trawling. Other commercial fisheries in The Pamlico River include crab pot, crab trawl, gill net, eel potting, pound netting, and long-haul. Over the last 11 years the Pamlico River has not been closed to shrimp trawling.

Pamlico River accounts for 0.60% of the total statewide shrimp production. Average annual shrimp landings are 38,301 pounds, with an average dockside value of $91,355. Ninety-eight percent of the shrimp landed from the Pamlico River are caught by shrimp trawls (1994 – 2003 Trip ticket Data). Other gears with reported shrimp landings are; skimmer trawls (0.96%), crab trawls (0.49%), crab pots (0.14%), seines (0.06%), and sink gill net (0.02%).

The Pamlico River ranks 11th in shrimp landings by shrimp trawls with average annual landings of 37,744 pounds (Figure 1). The average dockside value of these landings is $89,833. In addition to shrimp, an average of 1,474 pounds of marketable bycatch with a dockside value of $1,187 is landed annually by shrimp trawls from the Pamlico River. The landed bycatch is composed of blue crabs (58%; 854 pounds/year), finfish (41%; 607 pounds/year), and mollusks (0.5%; 9 pounds/year). Southern flounder are the most common finfish species landed with average annual landings of 248 pounds (Table 1), 45% of which are landed in September (Table 2). July and August account for 74% of the blue crabs landed by shrimp trawls.

July accounts for 40% of the shrimp landings from shrimp trawls for Pamlico River (Tables 2 and 3). The months of August (21%) and June (12%) are the other two main months of shrimp harvest from this system. Tables 4 through 6 show the percent contribution of daily shrimp landings by market grade for these three months.

The percent contribution of yearly shrimp trawl landings by various sized vessels is given in Table 7. Sixty-four percent of the shrimp trawl landings were harvested by vessels greater than 40 feet in length (Table 8).

No fishery dependent data is available from shrimp trawls working in Pamlico River. The DMF conducts two trawl surveys in the Pamlico River Program 120 is a nursery area survey, while Program 195 samples the river proper. Data from Program 120 shows that the CPUE of southern flounder in Pamlico River (CPUE = 3) is less than those seen in Bay (CPUE = 4), Neuse (CPUE = 4), or Pungo (CPUE = 4) rivers, and in the Bays of Pamlico County (CPUE = 5). However this area has the second highest CPUE (10 per tow) of southern flounder of all areas sampled in Program 195, the Pungo River has the highest. Figure 2 shows the CPUE of southern flounder from Program 195 by station and river section for the Pamlico River. Southern flounder make up 2% of the finfish captured in Program 195 in the Pamlico River.

Spot are the most abundant species (46%), followed by Atlantic croaker (31%), menhaden (5%), weakfish (4%), silver perch (3%), and pinfish (3%). Given the suppressed stock scenario of southern flounder, it is unclear what specific impacts shrimp trawl bycatch has on the overall stock status at this time. However, any reduction in southern flounder fishing mortality, especially directed toward sublegal fish, would benefit the stock. Management of the Pamlico River should include measures to further minimize southern flounder bycatch while still achieving the overall goal and objectives of this FMP.

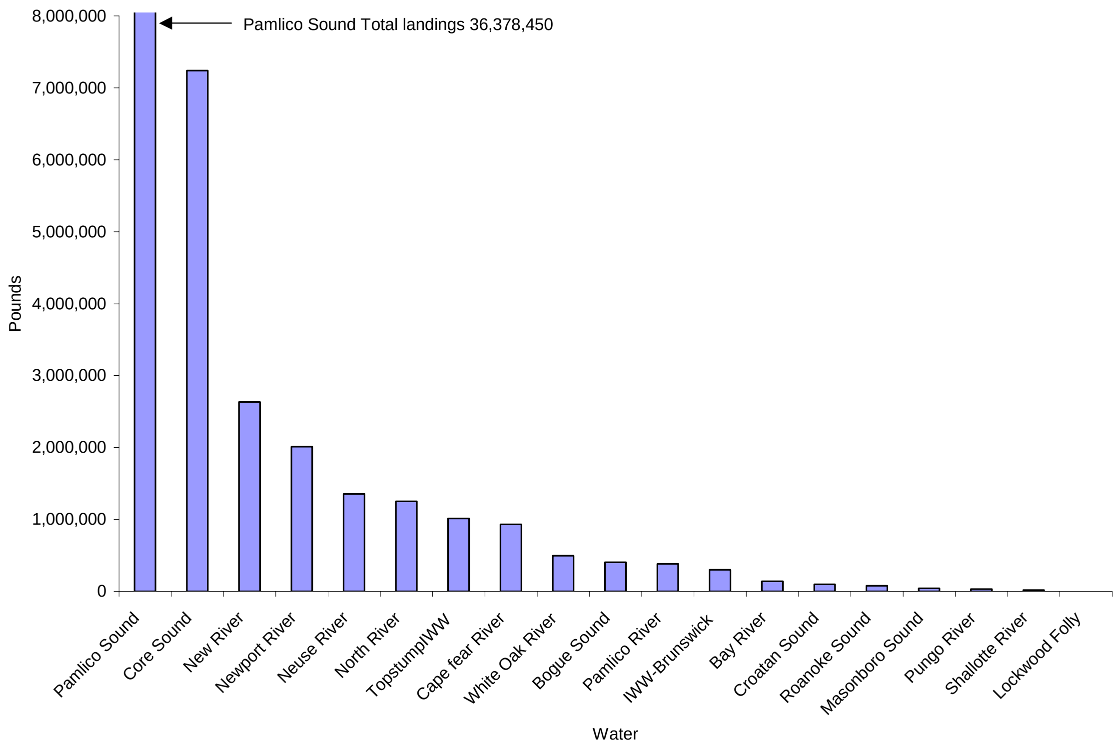


Figure 1. Total pounds of shrimp harvested by shrimp in major North Carolina waterbodies between 1994-2003.

Table 1. Landings (lbs) of finfish from shrimp trawls from the Pamlico River North Carolina; 1994 – 2003.

Species	Total pounds	Average pounds	Percent of total
Flounders	2,484	248	40.91%
Sea mullet	1,411	141	23.23%
Fish, Mixed	780	78	12.84%
Spot	505	51	8.32%
Weakfish	405	40	6.66%
Bluefish	101	10	1.66%
Atlantic croaker	92	9	1.51%
Spadefish	85	9	1.40%
Harvestfish	73	7	1.20%
Butterfish	40	4	0.66%
Pigfish	39	4	0.64%
Sheepshead	24	2	0.40%
Spanish Mackerel	15	2	0.25%
Speckled trout	9	1	0.15%
Cutlassfish	7	1	0.12%
Black drum	2	0.2	0.03%
Puffer	1	0.1	0.02%
Total	6,073	607	100%

Table 2. Monthly percent contribution of landed shrimp trawl catch for Pamlico River North Carolina; 1994 – 2003.

	Month											Total
Species	January	February	April	May	June	July	August	September	October	November	December	pounds
Shrimp	0.46%	0.28%	0.05%	0.39%	12.09%	40.14%	20.80%	8.87%	7.18%	7.95%	1.78%	377,442
Blue crab	0.00%	0.00%	0.29%	4.26%	15.22%	47.34%	26.40%	5.96%	0.00%	0.53%	0.00%	8,542
Flounders	0.00%	0.00%	0.00%	2.42%	1.97%	12.77%	20.81%	45.37%	7.41%	6.44%	2.82%	2,484
Sea mullet	0.00%	0.00%	0.00%	0.00%	11.91%	32.81%	22.54%	12.26%	10.13%	10.13%	0.21%	1,411
Fish, mixed	0.00%	0.00%	0.00%	0.00%	2.95%	2.44%	23.08%	20.38%	4.62%	0.90%	45.64%	780
Spot	0.00%	0.00%	0.00%	0.00%	0.00%	14.46%	40.59%	28.51%	14.85%	1.58%	0.00%	505
Weakfish	0.00%	0.00%	0.00%	4.94%	1.98%	13.97%	22.99%	14.34%	6.18%	27.69%	7.91%	405
Bluefish	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	99.01%	0.99%	0.00%	0.00%	0.00%	101
Atlantic croaker	0.00%	0.00%	0.00%	0.00%	1.09%	2.17%	65.22%	28.26%	0.00%	3.26%	0.00%	92
Spadefish	0.00%	0.00%	0.00%	0.00%	0.00%	11.76%	88.24%	0.00%	0.00%	0.00%	0.00%	85
Squid, Loligo	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	88.24%	11.76%	85
Harvestfish	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	94.52%	0.00%	5.48%	0.00%	73
Butterfish	0.00%	0.00%	0.00%	0.00%	0.00%	30.00%	60.00%	0.00%	0.00%	7.50%	2.50%	40
Pigfish	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	48.72%	0.00%	0.00%	51.28%	0.00%	39
Sheepshead	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	24
Spanish mackerel	0.00%	0.00%	0.00%	0.00%	0.00%	13.33%	73.33%	13.33%	0.00%	0.00%	0.00%	15
Speckled trout	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	9
Cutlassfish	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	7
Black drum	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	2
Puffer	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	1
Total	0.45%	0.27%	0.05%	0.49%	12.03%	39.91%	21.01%	9.12%	7.03%	7.81%	1.83%	392,062

Table 3. Monthly shrimp landings (lbs) from shrimp trawls from Pamlico River North Carolina; 1994 – 2003.

	Pounds		Percent	Percent of total
Month	total	average	of total	trips
January	1,747	175	0.46%	0.71
February	1,041	104	0.28%	0.18
April	177	18	0.05%	0.35
May	1,469	147	0.39%	1.24
June	45,635	4,564	12.09%	12.41
July	151,472	15,147	40.14%	42.20
August	78,509	7,851	20.80%	20.39
September	33,485	3,349	8.87%	7.80
October	27,105	2,711	7.18%	4.43
November	30,011	3,001	7.95%	8.33
December	6,709	671	1.78%	1.95
Total	377,362	37,736	100.00%	100.00

Table 4. Percent contribution of daily June shrimp landings* by market grade for Pamlico River, 1994 – 2003.

	Market grade										Total	Percent of
Day	20/25	26/30	31/35	36/40	41/45	46/50	56/60	60/70	70/80	Mixed	pounds	monthly total
6	10.31%	0.00%	0.00%	51.55%	0.00%	0.00%	0.00%	38.14%	0.00%	0.00%	97	0.22
8	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	862	1.92
11	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	176	0.39
20	0.00%	0.00%	0.00%	95.77%	0.00%	0.00%	0.00%	0.00%	4.23%	0.00%	1,869	4.17
21	0.00%	0.00%	0.00%	24.46%	61.87%	0.00%	0.00%	13.67%	0.00%	0.00%	139	0.31
22	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	406	0.91
24	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	95	0.21
25	0.00%	0.00%	61.83%	31.55%	3.39%	2.05%	0.00%	1.17%	0.00%	0.00%	6,985	15.58
26	0.00%	0.00%	28.37%	58.41%	11.15%	2.07%	0.00%	0.00%	0.00%	0.00%	15,307	34.14
27	0.00%	1.19%	28.52%	20.71%	5.13%	44.45%	0.00%	0.00%	0.00%	0.00%	5,399	12.04
28	0.84%	33.53%	34.87%	14.18%	15.82%	0.12%	0.00%	0.00%	0.00%	0.65%	9,288	20.71
29	0.00%	0.00%	82.44%	0.00%	12.99%	0.00%	0.00%	0.28%	0.00%	4.30%	3,957	8.83
30	0.00%	0.00%	0.00%	0.00%	22.48%	0.00%	0.00%	0.00%	0.00%	77.52%	258	0.58
Total	0.20%	9.01%	37.64%	34.47%	9.69%	6.40%	0.91%	0.33%	0.18%	1.17%	44,838	100.00

*Only showing heads on landings, which represent 98% of the monthly total.

Table 5. Percent contribution of daily July shrimp landings* by market grade for Pamlico River, 1994 – 2003.

	Market grade												Total	Percent of
Day	16/20	20/25	26/30	31/35	36/40	41/45	46/50	51/55	56/60	60/70	80+	Mixed	pounds	monthly total
2	0.00%	0.00%	94.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.97%	1,339	1.14
3	0.00%	0.00%	14.41%	74.12%	8.11%	0.00%	0.00%	1.83%	0.63%	0.90%	0.00%	0.00%	2,998	2.56
4	0.00%	0.00%	85.30%	0.00%	9.96%	4.74%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	6,625	5.66
5	0.00%	5.14%	71.67%	21.84%	0.51%	0.00%	0.00%	0.00%	0.13%	0.00%	0.00%	0.73%	15,571	13.29
6	0.00%	0.00%	19.07%	0.00%	67.65%	0.95%	12.33%	0.00%	0.00%	0.00%	0.00%	0.00%	3,787	3.23
7	0.00%	0.00%	0.00%	74.75%	7.27%	0.00%	10.19%	0.00%	0.00%	0.00%	5.38%	2.39%	2,090	1.78
8	0.00%	3.05%	0.00%	37.41%	44.42%	0.00%	0.00%	15.12%	0.00%	0.00%	0.00%	0.00%	2,526	2.16
9	0.00%	0.00%	97.31%	1.75%	0.00%	0.00%	0.00%	0.94%	0.00%	0.00%	0.00%	0.00%	3,716	3.17
10	0.00%	91.77%	0.00%	8.23%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1,421	1.21
11	0.00%	54.48%	31.24%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	14.28%	2,241	1.91
12	0.00%	63.65%	31.06%	2.80%	0.53%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.96%	12,248	10.46
13	0.00%	2.37%	15.14%	37.88%	0.00%	23.66%	0.00%	14.72%	0.00%	5.47%	0.00%	0.76%	2,616	2.23
14	0.00%	5.14%	84.05%	7.72%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.09%	972	0.83
15	0.00%	5.62%	89.82%	3.63%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.94%	2,671	2.28
16	0.00%	91.54%	0.00%	0.00%	0.00%	0.00%	5.38%	0.00%	0.00%	0.00%	0.00%	3.07%	1,301	1.11
17	0.00%	62.77%	5.49%	31.74%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1,477	1.26
18	0.00%	81.17%	14.88%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.96%	3,791	3.24
19	0.72%	98.03%	0.84%	0.00%	0.00%	0.00%	0.18%	0.00%	0.00%	0.00%	0.00%	0.23%	8,742	7.46
20	0.00%	78.95%	0.00%	13.16%	7.89%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	760	0.65
21	0.00%	0.00%	67.38%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	32.62%	1,257	1.07
22	0.52%	96.84%	0.00%	2.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.64%	3,106	2.65
23	78.53%	20.27%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.20%	7,918	6.76
24	67.77%	8.54%	1.39%	20.00%	0.00%	0.00%	0.00%	0.00%	2.31%	0.00%	0.00%	0.00%	5,551	4.74
25	15.55%	0.00%	84.45%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1,138	0.97
26	6.52%	23.65%	63.42%	1.53%	0.00%	1.46%	0.00%	0.00%	0.04%	0.00%	0.00%	3.39%	5,612	4.79
27	90.83%	1.91%	1.50%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.76%	4,341	3.71
28	76.51%	16.64%	0.65%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.27%	4.93%	4,929	4.21
29	17.27%	49.09%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	33.64%	110	0.09
30	86.40%	7.95%	0.00%	0.00%	4.63%	0.00%	0.20%	0.00%	0.00%	0.04%	0.00%	0.79%	5,094	4.35
31	0.00%	69.08%	7.44%	11.74%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	11.74%	0.00%	511	0.44
Unknown	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	670	0.57
Total	19.41%	29.56%	31.80%	9.99%	4.42%	0.90%	0.66%	0.73%	0.14%	0.15%	0.20%	2.03%	117,128	100.00

*Only showing heads on landings which represent 77% of the monthly total.

Table 6. Percent contribution of daily August shrimp landings* by market grade for Pamlico River, 1994 – 2003.

	Market grade												Total	Percent of
Day	0/15	16/20	20/25	26/30	31/35	36/40	41/45	46/50	56/60	60/70	80+	Mixed	pounds	monthly total
1	0.00%	40.93%	0.00%	58.96%	0.11%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	6,269	19.17
2	0.00%	49.62%	34.47%	15.91%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	264	0.81
3	0.00%	57.60%	13.40%	6.65%	0.00%	1.08%	0.00%	0.00%	0.00%	0.00%	0.00%	21.27%	2,045	6.25
4	0.00%	37.00%	30.31%	14.46%	0.00%	2.00%	0.00%	0.00%	0.00%	0.00%	0.00%	16.23%	1,300	3.98
5	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	219	0.67
6	0.00%	0.00%	92.43%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	7.57%	489	1.49
7	0.00%	0.00%	52.97%	0.00%	0.00%	47.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	202	0.62
8	0.00%	85.29%	14.71%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	680	2.08
9	0.00%	77.11%	22.89%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2,630	8.04
10	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	77	0.24
11	0.00%	27.13%	11.58%	5.38%	0.00%	0.00%	0.00%	16.05%	34.00%	0.00%	5.87%	0.00%	1,209	3.70
12	0.00%	12.77%	87.23%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	329	1.01
13	0.00%	63.47%	36.53%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	646	1.98
14	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	275	0.84
15	0.00%	85.34%	0.00%	0.00%	14.66%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3,343	10.22
16	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	35	0.11
17	0.00%	88.99%	10.55%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.46%	0.00%	0.00%	218	0.67
18	0.00%	74.94%	11.04%	0.00%	6.62%	0.00%	0.00%	0.00%	7.40%	0.00%	0.00%	0.00%	906	2.77
19	97.43%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.57%	0.00%	0.00%	0.00%	2,723	8.33
20	0.00%	70.52%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	29.48%	0.00%	0.00%	0.00%	424	1.30
21	0.00%	66.17%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	33.83%	0.00%	0.00%	0.00%	201	0.61
22	0.00%	94.78%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.22%	0.00%	0.00%	0.00%	2,300	7.03
23	0.00%	64.30%	11.52%	0.00%	0.00%	0.00%	0.00%	0.00%	24.17%	0.00%	0.00%	0.00%	1,241	3.79
24	0.00%	68.10%	3.88%	0.00%	0.00%	0.00%	17.61%	0.00%	10.40%	0.00%	0.00%	0.00%	721	2.20
26	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1,090	3.33
28	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	80	0.24
29	0.00%	12.66%	0.00%	87.34%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	790	2.42
30	83.42%	0.00%	0.00%	0.00%	0.00%	16.58%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	573	1.75
31	0.00%	11.33%	0.00%	59.76%	0.00%	0.00%	28.92%	0.00%	0.00%	0.00%	0.00%	0.00%	415	1.27
Unknown	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1,008	3.08
Total	9.57%	51.63%	12.53%	16.16%	1.95%	0.73%	0.76%	0.59%	3.78%	0.00%	0.22%	2.09%	32,702	100.00

*Only showing heads on landings which represent 41% of the monthly total.

Table 7. Percent contribution of various vessel size classes to total shrimp trawl landings in Pamlico River; 1994 – 2003.

	Vessel size range											
Year	<20'	20 - 24'	25 - 29'	30 - 34'	35 - 39'	40 - 44'	45 - 49'	50 - 54'	55 - 59'	>60'	Unknown	Total
1994	0.25%	0.56%	2.33%	1.62%	6.51%	2.83%	8.96%	4.39%	5.04%	65.00%	2.52%	100.00%
1995	66.68%	8.28%	2.95%	0.00%	0.30%	0.29%	0.96%	4.41%	6.57%	9.56%	0.00%	100.00%
1996	30.70%	4.06%	0.00%	0.00%	1.68%	1.66%	0.00%	0.00%	2.90%	48.13%	10.86%	100.00%
1997	1.40%	0.39%	6.80%	0.00%	11.91%	0.44%	1.60%	0.00%	22.35%	49.32%	5.79%	100.00%
1998	0.00%	0.00%	0.00%	0.00%	0.00%	5.07%	6.35%	0.00%	0.00%	88.57%	0.00%	100.00%
1999	0.08%	0.00%	9.74%	0.37%	3.70%	2.07%	0.64%	0.00%	0.90%	31.17%	51.31%	100.00%
2000	2.22%	4.52%	4.57%	13.24%	12.96%	0.47%	3.63%	0.00%	26.63%	31.76%	0.00%	100.00%
2001	2.88%	0.69%	4.71%	8.26%	7.20%	0.00%	10.57%	1.10%	23.48%	36.55%	4.55%	100.00%
2002	0.82%	1.01%	5.02%	10.06%	9.68%	1.26%	15.99%	8.83%	11.50%	35.83%	0.00%	100.00%
2003	0.00%	1.53%	0.85%	4.13%	19.86%	15.36%	1.50%	0.00%	16.24%	40.53%	0.00%	100.00%
Total	8.56%	1.98%	4.55%	5.10%	7.73%	1.82%	7.01%	3.36%	11.83%	40.35%	7.73%	100.00%

Table 8. Percent contribution of three vessel size groups to yearly shrimp trawl landings in Pamlico River; 1994 – 2003.

