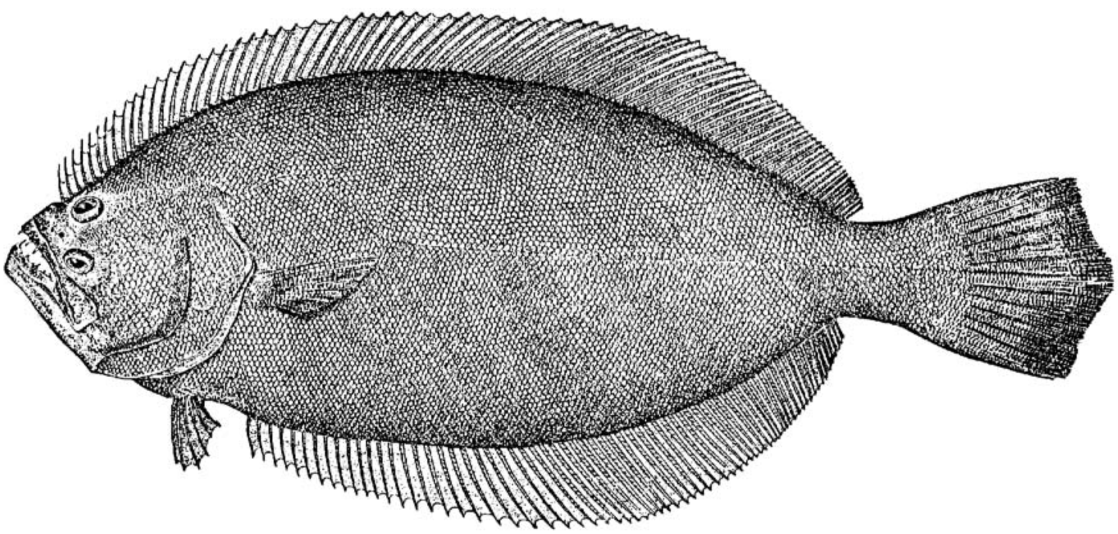
North Carolina
Fishery Management Plan

Southern Flounder



North Carolina
MARINE
FISHERIES
Dept. of Environment and Natural Resources

February 2005

North Carolina Fishery Management Plan

Southern Flounder
(*Paralichthys lethostigma*)

North Carolina Division of Marine Fisheries
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February 2005

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1. ACKNOWLEDGEMENTS

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3. EXECUTIVE SUMMARY

3.1 Goals and Objectives

The goal of the 2004 North Carolina Southern Flounder Fishery Management Plan (FMP) is to prevent overfishing in the stock of southern flounder (*Paralichthys lethostigma*) so that it can produce long-term sustainable harvest and to maintain the integrity of the stock at historical levels. To achieve this goal, the following objectives must be met:

1. Protect the southern flounder stock from overfishing to maintain the biomass and age distribution at the levels necessary to sustain the fisheries at historical levels.

2. Ensure that the spawning stock biomass of southern flounder is adequate to produce recruitment levels necessary to maintain stock biomass and age distribution similar to recent levels.

3. Promote harvesting practices that minimize bycatch.

4. Develop a program of education and public information to help identify the dynamics in the southern flounder stock, its habitat and fisheries, and the rationale for management efforts to sustain the stock.

5. Develop a regulatory process that provides adequate resource protection, optimizes the yield from the fishery, and considers the needs of all user groups.

6. Restore, improve and protect critical fish habitat and environmental quality to increase growth, survival, and reproduction of southern flounder.

7. Identify and encourage research to improve understanding of southern flounder population ecology and dynamics.

8. Initiate, enhance, and/or continue studies to collect and analyze the socio-economic data needed to properly monitor and manage the southern flounder fishery.

3.2 Commercial Fisheries

From 1994-2003 southern flounder is North Carolina's most economically valuable commercial finfish species, averaging 3.6 million pounds and $6.3 million per year. Gill nets and pounds nets together are responsible for approximately 96% of the total commercial landings of southern flounder. The peak season for these fisheries is from September to December as the flounder are migrating out of the sounds and estuaries to spawn offshore. Most of the flounder are harvested from the Pamlico Sound, although Albemarle and Core sounds produce a significant amount of the harvest as well. The majority of the flounder harvested are landed in Carteret, Dare, and Hyde counties. Participation in the pound net fishery has been in decline recently, partly due to the expense of acquiring and maintaining the gear and partly in response to the advent of the gill net fishery for flounder. In addition, over the past several years, the large mesh gill net fishery in the Pamlico Sound has been plagued by heavy federal restrictions and closures due to a large number of sea turtle strandings believed to be related to the gear.

3.3 Recreational Fisheries

The recreational fisheries account for approximately 13% of the total southern flounder landings in the State. Annual landings over the past decade average approximately 120,000 pounds for recreational anglers, and in 2002 recreational gig landings were approximately 361,000 pounds. Landings from Recreational Commercial Gear License holders in 2002 were estimated to be approximately 97,000 pounds. The majority of the trips targeting southern flounder occur from May to October with a peak during the last two months for the hook-and-line fishery and in June and July for the recreational gig fishery. Around two-thirds of the catch of southern flounder by recreational anglers comes from internal coastal waters, while the remaining one-third is taken from the ocean. The majority of the recreational landings of southern flounder occur in below the Albemarle Sound, particularly from the southern portion of the State from Core Sound to the Cape Fear River. The effort and harvest in the recreational gig and gill net fisheries have only been quantified for one year (2002) and efforts need to be made to begin obtaining these data on a recurring basis.

3.4 Socioeconomic Status

The ex-vessel inflation-adjusted value of southern flounder increased from 1972 to 1994, but has been slowly declining since then. However, the price per pound has remained mostly steady. While gill nets accounted for 65% of the landings, southern flounder landed in pound nets historically have brought a higher price per pound. In general, Dare County has landed the most pounds of southern flounder, followed by Carteret, Hyde, and Pasquotank counties. Approximately 65–75% of all North Carolina southern flounder are landed annually in these four counties.

Recreational angler landings of southern flounder from 1994–2002 accounted for 2–7% of the total annual landings. In 1999 alone it was estimated that there were nearly 263,000 recreational trips that targeted flounder, with two-thirds of those trips lasting for only one day.

There are three major needs with regard to the economic status of the southern flounder fishery that need to be addressed: 1) collect socioeconomic data in the commercial fishery; 2) collect data on recreational fishermen who use gigs or who use commercial gear (recreational commercial gear license holders); and 3) increase the Marine Recreational Fisheries Statistics Survey sample size so that more in-depth analyses can be made for more individual species, including southern flounder.

3.5 Stock Status

The North Carolina Fisheries Reform Act states that the goal of a fishery management plan is to ensure the long-term viability of the State's commercially and recreationally significant species or fisheries. Stock assessments, the mechanism to determine if a fishery is overfished and/or if overfishing is occurring, are the primary tools used by fisheries managers to develop management goals and objectives for significant State fisheries.

Data available on southern flounder include abundance indices and data on landings, size and age composition. Twenty abundance indices by age were developed from the North Carolina Division of Marine Fisheries (NCDMF) Biological Sampling Program (fishery-independent) and Trip Ticket Program (fishery-dependent). Reliable time-series of landings data are available from recreational and commercial fisheries, though it is very limited (one-year) from the Recreational Commercial Gear License and recreational gig fishery. A Virtual Population Analysis age-structured model and a Yield-Per-Recruit model were utilized to determine past and current fishing mortality and stock abundance levels as well as target spawning potential ratio levels.

The southern flounder fishery is largely dependent on incoming recruitment. Catch-at-age values indicate 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. Fishing mortality rates averaged 1.91 (ages 2-5) in 2002 with an 80% probability that F was between 1.69 and 2.89. It is likely that overfishing has occurred every year since 1991, and that the current fishing mortality rate can be expected to retain about 5.4% of the maximum spawning stock biomass, well below the percentage of spawning stock necessary to sustain most stocks.

3.6 Sustainable Harvest

The lack of an index of overall population biomass prevented use of a surplus production model to identify mortality rates for maximum sustainable yield (MSY). Instead, the rate of mortality in the fishery as a result of fishing practices was used to determine threshold and target levels for the fishery. Yield per recruit analysis, which characterizes the average effects of fishing mortality on a population given our understanding of the species' growth rate and rate of natural mortality, is commonly used when direct estimates of F_{MSY} (equivalent to the $F_{threshold}$) and F_{OY} (equivalent to the F_{target}) are not available. Proxy threshold and target fishing mortality rates corresponding with spawning potential ratio (SPR) levels chosen by the NCDMF Southern Flounder Plan Development Team were calculated through yield-per-recruit analysis.

Based on the southern flounder stock assessment, $F_{threshold}$ (20%SPR) was determined to be 0.57, while F_{target} (25%SPR) was calculated to be 0.46. To sustain the southern flounder fishery and assure its viability in the years to come, the level of annual fishing mortality needs to be maintained at or below the F_{target}.

Subsequent to the development of the plan and recommendations for MSY and optimum yield (OY) under the previous legislation, the NC General Assembly amended the requirements to achieve sustainable harvest rather that optimum yield in 2004. The estimates of spawning stock biomass that correspond to sustainable harvest were chosen as 20% for the threshold and 25% for the target to rebuild the fishery and prevent overfishing. These represent replacement spawning potential ratio (SPR) and sustainable harvest, respectively, as required by the Fisheries Reform Act. Consequently, MSY or OY in previous drafts have been replaced with replacement SPR and sustainable harvest.

3.7 Environmental Factors

Southern flounder utilize estuaries as juveniles and adults. Metamorphosing and post-metamorphosed fish settle on muddy substrates, less than 3.3 feet (1 meter) in depth, in the upper, mesohaline portion of estuaries. Post-metamorphic and small young-of-the-year southern flounder are most abundant in oligohaline environments and move to deeper and more saline waters as they grow. Adult southern flounder in North Carolina utilize oligohaline and mesohaline waters usually less than 6.6 feet (2 meters) in depth, including eastern Albemarle Sound and its tributaries, western Pamlico Sound and the upper reaches of rivers during the spring and summer. Adult southern flounder also utilize oyster reefs in central coastal North Carolina. In the fall, adult southern flounder migrate through polyhaline waters in eastern Pamlico and Core sounds, before they exit the estuaries to spawn. These areas are characterized by high salinities, muddy sand to sandy substrates, and have substantial coverage by submerged aquatic vegetation. Southern flounder have been collected in waters from 34° to 93.4° F (1.2° to 34.1° C) and with bottom dissolved oxygen levels of 0.2 to 15.0 mg/l.

Protection of habitat critical to southern flounder falls under the authority of several state and federal agencies. Bottom disturbing activities are generally not allowed in these areas. Shoreline development, such as bulkheading, is restricted as well in attempts to limit impacts to nursery and adult habitat. However, it is estimated that estuarine shoreline continues to be developed at a rate of at least 25 miles/year. Sediment contamination is common in major portions of the Neuse and Pamlico river systems and the Albemarle Sound. Bottom water hypoxia occurs frequently in summer and fall in the deeper regions the Neuse-Pamlico system as a result of stratification of the fresh surface water and more saline bottom water. Areas needing further protection include beaches scheduled for beach nourishment and inlets where jetties may be constructed and impede larval migration. Strict enforcement of buffer zones rules and other river basin management measures to reduce point and non-point source pollution is necessary.

3.8 Management Actions

The purpose of this plan is to recommend management measures and research needs that will return the North Carolina southern flounder stock to a viable level and ensure production of long-term sustainable harvest. Areas addressed in the management of North Carolina's southern flounder fishery in this FMP are: 1) management strategies to prevent overfishing; 2) habitat and water quality; 3) socioeconomic factors; 4) conflict between fisheries; 5) bycatch of under-sized flounder and economically-valuable or protected species in flounder fisheries; 6) bycatch of flounder in non-flounder fisheries; and 7) stock enhancement.

During the development of the FMP by the NCDMF and the Southern Flounder FMP Advisory Committee (AC), each of these areas was evaluated and options were proposed on how best to address the issues presented. The NCMFC then made management recommendation for these issues. The management actions for each of the main areas are as follows:

1) Management Strategies to Prevent Overfishing

- Implement a 14-inch minimum size limit, a closure period from December 1-December 31, a minimum mesh size of 5 ½-inches stretched mesh on large mesh gill nets, 3,000 yard limit on large mesh gill nets and 5 ½-inch stretched mesh on escape panels in flounder pound nets on the commercial fishery. The closure would disallow the harvest and sale of flounder by any means other than federally permitted flounder trawls working in the Atlantic Ocean. Another stock assessment will be conducted three years after the implementation of the plan to evaluate the progress towards rebuilding the population.

- Implement a 14-inch minimum size limit and an 8-fish bag limit in all inside waters for all recreational fisheries.

- Require a license or permit to fish with gigs recreationally.

- Capture gear specifics on the RCGL application.

- Endorse funding to investigate the potential of a portion of the southern flounder population to remain offshore following the spawning period, thus avoiding fishing pressure.

2) Habitat and Water Quality

- The North Carolina Division of Coastal Management should continue promoting the use of shoreline stabilization alternatives that maintain or enhance fish habitat. That includes using oyster cultch or limestone marl in constructing the sills (granite sills do not attract oyster larvae).

- To ensure protection of flounder nursery areas, fish-friendly alternatives to vertical stabilization should be required around primary and secondary nursery areas.

- The location and designation of nursery habitats should be continued and expanded by the NCDMF.

- No trawl areas and mechanical harvest prohibited areas should be expanded to include recovery/restoration areas for subtidal oyster beds and submerged aquatic vegetation.

- Expansion and coordination of habitat monitoring efforts is needed to acquire data for modeling the location of potential recovery/restoration sites for oysters and submerged aquatic vegetation.

- Any proposed stabilization project threatening natural inlet processes should be avoided.

- All coastal-draining river basins should be considered for nutrient sensitive waters classification because they all deliver excess nutrients to coastal waters, regardless of flushing rate.

- Efforts to implement phase II stormwater rules must be continued.

- The Ecological Enhancement Program process should be extended to other development projects.

- Reduce sediment and nutrient loading by addressing multiple sources, including:
    - improvement and continuation of urban and agricultural Best Management Practices;
    - more stringent sediment controls on construction projects; and
    - implementation of additional buffers along coastal waters.

3) Socioeconomic Factors

- Collect socioeconomic data on recreational fishermen who use gigs.

- Increase the Marine Recreational Fisheries Statistics Survey sample size for recreational flounder fishermen to gain better, more accurate information on their habits and fishing practices.

4) Conflict Between Fisheries

- Maintain the 1,000-yard limit between new and existing pound net sets.

- Implement a 200-yard limit between gill nets and active pound nets Statewide with the exception of the Albemarle Sound, excluding tributaries, west of a line between Caroon Point and Powell Point during August 15 - November 30, or until the fishery closes, when the minimum distance will be 500 yards.

5) Bycatch of Under-Sized Flounder and Economically-valuable or Protected Species in Flounder Fisheries

- Implement a 3,000-yard maximum limit Statewide on all large mesh flounder gill nets per fishing operation regardless of how many licenses are involved.

- Implement a minimum mesh size of 5½ stretched mesh Statewide for all large mesh gill nets.

- Recreational Commercial Gear License holders are required to attend their large mesh gill nets at all times from south of the NC Highway 58 bridge at Emerald Isle to the South Carolina State line.

- Require the incorporation of escape panels with 5½-inch webbing in all flounder pound nets Statewide.

- Establish a stakeholder group(s) to address interactions and management between large mesh estuarine gill nets and high profile species.

6) Bycatch of Flounder in Non-Flounder Fisheries

- Implement a 4-inch mesh in crab trawl tailbags in the western side of the sounds and a 3-inch mesh in crab trawl tailbags in the eastern side of the sounds.

- Recommend that the Shrimp FMP address the issue of the discard of sublegal southern flounder in the shrimp trawl fishery.

- Conduct research to test the feasibility of using biodegradable panels in crab pots.

- Conduct research to test the effectiveness of flatfish excluders in crab pots.

- Conduct research on the testing of galvanic time-release devices, natural twine, and non-coated steel (24 gauge or less) in crab pots across a wide range of salinities.

7) Stock Enhancement

- Do not endorse funding for pilot research on the feasibility of southern flounder stock enhancement at this time.

3.9 Management Plan Reductions and Economic Impacts

The North Carolina Marine Fisheries Commission (NCMFC) reviewed fisheries management proposals for the Southern Flounder FMP from the Southern Flounder Advisory Committee (AC), the North Carolina Division of Marine Fisheries (NCDMF), as well as NCMFC proposed alternatives on December 2, 2004. Proposals included the measurable percent reductions per specific management strategies, including gear changes, closures, size-limits, bag limits for commercial and recreational fisheries, and the projected direct economic impacts to the commercial fishery only.

The Southern Flounder FMP management measures result in a total reduction of 17.2% to the southern flounder fishery, with a 15.1% reduction to the commercial fishery and a 30.5% reduction to the recreational fishery, with an economic impact of $857,965 to the projected commercial fishery reductions in harvest. The FMP provides a provision to re-assess the stock status in three years.

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

The Fisheries Reform Act of 1997 (FRA) established a process for preparing coastal fisheries management plans in North Carolina. The FRA states "the goal of the plans shall be to ensure the long-term viability of the State's commercially and recreationally significant species or fisheries. Each plan shall be designed to reflect fishing practices so that one plan may apply to a specific fishery, while other plans may be based on gear or geographic areas. Each plan shall:

a. Contain necessary information pertaining to the fishery or fisheries, including management goals and objectives, status of the relevant fish stocks, stock assessments for multi-year species, fishery habitat and water quality considerations consistent with Coastal Habitat Protection Plans (CHPP) adopted pursuant to G.S. 143B-279.8, social and economic impact of the fishery to the State, and user conflicts.

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

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

d. Specify a time period, not to exceed 10 years from the date of the adoption of the plan, for ending overfishing and achieving a sustainable harvest. This subdivision shall only apply 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 to 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."

4.2 Goals and Objectives

The goal of the 2004 North Carolina Southern Flounder Fishery Management Plan (FMP) is to prevent overfishing in the stock of southern flounder (*Paralichthys lethostigma*) so that it can produce long-term sustainable harvest and maintain the integrity of the stock at historical levels. To achieve this goal, the following objectives must be met:

1. Protect the southern flounder stock from overfishing by maintaining stock biomass and age distribution at the levels necessary to sustain the fisheries at historical levels.

2. Ensure that the spawning stock biomass of southern flounder is adequate to produce recruitment levels necessary to maintain stock biomass and age distribution similar to recent levels.

3. Promote harvesting practices that minimize bycatch.

4. Develop a program of education and public information to help identify the dynamics in the southern flounder stock, its habitat and fisheries, and the rationale for management efforts to sustain the stock.

5. Develop a regulatory process that provides adequate resource protection, optimizes the yield from the fishery, and considers the needs of all user groups.

6. Restore, improve and protect critical fish habitat and environmental quality to increase growth, survival, and reproduction of southern flounder.

7. Identify and encourage research to improve understanding of southern flounder population ecology and dynamics.

8. Initiate, enhance, and/or continue studies to collect and analyze the socio-economic data needed to properly monitor and manage the southern flounder fishery.

4.3 Management Unit

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

4.4 General Problem Statement

The purpose of this plan is to recommend management measures and research needs that will return the North Carolina southern flounder stock to a viable level and ensure production of long-term sustainable harvest. Areas to be addressed in the management of North Carolina's southern flounder fishery are: 1) management strategies to prevent overfishing; 2) habitat and water quality; 3) socioeconomic factors; 4) conflict between fisheries; 5) bycatch of flounder in non-flounder fisheries; 6) bycatch of under-sized flounder and economically-valuable or protected species in flounder fisheries; and 7) stock enhancement.

4.5 Existing Plans, Statues, and Rules

4.5.1 Existing Plans

Currently, there are no federal, interstate, or State FMPs that apply specifically to the southern flounder fishery in North Carolina. However, the federal FMP for summer flounder (*Paralichthys dentatus*) does have a limited impact on the species. Due to the difficulty in distinguishing between the two closely related species, flounder in North Carolina are managed by area of occurrence rather than species. Summer flounder occur primarily in the ocean waters and around the inlets and are harvested commercially almost exclusively through the use of flounder trawls. In contrast, the main fisheries for southern flounder, such as gill nets, pound nets, and gigs, take place in the sounds and river systems. Therefore, regulations stemming from the federal summer flounder FMP, including harvest limits, size restrictions, and closures, only apply to ocean caught flounder in North Carolina, regardless of the species.

4.5.2 Statutes

All management authority for North Carolina's southern flounder fishery is vested in the State of North Carolina. General authorities that are noted in Section 4.1 provide the NCMFC and the NCDMF with the regulatory powers to manage the southern flounder fishery. Although most southern flounder harvest is taken from coastal and joint waters, the limited harvest from inland waters falls under the jurisdiction of the North Carolina Wildlife Resources Commission. Additional statutes that have been applied to the southern flounder fishery include:

G.S. 113-173. RECREATIONAL COMMERCIAL GEAR LICENSE

(a) License Required. – Except as provided in subsection (j) of this section, it is unlawful for any person to take or attempt to take fish for recreational purposes by means of commercial fishing equipment or gear in coastal fishing waters without holding a RCGL. As used in this section, fish are taken for recreational purposes if the fish are not taken for the purpose of sale. The RCGL entitles the licensee to use authorized commercial gear to take fish for personal use subject to recreational possession limits. It is unlawful for any person licensed under this section or fishing under a RCGL to possess fish in excess of recreational possession limits.

(b) Sale of Fish Prohibited. – It is unlawful for the holder of a RCGL or for a person who is exempt under subsection (j) of this section to sell fish taken under the RCGL or pursuant to the exemption.

(c) Authorized Commercial Gear. –

(1) The Commission shall adopt rules authorizing the use of a limited amount of commercial fishing equipment or gear for recreational fishing under a RCGL. The Commission may authorize the limited use of 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. The Commission shall periodically evaluate and revise the authorized use of commercial gear for recreational fishing. Authorized commercial gear shall be identified by visible colored tags or other means specified by the Commission in order to distinguish between commercial gear used in a commercial operation and commercial gear used for recreational purposes.

(2) A person who holds a RCGL may use up to 100 yards of gill net to take fish for recreational purposes. Two persons who each hold a RCGL and who are fishing from a single vessel may use up to a combined 200 yards of gill net to take fish for recreational purposes. No more than 200 yards of gill net may be used to take fish for recreational purposes from a single vessel regardless of the number of persons aboard the vessel who hold a RCGL.

(d) Purchase; Renewal. – A RCGL may be purchased at designated offices of the Division and from a license agent authorized under G.S. 113-172. A RCGL may be renewed by mail.

(e) Replacement RCGL. – The provisions of G.S 113-168.1(h) apply to this section.

(f) Duration; Fees. – The RCGL shall be valid for a one-year period from the date of purchase. The fee for a RCGL for a North Carolina resident shall be thirty-five dollars ($35.00). The fee for a RCGL for an individual who is not a North Carolina resident shall be two hundred fifty dollars ($250.00).

(g) RCGL Available for Inspection. – It is unlawful for any person to engage in recreational fishing by means of restricted commercial gear in the State without having ready at hand for inspection a valid RCGL. A holder of a RCGL shall not refuse to exhibit the RCGL upon the request of an inspector or any other law enforcement officer authorized to enforce federal or State laws, regulations, or rules relating to marine fisheries.

(h) Assignment and Transfer Prohibited. – A RCGL is not transferable. Except as provided in subsection (j) of this section, it is unlawful to buy, sell, lend, borrow, assign, or otherwise transfer a RCGL, or to attempt to buy, sell, lend, borrow, assign, or otherwise transfer a RCGL.

(i) Reporting Requirements. – The holder of a RCGL shall comply with the biological data sampling and survey programs of the Commission and the Division.

(j) Exemptions. –

(1) A person who is under 16 years of age may take fish for recreational purposes by means of authorized commercial gear without holding a RCGL if the person is accompanied by a parent, grandparent, or guardian who holds a valid RCGL or if the person has in the person's possession a valid RCGL issued to the person's parent, grandparent, or guardian.

(2) A person may take crabs for recreational purposes by means of one or more crab pots attached to the shore along privately owned land or to a privately owned pier without holding a RCGL provided that the crab pots are attached with the permission of the owner of the land or pier.

(3) A person who is on a vessel may take fish for recreational purposes by means of authorized commercial gear without holding a RCGL if there is another person on the vessel who holds a valid RCGL. This exemption does not authorize the use of commercial gear in excess of that authorized for use by the person who holds the valid RCGL or, if more than one person on the vessel holds a RCGL, in excess of that authorized for use by those persons.

(4) A person using non-mechanical means may take shellfish for personal use within the limits specified in G.S. 113-169.2(i) without holding a RCGL.

(5) A person may take fish for recreational purposes by means of a gig without holding a RCGL. (1997-400, s. 5.1; 1997-456, s. 55.7; 1998-225, s. 4.21; 1999-209, s. 9; 2000-139, s. 1.)

G.S. 113-268 INJURING, DESTROYING, STEALING, OR STEALING FROM NETS, SEINES, BUOYS, POTS, ETC.

(a) 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.

(b) It is unlawful for any master or other person having the management or control of a vessel in the navigable waters of the State to willfully, wantonly, and unnecessarily do injury to any seine, net or pot which may lawfully be hauled, set, or fixed in such waters for the purpose of taking fish except that a net set across a channel may be temporarily moved to accommodate persons engaged in drift netting, provided that no fish are removed and no damage is done to the net moved.

(c) It is unlawful for any person to willfully steal, destroy, or injure any buoys, markers, stakes, nets, pots, or other devices on property lawfully set out in the open waters of the State in connection with any fishing or fishery.

(d) Violation of subsections (a), (b), or (c) is a Class A1 misdemeanor.

(e) The Department may, either before or after the institution of any other action or proceeding authorized by this section, institute a civil action for injunctive relief to restrain a violation or threatened violation of subsections (a), (b), or (c) of this section pursuant to G.S. 113-131. The action shall be brought in the superior court of the county in which the violation or threatened violation is occurring or about to occur and shall be in the name of the State upon the relation of the Secretary. The court, in issuing any final order in any action brought pursuant to this subsection may, in its discretion, award costs of litigation including reasonable attorney and expert-witness fees to any party. (1987, c. 636, s. 1; 1989, c. 727, s. 112; 1993, c. 539, s. 849; 1994, Ex. Sess., c. 24, s. 14(c); 1998-225, s. 3.9.)

4.5.3 Rules

<u>North Carolina Fisheries Rules for Coastal Waters (15A NCAC)</u>

3I .0101 DEFINITIONS

(a) All definitions set out in G.S. 113, Subchapter IV apply to this Chapter.

(b) The following additional terms are hereby defined:

- (1) Commercial Fishing Equipment or Gear. All fishing equipment used in coastal fishing waters except:
  - (A) Seines less than 30 feet in length;
  - (B) Collapsible crab traps, a trap used for taking crabs with the largest open dimension no larger than 18 inches and that by design is collapsed at all times when in the water, except when it is being retrieved from or lowered to the bottom;
  - (C) Spears, Hawaiian slings or similar devices which propel pointed implements by mechanical means, including elastic tubing or bands, pressurized gas or similar means;
  - (D) A dip net having a handle not more than eight feet in length and a hoop or frame to which the net is attached not exceeding 60 inches along the perimeter;
  - (E) Hook-and-line and bait-and-line equipment other than multiple-hook or multiple-bait trotline;
  - (F) A landing net used to assist in taking fish when the initial and primary method of taking is by the use of hook and line;
  - (G) Cast Nets;
  - (H) Gigs or other pointed implements which are propelled by hand, whether or not the implement remains in the hand; and
  - (I) Up to two minnow traps.
- (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.
- (3) Mesh Length. The diagonal distance from the inside of one knot to the outside of the other knot, when the net is stretched hand-tight.
- (4) Possess. Any actual or constructive holding whether under claim of ownership or not.

(5) Transport. Ship, carry, or cause to be carried or moved by public or private carrier by land, sea, or air.
(6) Use. Employ, set, operate, or permit to be operated or employed.
(7) Purse Gill Nets. Any gill net used to encircle fish when the net is closed by the use of a purse line through rings located along the top or bottom line or elsewhere on such net.
(8) Gill Net. A net set vertically in the water to capture fish by entanglement by the gills in its mesh as a result of net design, construction, mesh size, webbing diameter or method in which it is used.
(9) Seine. A net set vertically in the water and pulled by hand or power to capture fish by encirclement and confining fish within itself or against another net, the shore or bank as a result of net design, construction, mesh size, webbing diameter, or method in which it is used.
(10) Internal Coastal Waters or Internal Waters. All coastal fishing waters except the Atlantic Ocean.
(17) Length of finfish.
(A) Total length is determined by measuring along a straight line the distance from the tip of the snout with the mouth closed to the tip of the compressed caudal (tail) fin.
(B) Fork length is determined by measuring along a straight line the distance from the tip of the snout with the mouth closed to the middle of the fork in the caudal (tail) fin.
(C) Fork length for billfish is measured from the tip of the lower jaw to the middle of the fork of the caudal (tail) fin.
(18) Licensee. Any person holding a valid license from the Department to take or deal in marine fisheries resources.
(19) Aquaculture operation. An operation that produces artificially propagated stocks of marine or estuarine resources or obtains such stocks from authorized sources for the purpose of rearing in a controlled environment. A controlled environment provides and maintains throughout the rearing process one or more of the following: predator protection, food, water circulation, salinity, or temperature controls utilizing proven technology not found in the natural environment.
(20) Critical habitat areas. The fragile estuarine and marine areas that support juvenile and adult populations of economically important seafood species, as well as forage species important in the food chain. Critical habitats include nursery areas, beds of submerged aquatic vegetation, shellfish producing areas, anadromous fish spawning and anadromous fish nursery areas, in all coastal fishing waters as determined through marine and estuarine survey sampling. Critical habitats are vital for portions, or the entire life cycle, including the early growth and development of important seafood species.
(A) Beds of submerged aquatic vegetation are those habitats in public trust and estuarine waters vegetated with one or more species of submerged vegetation such as eelgrass (*Zostera marina*), shoalgrass (*Halodule wrightii*) and widgeongrass (*Ruppia maritima*). These vegetation beds occur in both subtidal and intertidal zones and may occur in isolated

patches or cover extensive areas. In either case, the bed is defined by the presence of above-ground leaves or the below-ground rhizomes and propagules together with the sediment on which the plants grow. In defining beds of submerged aquatic vegetation, the Marine Fisheries Commission recognizes the Aquatic Weed Control Act of 1991 (G.S. 113A-220 et. seq.) and does not intend the submerged aquatic vegetation definition and its implementing rules to apply to or conflict with the non-development control activities authorized by that Act.

(B) Shellfish producing habitats are those areas in which economically important shellfish, such as, but not limited to clams, oysters, scallops, mussels, and whelks, whether historically or currently, reproduce and survive because of such favorable conditions as bottom type, salinity, currents, cover, and cultch. Included are those shellfish producing areas closed to shellfish harvest due to pollution.

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

(D) Anadromous fish nursery areas are defined as those areas in the riverine and estuarine systems utilized by post-larval and later juvenile anadromous fish.

(22) North Carolina Trip Ticket. Multiple-part form provided by the Department to fish dealers who are required to record and report transactions on such forms.

(23) Transaction. Act of doing business such that fish are sold, offered for sale, exchanged, bartered, distributed or landed. The point of landing shall be considered a transaction when the fisherman is the fish dealer.

(29) Pound Net Set. A fish trap consisting of a holding pen, one or more enclosures, a 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.

(34) Responsible party. Person who coordinates, supervises or otherwise directs operations of a business entity, such as a corporate officer or executive level supervisor of business operations and the person responsible for use of the issued license in compliance with applicable laws and rules.

(37) Holder. A person who has been lawfully issued in their name a license, permit, franchise, lease, or assignment.

(38) Recreational Purpose. A fishing activity has a recreational purpose if it is not a commercial fishing operation as defined in G.S. 113-168.

(39) Recreational Possession Limit. Includes, but is not limited to, restrictions on size, quantity, season, time period, area, means, and methods where take or possession is for a recreational purpose.

(40) Attended. Being in a vessel, in the water or on the shore immediately adjacent to the gear and immediately available to work the gear and within 100 yards of any gear in use by that person at all times. Attended does not include being in a building or structure.

(41) Commercial Quota. Total quantity of fish allocated for harvest taken by commercial fishing operations.
(42) Recreational Quota. Total quantity of fish allocated for harvest taken for a recreational purpose.
(44) Land:
   (A) For purposes of trip tickets, when fish reach a licensed seafood dealer, or where the fisherman is the dealer, when the fish reaches the shore or a structure connected to the shore.
   (B) For commercial fishing operations, when fish reach the shore or a structure connected to the shore.
   (C) For recreational fishing operations, when fish are retained in possession by the fisherman.
(45) Master. Captain of a vessel or one who commands and has control, authority, or power over a vessel.

3I .0120 POSSESSION OR TRANSPORTATION LIMITS
(a) It is unlawful to possess any species of fish which is subject to size or harvest restrictions, while actively engaged in a fishing operation, unless all fish are in compliance with the restrictions for the waterbody and area being fished.
(b) It is unlawful to import into the State species of fish native to North Carolina for sale in North Carolina that do not meet established size limits, except as provided in 15A NCAC 3K .0202 (c) and 3K .0305.

3J .0101 FIXED OR STATIONARY NETS
It is unlawful to use or set fixed or stationary nets:
(1) In the channel of the Intracoastal Waterway or in any other location where it may constitute a hazard to navigation;
(2) So as to block more than two-thirds of any natural or manmade waterway, sound, bay, creek, inlet or any other body of water;
(3) In the middle third of any marked navigation channel;
(4) In the channel third of the following rivers: Roanoke, Cashie, Middle, Eastmost, Chowan, Little, Perquimans, Pasquotank, North, Alligator, Pungo, Pamlico, and Yeopim.

3J .0102 NETS OR NET STAKES
It is unlawful to use nets or net stakes:
(1) Within 150 yards of railroad or highway bridge crossing the Northeast Cape Fear River, New River, White Oak River, Trent River, Neuse River, Pamlico River, Roanoke River, and Alligator River;
(2) Within 300 yards of any highway bridge crossing Albemarle Sound, Chowan River, Croatan Sound, Currituck Sound and Roanoke Sound;
(3) If such net stakes are of metallic material.

3J .0103 GILL NETS, SEINES, IDENTIFICATION, RESTRICTIONS
(a) It is unlawful to use a gill net with a mesh length less than 2½ inches.

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

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

(d) It is unlawful to use gill nets:
   (1) Within 200 yards of any pound net with lead and pound or heart in use;
   (2) From March 1 through October 31 in the Intracoastal Waterway within 150 yards of any railroad or highway bridge.

(e) It is unlawful to use gill nets within 100 feet either side of the center line of the Intracoastal Waterway Channel south of Quick Flasher No. 54 in Alligator River at the southern entrance to the Intracoastal Waterway to the South Carolina line, unless such net is used in accordance with the following conditions:
   (1) No more than two gill nets per boat may be used at any one time;
   (2) Any net used must be attended by the fisherman from a boat who shall at no time be more than 100 yards from either net; and
   (3) Any individual setting such nets shall remove them, when necessary, in sufficient time to permit unrestricted boat navigation.

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

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

(1) Pamlico River, west of a line beginning at a point on Mauls Point at 35° 26.9176’ N - 76° 55.5253’ W; to a point on Ragged Point at 35° 27.5768’ N - 76° 54.3612’ W;
(2) Within 200 yards of any shoreline in Pamlico River and its tributaries east of the line from Mauls Point at 35° 26.9176’ N - 76° 55.5253’ W; to Ragged Point at 35° 27.5768' N - 76° 54.3612' W and west of a line beginning at a point on Pamlico Point at 35° 18.5906' N - 76° 28.9530' W ; through Marker #1 to a point on Roos Point at 35° 22.3622' N - 76° 28.2032' W;
(3) Pungo River, east of a line beginning at a point on Durants Point at 35° 30.5312' N - 76° 35.1594' W; to the northern side of the breakwater at 35° 31.7198' N - 76° 36.9195' W;
(4) Within 200 yards of any shoreline in Pungo River and its tributaries west of the line from Durants Point at 35° 30.5312' N - 76° 35.1594' W; to the northern side of the breakwater at 35° 31.7198' N - 76° 35.1594' W, and west of a line beginning at a point on Pamlico Point at 35° 18.5906' N - 76° 28.9530' W; through Marker #1 to a point on Roos Point at 35° 22.3622' N - 76° 28.2032' W;
(5) Neuse River and its tributaries northwest of the Highway 17 highrise bridge;
(6) Trent River and its tributaries;
(7) Within 200 yards of any shoreline in Neuse River and its tributaries east of a line from the Highway 17 highrise bridge and west of a line beginning at a point on Wilkinson Point at 34° 57.9116' N - 76° 48.2240' W; to a point on Cherry Point at 34° 56.3658' N - 76° 48.7110' W.

(h) It is unlawful to use unattended gill nets with a mesh length less than five inches in a commercial fishing operation from May 1 through October 31 in the following internal coastal and joint waters of the State south of a line beginning at a point on Roanoke Marshes Point at 35° 48.3693' N - 75° 43.7232' W; to a point on Eagle Nest Bay at 35° 44.1710' N - 75° 31.0520' W to the South Carolina State Line:
(1) All primary nursery areas described in 15A NCAC 03R .0103, all permanent secondary nursery areas described in 15A NCAC 03R .0104, and no trawl areas described in 15A NCAC 03R .0106 (3),(4),(6), and (7);
(2) In the area along the Outer Banks, beginning at a point on Core Banks at 34° 58.7853' N - 76° 09.8922' W; to a point on Wainwright Island at 34° 59.4664' N - 76° 12.4859' W; to a point at 35° 00.2666' N - 76° 12.2000' W; to a point near Beacon “HL” at 35° 01.5833' N - 76° 11.4500' W; to a point near North Rock at 35° 06.4000' N - 76° 04.3333' W; to a point near Nine Foot Shoal Channel at 35° 08.4333' N - 76° 02.5000' W; to a point near the west end of Clark Reef at 35° 09.3000' N - 75° 54.8166' W; to a point south of Legged Lump at 35° 10.9666’ N – 75° 49.7166’ W; to a point on Legged Lump at 35° 11.4833’ N – 75° 51.0833’ W; to a point near No. 36 in Rollinson Channel at 35° 15.5000’ N – 75° 43.4000’ W; to a point near No. 2 in Cape Channel at 35° 19.0333' N - 75° 36.3166' W; to a point near No. 2 in Avon Channel at 35° 22.3000’ N – 75° 33.2000’ W; to a point on Gull Island at 35° 28.4500' N - 75° 31.3500' W; to a point west of Salvo at 35° 32.6000’ N – 75° 31.8500’ W; to a point west of Rodanthe Pier at 35° 35.0000’ N – 75° 29.8833’ W; to a point near No. 2 in Chicamacomico Channel, to a point west of Beach

Slough at 35° 40.0000’ N – 75° 32.8666’ W; to a point west of Pea Island at 35° 45.1833' N - 75° 34.1000' W; to a point at 35° 44.1710’ N - 75° 31.0520’ W. Thence running south along the shoreline across the inlets to the point of beginning;

(3) In Back and Core sounds, beginning at a point on Shackleford Banks at 34° 39.6601' N - 76° 34.4078' W; to a point at Marker #3 at 34° 41.3166' N - 76° 33.8333' W; to a point at 34° 40.4500' N - 76° 30.6833' W; to a point near Marker “A37" at 34° 43.5833' N - 76° 28.5833' W; to a point at 34° 43.7500' N - 76° 28.6000' W; to a point at 34° 48.1500' N - 76° 24.7833' W; to a point near Drum Inlet at 34° 51.0500' N - 76° 20.3000' W; to a point at 34° 53.4166' N - 76° 17.3500'; to a point at 34° 53.9166' N - 76° 17.1166' W; to a point at 34° 53.5500' N - 76° 16.4166' W; to a point at 34° 56.5500' N - 76° 13.6166' W; to a point at 34° 56.4833' N - 76° 13.2833' W; to a point at 34° 58.1833' N - 76° 12.3000' W; to a point at 34° 58.8000' N - 76° 12.5166' W; to a point on Wainwright Island at 34° 59.4664' N - 76° 12.4859' W; to a point on Core Banks at 34° 58.7832' N - 76° 09.8922' W; thence following the shoreline south across Drum and Barden inlets to the point of beginning;

(4) Within 200 yards of any shoreline, except from October 1 through October 31, south and east of Highway 12 in Carteret County and south of a line from a point on Core Banks at 34° 58.7853' N - 76° 09.8922' W; to Camp Point at 35° 59.7942' N - 76° 14.6514' W to the South Carolina State Line.

3J .0107 POUND NET SETS

(a) All initial, renewal or transfer applications for Pound Net Set Permits, and the operation of such pound net sets, shall comply with the general rules governing all permits in 15A NCAC 03O .0500. The procedures and requirements for obtaining permits are also found in 15A NCAC 03O .0500.

(b) It is unlawful to use pound net sets in coastal fishing waters without the permittee's identification being clearly printed on a sign no less than six inches square, securely attached to the outermost stake of each end of each set. For pound net sets in the Atlantic Ocean using anchors instead of stakes, the set must be identified with a yellow buoy, which shall be of solid foam or other solid buoyant material no less than five inches in diameter and no less than 11 inches in length. The permittee's identification shall be clearly printed on the buoy. Such identification on signs or buoys must include the pound net set permit number and the permittee's last name and initials.

(c) It is unlawful to use pound net sets, or any part thereof, except for one location identification stake or identification buoy for pound nets used in the Atlantic Ocean at each end of proposed new locations, without first obtaining a Pound Net Set Permit from the Fisheries Director. The applicant must indicate on a base map provided by the Division the proposed set including an inset vicinity map showing the location of the proposed set with detail sufficient to permit on-site identification and location. The applicant must specify the type(s) of pound net set(s) requested and possess proper valid licenses and permits necessary to fish those type(s) of net. A pound net set shall be deemed a flounder pound net set when the catch consists of 50 percent or more flounder by weight of the entire landed catch, excluding blue crabs. The type "other finfish pound net set" is for sciaenid (Atlantic croaker, red drum, weakfish, spotted seatrout, spot, for example) and other finfish, except flounder, herring, or shad, taken for human consumption. Following are the type(s) of pound net fisheries that may be specified:

(1) Flounder pound net set;
(2) Herring/shad pound net set;
(3) Bait pound net set;
(4) Shrimp pound net set;
(5) Blue crab pound net set;
(6) Other finfish pound net set.

(d) For proposed new locations, the Fisheries Director shall issue a public notice of intent to consider issuance of a Pound Net Set Permit allowing for public comments for 20 days, and after the comment period, may hold public meetings to take comments on the proposed pound net set. If the Director does not approve or deny the application within 90 days of receipt of a complete and verified application, the application shall be deemed denied. The applicant shall be notified of such denial in writing. For new locations, transfers and renewals, the Fisheries Director may deny the permit application if the Director determines that granting the permit will be inconsistent with one or more of the following permitting criteria, as determined by the Fisheries Director:

(1) The application must be in the name of an individual and shall not be granted to a corporation, partnership, organization or other entity;
(2) The proposed pound net set, either alone or when considered cumulatively with other existing pound net sets in the area, will not interfere with public navigation or with existing, traditional uses of the area other than navigation, and will not violate 15A NCAC 03J.0101 and .0102;
(3) The proposed pound net set will not interfere with the rights of any riparian or littoral landowner, including the construction or use of piers;
(4) The proposed pound net set will not, by its proximate location, interfere with existing pound net sets in the area. Except in Chowan River as referenced in 15A NCAC 03J .0203, proposed new pound net set locations shall be a minimum of 1,000 yards as measured in a perpendicular direction from any point on a line following the permitted location of existing pound net sets;
(5) The applicant has in the past complied with fisheries rules and laws and does not currently have any licenses or privileges under suspension or revocation. In addition, a history of habitual fisheries violations evidenced by eight or more convictions in ten years shall be grounds for denial of a pound net set permit;
(6) The proposed pound net set is in the public interest; and
(7) The applicant has in the past complied with all permit conditions, rules and laws related to pound nets.

Approval shall be conditional based upon the applicant's continuing compliance with specific conditions contained on the Pound Net Set Permit and the conditions set out in Subparagraphs (1) through (7) of this Paragraph. The final decision to approve or deny the Pound Net Set Permit application may be appealed by the applicant by filing a petition for a contested case hearing, in writing, within 60 days from the date of mailing notice of such final decision to the applicant, with the Office of Administrative Hearings.

(e) An application for renewal of an existing Pound Net Set Permit shall be filed not less than 30 days prior to the date of expiration of the existing permit, and shall not be processed unless filed by the permittee. The Fisheries Director shall review the renewal application under the criteria for issuance of a new Pound Net Set Permit, except that pound net sets approved prior to January 1, 2003 do not have to meet the 1,000 yard minimum distance requirement specified in Subparagraph (d)(4) of this Rule. The Fisheries Director may hold public meetings and may conduct such investigations necessary to determine if the permit should be renewed.

(f) A Pound Net Set Permit, whether a new or renewal permit, shall expire one year from the date of issuance. The expiration date shall be stated on the permit.

(g) Pound net sets, except herring/shad pound net sets in the Chowan River, shall be operational for a minimum period of 30 consecutive days during the permit period unless a season for the fishery for which the pound net set is permitted is ended earlier due to a quota being met. For purposes of this Rule, operational means with net attached to stakes or anchors for the lead and pound, including only a single pound in a multi-pound set, and a non-restricted opening leading into the pound such that the set is able to catch and hold fish. The permittee, including permittees of operational herring/shad pound net sets in the Chowan River, shall notify the Marine Patrol Communications Center by phone within 72 hours after the pound net set is operational. Notification shall include name of permittee, pound net set permit number, county where located, a specific location site, and how many pounds are in the set. It is unlawful to fail to notify the Marine Patrol Communications Center within 72 hours after the pound net set is operational or to make false notification when said pound net set is not operational. Failure to comply with this Paragraph shall be grounds for the Fisheries Director to revoke this and any other pound net set permits held by the permittee and for denial of any future pound net set permits.

(h) It is unlawful to transfer a pound net set permit without a completed application for transfer being submitted to the Division of Marine Fisheries not less than 45 days before the date of the transfer. Such application shall be made by the proposed new permittee in writing and shall be accompanied by a copy of the current permittee's permit and an application for a pound net set permit in the new permittee's name. The Fisheries Director may hold a public meeting and may conduct such investigations necessary to determine if the permit should be transferred. The transferred permit shall expire on the same date as the initial permit. Upon death of the permittee, the permit may be transferred to the Administrator/Executor of the estate of the permittee if transferred within six months of the Administrator/ Executor's qualification under G.S. 28A. The Administrator/Executor must provide a copy of the deceased permittee's death certificate, a copy of the certificate of administration and a list of eligible immediate family members as defined in G.S. 113-168 to the Morehead City Office of the Division of Marine Fisheries. Once transferred to the Administrator/Executor, the Administrator/Executor may transfer the permit(s) to eligible family members of the deceased permittee. No transfer is effective until approved and processed by the Division.

(i) Every pound net set in coastal fishing waters shall have yellow light reflective tape or yellow light reflective devices on each pound. The light reflective tape or yellow light reflective devices shall be affixed to a stake of at least three inches in diameter on any outside corner of each pound, shall cover a vertical distance of not less than 12 inches, and shall be visible from all directions. In addition, every pound net set shall have a marked navigational opening of at least 25 feet in width at the end of every third pound. Such opening shall be marked with yellow light reflective tape or yellow light reflective devices on each side of the opening. The yellow light reflective tape or yellow light reflective devices shall be affixed to a stake of at least three inches in diameter, shall cover a vertical distance of not less than 12 inches, and shall be visible from all directions. If a permittee notified of a violation under this Paragraph fails or refuses to take corrective action sufficient to remedy the violation within 10 days of receiving notice of the violation, the Fisheries Director shall revoke the permit.

(j) In Core Sound, it is unlawful to use pound net sets in the pound net sets prohibited areas designated in 15A NCAC 03R .0113 except that only those pound net set permits valid within the specified area as of March 1, 1994, may be renewed or transferred subject to the requirements of this Rule.

(k) Escape Panels:

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

(A) Specify size, number, and location.

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

(C) Specify time or season.

(D) Specify areas.

(2) It is unlawful to use flounder pound net sets without four unobstructed escape panels in each pound south and east of a line beginning at a point 35° 57.3950' N - 76° 00.8166' W on Long Shoal Point; running easterly to a point 35° 56.7316' N - 75° 59.3000' W near Marker "5" in Alligator River; running northeasterly along the Intracoastal Waterway to a point 36° 09.3033' N - 75° 53.4916' W near Marker "171"at the mouth of North River; running northwesterly to a point 36° 09.9093' N - 75° 54.6601' W on Camden Point. The escape panels must be fastened to the bottom and corner ropes on each wall on the side and back of the pound opposite the heart. The escape panels must be a minimum mesh size of five and one-half inches, hung on the diamond, and must be at least six meshes high and eight meshes long.

(l) Pound net sets are subject to inspection at all times.

(m) Daily reporting may be a condition of the permit for pound net sets for fisheries under a quota.

(n) It is unlawful to fail to remove all pound net stakes and associated gear within 30 days after expiration of the permit or notice by the Fisheries Director that an existing pound net set permit has been revoked or denied.

(o) It is unlawful to abandon an existing pound net set without completely removing from the coastal waters all stakes and associated gear within 30 days.

3J .0402 FISHING GEAR RESTRICTIONS

(a) It is unlawful to use commercial fishing gear in the following areas during dates and times specified for the identified areas:

(1) Atlantic Ocean - Dare County:

(A) Nags Head:

(i) Seines and gill nets may not be used from the North Town Limit of Nags Head at Eight Street southward to Gulf Street:

(I) From Wednesday through Saturday of the week of the Nags Head Surf Fishing Tournament held during October of each year the week prior to Columbus Day.

(II) From November 1 through December 15.

(ii) Commercial fishing gear may not be used within 750 feet of licensed fishing piers when open to the public.

(B) Oregon Inlet. Seines and gill nets may not be used from the Friday before Easter through December 31:

(i) Within one-quarter mile of the beach from the National Park Service Ramp #4 (35° 48' 15" N - 75° 32' 42" W) on Bodie Island to the northern terminus of the Bonner Bridge (35° 46' 30" N - 75° 32' 22" W) on Hwy. 12 over Oregon Inlet.

(ii) Within the area known locally as "The Pond", a body of water generally located to the northeast of the northern terminus of the Bonner Bridge.

(C) Cape Hatteras (Cape Point). Seines and gill nets may not be used within one-half mile of Cape Point from the Friday before Easter through December 31. The closed area is defined by a circle with a one-half mile radius having the center at Cape Point (35° 12' 54" N - 75° 31' 43" W). The closed area begins one-half mile north of Cape Point at a point on the beach (35° 13' 26" N - 75° 31' 39" W) and extends in a clockwise direction, one-half mile from Cape Point, to a point on the beach (35° 13' 23" N - 75° 31' 59" W) northwest of Cape Point.

(2) Atlantic Ocean - Onslow and Pender Counties. Commercial fishing gear may not be used during the time specified for the following areas:

(A) Topsail Beach. From January 1 through December 31, that area around Jolly Rodger Fishing Pier bordered on the offshore side by a line 750 feet from the end of the pier and on the northeast and southwest by a line beginning at a point on the beach one-quarter mile from the pier extending seaward to intersect the offshore boundary.

(B) Surf City:

(i) From January 1 to June 30, those areas around the Surf City and Barnacle Bill's Fishing Piers bordered on the offshore side by a line 750 feet from the ends of the piers, on the southwest by a line beginning at a point on the beach one-quarter mile from the piers and on the northeast by a line beginning at a point on the beach 750 feet from the piers extending seaward to intersect the offshore boundaries.

(ii) From July 1 to December 31, those areas around the piers bordered on the offshore side by a line 750 feet from the ends of the piers, on the southwest by a line beginning at a point on the beach 750 feet from the piers and on the northeast by a line beginning at a point on the beach one-quarter mile from the piers extending seaward to intersect the offshore boundaries.

(3) Atlantic Ocean - New Hanover County. Carolina Beach Inlet through Kure Beach. Commercial fishing gear may not be used during the times specified for the following areas:

(A) From the Friday before Easter to November 30, within the zones adjacent to the Carolina Beach, Center and Kure Beach Fishing Piers bordered on the offshore side by a line 750 feet from the ends of the piers and on the north and south by a line beginning at a point on the beach one-quarter mile from the pier extending seaward to intersect the offshore boundary, except the southern boundary for Kure Beach Pier is a line beginning on the beach one mile south of the pier to the offshore boundary for the pier.

(B) From May 1 to November 30, within 900 feet of the beach, from Carolina Beach Inlet to the southern end of Kure Beach with the following exceptions:

(i) From one-quarter mile north of Carolina Beach Fishing pier to Carolina Beach Inlet from October 1 to November 30:

(I) Strike nets may be used within 900 feet of the beach;

(II) Attended nets may be used between 900 feet and one-quarter mile of the beach.

(ii) Strike nets and attended gill nets may be used within 900 feet of the beach from October 1 to November 30 in other areas except those described in Part (a)(3)(A) and Subpart (a)(3)(B)(i) of this Rule.

(iii) It is unlawful to use commercial fishing gear within 900 feet of the beach from Carolina Beach Inlet to New Inlet from October 15 through October 17.

(b) It is unlawful to use gill nets or seines in the following areas during dates and times specified for the identified areas:

(1) Neuse River and South River, Carteret County. No more than 1,200 feet of gill net(s) having a stretched mesh of five inches or larger may be used:

(A) Within one-half mile of the shore from Winthrop Point at Adams Creek to Channel Marker "2" at the mouth of Turnagain Bay.

(B) Within South River.

(2) Cape Lookout, Carteret County:

(A) Gill nets or seines may not be used in the Atlantic Ocean within 300 feet of the Rock Jetty (at Cape Lookout between Power Squadron Spit and Cape Point).

(B) Seines may not be used within one-half mile of the shore from Power Squadron Spit south to Cape Point and northward to Cape Lookout Lighthouse including the area inside the "hook" south of a line from the

COLREGS Demarcation Line across Bardens Inlet to the eastern end of Shackleford Banks and then to the northern tip of Power Squadron Spit from 12:01 a.m. Saturdays until 12:01 a.m. Mondays from May 1 through November 30.

(3) State Parks/Recreation Areas:
  (A) Gill nets or seines may not be used in the Atlantic Ocean within one-quarter mile of the shore at Fort Macon State Park, Carteret County.
  (B) Gill nets or seines may not be used in the Atlantic Ocean within one-quarter mile of the shore at Hammocks Beach State Park, Onslow County, from May 1 through October 1, except strike nets and attended gill nets may be used beginning August 15.
  (C) Gill nets or seines may not be used within the boat basin and marked entrance channel at Carolina Beach State Park, New Hanover County.

(4) Mooring Facilities/Marinas. Gill nets or seines may not be used from May 1 through November 30 within:
  (A) One-quarter mile of the shore from the east boundary fence to the west boundary fence at U.S. Coast Guard Base Fort Macon at Beaufort Inlet, Carteret County;
  (B) Canals within Pine Knoll Shores, Carteret County;
  (C) Spooners Creek entrance channel and marina on Bogue Sound, Carteret County; and
  (D) Harbor Village Marina on Topsail Sound, Pender County.

(5) Masonboro Inlet. Gill nets and seines may not be used:
  (A) Within 300 feet of either rock jetty; and
  (B) Within the area beginning 300 feet from the offshore end of the jetties to the Intracoastal Waterway including all the waters of the inlet proper and all the waters of Shinn Creek.

(6) Atlantic Ocean Fishing Piers. At a minimum, gill nets and seines may not be used within 300 feet of ocean fishing piers when open to the public. If a larger closed area has been delineated by the placement of buoys or beach markers as authorized by G.S. 113-185(a), it is unlawful to fish from vessels or with nets within the larger marked zone.

(7) Topsail Beach, Pender County. It is unlawful to use gill nets and seines from 4:00 p.m. Friday until 6:00 a.m. the following Monday in the three finger canals on the south end of Topsail Beach.

3M .0503 FLOUNDER

(a) It is unlawful to possess flounder:
  (1) Less than 13 inches total length taken from internal waters:
  (2) Less than 14 inches total length taken from the Atlantic Ocean in a commercial fishing operation;
  (3) Less than 15 inches total length taken from the Atlantic Ocean for recreational purposes.

(b) From October 1 through April 30, it shall be unlawful to use a trawl in the Atlantic Ocean within three miles of the ocean beach from the North Carolina/Virginia state line (35° 33'N) to Cape Lookout (34° 36'N) unless each trawl has a mesh length of

5 1/2 inches or larger diamond mesh (stretched) or 6 inches or larger square mesh (stretched) applied throughout the body, extension(s) and the cod end (tailbag) of the net except as provided in Paragraphs (h) and (i) of this Rule.

(c) License to Land Flounder from the Atlantic Ocean:

(1) It is unlawful to land more than 100 pounds per trip of flounder taken from the Atlantic Ocean unless the owner of the vessel or in the case of Land or Sell Licenses, the responsible party, has been issued a License to Land Flounder from the Atlantic Ocean and the vessel in use is the vessel specified on the License to Land Flounder from the Atlantic Ocean.

(2) It is unlawful for a fish dealer to purchase or offload more than 100 pounds of flounder taken from the Atlantic Ocean by a vessel whose owner, or in the case of Land or Sell Licenses, the responsible party, has not first procured a valid North Carolina License to Land Flounder from the Atlantic Ocean and the vessel in use is the vessel specified on the License to Land Flounder from the Atlantic Ocean.

(3) It is unlawful for any person to land flounder from the Atlantic Ocean under a License to Land Flounder from the Atlantic Ocean unless that person is the holder of the license or the master designated on the license.

(4) It is unlawful for any individual to land flounder from the Atlantic Ocean without having ready at hand for inspection a valid License to Land Flounder from the Atlantic Ocean, except as specified in Subparagraph (c)(1) of this Rule.

(d) All fish dealer transactions in flounder landed from the Atlantic Ocean must be conducted in accordance with the Atlantic Ocean Flounder Dealer Permits in 15A NCAC 3O .0503 and related rules in 15A NCAC 3O .0500.

(e) It is unlawful to transfer flounder taken from the Atlantic Ocean from one vessel to another.

(f) It is unlawful to possess more than eight flounder per person per day taken for recreational purposes from the Atlantic Ocean.