	Vessel size range				Number of
Year	<20'	20 - 39'	>40'	Total	licenses
1994	0.25%	11%	86.23%	97.48%	35
1995	66.68%	12%	21.79%	100.00%	42
1996	30.70%	6%	52.69%	89.14%	17
1997	1.40%	19%	73.71%	94.21%	20
1998	0.00%	0%	100.00%	100.00%	8
1999	0.08%	14%	34.79%	48.69%	37
2000	2.22%	35%	62.49%	100.00%	26
2001	2.88%	21%	71.70%	95.45%	23
2002	0.82%	26%	73.40%	100.00%	49
2003	0.00%	26%	73.62%	100.00%	16
Total	8.56%	19%	64.35%	92.27%	

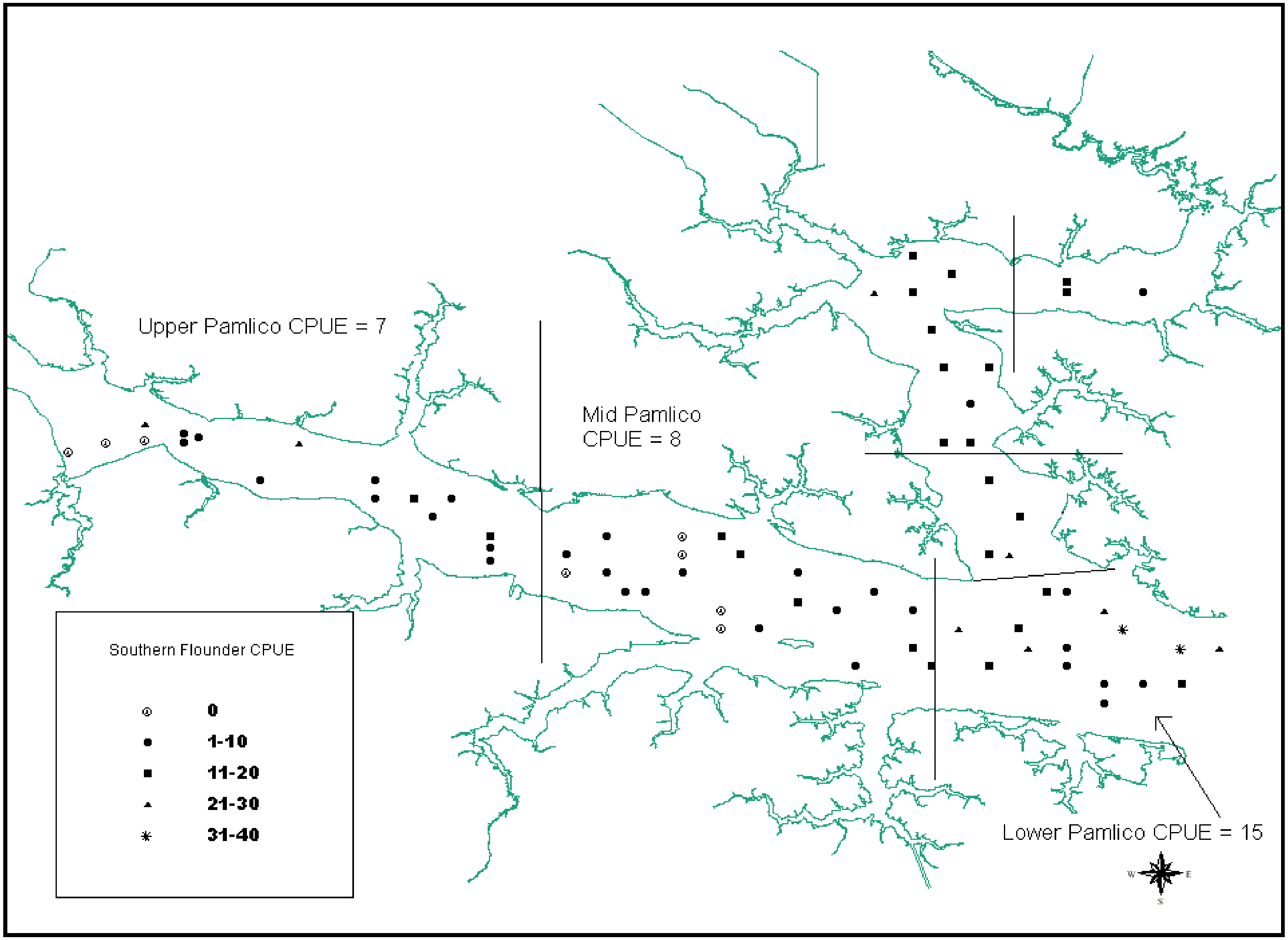
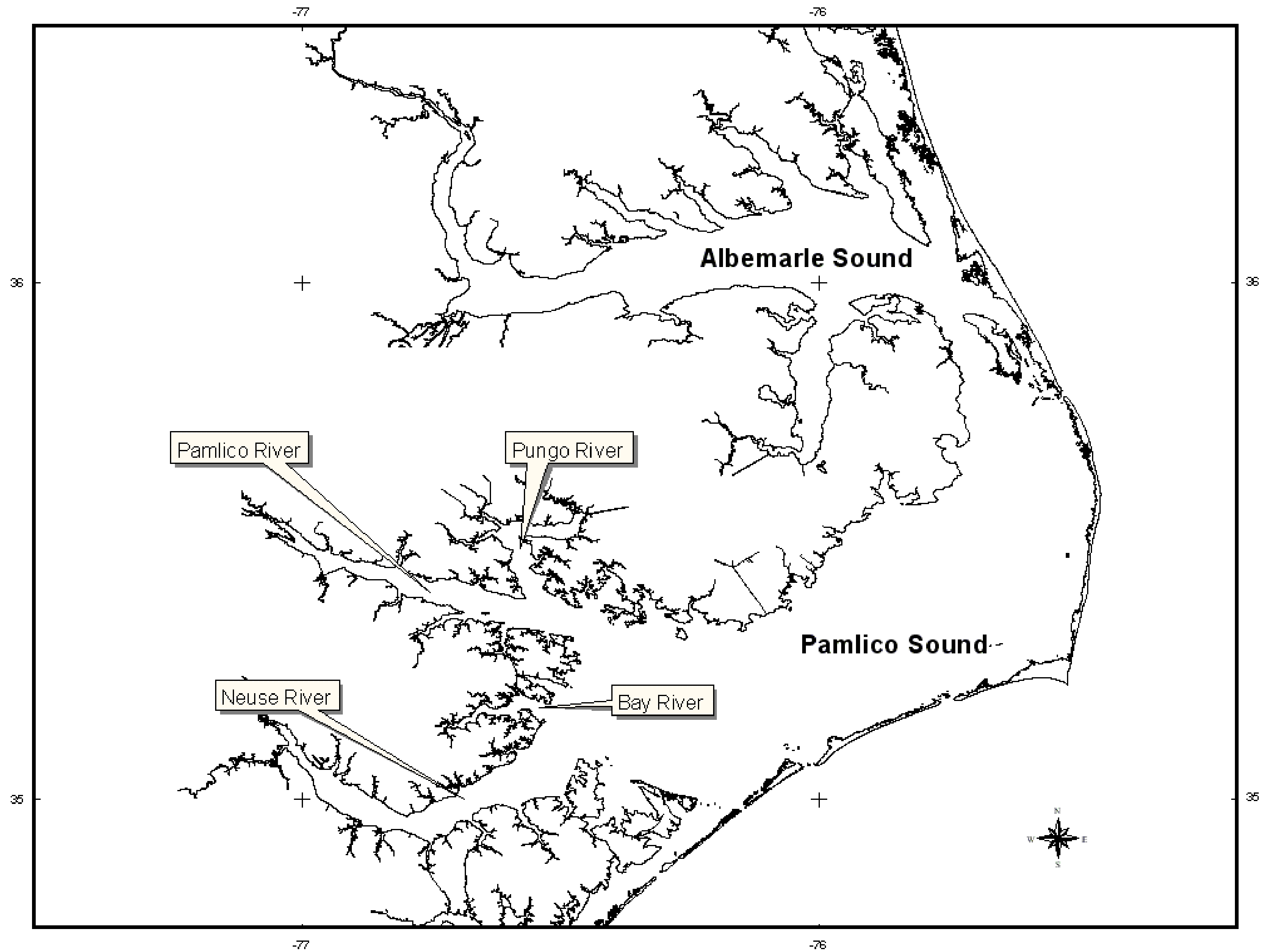
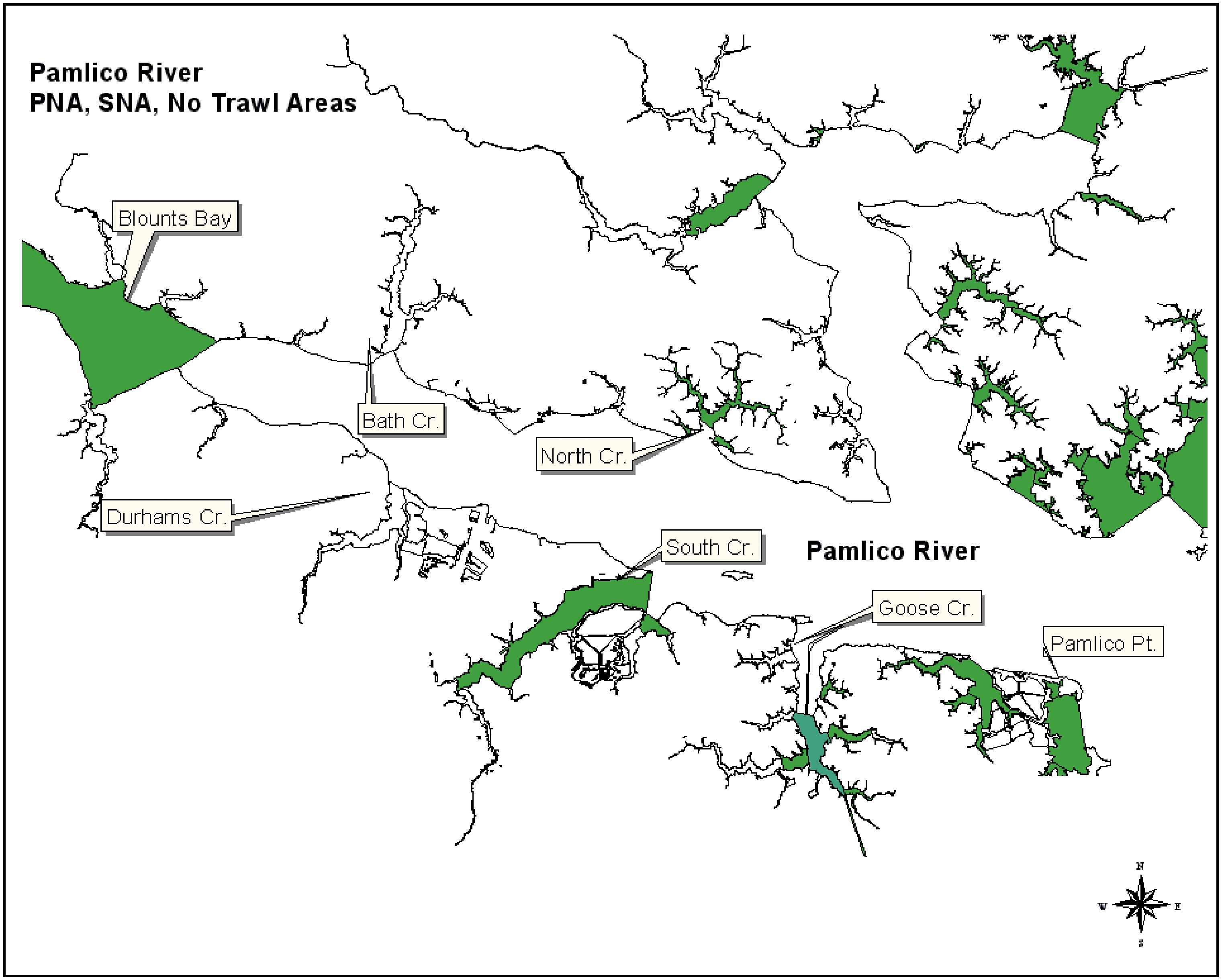


Figure 2. Catch per unit effort (CPUE) of southern flounder in the Pamlico and Pungo rivers from Program 195, June and September data combined, 1987 – 2003.



Map 1. Map of Pamlico and Albemarle sounds North Carolina.



Map 2. Map of Pamlico River North Carolina.

Management Option/Impacts

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

1. Status quo (potential to close and open when shrimp are of sufficient size)
   + Flexibility in reacting to variable conditions (excessive rainfall, early migration)
   + Access to resource by a variety of users
   - Does not minimize harvest of small shrimp and bycatch
   - Labor intensive and expensive to sample
   - Necessitates “grand openings”

2. Harvest Season (Month (s), or Month (s)/Day (s) closures)
   a) Implement closure of Pamlico River with initial June proclamation and open in mid July (based on predetermined heads-on count).
      + Eliminates grand openings (if coordinated with other areas)
      + Protection of small shrimp and juvenile fish and crabs.
      + Potential for larger shrimp when trawling is opened
      - Lose flexibility of management by proclamation
      - Loss of resource to RCGL and smaller commercial trawlers

   b) Implement split season for commercial and RCGL shrimpers (same as # 2 above except open to RCGL harvest 1 or 2 weeks prior to commercial opening)
      + Protection of small shrimp and juvenile fish and crabs
      + Allows access to resource by all users
      + Potential for larger shrimp when trawling is opened
      - Lose flexibility of management by proclamation

   c) Open in July (based on predetermined heads-on count or pre determined date) and close to shrimp trawling in mid to late August
      + Eliminates grand openings (if coordinated with other areas)
      + Protection of small shrimp and juvenile fish and crabs
      + Potential for larger shrimp when trawling is opened
      - Lose flexibility of management by proclamation
      - Loss of resource to RCGL and smaller commercial trawlers

3. Area Closures
   a) Prohibit all shrimp trawlers in Pamlico River
      + Bycatch issue completely eliminated
      + Potential for healthier shellfish/finfish stocks
      + Decrease navigational and fixed vs. mobile gear conflicts in inside waters
      + Allow for harvest of larger count shrimp once they migrate into Pamlico Sound
      - Loss of income to commercial fishermen and dealers
      - Loss of RCGL use of shrimp resource

   b) Close portions of the river to shrimp trawl harvest.
      + Decrease navigational and fixed vs. mobile gear conflicts in closed waters
      + Allow for harvest of larger count shrimp once they migrate into Open areas
      - Loss of income to commercial fishermen and dealers
      - Loss of recreational use of shrimp resource

4. Regulate Means and Methods (gear and vessel)
   a) Implement headrope size limit on shrimp trawlers working in Pamlico River
      + Allows for all size classes of vessels to work
      + Reduction in bycatch
      - Reduction in fishing power of larger vessels

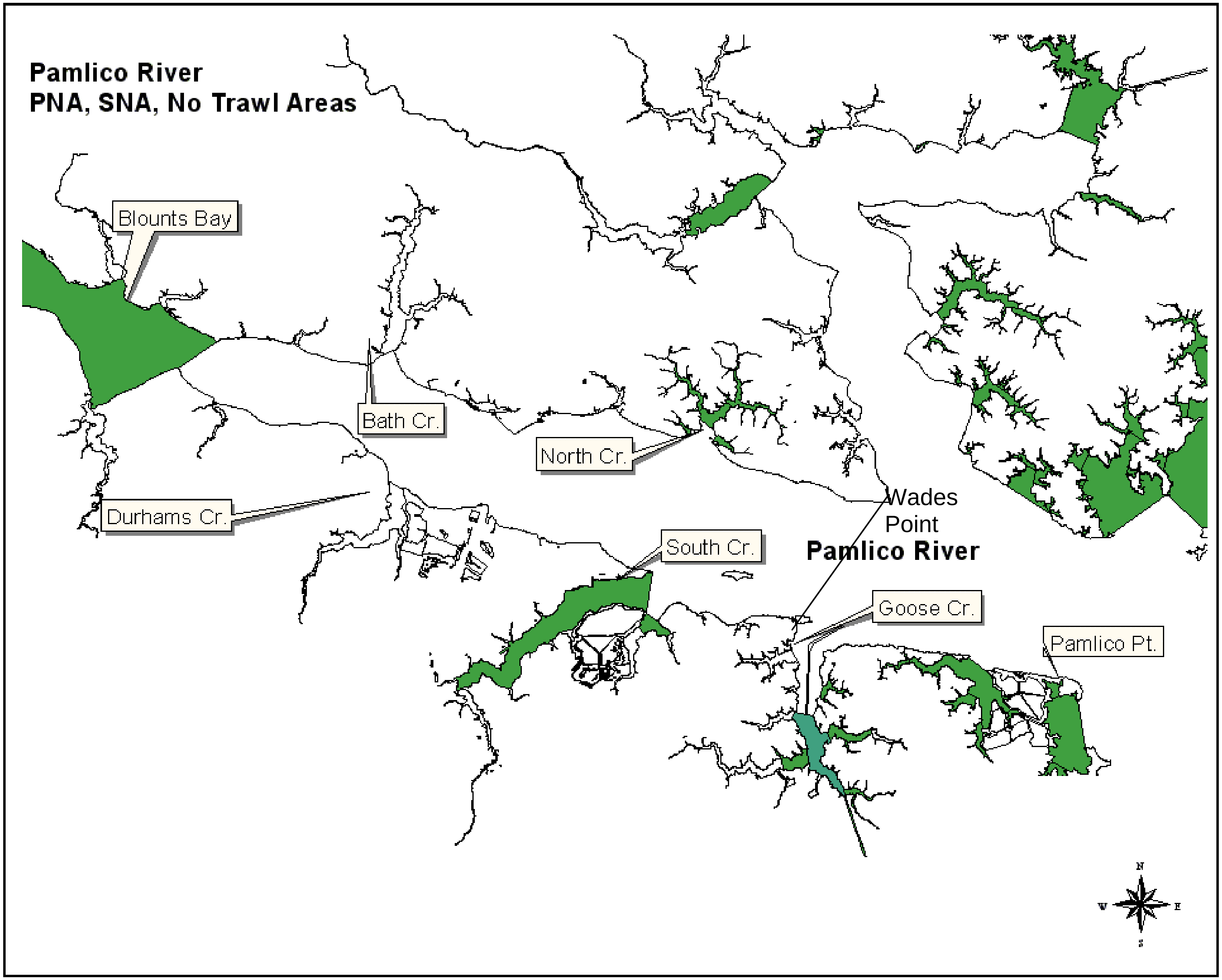
   b) Increase tailbag mesh size.
      + Reduction in bycatch
      + Catch larger size shrimp
      - Loss of smaller size shrimp
      - Insufficient data on different mesh sizes and shrimp loss and bycatch reduction

   c) Implement maximum vessel length restriction on shrimp trawlers working in Pamlico River
      + Decrease navigational and fixed vs. mobile gear conflicts in inside waters
      + Reduction in bycatch
      - Loss of income to commercial fishermen and dealers

AC Recommendation: Open on 26-30 count heads-on count on or after July 7. Restrict total headrope to 90 feet upstream of a line between Wades Point and Goose Creek.

DMF Recommendation: Open in July (31-35 heads-on) and close to shrimp trawling in August (July 7 through August 7). All waters upstream of a line from Wades Point to Goose Creek be closed to shrimp trawling (Map 3) and 90 feet maximum combined headrope length in Pamlico River.

MFC Recommendation: Open in July and close to shrimp trawling in August (July 7 through August 7). All waters upstream of a line from Wades Point to Goose Creek be closed to shrimp trawling (Map 3) and 90 feet maximum combined headrope length in Pamlico River.



Map 3. Map of Pamlico River North Carolina.

12.23 Appendix 23. SHRIMP MANAGEMENT IN PUNGO RIVER

The Pungo River is a tributary of Pamlico Sound (Map 1). The main bottom type is soft mud, with patches of hard sand bottom. The shallow waters of the feeder creeks contain patches of submerged aquatic vegetation (wild celery, eel grass, and widgeongrass).

Trawling (shrimp and crab) is only allowed in the main stem of the river. All feeder creeks are classified as either Nursery Areas (Primary, Secondary, Special Secondary) or Inland waters all of which are closed to trawling (Map 2). Overall the Pungo River is approximately 32,741 acres in size. Of that 25,530 acres are open to trawling. The remainder is either nursery areas (4,361 acres) or inland waters (3,850 acres) all of which is closed to trawling. Other commercial fisheries in the Pungo River include crab pot, crab trawl, gill net, eel potting, pound netting, and long-haul. Over the last 11 years the Pungo River has not been closed to shrimp trawling.

The Pungo River accounts for 0.05% of the total statewide shrimp production. Average annual shrimp landings are 3,862 pounds, with an average dockside value of $8,565. Ninety-nine percent of the shrimp landed from Pungo River are caught by shrimp trawls (1996 – 2003 Trip ticket Data). The remaining shrimp landings were reported from crab pots (67 pounds), and dip nets (30 pounds).

The Pungo River ranks 17th in shrimp landings by shrimp trawls with average landings of 3,850 pounds per year (Figure 1). The average dockside value of these landings is $8,547. In addition to shrimp, an average of 189 pounds of marketable bycatch with an annual dockside value of $120 is landed by shrimp trawls from Pungo River. The landed bycatch is composed of blue crabs (1,504 total pounds, 1996 – 2003), flounder (9.5 total pounds, 1996 – 2003), and Atlantic croaker (2 total pounds, 1996 – 2003).

August accounts for 35% of the shrimp landings from shrimp trawls for Pungo River (Table 1). June (26%), July (19%), and September (19%) are the other months with reported shrimp harvest from this system. Tables 2 through 4 show the percent contribution of daily shrimp landings by market grade for June, July, and August.

The percent contribution of yearly shrimp trawl landings by various sized vessels is given in Table 5. Sixty-two percent of the shrimp trawl landings were harvested by vessels greater than 40 feet in length (Table 6).

No fishery dependent data is available from shrimp trawls working in the Pungo River. The DMF conducts two trawl surveys in the Pungo River Program 120 is a nursery area survey, while Program 195 samples the river proper. Data from Program 120 shows that the CPUE of southern flounder in Pungo River (CPUE = 4) is the same as those seen in Bay (CPUE = 4), and Neuse rivers (CPUE = 4), greater than the Pamlico (CPUE = 3), and less than those seen in the Bays of Pamlico County (CPUE = 5). However this area has the highest CPUE (15 per tow) of southern flounder of all areas sampled in Program 195. Figure 2 shows the CPUE of southern flounder by station and river section for the Pungo River. Overall Southern flounder are the 6th most abundant finfish species captured in Program 195 in the Pungo River, accounting for 2% of the total finfish biomass. The most abundant species is Atlantic croaker (44%), which is followed by spot (38%), Atlantic menhaden (5%), weakfish (4%), and silver perch (3%). Given the suppressed stock scenario of southern flounder, it is unclear what specific impacts shrimp trawl bycatch has on the overall stock status at this time. However, any reduction in southern flounder fishing mortality, especially directed toward sublegal fish, would benefit the stock. Management of Pungo River should include measures to further minimize southern flounder bycatch while still achieving the overall goal and objectives of this FMP.