(g) Tailbag liners of any mesh size, the multiple use of two or more cod ends, or other netting material that in any way could restrict the legal size mesh shall not be used or possessed on the deck of a vessel in the Atlantic Ocean from October 1 through April 30 from the North Carolina/Virginia state line (36° 33’N) to Cape Lookout (34° 36’N).

(h) Trawls with a cod end mesh size smaller than described in Paragraph (b) of this Rule may be used or possessed on the deck of a vessel provided not more than 100 pounds of flounder per trip from May 1 through October 31 or more than 200 pounds from November 1 through April 30 is possessed aboard or landed from that vessel.

(i) Flynets are exempt from the flounder trawl mesh requirements if they meet the following definition:

(1) The net has large mesh in the wings that measure 8 inches to 64 inches;

(2) The first body section (belly) of the net has 35 or more meshes that are at least 8 inches; and

(3) The mesh decreases in size throughout the body of the net to as small as 2 inches or smaller towards the terminus of the net.

(j) Commercial Season.

(1) The North Carolina season for landing ocean-caught flounder shall open January 1 each year. If 70 percent of the quota allocated to North Carolina in accordance with the joint Mid-Atlantic Fishery Management Council/Atlantic States Marine Fisheries Commission Fishery Management Plan for Summer Flounder is projected to be taken, the Fisheries Director shall, by proclamation, close North Carolina ports to landing of flounder taken from the ocean.

(2) The season for landing flounder taken in the Atlantic Ocean shall reopen November 1 if any of the quota allocated to North Carolina in accordance with the joint Mid-Atlantic Fishery Management Council/Atlantic States Marine Fisheries Commission Fishery Management Plan for Summer Flounder remains. If after reopening, 100 percent of the quota allocated to North Carolina in accordance with the joint Mid-Atlantic Fishery Management Council/Atlantic States Marine Fisheries Commission Fishery Management Plan for Summer Flounder is projected to be taken prior to the end of the calendar year, the Fisheries Director shall, by proclamation, close North Carolina ports to landing of flounder taken from the ocean.

(3) During any closed season prior to November 1, vessels may land up to 100 pounds of flounder per trip taken from the Atlantic Ocean.

(k) The Fisheries Director may, by proclamation, establish trip limits for the taking of flounder from the Atlantic Ocean to assure that the individual state quota allocated to North Carolina in the joint Mid-Atlantic Fishery Management Council/Atlantic States Marine Fisheries Commission Fishery Management Plan for Summer Flounder is not exceeded.

5. GENERAL LIFE HISTORY

5.1 Description

Southern flounder are members of the family Bothidae (lefteye flounders), and as such, have both of their eyes on the left side of their body. Southern flounder are closely related and appear very similar to their congeners summer flounder and gulf flounder (*Paralichthys albigutta*). All three co-occur in the waters of North Carolina. Upon close examination, it is possible to distinguish between the three species based on physical characteristics (Figure 5.1). The southern flounder is typically dark in color with either lighter or darker blotches. Unlike either the summer or the gulf flounder, the southern flounder has no ocellated spots (dark spots ringed with a lighter color) (Ginsburg 1952).

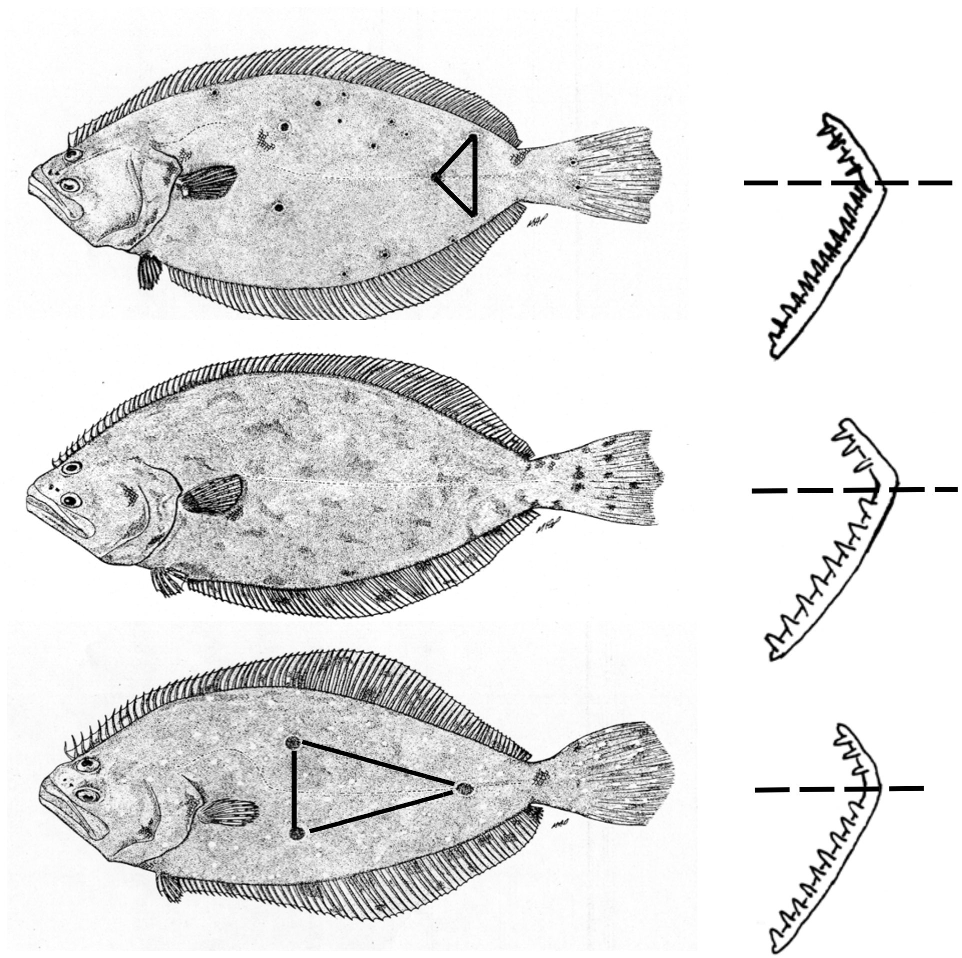
Flounder have a compressed body and spend much of their life lying on the bottom on their side, rather than swimming in the water column like other fish. Southern flounder lie on the right side of their body, which usually lacks pigmentation. The exposed left side of their body is dark and blotchy enabling the flounder to blend in with its surroundings. Both eyes and nostrils are located on the left or upper side of the head enabling the flounder to see and breath uninhibited while lying on its side. When a flounder swims, it remains on its side rather than righting itself in the water column like most fish.

5.2 Range and Distribution

Southern flounder inhabit the riverine, estuarine, and coastal waters along the East Coast of North America from Virginia south to the Loxahatchee River on the Atlantic Coast of Florida. They are also common along the Gulf of Mexico coastline from the Caloosahatchee River estuary in Florida west to Texas and south into northern Mexico. However, this species has yet to be found in waters surrounding the southern tip of Florida (Gilbert 1986). Blandon et al. (2001) have found that the South Atlantic population and the Gulf of Mexico population of southern flounder are not genetically distinct from one another based on samples tested from North Carolina, Florida, Alabama, Mississippi, and several sites in Texas.

5.3 Reproduction

Adult southern flounder migrate out of the rivers and estuaries in the late fall to spawn offshore in the warmer waters of the Gulf Stream between November and February (Reagan and Wingo 1985, Gilbert 1986, Daniels 2000). Southern flounder reach sexual maturity at around two years of age, the males being approximately 250 mm (10 inches) in length and weighing about 0.3 to 0.4 kg (0.7 to 0.9 pounds) and the females being



Summer Flounder

1. Ocellated spots form triangle near tail that points forward.

2. Gill rakers on lower portion of first gill arch number 13 to 18.

Southern Flounder

1. No ocellated spots. Dark and light blotches on dark background.

2. Gill rakers on lower portion of first gill arch number 8 to 11.

3. 63 to 74 anal rays.

Gulf Flounder

1. Ocellated spots form triangle pointing towards tail.

2. Gill rakers on lower portion of first gill arch number 9 to 12.

Figure 5.1. Physical characteristics of summer, southern, and gulf flounder that can be used to distinguish between the three species.

around 350 mm (14 inches) in length and weighing 0.8 to 1.0 kg (1.8 to 2.2 pounds) (Safrit and Schwartz 1998, Daniels 2000, Monaghan and Armstrong 2000). Fertilization occurs externally, the milt (sperm) and roe (unfertilized eggs) being broadcast into the water column (Pattillo et al. 1997).

5.4 Growth and Development

5.4.1 Embryos

The eggs have a diameter of approximately one millimeter, are nearly transparent, and contain a single oil droplet about 0.2 mm (0.008 inches) in diameter (Henderson-Arzapalo et al. 1988, Powell and Henley 1995, Daniels 2000). As a result, the eggs are highly buoyant, floating at or near the water surface (Arnold et al. 1977, Gilbert 1986). In the laboratory, eggs hatched following a 55-hour incubation period at 63° F (17° C) and 33 ppt salinity (Daniels 2000).

5.4.2 Larvae

Newly hatched larvae are about 2.1 mm (0.08 inches) notocord length (Powell and Henley 1995) and lack fins, eyes, and mouth, but develop these features during the five-day period between hatching and first-feeding (Daniels 2000). At the time of first-feeding, the yolk is completely absorbed. The oil droplet, however, is retained for several days longer (Daniels 2000). Metamorphosis into the post-larval stage occurs around day 30 at 63° F (17° C) in the laboratory, or between 30 to 70 days in the wild under variable conditions, when the larvae are approximately 8 to 11 mm (0.31 to 0.43 inches) total length (TL) (Arnold et al. 1977, Miller et al. 1991, Daniels 2000). This process generally takes two weeks to complete. During the process, the skull rotates as the eye on the right side of the head moves to the other side of the body to join the left eye. Based on laboratory results, cooler waters of around 63° F (17° C) are optimal conditions for egg hatching and larval survival and development. Conversely, temperature conditions for survival of the larvae through the metamorphosis process are optimum in warmer waters closer to 70° F (21° C) (Daniels 2000). Newly metamorphosed southern flounder are highly tolerant to low salinity. Twelve-week studies have shown that growth rates are not significantly different for southern flounder in water of 0 ppt versus 20 ppt up to a size of 60 g (2 oz) (Daniels 2000). As with other flatfish, the sex of the flounder is not determined until after metamorphosis occurs (Daniels 2000).

5.4.3 Juveniles

The minimum size of settled juvenile southern flounder, 10 to 15 mm (0.39 to 0.59 inches), overlaps that of the post-larvae for some fish (Pattillo et al. 1997). Following metamorphosis, female southern flounder grow approximately three times faster than males (Daniels 2000). Stokes (1977) estimated that the average size of southern flounder following the first and second year of growth was between 201 and 250 mm (7.91 to 9.84 inches) TL for males, and between 225 and 364 mm (8.86 to 14.33 inches) TL for females. In addition to sex-related size differences, size-at-age has also been found to be highly variable for southern flounder within each sex. According to Fitzhugh et al. (1996), southern flounder display a bimodal length-frequency distribution during the first year of growth that is independent of the sex of the fish. It is hypothesized that this divergence in growth rates, which generally occurs when the fish are between 75 to 100 mm (2.95 to 3.94 inches) TL, may be the result of variation in the onset of piscivory (the shift from eating primarily crustaceans to a diet consisting primarily of small fish).

5.4.4 Adults

In North Carolina, the oldest observed female southern flounder was seven years, and the oldest male aged was five years (NCDMF unpublished data). Wenner et al. (1990) reported similar maximum age differences between sexes for southern flounder from South Carolina, as did Stokes (1977) for the Gulf of Mexico. The oldest southern flounder reported coastwide was eight years for females and five years for males (Wenner et al. 1990).

Female southern flounder average between 2 to 4 pounds and 305 to 508 mm (12 to 20 inches), although fish between 10 to 12 pounds are not uncommon (McClane 1978, Dunaway 2001). Females have been known to obtain sizes up to just over 20 pounds and approximately 660 mm (26 inches) in length (McClane 1978, Dunaway 2001). Males achieve smaller sizes than females, rarely exceeding one pound or 330 mm (13 inches) in size (Wenner et al. 1990).

5.5 Diet and Food Habits

While still in the marine environment, larval southern flounder are found throughout the water column and feed on zooplankton prior to metamorphosis (Daniels 2000). In contrast, juvenile and adult southern flounder are demersal, lie-in-wait predators (Burke 1995). They feed by camouflaging themselves on the bottom and ambushing their prey. The flounder ambush the prey with a quick upward lunge and inhale it by creating a vacuum action with its mouth. Adult southern flounder feed almost exclusively on other fish, but will consume shrimp as well (Powell and Schwartz 1979). Southern flounder switch to piscivory when they are between 75 to 100 mm (2.95 to 3.94 inches) TL (Fitzhugh et al. 1996). As juveniles, a portion of their diet consists of epifaunal prey including mysids, amphipods, and calanoid copepods (Powell and Schwartz 1979, Burke 1995).

5.6 Migration and Movement Patterns

In North Carolina, adult southern flounder inhabit estuarine waters during the spring and summer, preferring the lower salinity portions of the sounds, rivers, and bays. In the fall, the adult flounder move out through the inlets into the ocean waters to spawn (Watterson and Monaghan 2001). These migrations coincide with falling water temperatures (Shepard 1986, Pattillo et al. 1997). This seasonal migration offshore, from September to November, is when the majority of the flounder are taken in the pound net, gill net, and gig fisheries. Juvenile and young, sexually immature adult flounder are believed to overwinter in the low salinity waters of the rivers and bays for the first two years of their life rather than migrating offshore (Powell and Schwartz 1977, Daniels 2000), as evident from crab trawl catches during the winter months in the Neuse, Pamlico, and Bay rivers (McKenna and Camp 1992, Lupton 1996, Hannah and Hannah 2000) and from winter catches in the gig fishery between White Oak River and the southern border of North Carolina (Watterson 2003).

Following the spawning period offshore, which extends from December to March (Monaghan and Armstrong 2000), the adult flounder return through the inlets to the estuaries and rivers. The migration of the flounder back inshore is typically less concentrated than the movement offshore, thus preventing pound nets and gill nets from harvesting the species in large numbers (Watterson and Monaghan 2001). There has also been speculation that a portion of the mature flounder may remain offshore following spawning, rather than returning to the rivers, sounds, and estuaries. While there is no empirical evidence to support this theory, it is currently the focus of ongoing research by the NCDMF. If true, then these flounder may essentially avoid fishing pressure, with the exception of the offshore spear fishery using SCUBA that is becoming increasingly popular.

Developing larval flounder remain in the offshore waters for between 30 to 60 days (Miller et al. 1991, Daniels 2000). Around the time of metamorphosis, the larval flounder are carried through the inlets into the estuaries during nighttime flood tides (Warlen and Burke 1990, Burke et al. 1991, Burke et al. 1998). Following metamorphosis, the juvenile flounder settle on tidal flats towards the head of the estuaries and move upstream to lower salinity riverine habitats (Burke et al. 1991).

6. STATUS OF THE FISHERIES

6.1 Commercial Fisheries

Southern flounder is the most economically important finfish species in North Carolina. Historically, summer flounder was the primary flounder species landed in the State. However, due to a decline in the fishery since the mid-1980s, followed by federal restrictions on harvest implemented in 1993, summer flounder landings have been reduced dramatically from historical levels (Figure 6.1). As the availability of summer flounder began to decline in the late 1980s, both the demand and value for flounder increased, resulting in an increase in southern flounder landings (Figure 6.2). In addition, the early 1990s saw the advent of the sushi and sashimi market, which substantially increased the value of live and bled jumbo flounder (Figure 6.2), as well as the development of a deepwater large mesh gill net fishery for flounder in Pamlico Sound. Subsequently, landings in both the pound net and the inshore gill net fisheries increased considerably (Figure 6.3). In 1993, a federal quota was established for summer flounder, which not only put a cap on the total pounds of summer flounder that could be landed in the State, but also resulted in an increase in both the ex-vessel value for all flounder and the amount of pressure being placed on the southern flounder stocks. Due to the culmination of these factors, southern flounder became the primary flounder species harvested in North Carolina during the 1990s, both in landings and value. During 1994-2002, landings have averaged approximately 3.8 million pounds.

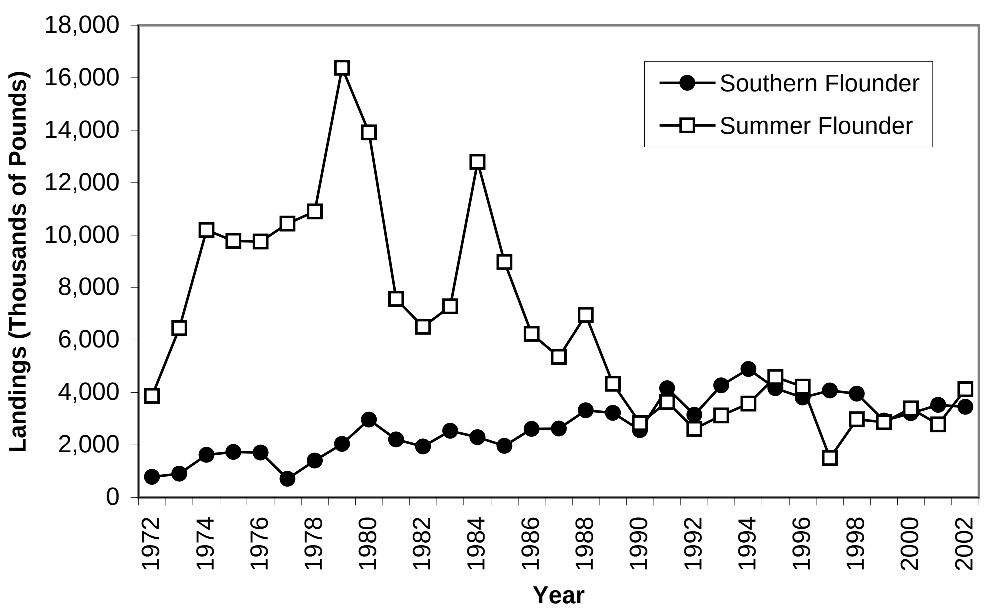


Figure 6.1. Commercial landings of southern and summer flounder during 1972-2002 (courtesy of the NCDMF Trip Ticket Program).

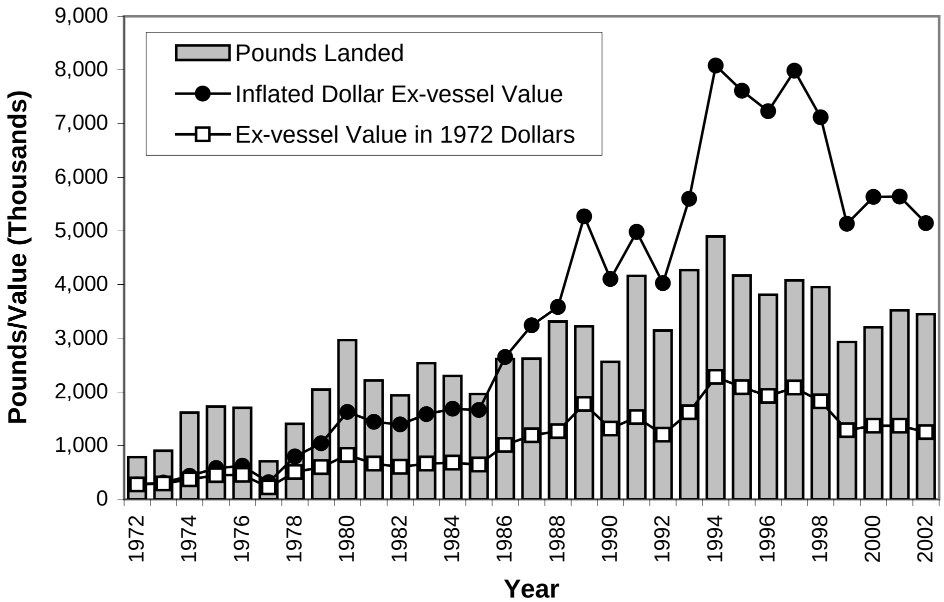


Figure 6.2. Commercial landings and ex-vessel value of southern flounder in North Carolina during 1972-2002 (courtesy of the NCDMF Trip Ticket Program).

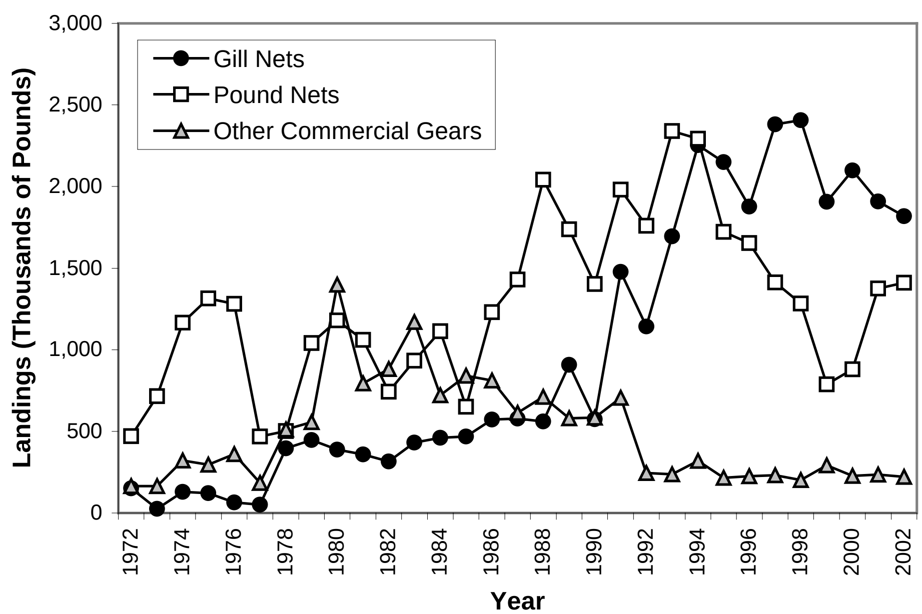


Figure 6.3. Commercial landings of southern flounder in North Carolina by pound nets, gill nets, and all other gears combined during 1972-2002 (courtesy of the NCDMF Trip Ticket Program).

6.1.1 Collection of Commercial Statistics

In North Carolina, the National Marine Fisheries Service (NMFS) initiated the collection of landings statistics on all commercial species in 1972. In 1978, the NCDMF, in conjunction with the NMFS, began collecting the data for the State, but still collected the data using the methods and format established by the NMFS. During this period, all landings data were collected on a voluntarily basis from seafood dealers and, as a result, some landings went unreported. In 1994, the NCDMF implemented the North Carolina Trip Ticket Program (NCTTP). Through this mandatory trip-level reporting program, all landings of commercial species within the State were captured on trip tickets by seafood dealers and submitted to the NCDMF on a monthly basis. Therefore, caution should be used when comparing data collected through the NCTTP with data collected prior to 1994.

Flounder landings reported through the NCTTP are not tabulated by species. To determine the commercial landings of each species, it is assumed that all flounder harvested from internal waters are southern flounder, while all flounder taken from the ocean are summer flounder. According to dependent sampling efforts of the commercial fish houses by the NCDMF, it has been determined that southern flounder make up less than one percent of the catch from ocean waters, while summer flounder and gulf flounder account for approximately two percent or less of the total flounder harvested from internal waters (NCDMF unpublished data).

6.1.2 Seasonal Harvest and Effort

Harvest and effort in the commercial southern flounder fishery in North Carolina begin around March or April, as the fish are moving into the sounds and estuaries from offshore, and remain moderate throughout the summer months (Figure 6.4). During September through November landings and effort peak, particularly in the pound net and gill net fisheries as the fish start to migrate through the sounds and estuaries to spawn offshore. On average during 1994-2002, 5% of the commercial landings of southern flounder have occurred in June, 6% in July, 8% in August, 19% in September, 34% in October, 19% in November, and 10% during the remaining months combined (January through May, and December).

6.1.3 Primary Waters Fished

The majority of the landings of southern flounder in North Carolina have historically come from Pamlico, Albemarle, and Core sounds (Figure 6.5). On average from 1972-2002, 45% (range of 31-62%) of the total State landings of southern flounder came from Pamlico Sound. Core Sound accounted for 17% (range of 6-57%), Albemarle Sound made up approximately 17% (range of 1-37%), and the remaining 21% (range of 3-31%) came from other waters in the State. During the last nine years, Pamlico Sound still comprised 42% (range of 36-53%) of the landings. The contribution of other waters, primarily the Croatan and Currituck sounds and the New and Pamlico rivers, to the

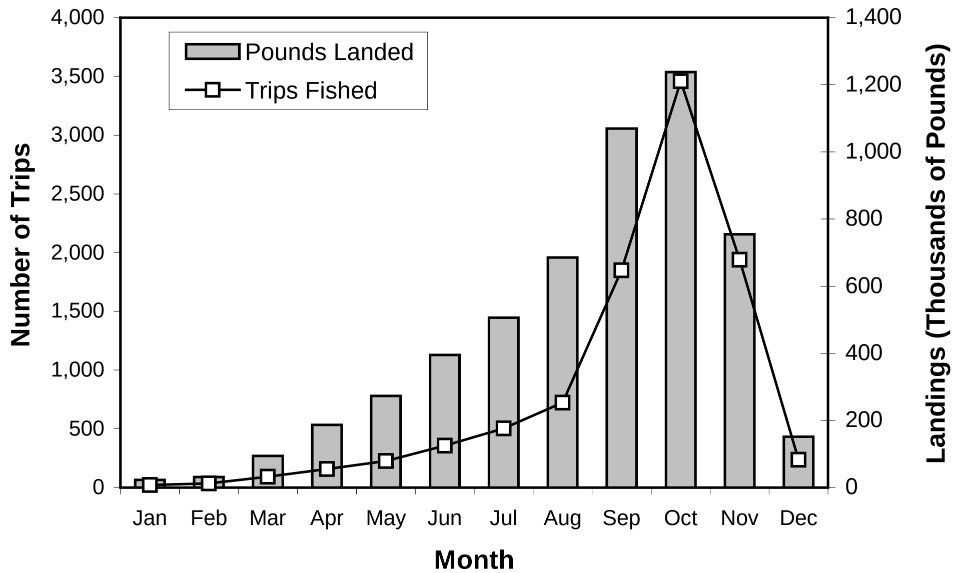


Figure 6.4. Average monthly commercial landings and number of directed flounder trips fished (trips with flounder landings exceeding 50 pounds) in North Carolina during 1994-2002 (courtesy of the NCDMF Trip Ticket Program).

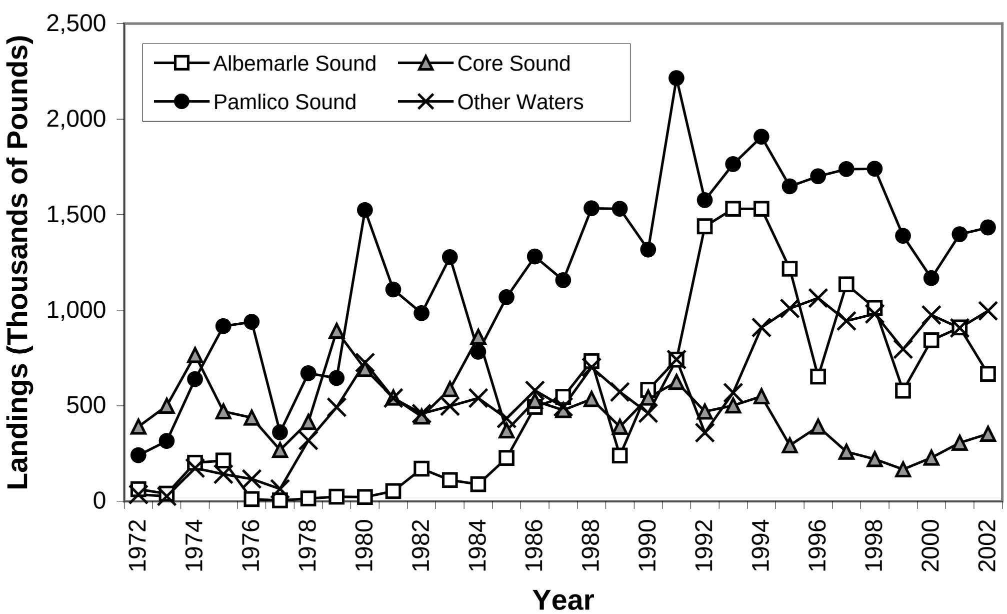


Figure 6.5. North Carolina commercial landings of southern flounder from Albemarle Sound, Pamlico Sound, Core Sound, and all other waters combined during 1972-2002 (courtesy of the NCDMF Trip Ticket Program).

overall harvest of the species increased over the last several years to a collective average of 24% (range of 20-31%). The harvest of southern flounder from the Albemarle Sound also increased in recent years, accounting for 26% (range of 17-31%) of the landings, while landings from Core Sound made up only 8% (range of 6-12%) of the total harvest.

6.1.4 Primary Counties of Landing

Carteret, Dare, and Hyde counties represent the areas of the State where most of the harvested southern flounder are landed (Figure 6.6). On average during 1972-2002, these three counties have accounted for 67% of the total harvest. Carteret County has historically been the dominant county in the State for southern flounder, comprising 35% (range of 16-73%) of the State's landings over the last three decades. However, during 1998 and 1999, landings in Carteret County exhibited a decline, largely as a result of the reduction in effort in the pound net fishery (Figure 6.3) and the hurricanes Bonnie in 1998 and Floyd, Dennis, and Irene in 1999. Landings have rebounded in 2002 to its highest level since 1996. Conversely, landings in both Dare and Hyde counties have increased in conjunction with the expanding gill net fishery in eastern Pamlico Sound and Albemarle Sound (Figures 6.3 and 6.6). On average, Dare County has historically accounted for 21% (range of 8-32%) of the State's landings, while Hyde County contributed 12% (range of 1-18%). The remaining coastal counties were responsible for the other 32% of the landings, which were primarily from Pasquotank, Tyrrell, Chowan, Pamlico, and Beaufort counties (Figure 6.6).

6.1.5 Primary Gears Fished

In North Carolina, pound nets and gill nets collectively account for an average of 82% of the total landings of southern flounder during 1972-2002, and 93% during the last eight years of the period (Figures 6.3 and 6.7). Due to the magnitude of the influence of these two gears on the harvest of the species, each fishery will be examined in detail. The gears that contribute to the remainder of the landings during 1972-2002 primarily include crab trawls, crab pots, shrimp trawls, and gigs (Figure 6.7).

6.1.5.1 Pound Net Fishery

The pound net fishery in North Carolina was historically the predominate fishery for catching southern flounder, reaching its zenith in pounds landed between 1988 and 1996 (Figure 6.8). However, landings of flounder within the gill net fishery began to rise in the late 1980s and early 1990s, and as of 1994, gill nets had surpassed pound nets for yielding the highest annual landings of the species (Figure 6.3).

Participation in the pound net fishery has been in decline since the early to mid-1990s (Table 6.1). As of 1995, there were approximately 394 active flounder pound net permits. By 2003, this number had decreased to 269. The same trend can be seen in the number of trips made within the fishery. In 1994, there were 4,632 trips made by pound netters landing southern flounder. The number of trips has declined since then to only

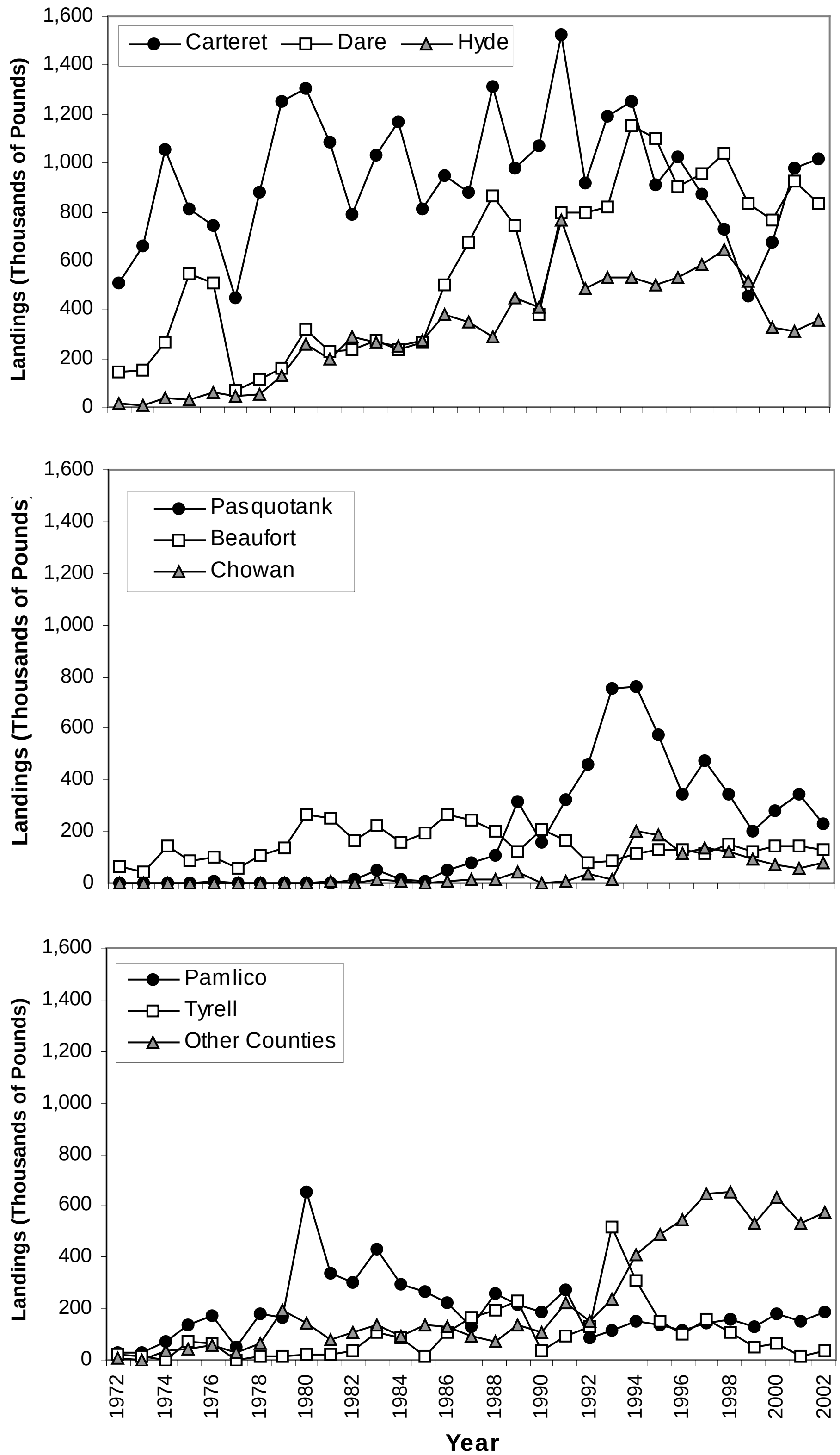


Figure 6.6. Commercial landings of southern flounder within select counties in North Carolina during 1972-2002 (courtesy of the NCDMF Trip Ticket Program).

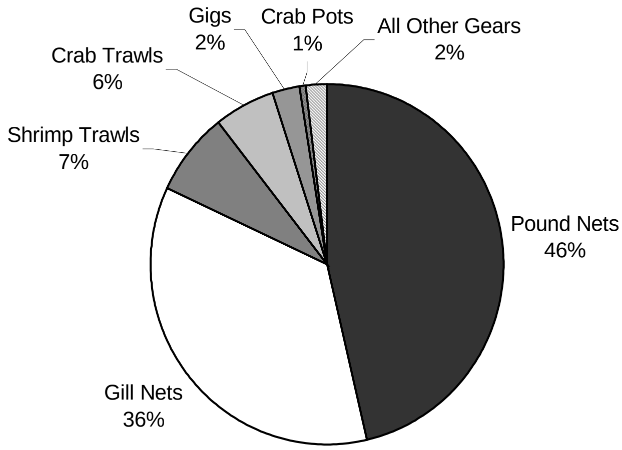


Figure 6.7. Gears used to catch flounder in North Carolina during 1972-2002 (courtesy of the NCDMF Trip Ticket Program).

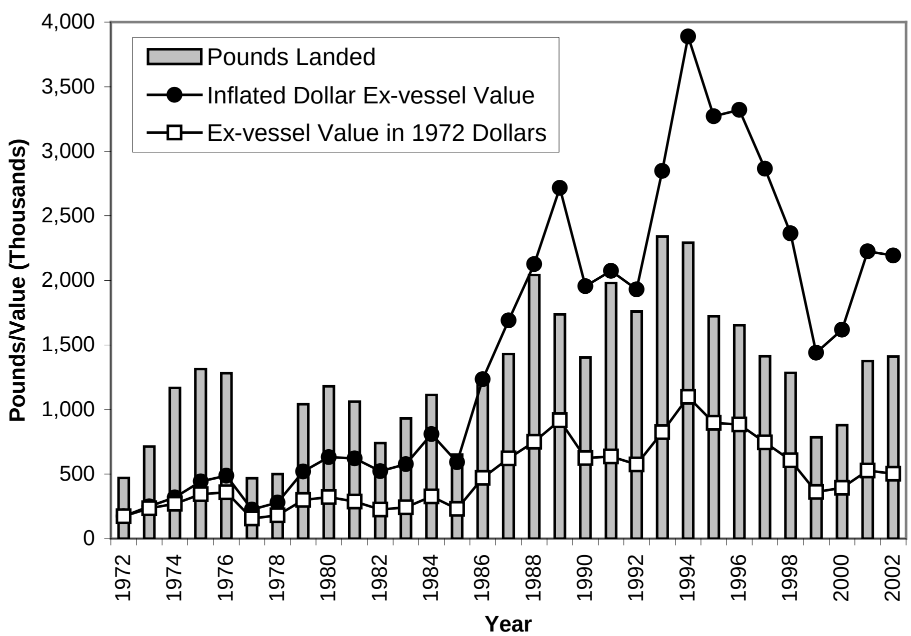


Figure 6.8. Commercial landings and ex-vessel value of southern flounder from pound nets during 1972-2002 (courtesy of the NCDMF Trip Ticket Program).

Table 6.1. The amount of active flounder pound net permits within each county during 1995-2003.

County	Year								
	1995	1996	1997	1998	1999	2000	2001	2002	2003
Beaufort		1	2	2	2	2	3	2	2
Camden	3	3	2	2	2	2	2	2	1
Carteret	238	224	220	216	215	197	163	145	140
Craven	1	1	1	1	1	1	1		1
Currituck	12	11	11	10	11	10	7	9	9
Dare	75	73	70	69	70	72	70	64	59
Hyde	50	52	55	53	54	53	51	44	44
Pasquotank	2	2							
Perquimans	1	1			1	3	3	2	2
Tyrrell	12	12	12	11	11	11	12	11	11
Total	394	380	373	364	367	351	312	279	269

1,951 trips in 2000. This decline was due in part to the expenses required to purchase and maintain a pound net, which can be fished in only one location, verses a gill net which can be moved to areas of high flounder concentration and are fairly inexpensive. However, 2001 and 2002 saw a resurgence in the pound net fishery with 2,392 and 2,503 trips made, respectively.

The flounder pound net fishery in North Carolina occurs primarily during September through December, with October being the peak month of the fishery (Figure 6.9). Pound nets typically catch the flounder as they are migrating out of the estuaries to spawn offshore, and the higher catches usually occur following periods of high winds or storm events.

During the 1970s, the landings of southern flounder from pound nets were relatively evenly split between Core and Pamlico sounds (Figure 6.10). However, since 1986, Pamlico Sound has accounted for the majority (61%, range of 49-73%) of the landings. During that same period, landings from Albemarle Sound pound nets also increased to levels rivaling that of Core Sound.

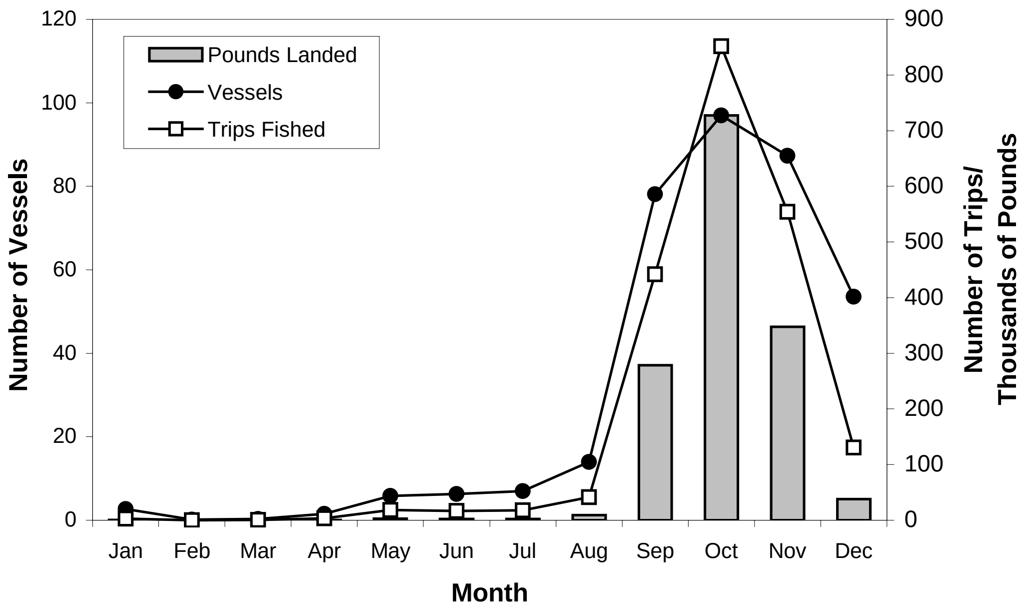


Figure 6.9. The number of commercial vessels fishing pound nets, the amount of directed trips (trips with flounder landings exceeding 50 pounds) made using the gear, and the amount of southern flounder landed on average during each month from 1994-2002 (courtesy of the NCDMF Trip Ticket Program).

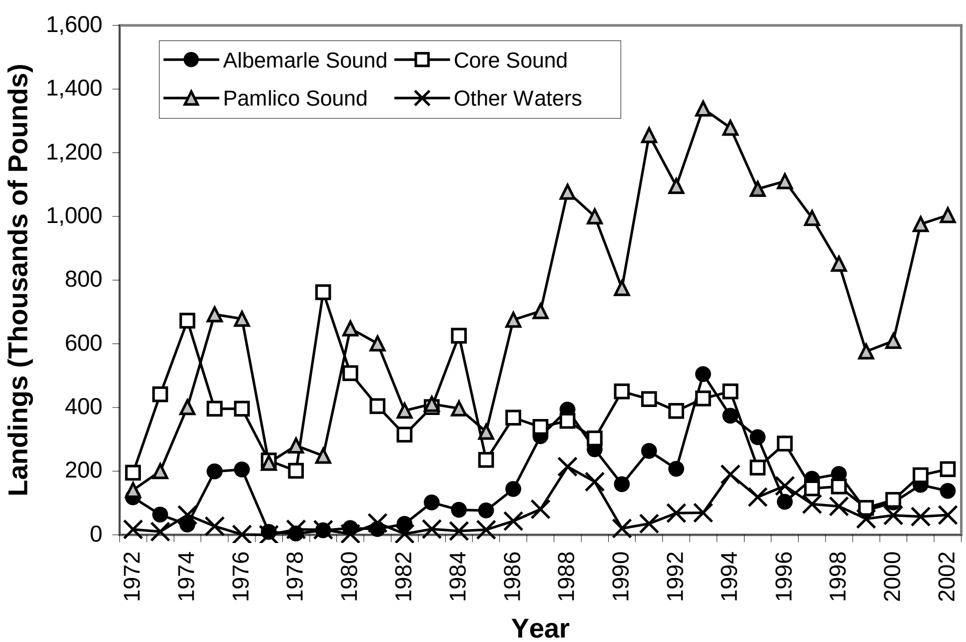


Figure 6.10. Commercial landings of southern flounder from pound nets from Albemarle, Core, and Pamlico sounds and all other waters combined during 1972-2002 (courtesy of the NCDMF Trip Ticket Program).

With the majority of the pound net landings of southern flounder coming from Core and Pamlico sounds, it follows that on average 54% (range of 38-89%) of these fish are sold in Carteret County, which is bordered by both bodies of water (Figure 6.11). The remaining landings in the fishery are primarily split between Dare and Hyde counties, both of which had shown an increasing trend in landings until recent years.

6.1.5.2 Gill Net Fishery

Landings of southern flounder in the estuarine gill net fishery in North Carolina were historically low until the early 1990s when the summer flounder fishery began to decline and demand increased for southern flounder (Figure 6.12). During this time, the State also saw a large influx of gill net fishers from Florida following the banning of nets in their waters. Estuarine gill nets quickly became the dominant gear landing the species, surpassing all other gears, including pound nets (Figure 6.3). However, beginning in 1999, the gill net fisheries in Pamlico Sound have faced increasingly stringent regulations and closures imposed on it by the NMFS due to the high number of sea turtle strandings believed to be associated with the fishery (Gearhart 2001, Gearhart 2002). In 2000, the NMFS closed the deep-water large mesh gill net fishery in Pamlico Sound between October 28 and December 31. Therefore, the landings from the gill net fishery during 2000 did not reflect what the landings would have been had the fishery been allowed to continue throughout the year.

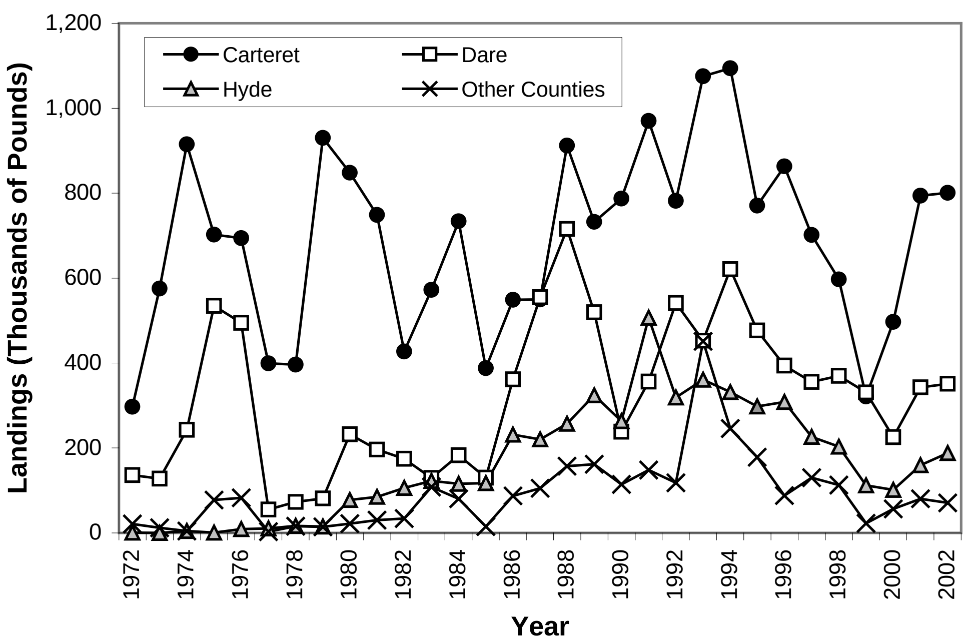


Figure 6.11. Commercial landings of southern flounder from pound nets within Carteret, Dare, Hyde, and all other counties combined during 1972-2001 (courtesy of the NCDMF Trip Ticket Program).

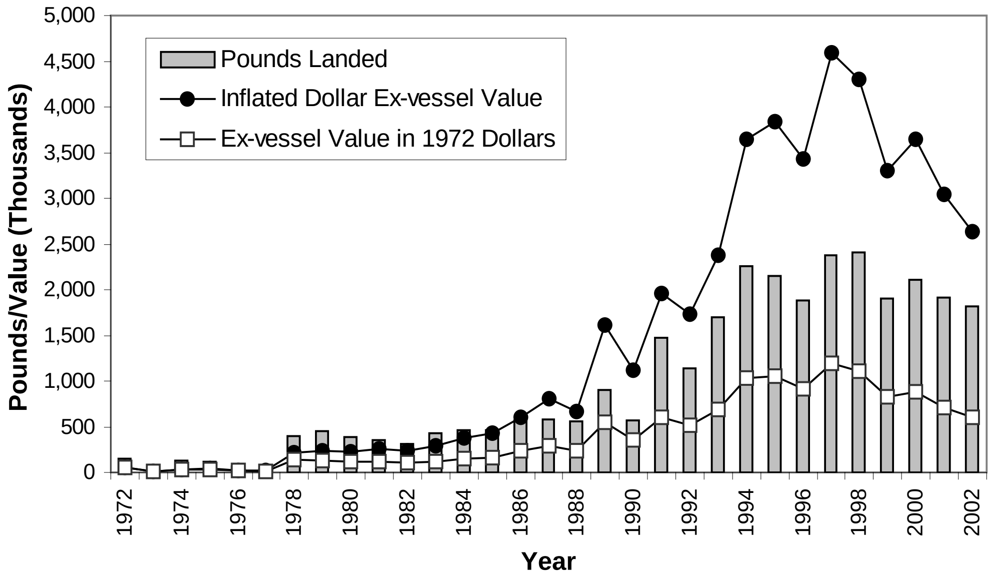
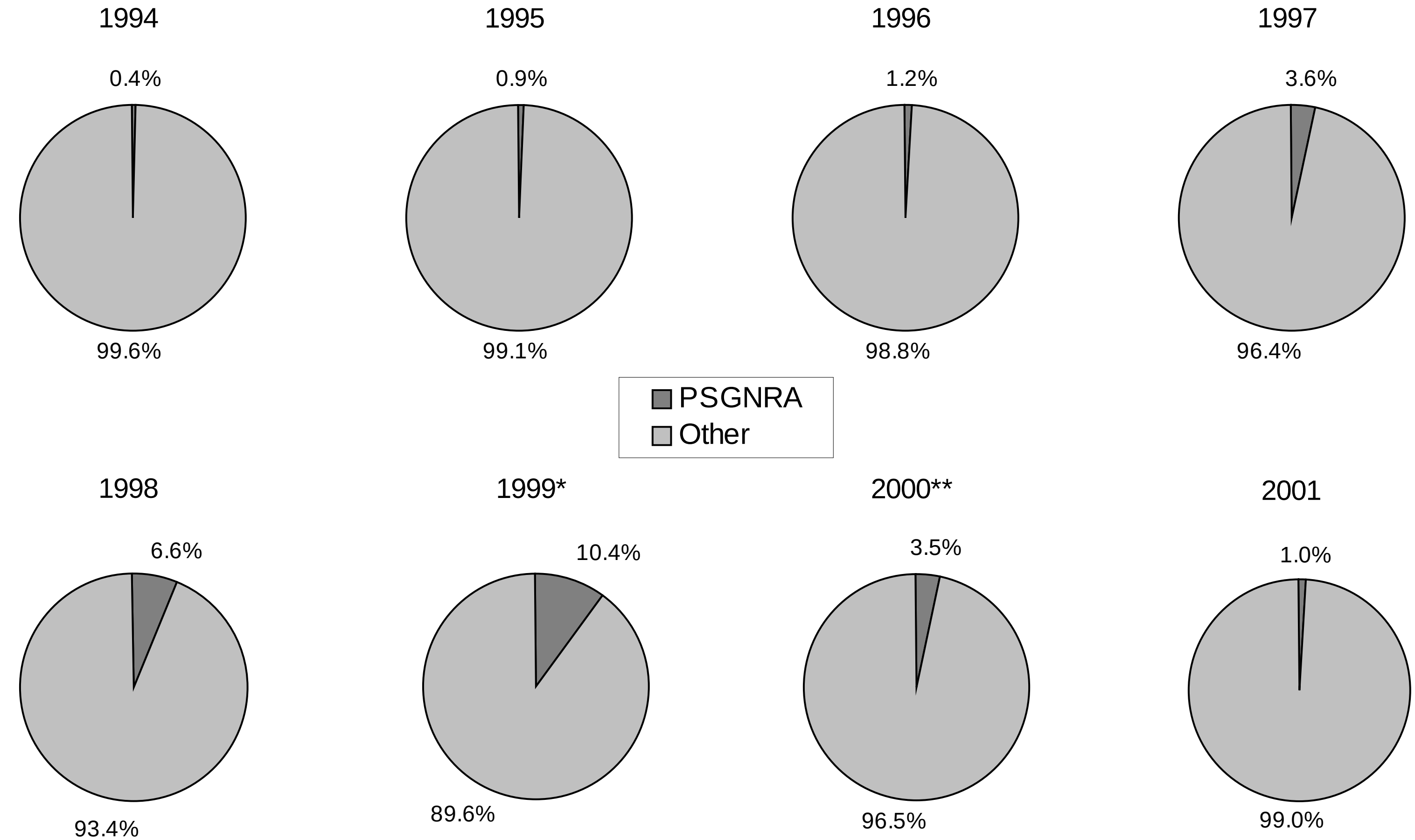


Figure 6.12. Commercial landings and ex-vessel value of southern flounder from the estuarine gill net fishery during 1972-2002 (courtesy of the NCDMF Trip Ticket Program).

In 2001, the NMFS closed the deep-water large mesh gill net fishery in Pamlico Sound between September 27 and December 15, and observers were required for a percentage of all other gill net trips in the area during the fall season when sea turtles are abundant (Gearhart 2002). There was much speculation over the impact that the closure of the deep-water large mesh gill net fishery in Pamlico Sound would have on the total landings of southern flounder. When examined, the deep-water fishery occurring during the period of the closure accounted for 10 percent of the total State landings during its peak year in 1999 (Figure 6.13). However, the magnitude of the landings in 1999 may reflect the reduction of landings in both the pound net and gill net fisheries during July through October due to the three hurricanes that occurred during the peak of the season. In contrast, the Pamlico Sound deep-water large mesh gill net fishery in 2000 was closed between October 28 and December 31. Therefore, the landings from the gill net fishery during 2000 did not reflect what the landings would have been allowed to continue throughout the year. Preceding 1997, when it began to really develop, the fishery only comprised about one percent of the total landings. Assuming the deep-water large mesh gill net fishery in Pamlico Sound would have continued to account for six to 10 percent of the total landings of southern flounder, the closure of this fishery could account for a significant reduction in the harvest of southern flounder from the State.

On average, effort and flounder landings within the gill net fishery begin to pick-up around April (Figure 6.14). As with the flounder pound net fishery, landings and effort in the gill net fishery peak from September to October as the fish are migrating to ocean waters to spawn. Participation in the fishery increases toward the peak of the season, as well, with more vessels becoming involved in the fishery. Following the peak, both



* The percentage of landings from the Pamlico Sound deep-water large mesh gill net fishery in 1999 are higher than typical due to the reduction in effort in the pound net and gill net fisheries during August through October as a result of hurricanes Irene, Dennis, and Floyd.

** Landings of southern flounder from the Pamlico Sound deep-water large mesh gill net fishery in 2000 were reduced due to the closure of the fishery from October 28 through December 31.

Figure 6.13. Portion of the total southern flounder commercial fishery that the Pamlico Sound deep-water large mesh gill net fishery comprised between 1994 and 2001. Data are based on landings from the fishery between September 27 and December 15 of each year (period of the closure of the fishery in 2001).

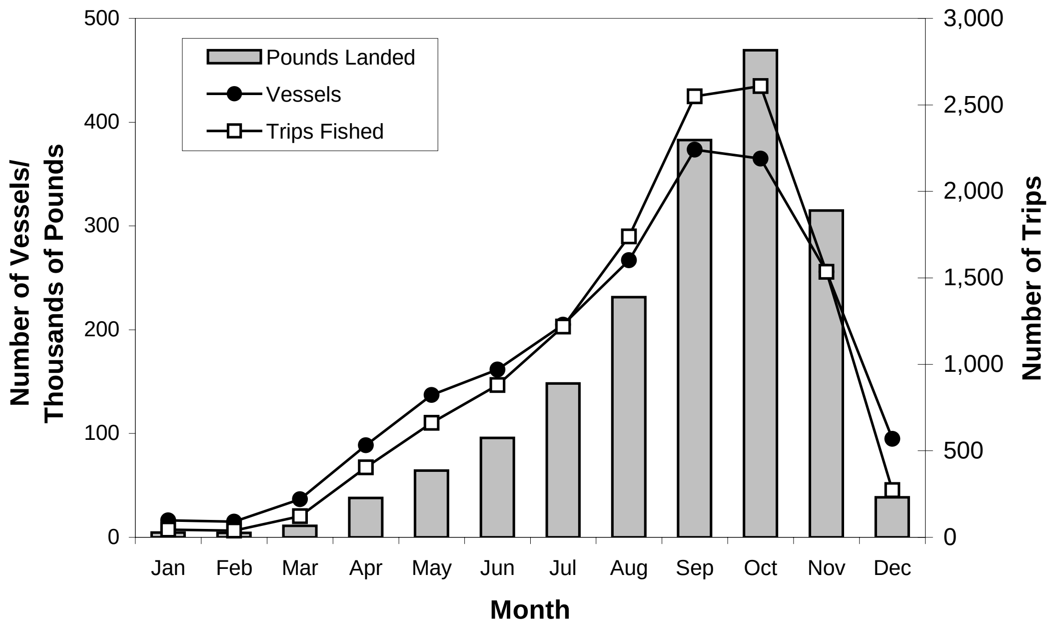


Figure 6.14. The number of commercial vessels fishing estuarine gill nets, the amount of directed trips (trips with flounder landings exceeding 50 pounds) made using the gear, and the amount of southern flounder landed on average during each month from 1994-2002 (courtesy of the NCDMF Trip Ticket Program).

landings and effort decline rapidly as the fish move offshore and are no longer available to the fishery.

As a whole, since the gill net fishery for southern flounder picked-up in the late 1980s, the majority of the landings have come from Albemarle Sound. This was particularly the case between the years of 1993 and 1998 when there was a large peak in the landings from that area, with the exception of 1996 when Hurricane Fran impacted the region (Figure 6.15). Pamlico Sound also contributes to a large portion of the gill net landings of southern flounder, exhibiting an increasing trend since the early 1990s. Other waters contributing significantly to the landings of the species include Pamlico River, Core Sound, New River, Currituck Sound, Neuse River, and Croatan Sound (Figure 6.15).

Most of the southern flounder caught in gill nets are sold in Pasquotank and Dare counties (Figure 6.16). Pasquotank County exhibited a sharp rise in landings between 1991 and 1994, but has been in relative decline since then. In contrast, landings in Dare County began to rise between 1991 and 1995, but rather than decline thereafter, landings have instead leveled off (Figure 6.16). Hyde County has exhibited an increasing trend in landings beginning around 1997; however, landings declined sharply in 2000 and 2001. A portion of this decline may be attributed to the closures of areas of Pamlico Sound to large mesh gill nets by the NMFS as a result of sea turtle interactions. Other counties contributing significantly to the landings include Carteret, Beaufort, Onslow, Pamlico, and Chowan counties.

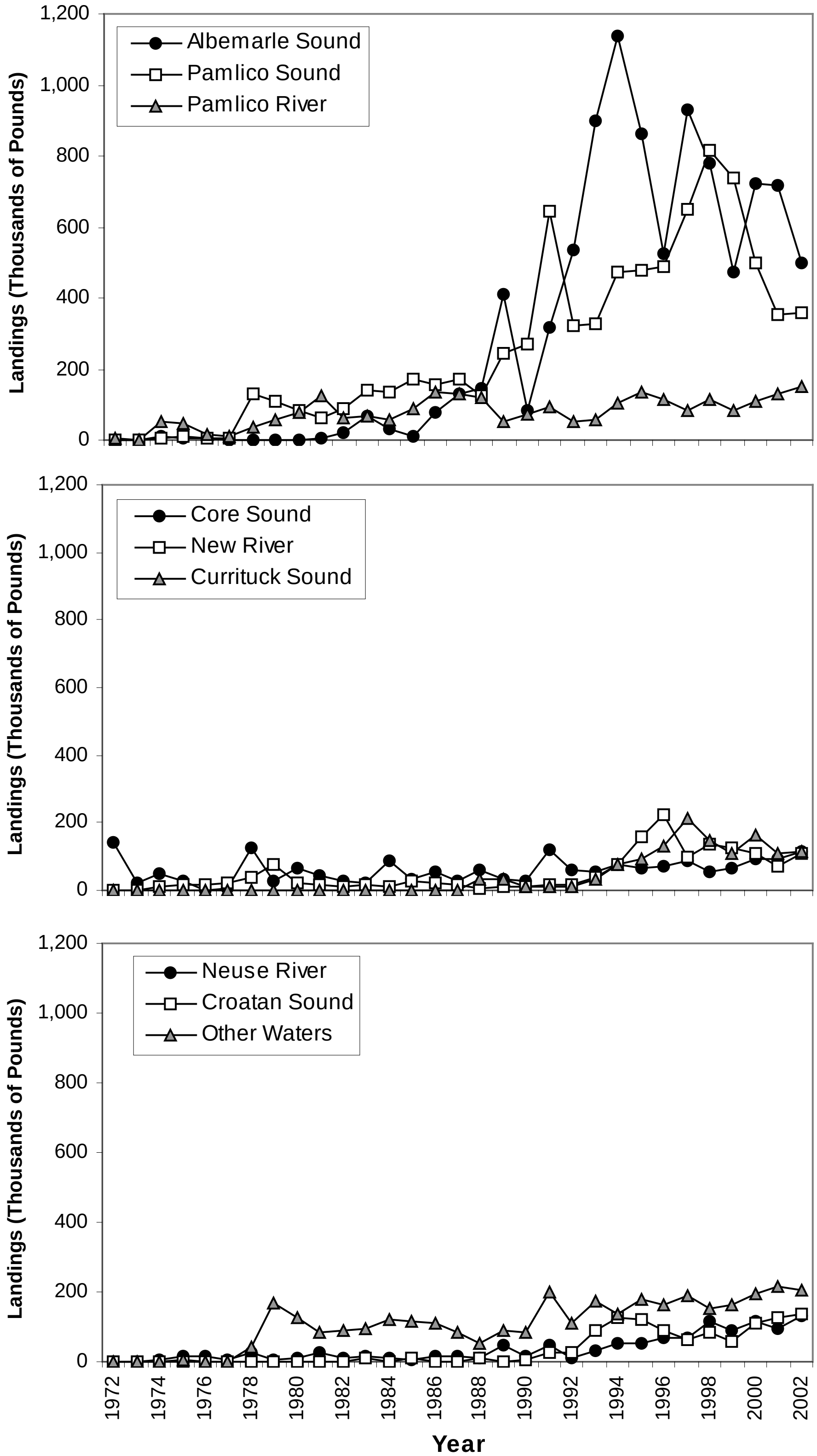


Figure 6.15. Commercial landings of southern flounder from estuarine gill nets from major waterbodies during 1972-2002 (courtesy of the NCDMF Trip Ticket Program).

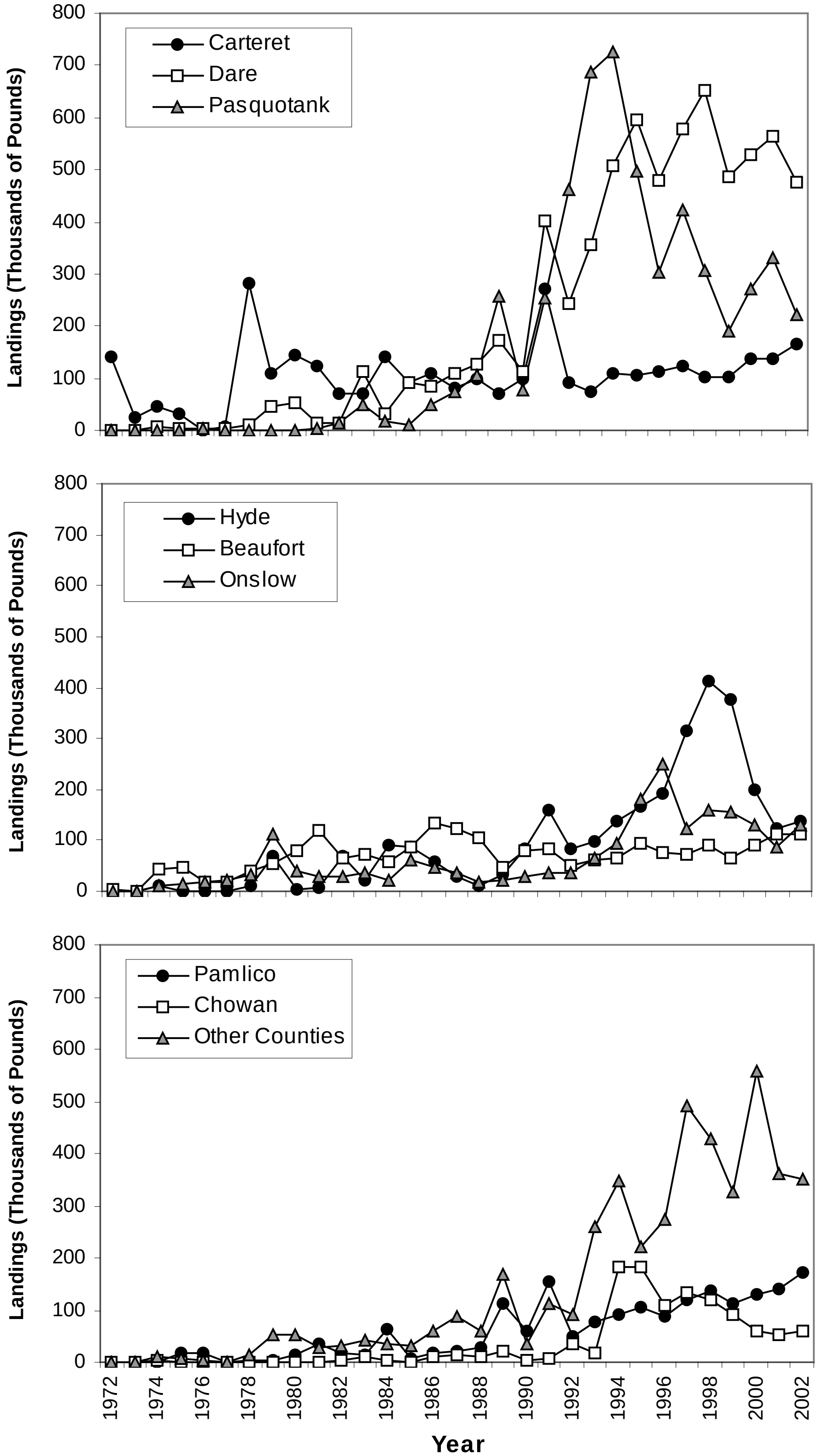


Figure 6.16. Commercial landings of southern flounder from estuarine gill nets from major counties during 1972-2002 (courtesy of the NCDMF Trip Ticket Program).

6.2 Recreational Fisheries

6.2.1 Collection of Recreational Statistics

Recreational statistics for the hook-and-line fisheries in each coastal state have been annually collected by the NMFS through the Marine Recreational Fisheries Statistics Survey (MRFSS) since 1979. However, until recently, there were no data collected on the other recreational fisheries occurring in North Carolina. These fisheries include gigs, gill nets, trawls, pots, and seines. In 2001 and 2002, efforts were made to quantify the effort and landings occurring within each of these fisheries using survey techniques.

6.2.1.1 Marine Recreational Fisheries Statistics Survey

The primary purpose of the MRFSS is to produce reliable estimates of catch, effort, and participation for recreational anglers at the regional level (Gulf of Mexico, South Atlantic, etc.). Because of the survey's inability to provide reliable catch statistics for the management of fisheries at the state level due to low sample sizes, the NCDMF increased the annual number of people interviewed by approximately 10 times (1,400 to 14,000) beginning in 1987. During 1999, approximately 20,000 anglers were interviewed. The NCDMF also implemented quality control measures needed to make better estimates of catch.

Data collected from the MRFSS provide the numbers of southern flounder landed by recreational anglers (Figure 6.17). The data presented are from surveys conducted with approximately 20,000 anglers per year. The MRFSS consists of telephone and on-site angler interviews. The telephone interviews are used to collect data on number of trips, fishing locations, and when the trips were made. Information on actual catch (species, number, weight, and length) is collected through on-site angler interviews. The data from both types of interviews are combined to produce estimates of total numbers and pounds of fish for North Carolina as a whole. Numbers and pounds presented in this section are estimates, not actual counts. Therefore, the level of precision, or the estimate's variability, varies. Statistical comparison between numbers must include the variability.

6.2.1.2 Assessment of the Recreational Gig Fishery

While the MRFSS obtains data on the catch and effort of recreational anglers, there is no ongoing program to collect data on the recreational gig fishery. Efforts were made to obtain information on the harvest and effort of recreational giggers by including gigs as a commercial gear on the Recreational Commercial Gear License (RCGL) implemented by the North Carolina General Assembly in July 1999. This license allows recreational fishermen to use limited amounts of commercial gear for recreational purposes. It also provides the NCDMF with a list of individuals fishing certain types of gear that may be sampled to obtain recreational effort and harvest statistics. However, the North Carolina Legislature decided to remove gigs from the license with Senate Bill 249, effectively eliminating the use of this license as a means to identify and survey recreational giggers.

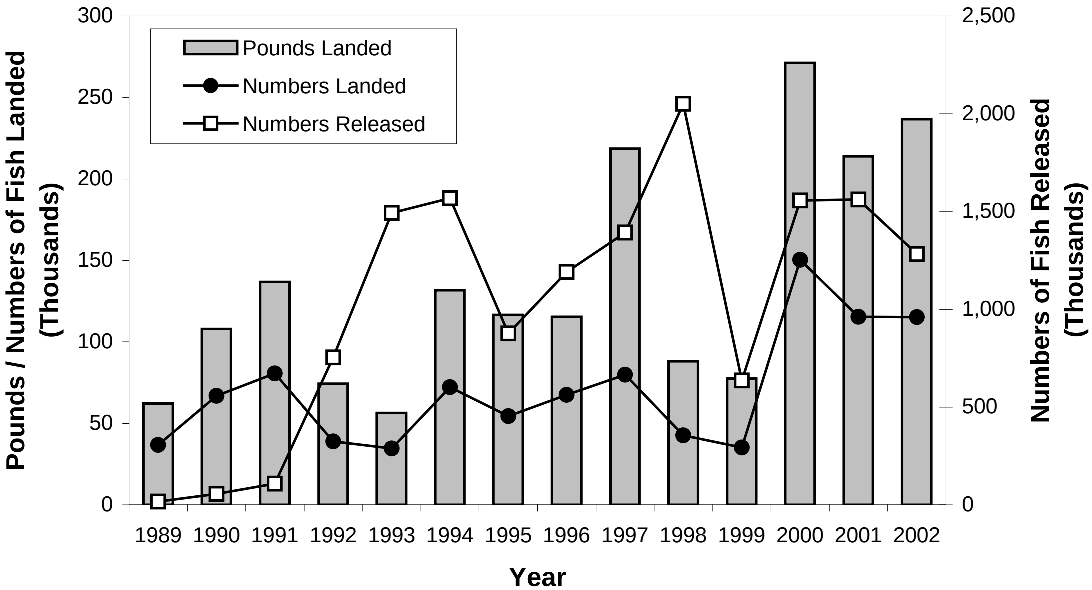


Figure 6.17. Pounds landed, numbers of fish landed, and numbers of fish released in the recreational hook-and-line southern flounder fishery in North Carolina during 1989-2002 (courtesy of the North Carolina MRFSS).

To determine the landings and effort in the recreational gig fishery, a survey was developed to quantify the landings and effort within the fishery (Watterson 2003). The survey consisted of three main components: access site surveys, on-the-water surveys, and nighttime flyovers. An access site refers to the point on shore from which a gigger begins his/her trip, typically a boat ramp or dock. All surveys were conducted between sunset and sunrise due to the nocturnal nature of the fishery. During the surveys, the giggers were asked a series of questions about their activities including the method of gigging, area fished, duration of trip, number of trips made in a year, number of people on the boat, disposition of catch, access site, and number of fish thrown back. All gigged fish in possession of the individual(s) being interviewed were identified to species, counted, and measured.

The surveys provided detailed trip level information about the gig fishery. Counts of boats actively engaged in gigging were obtained from nighttime flyovers of the coastal waters conducted twice a week during 2002. Combining the trip-level data from the surveys with the counts from the flyovers produced estimates of harvest from the gig fishery.

6.2.1.3 Recreational Commercial Gear License Survey

In 1999, the NCDMF began issuing the RCGL which allowed for the recreational use of limited amounts of the following commercial gears: seine, shrimp trawl, crab pot, eel pot, fish pot, shrimp pot, trotline, and gill net. RCGL holders must comply with all recreational size and bag limits and are not permitted to sell their catch.

Although the license was implemented in 1999, there were no data collected on the effort or landings from the gears licensed under the RCGL until 2001 (Wilson 2003). In 2001, an annual survey was implemented during which all RCGL holders were surveyed. Each RCGL holder was mailed a questionnaire to fill out concerning his or her fishing activities during the previous year. In addition to information concerning fishing practices, the questionnaire also included questions addressing demographics, experience, opinions on pertinent topics, and typical spending on fishing trips taken by RCGL holders. In 2002, the survey was adjusted to monthly interviews of a subset of the RCGL-holder population. From the results of the surveys, trip and catch extrapolations were made for each of the gear types.

6.2.2 Harvest and Seasonal Effort

6.2.2.1 Hook-and-Line Fishery (Anglers)

Anglers account for approximately six percent of the total southern flounder landings in the State (Figure 6.18). During 1989-2002, anglers harvested an average of 136,000 pounds (70,000 fish) per year, with individual years fluctuating between 56,405 pounds (34,588 fish) and 271,237 pounds (150,315 fish) (Figure 6.17). In 2000, nearly four times the amount of flounder was landed compared to 1999. However, the average weight of the fish landed in 2000 (1.8 pounds), was nearly half a pound less than those landed in 1999 (2.2 pounds).

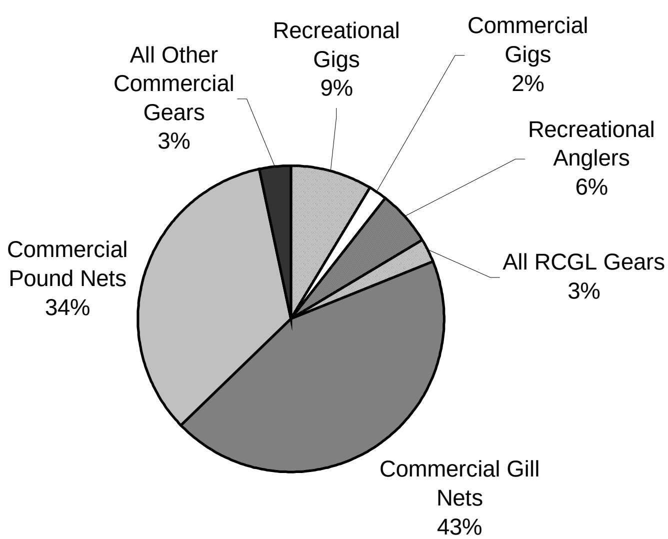


Figure 6.18. The percentage each fishery contributed to the total landings of southern flounder in North Carolina during 2002 (courtesy of the NCDMF).

According to data collected through North Carolina's MRFSS, only about seven percent (range of 3-11%) of the southern flounder caught by recreational anglers occur from

November to April (Figure 6.19). Catch usually begins to pick up around May and peaks between September and October. In contrast, releases of undersized flounder are generally highest in July and August and begin tapering off by September as more of the flounder begin approaching the legal size limit.

Flounder were targeted in approximately 7% of all recreational hook-and-line fishing trips in 2000 (Table 6.2). Most anglers are unable to distinguish between southern and summer flounder species. In MRFSS surveys, anglers' responses regarding targeting species are coded generically as flounder. Anglers are diverse in terms of modes of participation. MRFSS data estimate that approximately 78% of trips that targeted flounder were made from private boats (Table 6.2). The other anglers were estimated to have targeted flounder from manmade structures such as piers and from a beach or bank. Few (< 1%) anglers surveyed targeted flounder on a charter boat trip.

6.2.2.2 Gig Fishery

Based on the survey of the gig fishery conducted in 2002, the recreational landings of southern flounder for the State were approximately 361,539 pounds (183,284 fish). Recreational fishermen gig throughout the year (Figure 6.20). From December to March,

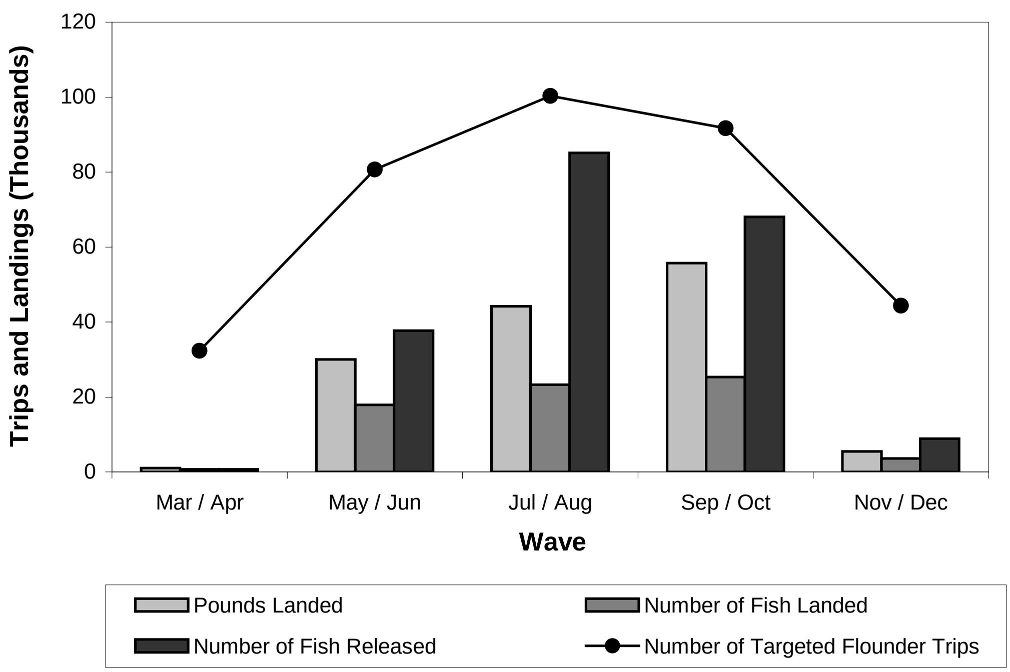


Figure 6.19. Pounds of fish landed, numbers of fish landed, numbers of fish released by wave (two-month periods), and number of trips fished in the recreational southern flounder hook-and-line fishery in North Carolina during 1989-2002 (courtesy of the North Carolina MRFSS).

Table 6.2. Recreational fishing trips targeting flounder by mode in North Carolina during 2000 (courtesy of the North Carolina MRFSS).

Mode of Fishing	Estimated Number Trips	Percent of Trips Made Targeting Flounder	Estimated Number of Targeted Flounder Trips
Charterboat	183,262	0.12	220
Manmade Structures	1,515,529	3.00	45,466
Private Boat	1,940,880	16.12	312,870
Beach/Bank	1,946,451	2.22	43,211
Total	5,586,122	7.19	401,767

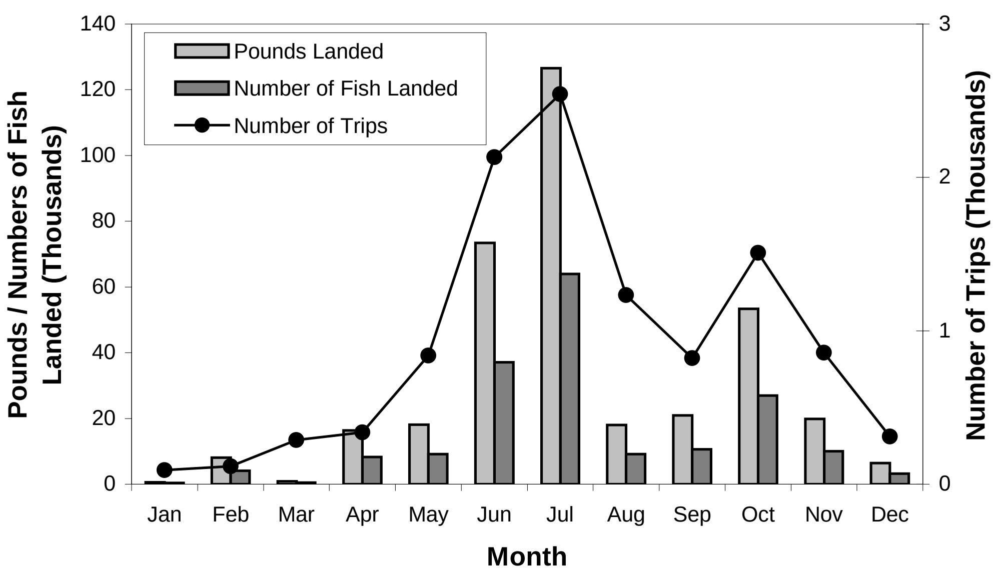


Figure 6.20. Pounds of fish landed, numbers of fish landed, and number of trips fished in the recreational southern flounder gig fishery in North Carolina during 2002 (Watterson 2003).

gigging activity is generally low. As the flounder begin moving inshore around late March and April, the gigging activity increases accordingly. The height of the fishery occurs in June and July, particularly in the southern part of the State. A smaller peak takes place around October as the flounder are beginning to move offshore for the winter, and begins to taper off in November.

6.2.2.3 RCGL Fisheries

Based on the RCGL survey results, there were four RCGL gears that landed southern flounder recreationally: large mesh gill nets, small mesh gill nets, shrimp trawls, and crab pots (Table 6.3). Overall in 2002, RCGL gears landed an estimated 97,474 pounds of southern flounder and accounted for three percent of the total landings for the State (Figure 6.18). The primary gear harvesting flounder was large mesh gill nets, which were responsible for 84% of the landings by RCGL gears (Table 6.3). While each of the gears tended to harvest flounder at different times of the year, both large and small mesh gill nets showed a similar trend to the hook-and-line and gig landings (Figures 6.21, 6.22, 6.23, and 6.24).

6.2.3 Economic Value of the Fisheries

6.2.3.1 Hook-and-Line Fishery

Economic analysis of the recreational hook-and-line fishery indicates that anglers generate significant revenues for the State of North Carolina. The MRFSS estimated that 132,842 trips targeting flounder (not species specific) were made in North Carolina in 2000. The MRFSS Southeast Economic Survey in 1999 estimated approximately two-thirds of trips by recreational flounder anglers were day trips. The remaining third involved at least one overnight stay. The average expenditure per day trip was $80.44 and $500.71 for overnight trips. The economic impact for recreational flounder angling cannot be separated from the entire impact of the trip where flounder were landed. For

Table 6.3. The number of trips and amount of landings within each of the RCGL fisheries that land flounder (Wilson 2003).

Gear Type	Number of Trips		Pounds Landed	
	Number	Percent	Number	Percent
Crab Pot	8,729	31.14	4,667	4.64
Large Mesh Gill Nets	14,394	51.35	84,316	83.89
Small Mesh Gill Nets	2,895	10.33	9,965	9.91
Shrimp Trawl	2,010	7.17	1,565	1.56
Total	28,028	100	100,513	100

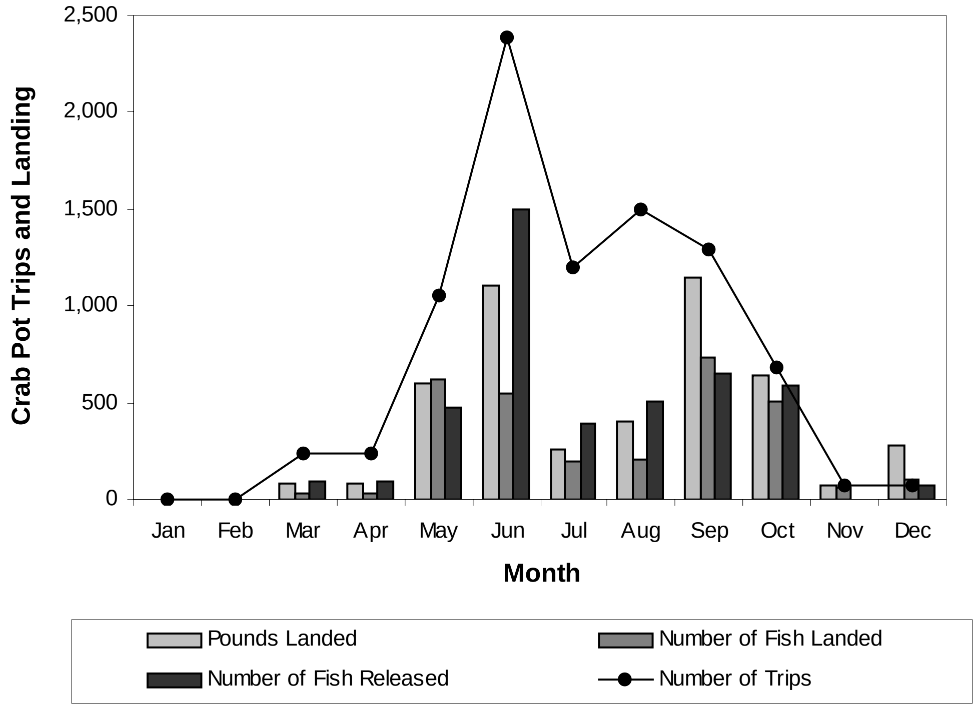


Figure 6.21. Pounds of flounder landed, numbers of flounder landed, numbers of flounder released, and number of trips fished in the recreational crab pot fishery in North Carolina during 2002 (Wilson 2003).

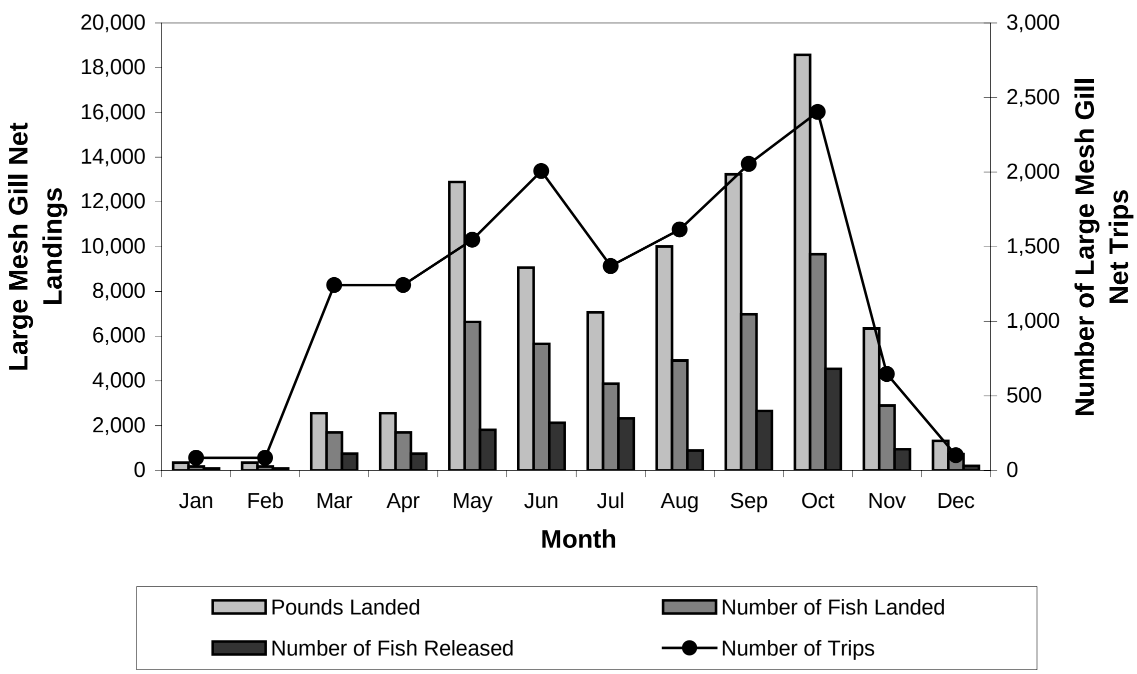


Figure 6.22. Pounds of flounder landed, numbers of flounder landed, numbers of flounder released, and number of trips fished in the recreational large mesh gill net fishery in North Carolina during 2002 (Wilson 2003).

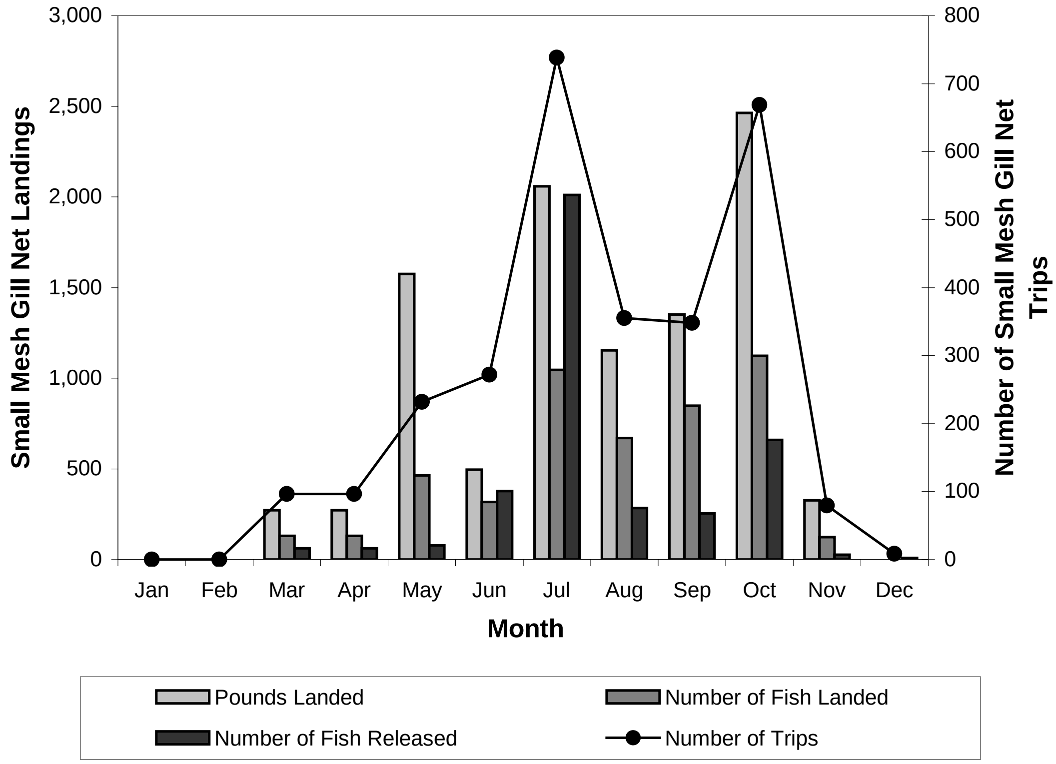


Figure 6.23. Pounds of flounder landed, numbers of flounder landed, numbers of flounder released, and number of trips fished in the recreational small mesh gill net fishery in North Carolina during 2002 (Wilson 2003).

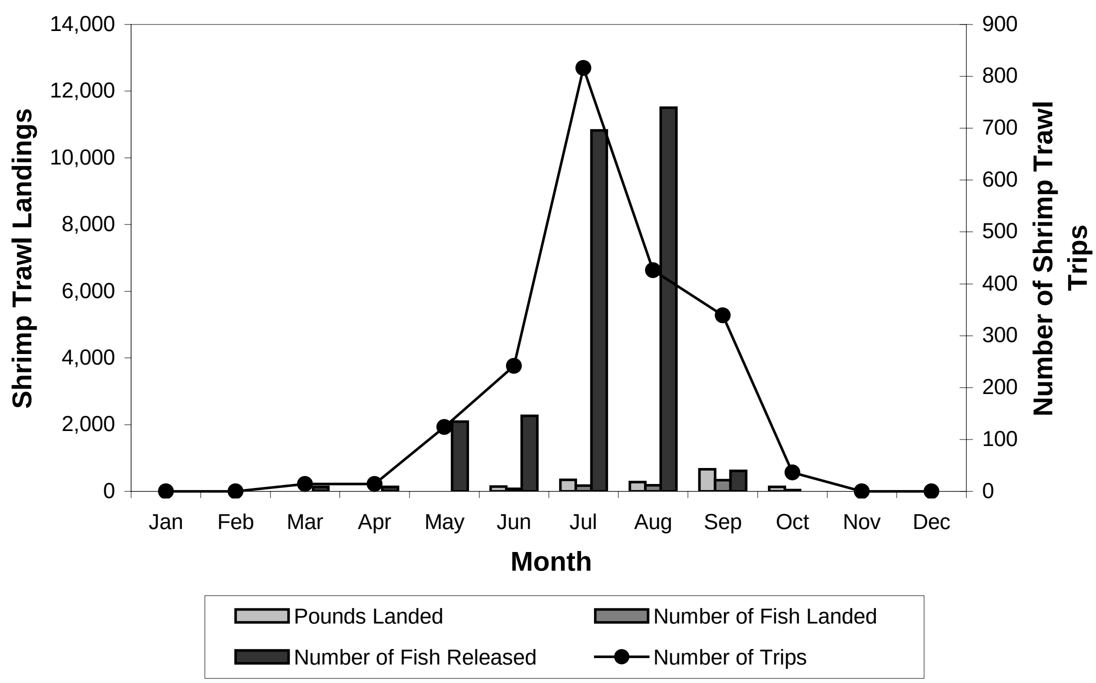


Figure 6.24. Pounds of flounder landed, numbers of flounder landed, numbers of flounder released, and number of trips fished in the recreational shrimp trawl fishery in North Carolina during 2002 (Wilson 2003).

example, the impacts include the value of other species of fish caught, other activities (i.e. beach trips), and the activities of other people who went on the trip but were not involved in fishing. The overall economic impact of trips where recreational angling for flounder took place was about $56.6 million (Table 6.4).

6.2.3.2 RCGL Fisheries

Table 6.5 gives an indication of the economic impact of the recreational southern flounder fishery by RCGL fishermen in 2002. The data are separated by those who made overnight trips as opposed to those who made day trips. The economic figures are based on an expansion of the actual values reported by RCGL fishermen and are considered the best available estimates. The economic impacts described below are those that can be attributed only to southern flounder landings by these fishermen. Additionally, on many trips, the fishermen and the non-fishers who accompanied them engaged in other, non-fishing activities.

The expenditures shown in Table 6.5 relate to the overall proportion of southern flounder landed. Other species were typically caught along with the southern flounder. The economic impact was based on the percent of southern flounder in the total pounds of all species kept by the fishermen on any given trip where southern flounder were landed. The total pounds of southern flounder caught was 97,474 out of a total 221,574 pounds harvested. Southern flounder accounted for 30.55% of the total catch on those trips.

Table 6.4. Estimated expenditures by anglers targeting flounder in North Carolina during 1999 (courtesy of the North Carolina MRFSS).

Expenditure Type	Day Trips	Multiple Night Trips	Total Expenditures
Food/Drinks	$38.96	$242.42	$281.38
Lodging	-----	$185.00	$185.00
Boat Fuel	$20.41	$20.23	$40.64
Bait	$10.08	$27.53	$37.61
Equipment, Ice, Fees	$10.99	$25.53	$36.52
Total	$80.44	$500.71	$581.15
Total Trips	178,424 (67.89%)	84,389 (32.11%)	262,813 (100%)
Total Expenditures	$14,352,426.56	$42,254,416.19	$56,606,842.75

Table 6.5. Economic impact of RCGL fishing trips for southern flounder in 2002 (NCDMF RCGL Survey Program).

Expenditure Type	Overnight Trips	Day Trips
# of trips	14,854	13,176
Ave. # of nights	3.3	-----
Ave. # of people on the trip	3.6	2.9
% of people on the trip who fished	86%	90%
Ave. cost of lodging/night	$36.43	-----
Ave. cost of food/trip	$76.59	$23.56
Ave. cost of ice/trip	$13.75	$6.36
Ave. cost of bait/trip	$20.68	$10.47
Ave. cost of equipment	$8.46	$7.42
Ave. cost of fuel and oil/trip	$62.92	$32.27
% of southern flounder landed	31%	31%
Ave. per trip impact	$80.78	$22.81

Expenditures by those who made overnight trips tend to be greater when compared to day trips because of the increased cost of lodging and meals. Additionally, more time is typically spent fishing on an overnight trip compared to a day trip, therefore, additional expenditures are noted for items such as bait and ice. An average overnight trip lasted just over three days and resulted in expenditures of $80.78 attributable to southern flounder. The total economic impact of overnight RCGL trips for southern flounder was nearly $1.2 million. The average expenditures for day trip fishermen were $22.81. The total economic impact of southern flounder caught on day trips was just over $300,000. The combined total economic impact of fishing for southern flounder by RCGL fishermen was approximately $1,500,372.

6.2.4 Primary Waters Fished

6.2.4.1 Hook-and-Line Fishery

On average between 1989 and 2002, over two-thirds of the catch of southern flounder by recreational anglers came from internal waters, while the remaining catch was taken from the ocean (Figure 6.25). Since 2000, the inshore landings have comprised a much larger proportion of the total catch than in previous years (Figure 6.25). The majority of the landings occur in the southern portion of the State below the Albemarle Sound, primarily around Hatteras Inlet, Core Sound near Cape Lookout, Bogue Sound, and Cape Fear. Figure 6.26 reflects the locations (boat ramps, shorelines, and fishing piers) where fishermen were interviewed and their catch sampled, but it does not necessarily reflect where the fishing actually occurred.

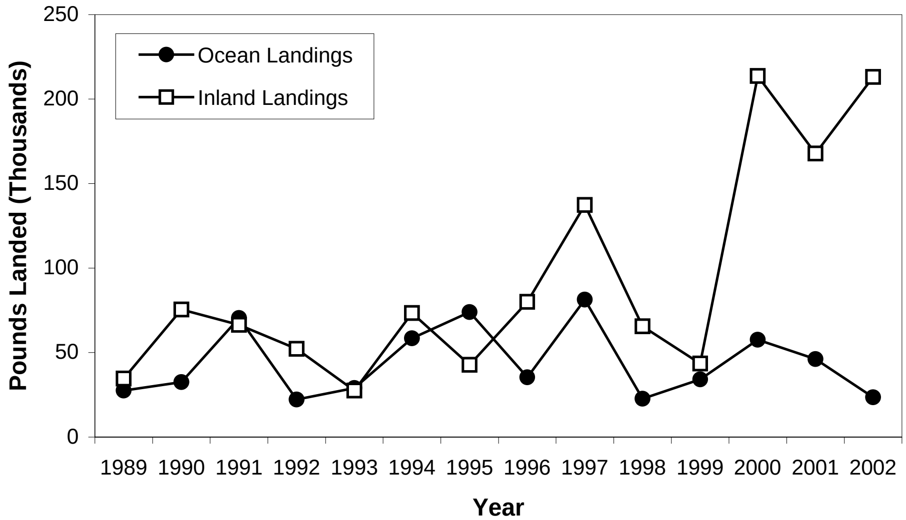


Figure 6.25. Pounds landed from either the ocean or inland waters in the recreational southern flounder fishery in North Carolina during 1989-2002 (courtesy of the North Carolina MRFSS).

6.2.4.2 Gig Fishery

Spatial trends in gigging effort were determined during the gigging survey from nighttime flyovers of the study area, Neuse River along the Intracoastal Waterway to the North Carolina/South Carolina state line (Table 6.6). In the colder months, December through March, effort was minimal and focused in the waters south of Bogue Sound. Throughout April and May effort increased and expanded along the coast to include Newport River, North River, and Core Sound. Peak effort in the fishery occurred between June and August in all waters south of Pamlico Sound, including the Neuse River. Effort began to slow in September, despite a small increase in October, and continued to taper off through December. Effort was not estimated in waters north of Neuse River and Core Sound.

6.2.4.3 RCGL Fisheries

To more easily describe the spatial distribution of RCGL flounder harvest, the coast was divide into four regions: Northern, Pamlico, Central, and Southern (Figure 6.27). Most of the effort and landings in the RCGL fisheries for southern flounder in 2002 occurred in the Pamlico region (Table 6.7). The Central and Southern regions displayed similar levels of effort and harvest, while the least amount came from the Northern regions (Table 6.7). The contributions from each region to the total poundage of flounder harvested by weight were 34.6%, 26.2%, 23.5% and 15.7% respectively for the Pamlico, Southern, Central, and Northern regions (Table 6.7).

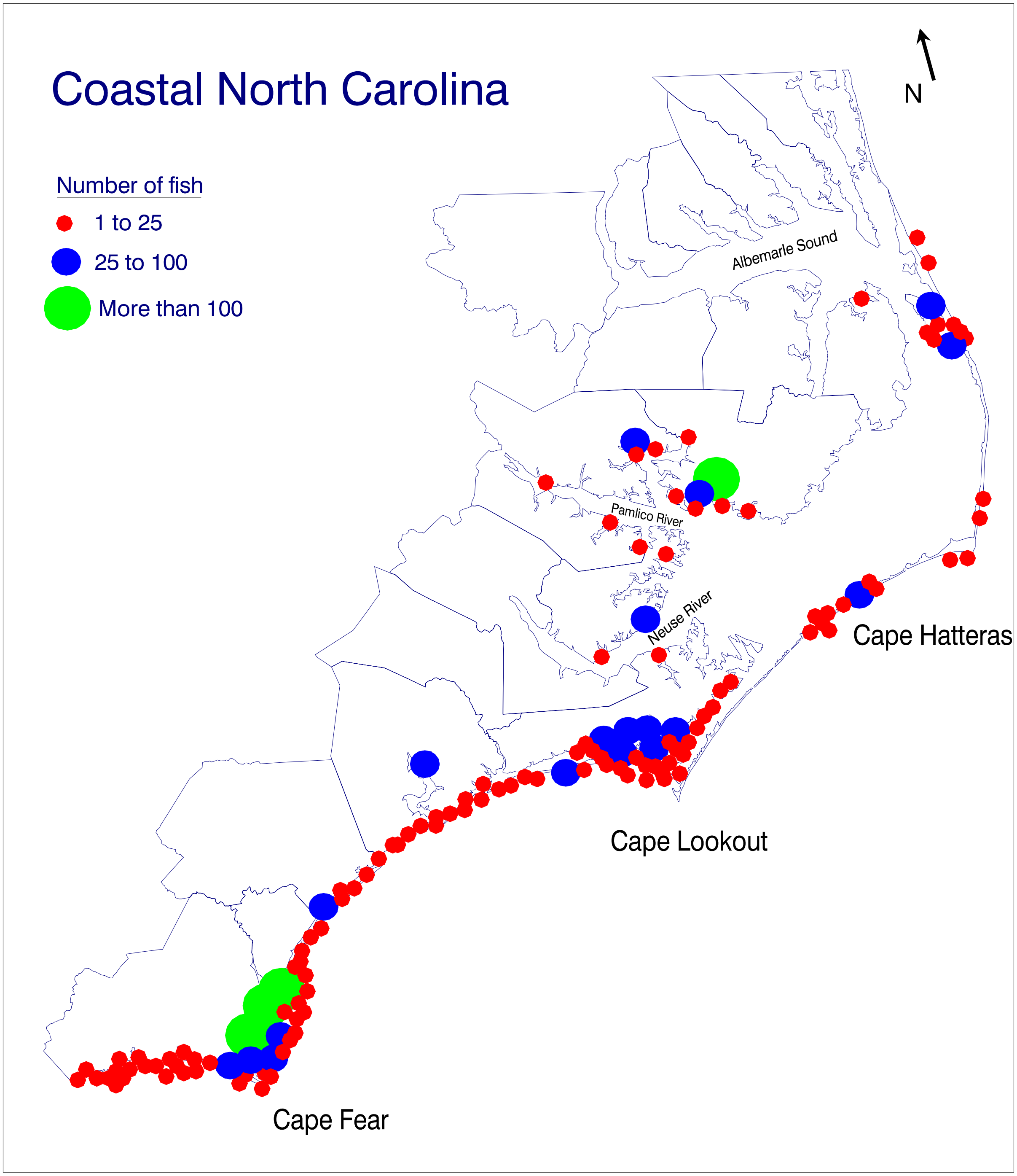


Figure 6.26. Distribution of the number of southern flounder landed and reported by recreational anglers by access site (total) in North Carolina during 1989-2002; southern flounder released are not included (courtesy of the North Carolina MRFSS).

Table 6.6. The mean nightly number of boats observed gigging within each area by month between March 2002 and January 2003 (Watterson 2003).

Location (from North to South)	2002										2003
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Neuse River				4	4	4	2				
Core Sound		1	3	6	8	11	4	4	2		
North River/Back Sound		2	3	14	9	7	5	4	3	1	
Newport River	1	1	3	9	7	2	1	3	2		
Bogue Sound	4	2	3	14	12	17	8	16	9	3	2
White Oak River						4	2	5			
Onslow Inland Waterway	3	3	6	21	12	13	12	10	10	4	2
New River	7	8	7	11	14	10	7	4	3	4	1
Stump Sound	2	1	3	6	8	6	2	3	2	2	3
Topsail Sound	4	10	7	13	15	14	8	11	8	6	3
Masonboro Sound	3	5	7	17	17	12	8	10	6	2	3
Cape Fear River			2	4	8	10	3	5	4		1
Brunswick Inland Waterway	2	6	3	11	11	11	5	9	6	2	4
Lockwood's Folly River	2	1	4	1	4	6	3	2	2		
Shallotte River	2		1	1	1	1	2	2			
Total	29	39	53	132	128	128	71	85	57	24	18

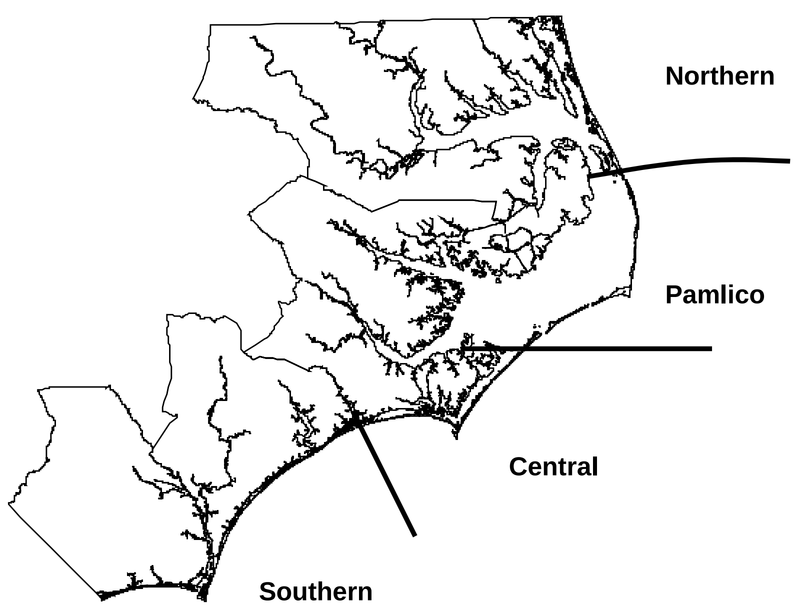


Figure 6.27. Regions used to describe the spatial distribution of flounder harvest from RCGL gears during 2002.

Table 6.7. **Regional contributions to the total RCGL harvest of flounder during 2002.**

Region	Number of Trips		Pounds Landed		Number Landed	
	Number	Percent	Pounds	Percent	Number	Percent
Northern	5,376	19.18	15,789	15.71	7,966	14.81
Pamlico	10,835	38.66	34,730	34.55	19,980	37.15
Central	6,288	22.43	23,639	23.52	12,138	22.57
Southern	5,530	19.73	26,355	26.22	13,701	25.47
Total	28,029	100.00	100,514	100.00	53,785	100.00

6.2.5 Primary Counties of Landings

6.2.5.1 Hook-and-Line Fishery

Most of the observed landings by recreational anglers occurred in Carteret, New Hanover, Hyde, and Brunswick counties (Figure 6.28). In Carteret County, most of the landings occurred around Bogue and Core sounds, as well as Newport and North rivers (Figure 6.26). In Brunswick and New Hanover counties, the landings came from primarily the Cape Fear River, Carolina Beach, and along the Intracoastal Waterway. In Hyde County, the fishing was centered around western Pamlico Sound and Ocracoke Island. Other counties where landings were prevalent include Dare and Onslow, counties.

6.2.5.2 Gig Fishery

Individuals from 31 counties were observed gigging in waters between Core Sound and the southern North Carolina border. The principle counties were Carteret and New Hanover, followed by Onslow, Brunswick, and Pender counties (Table 6.8). Other counties, in order of frequency of occurrence, included Duplin, Sampson, Craven, Johnston, Martin, Harnett, Wayne, Wake, Cumberland, Columbus, Guilford, Randolph, Wilson, Lenoir, Nash, Bladen, Davidson, Pitt, Rowan, Caldwell, Durham, Hoke, Jones, Lee, Stokes, and Surry (Table 6.8).

6.2.6 Recreational Landings in Other States

On the Atlantic Coast, southern flounder are landed recreationally by anglers from Virginia to Florida. Since 1989, recreational anglers in eastern Florida land more of the species than any other Atlantic coast state followed by North Carolina and South Carolina (Figure 6.29). Southern flounder harvested in North Carolina tend to be larger, which is due, in part, to North Carolina's larger minimum size limit for inshore flounder

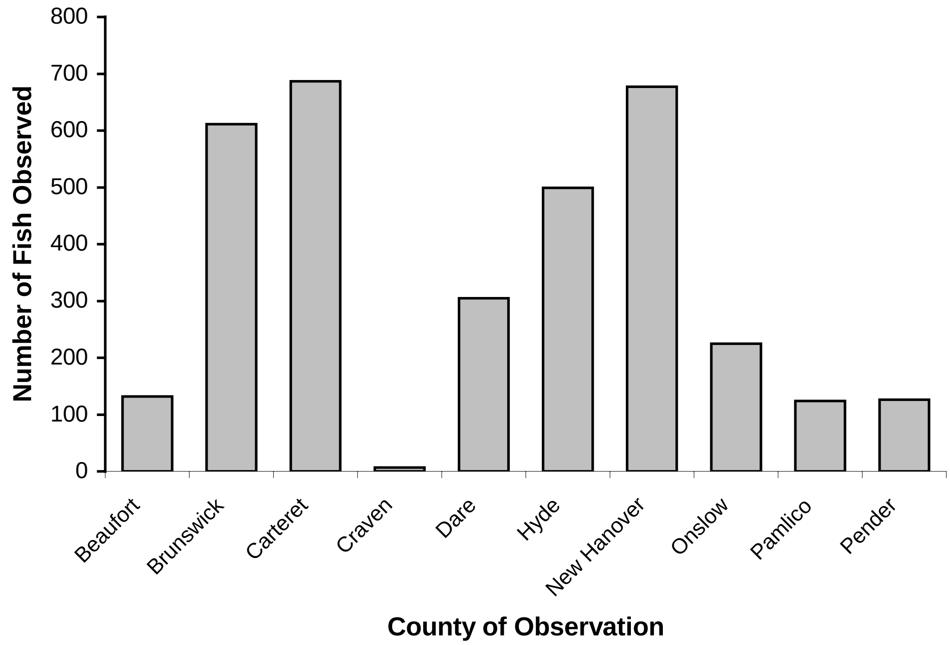


Figure 6.28. Number of fish observed by county in the recreational southern flounder fishery in North Carolina during 1994-2002 (courtesy of the North Carolina MRFSS).

(Table 6.9). The size limit for flounder in South Carolina, Georgia and Florida is 12 inches. Landings of southern flounder in Georgia have dropped off steadily since the mid-1990s, while Virginia has never had much of a fishery for the species due primarily to their low occurrence in the State. Instead, their regulations are designed for the management of summer flounder.

Unlike the landings, North Carolina leads all five states in releases of southern flounder (Figure 6.29). This may be due, in part, to the higher minimum size limit in North Carolina than South Carolina, Georgia and Florida. However, it may also be an artifact of North Carolina's increased sampling regime. On average, North Carolina conducts 13 times more interviews than required by the NMFS.

Table 6.8. The frequency and percentage of giggers interviewed that resided in each county of North Carolina.

County	Frequency	Percentage
Carteret	216	35.1
New Hanover	138	22.4
Onslow	63	10.2
Brunswick	37	6.0
Pender	35	5.7
Duplin	15	2.4
Sampson	12	1.9
Craven	11	1.8
Johnston	11	1.8
Martin	9	1.5
Harnett	8	1.3
Wayne	8	1.3
Wake	7	1.1
Cumberland	6	1.0
Columbia	5	0.8
Guilford	5	0.8
Randolph	5	0.8
Wilson	4	0.6
Lenoir	3	0.5
Nash	3	0.5
Bladen	2	0.3
Davidson	2	0.3
Pitt	2	0.3
Rowan	2	0.3
Caldwell	1	0.2
Durham	1	0.2
Hoke	1	0.2
Jones	1	0.2
Lee	1	0.2
Stoke	1	0.2
Surry	1	0.2

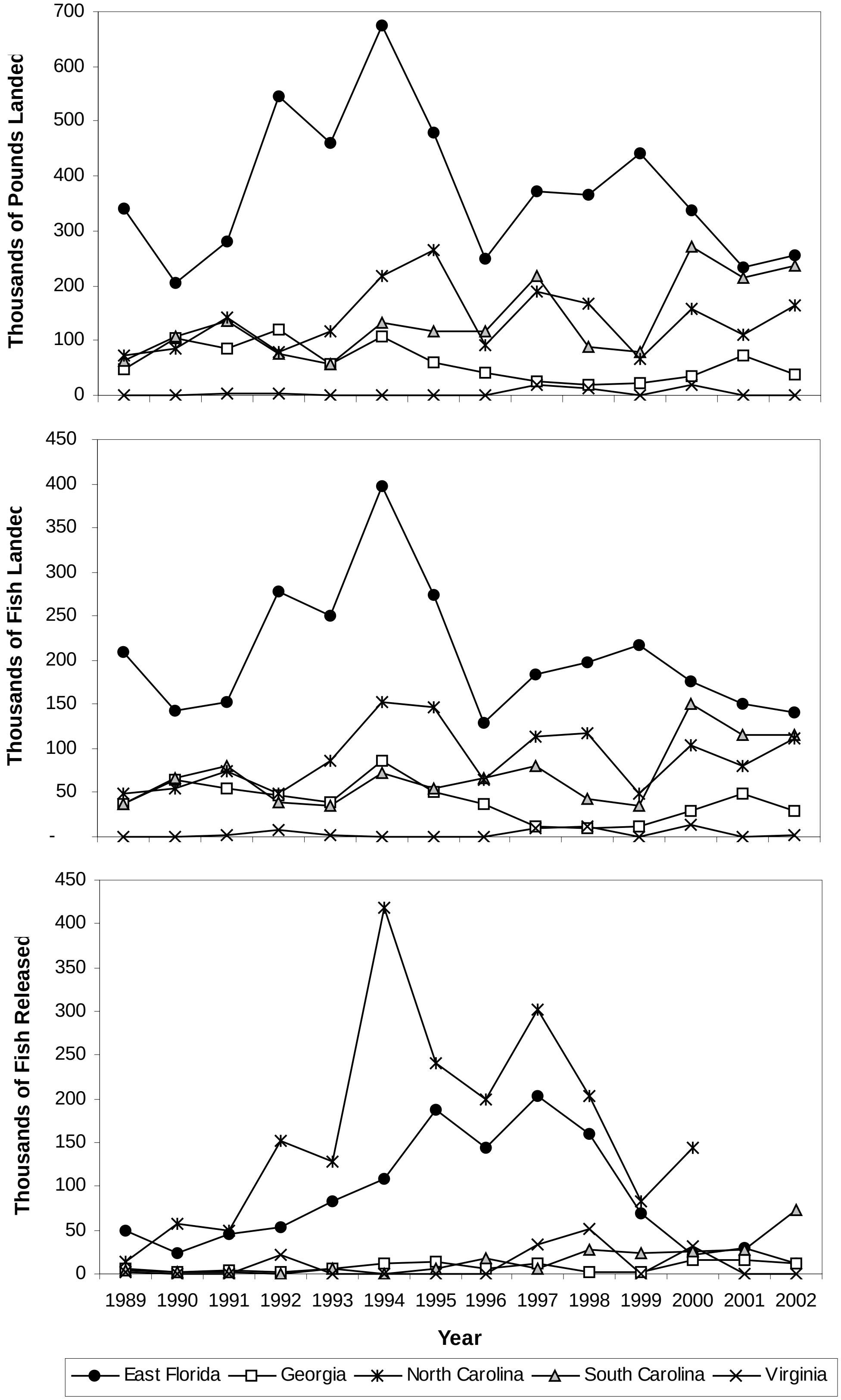


Figure 6.29. Annual pounds landed, numbers of fish landed, and numbers of fish released in the recreational southern flounder fishery for all Atlantic Coast states during 1989-2002 (courtesy of the MRFSS).

Table 6.9. A comparison of minimum size and creel limits on flounder between Florida, Georgia, North Carolina, South Carolina, and Virginia for 2004.