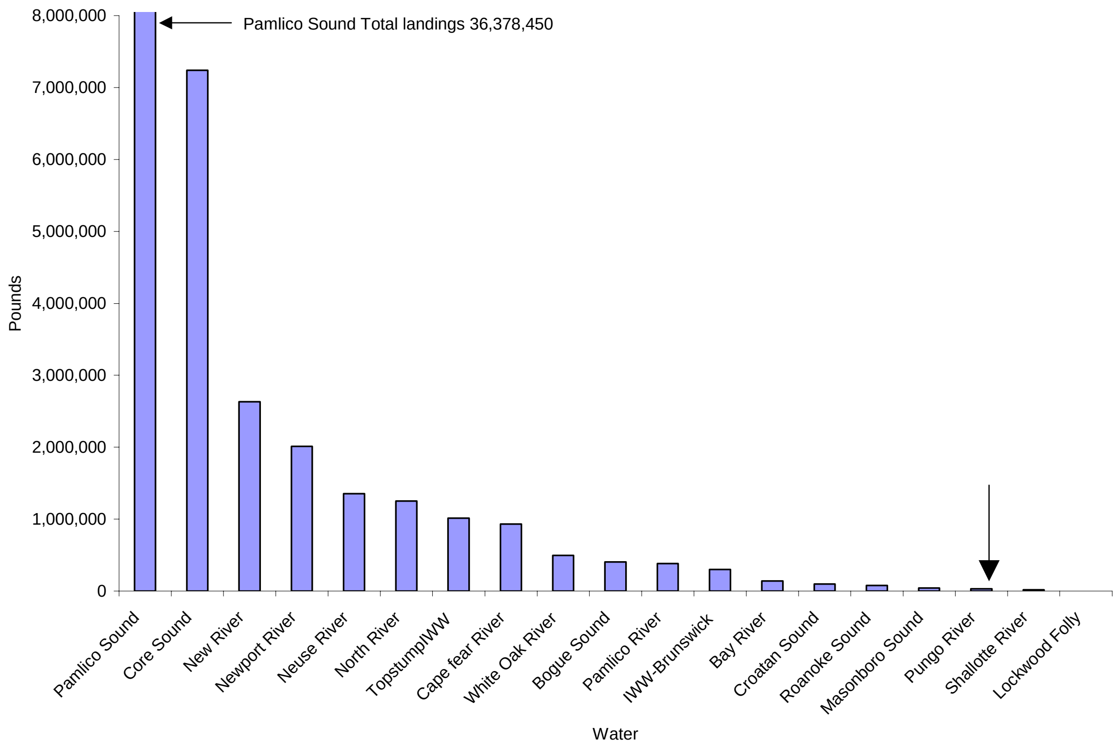


Figure 1. Total pounds of shrimp harvested by shrimp in major North Carolina waterbodies between 1994-2003.

Table 1. Monthly shrimp landings (lbs) from shrimp trawls from Pungo River North Carolina; 1996 – 2003.

	Pounds		Percent	Percent of
Month	Total	Average	of total	Total trips
June	8,143	1,018	26.44%	27.52%
July	5,846	731	18.98%	44.95%
August	10,820	1,352	35.13%	9.17%
September	5,987	748	19.44%	18.35%

Table 2. Percent contribution of daily June shrimp landings* by market grade for Pungo River, 1996 – 2003.

	Market grade									Total	Percent of
Day	16/20	20/25	26/30	31/35	36/40	41/45	46/50	80+	Mixed	pounds	monthly total
7	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	187	2.79%
17	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	121	1.80%
20	0.00%	0.00%	0.00%	0.00%	0.00%	46.15%	53.85%	0.00%	0.00%	52	0.77%
21	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	830	12.37%
24	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	60	0.89%
25	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	544	8.11%
26	0.00%	0.00%	0.00%	91.15%	0.00%	0.00%	0.00%	8.85%	0.00%	339	5.05%
27	0.00%	0.00%	0.00%	55.11%	44.89%	0.00%	0.00%	0.00%	0.00%	744	11.09%
28	0.00%	0.00%	0.00%	39.81%	12.36%	0.00%	47.83%	0.00%	0.00%	1,173	17.48%
29	0.00%	0.00%	0.00%	44.14%	42.93%	0.00%	12.93%	0.00%	0.00%	2,660	39.64%
Total	0.00%	0.00%	2.79%	35.17%	45.53%	0.36%	15.71%	0.45%	0.00%	6,710	100.00%

*Only showing heads on landings which represent 82% of the monthly total.

Table 3. Percent contribution of daily July shrimp landings* by market grade for Pungo River, 1996 – 2003.

	Market grade									Total	Percent of
Day	16/20	20/25	26/30	31/35	36/40	41/45	46/50	80+	Mixed	pounds	monthly total
3	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	107	7.21%
6	0.00%	0.00%	0.00%	0.00%	32.35%	0.00%	47.06%	20.59%	0.00%	204	13.75%
7	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	10	0.67%
8	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	431	29.04%
9	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	65	4.38%
10	0.00%	63.49%	0.00%	0.00%	0.00%	36.51%	0.00%	0.00%	0.00%	126	8.49%
16	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	228	15.36%
17	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	276	18.60%
19	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	37	2.49%
Total	0.00%	41.31%	0.00%	41.17%	4.45%	3.10%	6.47%	2.83%	0.67%	1,484	100.00%

*Only showing heads on landings which represent 25% of the monthly total.

Table 4. Percent contribution of daily August shrimp landings* by market grade for Pungo River, 1996 – 2003.

	Market grade									Total	Percent of
Day	16/20	20/25	26/30	31/35	36/40	41/45	46/50	80+	Mixed	pounds	monthly total
7	84.52%	0.00%	0.00%	0.00%	15.48%	0.00%	0.00%	0.00%	0.00%	7,029	99.79%
12	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	7	0.10%
13	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	8	0.11%
Total	84.34%	0.00%	0.00%	0.00%	15.45%	0.00%	0.00%	0.00%	0.21%	7,044	100.00%

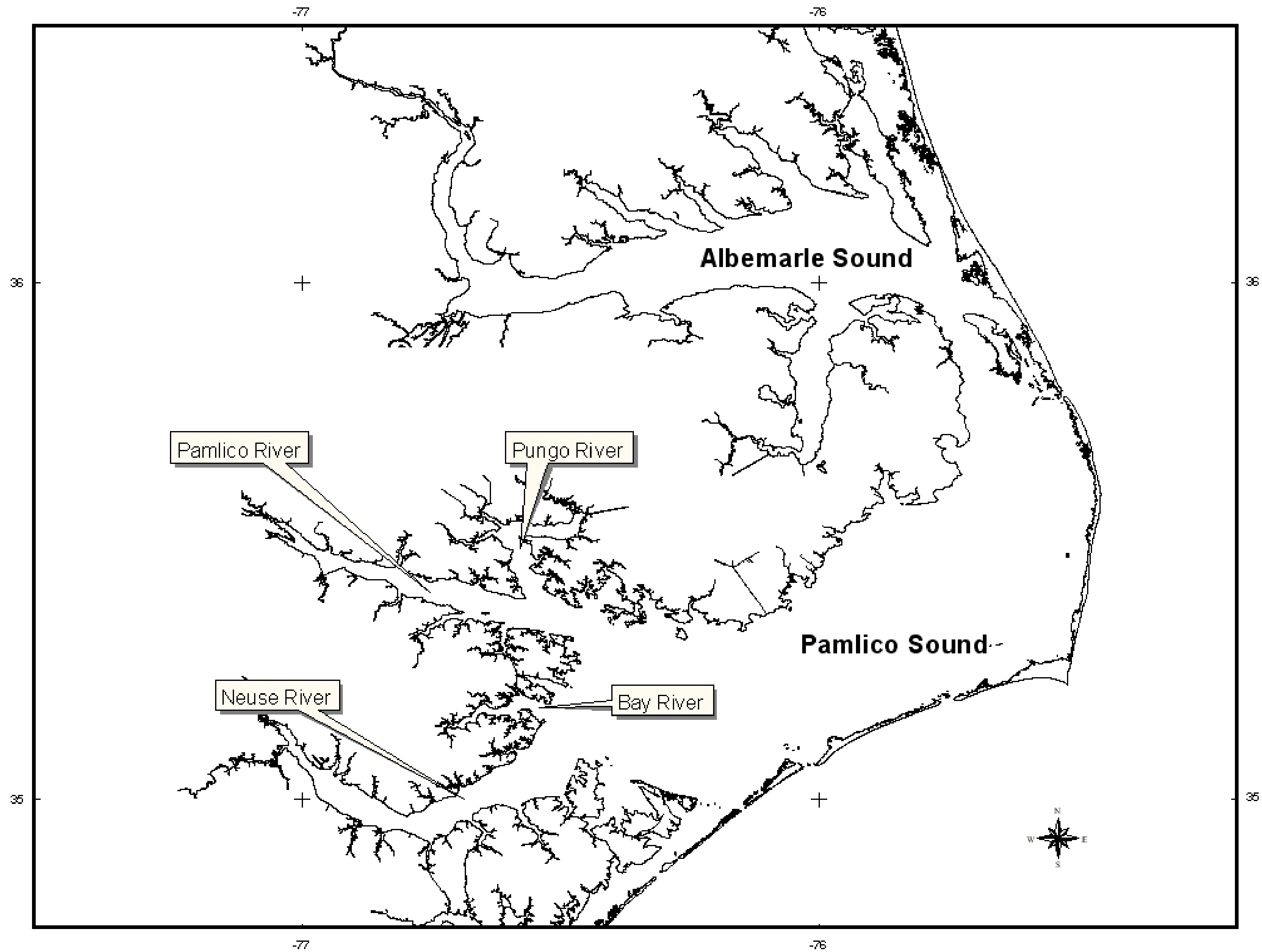
*Only showing heads on landings which represent 65% of the monthly total.

Table 5. Percent contribution of various vessel size classes to total shrimp trawl landings in Pungo River; 1996 – 2003.

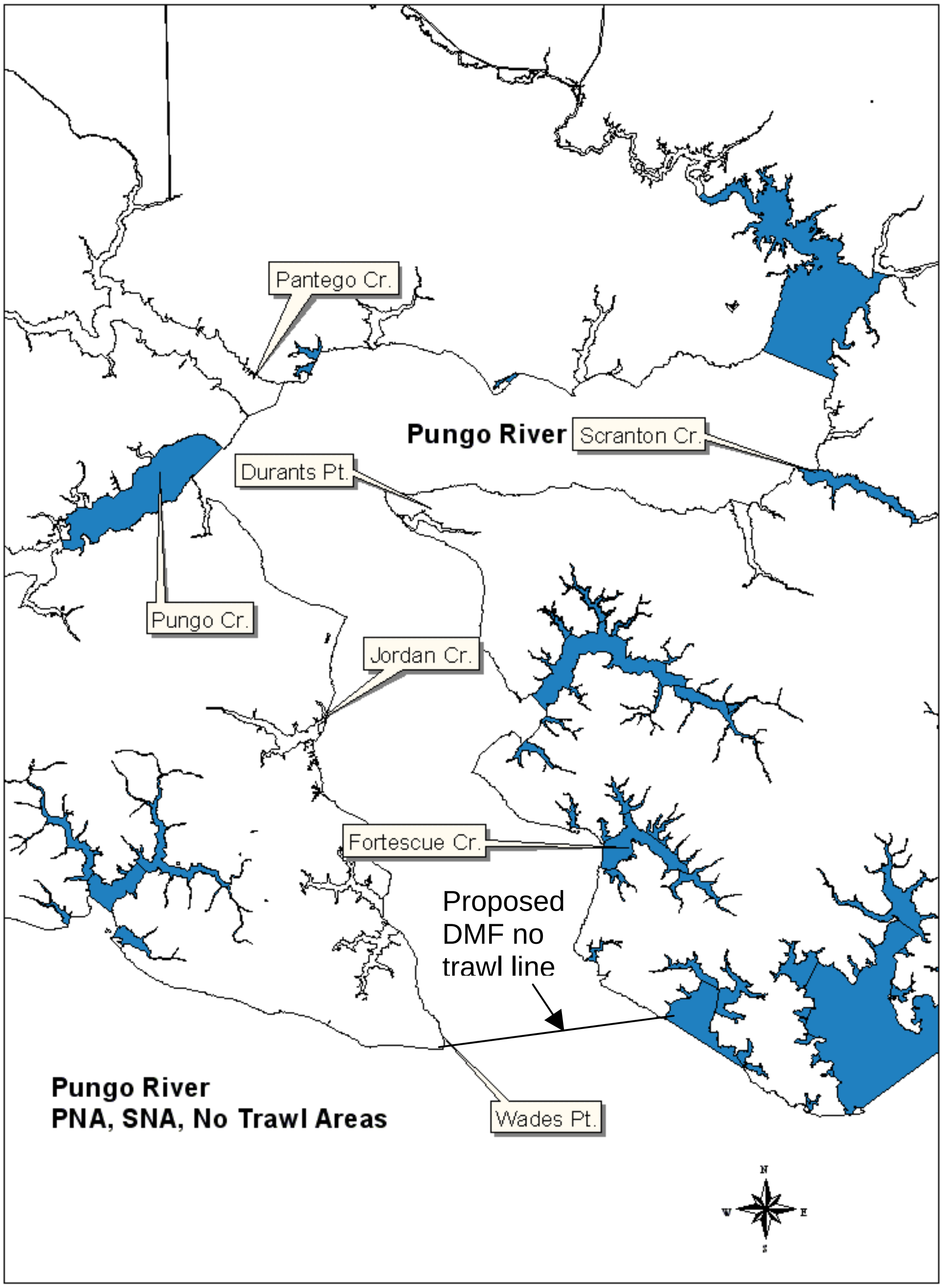
	Vessel size range											
Year	< 20'	20 - 24'	25 - 29'	30 - 34'	35 - 39'	40 - 44'	45 - 49'	50 - 54'	55 - 59'	> 60'	Unknown	Total
1996	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	100.00%
1997	0.00%	0.55%	7.87%	0.00%	15.74%	26.86%	9.37%	0.00%	0.00%	39.60%	0.00%	100.00%
1999	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	100.00%
2000	0.00%	0.00%	22.14%	0.00%	23.13%	2.09%	0.00%	0.00%	0.00%	51.63%	1.00%	100.00%
2001	0.00%	4.88%	0.84%	9.95%	38.46%	6.56%	20.62%	0.00%	17.34%	0.00%	1.35%	100.00%
2002	0.76%	7.11%	0.76%	5.93%	29.56%	6.10%	21.30%	0.00%	24.53%	3.94%	0.00%	100.00%
2003	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
Total	0.19%	2.95%	5.69%	3.72%	21.93%	4.59%	10.40%	0.00%	10.11%	37.08%	3.35%	100.00%

Table 6. Percent contribution of three vessel size groups to yearly shrimp trawl landings in Pungo River; 1996 – 2003.

	Vessel size range			
Year	< 20'	20 - 39'	> 40'	Total
1996	0.00%	0.00%	0.00%	0.00%
1997	0.00%	24.17%	75.83%	100.00%
1999	0.00%	0.00%	100.00%	100.00%
2000	0.00%	45.28%	53.72%	99.00%
2001	0.00%	54.13%	44.52%	98.65%
2002	0.76%	43.37%	55.87%	100.00%
2003	0.00%	100.00%	0.00%	100.00%
Total	0.19%	34.28%	62.18%	96.65%



Map 1. Map of Pamlico and Albemarle sounds North Carolina.



Map 2. Map of Pungo River North Carolina.

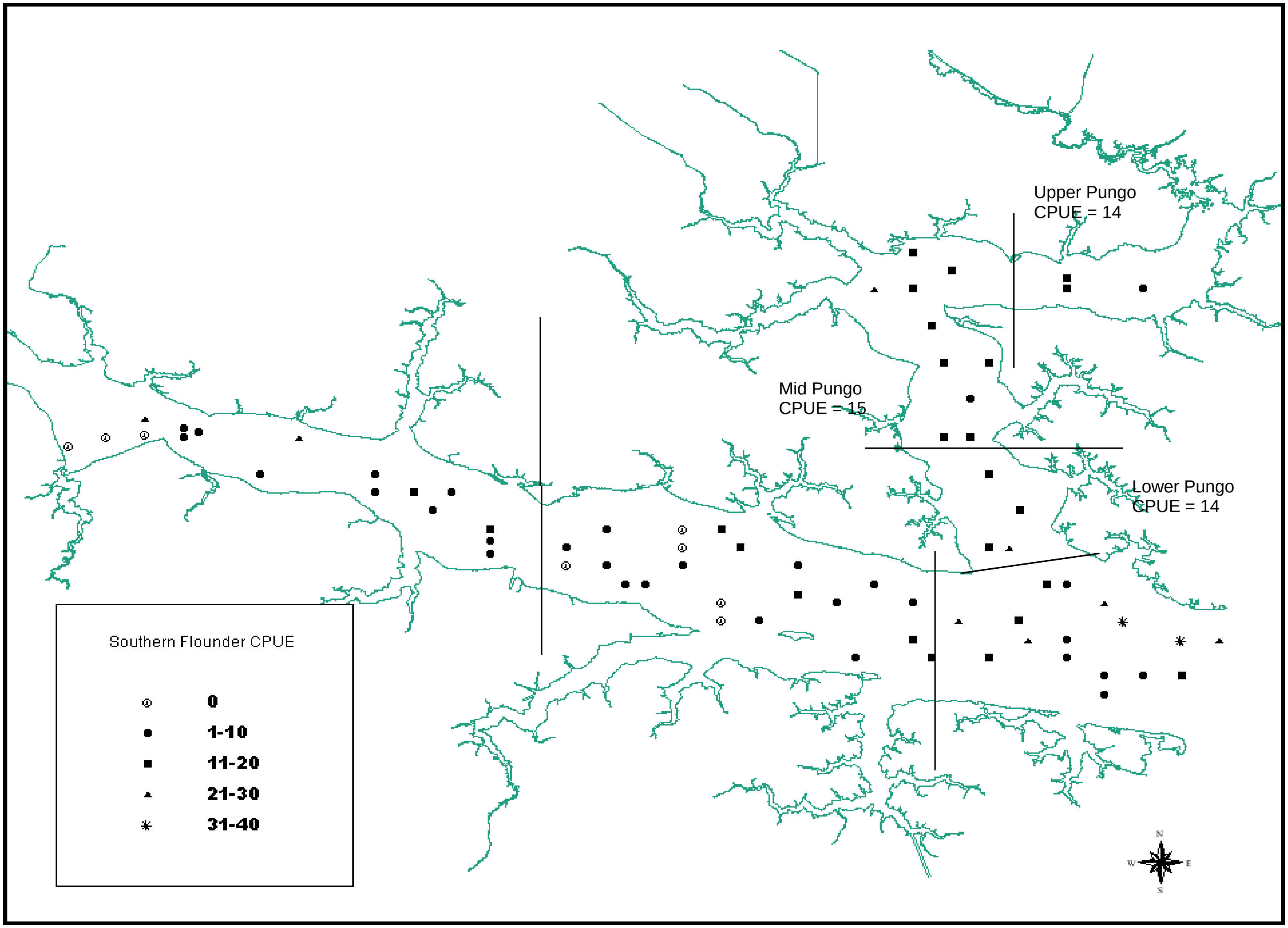


Figure 2. Catch per unit effort (CPUE) of southern flounder in the Pamlico and Pungo rivers from Program 195, June and September data combined, 1987 – 2003.

Management Option/Impacts

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

1. Status quo (potential to close and open when shrimp are of sufficient size)
   + Flexibility in reacting to variable conditions (excessive rainfall, early migration)
   + Access to resource by a variety of users
   - Does not minimize harvest of small shrimp and bycatch
   - Labor intensive and expensive to sample
   - Necessitates “grand openings”

2. Harvest Season (Month (s), or Month (s)/Day (s) closures)
   a) Implement closure of Pungo River with initial June proclamation and open in mid July (based on predetermined heads-on count).
      + Eliminates grand openings (if coordinated with other areas)
      + Protection of small shrimp and juvenile fish and crabs.
      + Potential for larger shrimp when trawling is opened
      - Lose flexibility of management by proclamation
      - Loss of resource to RCGL and smaller commercial trawlers

   b) Implement split season for commercial and RCGL shrimpers (same as # 2 above except open to RCGL harvest 1 or 2 weeks prior to commercial opening)
      + Protection of small shrimp and juvenile fish and crabs
      + Allows access to resource by all users
      + Potential for larger shrimp when trawling is opened
      - Lose flexibility of management by proclamation

   c) Open in July (based on predetermined heads-on count or pre determined date) and close to shrimp trawling in mid to late August
      + Eliminates grand openings (if coordinated with other areas)
      + Protection of small shrimp and juvenile fish and crabs
      + Potential for larger shrimp when trawling is opened
      - Lose flexibility of management by proclamation
      - Loss of resource to RCGL and smaller commercial trawlers

3. Area Closures
   a) Prohibit all shrimp trawlers in Pungo River
      + Bycatch issue completely eliminated
      + Potential for healthier shellfish/finfish stocks
      + Decrease navigational and fixed vs. mobile gear conflicts in inside waters
      + Allow for harvest of larger count shrimp once they migrate into Pamlico Sound
      - Loss of income to commercial fishermen and dealers
      - Loss of RCGL use of shrimp resource

   b) Close portions of the river to shrimp trawl harvest.
      + Decrease navigational and fixed vs. mobile gear conflicts in closed waters
      + Allow for harvest of larger count shrimp once they migrate into Open areas
      - Loss of income to commercial fishermen and dealers
      - Loss of recreational use of shrimp resource

4. Regulate Means and Methods (gear and vessel)
   a) Implement headrope size limit on shrimp trawlers working in Pungo River
      + Allows for all size classes of vessels to work
      + Reduction in bycatch
      - Reduction in fishing power of larger vessels

   b) Increase tailbag mesh size.
      + Reduction in bycatch
      + Catch larger size shrimp
      - Loss of smaller size shrimp
      - Insufficient data on different mesh sizes and shrimp loss and bycatch reduction

   c) Implement maximum vessel length restriction on shrimp trawlers working in Pungo River
      + Decrease navigational and fixed vs. mobile gear conflicts in inside waters
      + Reduction in bycatch
      - Loss of income to commercial fishermen and dealers

AC Recommendation: Open on 26-30 count heads-on count on or after July 7. Restrict total headrope to 90 feet upstream of a line between Wades Point and Abels Bay.

DMF, and MFC Recommendation: All waters upstream of a line from Wades Point to Abels Bay be closed to shrimp trawling (Map 2).

12.24 Appendix 24. SHRIMP MANAGEMENT IN THE ATLANTIC OCEAN

North Carolina's coastline on the Atlantic Ocean is comprised of barrier islands that stretch approximately 484 kilometers. Shoals extending perpendicular from shore accompany capes and inlets along North Carolina's coastal ocean. Ocean currents converging with these shoals, along with the meeting of the north-flowing Gulf Stream and the south-flowing Virginia Coastal Labrador current create a nutrient rich environment for marine organisms. On average, 24% of shrimp landed in North Carolina are harvested from these nearshore (< 3 miles) ocean waters. Near-shore hardbottom areas, dense concentrations of marine algae, artificial reefs and shipwrecks limit the amount of trawlable bottom available to commercial fishers. The many inlets separating the barrier islands act as corridors that marine organisms utilize as they enter and exit the estuaries. All three species of shrimp are harvested in the ocean waters.