State	Minimum Size Limits	Creel Limits	Closed Season	License and Permit Requirements / Comments
Virginia	17 inches TL	6 fish / person / day	January 1 - March 28	Saltwater recreational fishing license required for specific fishery and area combinations.
North Carolina	**Ocean:** 14 inches TL **Internal:** 14 inches TL (13 inches TL western Pamlico Sound)	**Ocean:** 8 fish / person / day **Internal:** none	none	License needed to use commercial gear for recreational purposes.
South Carolina	12 inches TL	20 fish / person / day	none	Saltwater recreational fishing license required for specific fishery and area combinations. Gigging limits same as for hook & line.
Georgia	12 inches TL	15 fish / person / day	none	Saltwater recreational fishing license required for specific fishery and area combinations.
Florida	12 inches TL	10 fish / person / day	none	Saltwater recreational fishing license required for specific fishery and area combinations.

7. SOCIOECONOMIC CHARACTERISTICS OF THE FISHERIES

7.1 Commercial Fisheries

7.1.1 Economic Value of the Commercial Fisheries

7.1.1.1 Ex-vessel Value and Price

The ex-vessel value (the total landed dollar amount of a given species) of North Carolina's southern flounder landings increased steadily from 1972 through 1997. However, since 1997, the value has been decreasing (Figure 6.2). The decreases in value from year to year become even greater when combined with changes in consumer purchasing power (as a result of inflation, one dollar in 2000 had the purchasing power of about $.24 in 1972). From 1972 until 1994 the general trend had been towards more pounds landed. Since 1994, the trend has been towards landing fewer pounds per year (Figure 6.2). Controlling for inflation, the price per pound has remained fairly steady from 1972 to 2002 (Figure 6.2).

Based on trip ticket data submitted in the years 1997–2002, it can be seen that the number of trips that landed southern flounder have declined since the high in 1997-1998 (Table 7.1). And consequently, in most years, the total ex-vessel values decreased, as well. When holding the value of the dollar constant to the 1998 fiscal year (July 1997 – June 1998) value, the average value per trip increased slightly from the 1998 fiscal year to the 1999 fiscal year. The average value of flounder landed in a single trip in the 2000 fiscal year did not change from 1999; however, it dropped dramatically by 36% in fiscal year 2001. It increased in fiscal year 2002, but remained below the 1998 fiscal year value.

7.1.1.2 Market Grades

Southern flounder harvested in North Carolina are sold through licensed fish dealers according to the size of the fish, or the market grade. The dealers include fishermen reporting as dealers, wholesalers, processors, retailers, and restaurants. Most flounder sold to dealers are already dead. Typically, these flounder are sold whole or processed into fillets and other cuts to be resold directly to consumers or restaurants.

Market grades vary greatly throughout the State based on market conditions and dealer preference. Most of the southern flounder landings for the State are made up of medium (1-2 pounds) and large (2-4 pounds) fish (Figure 7.1). Jumbo flounder (greater than or equal to four pounds) are not as plentiful, and are generally reserved for the sashimi and sushi market, as explained below. Small flounder (less than one pound) in recent years are rare due to the size limits currently in place. The majority of southern flounder landings prior to the implementation of North Carolina's Trip Ticket Program in 1994 were recorded as mixed or unclassified flounder (Figure 7.1). With the implementation of the Trip Ticket Program, flounder market grades were routinely recorded and submitted by commercial seafood dealers on trip tickets to the NCDMF. During 1994-

Table 7.1. Southern flounder ex-vessel values by individual trips in North Carolina during 1997-2002 (courtesy of the NCDMF Trip Ticket Program).

	1997-1998			1998-1999			1999-2000			2000-2001			2001-2002		
	Ex-vessel Value	Number of Trips	Average Value Per Trip	Ex-vessel Value	Number of Trips	Average Value Per Trip	Ex-vessel Value	Number of Trips	Average Value Per Trip	Ex-vessel Value	Number of Trips	Average Value Per Trip	Ex-vessel Value	Number of Trips	Average Value Per Trip
$1-100	$953,577	27,791	$34	$807,178	24,131	$33	$481,529	13,205	$36	$799,052	25,004	$32	$768,915	23,492	$33
$101-200	$1,046,353	7,378	$142	$973,925	6,838	$142	$595,076	4,194	$142	$902,270	6,377	$141	$956,995	6,744	$142
$201-500	$1,718,409	5,613	$306	$1,675,737	5,497	$305	$974,984	3,187	$306	$1,363,292	4,449	$306	$1,286,801	4,276	$301
$501-1,000	$1,203,381	1,741	$691	$1,121,619	1,614	$695	$634,216	916	$692	$940,123	1,370	$686	$749,349	1,092	$686
$1,001-2,000	$1,001,421	724	$1,383	$990,868	714	$1,388	$597,098	444	$1,345	$614,601	453	$1,357	$627,154	451	$1,391
$2,001-3,000	$398,377	167	$2,385	$452,296	189	$2,393	$250,177	103	$2,429	$266,145	108	$2,464	$381,829	155	$2,463
$3,001-4,000	$299,005	86	$3,477	$315,713	93	$3,395	$169,274	49	$3,455	$147,090	43	$3,421	$266,749	77	$3,464
$4,001-5,000	$254,006	57	$4,456	$164,284	37	$4,440	$126,510	28	$4,518	$127,316	28	$4,547	$215,579	49	$4,400
$5,001-10,000	$611,995	92	$6,652	$526,776	79	$6,668	$359,895	54	$6,665	$283,825	41	$6,923	$417,057	64	$6,517
> $10,000	$128,863	9	$14,318	$245,877	19	$12,941	$77,094	6	$12,849	$149,177	5	$29,835	$93,639	7	$13,377
Totals	$7,615,387	43,658	$174	$7,274,273	39,211	$186	$4,265,853	22,186	$192	$5,592,892	37,878	$148	$5,764,067	36,407	$158
In 1997 Dollars	$7,615,387	43,658	$174	$7,133,880	39,211	$182	$4,033,364	22,186	$182	$5,068,838	37,878	$134	$5,142,700	36,407	$141

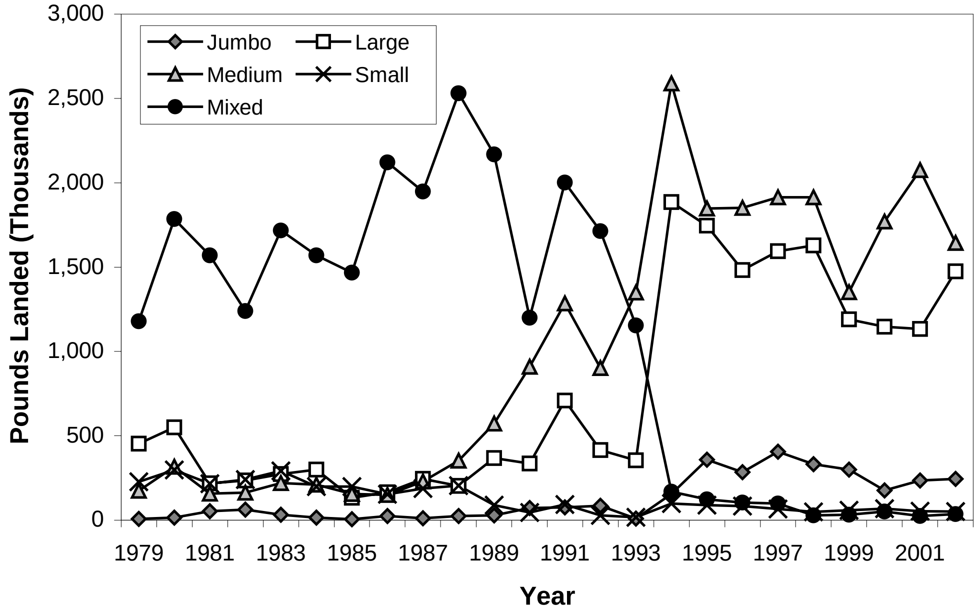


Figure 7.1. Commercial landings of southern flounder in North Carolina by market grades during 1979-2002 (courtesy of the NCDMF Trip Ticket Program).

2002, fish of medium grade represented an average of 50% (range of 44-59%) of the total southern flounder landings, while 39% (range of 32-42%) were considered to be large grade fish. The remaining 10% of the landings were divided between jumbo (7%, range of 3-10%), small (2%, range of 1-2%), and mixed (2%, range of 1-3%) flounder.

There is a premium market in North Carolina for fishermen to sell live flounder, particularly for sushi or sashimi markets in Japan and larger United States cities on the east and west coasts. Flounder sushi and sashimi are a type of Japanese raw fish appetizers in which strips of flounder are wrapped around rice or dipped in tangy soy sauce and eaten with chopsticks. Some live fish are held until soon after the season has ended and sold when the price increases. As only female flounders get larger than two pounds, they can be held and fattened-up for a year or more before being sold. These larger fish bring higher prices per pound on the market (Daniels et al. 2000).

7.1.1.3 Individual Income

Flounder sold for sushi or sashimi may be sold live, as is preferred in the Japanese market, where they are not killed until just before they are eaten to maintain maximum freshness. Other flounder landed live may be bled prior to selling and transporting from the processor to the retailer.

Southern flounder provide a significant, albeit decreasing source of income form many commercial fishermen in North Carolina. Table 7.2 shows the number of pounds and the value of southern flounder landed in North Carolina by county for 1994–2002. In

Table 7.2. Pounds and value of southern flounder landed in North Carolina by county from 1994–2002 (courtesy of the NCDMF Trip Ticket Program).

	1994					1995					1996				
County	Trips	Pounds	Avg. lbs/trip	Value	Price/ pound	Trips	Pounds	Avg. lbs/trip	Value	Price/ pound	Trips	Pounds	Avg. lbs/trip	Value	Price/ pound
Beaufort	2,521	118,113	46.85	$183,922	$1.56	2,876	130,809	45.48	$222,500	$1.70	2,654	130,236	49.07	$222,399	$1.71
Bertie	226	43,637	193.08	$70,976	$1.63	*	*	*	*	*	*	*	*	*	*
Brunswick	490	16,488	33.65	$25,881	$1.57	600	17,858	29.76	$29,347	$1.64	629	17,202	27.35	$28,655	$1.67
Camden	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Carteret	6,182	1,254,904	202.99	$2,133,896	$1.70	6,133	955,779	155.84	$1,794,810	$1.88	5,800	1,023,141	176.40	$2,018,551	$1.97
Chowan	2,126	204,161	96.03	$334,466	$1.64	2,415	185,737	76.91	$335,857	$1.81	*	*	*	*	*
Craven	1,094	29,055	26.56	$45,035	$1.55	764	27,585	36.11	$45,978	$1.67	722	18,025	24.97	$28,924	$1.60
Currituck	721	51,463	71.38	$80,997	$1.57	637	68,904	108.17	$118,857	$1.72	682	51,906	76.11	$96,809	$1.87
Dare	8,893	1,155,369	129.92	$1,959,939	$1.70	11,901	1,201,888	100.99	$2,281,557	$1.90	11,336	982,843	86.70	$1,960,386	$1.99
Hyde	3,345	534,124	159.68	$909,891	$1.70	2,897	392,558	135.51	$746,174	$1.90	2,794	454,714	162.75	$905,965	$1.99
New Hannover	1,576	59,209	37.57	$97,590	$1.65	1,898	89,818	47.32	$163,094	$1.82	1,227	52,308	42.63	$95,039	$1.82
Onslow	3,091	112,703	36.46	$160,098	$1.42	4,561	200,217	43.90	$312,524	$1.56	3,902	262,026	67.15	$413,368	$1.58
Pamlico	3,311	151,330	45.71	$236,127	$1.56	3,307	136,062	41.14	$231,419	$1.70	2,665	112,756	42.31	$195,283	$1.73
Pasquotank	5,727	759,127	132.55	$1,200,850	$1.58	4,967	570,696	114.90	$1,008,724	$1.77	3,982	346,010	86.89	$620,454	$1.79
Pender	162	4,187	25.85	$6,384	$1.52	260	5,457	20.99	$9,189	$1.68	303	7,825	25.83	$12,860	$1.64
Perquimans	61	5,809	95.23	$9,472	$1.63	165	7,241	43.88	$12,535	$1.73	398	46,455	116.72	$83,031	$1.79
Tyrrell	2,303	309,642	134.45	$493,530	$1.59	1,504	147,301	97.94	$265,545	$1.80	1,492	103,442	69.33	$186,418	$1.80
Washington	86	42,659	496.03	$55,513	$1.30	*	*	*	*	*	207	20,024	96.73	$27,983	$1.40
Confidential	545	45,479	83.45	$72,262	$1.59	863	28,397	32.90	$32,012	$1.13	1,810	178,005	98.35	$324,389	$1.82
Total/Avg.	42,460	4,897,459	115.34	$8,076,827	$1.65	45,748	4,166,307	91.07	$7,610,122	$1.83	40,603	3,806,918	93.76	$7,220,514	$1.90

* Denotes confidential data; counties where there were only confidential data are not listed here. All confidential data are summarized in the 'Confidential' category.

Table 7.2. (cont.).

County	1997 Trips	1997 Pounds	1997 Avg. lbs/trip	1997 Value	1997 Price/ pound	1998 Trips	1998 Pounds	1998 Avg. lbs/trip	1998 Value	1998 Price/ pound	1999 Trips	1999 Pounds	1999 Avg. lbs/trip	1999 Value	1999 Price/ pound
Beaufort	2,748	113,520	41.31	$207,534	$1.83	3,105	152,236	49.03	$263,467	$1.73	2,528	119,469	47.26	$197,710	$1.65
Bertie	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Brunswick	582	18,079	31.06	$33,293	$1.84	629	14,960	23.78	$25,403	$1.70	422	10,675	25.30	$17,314	$1.62
Camden	99	8,690	87.78	$16,298	$1.88	46	7,252	157.65	$12,734	$1.76	267	31,893	119.45	$55,003	$1.72
Carteret	6,399	873,829	136.56	$1,754,589	$2.01	4,573	729,193	159.46	$1,337,312	$1.83	3,711	455,144	122.65	$825,792	$1.81
Chowan	2,106	136,927	65.02	$268,372	$1.96	1,759	121,710	69.19	$219,911	$1.81	*	*	*	*	*
Craven	938	20,679	22.05	$36,740	$1.78	979	29,230	29.86	$50,475	$1.73	661	22,119	33.46	$36,593	$1.65
Currituck	1,358	145,636	107.24	$274,999	$1.89	1,234	123,137	99.79	$221,499	$1.80	1,172	89,480	76.35	$154,841	$1.73
Dare	11,121	1,003,610	90.24	$2,024,864	$2.02	9,889	1,097,334	110.97	$2,020,651	$1.84	10,580	869,172	82.15	$1,561,994	$1.80
Hyde	3,245	533,789	164.50	$1,084,743	$2.03	2,415	588,326	243.61	$1,081,913	$1.84	2,435	483,292	198.48	$860,297	$1.78
New Hannover	1,292	51,380	39.77	$96,098	$1.87	1,088	45,965	42.25	$79,412	$1.73	936	44,912	47.98	$74,647	$1.66
Onslow	3,251	142,696	43.89	$245,422	$1.72	3,193	174,800	54.74	$288,769	$1.65	2,878	164,245	57.07	$261,139	$1.59
Pamlico	3,297	141,767	43.00	$268,187	$1.89	3,134	160,496	51.21	$278,959	$1.74	2,487	131,898	53.03	$221,984	$1.68
Pasquotank	4,450	475,211	106.79	$895,352	$1.88	2,917	345,447	118.43	$607,011	$1.76	2,322	200,516	86.35	$338,820	$1.69
Pender	263	6,738	25.62	$12,205	$1.81	256	9,707	37.92	$16,940	$1.75	311	19,294	62.04	$31,620	$1.64
Perquimans	1,912	217,590	113.80	$418,808	$1.92	2,107	211,083	100.18	$371,362	$1.76	1,934	133,471	69.01	$228,559	$1.71
Tyrrell	3,006	154,439	51.38	$295,431	$1.91	1,663	105,193	63.25	$186,057	$1.77	1,362	47,140	34.61	$80,303	$1.70
Washington	*	*	*	*	*	*	*	*	*	*	264	12,748	48.29	$20,430	$1.60
Confidential	475	32,213	67.82	$59,365	$1.84	448	36,660	81.83	$62,511	$1.71	1,269	96,608	76.13	$166,212	$1.72
Total/Avg.	46,542	4,076,793	87.59	$7,992,300	$1.96	39,435	3,952,729	100.23	$7,124,386	$1.80	35,539	2,932,076	82.50	$5,133,258	$1.75

* Denotes confidential data; counties where there were only confidential data are not listed here. All confidential data are summarized in the 'Confidential' category.

Table 7.2. (cont.).

County	2000					2001					2002				
	Trips	Pounds	Avg. lbs/trip	Value	Price/ pound	Trips	Pounds	Ave. lbs/trip	Value	Price/ pound	Trips	Pounds	Avg. lbs/trip	Value	Price/ pound
Beaufort	3,187	143,150	44.92	$243,558	$1.70	3,116	146,412	46.99	$232,939	$1.59	2,452	128,150	52.26	$181,075	$1.41
Bertie	*	*	*	*	*	*	*	*	*	*	91	612	6.73	$896	$1.46
Brunswick	498	15,513	31.15	$25,800	$1.66	506	16,055	31.73	$25,212	$1.57	524	18,324	34.97	$25,394	$1.39
Camden	343	45,814	133.57	$77,514	$1.69	260	18,641	71.70	$29,580	$1.59	*	*	*	*	*
Carteret	5,070	687,613	135.62	$1,268,443	$1.84	5,073	977,816	192.75	$1,589,193	$1.63	4,647	1,019,423	219.37	$1,543,393	$1.51
Chowan	*	*	*	*	*	*	*	*	*	*	1152	76986	66.83	112530	$1.46
Craven	441	12,393	28.10	$21,080	$1.70	426	11,595	27.22	$18,403	$1.59	581	30,459	52.43	$43,228	$1.42
Currituck	636	70,996	111.63	$121,999	$1.72	574	77,017	134.18	$119,675	$1.55	598	92,152	154.10	$135,009	$1.47
Dare	11,032	821,040	74.42	$1,457,580	$1.78	10,076	922,082	91.51	$1,476,294	$1.60	8,794	837,031	95.18	$1,299,560	$1.55
Hyde	2,534	327,471	129.23	$586,933	$1.79	2,329	312,633	134.23	$500,429	$1.60	2,505	358,793	143.23	$537,450	$1.50
New Hannover	1,114	55,862	50.15	$95,138	$1.70	1,063	45,978	43.25	$72,584	$1.58	1,184	57,876	48.88	$77,979	$1.35
Onslow	2,760	144,994	52.53	$240,158	$1.66	2,052	102,788	50.09	$161,382	$1.57	2,448	148,937	60.84	$205,449	$1.38
Pamlico	3,150	177,116	56.23	$303,360	$1.71	2,683	151,160	56.34	$240,597	$1.59	2,833	186,518	65.84	$265,031	$1.42
Pasquotank	2,193	281,113	128.19	$478,825	$1.70	2,591	344,412	132.93	$546,529	$1.59	2,051	227,612	110.98	$326,444	$1.43
Pender	236	12,267	51.98	$20,334	$1.66	287	14,829	51.67	$23,467	$1.58	238	10,755	45.19	$14,852	$1.38
Perquimans	2,245	252,129	112.31	$430,825	$1.71	2,196	218,484	99.49	$347,173	$1.59	2,062	197,068	95.57	$286,857	$1.46
Tyrrell	1,418	62,503	44.08	$106,289	$1.70	2,020	72,100	35.69	$114,892	$1.59	1,195	28,596	23.93	$56,767	$1.99
Washington	185	10,812	58.44	$15,874	$1.47	206	23,739	115.24	$37,707	$1.59	*	*	*	*	*
Confidential	839	84,443	100.65	$145,769	$1.73	794	65,285	82.22	$103,952	$1.59	225	30,167	134.08	$29,045	$0.96
Total/Avg.	37,881	3,205,229	84.61	$5,639,479	$1.76	36,252	3,521,026	97.13	$5,640,008	$1.60	33,580	3,449,459	102.72	$5,140,959	$1.49

* Denotes confidential data; counties where there were only confidential data are not listed here. All confidential data are summarized in the 'Confidential' category.

general, Dare County has landed the most pounds of southern flounder, followed by Carteret, Hyde, and Pasquotank Counties. Approximately, 65-75% of all North Carolina southern flounder are landed annually in these four counties. In 1994, southern flounder accounted for $6.20 million in income for these counties. The economic impact to these counties in 2002 was less than 50% of the 1994 value ($3.05 million in 1994 dollars).

7.1.1.4 Primary Gears Fished

Flounder landed live can bring a higher price per pound. Pound nets are the only gear that routinely allow for the fish to be landed alive. Table 7.3 shows the average price per pound (unadjusted for inflation) using different gears for the years 1994–2002. Southern flounder caught in pound nets provided the highest price per pound. The next highest price was obtained using gill nets. The difference in price per pound among gears other than pound nets or gill nets was negligible. The price per pound for all gears increased from 1994 through 1997. Since 1998 the price per pound has dropped each year.

7.1.2 Commercial Flounder Fishermen

The NCDMF interviewed 111 flounder fishermen from Core Sound south to the North Carolina/South Carolina state line between 2001 and 2002 as part of an ongoing socioeconomic survey project (Cheuvront 2002, 2003). These surveys were not targeted towards any specific fishery. Fishermen were selected to participate in the survey based on their landings from specific water bodies. The survey asked fishermen about their fishing business characteristics and demographics. The results presented here are similar to findings of other studies of North Carolina commercial fishermen (Johnson and Orbach 1996).

Table 7.4 shows sociodemographics of the interviewed commercial fishermen. The average age of the fishermen was 49.2 years old with a range of 22 to 84 years. Over half of the respondents lived in Carteret County. Another 25% lived in Onslow County. The remaining respondents lived in Pender, New Hanover, Brunswick, or other counties. The fishermen have lived in their community generally, for the past 35 years. Approximately, 95% of the respondents were male and were overwhelmingly white.

Nearly 37% had less than a high school education. Another 36% were high school graduates. The remaining 27% had attended college or were college graduate. The majority of respondents were married (82%), with an additional 9.9% who were divorced at the time of the interview.

Approximately 8% of the respondents said they did not make money from fishing in the year previous to being interviewed. Fewer than 25% earned less than $5,000 from fishing. About 40% earned between $5,001 and $15,000. Another 25% earned between $15,001 and $30,000 from fishing. A few respondents earned more than $30,000 from fishing. The average fisherman earned slightly under half of all their fishing income from flounder.

Table 7.3. The average prices per pound for southern flounder (unadjusted for inflation) using different gears for the years 1994-2002 (courtesy of the NCDMF Trip Ticket Program).

		Crab Pot	Crab Trawl	Gill Net	Pound Net	Shrimp Trawl	Other Gears	Total / Average
1994	Trips	2,602	1,772	27,755	4,599	3,218	2,516	42,462
	Pounds	52,236	104,104	2,253,876	2,292,769	107,037	87,444	4,897,466
	Avg. pounds/trip	20.08	58.75	81.21	498.54	33.26	34.78	115.34
	Value	$82,813	$158,222	$3,640,766	$3,888,877	$168,648	$137,510	$8,076,836
	Price/pound	$1.59	$1.52	$1.62	$1.70	$1.58	$1.57	$1.65
1995	Trips	3,120	1,198	32,097	4,070	2,731	2,534	45,750
	Pounds	90,462	57,603	2,150,059	1,768,627	56,537	88,560	4,211,848
	Avg. pounds/trip	28.99	48.08	66.99	434.55	20.7	34.95	92.06
	Value	$156,358	$96,621	$3,841,142	$3,358,523	$95,963	$149,657	$7,698,264
	Price/pound	$1.73	$1.68	$1.79	$1.90	$1.70	$1.69	$1.83
1996	Trips	2,726	1,824	28,804	3,550	1,708	1,997	40,609
	Pounds	58,989	84,903	1,877,077	1,653,819	46,546	85,584	3,806,918
	Avg. pounds/trip	21.64	46.55	65.17	465.86	27.25	42.86	93.75
	Value	$102,270	$146,641	$3,424,320	$3,317,250	$78,951	$151,082	$7,220,514
	Price/pound	$1.73	$1.73	$1.82	$2.01	$1.70	$1.77	$1.90
1997	Trips	2,849	1,883	33,498	3,603	2,156	2,553	46,542
	Pounds	61,471	78,465	2,381,465	1,412,667	41,456	101,343	4,076,867
	Avg. pounds/trip	21.58	41.67	71.09	392.08	19.23	39.7	87.6
	Value	$114,245	$145,344	$4,594,138	$2,862,425	$78,226	$187,220	$7,981,598
	Price/pound	$1.86	$1.85	$1.93	$2.03	$1.89	$1.85	$1.96
1998	Trips	2,578	2,272	28,364	2,662	1,415	2,143	39,434
	Pounds	65,102	92,658	2,406,760	1,282,596	26,682	88,137	3,961,935
	Avg. pounds/trip	25.25	40.78	84.85	481.82	18.86	41.13	100.47
	Value	$113,950	$158,523	$4,301,548	$2,363,695	$46,259	$133,548	$7,117,523
	Price/pound	$1.75	$1.71	$1.79	$1.84	$1.73	$1.52	$1.80
1999	Trips	2,408	1,306	25,898	2,085	1,898	1,871	35,466
	Pounds	48,804	70,609	1,905,779	786,571	42,779	75,704	2,930,246
	Avg. pounds/trip	20.27	54.07	73.59	377.25	22.54	40.46	82.62
	Value	$83,126	$115,459	$3,296,310	$1,438,730	$71,838	$124,586	$5,130,049
	Price/pound	$1.70	$1.64	$1.73	$1.83	$1.68	$1.65	$1.75
2000	Trips	2,523	1,186	28,441	1,951	1,771	1,996	37,868
	Pounds	46,800	61,376	2,106,636	880,705	25,810	98,787	3,220,114
	Avg. pounds/trip	18.55	51.75	74.07	451.41	14.57	49.49	85.04
	Value	$78,314	$101,250	$3,577,578	$1,599,271	$43,136	$165,572	$5,565,121
	Price/pound	$1.67	$1.65	$1.70	$1.82	$1.67	$1.68	$1.73
2001	Trips	3,283	1,035	26,192	2,392	1,346	2,002	36,250
	Pounds	67,659	52,240	1,909,176	1,376,369	22,229	93,303	3,520,976
	Avg. pounds/trip	20.61	50.47	72.89	575.41	16.51	46.60	97.13
	Value	$107,208	$83,072	$3,040,907	$2,225,919	$35,313	$147,510	$5,639,929
	Price/pound	$1.58	$1.59	$1.59	$1.62	$1.59	$1.58	$1.60
2002	Trips	3,100	494	23,938	2,503	1,754	1,789	33,578
	Pounds	58,506	30,408	1,818,270	1,410,366	41,031	90,879	3,449,459
	Avg. pounds/trip	18.9	61.6	76.0	563.5	23.4	50.8	102.7
	Value	$82,822	$42,361	$2,634,278	$2,195,277	$57,406	$128,815	$5,140,959
	Price/pound	$1.42	$1.39	$1.45	$1.56	$1.40	$1.42	$1.49

Table 7.4. Sociodemographics of commercial fishermen interviewed from the coastal counties between Carteret and Brunswick counties during 2001 and 2002.

	Range/ Frequency	Average/ Percent
Age	22 - 84 yrs.	49.2
County of Residence		
Carteret	57	51.4%
Onslow	28	25.2%
Pender	5	4.5%
New Hanover	9	8.1%
Brunswick	8	7.2%
Other	4	3.6%
Years in County	1 - 81 yrs.	35.7
Gender		
Male	105	94.6%
Female	6	5.4%
Race		
White	110	99.1%
Other	1	0.9%
Education		
< High School	41	36.9%
High School Diploma	40	36.0%
Some College	17	15.3%
College Graduate	13	11.7%
Marital Status		
Married	91	82.0%
Divorced	11	9.9%
Widowed	3	2.7%
Separated	2	1.8%
Never Married	4	3.6%
Income from Fishing		
$0 or lost money	8	7.8%
$1 - $5,000	24	23.5%
$5,001 - $15,000	40	39.2%
$15,001 - $30,000	26	25.5%
$30,001 - $50,000	4	3.9%
Refused	9	8.1%
% Fishing Income from Flounder	2 - 100%	48.8%
Total Household Income		
Less than $15,000	12	12.2%
$15,001 - $30,000	40	40.8%
$30,001 - $50,000	29	29.6%
$50,001 - $75,000	12	12.2%
More than $75,000	5	5.1%
Refused	13	11.7%

7.2 Recreational Fisheries

7.2.1 Economic Value of the Recreational Fisheries

7.2.1.1 Hook-and-Line Fishery

Economic analysis of the recreational hook-and-line fishery indicates that anglers generate significant revenues for the State of North Carolina. The MRFSS estimated that 132,842 trips targeting flounder (not species specific) were made in North Carolina in 2000. The MRFSS Southeast Economic Survey in 1999 estimated approximately two-thirds of trips by recreational flounder anglers were day trips. The remaining third involved at least one overnight stay. The average expenditure per day trip was $80.44 and $500.71 for overnight trips. The economic impact for recreational flounder angling cannot be separated from the entire impact of the trip where flounder were landed. For example, the impacts include the value of other species of fish caught, other activities (i.e. beach trips), and the activities of other people who went on the trip but were not involved in fishing. The overall economic impact of trips where recreational angling for flounder took place was about $56.6 million (Table 7.5).

7.2.1.2 RCGL Fisheries

Table 7.6 gives an indication of the economic impact of the recreational southern flounder fishery by RCGL fishermen in 2002. The data are separated by those who made overnight trips as opposed to those who made day trips. The economic figures are based on an expansion of the actual values reported by RCGL fishermen and are considered the best available estimates. The economic impacts described below are those that can be attributed only to southern flounder landings by these fishermen. Additionally, on many trips, the fishermen and the non-fishers who accompanied them engaged in other, non-fishing activities.

The expenditures shown in Table 7.6 relate to the overall proportion of southern flounder landed. Other species were typically caught along with the southern flounder. The economic impact was based on the percent of southern flounder in the total pounds of all species kept by the fishermen on any given trip where southern flounder were landed. The total pounds of southern flounder caught were 97,474 out of a total 22,1574 pounds landed and kept. Southern flounder accounted for 30.55% of the total catch on those trips.

Expenditures by those who made overnight trips tend to be greater when compared to day trips because of the increased cost of lodging and meals. Additionally, more time is typically spent fishing on an overnight trip compared to a day trip; therefore, additional expenditures are noted for items such as bait, ice and fuel. An average overnight trip lasted just over three days and resulted in expenditures of $80.78 attributable to southern flounder. The total economic impact of overnight RCGL trips for southern flounder was nearly $1.2 million. The average expenditures for day trip fishermen were $22.81. The

Table 7.5. Estimated expenditures by anglers targeting flounder in North Carolina during 1999 (courtesy of the North Carolina MRFSS).

Expenditure Type	Day Trips	Multiple Night Trips	Total Expenditures
Food/Drinks	$38.96	$242.42	$281.38
Lodging	-----	$185.00	$185.00
Boat Fuel	$20.41	$20.23	$40.64
Bait	$10.08	$27.53	$37.61
Equipment, Ice, Fees	$10.99	$25.53	$36.52
Total	$80.44	$500.71	$581.15
Total Trips	178,424 (67.89%)	84,389 (32.11%)	262,813 (100%)
Total Expenditures	$14,352,426.56	$42,254,416.19	$56,606,842.75

Table 7.6. Economic impact of RCGL fishing trips for southern flounder in 2002 (NCDMF RCGL Survey Program).

Expenditure Type	Overnight Trips	Day Trips
# of trips	14,854	13,176
Ave. # of nights	3.3	-----
Ave. # of people on the trip	3.6	2.9
% of people on the trip who fished	86%	90%
Ave. cost of lodging/night	$36.43	-----
Ave. cost of food/trip	$76.59	$23.56
Ave. cost of ice/trip	$13.75	$6.36
Ave. cost of bait/trip	$20.68	$10.47
Ave. cost of equipment	$8.46	$7.42
Ave. cost of fuel and oil/trip	$62.92	$32.27
% of southern flounder landed	31%	31%
Ave. per trip impact	$80.78	$22.81

total economic impact of southern flounder caught on day trips was just over $300,000. The combined total economic impact of fishing for southern flounder by RCGL fishermen was approximately $1,500,372.

7.2.2 Recreational Flounder Fishermen

7.2.2.1 Hook-and-Line Fishery

The MRFSS surveys do not collect data each year for each demographic variable. Additionally, the data collected do not always allow for a 'by species' comparison. The data represented in Figures 7.2 and 7.3 reflect the most recent data available.

Nearly half of all flounder anglers are between 36 and 55 years old. Over 10% are older than 65 (Figure 7.2). More than four out of five are male (Figure 7.2). Approximately, three fourths of the anglers are employed (Figure 7.3). The others are unemployed, retired, or students. The average flounder angler in North Carolina is a male between 36 and 45 years old. He has been fishing for approximately 19 years and has a total household income of $35,001 to $60,000 (Figure 7.3).

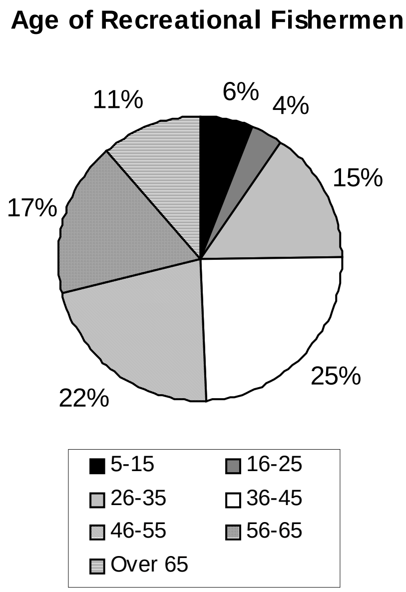
7.2.2.2 RCGL Fisheries

The average RCGL holder who targeted southern flounder was 54.2 years old and was born in North Carolina (Table 7.7). The vast majority were married white males. These anglers typically had at least some college education and tended to live in households earning more than $30,000 per year. On average, they had been using commercial gear for about 18 years.

7.3 Research Needs and Recommendations

- Collect socioeconomic data on recreational fishermen who use gigs.

- Increase the Marine Recreational Fisheries Statistics Survey sample size for recreational flounder fishermen to gain better, more accurate information on their habits and fishing practices.



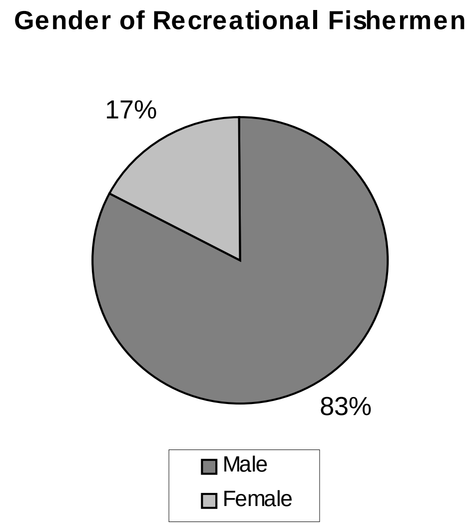
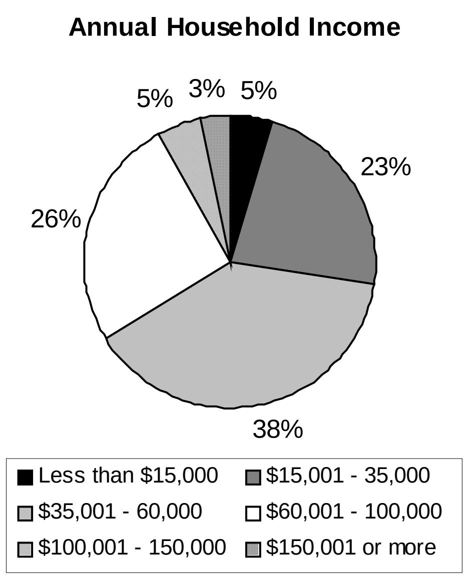


Figure 7.2. Demographic characteristics of recreational anglers targeting flounder in North Carolina during 2000 (courtesy of the NCDMF).



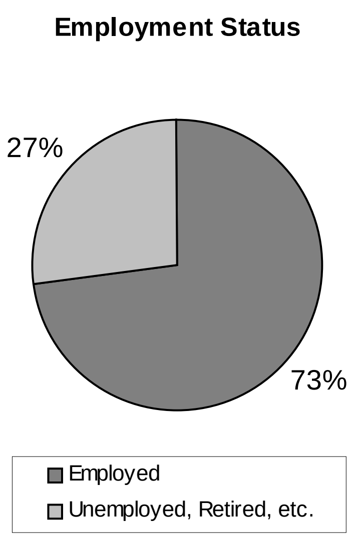


Figure 7.3. Additional demographic characteristics of recreational anglers in North Carolina during 1997 (courtesy of the North Carolina MRFSS).

Table 7.7. Demographic characteristics of RCGL holders targeting flounder in North Carolina during 2002 (courtesy of the NCDMF).

Categories and Values	Sample Size	Average/ Percent
Years experience fishing commerical gear	1,462	1831
% born in North Carolina	1,451	75
Age	1,437	54.2
< 16 years	1,236	0%
17 to 25	86	1%
26 to 40	39	14%
41 to 60	13	48%
> 60 years	58	37%
Marital Status	1,432	
Married	1,236	86%
Divorced	86	6%
Widowed	39	3%
Separated	13	1%
Never Married	58	4%
Ethnic Group	1,430	
Hispanic/Latino	5	0%
Caucasian/White	1,352	95%
African-American/Black	4	0%
Asian-Pacific Islander	1	0%
Native American	68	5%
Gender	1,409	
Male	1,336	95%
Female	73	5%
Education	1,425	
< High School	168	12%
High School Diploma	408	29%
Some College	485	34%
College Diploma or More	364	26%
Total Household Income	1,276	
< $5,000	11	1%
$5,000 to $15,000	40	3%
$15,001 to $30,000	219	17%
$30,001 to $50,000	347	27%
$50,001 to $75,000	306	24%
$75,001 to $100,000	177	14%
> $100,000	176	14%

8. STATUS OF THE STOCK

8.1 Stock Assessment

8.1.1 Introduction

Southern flounder support a substantial recreational and commercial fishery along the southeastern coast of the United States, with total landings averaging 4.3 million pounds annually. Increases in fishing pressure and low recruitment led the NCDMF to list southern flounder as a species of concern, that resulted in the NCMFC designating southern flounder as a priority species for development of a FMP under the 1997 FRA. Based on an initial NCDMF stock assessment in 2001, southern flounder were reclassified from a species of concern to being overfished.

8.1.1.1 Stock Definition

Population analysis was conducted under the premise that a single unit stock contributes to the harvest of the southern flounder in North Carolina. Tagging studies have failed to identify functionally distinct populations of southern flounder along the southeastern U.S. Coast (Music and Pafford 1984, Wenner et al. 1990). However, because independent stocks within the management area could confound mortality rate estimates and contribute to locally inappropriate management, a robust evaluation of the unit stock is needed.

8.1.1.2 Fisheries

The North Carolina southern flounder fishery has two major components, the commercial fishery and the recreational fishery. From 1991-2002, the commercial fishery represented 86.3% of the total landings, with a mean harvest of 3,799,063 pounds (Table 8.1) and the recreational fishery contributed 13.7% of the total landings with a mean harvest of 603,793 pounds. Recreational hook-and-line fisherman averaged 144,780 pounds of southern flounder annually from 1991-2002. The estimated harvest of the recreational gig and RCGL fisheries were 361,539 pounds and 97,474 pounds respectively in 2002. When extrapolated back for the 1991-2002 period, the recreational gig fishery represented 8.2% and the RCGL fishery only 2.2% of the mean total landings.

8.1.1.2.1 Commercial

Commercial and recreational fisheries throughout the southeastern United States harvest southern flounder. Two similar species, summer flounder and gulf flounder (, also occur within the southern flounder's geographic distribution, and could potentially confound the accuracy of landings estimates. This problem is considered minimal for the recreational fishery since kept flounder are identified to species level at survey intercept sites. Commercial harvest, however, is reported by fish dealers generically as "flounder" and state agencies apply their own criteria for determining the species composition of the "flounder" catch.

Table 8.1. North Carolina southern flounder commercial and recreational landings (courtesy of the NCDMF).

Year	Commercial Landings	Recreational Landings		
		Hook-and-Line	Gig	RCGL
1991	4,163,374	136,835	361,539*	97,474*
1992	3,145,020	74,308	361,539*	97,474*
1993	4,272,368	56,405	361,539*	97,474*
1994	4,897,459	131,804	361,539*	97,474*
1995	4,166,307	116,617	361,539*	97,474*
1996	3,806,918	115,336	361,539*	97,474*
1997	4,076,793	218,615	361,539*	97,474*
1998	3,952,729	88,147	361,539*	97,474*
1999	2,932,076	77,505	361,539*	97,474*
2000	3,205,229	271,234	361,539*	97,474*
2001	3,521,026	213,908	361,539*	97,474*
2002	3,449,459	236,648	361,539	97,474
Mean	3,799,063	144,780	361,539	97,474
Percent	86.3%	3.3%	8.2%	2.2%

* Recreational gig and RCGL 2002 values used as a proxy to represent all years at the recommendation of NCDMF staff.

NCDMF fish house sampling was used to characterize the species composition for 95% of the observed flounder catch from 1994 to 1999. Of that 95%, an average of 98.8% of the harvest from inshore waters was southern flounder, while an average of 99.7% of the offshore catch was summer flounder. Gulf flounder are also captured, mostly in the inshore gillnet and pound net fisheries, where they comprise 0.4% of the inshore landings. The NCDMF statistics section has a simplified record-keeping approach based on the low species overlap in the fisheries; landings reported from inshore waters are categorized as southern flounder, and offshore landings are categorized as summer flounder. Length and age compositions are acquired from samples that include species identification.

Estuarine gillnets represented 52% of commercial landings for southern flounder from 1991-2002 (mean landings of 1,960,256 pounds) and flounder pound nets comprised 37% of the commercial landings (mean landings of 1,409,618 pounds). An additional thirty-four commercial gears comprised the remaining 11% (429,189 pounds) of the commercial landings for southern flounder (Table 8.2). These additional gears were combined into an ‘Other Gear’ category for this assessment (Table 8.3).

Table 8.2. North Carolina mean annual commercial landings of southern flounder by gear during 1994-2002 (courtesy of the NCDMF Trip Ticket Program).

Gear Fished	Mean (lb)	Min (lb)	Max (lb)	Percent
Beach seine	195	0	2,046	0.0%
Butterfly net	5	0	34	0.0%
By hand	607	0	1,433	0.0%
Cast net	8	0	48	0.0%
Channel net	1,274	0	8,677	0.0%
Clam trawl kicking	186	0	429	0.0%
Common seine	98	0	784	0.0%
Crab dredge	48	0	352	0.0%
Crab pot	12,507	0	24,177	0.3%
Crab trawl	89,945	30,408	257,502	2.4%
Eel pot	106	0	466	0.0%
Fish pot	448	0	1,271	0.0%
Flounder pound net	1,409,618	736,995	2,175,617	37.1%
Flounder trawl	2,953	0	34,359	0.1%
Flynet	32	0	222	0.0%
Fyke net	891	0	2,252	0.0%
Gigs	77,400	40,587	174,392	2.0%
Gill net	1,960,256	1,141,439	2,463,860	51.6%
Haul seine	9,893	1,231	40,777	0.3%
Oyster dredge	0	0	2	0.0%
Peeler Pot	664	0	5,049	0.0%
Pound net	83,987	13,568	205,360	2.2%
Rakes bull	164	0	535	0.0%
Rakes hand	345	0	1,635	0.0%
Rod-n-reel	1,742	80	3,583	0.0%
Scallop scoop	2	0	26	0.0%
Sciaenid pound net	81,442	27,821	168,445	2.1%
Shrimp pound	11	0	136	0.0%
Shrimp trawl	63,448	22,229	230,916	1.7%
Skimmer trawl	147	0	523	0.0%
Spears diving	2	0	25	0.0%
Swipe net	400	0	2,897	0.0%
Tongs, hand	176	0	595	0.0%
Trolling	28	0	130	0.0%
Trotline	35	0	254	0.0%

Table 8.3. Annual North Carolina commercial landings of southern flounder by gear (courtesy of the NCDMF Trip Ticket Program).

Year	Flounder Pound Net (lb)	Gill Net (lb)	Other Gears (lb)
1991	1,795,716	1,478,357	889,301
1992	1,616,731	1,141,439	386,850
1993	2,175,617	1,695,248	401,503
1994	1,918,965	2,281,934	696,560
1995	1,444,501	2,222,816	498,990
1996	1,498,191	1,917,122	391,605
1997	1,250,767	2,426,382	399,645
1998	1,164,386	2,463,860	324,484
1999	736,995	1,941,145	253,936
2000	789,787	2,128,596	286,846
2001	1,222,173	1,966,316	332,537
2002	1,301,589	1,859,861	288,009
Mean	1,409,618	1,960,256	429,189
Percent	37%	52%	11%

8.1.1.2.2 Recreational

Recreational hook-and-line harvest of southern flounder for North Carolina is available from the MRFSS from 1981 to the present. During the 1991-2002 assessment period the recreational landings were highly variable. Hook-and-line landings ranged from a low of 56,405 pounds in 1993 to a high of 271,234 pounds in 2001, with a mean of 144,780 pounds per year (Table 8.1).

The MRFSS fails to collect data from the recreational gig fishery, primarily due to the fishery being prosecuted at night. Southern flounder are susceptible to gigging because they are sedentary and spend a large portion of their life cycle in estuaries. Since gig fisheries have an obvious potential to account for significant harvests, catch estimates obtained from MRFSS underestimate the actual recreational harvest. Watterson (2003) estimated 361,539 pounds of southern flounder was harvested Statewide in 2002 by the recreational gig fishery (Table 8.1).

Harvest estimates from the recreational use of ‘commercial-type’ gears, previously unknown, are now obtained through a mail survey of RCGL holders (Wilson 2003). Southern flounder rank second, following spot, of all finfish species harvested by RCGL holders. The NCDMF estimated a total removal of 97,474 pounds of southern flounder during 2002 (Table 8.1).

8.1.1.3 Regulations

The NCDMF regulates all flounder harvest under a general category called 'flounder'. Size-limit restrictions from 1988 until September 2002 for inshore flounder stocks were set at 13 inches (330 mm), regardless of species (NCAC 3M/.0503 and NCAC 3H/.0103). On October 1, 2002, North Carolina increased the inshore recreational size-limit to 14 inches for all flounder in response to regulations of summer flounder stocks by the Atlantic States Marine Fisheries Commission (ASMFC), which applied to all North Carolina inshore flounder species. This regulation was modified to 14 inches for all inshore waters except within an area including the western Pamlico Sound where a 13-inch size limit was reinstated on October 10, 2002.

8.1.1.4 Growth

The growth characteristics of male and female southern flounder vary (Stunz et al. 1996). The Gulf States Marine Fisheries Commission (GSMFC 2000) noted females grow faster and larger than males, and younger females cannot be distinguished from older males by length alone. In North Carolina, length, weight, age (sagittal otoliths) and sex data for southern flounder is available from 1991-2002 (no age data for 1994) through the North Carolina Aging Studies program (NCDMF F-42 Population Parameters: 1991-2002).

Using the Program 930 data and a nonlinear regression model (Proc NLIN; SAS Institute 1999), estimates of the parameters were obtained for the von Bertalanffy (LVB) growth equation:

$$L_t = L_\infty(1 - e^{-K(t-t_0)})$$

where L_t is total length in millimeters, t is age in years, and L_∞, K (growth parameter), and t_0 are parameters to be estimated. For each fish, only observed length-at-age adjusted for time of year collected was used to calculate the LVB parameters.

Individual year calculations for LVB parameters were not possible due to a lack of data convergence for multiple years by the LVB model. This resulted in the choice of an overall estimation for female and male southern flounder parameters (Table 8.4). Maximum size (L_∞) for female southern flounder was calculated at 849.1 mm, or 210% greater than males L_∞ at 405.7 mm.

Various ages of southern flounder have been reported, with females up to age-6 and males to age-3 (Stokes 1977, Wolff 1978, Music and Pafford 1984, Palko 1984, Frick 1988, Wenner et al. 1990, Stunz et al. 1996, GSMFC 2000). NCDMF Program 930 aging data for southern flounder reported females up to age-7 and males to age-5 during the 1991-2002 data period. Mean length-at-age for female southern flounder was greater than the mean length-at-age of male southern flounder for all age classes (Table 8.5).

Table 8.4. von Bertalanffy parameter estimates and standard errors for L_∞, K, and t_0 for male and female southern flounder.

Parameter	Estimate	Standard Error
Females (*n* =3,760)		
L_∞	849.1 mm (33.4 in)	48.68 mm
K	0.191 yr^{-1}	0.022 yr^{-1}
t_0	-0.932 yr	0.109 yr
Males (*n* =998)		
L_∞	405.7 mm (16.0 in)	12.97 mm
K	0.562 yr^{-1}	0.068 yr^{-1}
t_0	-0.491 yr	0.130 yr

Table 8.5. Mean length-at-age (mm and inches) for male and female southern flounder.

Sex	Unit of Measurement	Age							
		0	1	2	3	4	5	6	7
Female	mm	233	315	408	485	548	601	644	679
	in	9.2	12.4	16	19.1	21.6	23.7	25.4	26.7
Male	mm	204	273	330	363	381	392		
	in	8	10.8	13	14.3	15	15.4		

The maximum age for southern flounder is uncertain. Nall (1979) noted collecting a southern flounder ten years of age in Texas coastal waters. Randy Gregory (NCDMF, personal communication) reported an age-9 810 mm southern flounder, collected three miles offshore of Cape Lookout, NC, on November 23, 2003.

8.1.1.5 Objectives

Information on the status of the stock, including the magnitude of fishing exploitation and population abundance, is necessary to monitor the performance of the management program and to predict the impacts of potential management changes. Objectives of this assessment include estimating population abundance and fishing mortality of the North Carolina southern flounder stock.

8.1.1.6 Assessment Assumptions

The assessment of southern flounder is based on two key assumptions. First, the North Carolina inshore southern flounder stock may be treated as a unit stock. This is based in part on the NCDMF Statistics Section's simplified record-keeping approach based on the low species overlap in the fisheries, where landings reported from inshore waters are categorized as southern flounder, and offshore landings are categorized as summer flounder. Second, the stock status for southern flounder can be characterized by females only. Southern flounder females grow larger and faster than males, noted both in literature review and through examination of the LVB growth models for North Carolina southern flounder from 1991-2002. In 1978, Wolff noted a mean length for southern flounder females at 456 mm, while males averaged 328 mm. No flounder in excess of 405 mm were identified as male southern flounder, and very few males longer than 355 mm were observed in the fishery overall. There is no evidence that these findings have significantly changed since 1978, with current staff estimates indicating approxiamately 88% of all southern flounder harvested are female. This is primarily due to inshore harvest regulations set at 13 inches (330 mm) for most of 1991-2002. The spawning stock biomass (SSB) for this assessment is based on the biomass of the mature females in the stock.

8.1.2 Data Sources

8.1.2.1 Catch-at-Age

An overall catch-at-age (CAA) matrix was created by combining the commercial and recreational catch-at-length calculated for 20 mm length classes and converting them to CAA through the use of a semi-annual age-length-key (ALK) created from Program 930 aging data (Table 8.6). Age-1 southern flounder average 57% of the total CAA for the two combined fisheries, while the mean total number of age-2 fish harvested represented 38% (Table 8.7). The error in the CAA estimates is assumed to be zero.

Table 8.6. Combined catch-at-age of commercial and recreational fisheries for North Carolina southern flounder.

Year	Age							
	0	1	2	3	4	5	6	7
1991	842	1,038,837	1,056,825	17,718	1,312	78	1	1
1992	2,576	915,584	956,036	140,547	4,372	162	1	1
1993	842	1,871,929	606,044	307,267	1,180	108	1	1
1994	934	1,727,044	1,104,580	78,152	3,943	211	1	21
1995	1,326	1,514,767	838,769	70,403	2,343	46	1	1
1996	976	966,572	1,064,498	105,443	14,785	333	4	4
1997	842	1,413,255	837,822	124,152	36,856	228	1	1
1998	842	1,287,943	1,053,780	39,673	1,284	72	81	1
1999	842	968,528	658,384	152,070	8,483	2,856	1	3
2000	842	1,795,830	285,961	83,679	9,496	253	1	1
2001	842	1,233,083	1,097,149	17,778	12,536	586	1	8
2002	22,591	1,312,460	762,347	98,216	1,608	149	4	4

8.1.2.1.1 Commercial Fishery

Commercial landings data for the estuarine gillnet fishery and the flounder pound net fishery are collected through the NCDMF Trip Ticket Program (Lupton and Phalen 1996). The gillnet fishery is sampled by NCDMF Biological Program 461 and the pound net fishery by Program 432/442 to determine size and age; these data are used to convert commercial pounds into commercial numbers-at-length (Tables 8.8 and 8.9). The size and age samples for the flounder pound net fishery were used as proxy values to calculated the commercial CAA for the 'other gear' commercial category (Table 8.10).

8.1.2.1.2 Recreational Fishery

Data on the recreational hook-and-line harvest of southern flounder were acquired through the Marine Recreational Fisheries Statistics Survey (MRFSS) (NCDMF 1999). Unlike commercial landings, recreational landings are reported in numbers, so no conversion is necessary. Recreational hook-and-line harvest is reported in three "types": A, B1, and B2. Type A refers to catch observed and measured by a creel survey representative; type B1 is catch observed but not measured, and type B2 is catch that is released alive by the angler. The total recreational take in a given year was calculated as the sum of the type A and B1 catch as well as 10% of the B2 catch (Table 8.11). Since hooking mortality has not been estimated for southern flounder in NC, 10% mortality was chosen since that is consistent with the current rate applied to the closely related summer flounder (Terceiro 2000).

Table 8.7. Percent combined catch-at-age of commercial and recreational fisheries for North Carolina southern flounder.

Year	Age 0	1	2	3	4	5	6	7
1991	0%	49%	50%	1%	0%	0%	0%	0%
1992	0%	45%	47%	7%	0%	0%	0%	0%
1993	0%	67%	22%	11%	0%	0%	0%	0%
1994	0%	59%	38%	3%	0%	0%	0%	0%
1995	0%	62%	35%	3%	0%	0%	0%	0%
1996	0%	45%	49%	5%	1%	0%	0%	0%
1997	0%	59%	35%	5%	2%	0%	0%	0%
1998	0%	54%	44%	2%	0%	0%	0%	0%
1999	0%	54%	37%	8%	0%	0%	0%	0%
2000	0%	83%	13%	4%	0%	0%	0%	0%
2001	0%	52%	46%	1%	1%	0%	0%	0%
2002	1%	60%	35%	4%	0%	0%	0%	0%
Mean	**0%**	**57%**	**38%**	**4%**	**0%**	**0%**	**0%**	**0%**

Table 8.8. Catch-at-age for North Carolina commercial gill net fishery.

Year	Age 0	1	2	3	4	5	6	7
1991	0	221,869	343,791	2,026	196	0	0	0
1992	1,379	379,433	249,105	42,914	783	2	0	0
1993	0	786,542	209,255	102,701	31	0	0	0
1994	92	816,648	469,480	24,113	1,469	11	0	0
1995	477	829,863	368,333	20,971	573	0	0	0
1996	134	479,298	485,793	28,877	3,797	225	0	0
1997	0	796,179	441,107	55,141	18,712	66	0	0
1998	0	747,013	592,280	12,911	288	0	0	0
1999	0	569,950	385,283	77,728	3,378	1,260	0	0
2000	0	1,104,076	105,018	31,761	3,692	80	0	0
2001	0	634,844	505,520	1,350	4,498	158	0	0
2002	0	656,652	332,890	28,643	194	46	2	2

Table 8.9. Catch-at-age for North Carolina commercial flounder pound net fishery.

Year	Age							
	0	1	2	3	4	5	6	7
1991	0	459,220	446,480	1,863	280	28	0	0
1992	299	281,181	508,474	69,284	2,241	56	0	0
1993	0	767,399	255,972	164,432	419	26	0	0
1994	0	504,925	410,173	34,050	1,115	71	0	0
1995	5	336,612	282,903	29,263	702	0	0	0
1996	0	210,441	380,558	54,011	8,713	57	3	3
1997	0	279,095	213,524	43,471	12,299	32	0	0
1998	0	256,148	293,079	12,035	211	24	73	0
1999	0	142,266	135,535	51,023	4,090	1,348	0	2
2000	0	293,056	59,030	28,215	3,181	17	0	0
2001	0	257,602	353,279	2,209	5,909	236	0	7
2002	20,021	308,315	235,195	41,744	231	55	1	1

Table 8.10. Catch-at-age for the North Carolina commercial 'other gear' fisheries.

Year	Age							
	0	1	2	3	4	5	6	7
1991	0	131,139	129,114	465	74	4	0	0
1992	56	51,299	85,097	10,221	285	5	0	0
1993	0	112,404	34,224	22,433	51	3	0	0
1994	0	176,128	100,899	5,118	414	7	0	0
1995	2	125,339	68,813	5,379	118	0	0	0
1996	0	62,258	73,033	7,049	1,071	5	0	0
1997	0	101,962	42,158	5,548	3,399	3	0	0
1998	0	70,820	52,411	1,254	20	2	7	0
1999	0	51,742	24,193	4,747	231	74	0	0
2000	0	90,792	8,850	3,193	220	1	0	0
2001	0	99,671	81,313	773	697	16	0	0
2002	1,728	93,947	54,388	6,951	44	3	0	0

Recreational gig fishery landings and catch-at-size were provided from the survey of the gig fishery conducted by the NCDMF in 2001 and 2002 (Watterson 2003). It was recommended by NCDMF staff biologists that the 2002 landings and catch-at-size estimates be projected back annually to 1991 as a proxy value. The consensus opinion of NCDMF staff biologists was that the gig fishery has been active since 1991 and no distinguishable changes in effort or landings have been evident (Table 8.12).

Landings and catch-at-size from the RCGL fisheries were provided for 2002 (Wilson 2003). These fisheries for southern flounder include large mesh gill nets, small mesh gill nets, shrimp trawls, and crab pots. The estimates obtained during 2002 will serve as a proxy for previous years of RCGL harvest of southern flounder until a sufficient time series of removal estimates have been established for the RCGL community (Chris Wilson, NCDMF, personal communication).