Since shrimp that migrate from the estuaries are usually large, the Division of Marine Fisheries (DMF) does not actively manage the ocean waters. However, during the past few years and exclusively off the Brunswick county coast, DMF has been requested by the fishermen to take a more active role in the management of the ocean shrimp fishery. These requests were precipitated as result of the heavy hurricane or tropical storm induced rains that have impacted southeastern North Carolina with regularity since the mid 1990's. Fresh water from these heavy rains dramatically reduces salinities in the estuaries causing the shrimp to prematurely migrate from the estuaries into the ocean. When this occurs, DMF generally closes the impacted ocean and estuarine waters. With the exception of 2001, closures of this nature have occurred each year during the period 1999-2003.

According to data supplied by the DMF trip ticket program, an average of 221 vessels landed shrimp from the ocean during 1994-2003. Vessel size was variable but over 70% of the vessels in this fishery exceeded 40 ft. in length. Landings are charted by boat size and by year in order to highlight the trends in the ocean fishery (Figure 1). Noteworthy is the fact that the number of vessels/participants harvesting shrimp in the ocean has been decreasing in the last 10 years, with a dramatic decrease since 1999 (Figure 2).

The DMF trip ticket program separates ocean landings based on whether the shrimp were captured in federal ocean waters (> 3 miles) or state ocean waters (< 3 miles) (Figures 3 and 4). The ocean fishery is prosecuted up and down the coast but the majority of the harvest occurs in southeastern North Carolina (Onlsow County south) and in state waters less than 3 miles from the beach. On average, landings from ocean waters less than 3 miles represented 85.5% of the catch between 1994-2003 with approximately 75% of these shrimp being captured in the ocean adjacent to Onslow, Carteret and Brunswick counties (Figure 5).

Ten-year mean catches by percent of total pounds for the federal ocean waters (> 3 miles) were highest in Carteret County, (41.2%) followed by Brunswick, Pamlico and Onslow counties with 31.6, 16.3, and 5.8 percent respectively. Ten-year mean catches for state ocean waters (<3 miles) were highest in Brunswick County (44.7%) followed by Onslow, Carteret and New Hanover counties with 28.0, 15.1 and 8.3 percent respectively (Figure 5).

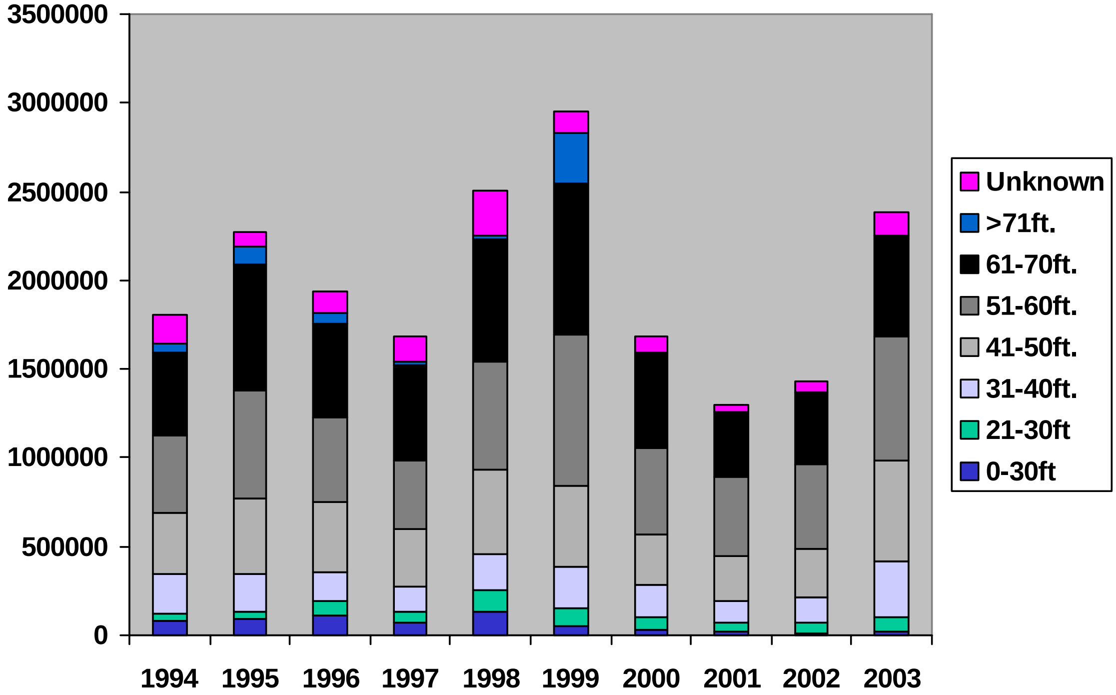


Figure 1. Landings in ocean waters by boat size and year 1994-2003.

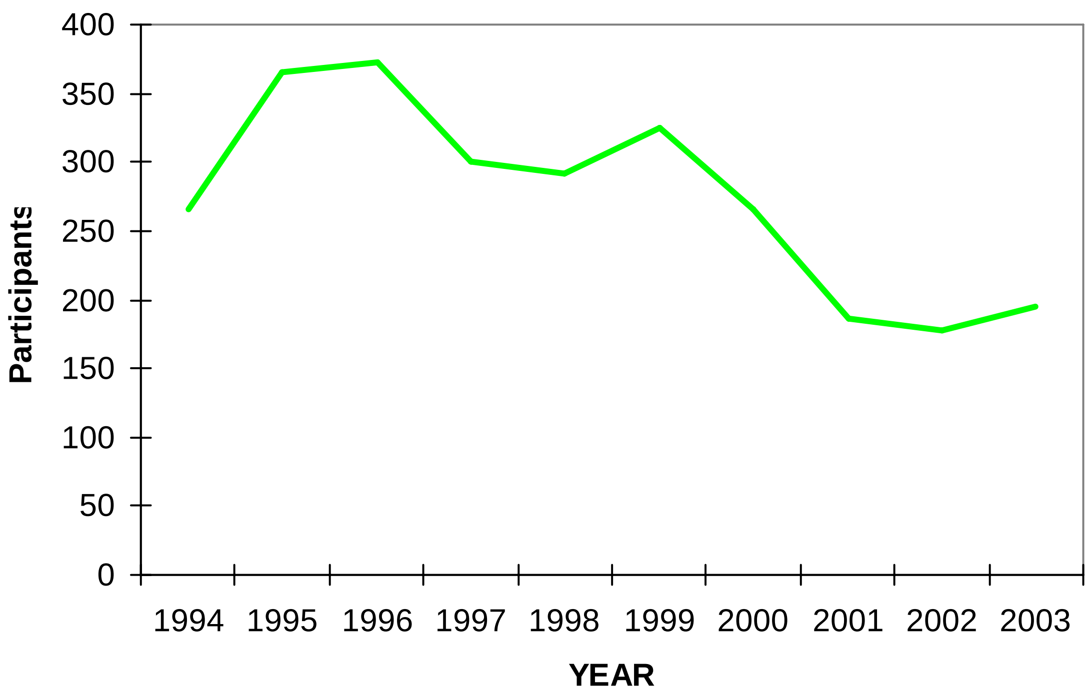


Figure 2. Number of participants/vessels in ocean fishery 1994-2003.

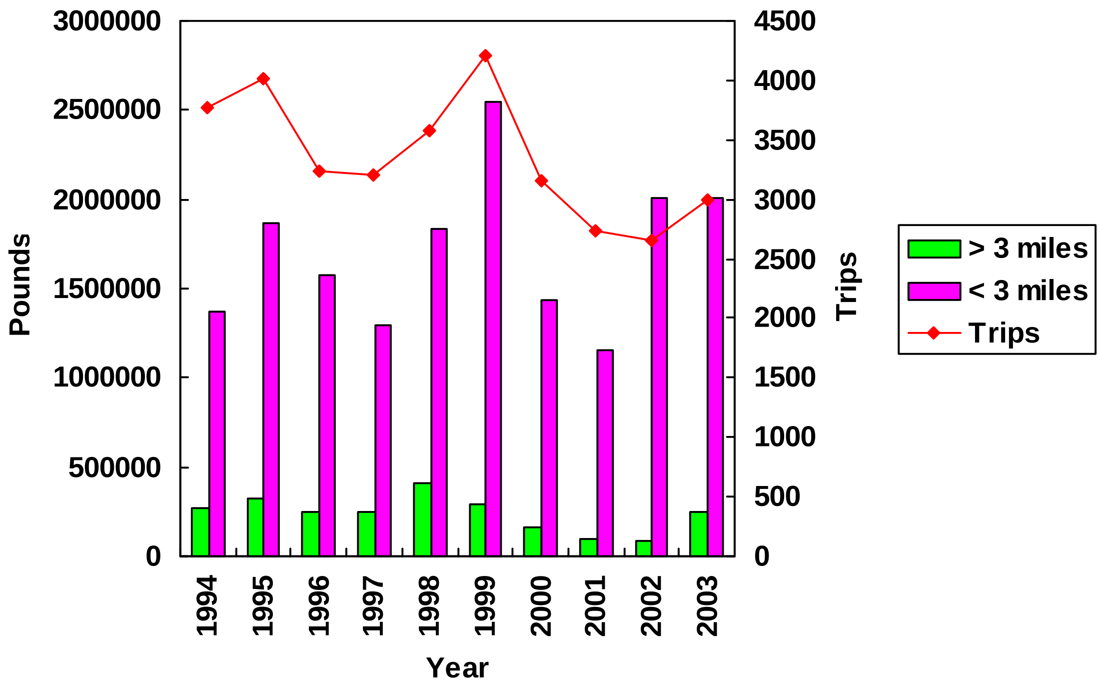


Figure 3. Landings in state and federal ocean waters and total trips, 1994-2003.

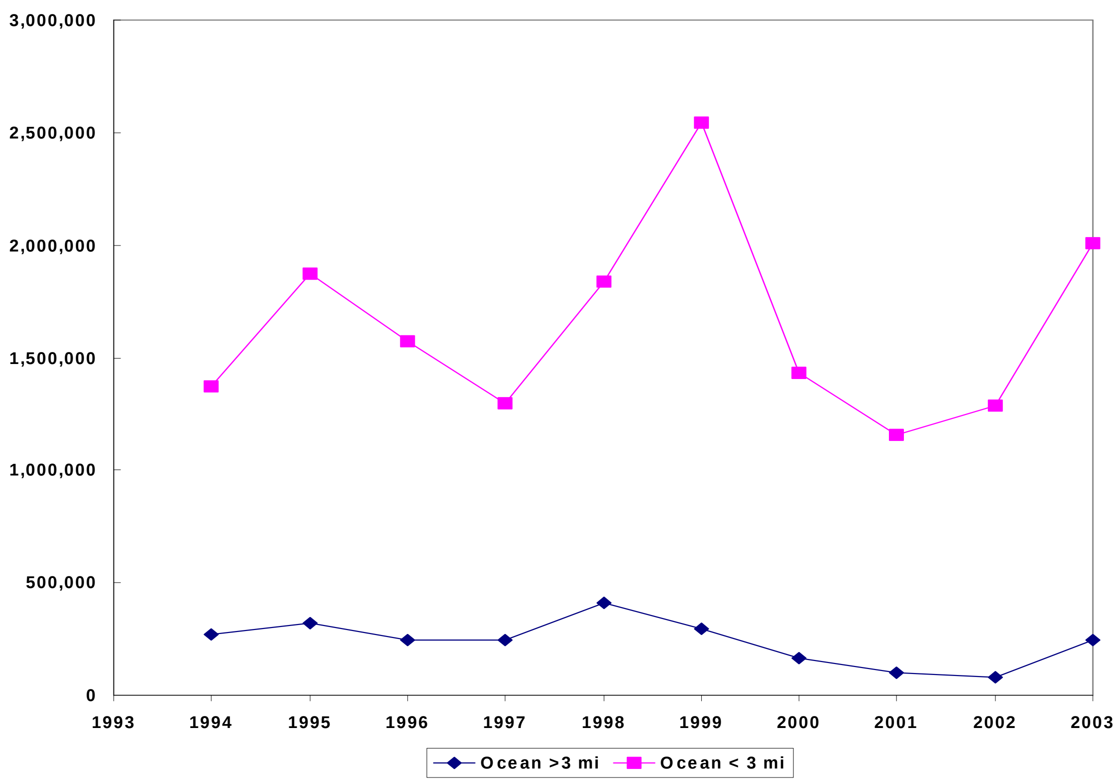


Figure 4. Trend of Landings in state and federal waters 1994-2003.

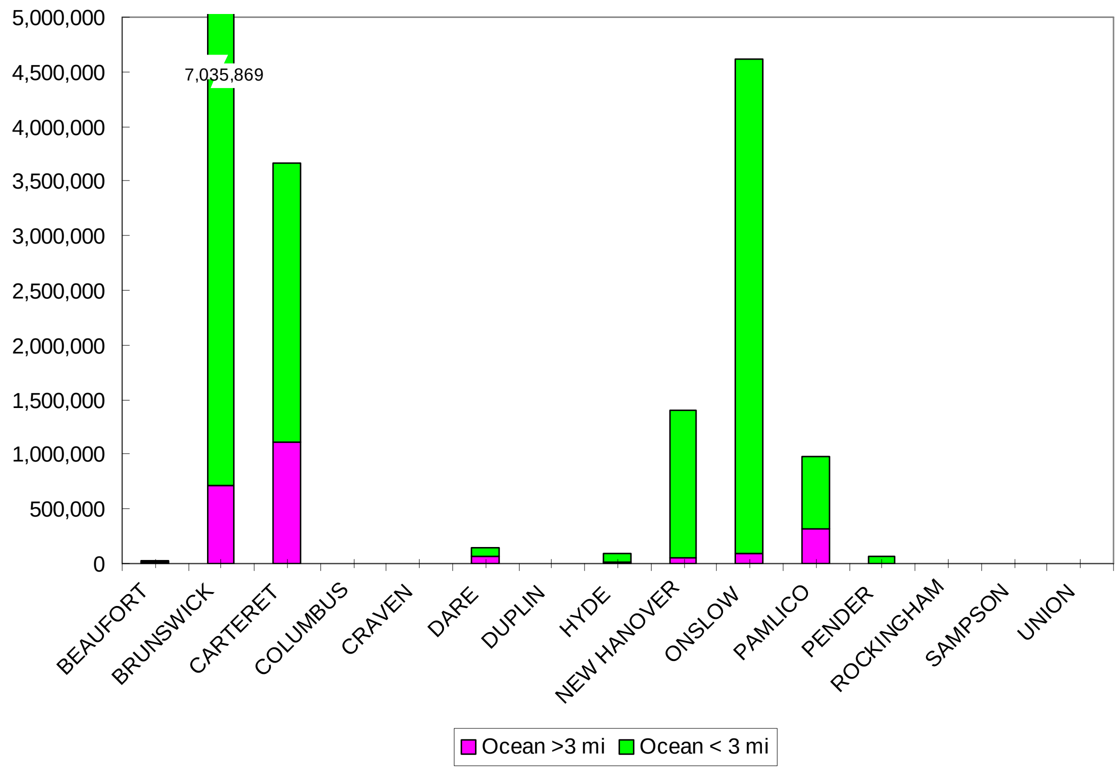


Figure 5. Combined ocean landings in pounds, by county, for the period 1994-2003 in state and federal ocean waters.

Marketable bycatch landed in ocean shrimp trawls was calculated based on trip ticket information provided to DMF. The total pounds of all landed species from shrimp trawls were summed for the years 1994-20003 and the top 5 species by weight are noted for both state and federal ocean waters (Figure 6). Excluding *Penaeid* shrimp, the remainder of the catch landed during 1994-2003 included approximately 59 species of fish as well as rock shrimp, crab, squid, octopus, and conch. By weight, for both state and federal waters, *Penaeid* shrimp accounted for 91.7% percent of the ocean trawl catch and the other species accounted for 9.3% of the catch. Further analysis of the trip ticket data indicated that, in the landed catch, species other than Penaeid shrimp accounted for 12.2% of the take in federal waters and 8.9% in state waters.

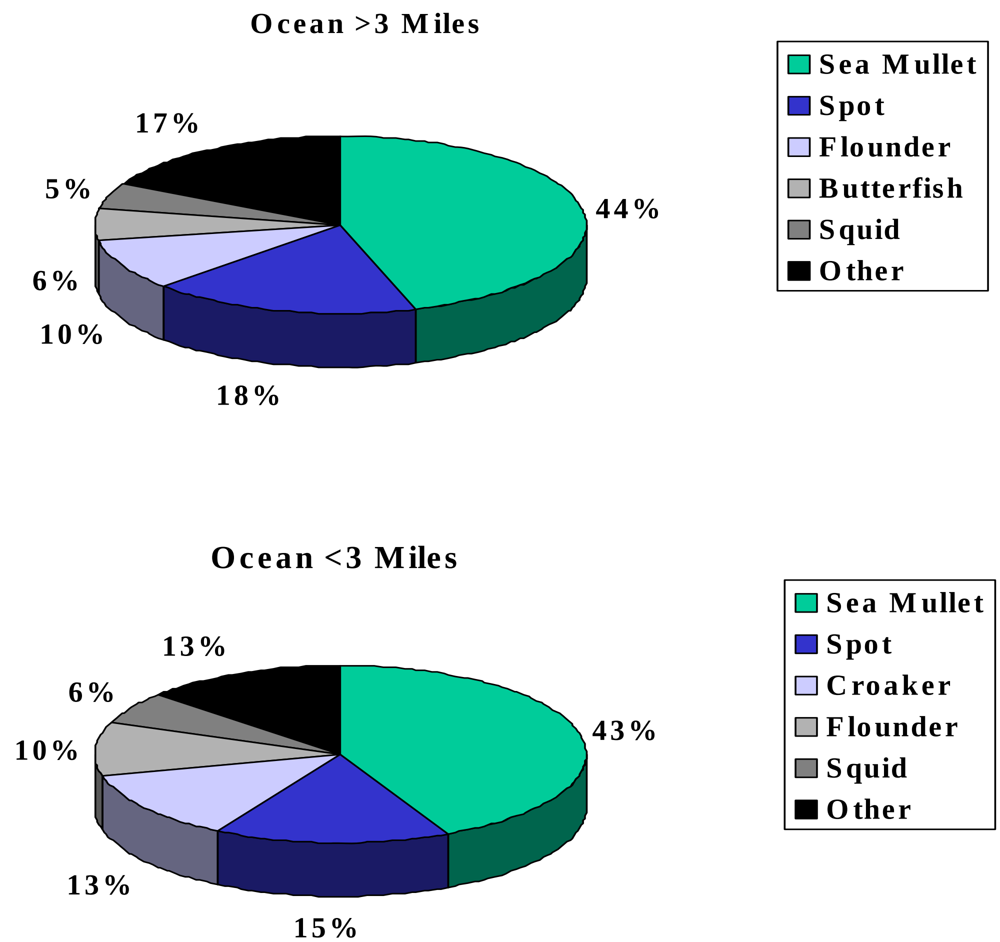


Figure 6. Percent contribution of top 5 species captured and sold in ocean shrimp trawls by weight, 1994-2003.

Bycatch in the ocean shrimp trawl fishery has long been a concern to fishery managers. North Carolina has completed several Bycatch Reduction Device (BRD) studies (Mckenna and Monaghan 1993; Coale et al. 1994; Murray et al. 1995; and Mckenna et al. 1996) to evaluate the selective technology available to reduce non-shrimp portions of the trawl catch. However, since these BRD studies were designed specifically to address finfish catches in shrimp trawls, they were often conducted at times of low shrimp abundance. Consequently, these data are not appropriate to use as bycatch benchmarks in the North Carolina shrimp trawl fishery. However, data from these BRD studies enabled North Carolina to be the first state to mandate through regulation the use of BRDs in all shrimp trawls. Although a detailed characterization of the shrimp trawl fishery in North Carolina has not been conducted, several regional studies have been conducted that characterize and quantify the magnitude of ocean bycatch in the South Atlantic.

The National Marine Fisheries Service, (NMFS) reporting to Congress in April, 1995 provided data on bycatch proportions in the South Atlantic. All data was gathered by observers aboard commercial shrimp trawlers in normal fleet operations (with TEDs). Analysis revealed that an average trawl pulled for one hour in the South Atlantic captured 1214 organisms weighing nearly 64 lbs. Commercial shrimp accounted for 29% of the total catch by number and 20% by weight. Finfish represented 46% of the catch by number and 47% by weight. The ratio of finfish to shrimp per hour of trawling was calculated at 1.6 **:** 1 by number and 2.3 **:** 1 by weight. The ratio of all the species captured to shrimp was 4.5 **:** 1. Besides finfish, the other portions of the typical catch were comprised of crustaceans (8% by weight, 11% by number) and other invertebrates (25% by weight and 14% by number (NMFS, 1995). The top 10 species captured by weight are shown below (Table 1).

Table 1. The top 10 species by weight found in South Atlantic shrimp trawl catches.

Species	Percent
Cannonball jellyfish	14
White Shrimp	9
Spot	9
Atlantic menhaden	9
Brown shrimp	8
Other jellyfish	8
Atlantic croaker	6
Southern kingfish (sea mullet)	4
Blue Crab	4
Star Drum	3

Finfish to shrimp ratios are commonly used for relative comparison in bycatch studies. However, it must be realized that these ratios may vary widely relative to times and areas fished and that it can be somewhat misleading to combine all of these variations into a single number. The NMFS study revealed that in the South Atlantic, the highest shrimp catches and the lowest finfish catches (by number) occurred during September through May (NMFS, 1995).

Diamond-Tissue's 1995 characterizations study focused primarily on the inshore shrimp fishery but did contain data on 8 tows off Carolina Beach. The boat used in this sampling had the required TEDs and BRDs. The catch in the ocean adjacent to Carolina Beach showed higher percentages (by number) of fish than shrimp in July, but reversed in August. However, by weight, the percentage of fish was greater than shrimp in August. Ratios of finfish to shrimp by weight in July and August were 2.7 **:** 1 and 4 **:** 1 respectively. However, these data were based on only 8 tows from 3 trips.

BRD requirements have significantly reduced the amount of non-targeted bycatch in both inshore and offshore shrimp trawlers. However, due to the limited number of studies in North Carolina ocean waters, the trawlers' impact on fish stocks needs more study.

Current Authority

<u>North Carolina Fisheries Rules for Coastal Waters (15A NCAC)</u>

3J .0202 – Atlantic Ocean

(2) It is unlawful to use trawls within one-half mile of the beach between the Virginia line and Oregon Inlet.

(5) Finfish taken with shrimp or crab trawls:

(a) It is unlawful to possess finfish (including pursuant to 15A NCAC 03M .0102) incidental to shrimp or crab trawl operations from December 1 through March 31 unless the weight of the combined catch of shrimp and crabs exceeds the weight of finfish except as provided in Sub-Item (5)(b) of this Rule:

(b) It is unlawful to possess 300 pounds of kingfish (Menticirrhus sp.) taken south of Bogue Inlet regardless of the amount of shrimp, crabs or finfish taken.

(8) It is unlawful to use shrimp trawls in all waters west of a line beginning at the southeastern tip of Baldhead Island 33° 50' 29" N – 77° 57' 28" W from one hour after sunset to one hour before sunrise.

3L.0102 – WEEKEND SHRIMPING PROHIBITED

It is unlawful to take shrimp by any method from 9:00 P.M. on Friday through 5:00 P.M. on Sunday except:

(1) In the Atlantic Ocean; or

(2) With the use of fixed and channel nets, hand seines, and cast nets.

The current rules which apply to the shrimp fishery in the Atlantic Ocean limit the amount of finfish that may be retained and were a result of an effort to limit the use of shrimp trawls to take finfish during the flynet season. The night closure off Brunswick County was initiated by shrimpers in the area to reduce effort. There was some discussion at the time of extending the weekend closure to the Ocean but it was never realized.

Management Options/Impacts

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

1) Status quo (potential opening dates set by proclamation and determined by sampling)
- \+ Flexibility in dealing with variety of conditions
- \+ No need for further rulemaking
- \- Does not address harvest of waste/bycatch

2) Allow night-time trawling off Brunswick County.
- \+ Allow harvest when shrimp are available
- \+ More efficient for individual operations
- \- Modifications to strategy may not have intended effect
- \- Possible increase in waste/bycatch

3) Prohibit weekend trawling off Brunswick County
- \+ Decrease in waste/bycatch
- \+ Decrease in interactions between trawlers and other user groups
- \+ Possible increase in CPUE following closure
- \- Economic loss to fishermen

4) Prohibit all trawling

- \+ Possible benefit to finfish stocks
- \+ Eliminates any social conflicts between trawlers, piers and beach communities

- \- Eliminates traditional trawl fishery in some areas
- \- Financial hardship on shrimpers
- \- Economic loss to the local economy

AC, DMF, and MFC Recommendation: Status quo except examine the night closure off Brunswick County.

12.25 Appendix 25. SHRIMP MANAGEMENT IN PAMLICO SOUND

Pamlico Sound system extends from Oregon Inlet south to Core Sound (Map 1). Salinity varies from 25 - 30 ppt near the three inlets to near zero in the upper tributaries. Two large river systems (Neuse and Tar-Pamlico) provide the major fresh water inputs. The average depth of the sound is 16 ft. Numerous small creeks and bays surround Pamlico Sound. The Sound is divided into two basins east and west of Bluff Shoal. Extensive low salinity *Juncus* marshes border the sound and many of the tributary bays and creeks. Significant SAV beds occur in the sound, with high salinity species (e.g., eel grass) along the shoals behind the Outer Banks in the east and low salinity species (e.g., widgeon grass, wild celery) along some of the western shores. There are diurnal tides of 2 - 3 ft near the three inlets, but virtually no lunar tides away from the inlet areas. However, wind tides exceeding 2 ft regularly occur during storms.

Trawling (shrimp and crab) is only allowed in the main portion of the sound. All feeder creeks and bays are classified as either Nursery Areas (Primary, Secondary, Special Secondary) or no trawl areas all of which are closed to trawling (Map 2). Overall this system is approximately 1,129,577 acres in size. 1,088,258 acres are under DMF jurisdiction (coastal and joint waters). 5,400 acres are classified as Primary Nursery areas, 30,184 acres as Secondary Nursery areas, 1,916 acres as Special Secondary Nursery areas, and 172,128 acres of no trawl areas. Seventy-nine percent of the water under DMF jurisdiction is open to trawling. Other commercial fisheries in Pamlico Sound include crab pot, crab trawl, crab dredging, oyster dredging, clam kicking, gill net, pound netting, and long-haul. Over the last 11 years portions of western Pamlico Sound have been closed six times to shrimp trawling (Map 3).

Pamlico Sound accounts for 51% of the total statewide shrimp production. Average annual shrimp landings are 3,637,844 pounds, with an average dockside value of $8,993,767. Ninety-nine percent of the shrimp landed from the Pamlico Sound are caught by shrimp trawls (1994 – 2003 Trip ticket Data). Other gears with reported shrimp landings are; channel net (0.01%) skimmer trawls (0.03%), and crab trawls (0.03%).

Pamlico Sound ranks 1st in shrimp landings by shrimp trawls with average annual landings of 3,634,168 pounds (Figure 1). The average dockside value of these landings is $8,984,478. In addition to shrimp, an average of 208,919 pounds of marketable bycatch with a dockside value of $160,593 is landed annually by shrimp trawls from Pamlico Sound. The landed bycatch is composed of finfish (63%; 131,965 pounds/year), blue crabs (36%; 74,574 pounds/year), and mollusks (1%; 2,378 pounds/year). Kingfishes are the most common finfish species landed with average annual landings of 39,057 pounds (Table 1), 92% of which are landed from July through November (Table 2).

July accounts for 30% of the shrimp landings from shrimp trawls for Pamlico Sound (Tables 2 and 3). The months of August (28%), September (16%), and October (14%) are the other three main months of shrimp harvest from this system.

The percent contribution of yearly shrimp trawl landings by various sized vessels is given in Table 4. Seventy-four percent of the shrimp trawl landings were harvested by vessels greater than 40 feet in length (Table 4).

Although a detailed characterization study of bycatch in the shrimp trawl fishery has not been conducted for Pamlico Sound, preliminary data was collected in 1995 (Diamond-Tissue 1999). Diamond-Tissue's (1999) 1995 characterization study examined 16 tows conducted over 5 trips (Tables 5 and 6). Penaeid shrimp were the most abundant species captured by weight and number. Atlantic croaker, spot, and weakfish were the top three finfish species captured (Tables 5 and 6).

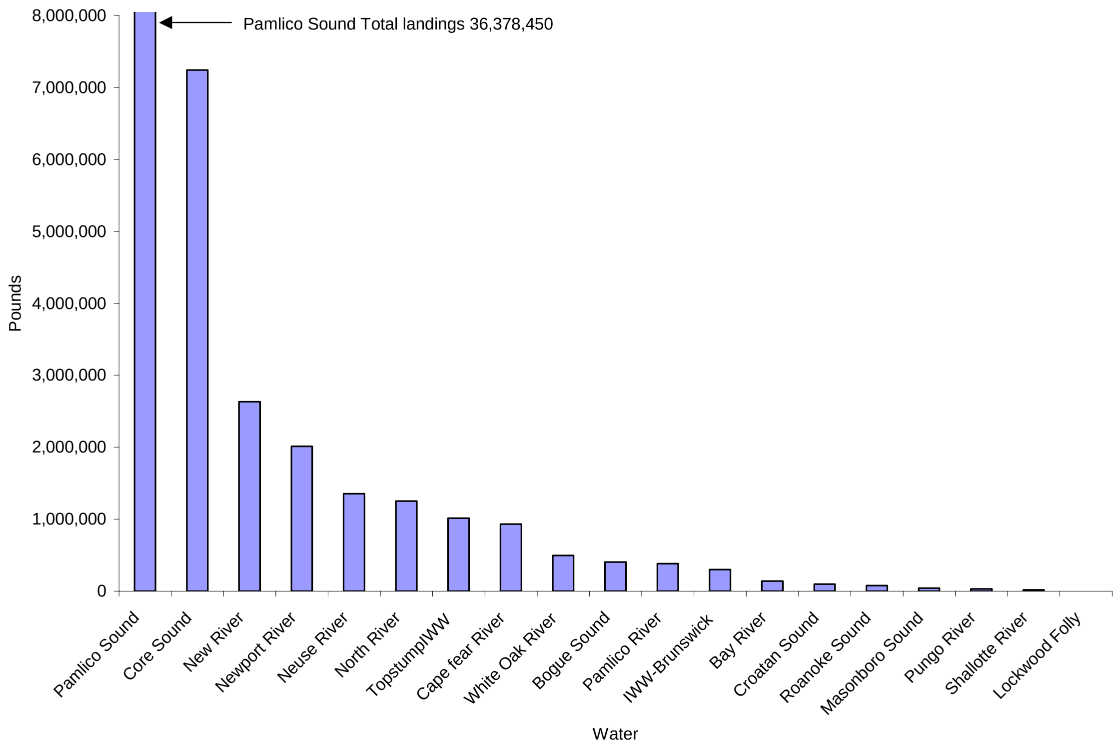


Figure 1. Total pounds of shrimp harvested by shrimp in major North Carolina waterbodies between 1994-2003.

Table 1. Landings (lbs) of finfish from shrimp trawls from the Pamlico Sound North Carolina; 1994 – 2003.

Species	Pounds Total	Pounds Average	Percent of total
Kingfish	390,572	39,057	29.60%
Flounders	360,464	36,046	27.32%
Spot	229,863	22,986	17.42%
Weakfish	137,707	13,771	10.44%
Fish, Mixed	52,018	5,202	3.94%
Butterfish	44,570	4,457	3.38%
Croaker	33,982	3,398	2.58%
Harvestfish	27,022	2,702	2.05%
Spanish Mackerel	8,693	869	0.66%
Sheepshead	7,345	735	0.56%
Spadefish	6,961	696	0.53%
Black drum	5,224	522	0.40%
Bluefish	4,770	477	0.36%
Pigfish	4,106	411	0.31%
Cutlassfish	1,744	174	0.13%
Puffer	1,052	105	0.08%
False albacore	624	62	0.05%
Pompano	606	61	0.05%
Grouper, snowy	442	44	0.03%
Snapper, cubera	400	40	0.03%
Angelfish	202	20	0.02%
Eels	182	18	0.01%
Red drum	182	18	0.01%
Speckled trout	141	14	0.01%
Shark, angel	130	13	0.01%
Mullets, jumping	116	12	0.01%
Triggerfish	104	10	0.01%
Porgies	84	8	0.01%
Yellow perch	57	6	0.00%
King mackerel	56	6	0.00%
Menhaden bait	45	5	0.00%
Hakes	42	4	0.00%
Black sea bass	33	3	0.00%
Pinfish	20	2	0.00%
Monkfish	19	2	0.00%
Cobia	15	2	0.00%
Cod	11	1	0.00%
Tautog	11	1	0.00%
Crevalle jack	10	1	0.00%
Boston mackerel	10	1	0.00%
Bait	8	1	0.00%
Mixed grouper	8	1	0.00%
Shad	2	0	0.00%
Permit	1	0	0.00%
Total	1,319,650	131,965	100.00%

Table 2. Monthly percent contribution of landed shrimp trawl catch for Pamlico Sound North Carolina; 1994 – 2003.

	Month												Total
Species	January	February	March	April	May	June	July	August	September	October	November	December	pounds
Shrimp	0.11%	0.03%	0.00%	0.09%	0.80%	3.66%	30.06%	28.17%	16.08%	14.24%	6.11%	0.66%	36,340,691
Blue crab	1.00%	0.08%	0.03%	1.46%	3.21%	12.71%	20.06%	17.07%	10.75%	12.73%	15.58%	5.33%	742,855
Sea mullet (whiting, kingfish)	0.03%	0.09%	0.02%	0.23%	1.20%	4.80%	17.42%	28.29%	12.82%	18.01%	15.08%	2.02%	390,572
Flounders (Paralichthid)	0.21%	0.10%	0.01%	0.44%	1.95%	3.22%	10.18%	16.37%	29.63%	24.83%	11.13%	1.92%	360,464
Spot	0.00%	0.00%	0.00%	0.00%	0.04%	0.58%	5.85%	19.26%	37.60%	32.06%	4.52%	0.09%	229,863
Weakfish	0.06%	0.03%	0.00%	0.03%	0.95%	2.83%	17.03%	27.24%	16.49%	19.11%	14.12%	2.09%	137,707
Fish, mixed	0.00%	0.04%	0.12%	0.42%	0.71%	2.98%	15.16%	18.77%	22.68%	18.20%	13.52%	7.41%	52,018
Butterfish	0.02%	0.00%	0.00%	0.00%	0.77%	3.28%	10.47%	25.48%	21.53%	23.15%	12.17%	3.15%	44,570
Croaker	0.00%	0.00%	0.00%	0.05%	0.19%	1.13%	9.23%	23.15%	36.77%	16.66%	9.05%	3.78%	33,982
Harvestfish	0.00%	0.00%	0.00%	0.30%	0.64%	5.66%	20.21%	26.60%	24.91%	19.53%	1.26%	0.89%	27,022
Squid, Loligo (lbs)	0.00%	1.02%	0.02%	0.00%	0.04%	0.69%	1.99%	12.42%	18.52%	19.59%	32.23%	13.48%	19,299
Mackerel, Spanish	0.00%	0.00%	0.00%	0.01%	0.62%	2.92%	7.49%	27.25%	35.48%	24.78%	1.45%	0.00%	8,693
Sheepshead	0.00%	0.00%	0.00%	0.14%	2.61%	7.31%	14.54%	12.02%	11.67%	41.76%	9.95%	0.00%	7,345
Spadefish	0.00%	0.00%	0.00%	0.00%	0.85%	6.68%	36.22%	43.38%	11.35%	1.52%	0.00%	0.00%	6,961
Drum, black	2.83%	0.00%	0.00%	0.00%	0.00%	0.34%	0.17%	2.16%	3.22%	28.91%	27.81%	34.55%	5,224
Bluefish	0.00%	0.00%	0.00%	0.00%	0.16%	1.69%	4.43%	35.61%	36.17%	18.97%	2.98%	0.00%	4,770
Squid	0.00%	0.00%	0.00%	0.00%	0.00%	0.77%	0.00%	0.50%	3.38%	61.01%	33.51%	0.84%	4,414
Pigfish	0.00%	0.00%	0.00%	0.00%	0.95%	1.84%	2.86%	5.33%	17.12%	33.82%	38.07%	0.00%	4,106
Crab, Horseshoe	7.70%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	62.23%	30.07%	2,883
Cutlassfish	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.99%	13.11%	45.17%	16.95%	22.79%	0.00%	1,744
Puffer	0.00%	0.00%	0.00%	0.00%	0.38%	0.10%	0.10%	0.10%	0.71%	10.18%	31.95%	56.49%	1,052
Shrimp, Rock	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.01%	69.88%	29.11%	0.00%	0.00%	0.00%	986
False Albacore	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	624
Pompano	0.00%	0.00%	0.00%	0.00%	0.00%	0.50%	4.13%	16.52%	38.73%	39.47%	0.66%	0.00%	606
Grouper, snowy	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	442
Snapper, cubera	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	400
Angelfish	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	80.20%	14.85%	4.95%	0.00%	0.00%	0.00%	202
Eels	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	18.68%	29.67%	37.36%	14.29%	0.00%	182
Drum, red	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	22.87%	9.92%	55.10%	12.12%	0.00%	0.00%	182
Trout, Speckled	22.78%	0.00%	0.00%	0.00%	1.42%	0.71%	15.66%	27.76%	1.42%	9.96%	20.28%	0.00%	141
Shark, Angel	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	130
Mullets, Jumping	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	22.41%	6.03%	71.55%	0.00%	0.00%	116

Table 2. Cont.

Species	Month												Total
	January	February	March	April	May	June	July	August	September	October	November	December	pounds
Triggerfish	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	7.69%	0.00%	0.00%	92.31%	0.00%	0.00%	104
Porgies Uncl.	0.00%	0.00%	0.00%	0.00%	0.00%	82.14%	0.00%	17.86%	0.00%	0.00%	0.00%	0.00%	84
Yellow Perch	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	57
Mackerel, King	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	68.52%	0.00%	31.48%	0.00%	0.00%	56
Menhaden Bait (lb)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	88.89%	0.00%	4.44%	6.67%	45
Hakes (Ling/Whiting)	83.33%	16.67%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	42
Octopus (lbs)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	37
Sea Bass, Black	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	30.30%	0.00%	3.03%	30.30%	0.00%	36.36%	33
Conchs/Whelk (lbs meat)	0.00%	0.00%	0.00%	0.00%	6.74%	77.53%	0.00%	0.00%	0.00%	0.00%	0.00%	15.73%	29
Turtles, Snapper (lbs)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	22
Pinfish	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	20
Monkfish (Whole)	0.00%	0.00%	0.00%	0.00%	0.00%	42.11%	0.00%	0.00%	57.89%	0.00%	0.00%	0.00%	19
Cobia	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	15
Cod	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	11
Tautog	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	11
Crevalle jack	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	90.00%	10.00%	0.00%	0.00%	0.00%	10
Mackerel, Boston	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	10
Bait	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	8
Grouper, mixed	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	8
Shad	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	2
Permit	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1
Total	0.12%	0.03%	0.00%	0.12%	0.86%	3.82%	29.25%	27.75%	16.25%	14.51%	6.49%	0.80%	38,430,867

Table 3. Monthly shrimp landings (lbs) from shrimp trawls from Pamlico Sound North Carolina; 1994 – 2003.

	Pounds		Percent	Percent of total
Month	total	average	of total	trips
January	38,624	3,862	0.11%	0.22%
February	9,882	988	0.03%	0.06%
March	1,328	133	0.00%	0.04%
April	31,307	3,131	0.09%	0.56%
May	290,861	29,086	0.80%	2.03%
June	1,330,971	133,097	3.66%	6.08%
July	10,923,071	1,092,307	30.06%	24.53%
August	10,236,515	1,023,652	28.17%	28.78%
September	5,845,062	584,506	16.08%	17.45%
October	5,175,027	517,503	14.24%	13.00%
November	2,219,694	221,969	6.11%	6.24%
December	238,349	23,835	0.66%	1.01%
Total	36,340,691	3,634,069	100.00%	100.00%

Table 4. Percent contribution of three vessel size groups to yearly shrimp trawl landings in Pamlico Sound; 1994 – 2003.

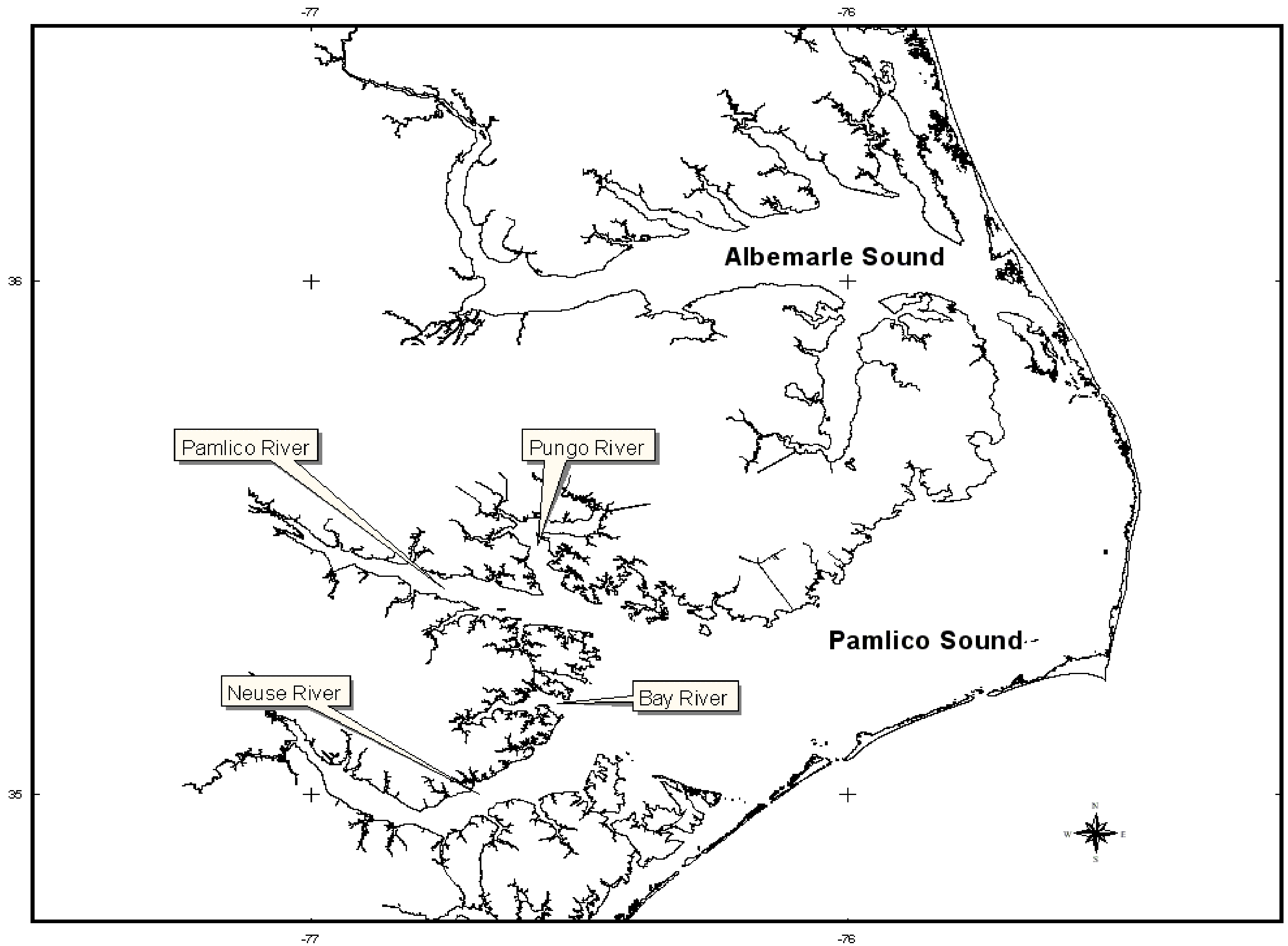
	Vessel size range				Number of
Year	<20'	20 - 39'	>40'	Total	licenses
1994	3%	14%	83%	98%	509
1995	52%	14%	34%	98%	519
1996	14%	12%	74%	97%	381
1997	3%	16%	81%	97%	335
1998	3%	15%	82%	98%	185
1999	2%	19%	79%	97%	509
2000	1%	19%	79%	98%	420
2001	1%	22%	77%	99%	298
2002	2%	18%	80%	100%	354
2003	0%	13%	87%	100%	189
Total	10%	17%	73%	98%	

Table 5. Catch composition (top ten species) by number for shrimp trawls in Pamlico Sound (from Diamond-Tissue 1999).