8.1.2.2 Weight-at-age

Overall weight at age (WAA), weight-at-age for January 1 (WAA-Jan1), and weight-at-age for the spawning stock biomass (WAA-SSB; February 1 birthdate) estimates were all based on estimates utilizing LVB growth model parameters for 1991-2002 (Table 8.13). Individual year calculations for all three weight-at-age matrices were attempted, but lack of model convergence for individual years by the NLIN algorithm resulted in the use of an overall model for all years.

Table 8.11. North Carolina recreational hook-and-line fishery catch-at-age.

Year	Age							
	0	1	2	3	4	5	6	7
1991	0	38,240	40,477	563	111	0	0	0
1992	0	15,303	16,397	5,328	413	53	0	0
1993	0	17,216	9,630	4,900	29	33	0	0
1994	0	40,975	27,064	2,070	295	76	0	19
1995	0	34,586	21,757	1,990	301	0	0	0
1996	0	26,206	28,151	2,706	554	0	0	0
1997	0	47,650	44,069	7,192	1,797	81	0	0
1998	0	25,594	19,046	672	115	0	0	0
1999	0	16,202	16,409	5,771	134	127	0	0
2000	0	119,538	16,100	7,709	1,753	109	0	0
2001	0	52,598	60,073	646	782	131	0	0
2002	0	65,178	42,910	8,077	490	0	0	0

Table 8.12. Recreational gig and RCGL catch-at-age for 2002 and used as proxy values from 1991-2001.

2002 Only	Age							
	0	1	2	3	4	5	6	7
Recreational Gigs	0	132,634	76,624	11,431	643	45	1	1
RCGL	842	55,734	20,340	1,370	7	1	0	0

8.1.2.3 Abundance Indices

Four survey-at-age (SAA) matrices for southern flounder were provided, two fishery-independent surveys and two fishery-dependent surveys. Both fishery-dependent surveys (flounder pound net and estuarine gillnet) and the Program 135 fishery-independent survey were positively correlated (Proc CORR; SAS Institute 1999) with the CAA (Table 8.14). The Program 120 juvenile abundance survey indicated a slight negative correlation with the CAA (Table 8.14), however, this is easily explained by comparing the CAA (Table 8.6) to the SAA (Table 8.15). The Program 120 SAA included values for all 12 years of the survey (1991-2002), whereas the CAA provided non-zero values for only 6 years for 1991-2002.

8.1.2.3.1 Juvenile Abundance Index (Fishery Independent)

Program 120 (NCDMF Juvenile Survey: 1991-2002) is otter trawl sampling at fixed stations in primary nursery areas from Roanoke Island to Cape Fear conducted annually to characterize year class strength of estuarine dependent fishes. Southern flounder captured in this survey are almost all young of the year (Table 8.15); the single catch-per-unit-effort (CPUE) from this survey represents age-0.

Table 8.13. Growth and population parameters for use in the ADAPT/VPA model.

VPA Inputs	Age							
	0	1	2	3	4	5	6	7
WAA (kg)	0.2980	0.7905	1.8188	3.1718	4.7162	6.3318	7.9265	9.4373
Jan1 WAA (kg)	0.1906	0.4337	1.2561	2.4630	3.9282	5.5216	7.1363	8.6952
SSB WAA (kg)	0.1906	0.4852	1.3435	2.5771	4.0577	5.6566	7.2692	8.8209
Natural Mortality	0.4040	0.4040	0.4040	0.4040	0.4040	0.4040	0.4040	0.4040
Maturity (%)	0.0000	0.5900	0.7900	1.0000	1.0000	1.0000	1.0000	1.0000

Table 8.14. Pearson correlation coefficients of SAA vs. CAA for southern flounder (α=0.05).

Survey	SAA VS CAA Correlation Coefficient	p-value
Flounder Pound Net	0.88081	<0.0001
Estuarine Gill Net	0.98438	<0.0001
Program 120	-0.24328	0.5282
Program 135	0.83856	<0.0001

Table 8.15. Survey-at-age for Program 120 and Program 135.

Program	Year	Age				
		0	1	2	3	4
120	1991	1.08	-----	-----	-----	-----
	1992	2.35	-----	-----	-----	-----
	1993	2.82	-----	-----	-----	-----
	1994	1.61	-----	-----	-----	-----
	1995	1.53	-----	-----	-----	-----
	1996	7.55	-----	-----	-----	-----
	1997	2.49	-----	-----	-----	-----
	1998	0.74	-----	-----	-----	-----
	1999	2.34	-----	-----	-----	-----
	2000	3.46	-----	-----	-----	-----
	2001	4.06	-----	-----	-----	-----
	2002	4.07	-----	-----	-----	-----
135	1994	1.48	43.15	9.97	0.63	0.02
	1995	6.21	58.89	6.46	0.40	0.00
	1996	0.15	11.24	4.06	0.17	0.00
	1997	1.83	53.21	5.93	0.95	0.43
	1998	0.73	39.06	10.23	0.05	0.00
	1999	0.45	10.33	3.47	0.48	0.02
	2000	6.44	33.07	0.89	0.10	0.00
	2001	5.49	53.35	16.93	0.00	0.04
	2002	4.66	60.33	15.97	2.42	0.00

8.1.2.3.2 Albemarle Sound Gillnet Survey (Fishery Independent)

Program 135 (NCDMF F-56 Striped Bass Monitoring: 1994-2002) was designed to gather data on the striped bass, *Morone saxatilis*, population that spawns in the Roanoke River. However, sampling methodology is randomized and there is a large enough catch of southern flounder within the program to produce a credible CPUE value for 1994-2002. This program provides indices for ages zero through four (Table 8.15).

8.1.2.3.3 Flounder Pound Net (Fishery Dependent)

The NCDMF Trip Ticket program provided trip (effort) data that was combined with the NCDMF biological program 432/442 (NCDMF Commercial Finfish Assessment: 1991-2002) commercial numbers-at-length (catch) to develop a survey-at-age for the flounder pound net fishery (Table 8.16). This survey provides indices for ages zero through seven.

8.1.2.3.4 Estuarine Gillnet (Fishery Dependent)

The NCDMF Trip Ticket program provided trip (effort) data that was combined with the NCDMF Biological Program 461 (NCDMF Commercial Finfish Assessment: 1991-2002) commercial numbers-at-length (catch) to develop a survey-at-age for the estuarine gillnet fishery (Table 8.16). This program provides indices for ages zero through five.

8.1.2.4 Population Parameters

8.1.2.4.1 Natural Mortality

An estimate of natural mortality (M) was calculated using several established approaches (Pauly 1980, Hoenig 1983). Pauly's (1980) method, which determines M from maximum length, growth rate, and mean ambient water temperature predicted M_{female} = 0.387. Hoenig (1983) provide methods of estimating M based on the lifespan (longevity) of a fish, with the assumption that M = Z (no fishing mortality) since the natural lifespan of an exploited fish stock is difficult to determine. Longevity can be defined as the maximum survival age of the fish. If we assume the maximum age for southern flounder is age 10, 1+ the age of the oldest sampled southern flounder in North Carolina, then M = 0.421. An average of the two estimates of female natural mortality (M_{mean} = 0.404; Table 8.9) was chosen for estimating biological reference points (Table 8.13).

8.1.2.4.2 Maturation Schedule

Monaghan and Armstrong (1999) established a maturity schedule for female southern flounder in North Carolina by fitting a logistic model to observed maturity at age:

$$\%\ \text{mature} = \frac{1}{1+e^{(-R(TL-L_{50}))}}$$

Table 8.16. Survey-at-age for the commercial flounder pound net fishery, and the commercial gill net fishery.

Gear	Year	Age 0	1	2	3	4	5	6	7
Pound Nets	1994	0.00	88.51	62.31	4.84	0.20	0.01	0.00	0.00
	1995	4.80	59.33	42.25	4.09	0.10	0.00	0.00	0.00
	1996	0.00	33.11	50.33	6.77	1.09	0.01	0.00	0.00
	1997	0.00	50.64	32.73	6.36	2.06	0.00	0.00	0.00
	1998	0.00	60.70	59.38	2.25	0.04	0.00	0.01	0.00
	1999	0.00	47.96	39.73	14.06	1.12	0.37	0.00	0.00
	2000	0.00	93.29	16.23	7.65	0.86	0.00	0.00	0.00
	2001	0.00	76.03	88.33	0.51	1.38	0.05	0.00	0.00
	2002	11.70	85.11	60.66	10.14	0.06	0.01	0.00	0.00
Gill Nets	1994	0.62	20.65	10.15	0.49	0.04	0.00	0.00	0.00
	1995	0.08	17.34	6.71	0.35	0.01	0.00	0.00	0.00
	1996	0.00	11.22	10.01	0.51	0.07	0.00	0.00	0.00
	1997	0.00	14.94	7.34	0.87	0.36	0.00	0.00	0.00
	1998	0.19	17.16	12.03	0.23	0.01	0.00	0.00	0.00
	1999	0.00	14.67	9.02	1.59	0.07	0.03	0.00	0.00
	2000	0.00	27.72	2.14	0.62	0.08	0.00	0.00	0.00
	2001	0.00	17.49	12.08	0.03	0.10	0.00	0.00	0.00
	2002	0.29	19.30	8.98	0.69	0.00	0.00	0.00	0.00

where R is the rate of change, TL is total length (mm), and L_{50} is the length at which 50% of the fish are expected to be mature. Their results indicate that 0% of age-zero females, 59% of the age-one females, 79% of the age-two females, and 100% of age-three and older females are reproductively capable (Table 8.13). The size at which 50% of southern flounder females are mature (L_{50}) was estimated to be 345 mm (13.6 inches).

The ratio of ovary weight to body weight (gonado-somatic index or GSI) was used by Monaghan and Armstrong (2000) to define the southern flounder spawning season. Over the course of the year, GSI increases gradually, beginning in the fall and then drops sharply between February and March suggesting that peak spawning occurs in February. February 1st was utilized as the theoretical birth date for this assessment.

8.1.3 Assessment Model

8.1.3.1 VPA/ADAPT

The VPA/ADAPT software 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. The iterative re-weighting option was not used. Uncertainty in model estimates of abundance and fishing mortality were evaluated through 1000 bootstraps trials within 80% confidence intervals and retrospective analysis. Many combinations of the available survey indices were considered through sensitivity runs. The base model was selected based on examination of coefficients of variance (CV) for terminal abundance estimates and the ability to provide the most reliable estimates of population abundance.

8.1.3.2 Model Configuration and Measures of Precision

The base model includes catch at age for 1991-2002 and 11 survey tuning indices at age. Tuning indices include the Program 120 juvenile CPUE (age-0), flounder pound net CPUE for ages 1-5, and Statewide commercial gill net CPUE for ages 1-5. None of the indices are lagged, and all end in 2002. The age-0 CPUE for the fishery dependent surveys and all Program 135 indices were dropped from the model due to their consistent trend to drive the model estimates to unreasonably high levels of uncertainty. The flounder pound net CPUE's for ages 6 and 7 were dropped due to zero values in many years.

Flounder pound net CPUE's for 1999 were omitted (replaced with zeros, which the model treats as missing values) because catchability apparently increased that year (Figure 8.1 – survey values for ages 3-5 years show a spike across ages for 1999). Catchability should refer to the abundance of southern flounder in the fishery, but not to their availability. Though it is not uncommon for individual age CPUE values within a particular year to contain noticeably higher values, spiked values for the majority of ages within the same year and fishery are considered erroneous data. Flounder pound net CPUE's for ages 3-5 were noticeably higher in 1999 than in any other years as a group, presumably related to the effects of effort and fishing behavior resulting from several hurricanes that occurred that year.

The mean squared residual was 0.32 with 86 df and a standard deviation of 0.57. Coefficients of variation for terminal abundance estimates range from $1.4e^{-14}$ for age 1 to $5.4e^{--2}$ for age 5. Coefficients of variation for survey catchabilities range from 0.058 for the CPUE from the gill net survey age-2, to 0.556 for the CPUE from the gill net survey age-5.

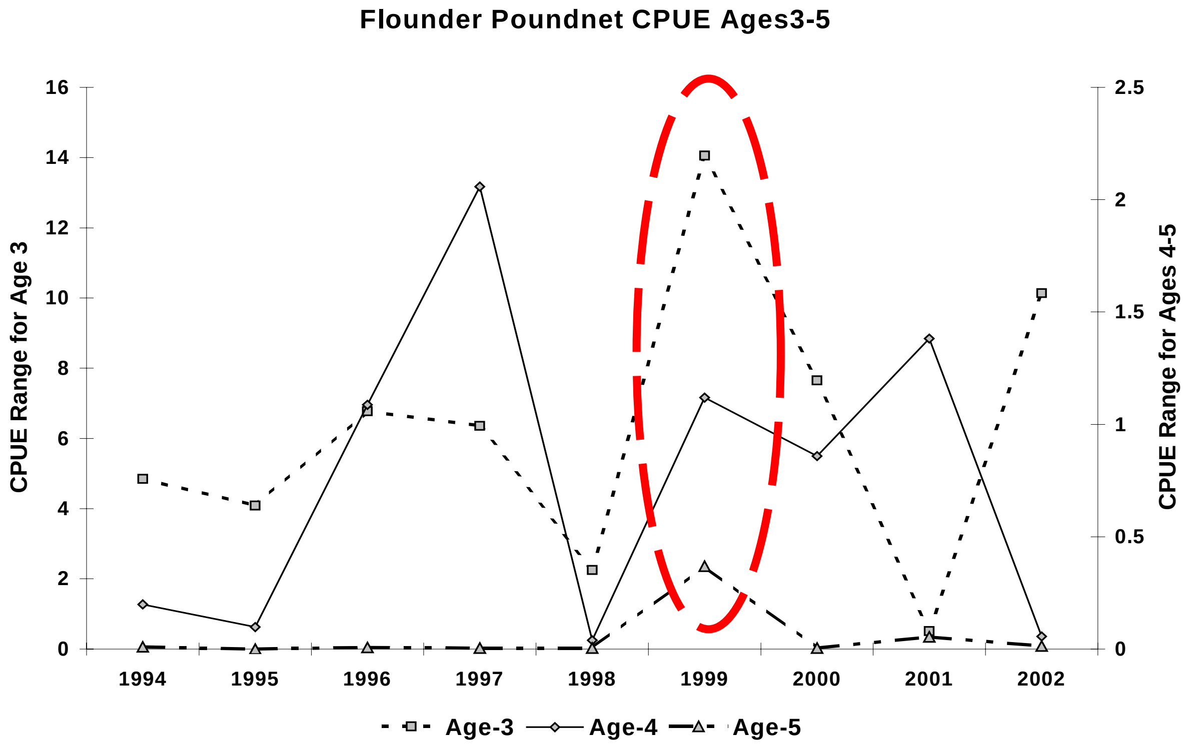


Figure 8.1. **Survey values for 1999, indicating higher catchability for ages 3-5 within the same year (dashed circle). This is a result of the survey reflecting availability during 1999, not abundance for which it is intended to represent.**

8.1.4 Results

8.1.4.1 VPA Base Model

8.1.4.1.1 Total Abundance

Population abundance declined from around 11 million in the early 1990s to just below 7 million in 1998 (Table 8.17, Figure 8.2). Estimated abundance has since increased, peaking at over 15 million in 2002. There is a possibility that abundance declined in 2003, although the terminal estimate (2003) is the most uncertain and must be viewed with caution.

8.1.4.1.2 Recruitment

Recruitment, measured as abundance at age-0, averaged 5.6 million from 1991-2003, with a low of 2.5 million in 1998 and high of 9.1 million in 2002 (Table 8.17). There was a steady decline from 1992 -1998, followed by an increase from 1998-2002 (Figure 8.3). Terminal year recruitment (2003) is estimated at 3.9 million.

Table 8.17. Estimated annual abundance at age of southern flounder based on ADAPT VPA, for 1991-2002.

	AGE								
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
1991	3,504,006	3,691,787	1,447,093	28,163	1,769	88	1	1	8,672,908
1992	6,510,226	2,338,746	1,633,207	156,066	5,023	178	2	2	10,643,450
1993	5,735,529	4,344,423	833,693	343,119	1,708	120	1	1	11,258,594
1994	5,904,762	3,828,609	1,416,894	91,797	4,416	230	1	26	11,246,735
1995	4,057,413	3,941,522	1,189,484	107,295	3,083	61	1	1	9,298,860
1996	5,890,324	2,707,831	1,426,906	148,561	17,065	272	6	6	10,190,971
1997	4,388,230	3,931,848	1,037,765	138,987	18,087	442	1	1	9,515,361
1998	2,496,324	2,929,093	1,499,270	60,818	1,913	81	115	1	6,987,615
1999	6,754,695	1,665,973	935,496	189,609	9,839	284	1	4	9,555,901
2000	5,745,997	4,509,049	354,906	117,720	11,721	275	1	1	10,739,670
2001	7,260,248	3,835,598	1,583,700	21,140	14,246	667	1	12	12,715,612
2002	9,105,856	4,846,578	1,576,124	211,290	828	277	13	6	15,740,972
2003	3,925,256	6,061,139	2,184,512	450,623	63,430	4	68	2	12,685,034

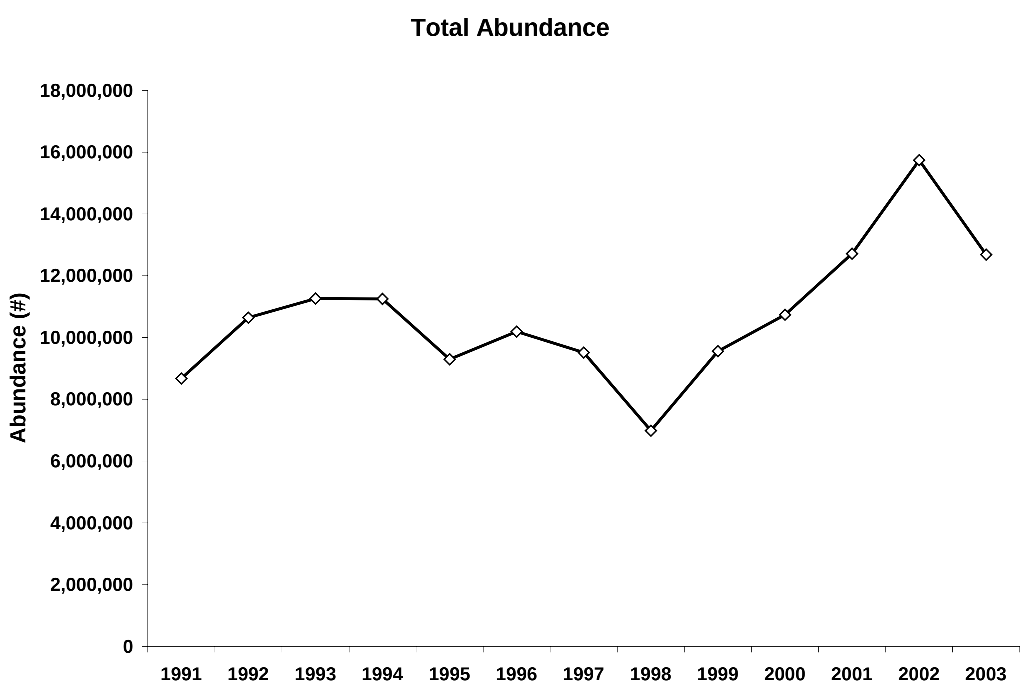


Figure 8.2. Estimated total abundance at age for southern flounder based on ADAPT VPA, 1991-2003.

Recruitment

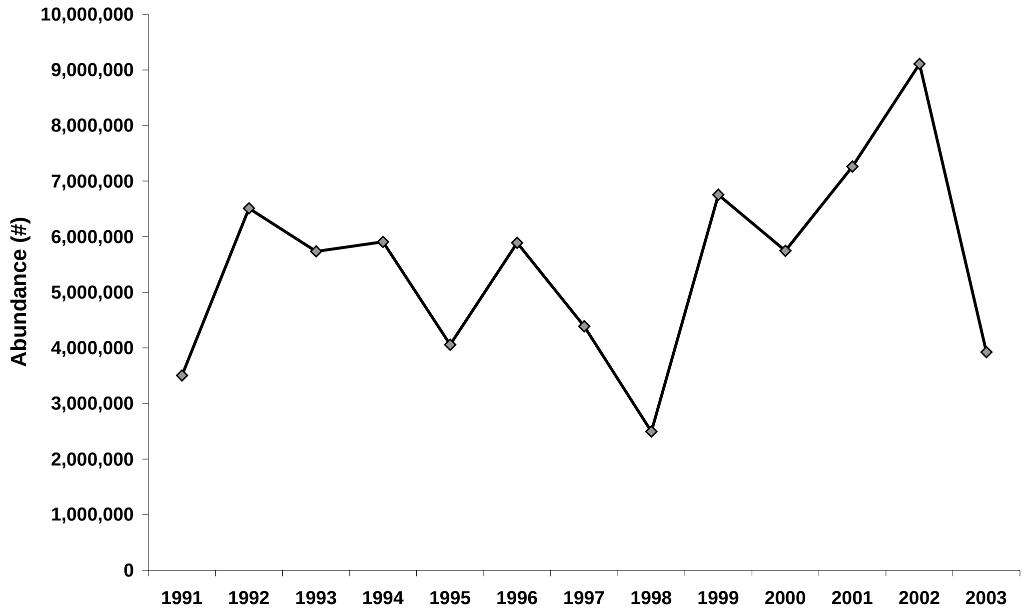


Figure 8.3. Recruitment, measured as abundance at age-0 for southern flounder, based on ADAPT VPA.

8.1.4.1.3 Spawning Stock Biomass

Spawning stock biomass dropped from 2.5 million pounds in 1993 to 1.6 million pounds in 1999, and has since increased to a series high of 3.3 million pounds in 2002 (Table 8.18, Figure 8.4), which represents the terminal year. The average from 1991-2002 is 2.3 million pounds.

8.1.4.1.4 Fishing Mortality

The ADAPT model estimates fishing mortality at each age for each year. Individual estimated values therefore reflect both selectivity by age and the annual exploitation rate. Further, model calculations dictate that annual estimated fishing mortality for the oldest age is equal to the value for the preceding age (i.e. one year younger than the oldest age), and that the value for the preceding age is based on the average of a specified function, not a free estimate. Therefore, it is necessary to select a range of ages over which annual fishing mortality at age can be averaged to provide a measure of the 'full' or 'fully recruited' annual fishing mortality for comparison with biological benchmark values estimated through subsequent analyses such as yield per recruit. By definition, this range should not include the oldest two ages. Examination of annual catch frequencies by age and size frequencies by age suggests that ages 0 and 1 are not fully recruited to the fishery, and should not be included in the averaging to determine fully recruited annual fishing mortality rate (F). The oldest age is 7, thus ages 6 and 7 should also not be

Table 8.18. Spawning stock biomass by year and age of female southern flounder based on ADAPT VPA.

Year	Age								Total
	0	1	2	3	4	5	6	7	
1991	0	987,669	1,276,688	62,902	5,930	359	8	10	2,333,566
1992	0	614,573	1,522,880	276,491	14,949	668	10	13	2,429,584
1993	0	1,133,229	736,787	616,127	5,867	466	8	9	2,492,493
1994	0	994,663	1,213,890	178,497	12,566	853	7	185	2,400,661
1995	0	1,037,078	1,062,274	237,376	10,227	286	9	11	2,347,261
1996	0	715,852	1,248,281	321,462	51,126	982	35	43	2,337,781
1997	0	1,039,001	870,367	250,972	46,864	2,234	7	8	2,209,453
1998	0	762,717	1,340,321	134,742	6,627	328	706	11	2,245,452
1999	0	419,471	835,970	387,839	29,670	1,027	8	32	1,674,017
2000	0	1,183,427	298,059	254,600	37,489	1,007	7	9	1,774,598
2001	0	1,019,877	1,422,099	41,635	41,686	2,276	9	90	2,528,122
2002	0	1,298,624	1,507,723	492,761	2,146	1,396	80	43	3,302,773

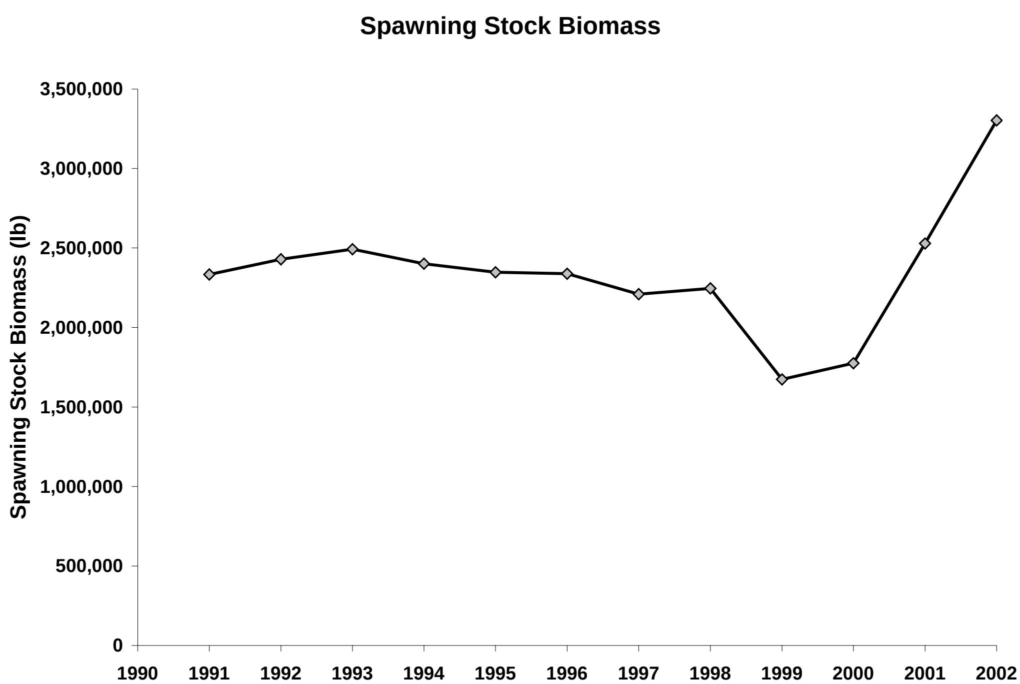


Figure 8.4. Spawning stock biomass by year of female southern flounder based on ADAPT VPA.

included in the averaging. Given these conditions, the average fishing mortality each year is appropriately estimated as the average of the estimated fishing mortality across ages 2-5.

Fishing mortality rates over ages 2 - 5 has varied without trend, averaging 2.69 for all ages (Table 8.19, Figure 8.5). Annual fishing mortality rates averaged over abundance for ages 2-5 averaged 1.86 for 1991-2002, while annual fishing mortality rates averaged over catch for ages 2-5 averaged 1.89 (Table 8.20). Terminal year F (2002) was 1.91.

8.1.4.1.5 Surplus Production

Simple surplus production averaged 3.3 million pounds from 1991-2002, compared to an average catch of 3.0 million pounds (Table 8.21). In 5 of the 12 years of analysis, catches exceeded surplus production; over the six-year period from 1993 – 1998, catches exceeded surplus production in every year except 1995 (Figure 8.6). The model suggests high surplus production in the last couple years reflective of increased total abundance. However, estimated abundance in the most recent years is considerably uncertain and this suggested stock improvement may not hold in subsequent years.

8.1.4.1.6 Stock Recruitment Relationship

A plot of recruitment (abundance at age-0) versus spawning stock biomass indicates essentially a random scattering of recruitment over the range of observed spawning stock biomass (Figure 8.7). While there may be, and likely is, a relationship between spawning stock biomass and recruitment, none is discernable in the available data. Therefore, no attempt was made to fit any formal stock recruitment models.

Table 8.19. Estimated fishing mortality by age and year, and averaged across ages 2-5 for southern flounder based on ADAPT VPA.

Year	Age								Average F 2,5
	0	1	2	3	4	5	6	7	
1991	0	0.41	1.82	1.32	1.89	3.58	1.81	1.81	2.16
1992	0	0.63	1.16	4.11	3.33	4.51	1.25	1.25	3.28
1993	0	0.72	1.8	3.95	1.6	4.1	2.1	2.1	2.87
1994	0	0.77	2.18	2.99	3.87	4.68	2.21	2.21	3.43
1995	0	0.61	1.68	1.43	2.02	1.94	1.65	1.65	1.77
1996	0	0.56	1.92	1.7	3.25	5	1.91	1.91	2.97
1997	0	0.56	2.43	3.88	5	0.94	2.54	2.54	3.06
1998	0	0.74	1.66	1.42	1.5	3.67	1.65	1.65	2.06
1999	0	1.14	1.67	2.38	3.17	5	1.77	1.77	3.06
2000	0	0.64	2.42	1.71	2.46	4.85	2.19	2.19	2.86
2001	0	0.49	1.61	2.84	3.54	3.51	1.63	1.63	2.87
2002	0	0.39	0.85	0.8	5	1	1.91	1.91	1.91

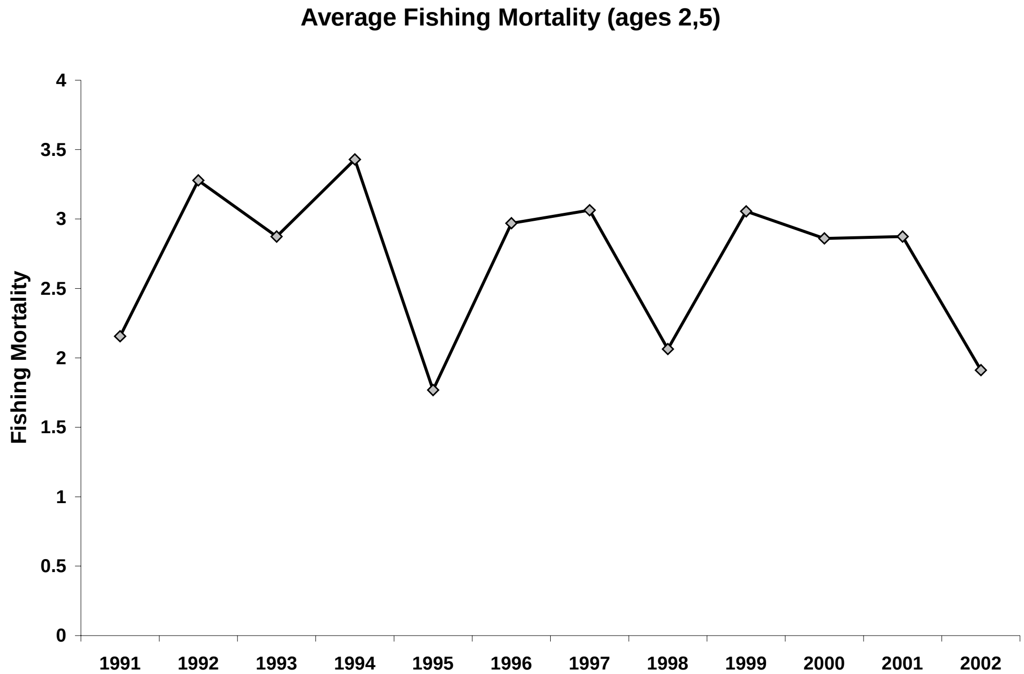


Figure 8.5. Estimated fishing mortality by year for southern flounder (ages 2-5) based on ADAPT VPA.

Table 8.20. Fishing mortality based on average F, abundance (N Wtd) and Catch (Catch Wtd) for southern flounder from ADAPT VPA.

Year	Average F	N Wtd	Catch Wtd
1991	2.16	1.81	1.82
1992	3.28	1.42	1.54
1993	2.87	2.43	2.52
1994	3.43	2.23	2.24
1995	1.77	1.66	1.66
1996	2.97	1.92	1.92
1997	3.06	2.64	2.71
1998	2.06	1.65	1.65
1999	3.06	1.80	1.83
2000	2.86	2.25	2.26
2001	2.87	1.64	1.65
2002	1.91	0.84	0.85
Mean	2.69	1.86	1.89

Table 8.21. Surplus production catch and biomass for southern flounder based on ADAPT VPA.

Year	Biomass	Catch	Surplus
1991	4,163,509	2,806,500	3,354,753
1992	4,711,762	2,930,826	3,096,126
1993	4,877,062	3,563,142	3,496,704
1994	4,810,624	3,642,532	3,085,540
1995	4,253,632	2,958,040	3,228,362
1996	4,523,954	3,106,834	2,843,886
1997	4,261,006	3,210,329	2,737,298
1998	3,787,975	3,067,979	2,972,331
1999	3,692,327	2,503,804	2,645,563
2000	3,834,086	2,251,778	3,566,106
2001	5,148,414	3,089,809	4,284,041
2002	6,342,645	2,750,917	3,888,681
Mean	**4,533,916**	**2,990,207**	**3,266,616**

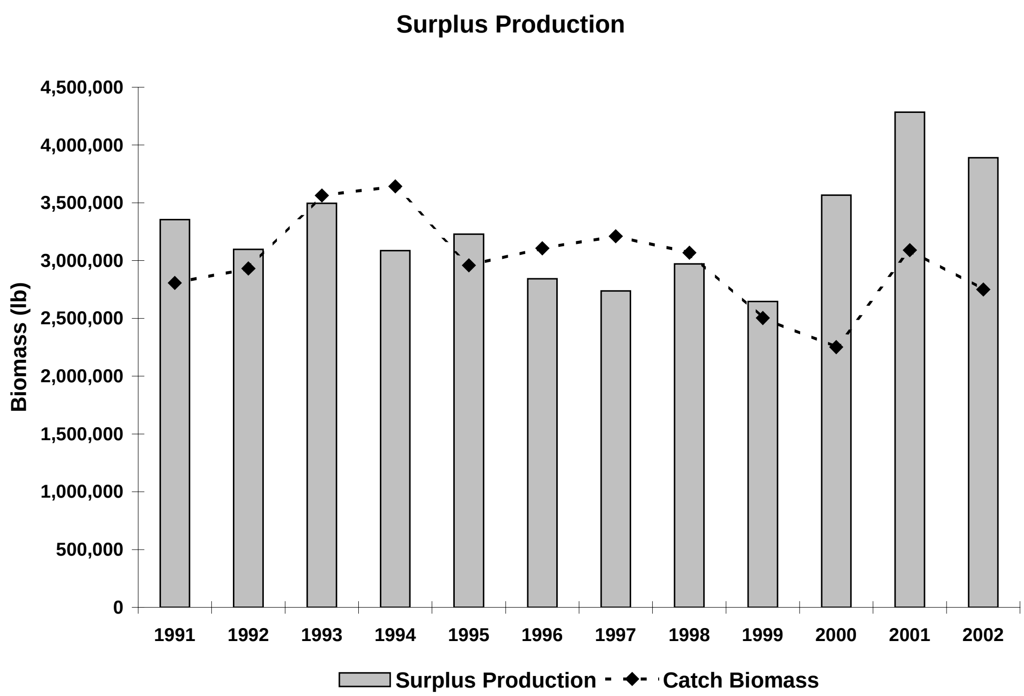


Figure 8.6. Mean surplus production and catch biomass for southern flounder based on ADAPT VPA.

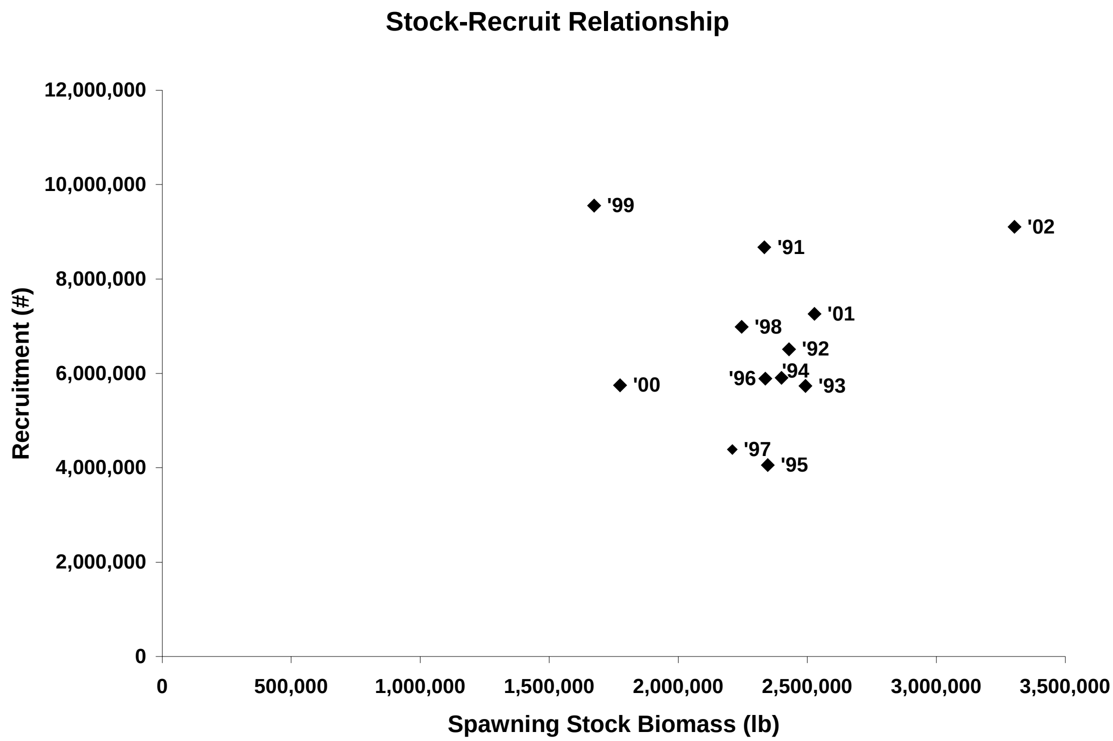


Figure 8.7. Stock-recruitment relationship for southern flounder based on ADAPT VPA.

8.1.4.1.7 Measures of Uncertainty

8.1.4.1.7.1 Bootstrap Estimates

Confidence intervals and bias estimates are provided by 1000 bootstrap iterations. Confidence intervals from bootstrapping are considered minimal estimates, only reflecting uncertainty among the observed data points and not incorporating uncertainty that likely exists around each data point or uncertainty in model configuration. The bias is a measure of the difference between the point estimate and the bootstrap mean. There is an 80% probability that 2002 fishing mortality over ages 2-5 was between 1.69 and 2.89, with a bias of 13.8% and a coefficient of variation (CV) of 0.23 (Table 8.22). There is an 80% probability that 2002 spawning stock biomass was between 2.84 and 3.89 million pounds, with a bias of 2.3% and CV of 0.13.

8.1.4.1.7.2 Retrospective Analyses

There is no consistent retrospective bias in estimated terminal year fishing mortality. Terminal years 1998 and 1999 tended to underestimate fishing mortality, while terminal year 2000 and 2001 tended to overestimate fishing mortality (Figure 8.8). Spawning stock biomass is slightly overestimated in terminal year 1998, but there is no retrospective pattern evident for any other terminal years (Figure 8.9). Recruitment (age-0 abundance) does not show any consistent retrospective bias (Figure 8.10). There is a tendency in some terminal years to overestimate recruitment in the last few years by about 10%.

Table 8.22. Bootstrap estimates and bias intervals for Average F and SSB based on ADAPT VPA.

	Bootstrap Estimates	80% C.I. Lower	80% C.I. Upper	Percent Bias	C.V.
Average F	1.91	1.69	2.89	13.8	0.23
SSB	3,302,773	2,843,906	3,891,079	2.3	0.13

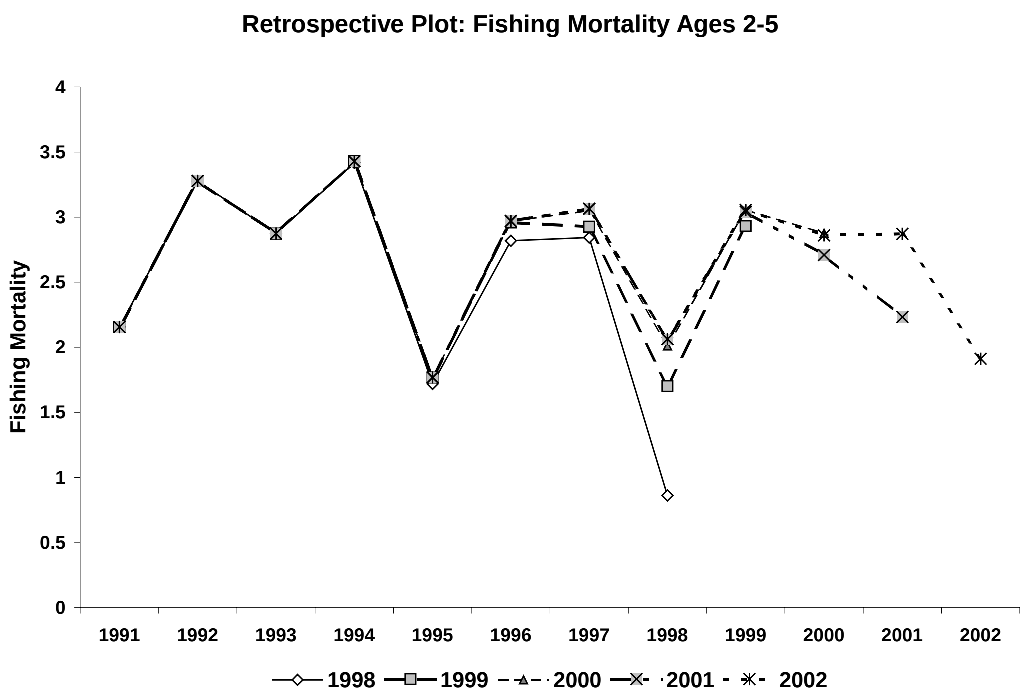


Figure 8.8. Retrospective trend in fishing mortality, for terminal years from 1998 to 2002.

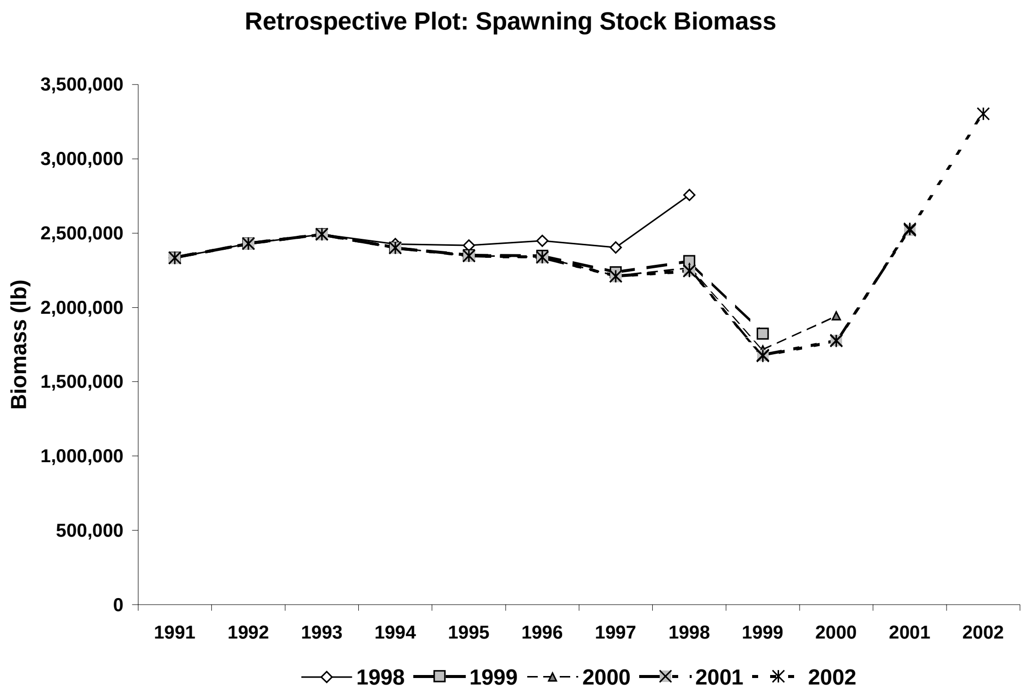


Figure 8.9. **Retrospective trend in estimated spawning stock biomass, for terminal years 1998 to 2002.**

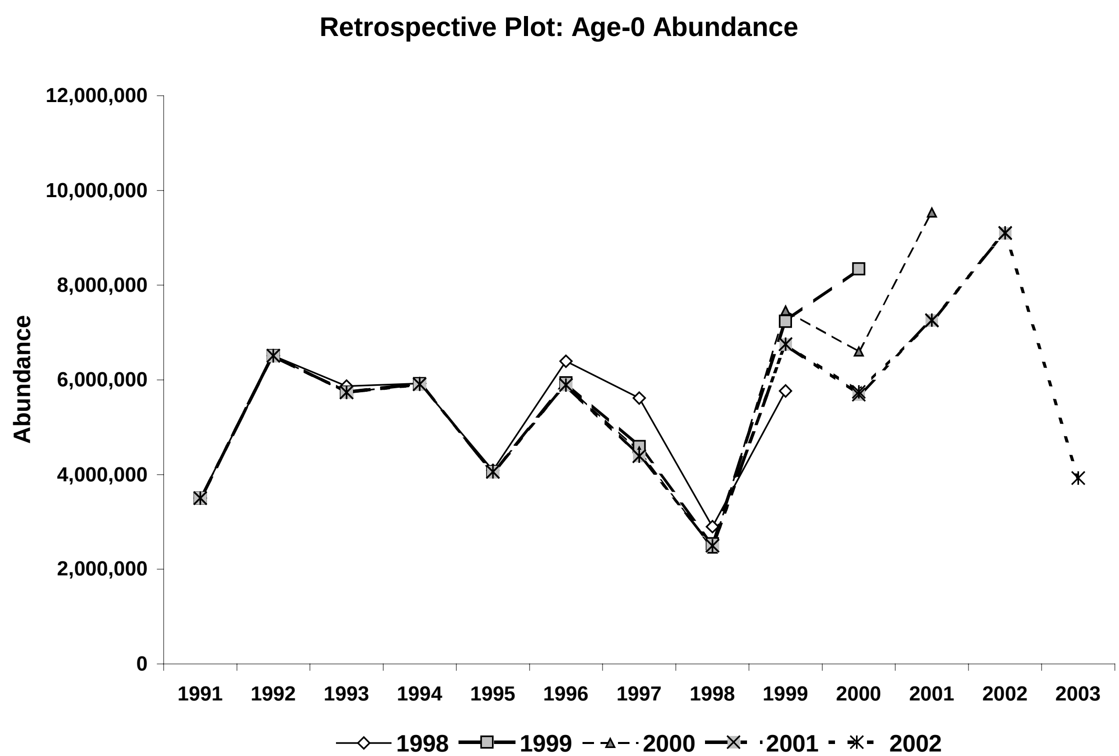


Figure 8.10 **Retrospective trend in estimated abundance of age-0 fish, for terminal years 1998 to 2002.**

8.1.4.2 Biological Reference Points

8.1.4.2.1 YPR and SPR

Yield-per-recruit (YPR) analysis provides biological reference points such as F_{max} and $F_{0.1}$ that allow evaluation of growth overfishing. YPR modeling was conducted using the weight at age calculated from the growth model based on data pooled across all years and fishery selectivity at age consistent with the input partial recruitment in the VPA model. F_{max} is estimated at F=0.52 and $F_{0.1}$ at 0.28 (Table 8.23).

YPR models can be extended to consider recruitment overfishing by including maturity at age. This allows estimation of reference points based on the percentage of the virgin spawning stock biomass (i.e. at F = 0) that is retained at any fishing mortality rate. Such reference points commonly include $F_{20\%}$ spawning potential ratio (SPR), that which retains 20% of the unfished spawning stock biomass (SSB), and $F_{30\%}$ SPR, that which retains 30% of the unfished SSB. Equilibrium fishing mortality rates associated with a range of percent SPR's from 20% to 30% are calculated, resulting in $F_{20\%}$ = 0.57, $F_{25\%}$ = 0.46, and $F_{30\%}$ = 0.38 (Table 8.23).

8.1.4.2.2 Estimation of Yield and Stock Biomass Reference Levels

No stock recruitment relationship is apparent over the range of observed data, and recruitment has varied without any consistent trend over the observed years. Therefore, it may be reasonable to calculate yield and stock biomass reference levels from the yield and SSB per recruit provided in the yield-per-recruit analysis and the average observed recruitment. Potential equilibrium yield calculated by this approach ranges from 3.1 million pounds at $F_{0.1}$ to 3.4 million pounds at F_{max} (Table 8.23). Reference spawning stock biomass levels range from 5.7 million pounds at $F_{20\%}$ to 10.9 million pounds at $F_{0.1}$ (Figure 8.11).

Table 8.23. Estimated spawning stock biomass and yield for various fishing mortality reference points, including 20, 25, and 30% SPR and the current fishing mortality.

	F	%SPR	SSB/r (lb)	Estimated SSB (lb)	Y/R (lb)	Estimated Yield (lb)
Fmax	0.52	23	1.11	6,255,635	0.61	3,400,628
F20%	0.57	20	1.01	5,668,929	0.61	3,395,745
F25%	0.47	25	1.26	7,072,129	0.60	3,390,132
F30%	0.38	30	1.51	8,473,365	0.59	3,336,305
F0.1	0.28	67	1.95	10,944,962	0.56	3,143,168
Fcurr	1.91	5.4	0.27	1,515,456	0.51	2,884,980

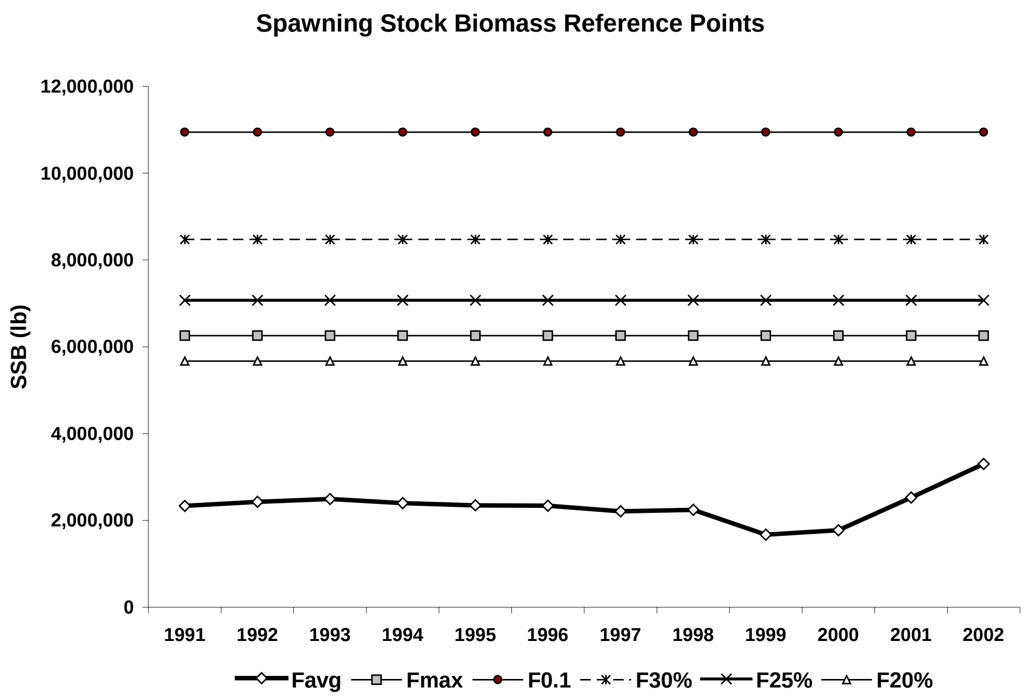


Figure 8.11. SSB reference points by fishing mortality levels for comparison to average annual F (F_{avg}).

8.1.4.2.3 Stock Status Determinations and FRA criteria

According to the FRA, population status should be evaluated on the stock's ability to produce the replacement SPR. Such an approach reflects stock biomass, and is typically used to determine whether or not a stock is overfished. Stocks are also evaluated based on the rate of removals, i.e. the fishing mortality rate, which typically determines whether or not overfishing is occurring. Actual reference levels for this stock will be determined through the FMP development process, and therefore only generalized statements are provided here. Based on the range of possible reference fishing mortality rates from $F_{0.1}$ to $F_{20\%SPR}$, a reasonable fishing mortality threshold for this stock is between F = 0.28 and F = 0.57. Estimated fishing mortality in all years between 1991 and 2002 exceeds the upper bound of $F_{20\%SPR}$ = 0.57, and thus overfishing likely occurred in every year. The average fishing mortality rate over 1991-2002 of F = 1.91 is well above the upper bound of reasonable reference mortality rates. Based on the reference SSB levels associated with the range of fishing mortality thresholds from $F_{20\%SPR}$ to $F_{0.1}$, a reasonable threshold spawning stock biomass is between 6.8 million pounds and 13.1 million pounds. Possible reference spawning stock biomass levels exceed the estimated spawning stock biomass in every year (1991-2002; Figure 8.11). Therefore, it is likely that the stock has been overfished since 1991.

Possible values for replacement SPR and sustainable harvest range from 3.8 million pounds at $F_{0.1}$ to 4.1 million pounds at F_{max}. Average yield from 1991-2002 is 4.4 million pounds, suggesting that the fishery is removing more than the population can reasonably be expected to produce.

8.1.5 Discussion

North Carolina southern flounder are overfished and overfishing is occurring. Total landings dropped from nearly 5.5 million pounds in 1994 to 3.5 million pounds in 1999. The low in 1999 is likely due to low abundance of the 1998 cohort, since about 60% of the harvest in most years is age-1 fish. There was a slight increase to around 4 million pounds since, supported by the increased recruitment since 1998. Landings since 1998 are below the 1991-2002 average of 4.4 million pounds.

The southern flounder fishery in North Carolina is largely dependent on incoming recruitment. Catch-at-age values indicate extremely high exploitation of age-1 and age-2 southern flounder in the North Carolina fishery, accounting for 95% of the total harvest. The exploitation of young fish is of special concern given that the maturity schedule for southern flounder indicates only 59% of age-1 and 79% of age-2 female southern flounder are sexually mature. Reliance on incoming recruitment to support the fishery also means the landings are subject to considerable year to year fluctuations as recruitment varies, and to declines whenever recruitment is poor. Landings declined by a million pounds from the mid- to late-1990s, with the lowest observed landings of the analytical period occurring in 1999 following the lowest observed recruitment in 1998. If the strength of the 2003 cohort is as poor as indicated, it is likely that future fishery landings, in 2004 and 2005, may also be quite low.

Fishing mortality in 2002 averaged over the reference ages (2-5) was 1.91 with an 80% probability that F was between 1.69 and 2.89. Fishing mortalities since 1991 have ranged between a low of 1.77 (1995) and high of 3.43 (1994). It is likely that overfishing has occurred every year since 1991.

Although the actual percent of the maximum spawning stock biomass necessary to prevent recruitment overfishing is debatable, the fact that fishing mortality rates exceeded F_{max} in every year provides clear evidence that the stock is being growth overfished. Furthermore, ninety-six percent of the harvest is ages 0-2, although 100% maturity does not occur until age-3. The average fishing mortality rate from 1991 – 2002 of F = 1.91 can be expected to retain about 5.4% of the maximum spawning stock biomass, well below the percentage of the spawning stock that is considered necessary to sustain most stocks.

To recover the spawning stock to an adequate level and prevent overfishing from occurring, the Southern Flounder Fishery Management Plan Development Team (PDT) selected $F_{20\%SPR}$ as the threshold rate for overfishing (Table 8.23). This rate is equivalent to the replacement SPR for the fishery. When F for a given year exceeds this level, then overfishing is occurring within the fishery. In addition, $F_{25\%SPR}$ was chosen as the target rate for fishing mortality, or the equivalent of the sustainable harvest for the fishery (Table 8.23). This is the rate at which the fishery should be operating. Continued fishing at this rate over time should restore the SSB to 25% of the level of a virgin (unfished) stock.

8.1.6 Research Recommendations

This assessment is based on the assumption that the North Carolina inshore stock may be treated as a unit stock, independent of regional fishery recruitment and harvest. A regional FMP and stock assessment by ASMFC would be useful in determining the overall status of the east coast southern flounder stock.

Fishery specific growth and aging data is useful in determining changes in catch-at-age by fishery, as well as spatial differences in weight-at-age and specific estimates of males versus females catch by fishery. An increase in fishery specific age, growth, and sex samples across all sizes with special attention to spatial specific information is needed to better quantify southern flounder life-history and fishery specific datasets.

The recreational gig fishery and RCGL estimates are based on one year of data. Due to the possibilities that these gears could account for a higher percentage of landings than other recreational and some commercial gears, direct yearly measurements of these fisheries are needed for future assessments.

Development of an annual fishery-independent survey (CPUE) for inshore adult flounder. Only Program 120 was able to contribute viable fishery-independent data to this assessment, but is only useful for juvenile abundance. Fishery-dependent data was heavily relied upon to tune the VPA model.

Discard losses can be a substantial portion of total stock removals, and will become even more influential if stricter restrictions on harvest of southern flounder are decided upon. Discard estimates were only available for the recreational hook-and-line and RCGL fisheries. Discard estimates from the commercial fishery are needed, as well as from the recreational gig fishery.

Natural mortality estimates for this assessment were based on a constant M across all ages. An age-specific natural mortality rate for southern flounder would improve estimates of recruitment and total population abundance.

Monaghan and Armstrong (1999) established a maturity schedule for southern flounder in North Carolina. This work should be updated regularly to determine if any changes in maturation schedules are occurring over time in response to harvest. In addition, a regional examination of southern flounder maturation should be initiated.

8.1.7 Abbreviations and Symbols

ADAPT A type of tuned VPA often used in assessment of North Atlantic fish stocks.

CAA Catch at age; fish captured by commercial and recreational fisheries represented in a numbers by age matrix.

CPUE	Catch per unit effort; used as an index of abundance.
F	Instantaneous rate of fishing mortality.
$F_{0.1}$	Optimal fishing mortality.
F_{max}	Fishing mortality that will produce the maximum yield per recruit.
M	Natural mortality; a measurement of the rate of removal of fish from a population from natural causes.
MSP	Maximum spawning potential; % MSP is the spawning stock biomass per recruit at a given F, divided by the SSBR at F=0. (also known as %SPR).
MSY	Maximum sustainable yield; the largest average catch that can be taken continuously (sustained) from a stock under average environmental conditions.
OY	The harvest level for a species that achieves the greatest overall benefits, including economic, social, and biological considerations. Sustainable harvest is different from MSY in that MSY considers only the biology of the species. The term includes both commercial and sports yields.
SAA	Survey at age; CPUE by age from fishery independent or dependent information.
SPR	Spawning potential ratio; the number of eggs that could be produced by an average recruit in a fish stock divided by the number of eggs that could be produced by an average recruit in an unfished stock.
SSBR	Spawning-stock biomass per recruit; how much spawning biomass an average recruit would be expected to produce.
SSB	Spawning-stock biomass; the total weight of the fish in a stock that are old enough to spawn.
VPA	Virtual population analysis, an age-structured assessment model characterized by cohort-wise computations backward in time; 'tuned' VPA also employs abundance indices to influence the estimate.
WAA	Weight at age; mean weight of fish by age.
YPA	Yield per recruit; a model that estimates yield in terms of weight, but more often as a percentage of the maximum yield, for various combinations of natural mortality (M), fishing mortality (F), and time exposed to the fishery.

8.2 Recovery Projections

8.2.1 Introduction

Age-structured projection models are used to evaluate the probable response and recovery of a fishery under a range of various management measures and are dependent on a reliable stock-recruitment relationship. A plot of southern flounder recruitment versus spawning stock biomass (Figure 8.7) indicates essentially a random scattering of recruitment over the range of observed spawning stock biomass. While there may be, and likely is, a relationship between spawning stock biomass and recruitment, none is discernable in the available data. This lack of a relationship may be attributed to the very high fishing mortality rate (F = 1.91) and the extraordinarily low spawning stock biomass (SSB = 5.4%), well below the percentage of the spawning stock that is considered necessary to sustain most fisheries. There are no historical data to guarantee what level of increase in recruitment would occur in response to an increase in southern flounder spawning stock biomass. In the absence of a reliable stock-recruitment relationship the age-structured model will produce a conservative recovery estimate because the absolute response to increased spawning stock biomass is unknown.

The age-structured model was used to project the population forward under several management regimes defined by the NCDMF Southern Flounder Plan Development Team. These regimes incorporated a combination of reductions in landings and increases in size-limits to rebuild southern flounder stocks within 10 years of plan implementation. Size-limits were addressed due to the high occurrence of age-1 southern flounder in the overall catch, of which only 59% are mature. The size at which 50% of southern flounder females are mature is 345 mm (13.6 inches).

8.2.2 Methods

Projections cover the time period 2004-2009. The population parameters were the same as those used in the VPA for the stock status report. Time-varying parameters, such as age-specific partial recruitment and fishing mortality were estimated. Age-specific partial recruitment was estimated based on a combination of size-at-age and size-at-time of year parameters. Fishing mortality rate reductions were based on the reflections of instantaneous mortality rates through annual mortality rate percentages, where F = 1.91 represents an annual mortality rate of 85.0%. The annual rate for $F_{threshold}$ (0.57) is 43.4%, and for F_{target} (0.46) the annual rate is 36.9%.

Projections were bootstrapped 1,000 times, and across bootstrap replicates the 10^{th}, 50^{th} (median) and 90^{th} percentiles were computed on spawning stock biomass, fishing mortality rates, and landings. The rebuilding criterion was based on the empirical recruitment of age-0 southern flounder.

8.2.3 Results

Spawning stock biomass increases at various rates throughout the recovery period in each of the management scenarios. In response to no fishing (F = 0.0), spawning stock biomass surpasses the overfishing F_{target} (F25%SPR) and $F_{threshold}$ (F30%SPR) by 2007 (Figure 8.12). A 45% reduction projects SSB reaching the $F_{threshold}$ by 2007 and F_{TARGET} by 2008 (Figure8.13). The 30% reduction scenarios reaches $F_{threshold}$ by 2008 (Figure 8.14). Finally, the 20% reduction scenario increases SSB slowly and begins to apex by 2009, below the $F_{threshold}$, unlikely to reach the 10-year target (Figure 8.15).

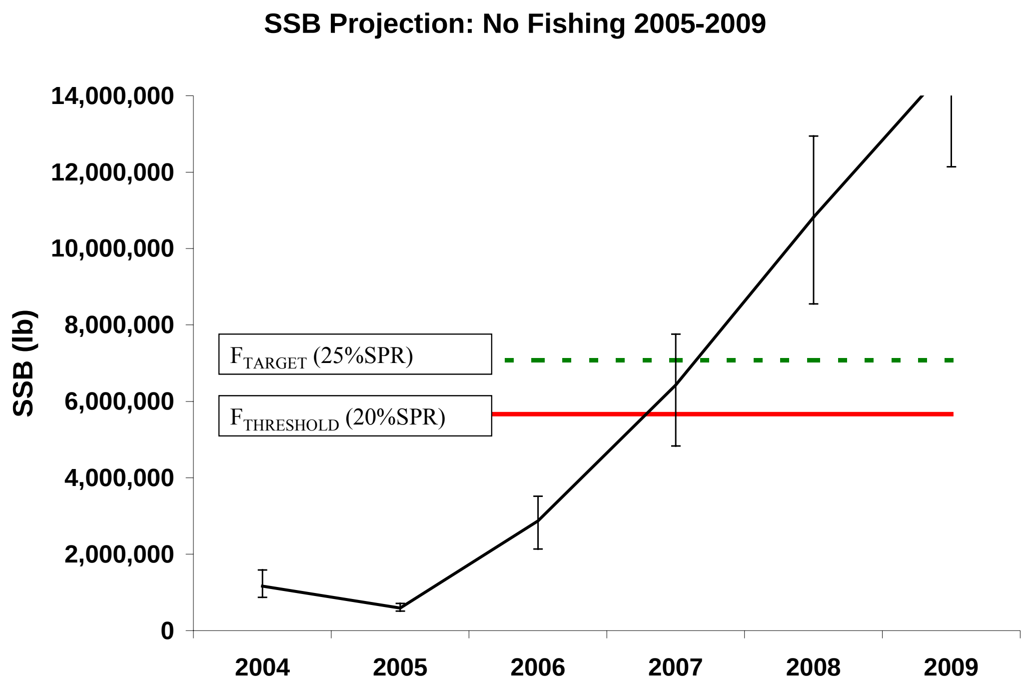


Figure 8.12. Projection of stock recovery if no fishing mortality beginning 2005.

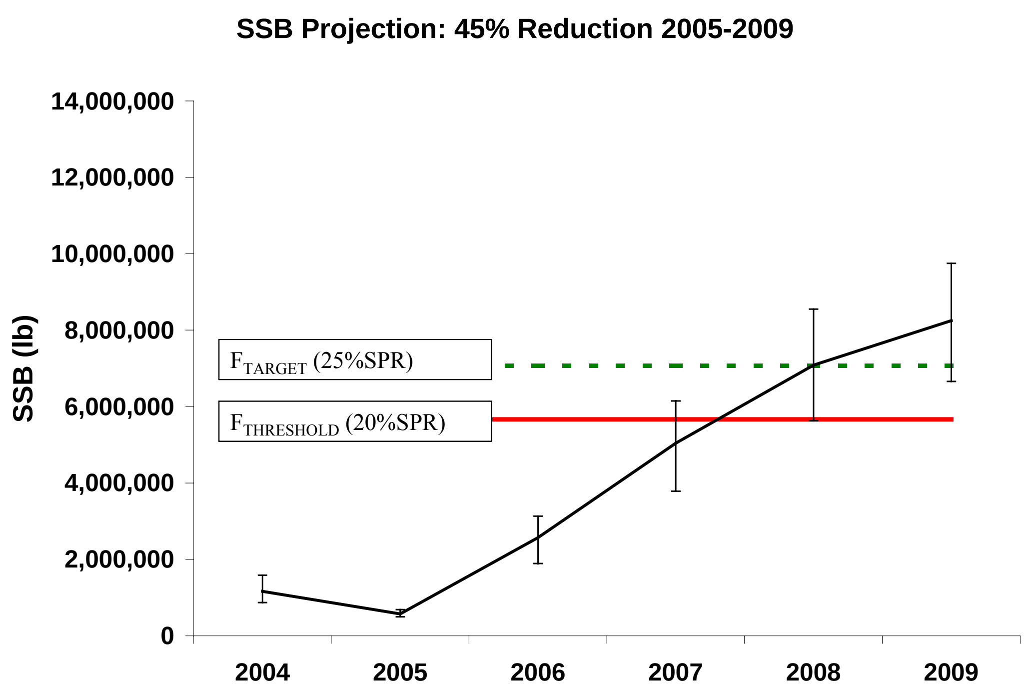


Figure 8.13. Projection of stock recovery with 45% reduction scenario beginning 2005.

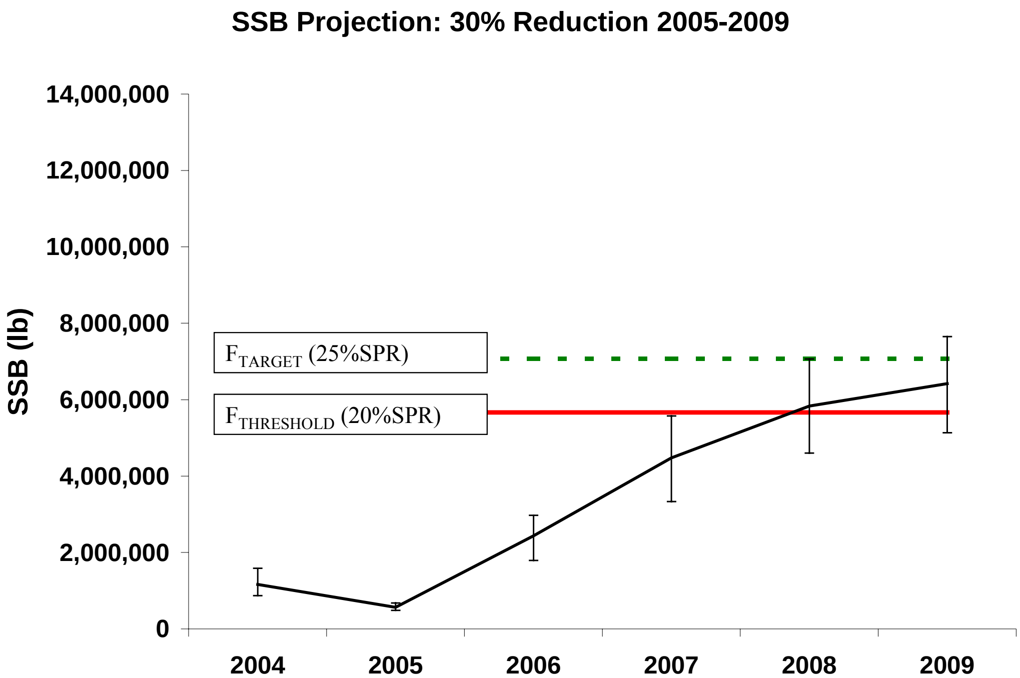


Figure 8.14. **Projection of stock recovery with 30% reduction scenario beginning 2005.**

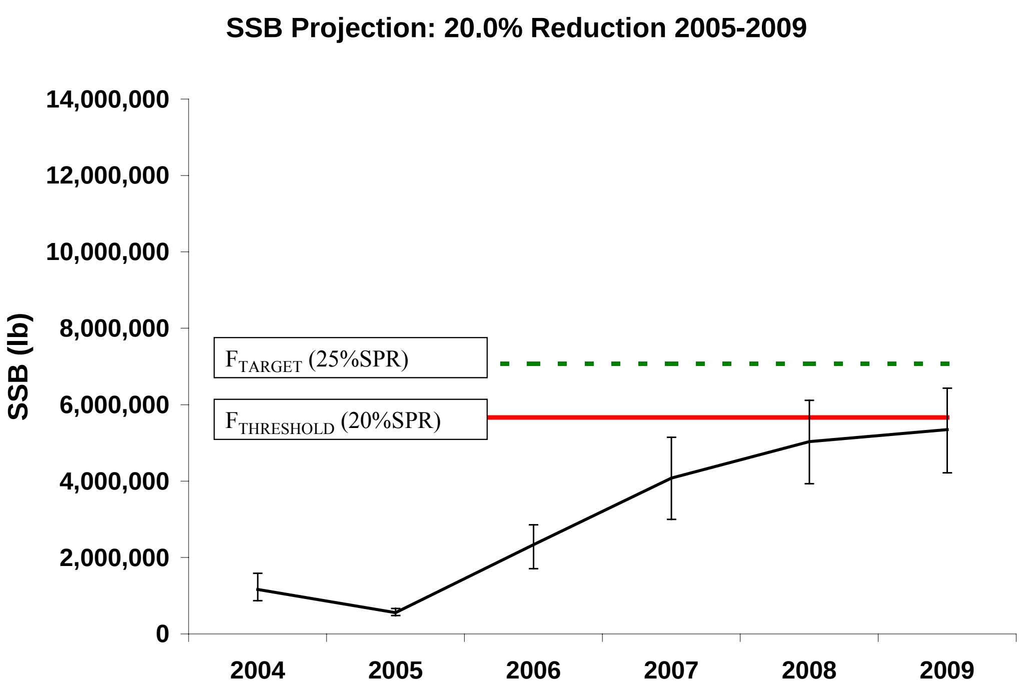


Figure 8.15. **Projection of stock recovery with 20% reduction scenario beginning 2005.**

8.2.4 Discussion

The goal of these projections was to explore four rebuilding strategies that may bring southern flounder to the SSB target within 10 years, including an increase in size limit above the 50% maturity level for female southern flounder (13.6 in). The accuracy of any projection relies on the validity of the model assumptions and the key signals in the assessment data. Projections assume that the estimated stock-recruit relationship applies into the future and that past residuals represent future uncertainty in recruitment. The lack of historical data to better depict the response of age-0 recruitment to an increase in spawning stock biomass emphasizes that the projections presented here are conservative. The 30% reduction scenario will achieve the threshold SSB within five years, however the 20% scenario mean is projected to peak before reaching the threshold. A re-assessment of our progress can be made after three years of a new management scenario to ground-truth projection results.

8.3 Determination of Sustainable Harvest

The FRA requires that each FMP include "conservation and management measures that prevent overfishing, while achieving, on a continuing basis, the sustainable harvest from each fishery." 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."

In this assessment, it is proposed that sustainable harvest can be achieved by fishing southern flounder at F_{target} (target mortality rate) and that overfishing will occur above replacement SPR at $F_{threshold}$ (threshold mortality rate). Yield per recruit analysis characterizes the average effects of fishing mortality on a population given our understanding of the species' growth rate and rate of natural mortality. Sustainable harvest and replacement SPR fishing mortality rates were chosen by the PDT through yield-per-recruit analysis. The rates chosen were $F_{20\%SPR}$ as the $F_{threshold}$ and $F_{25\%SPR}$ as the F_{target}.

9. ENVIRONMENTAL FACTORS

9.1 Physical Habitat Preferences and Threats

Habitat use patterns of southern flounder (*P. lethostigma*) vary over time, space and by lifestage. The species typically spawns in early winter over shoals in the nearshore ocean. Water circulation passively transports planktonic flounder larvae through ocean inlets to interior coastal waters, and developing fry pass into the estuary in late winter (Peters et al. 1995). Post-larval flounder actively move to shallow, nearshore waters in the upper regions of low to moderate salinity estuaries (Walsh et al. 1999), the majority of which are designated by State resource managers as fish nursery areas (Figure 9.1a-c). The relatively turbid water typical of this region likely provides a certain degree of protection for small flounder from visual-searching predators. As the flounder's body size increases, the likelihood of their survival in lower, less turbid regions of the estuary may increase. Juvenile southern flounder prefer waters above mud bottoms along the edge of salt/brackish marsh, near areas with shell bottom substrate and submerged aquatic vegetation (SAV) (Pattilo et al. 1997, Minello 1999, Walsh et al. 1999, Peterson et al. 2003). However, juvenile and adult southern flounder are also abundant in deeper

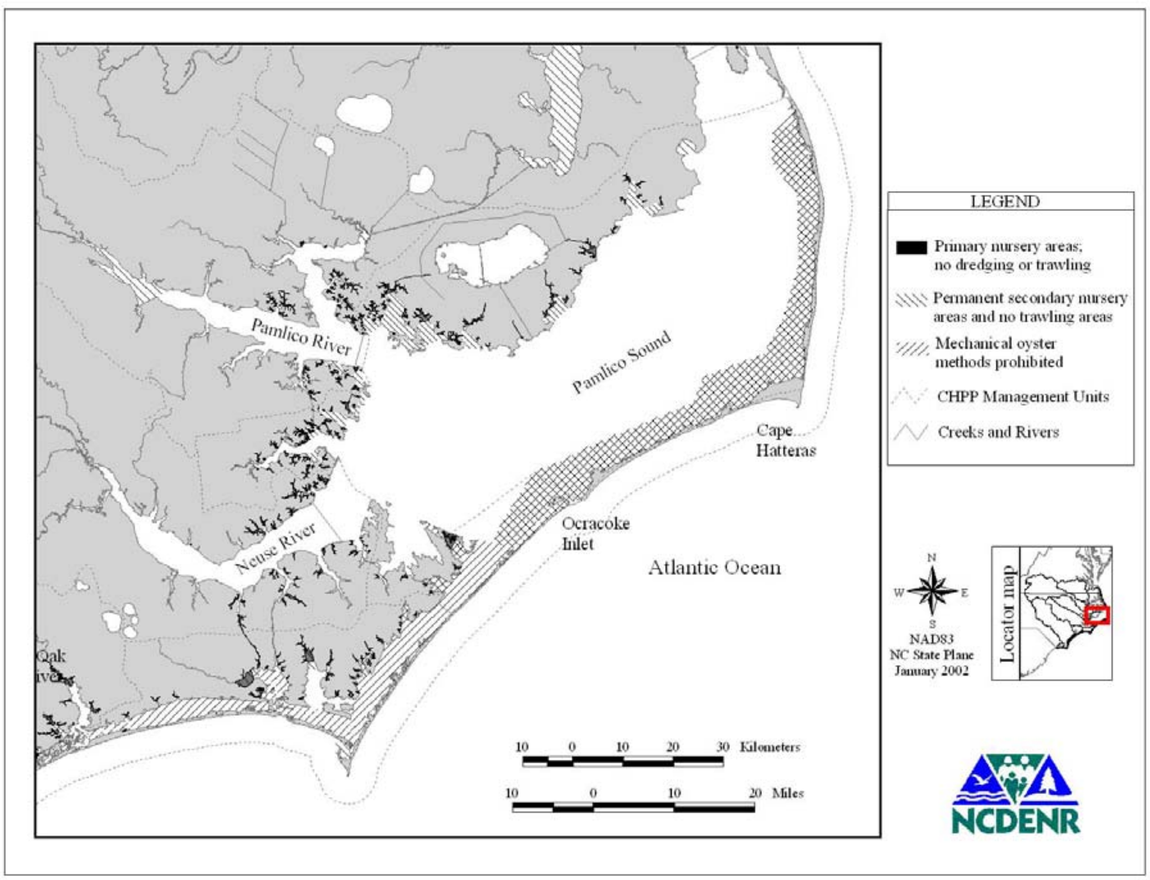


Figure 9.1(a). Areas where mechanical oyster harvesting and bottom trawling are prohibited in Pamlico Sound, North Carolina.

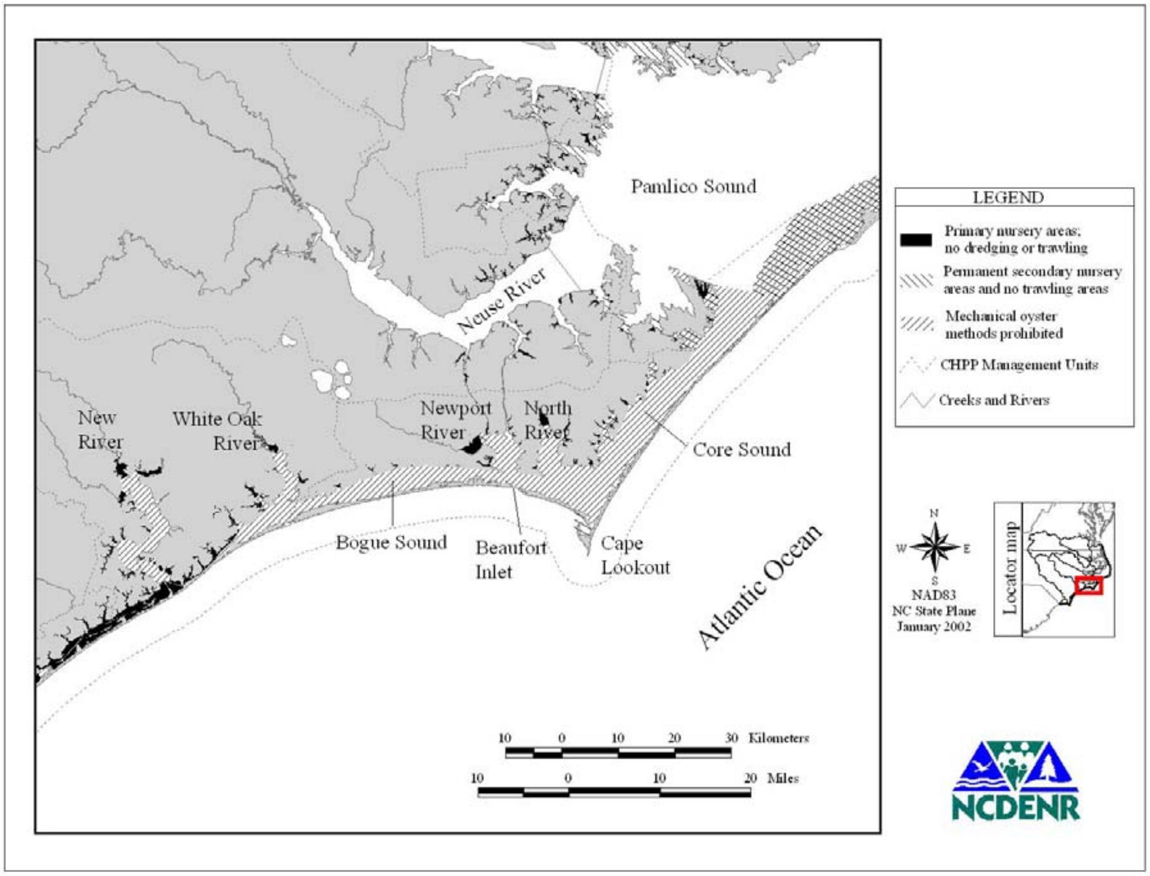


Figure 9.1(b). Areas where mechanical oyster harvesting and bottom trawling are prohibited in Core/Bogue Sound and New/White Oak River, North Carolina.

waters away from shore (NCDMF Pamlico Sound and Estuarine Trawl surveys, unpublished data) (Figure 9.2a-b). Despite differences in methodology, multi-year surveys conducted by the NCDMF have noted consistent prevalence of southern flounder in areas of high salinity within Core Sound's tidal bays and creeks (Noble and Monroe 1991). The diet of this predatory demersal species consists of mainly fish (including mullet, menhaden, shad, anchovies, pinfish, mojarra, croaker), crabs (including blue, mud, and stone crabs), mysids, molluscs, penaeid shrimp, and amphipods (Peterson et al. 1979). In addition to providing a valuable fishery resource, adult southern flounder serve as prey to a variety of vertebrate species, including shark, dolphin, goosefish, and large wading birds.

Southern flounder habitat is lost or degraded by a number of activities, including, but not limited to, bulkhead construction, dredging for navigational purposes and fishery harvest, trawling activities, and inlet stabilization.

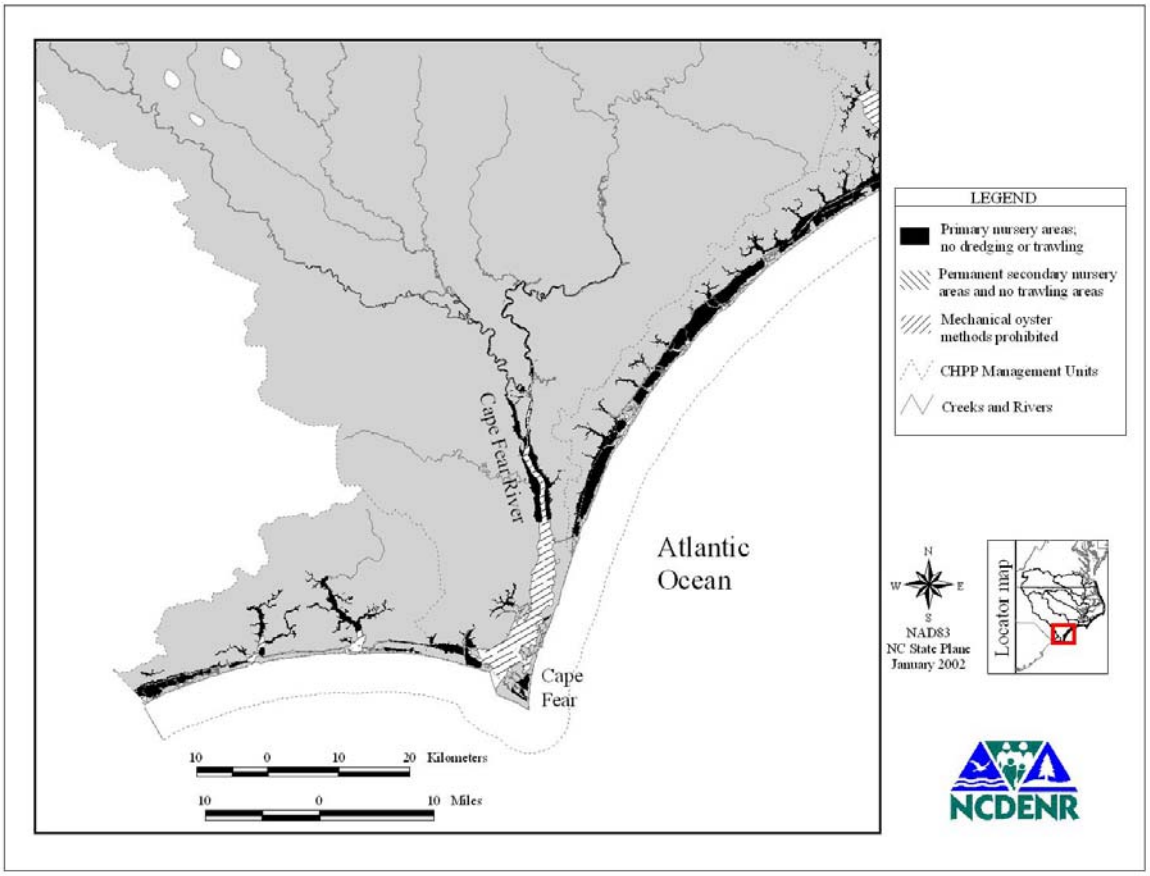


Figure 9.1(c). Areas where mechanical oyster harvesting and bottom trawling are prohibited in the Cape Fear River and southern estuaries, North Carolina.

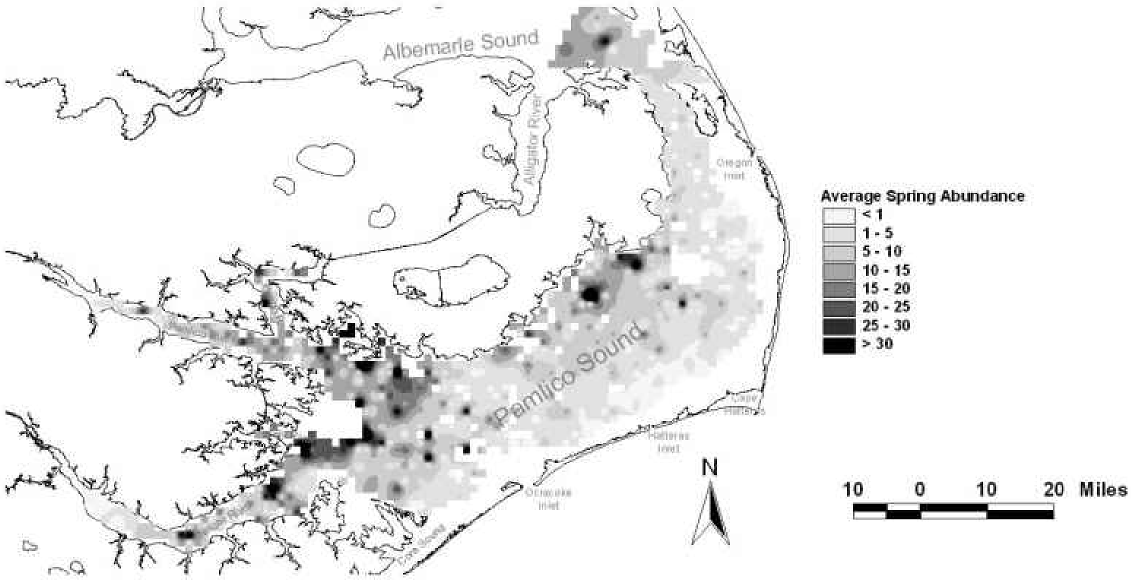


Figure 9.2(a). Average spring abundance of southern flounder less than 330 mm or 13 inches total length (TL) from the NCDMF Pamlico Sound Survey.

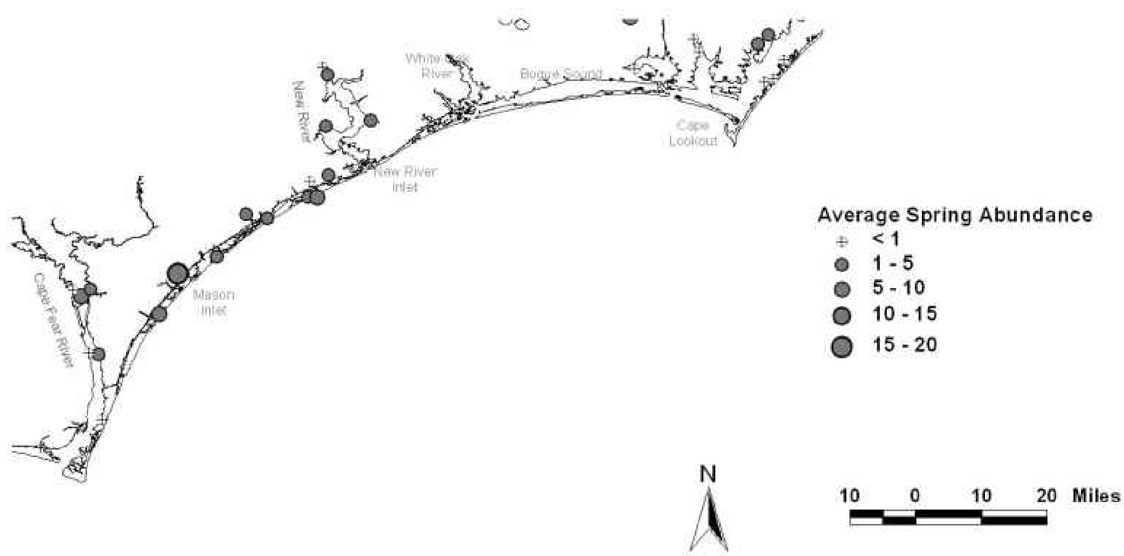


Figure 9.2(b). Average spring abundance of southern flounder less than 330 mm (13 inches) TL from the Estuarine Trawl Survey, southern North Carolina.

9.1.1 Bulkhead Construction

According to rules developed by the North Carolina Coastal Resources Commission (NCCRC), bulkheads must be constructed landward of coastal wetlands [NCCRC rule 15A NCAC 7H .0208 (b) (7)]. While such action prevents loss of existing marsh edge habitat, the landward migration of coastal marshes prompted by gradual sea level rise is thereby effectively inhibited. Furthermore, increased magnitude or rate of erosion on the fringing marshes remaining in front of bulkheads seems likely to occur. These consequences could result in the loss of important habitat for juvenile southern flounder. In North Carolina, between 1984 and 2000, the North Carolina Division of Coastal Management (NCDCM) issued permits to bulkhead approximately 457 miles or 735.47 km of shoreline. During this time period, the amount of bulkheading permitted annually along the coast is estimated to range from eight to 91 miles (12.87 to 146.45 km). Because the permits allow for repairs, replacements, or projects that have yet to be completed, the above figures may underestimate the actual shoreline distance affected by bulkheading. The total amount of bulkheading per county has ranged from less than one mile in Gates County to 109 miles (175.41 km) in Beaufort County. Beaufort, Dare, Carteret, and Currituck counties have the greatest total lengths of permitted bulkheads (Figure 9.3). In these counties, the percent of shoreline along major waterbodies that is potentially hardened by bulkheads ranges from roughly eight to 32 %.

Some alternatives to vertical stabilization are being encouraged by the NCDCM. The foremost alternative involves the creation of an offshore rock sill that serves to protect shallow, nearshore waters planted with marsh grass and SAV (i.e., ideal fish nursery

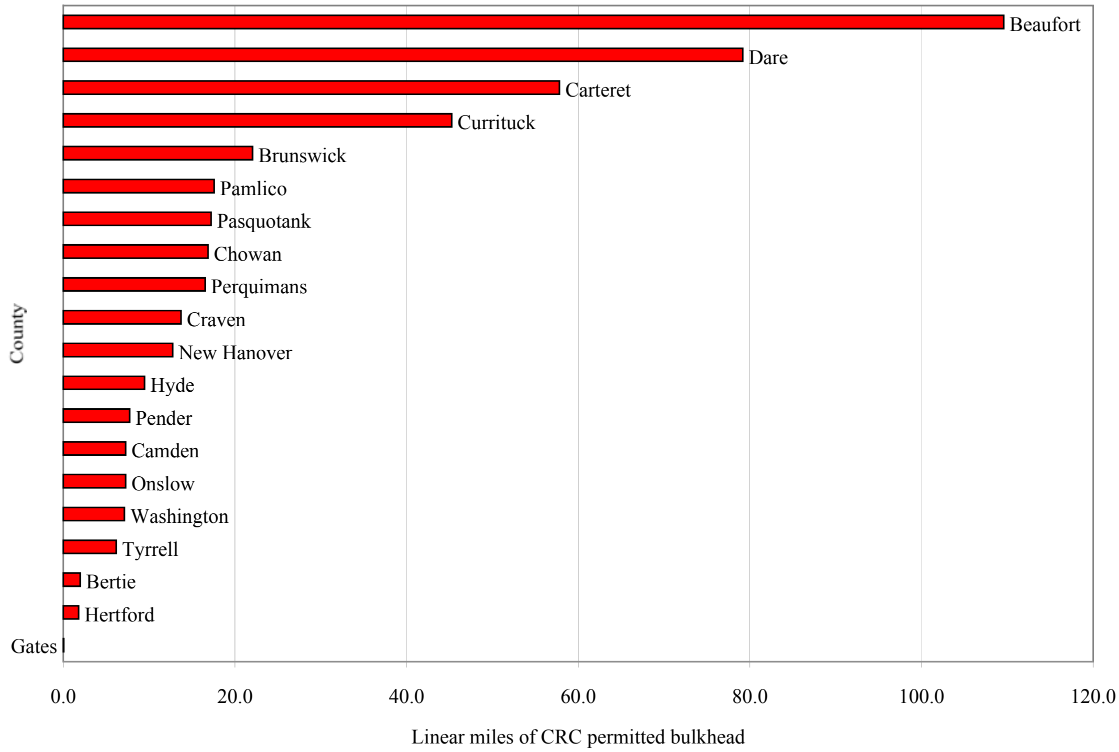


Figure 9.3. Linear miles of bulkheading permitted by selected counties in North Carolina (1986 - 2000).

habitat). An opening in the sill allows for fish use of waters within the enclosed area. The NCDCM promotes the construction of rock sills by requiring only a general permit. *The NCDCM should continue promoting the use of shoreline stabilization alternatives that maintain or enhance fish habitat. Oyster cultch or limestone marl should, if possible, be used in sill construction (i.e., granite sills fail to attract oyster larvae). To ensure protection of shallow nursery habitat for southern flounder, alternatives to vertical stabilization (i.e. rip rap) should be required around Primary and Secondary Nursery Areas. Hard vertical structures degrade nursery habitat by increasing erosion on the waterward marsh and eventually deepening the shoreline with gradual sea level rise.*

9.1.2 Dredging and Trawling

By physically disturbing the bottom, dredging has multiple effects on habitat and water quality, including, but not limited to, increasing the turbidity of the water, covering over nearby SAV and oyster beds with sediment, and facilitating the release of toxic chemicals potentially stored in the sediment into the water column. While the increased turbidity could temporarily enhance the refuge value of nursery habitats, it could also result in the loss of important foraging habitats. Newly settled larvae could be affected by toxic chemicals if dredging were conducted in contaminated areas during their peak immigration. Although dredging for new deep water access is prohibited in Primary

Nursery Areas (PNA) [NCCRC rule 15A NCAC 07H .0208 (b)(5)(B)], the activity is allowed to occur within many undesignated nursery areas. *The location and designation of nursery habitats should be continued and expanded by the NCDMF.* Oyster dredging, however, is prohibited in PNAs and Mechanical Methods Prohibited areas [NCMFC rule 15A NCAC 3N .0104 and 15A NCAC 3K .0204] (Figure 9.1a-c). The fishing practice occurs mostly over subtidal beds inside western Pamlico Sound and its tributaries. Bottom trawling also disturbs the bottom, in a fashion similar to that of dredging. Although shrimp trawls are used extensively throughout the State's coastal sounds and rivers (Cunningham et al. 1992), trawling is currently prohibited in PNAs and Secondary Nursery Areas (SNA) and in No Trawl Areas [NCMFC rules 15A NCAC 3N .0104-.0105, 15A NCAC 3J .0104, and 15A NCAC 3J .0200] (Figure 9.1a-c). Dredging and trawling can prevent or delay the natural recovery of oyster beds and SAV. *No Trawl Areas and Mechanical Harvest Prohibited Areas should be expanded to include recovery/restoration areas for subtidal oyster beds and SAV. Locating potential recovery/restoration sites will require modeling the physical and chemical parameters affecting oyster and SAV survival. Expansion and coordination of habitat monitoring efforts are needed to acquire the necessary data for such a model.*

9.1.3 Inlet Stabilization

In addition to physical loss of habitat, larval transport corridors can be threatened by inlet stabilization. Jetties alter the flow of water carrying larval flounder into interior waters (Hettler and Barker 1993, Peters et al. 1995, Blanton et al. 1999, Churchill et al. 1999, Hare et al. 1999). Water circulation patterns affecting settlement location are among the major factors determining post-larvae distribution (Ross 2003). Settlement in appropriate habitat is essential to the development and survival of larval fish. The relative value of inlets to settlement success is likely to vary by the volume of water entrained and by their spatial proximity to high quality estuarine habitat. Of the 20 inlets currently existing along North Carolina's coastline, four are stabilized with jetties. *Any proposed stabilization project threatening the passage of flounder larvae through coastal inlets should be avoided.*

9.2 Water Quality Requirements and Threats

Compared to other fish species, southern flounder are fairly tolerant of temperature extremes and low dissolved oxygen (Table 8.1). However, due to their behavioral tendency to lie upon the bottom, flounder are often exposed to anoxic and hypoxic conditions, as well as to possible toxins within the sediment. According to data from the North Carolina Division of Water Quality (NCDWQ), the greatest amount of impairment to coastal fresh water streams is due to excessive sediment loading and low dissolved oxygen. Fish kills are one of the more obvious indicators of habitat degradation and most of which have been attributed to low levels of dissolved oxygen.

Table 9.1. Values for selected physicochemical parameters suitable to or preferred by lifestages of southern flounder. Sources include Warlen and Burke (1990), Taylor (2001), Powell and Schwartz (1977), van Maaren et al. (1999), and Taylor and Miller (2001).

Parameter	Flounder Lifestage		
	Larva	Juvenile	Adult
Temperature (^{o}F)	46.4 - 50.0	77.0 - 84.2	34.2 - 93.4
Salinity (ppt)		0 - 17	0.5 - 18
Dissolved oxygen (mg/l)		>4	

9.2.1 Oxygen Depletion

Bottom water hypoxia occurs frequently during summer and fall months in the relatively deeper waters of the Neuse-Pamlico Estuarine System (Paerl et al. 1998). Moreover, low oxygen may also be attributed to ischemia or reduced blood flow in flounder, which is possibly responsible for the observed development of lesions on fish collected in the region (M. Law, personal communication).

9.2.2 Temperature

Southern flounder can typically survive in water temperatures approaching 50° F (10° C) and 44.6° F (7° C) for freshwater and saltwater, respectively (Prentice 1989). Despite their relative tolerance to cold, juvenile flounder overwintering in estuarine waters may experience mortality if the water temperature surpasses a minimum threshold. The temperature in freshwater rivers in North Carolina commonly drops below 50° F (10° C) from December to late March (USGS hydrological data). However, overwintering juvenile flounder may avoid cold waters by relocating to more saline water, where water temperature is generally higher. Although southern flounder can also tolerate a broad range of salinities (Table 9.1), extreme variation in salinity can be stressful. Physiologically stressed flounder are likely to be more susceptible to infection and death. Unfortunately, certain human activities that increase freshwater drainage have promoted excessive variability in estuarine salinity levels (Pate and Jones 1981).

9.2.3 Turbidity and Toxins

Because southern flounder are visual predators, excessive turbidity will likely reduce their ability to pursue and capture prey effectively. Sediment is a significant pollutant in North Carolina’s waters (NCDWQ 2000). Turbidity and sediment occur mainly in the upper region of estuaries, where they have relatively less effect on flounder stocks. Toxic chemicals can, however, adsorb to suspended particles, which allows the potential for their transport within the waters of the estuary. Sources of these toxic contaminants include agricultural runoff (pesticides), industrial discharges, stormwater runoff, and wood preservatives. In addition to the proposed pathological effects of ischemia (localized tissue anemia due to obstruction of the inflow of arterial blood), sediment contamination has been correlated with the development of lesions on adult southern flounder (Hackney et al. 1998). Nevertheless, larval southern flounder belong to the lifestage most vulnerable to mortality and sublethal effects associated with toxins. Low-salinity areas with poor water circulation (e.g., marina basins) may serve to prolong exposure of toxins to post-larval settlers. Currently, the majority of marina development occurs in lower salinity areas, areas that, despite their small size, may contain undesignated fish nursery areas. Marina development, however, is restricted in shallow, Primary Nursery Areas and shellfishing waters that are not permanently closed [NCCRC rule 15A NCAC 07H .0208 (5)(B)&(E)].

9.2.4 Nutrients

Coastal habitats and fish species, in general, are negatively affected by nutrient enrichment from land-based human activities (e.g., agriculture, lawn care, wastewater and stormwater discharge). Excess nutrients and sediment derived from these and other sources encourage the growth of microscopic organisms, such as blue-green algae and dinoflagellates. Fecal coliform contamination is also commonly associated with nutrient enrichment and turbidity (Mallin et al. 2000 & 2001a). Various monitoring programs have demonstrated increasing nutrient levels and greater prevalence of algae blooms in North Carolina estuaries (NOAA 1996, Spruill et al. 1998, Glasgow and Burkholder 2000, Mallin et al. 2001b). Overabundant algae reduces light penetration through the water column, which may limit the growth and distribution of SAV. While hypoxia and anoxia can occur naturally, eutrophication aggravates low-oxygen conditions. Moreover, the process of algal decomposition lowers dissolved oxygen which thereby increases the potential for fish kills. From 1996 to 2000, the annual number of reported fish kill events remained fairly consistent, ranging from 54 to 60 per year, but increased to 77 in 2001 (NCDWQ 2001). Flounder have been identified in a large number of coastal fish kills (NCDWQ 2001). Toxic dinoflagellate blooms encouraged by nutrient enrichment (Burkholder et al. 2001, Glasgow et al. 2001) also contribute to fish kills (Tyler 1989, Burkholder et al. 1995) and pose a danger to human health (Gratten et al. 1999). Recovery of southern flounder and other fish stocks may be limited by these anthropogenic changes in coastal ecosystems. *Both sediment and nutrient loading can be reduced by addressing multiple sources, including improvement and continuation of urban and agricultural Best Management Practices (BMP), more stringent sediment controls on construction projects, and implementation of additional buffers along coastal waters.*

9.3 Physical Habitat and Water Quality Protection

Protection of habitat critical to southern flounder falls under the authority of several state and federal agencies. The NCMFC has designated portions of the State's estuarine waters as PNAs and SNAs. Use of trawl nets, long haul seines, swipe nets, dredges, and mechanical harvest of shellfish is prohibited in PNAs and the use of trawl nets is prohibited in permanent SNAs (15A NCAC 3N .0104 and .0105). Special Secondary

Nursery Areas (SSNA) are protected from trawling between May 14 and August 16 each year. There are approximately 147,000 acres (59,488 hectares) of designated PNAs and SNAs (NCMFC rule 15A NCAC 3R .0103 - .0105) in North Carolina. These nursery areas are generally located in the upper portions of tidal creeks and rivers and may include coastal wetlands, shell bottom, and soft sub-tidal bottom, all of which are of great importance to juvenile, and to some extent adult, southern flounder. An additional 10,000 acres (4,046 hectares) of coastal streams under jurisdiction of the NCWRC are designated as Inland Primary Nursery Areas. These waters serve as PNAs designated by the NCMFC. Rules established by the NCCRC discourage authorization of projects that violate water quality standards or adversely affect the life cycle of organisms characterized as estuarine resources [NCCRC rule 15A NCAC 7H .0207]. Areas affected by these rules include PNAs, SAV beds, and oyster beds.

Waters designated as PNAs by the NCMFC or that have a special water quality classification by the North Carolina Environmental Management Commission (NCEMC), such as Outstanding Resource Waters (ORW) and High Quality Waters (HQW), are given additional consideration by the NCDCM prior to issuing development permits. Note that all PNAs are regarded as HQW, but not all HQW qualify as PNAs. Rules by the NCCRC state that activities which will directly impact SAV, such as dredging or construction of docking facilities, should be avoided [NCCRC rule 15A NCAC 7H .0208(a)(5)]. Some areas of significant SAV coverage have been classified by NCEMC as ORW. Regulations by NCCRC prohibit dredge and fill activities in ORW. In addition, NCCRC rules require new development adjacent to ORW to comply with specified storm water provisions (15A NCAC 2H .1007) including reduced loading rates and increased buffer zones.

Several NCMFC rules restrict harvesting methods in shell bottom to avoid unnecessary damage to the habitat. The NCDMF Director is delegated authority by the NCMFC to close areas to the taking of shellfish to protect populations for management purposes (NCMFC rule 15A NCAC 3K .0101b), to designate Shellfish / Seed Management Areas (NCMFC rule 15A NCAC 3K .0103) and to protect these areas through gear and harvest restrictions. Other regulations prohibit trawling across oyster management areas (NCMFC rule 15A NCAC 3K .0203) or mechanical harvest or dredging of oysters in certain areas (NCMFC rule 15A NCAC 3K .0204), including Core Sound and portions of Pamlico Sound.

The NCCRC designates Areas of Environmental Concern (AEC) to protect "areas of natural importance", which include coastal wetlands, from uncontrolled or incompatible development. The Coastal Area Management Act (CAMA) defines development as "any activity in a duly designated area of environmental concern...involving, requiring or consisting of the construction or enlargement of a structure; excavation; dredging; filling; dumping; removal of clay, silt, sand, gravel or minerals; bulkheading; driving of pilings; clearing or alteration of land as an adjunct of construction; alteration or removal of sand dunes; alteration of the shore, bank or bottom of the Atlantic Ocean or any sound, bay, river, creek, stream, lake or canal [NCGS 113A-103(5)(a)]." There are four categories of

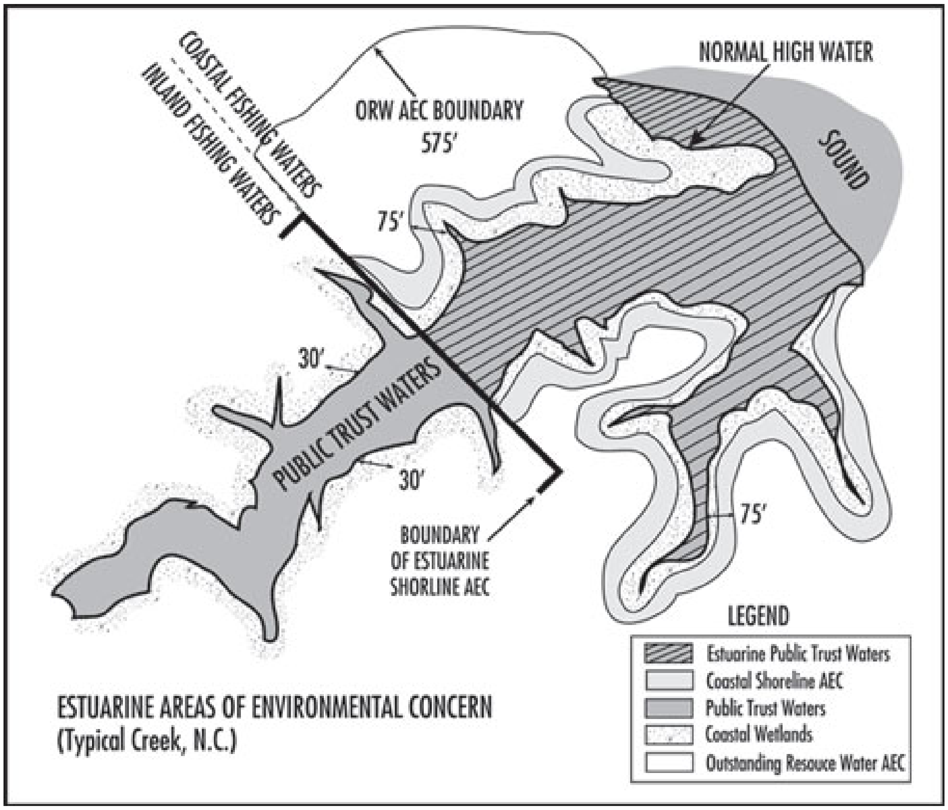


Figure 9.4. The location of AEC boundaries within a representative creek in coastal North Carolina (http://dcm2.enr.state.nc.us/Handbook/ handbook.htm).

AECs that, in all, encompass most coastal waters within the 20 CAMA counties of North Carolina: The Estuarine and Ocean System, The Ocean Hazard System, Public Water Supplies, and Natural and Cultural Resource Areas (http://dcm2.enr.state.nc.us/ Handbook/handbook.htm). Permits may be required to pursue development projects within the Estuarine System, which, as defined by the NCDCM, includes four components: Public Trust Areas, Estuarine Waters, Coastal Shorelines, and Coastal Wetlands (Figure 9.4). Generally, development is prohibited in coastal wetlands except water dependent activities, such as docks.

Construction of bulkheads and shoreline stabilization measures are regulated by the NCCRC. Under these regulations bulkheads must be constructed landward of significant marshland or marshgrass fringes and bulkhead alignment must approximate mean high water or normal water level (NCCRC rule 15A NCAC 7H .0208 (b) (7)). If certain standards are met, including an identifiable erosion problem, recovery of eroded property, and others as identified in NCCRC rule 15A NCAC 7H .1105, are met, bulkheads along natural shorelines (rivers, creeks, bays, sounds, etc.) can be positioned waterward of mean high water or normal water level. However, even if these standards are met the bulkhead cannot be positioned more than an average distance of two feet or a maximum of five feet waterward of mean high water or normal water level. The NCEMC manages wetlands through the 401/404 Certification Program, under the federal Clean Water Act. This program focuses on avoiding and minimizing filling of wetlands and streams through review of all Environmental Assessments, CAMA Major Permits, and US Army Corps of Engineers (ACOE) permit applications to determine if the project will violate water quality standards or if a 401 certification is needed.

Several State rules and programs have been created with the intent to reduce sediment, toxic chemicals, and nutrients in coastal waters. The NCEMC has designated the Chowan River, Neuse River and Tar-Pamlico River basins as Nutrient Sensitive Waters (NSW) and has developed corresponding NSW strategies for all river basins. The NSW strategy includes a 30% reduction in nitrogen loading from agriculture, a declaration of "no net increase" in the amount of phosphorous, protection for riparian areas, stormwater runoff control, and wastewater discharge standards. Substantial reductions in nutrient loading have already been achieved in the Chowan River Basin. Adherence to existing rules and to those proposed by the NCEMC as part of the NSW strategy should slow the eutrophication in the Neuse and Tar-Pamlico basins. Despite that the Roanoke and Cape Fear Rivers deliver excess nutrients to coastal waters, these rivers are not currently classified as NSW because of their high flushing rates. Nutrient management strategies may need to be applied to the Cape Fear river basin if the coastal ocean shows any signs of a "dead" zone. Currently, there are no water quality monitoring stations in coastal ocean waters receiving discharge from the Cape Fear River. *There may therefore be a need to monitor water quality in ocean bottom areas receiving discharge from the Cape Fear River.*

There are also stormwater management rules for development activities either requiring an Erosion and Sediment Control Plan (for disturbances of one or more acres) or a CAMA Major Permit (apply to large development projects overlapping an AEC). The State Stormwater Management Program requires developments to protect these sensitive waters by maintaining low and high density options for stormwater management, varying with water quality classification. Low density options include limits on the maximum amount of built-upon (or impervious surfaces), type of development (single family residential rather than commercial), and requiring vegetative buffers to ensure the transport of runoff through vegetative conveyances. The built-upon limit for HQWs and freshwater ORWs is 12% [NCEMC rule 15A NCAC 02H .1006 and .1007]. For saltwater ORWs and for areas within 0.5 miles (0.8 km) of surface waters used for shellfishing (SA), the built-upon limit is 25% [NCEMC rule 15A NCAC 02H .1005]. The built-upon limit is 30% for low density development adjacent to waters not classified as ORW, SA, or HQW [NCEMC rule 15 NCAC 02H .1005]. Development adjacent to HQW, ORW, and SA waters must also maintain a 30 feet (9.14 meters) wide vegetative buffer and transport stormwater runoff primarily by vegetated conveyances. Alternative stormwater control methods for high density development must be used if low density criteria cannot be met. The rising number of closed shellfish areas in ORWs (NCDEH unpublished data), however, may indicate that the protective measures associated with the ORW designation may have not been entirely effective in preventing closures.

Implementation of stormwater management is occurring in phases. Phase I, established in 1990, applies to certain industrial facilities, construction activities that disturb five or more acres of land, and municipal separate storm sewer systems (MS4) serving populations of 100,000 or more (based on 1990 census data). Phase II will implement controls on stormwater discharges from smaller communities currently not regulated by Phase I. In North Carolina, there are 60 cities and 25 counties of this size that will be included automatically based on population. However, phase II stormwater rules have been blocked by the State Rules Review Commission. Under phase II rules, low density projects in areas within 0.5 miles (0.8 km) of and draining to SA waters can have no more than 12% built-upon area for all residential and non-residential development. All other Phase II areas can have no more than 24% built-upon area. High density criteria require control and treatment of the first inch (2.54 cm) of stormwater runoff, an 85% average annual removal of total suspended solids, and several other requirements. In addition, no new direct points of stormwater discharge or expansion of discharge to SA waters is allowed. *Efforts to implement phase II stormwater rules must be continued.*

Serving as natural stormwater controls (Mitsch and Gosselink 1993), many wetland areas are protected by state and federal regulations. Yet it is estimated that as much as 40-50% of North Carolina's original wetlands have been lost, primarily due to ditching, channelization, and filling for agriculture and development (Dahl 1990; NCDWQ 1993). Although the rate of wetland loss has slowed, losses continue to occur. The majority of losses has been to isolated or headwater wetlands, although piecemeal loss of fringing marsh and swampland also occurs. The cumulative impact of small wetlands losses to gradual development remains essentially unlimited, despite rules requiring consideration of cumulative impacts in permit review. Mitigation for permitted losses and voluntary restoration efforts in some areas have partially offset some recent losses, but the type of wetland gained is not necessarily functionally equivalent to what was lost. The recent establishment of the Ecological Enhancement Program (EEP) under the NCDENR may remedy concerns regarding existing mitigation. The EEP will identify potential wetland impacts early in the roadway planning process (Water Resources Research Institute News, March/April 2003). The potential impacts will then be evaluated in a watershed context and assessed for functional equivalency prior to the permitting process. Mitigation efforts will be prioritized by area, which will be consistent with NCDWQ basinwide planning reports, Coastal Habitat Protection Plans, and Wetland Restoration Plans. Once in place, mitigation projects will be monitored to determine their effectiveness in replicating wetland functions. However, because the EEP is primarily focused on North Carolina Department of Transportation (NCDOT) projects, many other development projects are not included (e.g., subdivision development). *The EEP process should be extended to development projects beyond those associated with the NCDOT.*

9.4 Habitat Protection Management Recommendations

1. The NCDCM should continue promoting the use of shoreline stabilization alternatives that maintain or enhance fish habitat. That includes using oyster cultch or limestone marl in constructing the sills (granite sills do not attract oyster larvae).

1. To ensure protection of flounder nursery areas, fish-friendly alternatives to vertical stabilization should be required around primary and secondary nursery areas.

2. The location and designation of nursery habitats should be continued and expanded by the NCDMF.

3. No trawl areas and mechanical harvest prohibited areas should be expanded to include recovery/restoration areas for subtidal oyster beds and SAV.

4. Expansion and coordination of habitat monitoring efforts is needed to acquire data for modeling the location of potential recovery/restoration sites for oysters and SAV.

5. Any proposed stabilization project threatening the passage of flounder larvae through coastal inlets should be avoided.

6. All coastal-draining river basins should be considered for NSW classification because they all deliver excess nutrients to coastal waters, regardless of flushing rate.

7. Efforts to implement phase II stormwater rules must be continued.

8. The EEP process should be extended to other development projects.

9. Reduce sediment and nutrient loading by addressing multiple sources, including:
   - improvement and continuation of urban and agricultural BMPs,
   - more stringent sediment controls on construction projects, and
   - implementation of additional buffers along coastal waters.

10. PRINCIPAL ISSUES AND MANAGEMENT OPTIONS

Major issues and management options developed during the FMP process are briefly summarized in this section. The full issue papers, along with a detailed explanation of the issue and the management options can be found in the Appendix. Management issues in the North Carolina southern flounder fishery have been solicited from the public, the Southern Flounder Advisory Committee (AC), the NCMFC, the Finfish and Regional Advisory Committees, the NCDMF, the NCDENR, and the scientific community. Each issue is listed along with potential management options, recommended strategies, and actions to be taken by the NCMFC, NCDMF, and others.

10.1 Achieving Sustainable Harvest

10.1.1 Issue

Maintain the annual fishing mortality for the southern flounder fishery at or below the target fishing mortality level.

10.1.2 Background

Based on the latest stock assessment, the southern flounder fishery is overfished and the spawning stock biomass is less than six percent of what it would be in an unfished population. Management measures must be chosen that will rebuild the spawning stock biomass to 25% or more over the next decade.

10.1.3 Research Needs

- Initiate studies to investigate the potential for a portion of the flounder population to remain offshore following the spawning period, thus avoiding fishing pressure.