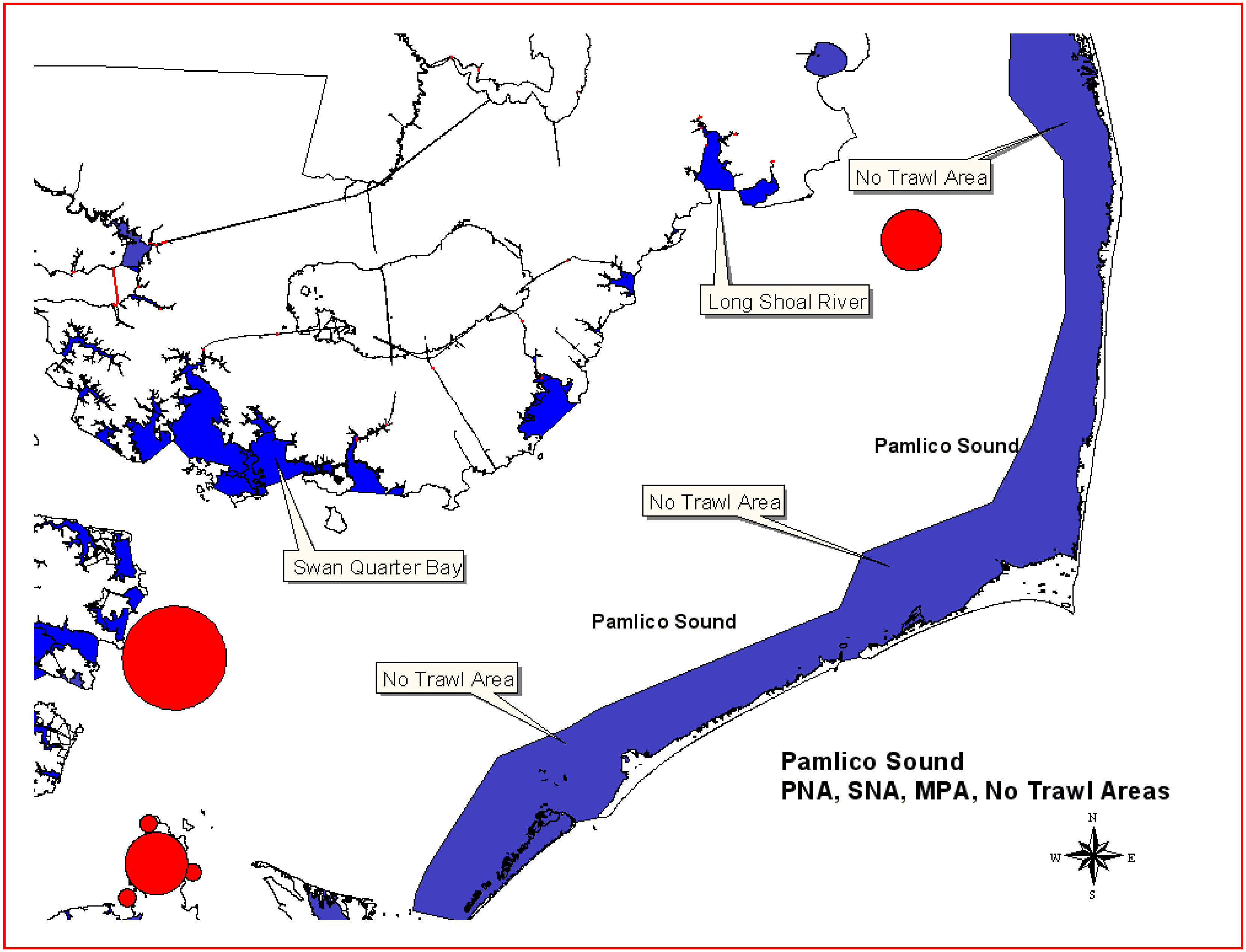
Rank	Species	Total number	Percent of total number	Frequency of occurrence
1	Penaeid shrimp	13,671	28.9	16
2	Atlantic croaker	12,046	25.5	16
3	Spot	8,043	17	16
4	Weakfish	5,047	10.7	15
5	Blue crab	2,023	4.3	14
6	Jellyfish	1,586	3.4	6
7	Silver perch	884	1.9	8
8	Summer flounder	656	1.4	11
9	Hogchoker	489	1	12
10	Brown shrimp	392	0.8	6
			94.9	

Table 6. Catch composition (top ten species) by weight for shrimp trawls in Pamlico Sound (from Diamond-Tissue 1999).

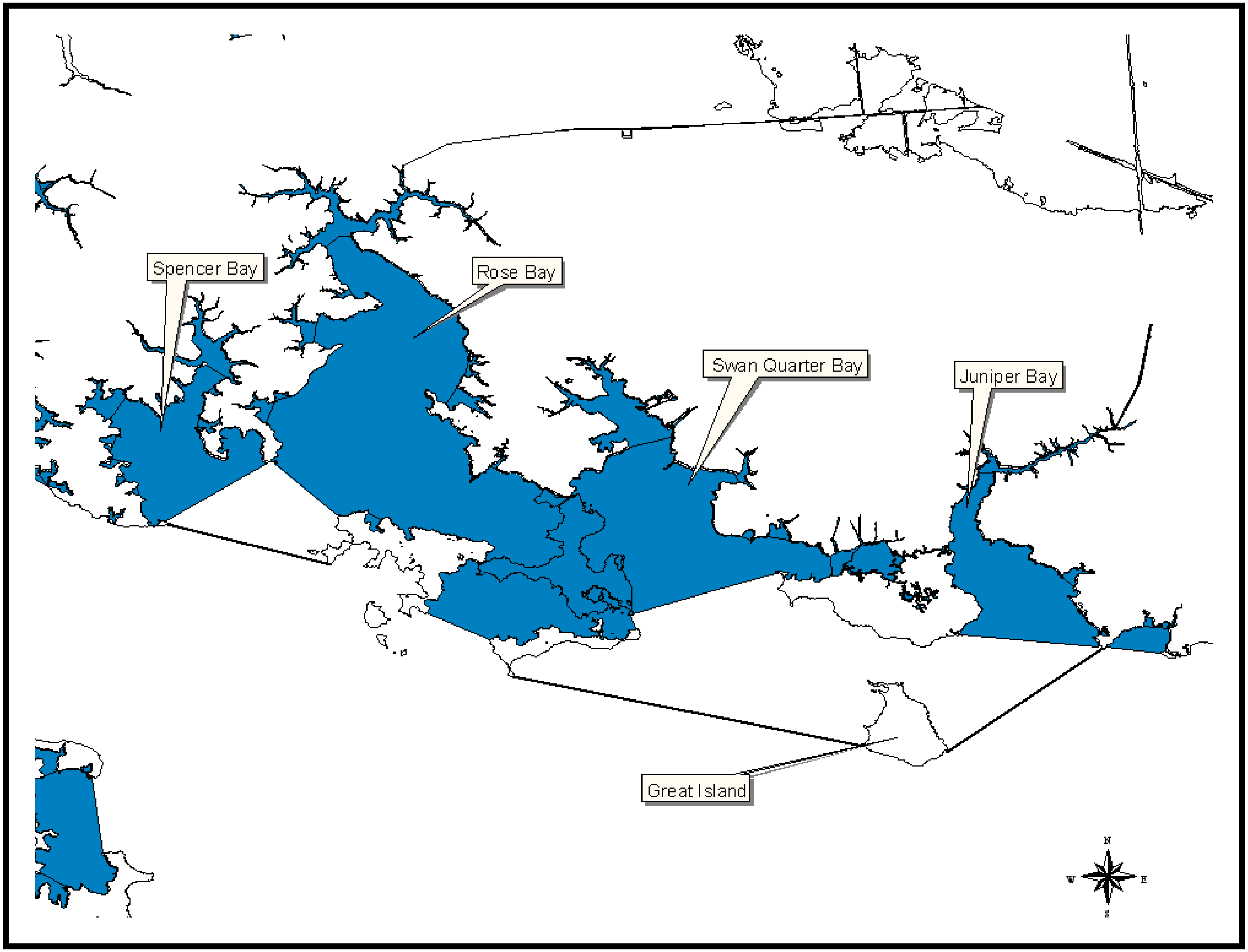
Rank	Species	Total weight (pounds)	Percent of total weight	Frequency of occurrence
1	Penaeid shrimp	635	22.4	16
2	Weakfish	583	20.5	15
3	Atlantic croaker	546	19.2	16
4	Spot	458	16.2	16
5	Blue crab	254	9.0	14
6	Silver perch	84	3.0	8
7	Summer flounder	71	2.5	11
8	Atlantic menhaden	45	1.6	5
9	Jellyfish	45	1.6	6
10	Hogchoker	27	0.9	12
			96.9	



Map 1. Map of Pamlico and Albemarle sounds North Carolina.



Map 2. Map of Pamlico Sound North Carolina.



Map 3 Shrimp areas closed by proclamation in Pamlico Sound.

Management Option/Impacts

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

1. Status quo (potential to close and open when shrimp are of sufficient size)
   + Flexibility in reacting to variable conditions (excessive rainfall, early migration)
   + Access to resource by a variety of users
   - Does not minimize harvest of small shrimp and bycatch
   - Labor intensive and expensive to sample
   - Necessitates “grand openings”

2. Harvest Season (Month (s), or Month (s)/Day (s) closures)
   a) Implement closure of Pamlico Sound with initial June proclamation and open in mid July (based on predetermined heads-on count).
      + Eliminates grand openings (if coordinated with other areas)
      + Protection of small shrimp and juvenile fish and crabs.
      + Potential for larger shrimp when trawling is opened
      - Lose flexibility of management by proclamation
      - Loss of resource to RCGL and smaller commercial trawlers

   b) Implement split season for commercial and RCGL shrimpers (same as # 2 above except open to RCGL harvest 1 or 2 weeks prior to commercial opening)
      + Protection of small shrimp and juvenile fish and crabs
      + Allows access to resource by all users
      + Potential for larger shrimp when trawling is opened
      - Lose flexibility of management by proclamation

   c) Open in July (based on predetermined heads-on count or pre determined date) and close to shrimp trawling in mid to late August
      + Eliminates grand openings (if coordinated with other areas)
      + Protection of small shrimp and juvenile fish and crabs
      + Potential for larger shrimp when trawling is opened
      - Lose flexibility of management by proclamation
      - Loss of resource to RCGL and smaller commercial trawlers

3. Area Closures
    a) Prohibit all shrimp trawlers in Pamlico Sound
        + Bycatch issue completely eliminated
        + Potential for healthier shellfish/finfish stocks
        + Decrease navigational and fixed vs. mobile gear conflicts in inside waters
        + Allow for harvest of larger count shrimp once they migrate into Pamlico Sound
        - Loss of income to commercial fishermen and dealers
        - Loss of RCGL use of shrimp resource

    b) Close portions of the river to shrimp trawl harvest.
        + Decrease navigational and fixed vs. mobile gear conflicts in closed waters
        + Allow for harvest of larger count shrimp once they migrate into Open areas
        - Loss of income to commercial fishermen and dealers
        - Loss of recreational use of shrimp resource

4. Regulate Means and Methods (gear and vessel)
    a) Implement headrope size limit on shrimp trawlers working in Pamlico Sound
        + Allows for all size classes of vessels to work
        + Reduction in bycatch
        - Reduction in fishing power of larger vessels

    b) Increase tailbag mesh size.
        + Reduction in bycatch
        + Catch larger size shrimp
        - Loss of smaller size shrimp
        - Insufficient data on different mesh sizes and shrimp loss and bycatch reduction

    c) Implement maximum vessel length restriction on shrimp trawlers working in Pamlico Sound
        + Decrease navigational and fixed vs. mobile gear conflicts in inside waters
        + Reduction in bycatch
        - Loss of income to commercial fishermen and dealers

AC and DMF Recommendation: Open on 26-30 heads-on count; July 5 opening for areas at the mouths of the bays on the north side of the Sound.

MFC Recommendation: Open on 31-35 heads-on count; July 5 opening for areas at the mouths of the bays on the north side of the Sound.

12.26 Appendix 26. SHRIMP MANAGEMENT IN ROANOKE SOUND

Roanoke Sound system extends from Oregon Inlet north to Albemarle Sound (Map 1). Trawling (shrimp and crab) is only allowed in the main portion of the sound. All feeder creeks and bays are classified as either Nursery Areas (Primary, Secondary, Special Secondary) or no trawl areas all of which are closed to trawling (Map 2). Overall this system is approximately 21,168 acres in size. One hundred sixty seven acres are classified as Primary Nursery areas, 168 acres as Secondary Nursery areas, and 468 acres as Special Secondary Nursery areas. The majority of the shrimp trawling in Roanoke Sound occurs in Roanoke channel. Other commercial fisheries in Roanoke Sound include crab pot, crab trawl, gill net, pound netting, fyke net and long-haul.

Roanoke Sound accounts for 0.11% of the total statewide shrimp production. Average annual shrimp landings are 7,959 pounds, with an average dockside value of $16,514. Ninety-five percent of the shrimp landed from the Roanoke Sound are caught by shrimp trawls (1994 – 2003 Trip ticket Data). Other gears with reported shrimp landings are crab pots (3.09%), peeler pots (1.45%), and crab trawls (0.02%).

Roanoke Sound ranks 15th in shrimp landings by shrimp trawls with average annual landings of 7,597 pounds (Figure 1). The average dockside value of these landings is $15,770. In addition to shrimp, an average of 1,498 pounds of marketable bycatch with a dockside value of $1,472 is landed annually by shrimp trawls from Roanoke Sound. The landed bycatch is composed of blue crabs (92%; 1,364 pounds/year), and finfish (8%; 117 pounds/year). Flounder are the most common finfish species landed with average annual landings of 45 pounds (Table 1), 89% of which are landed in July and August (Table 2).

July accounts for 54% of the shrimp landings from shrimp trawls for Roanoke Sound (Tables 2 and 3). The months of August (32%), and September (9%) are the other two main months of shrimp harvest from this system.

The percent contribution of yearly shrimp trawl landings by various sized vessels is given in Table 4. Seventy-two percent of the shrimp trawl landings were harvested by vessels 20 to 39 feet in length (Table 4).

Currently there are no bycatch estimates available from shrimp trawlers working in Roanoke Sound.

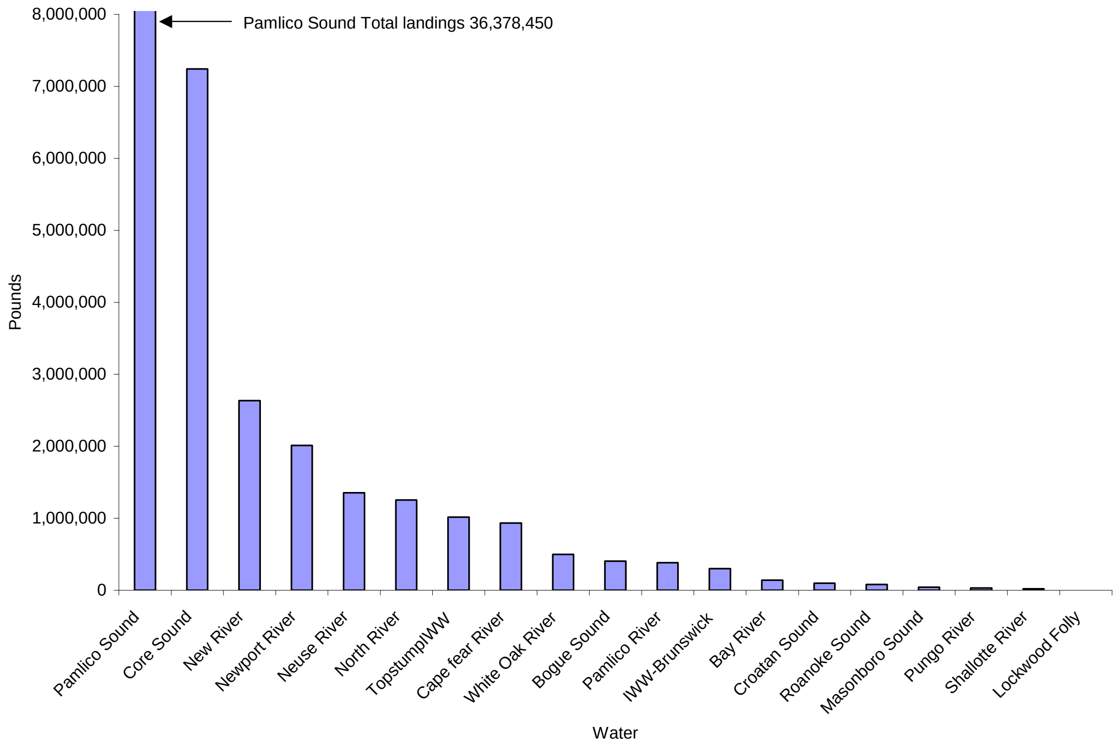


Figure 1. Total pounds of shrimp harvested by shrimp in major North Carolina waterbodies between 1994-2003.

Table 1. Landings (lbs) of finfish from shrimp trawls from the Roanoke Sound North Carolina; 1994 – 2003.

	Pounds		Percent
Species	total	average	of total
Flounders	448	45	38.14%
Spot	387	39	32.95%
Weakfish	97	10	8.26%
Mullets	65	7	5.53%
Fish, Mixed	48	5	4.09%
Croaker	28	3	2.39%
Harvestfish	28	3	2.38%
Bait	18	2	1.53%
Kingfish	15	2	1.31%
Speckled trout	13	1	1.12%
Spanish Mackerel	11	1	0.94%
Pigfish	7	1	0.60%
Black drum	6	1	0.51%
Sheepshead	2	0	0.17%
Butterfish	1	0	0.09%
Total	1,174	117	100.00%

Table 2. Monthly percent contribution of landed shrimp trawl catch for Roanoke Sound North Carolina; 1994 – 2003.

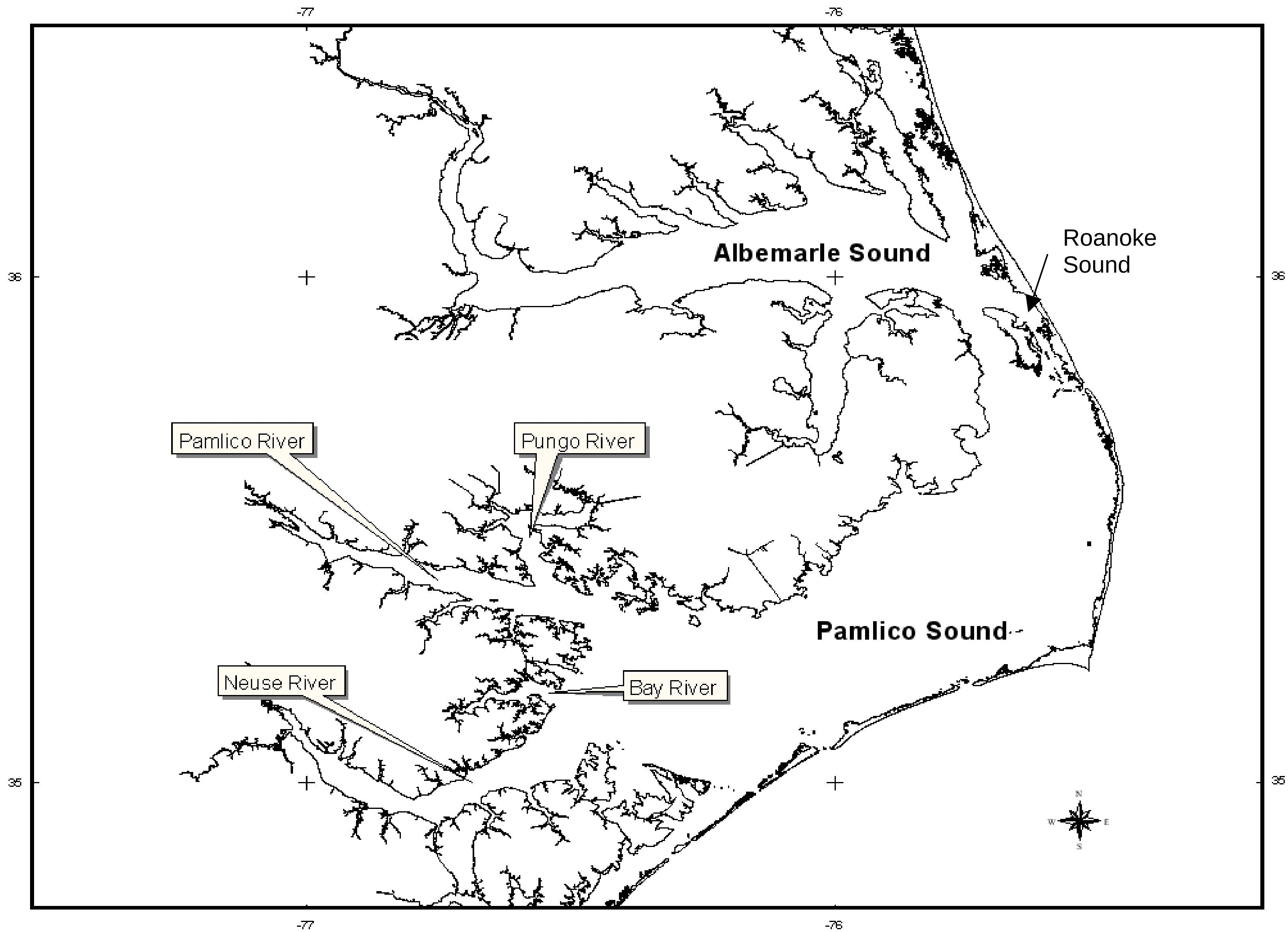
	Month							Total
Species	March	June	July	August	September	October	November	pounds
Shrimp	0.10%	1.41%	53.67%	32.06%	9.24%	3.34%	0.18%	75,456
Blue crab	0.00%	0.83%	21.07%	64.24%	9.01%	4.72%	0.13%	13,640
Flounders	0.00%	0.22%	38.55%	50.45%	8.99%	1.79%	0.00%	448
Spot	0.00%	0.00%	52.20%	20.93%	22.74%	4.13%	0.00%	387
Weakfish	0.00%	0.00%	31.96%	43.30%	17.53%	7.22%	0.00%	97
Mullets	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	65
Fish, mixed	0.00%	0.00%	0.00%	22.92%	77.08%	0.00%	0.00%	48
Croaker	0.00%	0.00%	7.13%	39.19%	50.12%	3.56%	0.00%	28
Harvestfish	0.00%	0.00%	7.14%	7.14%	53.57%	32.14%	0.00%	28
Bait	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	18
Kingfish	0.00%	0.00%	6.52%	60.89%	26.08%	6.52%	0.00%	15
Speckled trout	0.00%	0.00%	77.17%	0.00%	0.00%	22.83%	0.00%	13
Spanish mackerel	0.00%	0.00%	0.00%	0.00%	45.45%	54.55%	0.00%	11
Pigfish	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	7
Black drum	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	6
Sheepshead	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	2
Butterfish	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	1
Total	0.09%	1.30%	48.53%	36.93%	9.33%	3.64%	0.17%	90,270

Table 3. Monthly shrimp landings (lbs) from shrimp trawls from Roanoke Sound North Carolina; 1994 – 2003.