10.1.4 Recommendations

- Implement a 14-inch minimum size limit, a closure period from December 1-December 31, a minimum mesh size of 5 ½-inches stretched mesh on large mesh gill nets, 3,000 yard limit on large mesh gill nets, 5 ½ inch stretched mesh on escape panels in flounder pound nets, a minimum distance of 1,000 yards between new and existing flounder pound nets, and a 200-yard limit between gill nets and active pound nets Statewide with the exception of the Albemarle Sound, excluding tributaries, west of a line between Caroon Point and Powell Point, from August 15 – December 1, or until the fishery is closed, when the minimum distance will be 500 yards on the commercial fishery. The closure would disallow the harvest and sale of flounder by any means other than federally permitted flounder trawls working in the Atlantic Ocean. Another stock assessment will be conducted three years after the implementation of the plan to evaluate the progress towards rebuilding the population.

- Implement a 14-inch minimum size limit and an 8-fish bag limit for the recreational fishery.
- Require a RCGL or other appropriate license to use gigs recreationally.

10.2 Minimum Distance Between Gears

10.2.1 Issue

Reduce conflict between the commercial southern flounder fisheries.

10.2.2 Background

This primary focus of this issue is reducing conflict within and between user groups. Pound netters have stated that other pound nets and gill nets set too close to their main set will prevent them from catching fish by effectively blocking them off. A 1,000-yard limit between new and existing permitted pound net sets has already been implemented by rule by the NCMFC.

10.2.3 Recommendations

- Continue the rule requiring a minimum distance of 1,000 yards between new and existing flounder pound nets.
- Continue 200-yard limit between gill nets and active pound nets Statewide with the exception of the Albemarle Sound, excluding tributaries, west of a line between Caroon Point and Powell Point, from August 15 – December 1, or until the fishery is closed, when the minimum distance will be 500 yards.

10.3 Gear Requirements in the Flounder Gill Net Fishery

10.3.1 Issue

Establishing regulations for the gill net fishery to prevent further increases in effort and minimize the bycatch of under-sized southern flounder.

10.3.2 Background

With the recommended increase in the minimum size limit of southern flounder from 13 to 14 inches, the minimum mesh required for large mesh flounder gill nets needed to be re-evaluated. In addition, a maximum yardage limit for large mesh flounder gill nets also needed to be assessed to prevent an increase in effort, thereby minimizing the effectiveness of the proposed closure.

10.3.3 Research Needs

- Collect selectivity data for large mesh gill nets of varying mesh sizes.

10.3.4 Recommendations

- Implement a minimum mesh size of 5 ½-inches stretched mesh on large mesh gill nets.
- Recreational Commercial Gear License holders are required to attend their large mesh gill nets at all times from south of the NC Highway 58 bridge at Emerald Isle to the South Carolina state line.

10.4 Bycatch in the Commercial Flounder Gill Net Fishery

10.4.1 Issue

Characterize bycatch in the commercial flounder gill net fishery.

10.4.2 Background

Several economically valuable species including red drum, striped bass, spotted sea trout, and weakfish are taken as bycatch in the commercial large mesh flounder gill net fishery in addition to southern flounder. The effectiveness of the large mesh gill nets in minimizing the harvest of both undersized and oversized fish needed to be assessed to prevent excessive discard mortality on these species.

10.4.3 Research Needs

- Increase at-sea sampling to determine the number of undersized and oversized fish caught in all mesh sizes of actual fishing operations.

- Determine mortality of the undersized fish returned to the water.

- Expand the observer program (Program 466) to sample more areas and seasons in the State. Also, initiate an independent gill net survey in the Neuse, Pamlico, and Pungo rivers.

- Expand the trip ticket to include more specific gear parameters, such as mesh size, to more easily identify between large and small mesh gill nets.

- Investigate gear modification to reduce regulatory discards, including mesh selectivity studies.

10.4.4 Recommendations

- Implement a 3,000-yard maximum limit Statewide on all large mesh flounder gill nets per fishing operation.

10.5 Incidental Capture of Non-Target Species of Concern in the Commercial Large Mesh Estuarine Flounder Gill Net Fishery

10.5.1 Issue

Management actions for North Carolina's commercial large mesh estuarine flounder gill net fishery addressing incidental capture of non-target species of concern.

10.5.2 Background

Large mesh flounder gill nets interact with many different endangered and protected species. The nature of these interactions needs to be evaluated to minimize any detrimental effects on the populations of these recovering species.

10.5.3 Recommendations

- Establish a stakeholder group(s), similar to the Bottlenose Dolphin Take Reduction Team, to address interactions and management between large mesh estuarine gill nets and high profile species.

10.6 Gear Requirements in the Flounder Pound Net Fishery

10.6.1 Issue

Establishing regulations for the pound net fishery to minimize the bycatch of under-sized southern flounder.

10.6.2 Background

Given the overfished status of the southern flounder fishery and the proposed increase in the minimum size limit for flounder from 13 to 14 inches, adequate mesh sizes in the pound net escape panels need to be evaluated to ensure that the majority of the sublegal southern flounder have an opportunity to get out of the net.

10.6.3 Research Needs

- Conduct further and more intensive studies into the level of bycatch and sublegal flounder reduction in pound nets that each of the different mesh sizes provides. Studies should include 5½, 5¾, 6, 6¼, and 6½-inch escape panels.

- Conduct studies to test the effectiveness of increasing the mesh size in the heart or crib of the net in pound nets without escape panels in releasing bycatch and sublegal flounder.

10.6.4 Recommendations

- Implement a 5 ½ inch stretched mesh on escape panels in flounder pound nets Statewide.

10.7 Bycatch in the Flounder Pound Net Fishery

10.7.1 Issue

The capture of undersized marketable species in the flounder pound net fishery.

10.7.2 Background

Flounder pound nets catch and retain a variety of species in addition to southern flounder. This issue addresses this bycatch and evaluates the need to alter the fishing practices or gear to prevent the excessive discard of unwanted or non-legal specimens.

10.7.3 Recommendations

- Implement a 5 ½ inch stretched mesh on escape panels in flounder pound nets Statewide.

10.8 Southern Flounder Bycatch in the Shrimp Trawl Fishery

10.8.1 Issue

Southern flounder bycatch in the inshore shrimp trawl fishery.

10.8.2 Background

Shrimp trawls catch and retain a variety of species in addition to shrimp, including juvenile southern flounder. This issue addresses this bycatch and evaluates the need to alter the fishing practices or modify the gear to prevent the excessive discard of sublegal southern flounder.

10.8.3 Research Needs

- Shrimp trawl bycatch characterization studies involving at-sea observers covering a broad regionalized sampling base over an extended period of time (at least three years) to minimize yearly variances.

- Investigations into fish excluder devices with a higher success rate for reducing the harvest and retention of flounder in shrimp trawls.

10.8.4 Recommendations

- Endorse additional research to reduce bycatch in the shrimp trawl fishery, primarily shrimp trawl characterization studies involving at-sea observers and investigations into fish excluder devices with a higher success rate for reducing the harvest and retention of flounder in shrimp trawls.

- Recommend that the Shrimp FMP address the issue of the discard of sublegal southern flounder in the shrimp trawl fishery.

10.9 Southern Flounder Bycatch in the Crab Trawl Fishery

10.9.1 Issue

The reduction of sublegal southern flounder bycatch in the crab trawl fishery.

10.9.2 Background

Crab trawls catch and retain a variety of species in addition to blue crabs, including juvenile southern flounder. This issue addresses this bycatch and evaluates the need to alter the fishing practices or modify the gear to prevent the excessive discard of sublegal southern flounder.

10.9.3 Research Needs

- Long-term (three years or more) characterization studies of bycatch in the crab trawl fishery.

- Further evaluation of tailbag mesh sizes throughout the State.

- Development and testing of other gears, methods, and/or techniques for reducing bycatch within the fishery.

- In-depth assessment of the full-time and part-time participants in the crab trawl fishery, including the level of economic dependence most of the participants have on the fishery.

10.9.4 Recommendations

- Implement a 4-inch mesh in crab trawl tailbags in the western side of the sounds and a 3-inch mesh in crab trawl tailbags in the eastern side of the sounds.

10.10 Southern Flounder Bycatch in the Crab Pot Fishery

10.10.1 Issue

Southern flounder bycatch in crab pots.

10.10.2 Background

Crab pots catch and retain a variety of species in addition to blue crabs, including southern flounder. This issue addresses this bycatch and evaluates the need to alter the fishing practices or modify the gear to prevent the excessive discard of southern flounder.

10.10.3 Research Needs

- Collect baseline data on the composition, quantity, and fate of unmarketable finfish bycatch in the crab pot (hard and peeler) fishery, by season and area.
- Develop a flounder bycatch reduction device for hard and peeler crab pots.
- Test galvanic time-release devices, natural twine, and non-coated steel (24 gauge or less) across a wide range of salinities.
- Determine the optimal panel location for finfish and crab escapement.
- Determine minimum panel size for blue crab and finfish escapement.
- Determine desired release time for blue crabs and finfish.

10.10.4 Recommendations

- Endorse research to test the feasibility of using biodegradable panels in crab pots.
- Endorse research to test the effectiveness of flatfish excluder devices in hard and peeler crab pots. The motion was passed unanimously by the Marine Fisheries Commission.

10.11 Stock Enhancement of Southern Flounder

10.11.1 Issue

Conduct the necessary research in North Carolina to determine if stock enhancement of southern flounder is economically feasible and ecologically responsible.

10.11.2 Background

Evaluate the feasibility of stocking laboratory-reared southern flounder in under-utilized habitats that have the ability to support juvenile flounder to protect against years when recruitment is low.

10.11.3 Research Needs

SEEK FUNDING FOR RESEARCH

- Conduct pilot-scale research on the feasibility of southern flounder stock enhancement. Research would focus on the following key areas:
  - Identify optimal southern flounder habitat;
  - Identify pathogens in wild and cultured fish;
  - Establish a baseline of genetic diversity of wild fish;
  - Measure the impacts of stocked fish on the wild population;
  - Determine the fate of stocked individuals (mortality, emigration, etc.);
  - Develop optimal stocking strategies;

10.11.4 Recommendations

- Do not endorse funding for pilot research on the feasibility of southern flounder stock enhancement at this time.

11. MANAGEMENT PLAN REDUCTIONS AND ECONOMIC IMPACTS

The North Carolina Marine Fisheries Commission (NCMFC) reviewed fisheries management proposals for the Southern Flounder FMP from the Southern Flounder Advisory Committee (AC), the North Carolina Division of Marine Fisheries (NCDMF), as well as NCMFC proposed alternatives on December 2, 2004. Proposals included the measurable percent reductions per specific management strategies, including gear changes, closures, size-limits, and bag limits for commercial and recreational fisheries.

The NCMFC also requested the economic impacts due to the proposed fishery reductions. The NCDMF was able to provide the projected direct economic impacts to the commercial fishery only. The NCDMF is unable to estimate the total economic impact of the proposed actions because it is likely that many fishermen will diversify and engage in other fishing activities. The NCDMF cannot reliably estimate impacts to the recreational southern flounder fishery. The NCDMF is unable to estimate economic impacts of the management measures on the RCGL and hook-and-line fisheries because it is not clear whether fewer trips would be taken or trip duration would be shortened due to potential seasonal closures and bag limits. However, the RCGL flounder fishery, which is primarily large mesh gill nets, and has an estimated total economic impact of $1,500,372, will probably be affected by the mandatory attendance rule for large mesh RCGL gill nets from south of the Highway 58 bridge at Emerald Isle to the South

Carolina state line. In addition, there are no data to make economic estimates concerning the recreational gig fishery.

The NCDMF was unable to provide the AC or the NCMFC recovery projections beyond 2009 due to data limitations. However, the Fisheries Reform Act provides a 10-year timeframe to rebuild an overfished population. With the implementation of the Southern Flounder FMP in 2005, the southern flounder stock is required to be rebuilt by 2015.

The Southern Flounder FMP management measures result in a total reduction of 17.2% to the southern flounder fishery, with a 15.1% reduction to the commercial fishery and a 30.5% reduction to the recreational fishery (Table 11.1). The reduction estimate approaches the $F_{THRESHOLD}$(20%SPR) in four years after management implementation and is within the confidence bounds (Figure 11.1). A provision in the FMP to re-assess the stock status in three years is critical to the recommendation. Economically, the FMP estimated a specific direct commercial fishery economic impact of $857,965 due to projected commercial fishery reductions in harvest (Table 11.1).

Table 11.1. Specific management recommendations, percent reductions, and economic impacts of the Southern Flounder FMP.

Specific Management Recommendations

	Gear Change	Closure	Size-Limit
Commercial			
Gill Nets	5 1/2-inch	Dec.1-Dec.31	14-inch Statewide
Flounder Pound Nets	5 1/2-inch escape	Dec.1-Dec.31	14-inch Statewide
Other Gears	n/a	Dec.1-Dec.31	14-inch Statewide
Recreational*			
Hook-and-Line	n/a	n/a	14-inch Statewide
RCGL	n/a	n/a	14-inch Statewide
Gig	n/a	n/a	14-inch Statewide

Specific Percent Reductions (not additive)

	Gear Change	Closure	Size-Limit	TOTAL
Commercial	-->			**15.1%**
Gill Nets	0.5%	2.3%	15.3%	17.4%
Flounder Pound Nets	0.3%	2.9%	10.0%	12.8%
Other Gears	n/a	1.6%	10.3%	11.5%
Recreational*	-->			**30.5%**
Hook-and-Line	n/a	n/a	12.2%	12.2%
RCGL	n/a	n/a	8.2%	8.2%
Gig	n/a	n/a	8.7%	8.7%

** 8-fish bag limit represents a specific recreation RCGL and GIG reduction of 22.5%*

Specific Economic Impacts Due to Commercial Reductions

	Gear Change	Closure	Size-Limit	TOTAL
Gill Nets	$16,211	$74,573	$496,071	$564,159
Flounder Pound Nets	$5,571	$53,851	$185,695	$237,689
Other Gears	----	$7,808	$50,261	$56,117
*** Calculated using 2000-2002 ex-vessel values*				$857,965

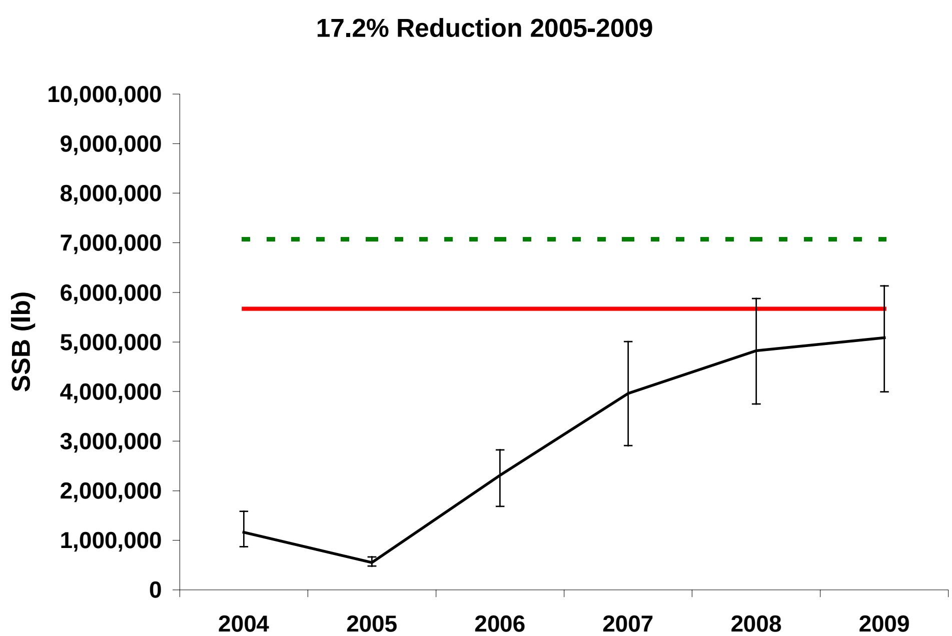


Figure 11.1. Recovery projection of the Southern Flounder FMP.

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13. APPENDICES

13.1 Appendix 1 - Issue Papers

The issue papers developed during the FMP process appear in this section. Management issues in the North Carolina southern flounder fishery have been solicited from the public, the Southern Flounder Advisory Committee (AC), the NCMFC, the Finfish and Regional Advisory Committees, the NCDMF, the NCDENR, and the scientific community. Each issue is described in detail along with potential management options, recommended strategies, and actions to be taken by the NCMFC, NCDMF, and others. The issues discussed include:

- Achieving Sustainable Harvest
- Minimum Distance Between Gears
- Gear Requirements in the Flounder Gill Net Fishery
- Bycatch in the Commercial Flounder Gill Net Fishery
- Incidental Capture of Non-Target Species of Concern in the Commercial Large Mesh Estuarine Flounder Gill Net Fishery
- Update on the Incidental Capture of Non-Target Species of Concern in the Commercial Large Mesh Estuarine Flounder Gill Net Fishery
- Gear Requirements in the Flounder Pound Net Fishery
- Bycatch in the Flounder Pound Net Fishery
- Southern Flounder Bycatch in the Shrimp Trawl Fishery
- Southern Flounder Bycatch in the Crab Trawl Fishery
- Southern Flounder Bycatch in the Crab Pot Fishery
- Stock Enhancement of Southern Flounder

13.1.1 Achieving Sustainable Harvest

Issue

Maintain the annual fishing mortality for the southern flounder fishery at or below the target fishing mortality level (F_{target}).

Background

The southern flounder fishery in North Carolina is largely dependent on incoming recruitment of juvenile fish to the fishery. Catch-at-age values indicate extremely high exploitation of age-1 and age-2 southern flounder (57% and 38% respectively; Tables 13.1 and 13.2). This exploitation of younger fish is of particular concern since only 59% of age-1 and 79% of age-2 female southern flounder are sexually mature (Table 13.3). Fishing mortality rates (the rate at which fish are removed from the population as a result of fishing) averaged 1.91 (ages 2-5) in 2002 with an 80% probability that F was between 1.69 and 2.89 (see Section 8—Status of the Stock).

Total landings dropped from nearly 5.5 million pounds in 1994 to 3.5 million pounds in 1999 (Table 13.4). The low in 1999 is likely due to low abundance of the 1998 cohort, since about 60% of the harvest in most years is age-1 fish. There was a slight increase to around 4 million pounds since, supported by the increased recruitment since 1998. Landings since 1998 are below the 1991-2002 average of 4.4 million pounds.

The average fishing mortality rate from 1991–2002 of F = 1.91 can be expected to retain about 5.4% of the maximum spawning stock biomass, well below the percentage of the spawning stock that is considered necessary to sustain most stocks. Fishing mortality rates exceeded F_{max} (0.52) in every year providing clear evidence that the stock is being growth overfished.

Management measures adopted in response to the assessment should be aimed at reducing harvest of immature female southern flounder, and increasing spawning stock biomass. Based on the stock assessment's range of possible reference fishing mortality rates (Table 13.5) from $F_{0.1}$ SPR to $F_{20\%}$, a reasonable fishing mortality threshold for this stock is between F=0.28 and F=0.57.

Projection schedules for recovery of the fishery based on four different levels of landings reductions in the fishery (no fishing, 45%, 30%, and 20%) can be found in Section 8.2 (Recovery Projections). The 30% reduction scenario will achieve the threshold SSB within five years, however the 20% scenario mean is projected to peak before reaching the threshold. A re-assessment of our progress can be made after 3 years of a new management scenario to ground-truth projection results.

Prepared by the North Carolina Division of Marine Fisheries on November 26, 2000; updated on June 15, 2002, February 19, 2004, and on December 10, 2004.

Table 13.1. Combined catch-at-age of commercial and recreational fisheries for North Carolina southern flounder.

Year	Age 0	1	2	3	4	5	6	7
1991	842	1,038,837	1,056,825	17,718	1,312	78	1	1
1992	2,576	915,584	956,036	140,547	4,372	162	1	1
1993	842	1,871,929	606,044	307,267	1,180	108	1	1
1994	934	1,727,044	1,104,580	78,152	3,943	211	1	21
1995	1,326	1,514,767	838,769	70,403	2,343	46	1	1
1996	976	966,572	1,064,498	105,443	14,785	333	4	4
1997	842	1,413,255	837,822	124,152	36,856	228	1	1
1998	842	1,287,943	1,053,780	39,673	1,284	72	81	1
1999	842	968,528	658,384	152,070	8,483	2,856	1	3
2000	842	1,795,830	285,961	83,679	9,496	253	1	1
2001	842	1,233,083	1,097,149	17,778	12,536	586	1	8
2002	22,591	1,312,460	762,347	98,216	1,608	149	4	4

Table 13.2. Percent combined catch-at-age of commercial and recreational fisheries for North Carolina southern flounder.

Year	Age 0	1	2	3	4	5	6	7
1991	0%	49%	50%	1%	0%	0%	0%	0%
1992	0%	45%	47%	7%	0%	0%	0%	0%
1993	0%	67%	22%	11%	0%	0%	0%	0%
1994	0%	59%	38%	3%	0%	0%	0%	0%
1995	0%	62%	35%	3%	0%	0%	0%	0%
1996	0%	45%	49%	5%	1%	0%	0%	0%
1997	0%	59%	35%	5%	2%	0%	0%	0%
1998	0%	54%	44%	2%	0%	0%	0%	0%
1999	0%	54%	37%	8%	0%	0%	0%	0%
2000	0%	83%	13%	4%	0%	0%	0%	0%
2001	0%	52%	46%	1%	1%	0%	0%	0%
2002	1%	60%	35%	4%	0%	0%	0%	0%
Mean	**0%**	**57%**	**38%**	**4%**	**0%**	**0%**	**0%**	**0%**

Table 13.3. Percent of mature female southern flounder at age.

	Age							
	0	1	2	3	4	5	6	7
Maturity	0%	59%	79%	100%	100%	100%	100%	100%
Ave. Size (mm)	233	315	408	485	548	601	644	679
Ave. Size (in)	9.2	12.4	16.0	19.1	21.6	23.7	25.4	26.7

Table 13.4. North Carolina southern flounder commercial and recreational landings.

Year	Southern Flounder Landings in Pounds by Fishery				
	Commercial	Recreational Hook-and-line	Recreational Gig	RCGL	Total
1991	4,163,374	136,835	361,539	97,474	4,759,222
1992	3,145,020	74,308	361,539	97,474	3,678,341
1993	4,272,368	56,405	361,539	97,474	4,787,786
1994	4,897,459	131,804	361,539	97,474	5,488,276
1995	4,166,307	116,617	361,539	97,474	4,741,937
1996	3,806,918	115,336	361,539	97,474	4,381,267
1997	4,076,793	218,615	361,539	97,474	4,754,421
1998	3,952,729	88,147	361,539	97,474	4,499,889
1999	2,932,076	77,505	361,539	97,474	3,468,594
2000	3,205,229	271,234	361,539	97,474	3,935,476
2001	3,521,026	213,908	361,539	97,474	4,193,947
2002	3,449,459	236,648	361,539	97,474	4,145,120
Mean	3,799,063	144,780	361,539	97,474	4,402,856
Percent	86.30%	3.30%	8.20%	2.20%	100.00%

Table 13.5. Estimated spawning stock biomass and yield for various fishing mortality reference points, including 20, 25, and 30% SPR and the current fishing mortality.

	F	%SPR	SSB/r (lb)	Estimated SSB (lb)	Y/R (lb)	Estimated Yield (lb)
Fmax	0.52	23	1.11	6,255,635	0.61	3,400,628
F20%	0.57	20	1.01	5,668,929	0.61	3,395,745
F25%	0.47	25	1.26	7,072,129	0.60	3,390,132
F30%	0.38	30	1.51	8,473,365	0.59	3,336,305
F0.1	0.28	67	1.95	10,944,962	0.56	3,143,168
Fcurr	1.91	5.4	0.27	1,515,456	0.51	2,884,980

Current Authority

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)

3J .0101 FIXED OR STATIONARY NETS
3J .0102 NETS OR NET STAKES
3J .0103 GILL NETS, SEINES, IDENTIFICATION, RESTRICTIONS
3J .0107 POUND NET SETS
3M .0503 FLOUNDER

Discussion

There are several management options available which could be used individually or in conjunction with one another to maintain the fishing mortality at or below the target level fishing mortality rate. These management options are detailed below:

Static Quota

A quota refers to the maximum amount of fish that can be legally landed within a specified time period. A static quota is one that undergoes few changes between time periods and is usually established based on historical levels of landings to prevent over-expansion of the fishery. An example of a static quota would be the red drum harvest limit rule that went into effect in 1998 for North Carolina (Figure 13.1). The commercial harvest limit was set at 250,000 pounds, which was around the highest historical landings for any one year. The objective was to prevent a directed commercial fishery for red drum from developing. The intent of a static quota for the southern flounder fishery would be to prevent further expansion and reduce harvest; however, due to the recruitment dependence of the fishery and the resulting variability in available fish for harvest between years, a static quota may not be sufficient in preventing overfishing during years of poor recruitment based on the level of fishing mortality.

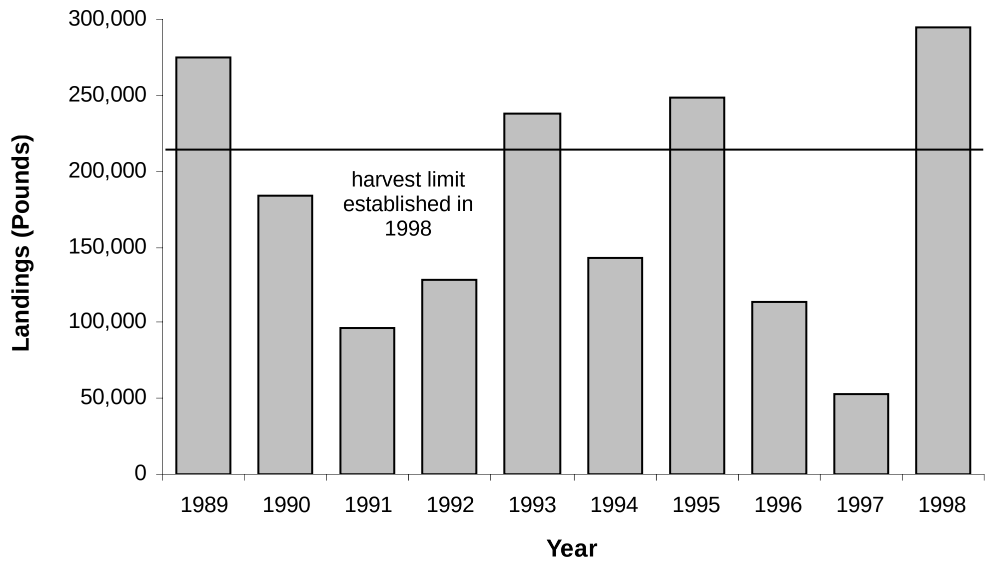

Figure 13.1. Commercial landings of red drum during 1989-1998 and the implemented harvest limit (courtesy of the NCDMF Trip Ticket Program).

Another potential problem with regulating the southern flounder commercial fishery with a quota is the extremely high variability in daily landings, particularly in the pound net fishery (Figures 13.2 and 13.3). A quota would have to be monitored with daily landing reports if the fishery is to be closed prior to exceeding the harvest limit. However, the potential magnitude of daily landings in both the gill net and pound net fishery would make it very easy to surpass the quota before the fishery could be closed. Daily landings in the pound net fishery have the potential of exceeding 400,000 pounds in a two-day period, as was the case in 1996.

In addition, a quota system would be an additional burden on both the commercial dealers and the North Carolina Division of Marine Fisheries (NCDMF). Unlike the current quotas being monitored by the NCDMF (striped bass, red drum, river herring, and summer flounder) that only have between 150 to 900 participants and less than 100 dealers involved, the southern flounder fishery consists of as many as 2,700 participants and 270 dealers. Although currently beyond the capabilities of the NCDMF to monitor given the existing level of personnel and available resources, additional resources could be investigated. It would not be possible, however, to implement a quota system until the necessary resources and personnel could be put in place.

If a quota system is considered for the commercial fisheries, it may be beneficial to allow the quota to only apply to the two major fisheries for southern flounder, gill nets and pound nets, which together have comprised approximately 90% of the commercial landings of southern flounder between 1991 and 2002. This would make reporting easier on the dealers, in addition to reducing the number of dealers and fishermen involved in the reporting process. Due to the differences in fishing practices and seasons, it may also be beneficial to divide the quota between the two fisheries. One approach to splitting the quota between the two gears would be to base it on historical landings. However, because gill nets have risen to prominence just within the past decade, the division of the quota would be dependent upon the amount of years of historical landings that are considered (Figure 13.4). By using the landings from 1987-2001, the split of the quota would be exactly fifty percent between the fisheries. If more years are considered more of the quota would go to pound nets, whereas if fewer years are considered more of the quota would be allocated to gill nets.

Managing the recreational fisheries with a quota is not feasible due to the lag time between the time of fishing and the time the harvest estimates become available through the Marine Recreational Fisheries Statistics Survey (MRFSS). There is no system in place for monitoring recreational landings on a real-time basis that would allow for the fishery to be closed upon reaching the harvest limit.

<u>Dynamic Quota</u>

A dynamic quota refers to a total allowable catch that fluctuates between years relative to the abundance of the resource and fishing pressure. In the case of southern flounder, the quota for a given year would be primarily driven by the strength of the year-classes being subjected to fishing pressure. This would perhaps be the best method for maintaining the southern flounder harvest around the target level fishing mortality rate. However, as with the static quota, all of the same drawbacks, including the issues with monitoring the landings on a daily basis and the high degree of variability in the daily landings, go along with implementing a dynamic quota. In addition, to adequately manage a dynamic quota, southern flounder specific Statewide abundance surveys (CPUE by age) for both juvenile and adult fish would be needed to develop appropriate abundance indices required to determine year-class strengths. Annual catch-at-age assessments would also have to be generated to verify stock status and annual correlations between abundance indices and catch-at-age values.

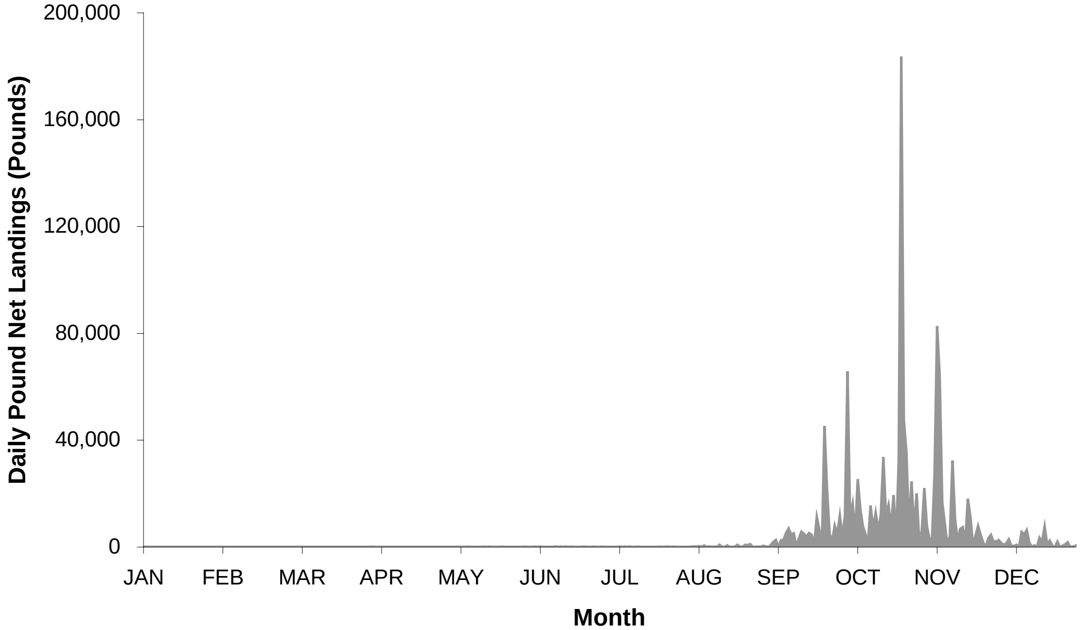

Figure 13.2. Daily pound net landings of southern flounder during 1998 (courtesy of the NCDMF Trip Ticket Program).

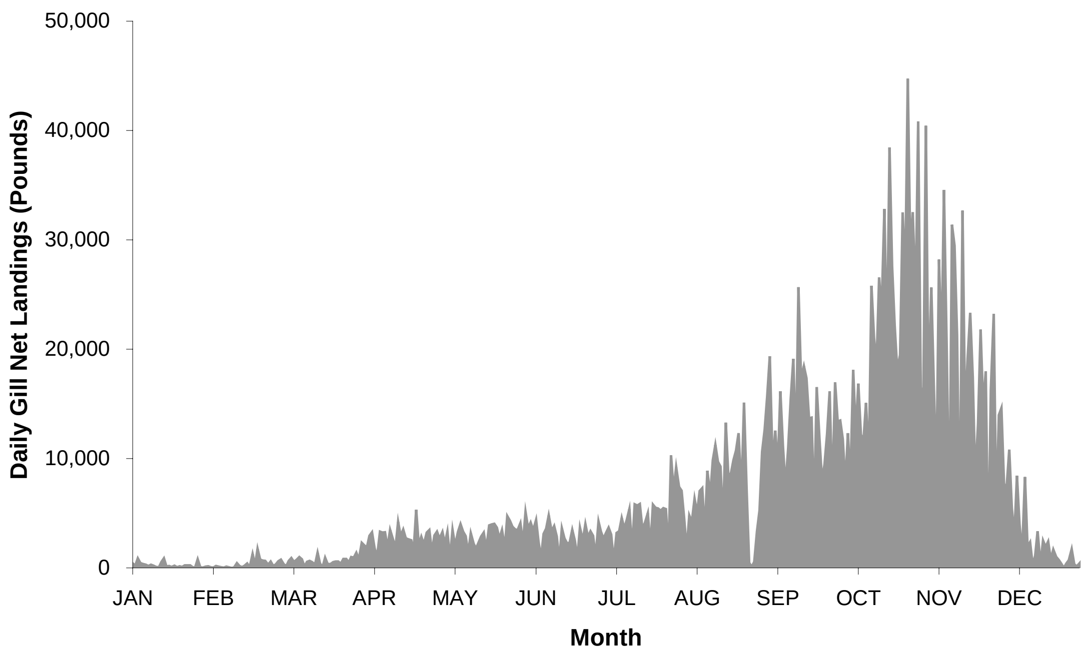

Figure 13.3. Daily gill net landings of southern flounder during 1998 (courtesy of the NCDMF Trip Ticket Program).

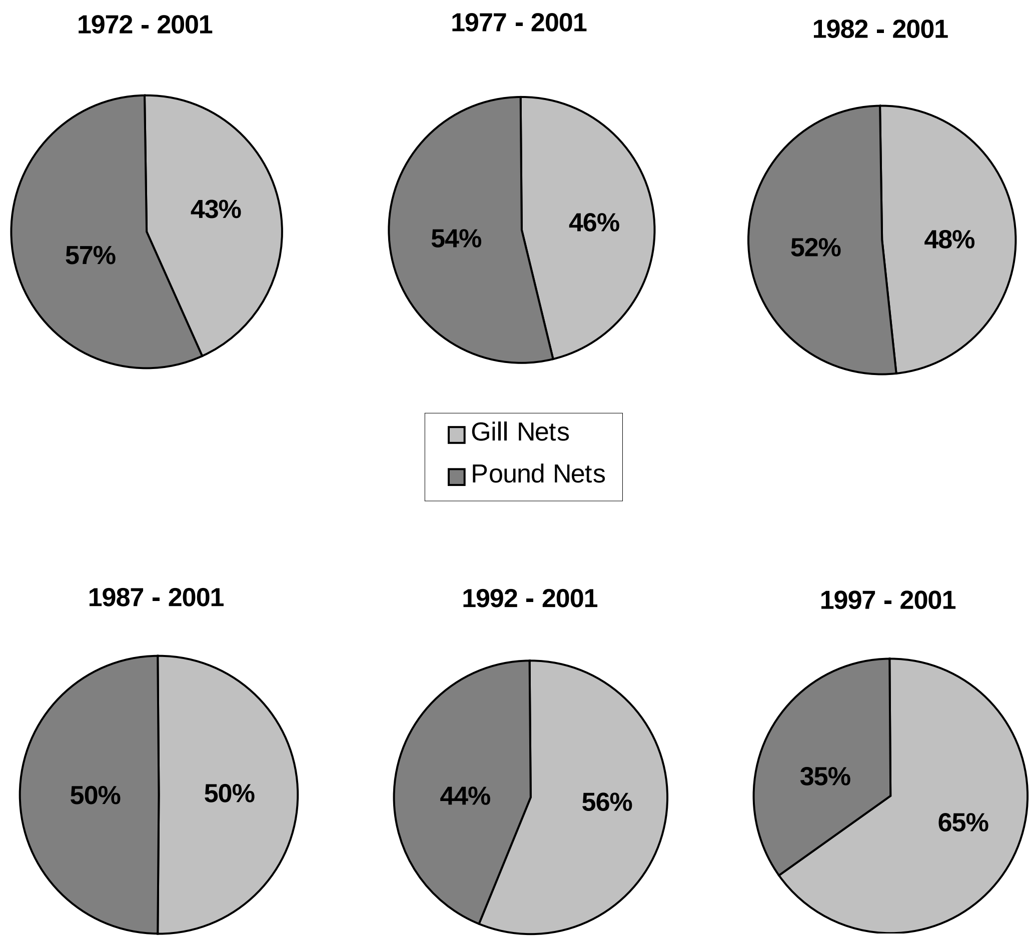

Figure 13.4. The allocation of a quota between gill nets and pound nets based on the number of years of historical landings that are considered.

Limited Entry

A limited entry system would prevent expansion in the fishery beyond a specified level of participants. In such a system, a control is placed on the number of fishermen allowed to participate in the fishery. This type of system is established to prevent more fishermen from entering a fishery than the resource can support, or to reduce participants when the situation has already occurred. Eligibility for participation within the fishery is typically granted to those individuals who have demonstrated a historical utilization of and reliance on the resource. While a limited entry system could be established as a stand-alone system, it would be insufficient in preventing an increase in effort by those individuals allowed in the fishery. Therefore, overfishing may still occur. Limited entry systems work best when implemented in concert with quotas or gear restrictions. When a limited entry system and a quota are issued in conjunction, the quota insures that the resource is not over-utilized, while the limited participation allows the fishermen remaining in the fishery enough of the resource to make a reasonable living. In a limited entry system with no quota in place, restrictions on gear amounts and/or use per individual would aid in maintaining effort at a consistent level.

There are limitations to establishing a limited entry system for fisheries in North Carolina. Section 2.1 of the Fisheries Reform Act (G.S. 113-182.1) concerning Fishery Management Plans (FMP) states that the North Carolina Marine Fisheries Commission can only recommend that the General Assembly limit participation in a fishery if the NCDMF determines that sustainable harvest in the fishery cannot otherwise be achieved. Currently, there are other options available for achieving sustainable harvest, or F_{target} in the case of the southern flounder fishery. Therefore, limited entry is not a viable option for consideration at this time.

Increased Minimum Size Limit

In addition to other management strategies to control effort, the effects of an increase in minimum size may be considered. The short term effects of a minimum size increase would be to diminish the pool of younger and smaller fish immediately available for harvest, which in turn would produce a decrease in overall landings. The drop in landings, however, may not produce a corresponding drop in the fishing mortality rate initially, since for southern flounder, annual fishing mortality is measured from the age two and older year classes (southern flounder are fully recruited to the fishery by the time they are two years of age), and an increase in minimum size would predominately affect age one and age two fish. In other words, decreasing the fishing mortality on age one fish may not have an immediate effect on reducing the annual fishing mortality that is based on age two and older fish. Therefore, the benefit to the fishery of an increase in minimum size would not be realized until the increased survival of age one fish has occurred for multiple years and has contributed to the pool of older age classes.

However, one of the major benefits of increasing the minimum size limit is that it would allow a larger number of the age one and age two fish that would normally have been harvested the opportunity to spawn at least once prior to being harvested. This would increase the size of the spawning stock biomass and therefore the number of recruits to the fishery in subsequent years. The reductions in harvest associated with various size limits for the commercial gill net fishery, commercial pound net fishery, and all commercial fisheries combined can be found in Table 13.6. Likewise, Table 13.7 contains reductions in harvest for the recreational hook-and-line fishery, recreational gig fishery, the RCGL fisheries, and all recreational fisheries combined.

By implementing an increase in the minimum size limit in the commercial fisheries, some regions of the State may be more adversely affected than others, particularly in the gill net fishery. Gill net fishermen in the rivers and the Albemarle Sound that typically have smaller flounder available to them will face the biggest impact, while those in the

Pamlico Sound will be less affected. This is evident by looking at the composition of the commercial catch by market grade from each of the four areas (Figure 13.5).

Until October 2002, the minimum size limit for flounder caught recreationally in inshore waters in North Carolina had been 13 inches for well over a decade (Table 13.8). In 2002, the NCDMF was forced to increase the size limit to 14 inches to avoid exceeding

Table 13.6. Percent reductions associated with an increase in the minimum size limit for each commercial fishery.

	Cumulative Percent Reduction			
Size Limit (inches)	Commercial Gill Net Fishey (%)	Commercial Pound Net Fishery (%)	Other Commercial Fisheries (%)	All Commercial Fisheries (%)
14	15.30	10.01	10.28	12.97
15	48.24	25.04	25.43	38.11
16	73.86	38.42	38.71	58.37
17	87.10	54.96	55.30	73.07
18	94.02	70.89	71.28	83.94
19	97.24	81.64	81.98	90.45
20	98.88	88.52	88.77	94.37
21	99.48	93.80	93.96	97.01
22	99.79	97.36	97.44	98.74
23	99.89	98.97	99.00	99.49
24	99.95	99.57	99.59	99.79
25	99.97	99.81	99.82	99.90
26	99.98	99.89	99.89	99.94
27	99.99	99.94	99.94	99.97
28	99.99	99.97	99.98	99.98
29	99.99	99.99	99.99	99.99
30	100.00	100.00	100.00	100.00

Table 13.7. Percent reductions associated with an increase in the minimum size limit for each recreational fishery.

	Cumulative Percent Reduction			
Size Limit (inches)	Recreational Hook-and-Line Fishery (%)	Recreational Gig Fishery (%)	RCGL Gill Net Fishery (%)	All Recreational Fisheries (%)
14	12.20	8.71	8.21	9.47
15	30.50	22.98	48.24	28.86
16	43.40	35.67	73.86	43.69
17	55.30	50.80	87.10	57.74
18	65.20	62.76	94.02	68.39
19	74.70	73.80	97.24	77.80
20	81.90	82.43	98.88	84.96
21	88.00	87.79	99.48	89.73
22	90.90	91.39	99.79	92.63
23	94.70	94.91	99.89	95.66
24	95.80	97.00	99.95	97.19
25	96.20	97.84	99.97	97.79
26	96.70	98.68	99.98	98.42
27	96.70	99.25	99.99	98.76
28	97.10	99.46	99.99	98.98
29	99.70	100.00	99.99	99.93
30	100.00	100.00	100.00	100.00

North Carolina's harvest limit for summer flounder. Summer flounder harvest is managed jointly by the Atlantic States Marine Fisheries Commission (ASMFC) and the Mid-Atlantic Fisheries Management Council (MAFMC) through the federal summer flounder, scup, and black sea bass FMP. However, a portion of the western Pamlico Sound and its tributaries that rarely encounter summer flounder did retain a 13-inch minimum size limit. The increase to 14 inches applied to all recreational flounder fisheries in North Carolina, including gigs and RCGL gears. The implementation of the 14-inch minimum size limit should have reduced the harvest of flounder by the recreational fisheries by approximately 9.47% (Table 13.7).

In addition, North Carolina decreased the size limit for flounder caught in the Atlantic Ocean to 14 inches in 2004 through the federal summer flounder FMP (Table 13.8). Differences in the minimum size limit between the ocean and inshore waters have always been a source of confusion and consternation for the recreational community, as well as a burden on law enforcement. With a decrease to 14-inch minimum size limit in the ocean and by maintaining the 14-inch minimum size limit in inshore waters, the State would have the same size limits throughout its coastal waters for the first time since 1993 (Table 13.8).

However, any change to the minimum size limits in coastal and joint waters will result in incompatible NCMFC rules with the inland North Carolina Wildlife Resources Commission (NCWRC) rules. In essence, the angler confusion would shift from one area (ocean and inside waters) to another (coastal to inland). The NCWRC would need to change their existing flounder rules to be compatible with the coastal rules.

To lessen the amount the minimum size limit has to be increased to achieve the desired level of reduction in the southern flounder fishery, it can be combined with other management options such as a seasonal closure or a harvest/creel limit.

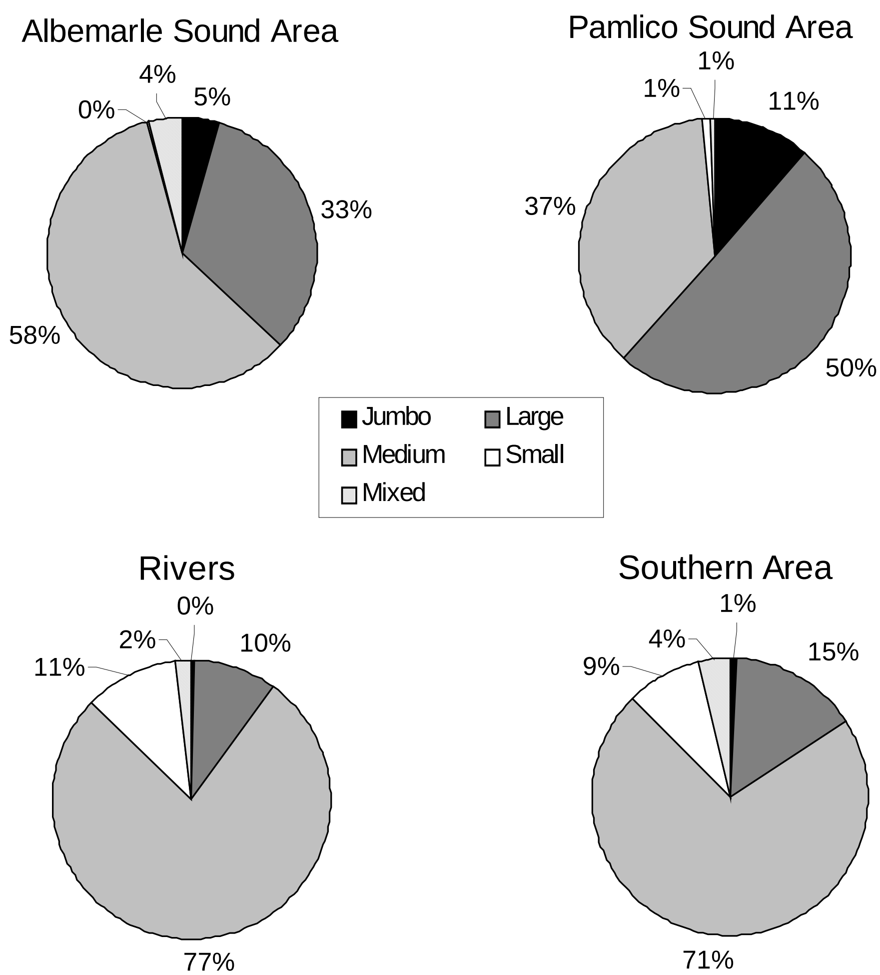

Figure 13.5. The percentage of fish of each market grade landed within each area of the State. The Albemarle Sound Area includes the Albemarle Sound, Alligator River, Chowan River, Croatan Sound, Currituck Sound, Pasquotank River, Perquimans River, Roanoke River, and Roanoke Sound. The Pamlico Sound Area includes the Pamlico Sound, Bay River, Core Sound, and Newport River. The Rivers include Neuse River, New River, Pamlico River, and Pungo River. The Southern Area includes Bogue Sound, Cape Fear River, the Inland Waterway, Lockwood Folly, Masonboro Sound, North River, Shallotte River, Stump Sound, Topsail Sound, and White Oak River. Courtesy of the NCDMF Trip Ticket Program.

Limited Harvest Season

A limited harvest season, or a seasonal closure, can be used to restrict harvest during certain times of the year and to reduce landings. Seasonal closures are periods of time during which no landings of the target species are permitted. Because effort can be increased during the open periods of the fishery to offset the benefits of the closed season, it is best to have closures that are a minimum of two weeks in duration, but preferably longer. To determine the effect a specific seasonal closure would have on reducing harvest in the fishery, daily landings for each fishery were averaged together for the years 1994-2002. A percent of the total annual harvest was then attributed to each day of the year. An implicit assumption in this approach is that harvest effort during the open part of the year would not differ from years in which there is no limited season.

If the season were closed early in the year for the commercial fisheries, the closure would primarily affect gill nets and trawls (Figure 13.6). In addition, the rivers, Albemarle Sound, and Pamlico Sound would be impacted the most by the closure (Figure 13.7). If the closure were instead at the end of the year, then the pound nets and gill nets in Albemarle and Pamlico sounds would be affected the most (Figures 13.6 and 13.7).

As with the quota, one approach to managing the closures for the commercial fisheries would be to have them only apply to gill nets and pound nets. In addition, because the fisheries are so different from one another, each of the two gears could also have separate openings and closures, although this may be confusing for the fishermen and dealers. It would also make enforcement more problematic when some gears are closed to landing flounder, while others are still allowed to continue.

For southern flounder, the best time to have a closure would be late in the year. This will allow more of the flounder that are moving offshore in the fall and winter an opportunity to contribute to the spawning population. In addition, a closure late in the year would also be more beneficial for the price per pound the flounder brings in at the fish house. The winter trawl fishery for summer flounder opens November 1 in Virginia and usually between November 15 and December 1 in North Carolina, flooding the market with flounder during the same period when the gill net and pound net fisheries are still bringing in southern flounder. When this occurs, there is generally a large decline in the value of the fish for the fishermen. By closing the fishery at the end of the year when the commercial trawl fishery is in operation, the reduction in landings to the pound netters and gill netters coincides with the time of year when they are getting the least amount of money for their catch.

One possible result of a seasonal closure could be an increase in effort during the open period. A closure early in the year could lead to increased amounts of nets being fished once the season opens, raising both effort and spatial conflict within the fishery. Similarly, a closure late in the year could lead to more effort as fishermen try to catch as much fish as possible before the fishery shuts down for the year. In either instance, the effectiveness of the closed season at maintaining the fishing mortality at or below the target level would be reduced. Another possible result of a seasonal closure could be a

Table 13.8. Regulations for the recreational flounder fishery in North Carolina between 1993 and 2004.

Year	Inland Waters			Ocean Waters		
	Size Limit	Bag Limit	Closed Season	Size Limit	Bag Limit	Closed Season
1993	13"	-----	-----	13"	-----	-----
1994	13"	-----	-----	14"	8 (1/1 - 10/31) / 6 (11/1 - 12/31)	-----
1995	13"	-----	-----	14"	8	-----
1996	13"	-----	-----	14"	8	-----
1997	13"	-----	-----	14" (1/1 - 3/31) / 14½" (4/1 - 12/31)	8 (1/1 - 3/31) / 10 (4/1 - 12-31)	-----
1998	13"	-----	-----	14½" (1/1 - 6/6) / 15" (6/7 - 12/31)	10 (1/1 - 6/6) / 8 (6/7 - 12-31)	-----
1999	13"	-----	-----	15"	8	-----
2000	13"	-----	-----	15"	8	-----
2001	13"	-----	-----	15½"	8	5/1 - 5/14
2002	13" (1/1 - 9/30) / 14" (10/1 - 12/31)	-----	-----	15½"	8	4/3 - 7/4
2003	14" (13" in western Pamlico Sound)	-----	-----	15"	8	-----
2004	14" (13" in western Pamlico Sound)	-----	-----	14"	8	-----

loss of a fishery instead of the harvest reduction predicted by previous years' landings. For example, the flounder pound net fishery generally takes place from September to December. A significant capital investment must be made by pound netters in order to set their gear. If a seasonal closure does not allow the pound netters to land enough fish to cover their expenses, they would not set their gear due to the economic impacts.

Table 13.9. Summary of North Carolina's 1999 summer flounder winter and fall seasons for only those dealers possessing a valid 1999 Atlantic Ocean Commercial Dealer Flounder Permit (Watterson et al 2000).

Season	Vessel Limit (lbs)	Number of Vessels	Number of Dealers	Total Landings (lbs)
Jan. 1-10	10,000	91	22	459,509
Jan. 11-20	10,000	101	23	667,840
Jan. 21-30	10,000	88	24	556,460
Jan. 31 - Feb. 9	5,000	68	19	21,268
Feb. 10-13	5,000	38	15	110,205
Feb. 14-20	4,000	64	19	239,280
Dec. 1-12	10,000	75	38	46,101
Dec. 13-22	20,000	83	31	375,634
Dec. 23-31	20,000	61	30	157,559

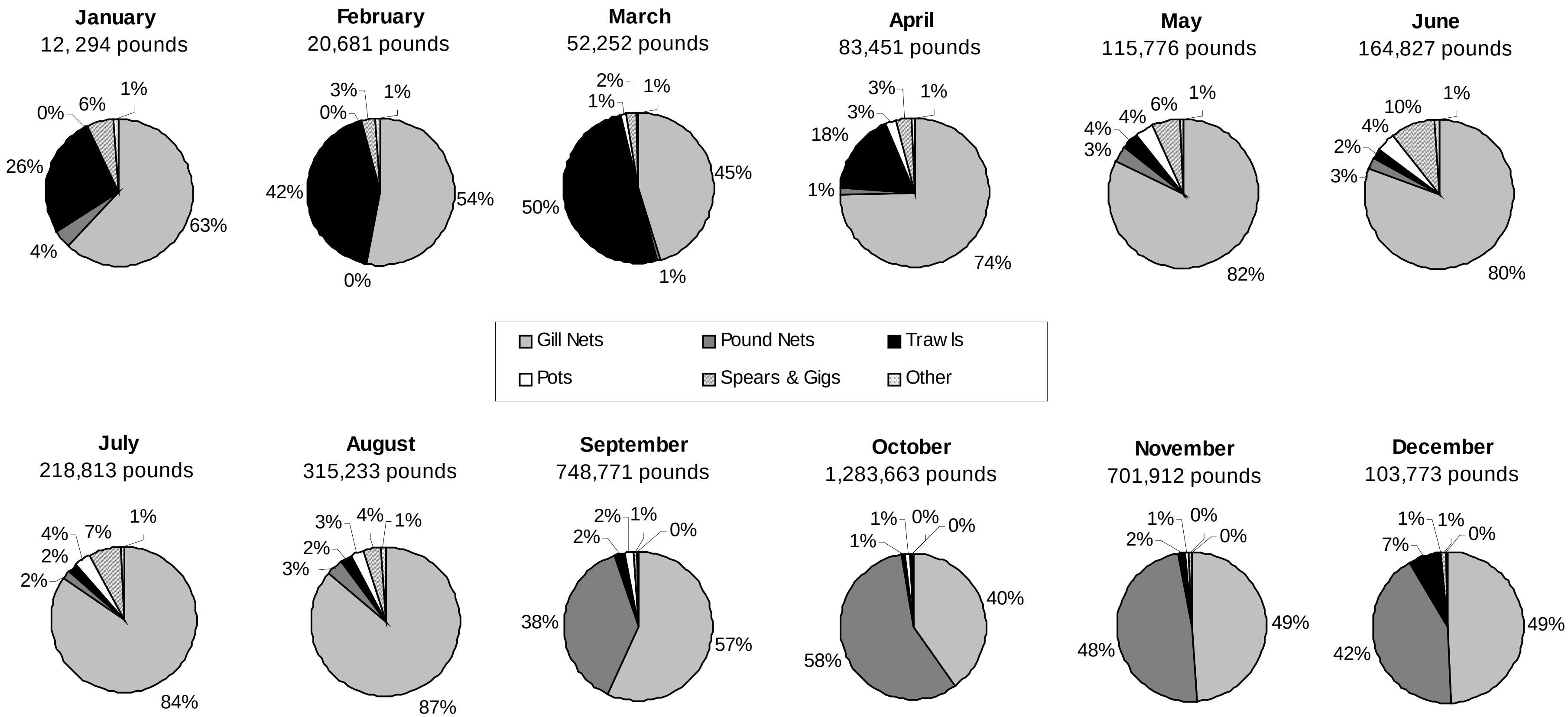

Figure 13.6. The percent contribution of each gear type to the average monthly landings of southern flounder during 1994-2001 (courtesy of the NCDMF Trip Ticket Program).

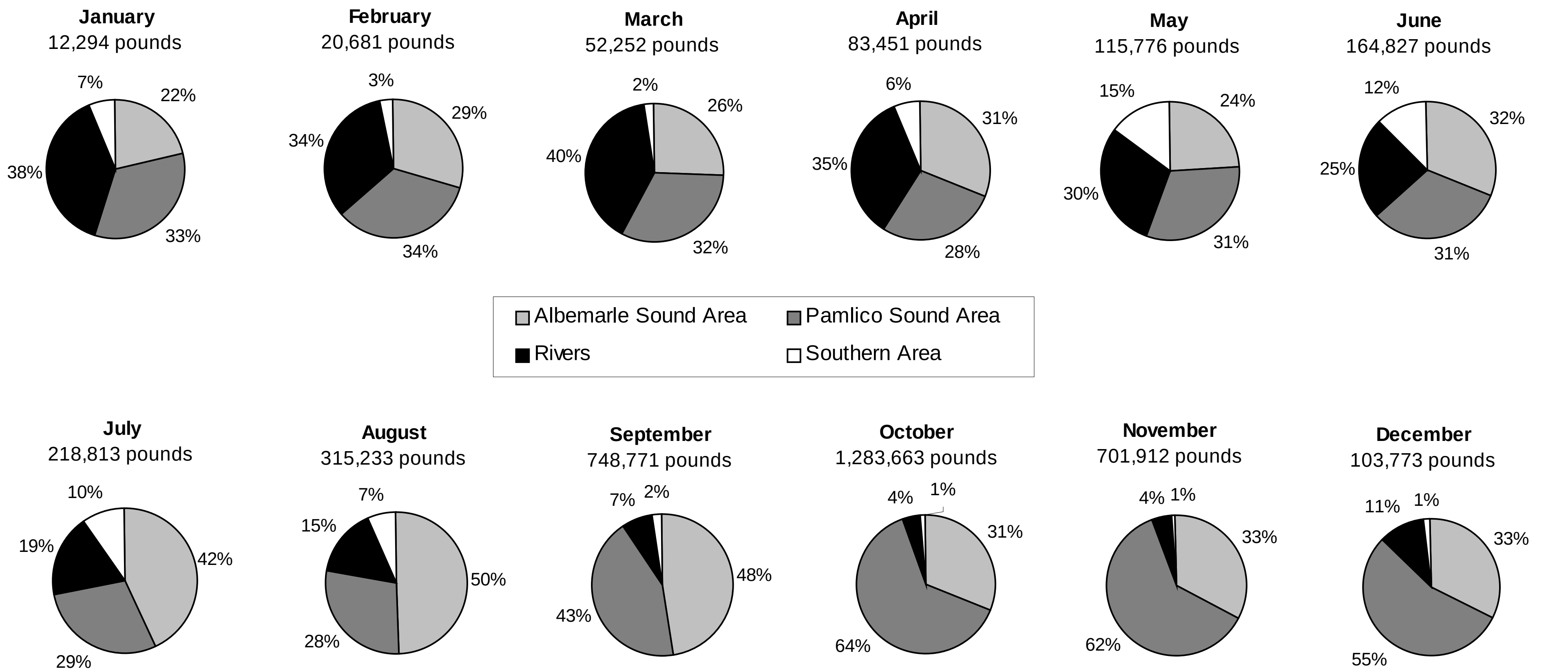

Figure 13.7. The percent contribution of each area of water to the average monthly landings of southern flounder during 1994-2001 (courtesy of the NCDMF Trip Ticket Program). The Albemarle Sound Area includes the Albemarle Sound, Alligator River, Chowan River, Croatan Sound, Currituck Sound, Pasquotank River, Perquimans River, Roanoke River, and Roanoke Sound. The Pamlico Sound Area includes the Pamlico Sound, Bay River, Core Sound, and Newport River. The Rivers include Neuse River, New River, Pamlico River, and Pungo River. The Southern Area includes Bogue Sound, Cape Fear River, the Inland Waterway, Lockwood Folly, Masonboro Sound, North River, Shallotte River, Stump Sound, Topsail Sound, and White Oak River.