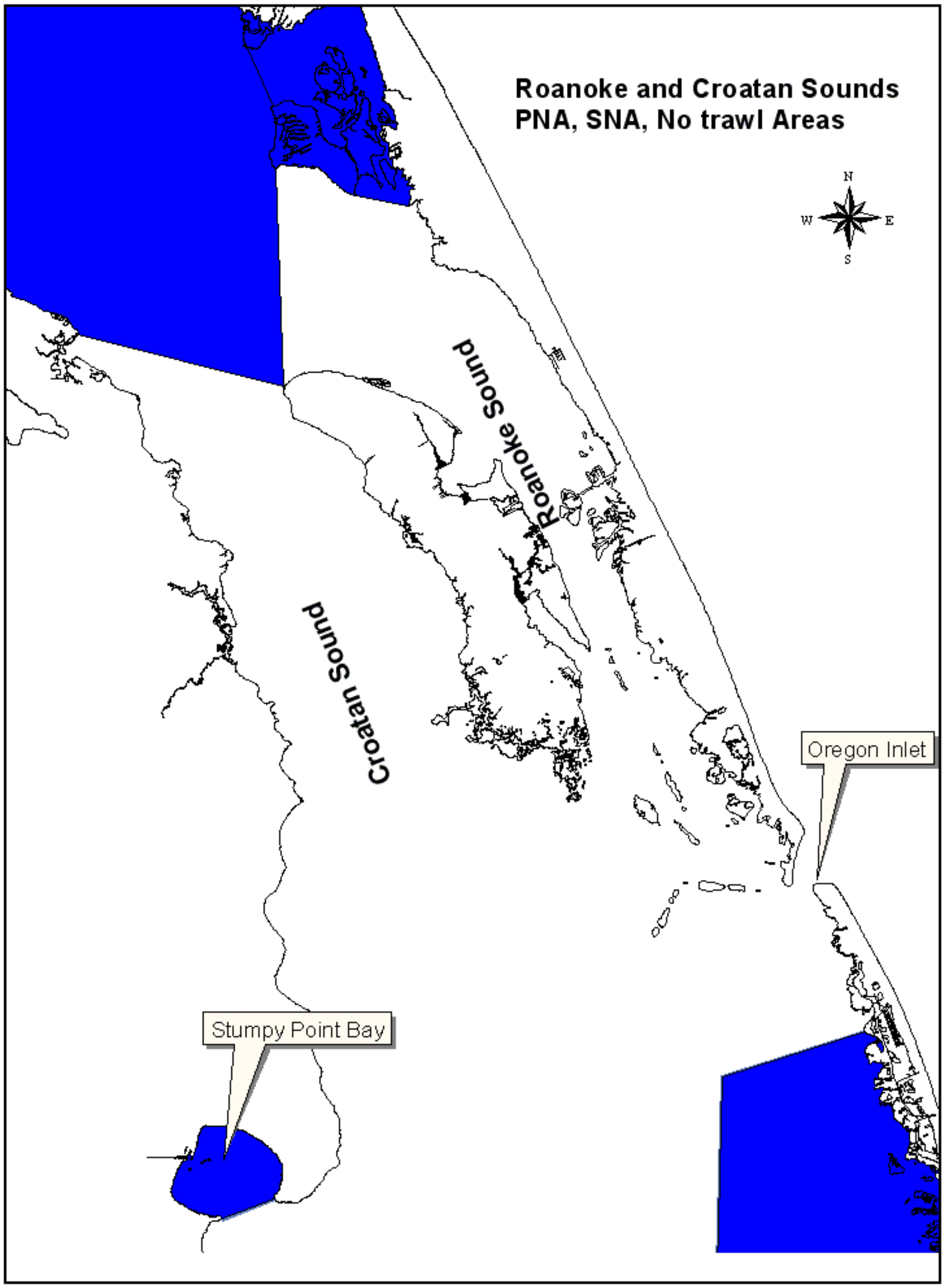
Month	Pounds total	Pounds average	Percent of total	Percent of total trips
March	77	8	0.10%	0.08%
June	1,062	106	1.41%	1.85%
July	40,498	4,050	53.67%	45.84%
August	24,189	2,419	32.06%	39.55%
September	6,970	697	9.24%	9.49%
October	2,521	252	3.34%	2.77%
November	139	14	0.18%	0.42%
Total	75,456	7,546		

Table 4. Percent contribution of three vessel size groups to yearly shrimp trawl landings in Roanoke Sound; 1994 – 2003.

Year	Vessel size range <20'	Vessel size range 20 - 39'	Vessel size range >40'	Total	Number of licenses
1994	33.33%	62.86%	3.81%	97.22%	51
1995	60.00%	40.00%	0.00%	71.43%	15
1996	30.00%	70.00%	0.00%	96.77%	35
1997	22.58%	72.58%	4.84%	93.94%	33
1998	20.00%	80.00%	0.00%	100.00%	4
1999	13.64%	81.82%	4.55%	100.00%	13
2000	12.73%	87.27%	0.00%	96.49%	21
2001	50.00%	0.00%	50.00%	100.00%	2
2002	17.31%	78.21%	4.49%	100.00%	53
2003	11.11%	88.89%	0.00%	100.00%	5
Total	24.70%	72.13%	3.16%	95.65%	



Map 1. Map of Pamlico and Albemarle sounds North Carolina.



Map 2. Map of Roanoke Sound North Carolina.

Management Option/Impacts

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

1. Status quo (potential to close and open when shrimp are of sufficient size)
   + Flexibility in reacting to variable conditions (excessive rainfall, early migration)
   + Access to resource by a variety of users
   - Does not minimize harvest of small shrimp and bycatch
   - Labor intensive and expensive to sample
   - Necessitates "grand openings"

2. Harvest Season (Month (s), or Month (s)/Day (s) closures)
   a) Implement closure of Roanoke Sound with initial June proclamation and open in mid July (based on predetermined heads-on count).
      + Eliminates grand openings (if coordinated with other areas)
      + Protection of small shrimp and juvenile fish and crabs.
      + Potential for larger shrimp when trawling is opened
      - Lose flexibility of management by proclamation
      - Loss of resource to RCGL and smaller commercial trawlers

   b) Implement split season for commercial and RCGL shrimpers (same as # 2 above except open to RCGL harvest 1 or 2 weeks prior to commercial opening)
      + Protection of small shrimp and juvenile fish and crabs
      + Allows access to resource by all users
      + Potential for larger shrimp when trawling is opened
      - Lose flexibility of management by proclamation

   c) Open in July (based on predetermined heads-on count or pre determined date) and close to shrimp trawling in mid to late August
      + Eliminates grand openings (if coordinated with other areas)
      + Protection of small shrimp and juvenile fish and crabs
      + Potential for larger shrimp when trawling is opened
      - Lose flexibility of management by proclamation
      - Loss of resource to RCGL and smaller commercial trawlers

3. Area Closures
   a) Prohibit all shrimp trawlers in Roanoke Sound
      + Bycatch issue completely eliminated
      + Potential for healthier shellfish/finfish stocks
      + Decrease navigational and fixed vs. mobile gear conflicts in inside waters
      + Allow for harvest of larger count shrimp once they migrate into Roanoke Sound
      - Loss of income to commercial fishermen and dealers
      - Loss of RCGL use of shrimp resource

   b) Close portions of the river to shrimp trawl harvest.
      + Decrease navigational and fixed vs. mobile gear conflicts in closed waters
      + Allow for harvest of larger count shrimp once they migrate into Open areas
      - Loss of income to commercial fishermen and dealers
      - Loss of recreational use of shrimp resource

4. Regulate Means and Methods (gear and vessel)
   a) Implement headrope size limit on shrimp trawlers working in Roanoke Sound
      + Allows for all size classes of vessels to work
      + Reduction in bycatch
      - Reduction in fishing power of larger vessels

   b) Increase tailbag mesh size.
      + Reduction in bycatch
      + Catch larger size shrimp
      - Loss of smaller size shrimp
      - Insufficient data on different mesh sizes and shrimp loss and bycatch reduction

   c) Implement maximum vessel length restriction on shrimp trawlers working in Roanoke Sound
      + Decrease navigational and fixed vs. mobile gear conflicts in inside waters
      + Reduction in bycatch
      - Loss of income to commercial fishermen and dealers

AC, DMF, and MFC Recommendation: Status quo.

12.27 Appendix 27. SHRIMP MANAGEMENT IN CROATAN SOUND

Croatan Sound is bound by Pamlico Sound to the south and Albemarle Sound to the North (Map 1). This system is approximately 26,272 acres in size. There are no nursery areas in Croatan Sound. One hundred and thirty five acres are classified as inland areas and are closed to trawling (Map 2). The majority of the shrimp trawling in Croatan Sound occurs in deep holes and sloughs. Other commercial fisheries in Croatan Sound include crab pot, crab trawl, gill net, and pound netting,

Croatan Sound accounts for 0.14% of the total statewide shrimp production. Average annual shrimp landings are 9,605 pounds, with an average dockside value of $23,067. Ninety-eight percent of the shrimp landed from the Croatan Sound are caught by shrimp trawls (1994 – 2003 Trip ticket Data). Other gears with reported shrimp landings are crab pots (1.3%), and crab trawls (0.1%).

Croatan Sound ranks 14th in shrimp landings by shrimp trawls with average annual landings of 9,657 pounds (Figure 1). The average dockside value of these landings is $23,067. In addition to shrimp, an average of 3,222 pounds of marketable bycatch with a dockside value of $3,357 is landed annually by shrimp trawls from Croatan Sound. The landed bycatch is composed of blue crabs (92%; 2,973 pounds/year), and finfish (8%; 248 pounds/year). Spot are the most common finfish species landed with average annual landings of 103 pounds (Table 1), 88% of which are landed in July and August (Table 2).

August accounts for 44% of the shrimp landings from shrimp trawls for Croatan Sound (Tables 2 and 3). The months of July (30%), September (12%), and October (13%) are the other three main months of shrimp harvest from this system.

The percent contribution of yearly shrimp trawl landings by various sized vessels is given in Table 4. Sixty percent of the shrimp trawl landings were harvested by vessels 20 to 39 feet in length (Table 4).

Currently there are no bycatch estimates available from shrimp trawlers working in Croatan Sound.

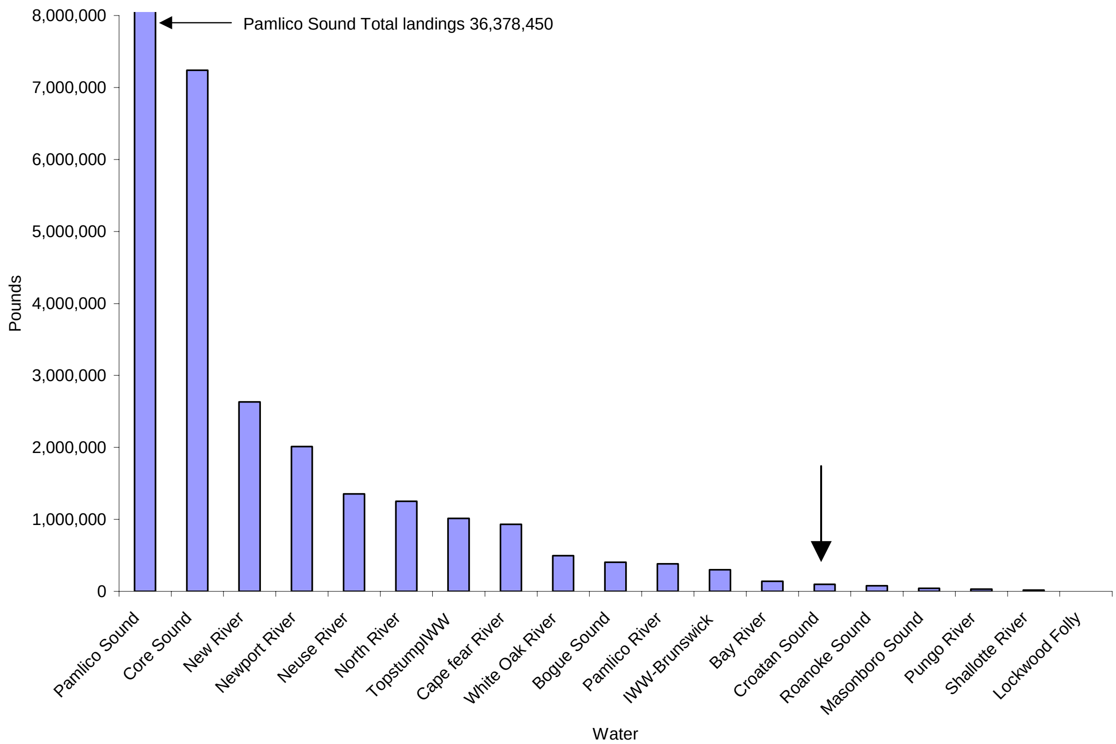


Figure 1. Total pounds of shrimp harvested by shrimp in major North Carolina waterbodies between 1994-2003.

Table 1. Landings (lbs) of finfish from shrimp trawls from the Croatan Sound North Carolina; 1994 – 2003.

	Pounds		Percent
Species	total	average	of total
Spot	1,027	103	41.37%
Flounders	441	44	17.74%
Weakfish	440	44	17.72%
Fish, mixed	195	20	7.85%
Croaker	108	11	4.35%
Sheepshead	76	8	3.06%
Harvestfish	58	6	2.34%
Kingfish	47	5	1.89%
Black drum	26	3	1.05%
Butterfish	15	2	0.60%
Mullets	15	2	0.60%
Spanish mackerel	12	1	0.48%
Bluefish	8	1	0.32%
Pigfish	5	1	0.20%
Bait	4	0	0.16%
Spadefish	3	0	0.12%
Speckled trout	2	0	0.08%
Pompano	1	0	0.04%
Total	2,483	248	

Table 2. Monthly percent contribution of landed shrimp trawl catch for Croatan Sound North Carolina; 1994 – 2003.

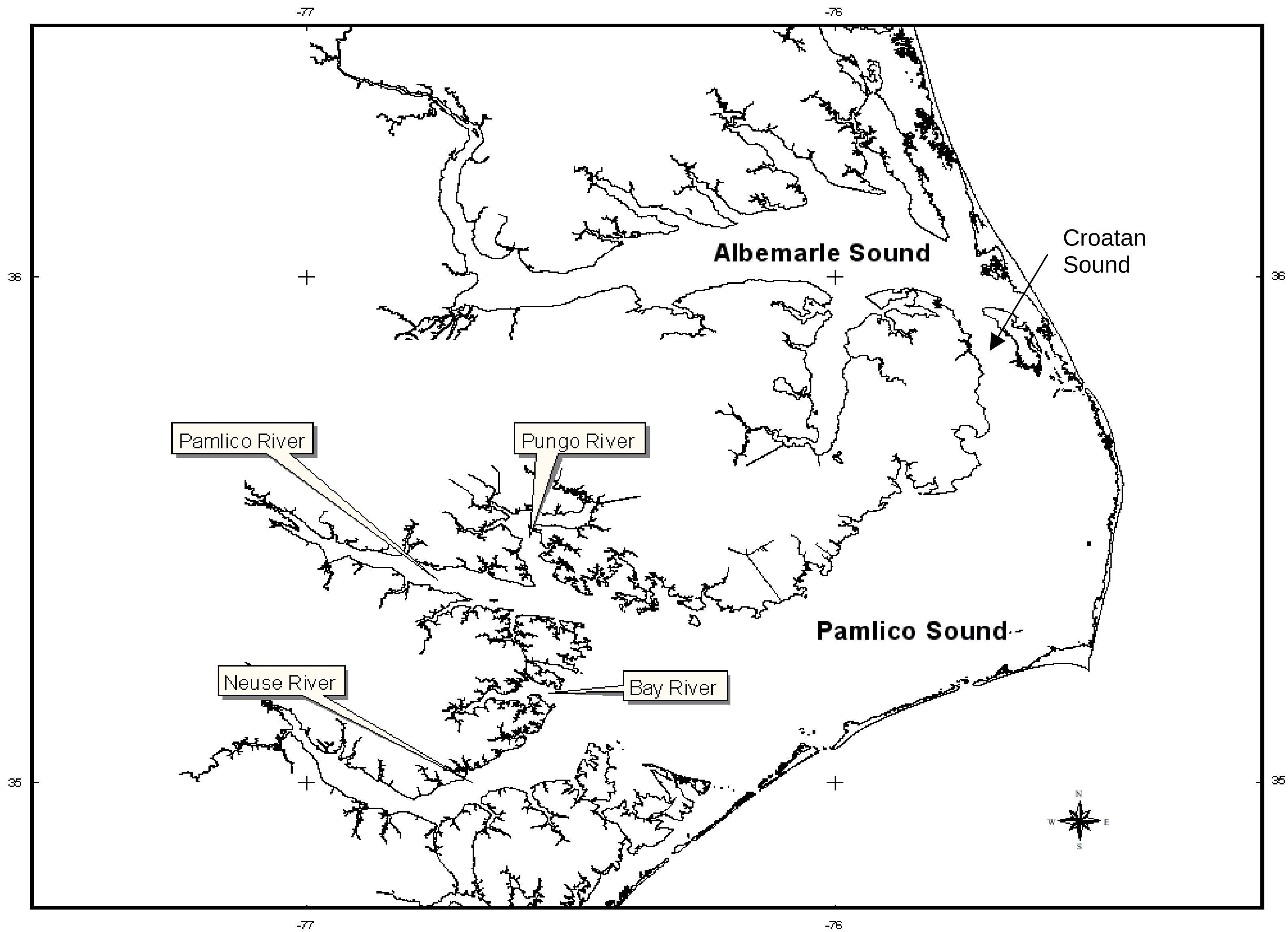
	Month								Total
Species	February	June	July	August	September	October	November	December	pounds
Shrimp	0.11%	0.24%	30.44%	44.18%	11.65%	13.11%	0.02%	0.27%	96,053
Blue Crab	0.05%	0.01%	20.90%	67.64%	9.00%	2.40%	0.00%	0.00%	29,739
Spot	0.00%	0.00%	21.13%	66.60%	9.64%	2.63%	0.00%	0.00%	1,027
Flounders	0.00%	0.00%	20.32%	50.40%	24.29%	4.99%	0.00%	0.00%	441
Weakfish	0.00%	0.00%	13.41%	51.36%	26.59%	8.64%	0.00%	0.00%	440
Fish, Mixed	0.00%	0.00%	0.00%	97.44%	2.56%	0.00%	0.00%	0.00%	195
Croaker	0.00%	0.00%	25.93%	54.63%	19.44%	0.00%	0.00%	0.00%	108
Sheepshead	0.00%	0.00%	9.21%	71.05%	19.74%	0.00%	0.00%	0.00%	76
Harvestfish	0.00%	0.00%	10.34%	29.31%	51.72%	8.62%	0.00%	0.00%	58
Kingfish	0.00%	0.00%	6.38%	46.81%	42.55%	4.26%	0.00%	0.00%	47
Black drum	0.00%	0.00%	92.31%	7.69%	0.00%	0.00%	0.00%	0.00%	26
Butterfish	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	15
Mullets	0.00%	0.00%	0.00%	13.33%	86.67%	0.00%	0.00%	0.00%	15
Spanish Mackerel	0.00%	0.00%	8.33%	66.67%	25.00%	0.00%	0.00%	0.00%	12
Bluefish	0.00%	0.00%	12.50%	87.50%	0.00%	0.00%	0.00%	0.00%	8
Pigfish	0.00%	0.00%	0.00%	20.00%	20.00%	60.00%	0.00%	0.00%	5
Bait	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	4
Spadefish	0.00%	0.00%	66.67%	33.33%	0.00%	0.00%	0.00%	0.00%	3
Speckled trout	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	2
Pompano	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	1
Total	0.10%	0.18%	27.98%	49.94%	11.15%	10.45%	0.01%	0.20%	128,274

Table 3. Monthly shrimp landings (lbs) from shrimp trawls from Croatan Sound North Carolina; 1994 – 2003.

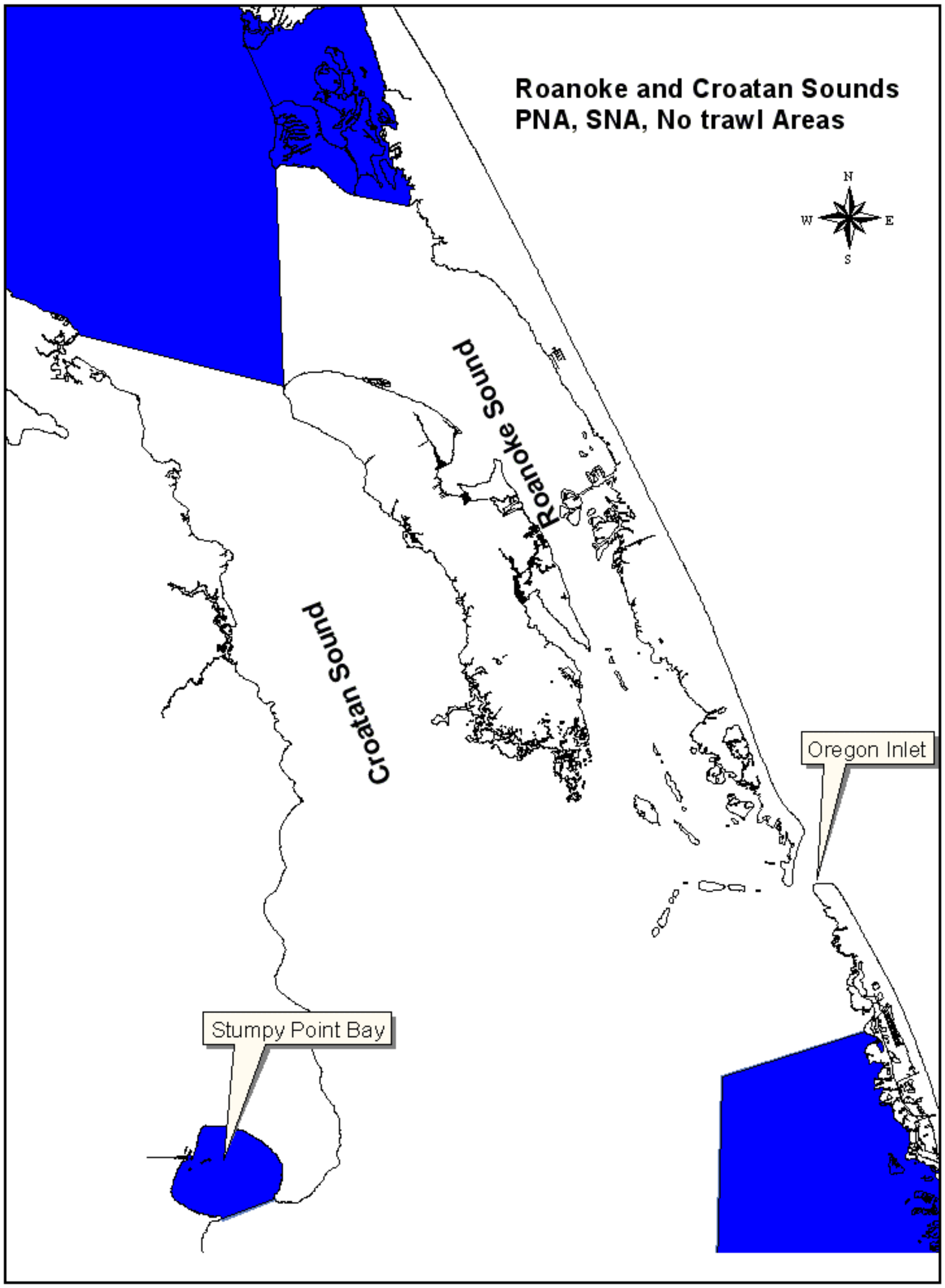
Month	Pounds total	Pounds average	Percent of total	Percent of total trips
February	108	11	0.11%	0.11%
June	232	23	0.24%	0.23%
July	29,234	2,923	30.44%	25.04%
August	42,432	4,243	44.18%	53.53%
September	11,185	1,119	11.65%	16.12%
October	12,591	1,259	13.11%	4.89%
November	16	2	0.02%	0.04%
December	255	26	0.27%	0.04%
Total	96,053	9,605		

Table 4. Percent contribution of three vessel size groups to yearly shrimp trawl landings in Croatan Sound; 1994 – 2003.

Year	Vessel size range <20'	Vessel size range 20 - 39'	Vessel size range >40'	Total	Number of licenses
1994	26%	72%	2%	98%	23
1995	92%	6%	2%	89%	17
1996	19%	77%	5%	96%	19
1997	16%	70%	14%	97%	30
1998	20%	70%	10%	100%	6
1999	5%	67%	29%	100%	16
2000	29%	62%	10%	97%	54
2001	45%	27%	27%	100%	5
2002	19%	60%	21%	100%	18
2003	0%	80%	20%	100%	4
Total	29%	60%	11%	97%	



Map 1. Map of Pamlico and Albemarle sounds North Carolina.



Map 2. Map of Croatan Sound North Carolina.

Management Option/Impacts

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

1. Status quo (potential to close and open when shrimp are of sufficient size)
   + Flexibility in reacting to variable conditions (excessive rainfall, early migration)
   + Access to resource by a variety of users
   - Does not minimize harvest of small shrimp and bycatch
   - Labor intensive and expensive to sample
   - Necessitates “grand openings”

2. Harvest Season (Month (s), or Month (s)/Day (s) closures)
   a) Implement closure of Croatan Sound with initial June proclamation and open in mid July (based on predetermined heads-on count).
      + Eliminates grand openings (if coordinated with other areas)
      + Protection of small shrimp and juvenile fish and crabs.
      + Potential for larger shrimp when trawling is opened
      - Lose flexibility of management by proclamation
      - Loss of resource to RCGL and smaller commercial trawlers

   b) Implement split season for commercial and RCGL shrimpers (same as # 2 above except open to RCGL harvest 1 or 2 weeks prior to commercial opening)
      + Protection of small shrimp and juvenile fish and crabs
      + Allows access to resource by all users
      + Potential for larger shrimp when trawling is opened
      - Lose flexibility of management by proclamation

   c) Open in July (based on predetermined heads-on count or pre determined date) and close to shrimp trawling in mid to late August
      + Eliminates grand openings (if coordinated with other areas)
      + Protection of small shrimp and juvenile fish and crabs
      + Potential for larger shrimp when trawling is opened
      - Lose flexibility of management by proclamation
      - Loss of resource to RCGL and smaller commercial trawlers

3. Area Closures
   a) Prohibit all shrimp trawlers in Croatan Sound
      + Bycatch issue completely eliminated
      + Potential for healthier shellfish/finfish stocks
      + Decrease navigational and fixed vs. mobile gear conflicts in inside waters
      + Allow for harvest of larger count shrimp once they migrate into Croatan Sound
      - Loss of income to commercial fishermen and dealers
      - Loss of RCGL use of shrimp resource

   b) Close portions of the river to shrimp trawl harvest.
      + Decrease navigational and fixed vs. mobile gear conflicts in closed waters
      + Allow for harvest of larger count shrimp once they migrate into Open areas
      - Loss of income to commercial fishermen and dealers
      - Loss of recreational use of shrimp resource

4. Regulate Means and Methods (gear and vessel)
   a) Implement headrope size limit on shrimp trawlers working in Croatan Sound
      + Allows for all size classes of vessels to work
      + Reduction in bycatch
      - Reduction in fishing power of larger vessels

   b) Increase tailbag mesh size.
      + Reduction in bycatch
      + Catch larger size shrimp
      - Loss of smaller size shrimp
      - Insufficient data on different mesh sizes and shrimp loss and bycatch reduction

   c) Implement maximum vessel length restriction on shrimp trawlers working in Croatan Sound
      + Decrease navigational and fixed vs. mobile gear conflicts in inside waters
      + Reduction in bycatch
      - Loss of income to commercial fishermen and dealers

AC, DMF, and MFC Recommendation: Status quo.

12.28 Appendix 28. PROPOSED RULES

15A NCAC 03L .0103 is proposed for amendment as follows:

15A NCAC 03L .0103PROHIBITED ~~NETS, AND~~ NETS, MESH SIZES AND AREAS

(a) It is unlawful to take shrimp with nets with mesh lengths less than the following:

- (1) Trawl net - one and one-half inches;
- (2) Fixed nets, channel nets, float nets, butterfly nets, and hand seines - one and one-fourth inches; and
- (3) Cast net - no restriction.

(b) It is unlawful to take shrimp with a net constructed in such a manner as to contain an inner or outer liner of any mesh size. Net material used as chafing gear shall be no less than four inches mesh length except that chafing gear with ~~small~~ smaller mesh may be used only on the bottom one-half of the tailbag. Such chafing gear shall not be tied in a manner that forms an additional tailbag.

(c) It is unlawful to take shrimp with trawls which have a combined headrope of greater than 90 feet in internal coastal waters except:

- (1) Pamlico Sound;
- (2) Pamlico River downstream of a line from a point 35° 18.5882'N – 76° 28.9625'W at Pamlico Point; running northerly to a point 35° 22.3741'N – 76° 28.6905'W at Willow Point;
- (3) Neuse River northeast of a line from a point 34° 58.2000'N – 76° 40.5167'W at Winthrop Point on the eastern shore of the entrance to Adam's Creek running northerly to a point 35° 01.0744' N – 76° 42.1550' W at Windmill Point at the entrance of Greens Creek at Oriental.

(d) It is unlawful to use a shrimp trawl in the areas described in 03R .0114.

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

15A NCAC 03O .0302 is proposed for amendment as follows:

15A NCAC 03O .0302 AUTHORIZED GEAR

(a) The following are the only commercial fishing gear authorized (including restrictions) for use under a valid Recreational Commercial Gear License:

- (1) One seine 30 feet or over in length but not greater than 100 feet with a mesh length less than 2 ½ inches when deployed or retrieved without the use of a vessel or any other mechanical methods. A vessel may only be used to transport the seine;
- (2) One shrimp trawl with a headrope not exceeding 26 feet in length per vessel. Mechanical methods for retrieving ~~the trawl~~ otter trawls are not authorized for recreational purposes.
- (3) With or without a vessel, five eel, fish, shrimp, or crab pots in any combination, except only two pots of the five may be eel pots. Peeler pots are not authorized for recreational purposes;
- (4) One multiple hook or multiple bait trotline up to 100 feet in length;
- (5) Gill Nets:
  - (A) Not more than 100 yards of gill nets with a mesh length equal to or greater than
    2 ½ inches except as provided in (C) of this Subparagraph. Attendance shall be required at all times;

(B) Not more than 100 yards of gill nets with a mesh length equal to or greater than 5 ½ inches except as provided in (C) of this Subparagraph. Attendance shall be required when used from one hour after sunrise through one hour before sunset in internal coastal fishing waters east and north of the Highway 58 Bridge at Emerald Isle and in the Atlantic Ocean east and north of 77° 04.0000’ W. Attendance shall be required at all times in internal coastal fishing waters west and south of the Highway 58 Bridge at Emerald Isle and in the Atlantic Ocean west and south of 77° 04.0000’ W; and

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

(D) It is unlawful to possess aboard a vessel more than 100 yards of gill nets with a mesh length less than 5 ½ inches and more than 100 yards of gill nets with a mesh length equal to or greater than 5 ½ inches identified as recreational commercial fishing equipment when only one Recreational Commercial Gear License holder is on board. It is unlawful to possess aboard a vessel more than 200 yards of gill nets with a mesh length less than 5 ½ inches and more than 200 yards of gill nets with a mesh length equal to or greater than 5 ½ inches identified as recreational commercial fishing equipment when two or more Recreational Commercial Gear License holders are on board; and

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

<u>(7) Skimmer trawls not exceeding 26 feet in total combined width.</u>

(b) It is unlawful to use more than the quantity of authorized gear specified in Subparagraphs (a)(1) through (a)(6) of this Rule, regardless of the number of individuals aboard a vessel possessing a valid Recreational Commercial Gear License.

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

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

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

15A NCAC 03O .0303 is proposed for amendment as follows:

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

(a) It is unlawful to possess more than a single recreational possession limit when only one person aboard a vessel possesses a valid Recreational Commercial Gear License and recreational commercial fishing equipment as defined in 15A NCAC 3O .0302(a) is used, regardless of the number of persons on board.
(b) It is unlawful to possess individual recreational possession limits in excess of the number of individuals aboard a vessel holding valid Recreational Commercial Gear ~~Licenses.~~ Licences except as provided in Paragraph (f) of this Rule.
(c) It is unlawful for any person who holds both a Recreational Commercial Gear License and a Standard or Retired Standard Commercial Fishing License and who is in possession of identified recreational commercial fishing equipment as defined in 15A NCAC 3O .0302(a), to exceed the single recreational possession limit.
(d) It is unlawful for persons aboard a vessel collectively holding only one Recreational Commercial Gear License and any Standard Commercial Fishing License or Retired Standard Commercial Fishing License and who are in possession of any identified recreational commercial fishing equipment as defined in 15A NCAC 3O .0302(a), to exceed one recreational possession limit.
(e) It is unlawful to possess more than 48 quarts, heads on, or 30 quarts, heads off, of shrimp when only one person aboard a vessel possesses a valid Recreational Commercial Gear License and recreational commercial fishing equipment as defined in 15A NCAC 3O .0302(a) is used.
(f) It is unlawful to possess more than 96 quarts, heads on or 60 quarts, heads off, of shrimp if more than one person aboard a vessel possesses a valid Recreational Commercial Gear License and recreational commercial fishing equipment as defined in 15A NCAC 3O .0302(a) is used.

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

15A NCAC 03R .0106 is proposed for amendment as follows:

15A NCAC 03R .0106 TRAWL NETS PROHIBITED

The trawl net prohibited areas referenced in 15A NCAC 03J .0104 (b)(4) are delineated in the following coastal water areas:

(1) In Pamlico, ~~Sound~~ Core and Back sounds - within the area described by a line beginning at a point 35° 43.7457' N - 75° 30.7014' W on the south shore of Eagles Nest Bay on Pea Island; running westerly to a point 35° 42.9500' N - 75° 34.1500' W; running southerly to a point 35° 39.3500' N – 75° 34.4000' W; running southeasterly to a point 35° 35.8931' N - 75° 31.1514' W in Chicamacomico Channel near Beacon "ICC"; running southerly to a point 35° 28.5610' N - 75° 31.5825' W on Gull Island; running southwesterly to a point 35°

22.8671' N - 75° 33.5851' W in Avon Channel near Beacon "1"; running southwesterly to a point 35° 18.9603' N - 75° 36.0817' W in Cape Channel near Beacon "2"; running westerly to a point 35° 16.7588' N - 75° 44.2554' W in Rollinson Channel near Beacon "42RC"; running southwesterly to a point 35° 14.0337' N - 75° 45.9643' W southwest of Oliver Reef near the quick-flashing beacon; running westerly to a point 35° 09.3650' N – 76° 00.6377' W in Big Foot Slough Channel near Beacon "14BF"; running southwesterly to a point 35° 08.4523' N – 76° 02.6651'W in Nine Foot Shoal Channel near Beacon "9"; running westerly to a point 35° 07.1000' N – 76° 06.9000' W; running southwesterly to a point 35° 01.4985' N – 76° 11.4353' W near Beacon "HL"; running southwesterly to a point 35° 00.2728' N - 76° 12.1903' W near Beacon "2CS"; running southerly to a point 34° 59.5027' N – 76° 12.3204' W in Wainwright Channel immediately east of the northern tip of Wainwright Island; running easterly to a point ~~34° 58.8333' N – 76° 09.2167' W on Core Banks; running northerly along the shoreline and across the inlets following the COLREGS Demarcation lines to the point of beginning;~~ 34° 58.6760'N – 76° 12.4164'W; running southerly to a point 34°56.6697'N – 76° 13.6052'W near Marker "15"; running southwesterly to a point 34° 54.1584'N – 76° 16.9016'W; running southwesterly to a point 34° 52.1484'N – 76° 19.2607'W; running southwesterly to a point 34° 51.0617'N – 76° 21.0449'W; running southwesterly to a point 34° 48.3137' N - 76° 24.3717' W; running southwesterly to a point 34° 46.3739' N – 76° 26.1526' W; running southwesterly to a point 34° 44.5795' N – 76° 27.5136' W; running southwesterly to a point 34° 43.4895' N – 76° 28.9411' W near Beacon "37A"; running southwesterly to a point 34° 40.4500' N – 76° 30.6833' W; running westerly to a point 34° 40.7061' N – 76° 31.5893' W near Beacon "35" in Back Sound; running westerly to a point 34° 41.3178' N - 76° 33.8092' W near Buoy "3"; running southwesterly to a point 34° 39.6601' N – 76° 34.4078' W on Shackleford Banks; running easterly and northeasterly along the shoreline and across Barden Inlet following the COLREGS Demarcation line; then running northerly along the shoreline across the inlets following the COLREGS Demarcation line up the Outer Banks to Eagles Nest Bay at the point of beginning.

(2) In Northern Pamlico Sound, Stumpy Point Bay - north of a line beginning at a point 35° 40.9719' N - 75° 44.4213' W on Drain Point; running westerly to a point 35° 40.6550' N - 75° 45.6869' W on Kazer Point;

(3) In the Pamlico River area, lower Goose Creek - south of a line beginning at a point 35° 18.2676' N - 76° 37.4706' W on the north shore of Snode Creek; running easterly to a point 35° 18.1660' N - 76° 36.9095' W on Store Point;

(4) In the Bay River Area:

(a) In Dump Creek - north of a line beginning at a point 35° 11.6666' N - 76° 33.4207' W on the west shore; running southeasterly to a point 35° 11.3926' N - 76° 32.8993' W on the east shore;

(b) In Rockhole Bay - north of a line beginning at a point 35° 11.3926' N - 76° 32.8993' W on the west shore; running southeasterly to a point 35° 11.1321' N - 76° 32.1360' W on the east shore;

(c) In Vandemere Creek - north of a line beginning at a point 35° 11.2681' N - 76° 39.5220' W on the west shore; running southerly to a point 35° 11.0879' N - 76° 39.3200' W on the east shore;

(d) In Cedar Creek - west of a line beginning at a point 35° 11.2681' N - 76° 39.5220' W on the north shore; running southwesterly to a point 35° 11.1033' N - 76° 39.7321' W on the south shore of an unnamed tributary;

(e) In Chapel Creek - north of a line beginning at a point 35° 08.6768' N - 76° 42.7985' W on the west shore; running easterly to a point 35° 08.7677' N - 76° 42.3604' W on the east shore;

(f) In Upper Bay River - west of a line beginning at a point 35° 08.6704' N - 76° 43.0836' W on the north shore; running southwesterly to a point 35° 08.4590' N - 76° 43.1930' W on the south shore;

(5) In the Neuse River Area, Pierce Creek - west of a line beginning at a point 35° 02.4336' N - 76° 39.7653' W on the north shore; running southerly to a point 35° 02.3767' N - 76° 39.7876' W on the south shore.

~~(6) In Core and Back sounds beginning at a point 34° 50.4333' N – 76° 20.2000' W on Core Banks near Drum Inlet; running northwesterly to a point 34° 51.0617' N – 76° 21.0449' W; running southwesterly to a point 34° 48.3137' N - 76° 24.3717' W; running southwesterly to a point 34° 46.3739' N – 76° 26.1526' W; running southwesterly to a point 34° 44.5795' N – 76° 27.5136' W; running southwesterly to a point 34° 43.4895' N – 76° 28.9411' W near Beacon "37A"; running southwesterly to a point 34° 40.4500' N – 76° 30.6833' W; running westerly to a point 34° 40.7061' N – 76° 31.5893' W near Beacon "35" in Back Sound; running westerly to a point 34° 41.3178' N - 76° 33.8092' W near Buoy "3"; running southwesterly to a point 34° 39.6601' N – 76° 34.4078' W on Shackleford Banks; running easterly and northeasterly along the shoreline and across Barden Inlet following the COLREGS Demarcation line to the point of beginning.~~

~~(7)~~(6) In Cape Lookout Bight, all of Cape Lookout Bight - southwest of the COLREGS Demarcation line at Barden Inlet to the northeastern most point of Power Squadron Spit; running northeasterly to a point 34° 38.6150' N – 76° 32.7434' W on Shackleford Banks.

(7) Newport River - all waters upstream of a line beginning at a point 34° 45.6960’N – 76° 43.5180’ W near Penn Point; running northeasterly to a point 34° 46.5733’ N – 76° 42.6350’ W at Hardesty Farms subdivision.

(8) White Oak River - all waters upstream of a line beginning at a point on the west side of the river 34° 43.3425’ N – 77° 07.2209’ W; running northerly to a point 34° 43.6445’N – 77° 07.3177’ W in the river above Cahoon’s Slough; running easterly to a point 34° 43.5588’ N – 77° 06.6206’ W at Hancock Point.

(9) Intracoastal Waterway - all waters in the maintained channel from a point near Marker #105 34° 18.8167’ N – 77° 42.8833’ W running southerly to a point at the Wrightsville Beach Drawbridge 34° 12.9500’ N – 77° 47.9833’ W.

(10) Cape Fear River - all waters bounded by a line beginning at a point near Fort Fisher 33° 57.5333’ N – 77° 56.9333’ W running southwesterly along The Rocks to a point 33° 55.1833’ N – 77° 58.0833’ W running southeasterly and southerly along the shorelines of Second and Buzzard’s Bays to a point 33° 53.0333’ N – 57.9333’ W running northeastly and northwestly along the barrier island shorelines of Buzzard’s Bay, Second Bay and The Basin back to the point of origin.

(11) Cape Creek - all waters upstream of a line beginning at a point on the north shore 33° 53.6167’ N – 77° 59.3333’ W running southwesterly to a point on the south shore 33° 53.3667’ N – 77° 59.4667’ W.

(12) Bald Head Creek - all waters upstream of a line beginning at a point on the west shore 33° 52.8667’ N – 77° 59.8000’ W running easterly to a point on the east shore 33° 52.8667’ N – 77° 59.7167’ W.

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

Amended Eff. March 1, 1994;
Recodified from 15A NCAC 3R .0006 Eff. December 17, 1996;
Amended Eff. August 1, 2004; April 1, 1997.

15A NCAC 03R .0114 is proposed for adoption as follows:

15A NCAC 03R .0114 SHRIMP TRAWL PROHIBITED AREAS

The shrimp trawl prohibited areas referenced in 15A NCAC 03L .0103(d) are delineated in the following coastal water areas:

(1) Pungo River- all waters upstream of a line from a point 35° 23.3166'N – 76° 34.4833'W at Wades Point; running westerly to a point 35° 23.6463'N – 76° 31.0003'W on the north shore of the entrance to Abels Bay.

(2) Pamlico River- all waters upstream of a line from a point 35° 20.5108'N – 76° 37.7218'W on the western shore of the entrance to Goose Creek; running northeasterly to a point 35° 23.3166'N – 76° 34.4833'W at Wades Point.

(3) Neuse River- all waters upstream of a line from a point 34° 56.3658'N – 76° 48.7110'W at Cherry Point; running northerly to a point 34° 57.9116'N – 76° 48.2240'W at Wilkerson Point.

History Note: Authority G.S. 113-134; 113-182; 143B-289.52;