Trip/Vessel Harvest Limits

Trip or vessel harvest limits are generally used within the confines of a quota to prevent harvesting the available amount of fish too quickly. An example of this in a commercial fishery would be the winter trawl fishery for summer flounder. In the winter trawl fishery, during specified time periods of one to two weeks, fishermen are only allowed to land a specified amount of flounder which varies based, in part, on how close the fishery is to reaching the quota (Table 13.9).

A trip or vessel harvest limit may not work well for the southern flounder commercial fisheries primarily due to their nature. Pound nets generally rely on storms and periods of high winds to move the flounder into the nets. As a result, landings are very sporadic, with daily landings sometimes exceeding 200,000 pounds (Figure 13.2). In contrast, landings in the gill net fishery are more consistent on a day-to-day basis with daily landings rarely surpassing 35,000 pounds (Figure 13.3). A trip or vessel limit for southern flounder would prevent the pound net fishery from taking advantage of periods of large catches due to wind and storm events on which its dependent, thus greatly reducing its productivity and the ability of the fishermen to make a living. Unlike gill net fishermen, pound netters cannot follow the flounder and are therefore more tied to the periodic weather occurrences for providing them with good catches. There is a potential for gill netters to be adversely affected by trip limits as well. A fisherman's gill net catches per yard of net fished can be variable. Restrictive trip limits could result in high discard mortality on days when catch rates are high.

Similar to a trip limit for the commercial fishery, a creel or bag limit for the recreational fishery denotes the number of fish allowed to be kept during a trip by an individual or boat. Currently, there is no creel limit in place for flounder in inshore waters. The first creel limit in the ocean went into affect in 1994 as a result of the federal FMP for summer flounder (Table 13.8). Currently, it is set at eight fish in the Atlantic Ocean. Examples of the impact a creel limit would have on the total recreational landings for the State can be found in Table 13.10. A creel limit of eight fish would match the limit for the ocean waters through the federal summer flounder FMP (Table 13.8). As with the minimum size limit, this would make management of the fishery easier on both recreational fishermen and law enforcement. However, an adoption of any creel limit would be different from the inland limits implemented by the NCWRC.

Another benefit of the implementation of a creel limit for the gig fishery would be to facilitate the enforcement of the no sale provision for recreational fishermen. The NCDMF has received numerous anecdotal reports of significant amounts of gigged flounder being sold, particularly inland, without being reported, as required by law. Individuals not possessing a Standard Commercial Fishing License (SCFL) or a Retired Standard Commercial Fishing License (RSCFL) may be selling these fish. Under current regulations, such violations are difficult for Marine Patrol to prosecute because there is no limit on how many fish may be taken recreationally with gigs. The violation does not take place until the fish are sold, which presumably occurs further inland, beyond Marine Patrol's area of focus. The implementation of a creel limit would provide law enforcement with an enforceable means of limiting harvest of flounder by recreational giggers to a level suitable for personal consumption, yet low enough to dissuade any incentive for selling the catch without a commercial license.

Gear Restrictions/Limitations

Maintaining effort at a stable level in the southern flounder fishery could be partially achieved by implementing specific gear limitations. These measures will only control effort provided the fishery does not expand much beyond its current level of participants. Over the past eight years, gill nets and pound nets have accounted for 93% of the total landings of southern flounder in North Carolina (Figures 13.8 and 13.9). Therefore, any limitations would need to focus on those two gears to be effective.

Table 13.10. Percent reductions associated with an implementation of a bag limit for recreational fisheries.

Bag Limit	Percent Reduction for All Recreational Fisheries (%)
1	82.27
2	67.91
3	55.90
4	45.73
5	37.82
6	31.66
7	26.67
8	22.45
9	19.27
10	16.23
11	13.74
12	11.40
13	9.46

Commercial Gill Nets

Participation, effort, and landings within the gill net fishery for flounder have increased dramatically since the early 1990s. This expansion is related, in part, to an increased demand for flounder (increased ex-vessel value), the development of a deepwater fishery in Pamlico Sound, rapid expansion in the Albemarle Sound gill net fishery for flounder, and the displacement of fishermen from other states and fisheries.

Yardage Limit

One means of reducing effort within the gill net fishery for flounder would be to limit each fishing operation to a specified amount of yardage of gill net. The average yards of large mesh gill net fished in the State per fishing operation, based on fish house sampling data, is approximately 1,100-2,200 yards depending on the area (NCDMF 2001). However, a single fishing operation can have over 6,000 yards of gill net out at a time. Limiting the fishery to a specified yardage will reduce the effort in the fishery, but may or may not achieve the target fishing mortality level.

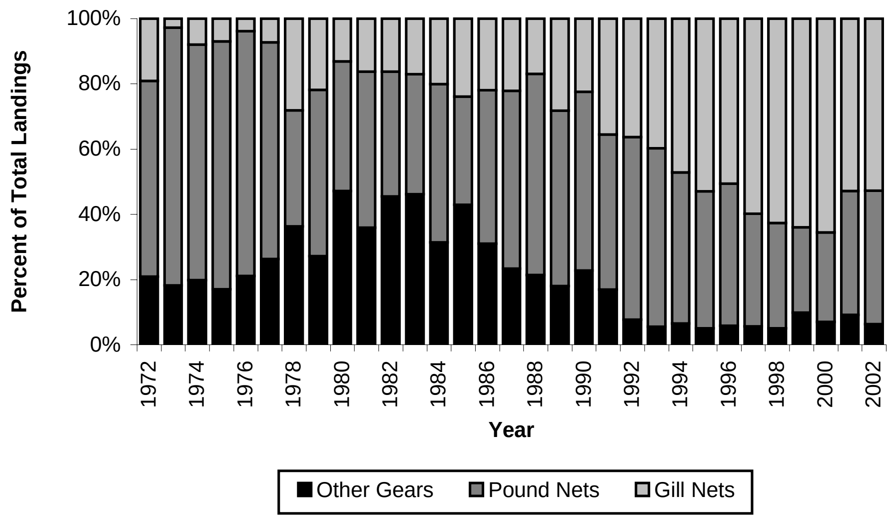

Figure 13.8. Landings of southern flounder during 1972-2002 by gill nets, pound nets, and all other gears combined (courtesy of the NCDMF Trip Ticket Program).

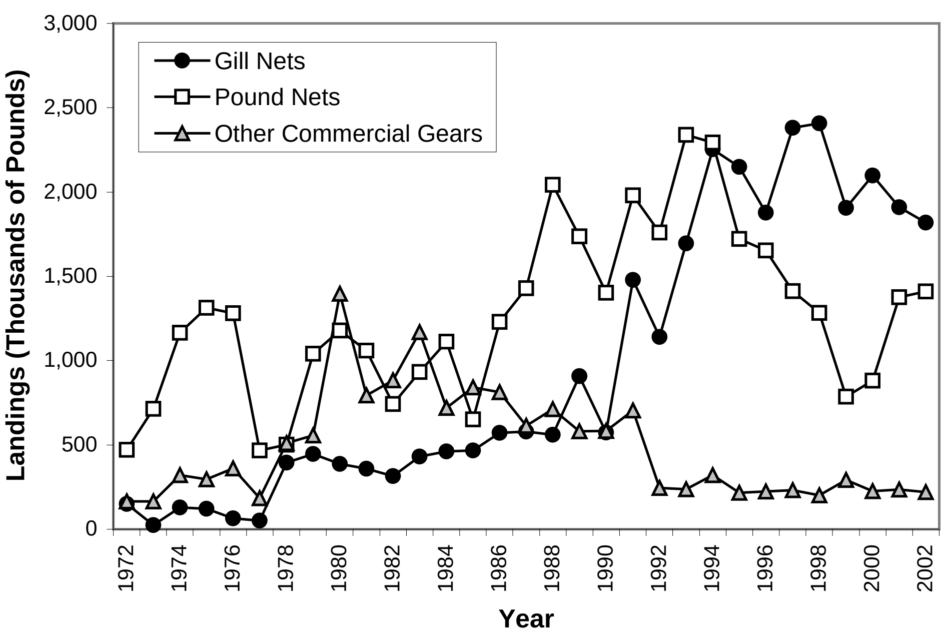

Figure 13.9. The percent contribution of gill nets, pound nets, and all other gears combined to the total landings of southern flounder for each year from 1972-2002 (courtesy of the NCDMF Trip Ticket Program).

Specified Fishing Time Periods

Another means of reducing effort within the gill net fishery would be to have specific periods during which the fishery could operate. This could include specific days of the week or even weeks of the year. The resulting level of effort would be dependent upon the amount of time allotted during which the fishery could operate.

Commercial Pound Nets

The number of pound nets increased dramatically in the Core Sound and southeastern Pamlico Sound area from the late 1980s to the mid-1990s, partly due to the increased demand for sushi/sashimi grade flounder. Fishermen claim the increase in the number of pound net sets in the late 1980s was also due in part to loss in catch, and thus income, caused by increasing the minimum fish size from 11 to 13 inches in 1988. In cooperation with fishermen and net makers, the NCDMF developed escape panels to release fish less than 13 inches from pound nets. The escape panels were first required in 1991. The number of sets leveled off in the late 1990s and even decreased in 1998-2000 due to gear losses from storms and drop-offs in catches, which has been attributed to the increased cost in gear maintenance and also to the increase in gill net pressure (Table 13.11).

Table 13.11. The number of annual active flounder pound net permits in each county during 1995-2003.

County	Year								
	1995	1996	1997	1998	1999	2000	2001	2002	2003
Beaufort		1	2	2	2	2	3	2	2
Camden	3	3	2	2	2	2	2	2	1
Carteret	238	224	220	216	215	197	163	145	140
Craven	1	1	1	1	1	1	1		1
Currituck	12	11	11	10	11	10	7	9	9
Dare	75	73	70	69	70	72	70	64	59
Hyde	50	52	55	53	54	53	51	44	44
Pasquotank	2	2							
Perquimans	1	1			1	3	3	2	2
Tyrrell	12	12	12	11	11	11	12	11	11
Total	394	380	373	364	367	351	312	279	269

Required Escape Panels Throughout the State

Currently, escape panels are only required in waters south of the Albemarle Sound. Fishermen in the northern part of the State claim that they have smaller flounder in the Albemarle Sound and use of the escape panels would eliminate too much of their harvest.

Pound Net Limitations

Effort within the pound net fishery can be leveled to some degree by limiting the number of pound nets that a fishing operation can set. Another variation would be to limit the total number of pounds and hearts that a fishing operation could have, with or without a limit on the number of nets.

Management Options/Impacts

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

<u>Commercial Fisheries</u>

1) Status Quo
   - \+ No additional burden on fishermen, dealers, or managers
   - \- Does not address historical trend of overfishing
   - \- Does not address dependence of fishery on year-class strength
   - \- Continued overfishing will not allow the stock to rebuild to the level of sustainable harvest as required by the FRA
   - \- Recovery of spawning stock biomass unlikely, stock could suffer further decline

2) Static Quota
   - \+ Controls harvest levels
   - \+ No confusion over quota from year to year
   - \- Not sensitive to fluctuations in recruitment or availability of fish to the fishery
   - \- Additional reporting burden on commercial dealers
   - \- Requires a permitting system for dealers to implement
   - \- Requires additional resources for NCDMF to implement
   - \- Overfishing may still occur based on fishing mortality levels
   - \- May restrict harvest levels more or less than necessary
   - \- Large potential to over-run the quota due to the potential magnitude of daily landings

3) Dynamic Quota
   - \+ Controls harvest levels
   - \+ Sensitive to fluctuations in recruitment or availability of fish to the fishery
   - \+ Overfishing would no longer be occurring
   - \- Additional reporting burden on commercial dealers
   - \- Requires a permitting system for dealers to implement
   - \- Requires additional resources for NCDMF to implement

- Large potential to over-run the quota due to the potential magnitude of daily landings

4) Limited Entry
   + Prevents growth of fishery
   + Could protect historical participants in the fishery
   - Will not prevent expansion in effort by allowed participants if implemented without other management options
   - Overfishing may still occur based on fishing mortality levels
   - Requires a license or permit system to implement
   - Cannot be considered as an option unless there is no other means of achieving the target fishing mortality level

5) Increased Minimum Size Limit
   + Increase in the spawning stock biomass and the overall yield to the fishery in the long-term
   + Allows more younger fish to have the opportunity to spawn at least once before being caught
   + Reduces harvest levels closer to the target fishing mortality level
   + No additional resources required to implement
   - Decrease in the yield to the fishery in the short-term
   - Some regions may be more adversely impacted than others (i.e. Albemarle Sound and the rivers)
   - Works best in conjunction with a quota or seasonal closure

6) Limited Harvest Season
   + Reduces harvest levels closer to the target fishing mortality level
   + Potentially allows more fish to survive the migration to the ocean to spawn
   + No additional resources required to implement
   + No reporting burden on fishermen or dealers
   - Some fisheries may be more adversely impacted than others
   - Effort may be increased during the open periods, thus reducing the effectiveness of the closure

7) Trip/Vessel Harvest Limits
   + Reduces effort in the fishery
   - May lead to large increases in discard mortality
   - May adversely impact some fisheries and fishermen more than others
   - Would not guarantee reduction of fishing mortality to the target level
   - Does not work well as a stand alone measure

8) Gear Restrictions

   a) Gill Nets

      i) Yardage Limit
         + Maintains effort at a consistent level for each participant

+ Reduces the amount of nets in the water
- Some areas of the State may be more heavily impacted than others
- May not result in a reduction in landings
- Overfishing may still occur based on fishing mortality levels

ii) Specified Fishing Time Periods
+ Reduces effort from current level
- Weather may prevent fishing during open periods
- Overfishing may still occur based on fishing mortality levels

b) Pound Nets

i) Pound Net Limitations
+ Maintains effort at a consistent level for each participant
- Overfishing may still occur based on fishing mortality levels

<u>Recreational Fisheries</u>

1) No action
+ No rule changes or legislative actions
+ No additional restrictions on fishing practices
- Confusion over different size and creel limits between ocean and inshore waters
- No enforceable measures for preventing the sale of recreationally caught fish
- The southern flounder stock continues to be overfished

2) Increase of recreational minimum size limit to 14 inches for inshore waters
+ Alleviates confusion over different size limits between ocean and inshore waters
+ Reduces harvest on an overfished stock
+ Allows more of the younger, smaller fish the potential to spawn at least once before being harvested from the population
- Potential short-tem reduction in the amount of flounder available to the fishery
- Potential reduction in participation in the recreational flounder fishery

3) Implement recreational creel limit for inshore waters
+ Increased enforceability
+ Potential reduction in illegal sales
+ Imposes cap on recreational harvest, particularly in the gig fishery
- Restricts fishing practices
- Additional burden on law enforcement

4) Implement a seasonal closure for the recreational fisheries
+ Reduces harvest on an overfished stock
+ A closure late in the year would allow more fish the opportunity to make it to the ocean to spawn
- Expansion in effort during the open season may offset benefits of the closed period

- May adversely impact some recreational user groups more then others
- Creates a discrepancy with the ocean fishery or forces the ocean fishery to take further unnecessary restrictions on harvest to compliment the actions taken in inside waters

5) Expand existing gig fishery survey beyond the scope of one year
   + No financial burden to fishermen
   + Obtain effort and landings estimates
   + Characterize catch by species and size (trip level data)
   - Cost and labor intensive
   - Require additional funding and personnel
   - Data obtained limited by sampling design
   - Incomplete sampling universe

6) Add gigs to the list of RCGL gears
   + Obtain universe of all giggers from which to survey
   + More accurate estimates of effort and landings
   + Positions already in place to conduct survey
   - Requires Legislative action
   - Increased financial burden to fishermen
   - Cannot determine species composition or size distribution of catch

7) Create a permit for gig use
   + No financial burden to fishermen
   + Obtain universe of all giggers from which to survey
   + More accurate estimates of effort and landings
   - Cannot determine species composition or size distribution of catch
   - Requires development of new permit at cost to the NCDMF

8) Capture gear specifics on the RCGL License application
   + No financial burden to fishermen
   + Improve sampling universe
   - Requires additional funding and personnel
   - Requires extensive redesigning of the system used to sell RCGLs

Research Needs

1) Initiate studies to investigate the potential for a portion of the flounder population to remain offshore following the spawning period, thus avoiding fishing pressure.

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13.1.2 Minimum Distance Between Gears

Issue

Reduce conflict between the commercial southern flounder fisheries.

Background

Historically, the pound net fishery contributed the majority of southern flounder landings for North Carolina. However, gill net landings began to increase dramatically beginning in the early 1990s, and by 1995, gill nets had supplanted pound nets as the primary gear landing southern flounder (Figure 13.11). The increase in gill net effort was due in part to an increased demand for southern flounder as the summer flounder landings began to drop off through the 1980s and early 1990s. In addition, the increase could also be partially attributed to an influx of fishermen from Florida as a result of a gill net ban in their home state that became effective on July 1, 1995. Since 1995, gill net landings and effort have remained fairly constant with only minor fluctuations (Figure 13.12). Pound net catch and effort began to decrease beginning that same year, and reached its lowest point in the past 16 years in 1999 (Figure 13.13). This decline is also reflected in the number of active pound net permits (Table 13.18). As gill net effort has increased through the years, competition for space and resources between the fisheries has increased as well.

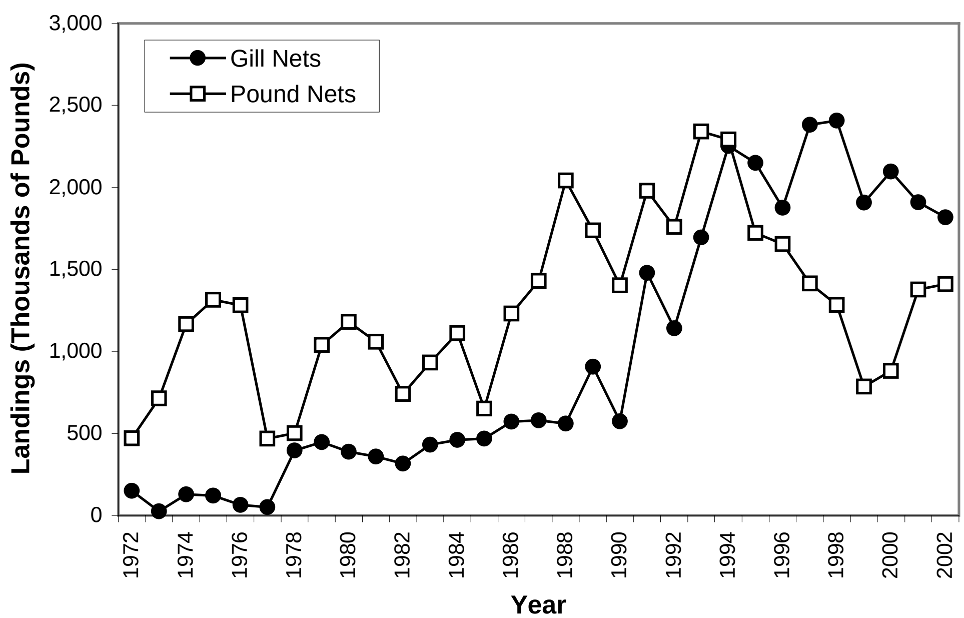


Figure 13.11. Southern flounder landings from pound nets and gill nets during 1972-2002 (courtesy of the NCDMF Trip Ticket Program).

Prepared by the North Carolina Division of Marine Fisheries on January 12, 2001; revised on January 12, 2004.

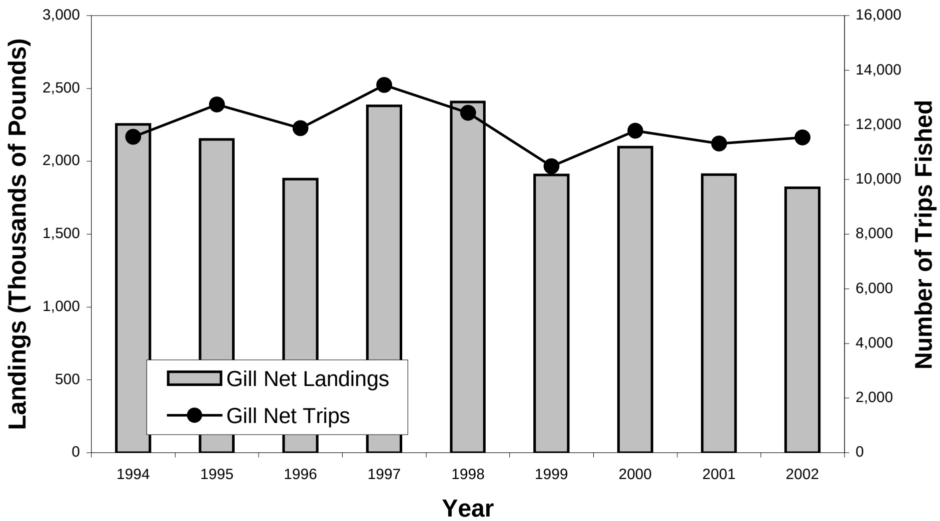


Figure 13.12. The number of directed gill net trips (trips with landings of greater than 50 pounds) and landings during 1994-2002 (courtesy of the NCDMF Trip Ticket Program).

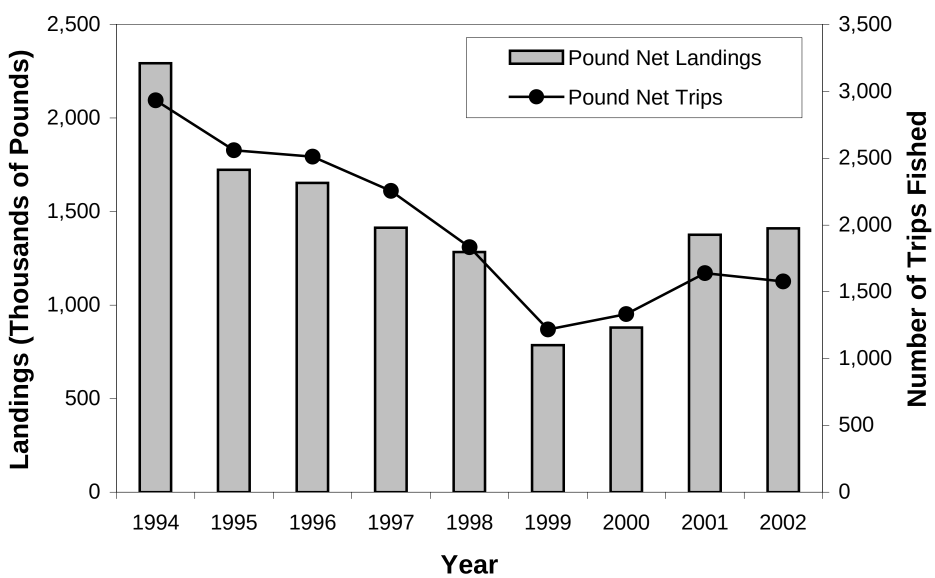


Figure 13.13. The number of directed pound net trips (trips with landings of greater than 50 pounds) and landings during 1994-2002 (courtesy of the NCDMF Trip Ticket Program).

Table 13.18. The number of annual active flounder pound net permits in each county during 1985-2003.

County	Year								
	1995	1996	1997	1998	1999	2000	2001	2002	2003
Beaufort		1	2	2	2	2	3	2	2
Bertie								15	13
Camden	3	3	2	2	2	2	2	2	1
Carteret	238	224	220	216	215	197	163	145	140
Chowan	1	1						9	9
Craven	1	1	1	1	1	1	1		1
Currituck	12	11	11	10	11	10	7	9	9
Dare	75	73	70	69	70	72	70	64	59
Gates								4	
Hertford	2	2	1	1	1	1	3	16	10
Hyde	50	52	55	53	54	53	51	44	44
Pasquotank	2	2							
Perquimans	1	1			1	3	3	2	2
Tyrrell	12	12	12	11	11	11	12	11	11
Washington	1	1				1	1	1	1
Total	398	384	374	365	368	353	316	324	302

Competition for resources has not just been between pound netters and gill netters, however. Pound nets are stationary gear and a permit is required in North Carolina to fish the gear. The exact location and placement of the net is specified in the permit, and the fisherman is limited to setting his/her net only in that location. As the demand for southern flounder grew and effort increased throughout the 1980s and early 1990s, more pound nets permits were being issued each year. Since there were no regulations on how close pound nets had to be from one another, some fishermen began to apply for pound net permits for nets to be used as "blocker nets". These sets were small and intended to keep other fishermen from placing a net to close to a pound netters main set of nets and thus cutting him/her off. With more and more of these "blocker nets" being employed, the amount of non-functional gear in the water increased.

Current Authority

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)

3J .0103 GILL NETS, SEINES, INDENTIFICATION, RESTRICTIONS
3J .0107 POUND NET SETS

Discussion

During the initial development of the Southern Flounder Fishery Management Plan, the issue of pound netters using "blocker nets" was discussed. Subsequently, the Advisory Committee (AC) made the recommendation to implement a 1,000-yard minimum distance between existing and new pound nets. This would allow pound netters to remove their "blocker nets" from the water without fear of another fisherman setting a pound net right next to an existing one and thereby cutting it off from catching fish. As a result, the amount of gear in the water would be reduced and further growth in the fishery would be limited.

As word of the 1,000-yard minimum distance recommendation reached the public, the amount of pound net permit applications increased dramatically as fishermen tried to obtain permits before the recommendation was approved. In response, the North Carolina Marine Fisheries Commission implemented the 1,000-yard minimum distance as a temporary rule on February 10, 2003. The rule became permanent on August 1, 2004.

The AC also discussed whether or not the current rule of a minimum distance of 200 yards between pound nets and gill nets [15A NCAC 3J .0103 (d) (1)] was adequate. Following this discussion, the North Carolina Division of Marine Fisheries received several phone calls and correspondences from fishermen stating that the 200-yard minimum distance between pound nets and gill nets was not a sufficient buffer. In essence, the general concern was that a gill net or gill nets of sufficient length set 200 yards in front of a pound net could adversely affect the ability of the pound net to catch flounder. By removing the "blocker nets" from the water, pound netters were allowing gill netters more area in which to fish and closer access to their main nets.

In addition, gill netters expressed the concern that by increasing the distance that gill nets could be fished to a pound net that they would be excluded from certain areas as new pound net permits were issued. However, one of the stipulations for a new pound net permit to be granted in a particular area is that it will not interfere with public navigation or existing, traditional uses of the area. This includes the historical use of gillnets or other fishing gears. Therefore, gill nets will not be excluded from areas in which they are currently fishing due to the introduction of new pound nets.

Management Options/Impacts

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

1) Status quo (1,000-yard minimum distance between new and existing pound net sets and a 200-yard minimum distance between gill nets and active pound nets)
   + "Blocker nets" are not necessary to keep other pound nets away
   + Gill netters are not further restricted on where to place their gear

- Pound nets could potentially be "cut-off" by gill nets placed in front of them
- Conflict between the fisheries is not reduced

2) Implement a 500-yard minimum distance between gill nets and active pound nets
   - + Reduce the amount of gear in the water
   - + Pound nets would be protected from gill nets being set too close
   - + Reduce conflict between user groups
   - +/- Would allow for no gill nets to be fished between active pound net sets that are 1,000 yards apart
   - - Reduction in the available area for gill net fishermen to set their nets

3) No gill nets between active pound nets set 1,000 yards apart in the Pamlico Sound and the eastern portion of the Albemarle Sound, and 200 yards apart in all other areas
   - + Reduce the amount of gear in the water
   - + Pound nets would be protected from gill nets being set too close in areas where it is a problem
   - + Reduce conflict between user groups
   - +/- Would allow for no gill nets to be fished between active pound net sets that are 1,000 yards apart in areas with the 500-yard minimum distance requirement
   - - Reduction in some waters in the available area for gill net fishermen to set their nets

4) No gill nets between active pound nets set 1,000 yards apart
   - + Reduce the amount of gear in the water
   - + Pound nets would be protected from gill nets being set too close
   - + Reduce conflict between user groups
   - +/- Would prevent gill nets being set between pound net sets that are 1,000 yards apart
   - - Reduction in the available area for gill net fishermen to set their nets

13.1.3 Gear Requirements in the Flounder Gill Net Fishery

Issue

Establishing regulations for the gill net fishery to prevent further increases in effort and minimize the bycatch of under-sized southern flounder.

Background

Gill nets surpassed pound nets as the predominant gear landing southern flounder in 1995 and since that time effort and landings in the gill net fishery have continually increased. Between 1999 and 2003 gill nets were responsible for over 60% of the commercial southern flounder landings in North Carolina (NCDMF Trip Ticket Program 2003). The minimum size limit in internal waters for flounder has been 13 inches since 1988 with no closure period. However, in light of the overfished status of the southern flounder population based on the most recent assessment, both the North Carolina Division of Marine Fisheries (NCDMF) and the Southern Flounder Fishery Management Plan Advisory Committee (AC) recommended increasing the commercial minimum size limit to 14 inches, and implement a closed season. For the recreational fisheries, in addition to a 14-inch minimum size limit, an eight fish bag limit per person per day has also been recommended. These actions were proposed to reduce landings in the fishery and allow more flounder the opportunity to move offshore to spawn.

This issue paper presents data on net mesh sizes relative to flounder length and on the amount of yardage of commercial gill nets currently fished in given areas. There are three objectives of this paper. The first is to provide data that might justify a regulation on minimum mesh size in the southern flounder gill net fishery, with a goal of considering the choice of a mesh size that will target southern flounder 14 inches or larger while minimizing the bycatch of flounder less than 14 inches. The second objective is to provide information about the current level of effort (yardage of net fished) in the major waters of gill net activity, with a goal of establishing a yardage limit that will prevent further expansion in effort within the flounder gill net fishery. The final objective is to evaluate the level of individual trip harvest in the recreational gill net fishery to determine if full-time attendance of large mesh recreational gill nets is necessary to prevent excessive harvest beyond the proposed bag limit of eight fish.

Current Authority

<u>North Carolina Fisheries Rules for Coastal Waters (15A NCAC)</u>

3J .0103 GILL NETS, SEINES, IDENTIFICATION, RESTRICTIONS

3J .0107 POUND NET SETS
3M .0503 FLOUNDER

Prepared by the North Carolina Division of Marine Fisheries on April 11, 2001; updated on April 2, 2004.

Proclamations

M-6-2004 regulates large and small mesh gill nets by area, mesh size, net length, and vertical fishing height in the Albemarle Sound Management Area.

Discussion

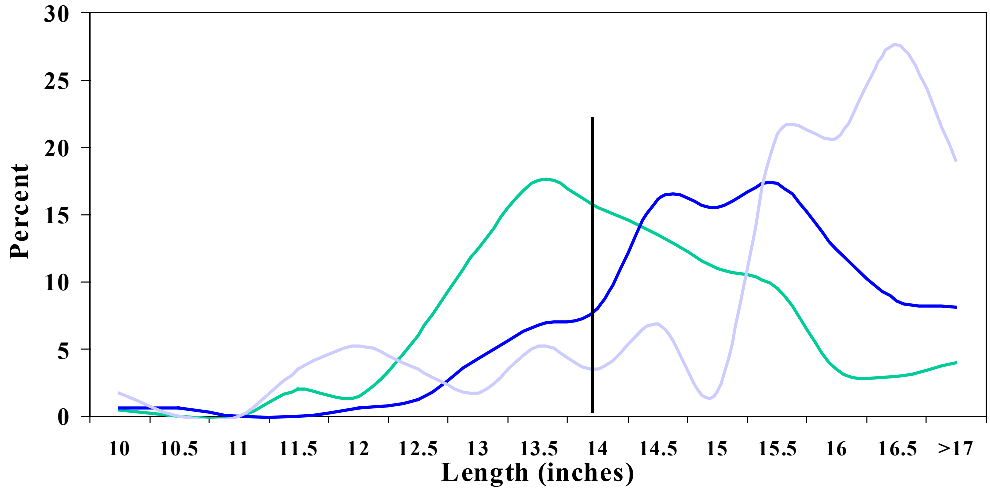
Minimum Mesh Size

The size of flounder caught by gill nets depends on a number of variables, including area fished, twine size, depth of water, hanging ratio, use of tie-downs, type of lead lines, float lines, and mesh size. The results presented here are based on data from two of NCDMF's independent sampling programs (Albemarle Sound independent gill net study and the Pamlico Sound independent gill net study) as well as data collected from NCDMF's commercial fishing observer program (Program 466), and a Fisheries Resource Grant (FRG) gill net study conducted in Brunswick County, 00-FEG-14 (Beresoff et al 2001). In addition, effort data from NCDMF's dependent sampling program (461) is presented. Due to sampling design or fishermen preferences, nets employed in these studies differed among the aforementioned variables and this may explain differences in the results within the programs and/or FRG. All analyses were based on the 2001-2003 period.

The Albemarle Sound gill net study was designed to monitor the Albemarle/Roanoke striped bass population. Figure 13.14 indicates the length frequency and the percent of less than 14-inch flounder retained with the three different mesh sizes. The figure clearly indicates the size of flounder caught increases with the increase in mesh size. All of these fish were captured during the fall, winter or spring of the year. Nets were hung utilizing a 0.5 ratio and a twine diameter of #104.

The Pamlico Sound independent gill net study area includes the Outer Banks (Roanoke Sound to Portsmouth Island) and the mainland side of the Pamlico Sound (Stumpy Point to Abels Bay). This gill net study provides length data from three sizes of large mesh gill nets commonly used in the southern flounder gill net fishery (5, 5½, and 6-inch). Twine diameter is #208 along the Outer Banks and #177 along the mainland side of Pamlico Sound, and the hanging ratio is 0.5. Nets are generally fished 12 hours in shallow and deep water. Figure 13.15 represents southern flounder selectivity data generated in this study.

For the Pamlico Sound data, less than 14-inch southern flounder account for 16.8% of the total catch in a 5½-inch stretched mesh net compared to 22.2% in the Albemarle Sound data. Differences may be attributed to the differences in the twine size (#104 and #208)



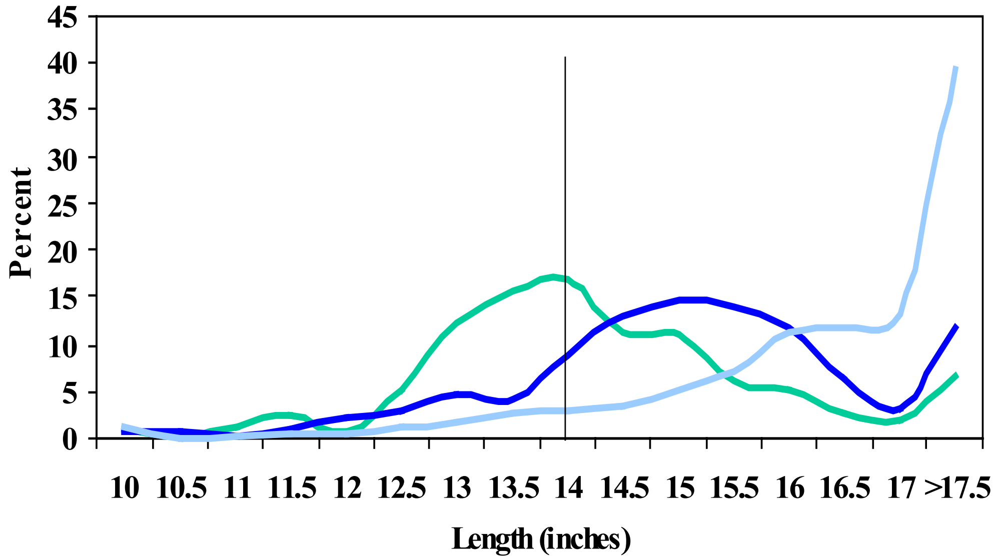
Net Size	N	% < 14 "	% > 14 "
5.0 "	210	55.5 %	44.5 %
5.50 "	162	22.2%	77.8%
6.00 "	58	24.1%	75.9%

Figure 13.14. Southern flounder length frequency by percent and mesh size in the Albemarle Sound during 2001-2003 (NCDMF biological database).

in the two studies or to the differences in sample size. Smaller diameter mesh size would be more prone to entangle fish as opposed to gilling them. Neither study utilized 5¼ or 5¾-inch stretched mesh nets.

Data collected during September–December 2001-03 from the Division's observer program (466) were examined for southern flounder large mesh net selectivity in the Pamlico Sound. Stipulations of the Pamlico Sound Gillnet Restricted Area (PSGNRA) permit require observer coverage on 10% of the large mesh gill net trips. A list of permit holders was utilized to randomly assign scientific observers to the vessels. In addition to sea turtle strandings, the observers collected data on bycatch, including the size of nets and length of southern flounder captured. Figure 13.16 summarizes these data.

Captures of southern flounder from a large mesh gill net study in Brunswick County were also examined. This study, conducted by Beresoff et al (2001), was funded by the FRG program (00-FEG-14). One objective of the study was to characterize the bycatch (especially red drum) in the most common sized estuarine flounder gill nets fished by commercial fishermen in southeastern North Carolina. As a part of the study, 72 trips were made utilizing 480 yards of 5½-inch stretched mesh. Trips were conducted during June - November 2000 and March - May 2001. Nets were 25 meshes deep and the twine diameter was # 177. Figure 13.17 depicts the length frequency of the southern flounder captured. Also indicated are the differences that might be expected with a 14-inch minimum size limit and this particular mesh size in this area.

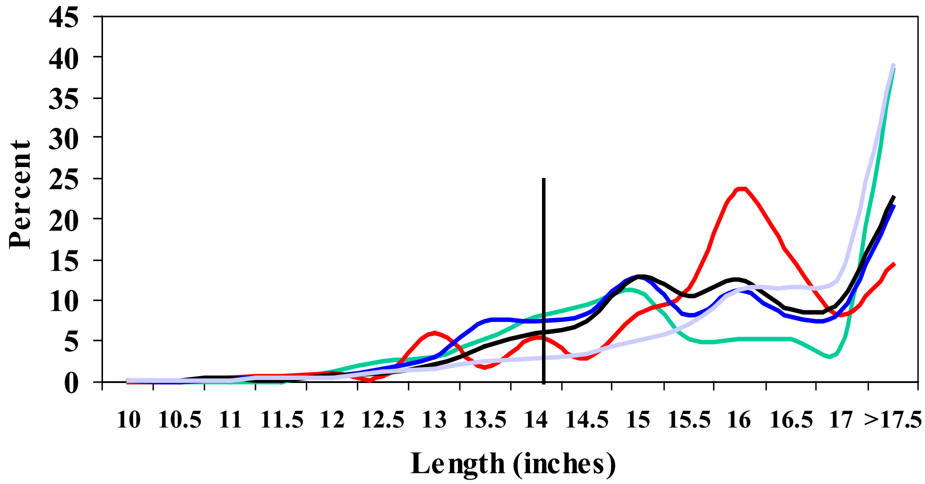


Net Size	N	% < 14	% > 14
5.0”	374	39..0	61
5.50”	358	16.8	83.2
6.0”	248	8.5	91.5

Figure 13.15. Southern flounder length frequency by percent and mesh size in the Pamlico Sound during 2001-2003 (NCDMF biological database).

The NCDMF also has a dependent sampling program (Program 461) that is designed to sample estuarine flounder catches when they are landed. In addition to recording fish lengths, data are obtained on mesh sizes and total yardages of net used. The fish length data have little value to the gill net mesh size issue since lengths of discards are not normally available. However, data from this program does indicate the frequency of use of the different mesh sizes in this fishery. Table 13.19 and Figure 13.18 illustrate these frequencies during 2000-2003.

Based on the results of the observer data, the FRG study and the present 13-inch size limit, it appears that during 2001-2003 commercial fishermen caught a limited number of undersized southern flounder. The fishermen appear to use net configurations and fishing methods (temporal and spatial) that serve to minimize the catch of southern flounder they cannot sell. These fishing practices may account for the slight differences in the NCDMF independent studies that are designed to catch more than one fish species.



Net Size	N	% < 14"	%>14"	# of trips
5.0 "	190	20	80	51
5.25 "	333	15.6	84.4	107
5.50 "	3121	21	79	895
5.75 "	2621	15	85	643
6.0 "	4005	9.3	90.7	1,426

Figure 13.16. Southern flounder length frequency by percent and mesh size in the PSGNRA during 2001-2003 (PSGNRA observer data).

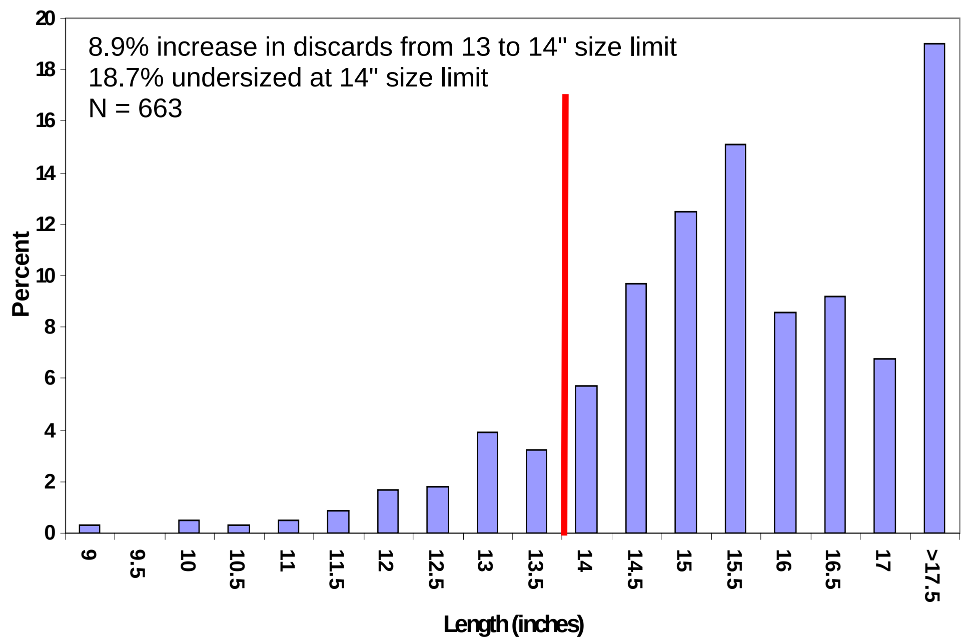


Figure 13.17. Southern flounder length frequency for 5½-inch stretched mesh gill nets, by percent, fished in southeastern North Carolina (Beresoff et al 2001).

Table 13.19. The frequency of use of each mesh size of gill nets in the commercial fishery based on fish house sampling of commercial trips (NCDMF biological database).

Stretched Mesh Size	Frequency	Percent
5.00	10	1.1%
5.25	85	9.6%
5.50	587	66.0%
5.75	84	9.5%
6.00	105	11.8%

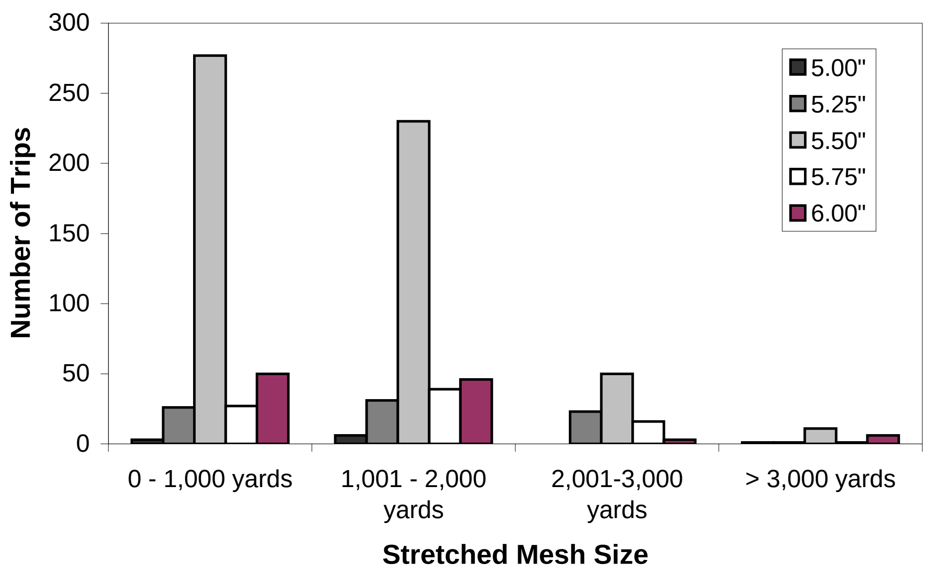


Figure 13.18. The number of commercial large mesh gill net trips made using each mesh size and range of yardage (NCDMF biological database).

Yardage Limits

Currently, the only area of the State that has a limit on the amount of gill net that can be fished is the Albemarle Sound Management Area. In this area, flounder gill nets are limited to 3,000 yards per fishing operation. This limit was implemented in 1991 to reduce the amount of striped bass bycatch in the large mesh flounder gill net fishery. As set forth in Proclamation M-6-2004, large mesh gill nets in the Albemarle Sound Management Area are limited to 3,000 yards and must meet one of the two following criteria:

1) Gill nets with a mesh length of 5¼ inches and larger that are equipped with floats that do not exceed 2 inches in diameter and 6 inches in length placed a minimum of 10 yards apart, not to exceed 11 floats per 100 yards of net; nets must be set so as to fish on the bottom not to exceed a vertical height of 48 inches;

2) All gill nets with a mesh length of 5¼ inches and larger not meeting the criteria for floats are required to be equipped with tie downs spaced no farther apart than 10 yards, restricting the vertical distance between the top and bottom lines to 48 inches or less; nets must be set so as to fish on the bottom not to exceed a vertical height of 48 inches.

Between 2000 and 2002, flounder gill net fishing operations in the Albemarle Sound Management Area used an average of 1,627 yards of net, with a range of 30–3,000 yards (Tables 13.20, 13.21, and 13.22). During the same period in the Pamlico Sound, fishing operations used an average of 1,524 yards of net, with a range of 100-6,000 yards. While the Pamlico Sound had no upper limit on the amount of net that could be fished at a given time, the mean amount of net that was fished was lower than in the Albemarle Sound area. Fishermen in the Rivers area (including the Neuse, Pamlico, Pungo, and New rivers) tended to fish fewer yards of net than in either the Pamlico or the Albemarle Sound, with a mean yardage of 1,237 yards and a range of 100-3,200 yards. The Southern area of the State (all coastal waters southwest of Newport River) displayed the least amount of gill net yardage per fishing operation with an average of 940 yards and a range of 150-2,300 yards. Both the Rivers and the Southern area tend to have smaller fishing operations due to the limited area in which to fish.

Based on the NCDMF sampling of the commercial gill net fishery, most commercial fishermen (87%) in North Carolina fish less than 2,000 yards of large mesh gill nets per trip (Figure 13.19). Out of a total of 865 trips sampled, 2,000 yards of gill nets or more were used on 11% of the trips.

In response to the proposed increase in the minimum size limit and the seasonal closure of the commercial fisheries, many commercial gill net fishermen have stated that they will increase their effort during the open season to compensate for the losses they will incur once the fishery closes. This increase in effort will likely come in the form of an increase in the amount of gill net yardage each fishing operation has in the water at a given time. A large increase in the amount of gill nets being fished during the open period of the fishery will likely offset much of the benefits of having a closed season.

Table 13.20. Summary of sampled estuarine gill net catches during 2000 from Albemarle Sound, Pamlico Sound, Rivers, and Southern areas by mesh size category. n = number of samples, including trip tickets only (NCDMF fishery dependent biological database).

Area	Mesh	n	Net Length (yd)		Set Time (hr)	
			Mean	Range	Mean	Range
Albemarle Sound	Large	63	1,524.3	30.0-3,000.0	26.8	12.0-72.0
	Multiple	8	1,116.3	250.0-2,000.0	21.5	4.0-24.0
	Small	13	392.3	200.0-500.0	28.1	0.5-72.0
	Unknown	6	-	-	24	-
Pamlico Sound	Large	126	1,385.4	150.0-5,600.0	20.2	12.0-72.0
	Multiple	18	1,416.7	400.0-4,300.0	28	0.2-96.0
	Small	86	1,003.7	100.0-3,500.0	18.1	0.3-48.0
	Unknown	13	2,200.0	-	15.4	12.0-24.0
Rivers	Large	89	1,564.2	100.0-3,000.0	26.6	3.0-72.0
	Multiple	6	1,858.3	700.0-2,400.0	26	10.0-48.0
	Small	23	748.0	200.0-3,000.0	7.1	0.1-12.0
	Unknown	54	700.0	-	20.7	8.0-48.0
Southern Area	Large	5	870.0	150.0-2,000.0	13.8	9.0-24.0
	Multiple	1	250.0	-	12	-
	Small	21	393.0	135.0-1,000.0	3.3	1.0-12.0
Overall	All	532	1,257.3	30.0-5,600.0	21.2	0.1-96.0

Table 13.21. Summary of sampled estuarine gill net catches during 2001 from Albemarle Sound, Pamlico Sound, Rivers, and Southern areas by mesh size category. n = number of samples, including trip tickets only (NCDMF fishery dependent biological database).

Area	Mesh	n	Net Length (yd)		Set Time (hr)	
			Mean	Range	Mean	Range
Albemarle Sound	Large	39	1,702.5	100.0-3,000.0	31.1	12.0-96.0
	Small	7	533.3	400.0-800.0	7.9	0.5-24.0
	Unknown	2	-	-	-	-
Pamlico Sound	Large	74	1,640.9	100.0-1,600.0	14.2	8.0-48.0
	Multiple	12	1,166.7	500.0-1,800.0	29.5	12.0-48.0
	Small	78	848.2	100.0-4,000.0	19.2	0.0-48.0
	Unknown	14	1,000.0	-	28.5	12.0-48.0
Rivers	Large	105	1,036.1	100.0-3,000.0	20.3	6.0-48.0
	Multiple	12	954.5	400.0-2,500.0	18.8	0.8-48.0
	Small	23	429.1	70.0-800.0	6.5	1.5-12.0
	Unknown	59	-	-	12	-
Southern Area	Large	1	200.0	-	13	-
	Multiple	1	200.0	-	12	-
	Small	16	623.4	200.0-2,000.0	1.3	0.0-3.3
Overall	All	443	1,125.0	70.0-4,000.0	19.6	0.0-96.0

Table 13.22. Summary of sampled estuarine gill net catches during 2002 from Albemarle Sound, Pamlico Sound, Rivers, and Southern areas by mesh size category. n = number of samples, including trip tickets only (NCDMF fishery dependent biological database).

Area	Mesh	n	Net Length (yd)		Set Time (hr)	
			Mean	Range	Mean	Range
Albemarle Sound	Large	22	1,654.5	300.0-3,000.0	25.7	0.1-72.0
	Multiple	2	600.0	500.0-700.0	18	12.0-24.0
	Small	13	661.5	300.0-900.0	6	0.3-48.0
	Unknown	3	-	-	-	-
Pamlico Sound	Large	100	1,545.6	200.0-6,000.0	18.7	8.0-48.0
	Multiple	3	1,183.3	650.0-2,000.0	6.3	0.5-12.0
	Small	44	704.9	200.0-1,900.0	20.1	0.3-48.0
	Unknown	6	-	-	-	-
Rivers	Large	157	1,112.3	200.0-3,200.0	19.2	12.0-48.0
	Multiple	3	800.0	400.0-1,400.0	24	-
	Small	46	466.3	200.0-1,600.0	4.4	0.5-12.0
	Unknown	65	-	-	12	-
Southern Area	Large	5	1,750.0	200.0-2,300.0	20	12.0-24.0
	Small	13	307.7	100.0-500.0	2.3	0.1-4.5
Overall	All	482	1,093.0	100.0-6,000.0	18.6	0.1-72.0

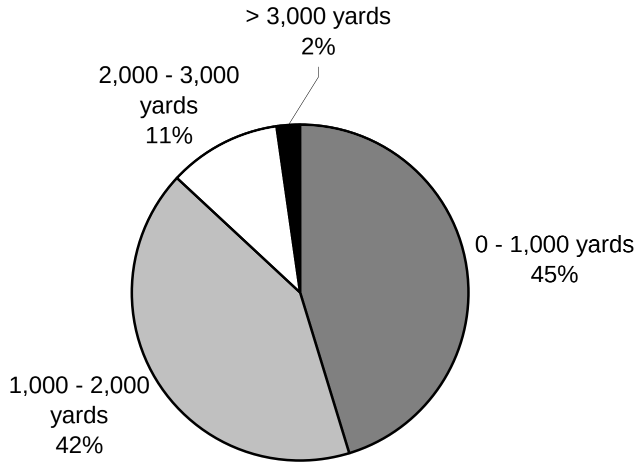


Figure 13.19. The yardage of large mesh gill nets fished per trip by percent in the commercial fishery (NCDMF biological database).

Mandatory Attendance of Recreational Large Mesh Gill Nets

It has been proposed by some user groups that recreational large mesh gill nets be attended at all times to prevent exceeding the recommended eight fish bag limit. According to data collected through the RCGL survey (Wilson 2003), if an eight fish bag limit had been in place in 2002, only nine percent of large mesh gill net trips that used the allowable quantity of gear (100 yards) would have had to discard flounders that exceeded the existing 13-inch size limit. This percentage would be even smaller had a 14-inch size limit been in place. Overall, 91% of the recreational large mesh gill net trips in 2002 landed eight or less flounder (Figure 13.20).

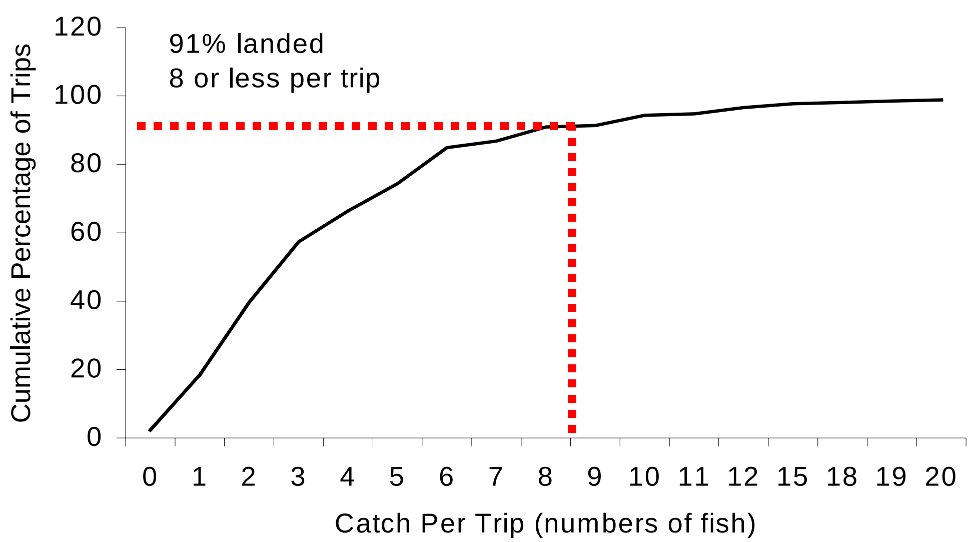


Figure 13.20. Cumulative percent of RCGL large meshed gill net trips that landed less than 8 fish per trip during 2002

Management Options/Impacts

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

Minimum Mesh Size

1) Status quo (no change)
   + No rule changes or Legislative actions
   + No additional restrictions on fishing practices
   - Continued harvest and discard of sub-legal southern flounder

2) Establish a minimum mesh size of 5½-inch stretched mesh
   + Reduce catch of sub-legal southern flounder by 22-33% depending on the area
   + Minimal impact on fishermen (less than 11% of gill net trips are made using webbing less than 5½ inches)
   - Potential for financial hardship on fishermen to replace undersized nets
   - May eliminate a portion of legal catch

3) Establish a minimum mesh size of 6-inch stretched mesh
   + Reduce catch of sub-legal southern flounder by 30-31% depending on the area
   - Large impact on fishermen (82% of gill net trips are made using webbing less than 6 inches)
   - Potential for financial hardship on fishermen to replace undersized nets
   - May eliminate a portion of legal catch

Yardage Limit

1) Status quo (no change)
   + No impact on current fishing practices
   - Potential for unlimited expansion in the gill net fishery
   - Increase in effort could offset the benefits of having a closed season

2) Implementation of 3,000-yard limit on gill nets
   + Establishes a cap on yardage for the fishery, capping expansion
   + Allows for the whole State have the same yardage limit
   + Few fishing operations will be impacted
   - Some fishing operations will have to reduce the amount of gear they are currently setting

3) Implementation of 2,000-yard limit on gill nets
   + Establishes a cap on yardage for the fishery, limiting expansion
   + Reduces the amount of gill net in the water
   + Allows for the whole State have the same yardage limit
   - Many fishing operations will have to reduce the amount of gear they are currently setting
   - May force some fishermen to find other avenues of income

Recreational Gill Net Attendance

1) Status quo (no change)
   + No additional burden on recreational gill netters and law enforcement
   + No additional rules or proclamations
   - Potential increase in discards of legal fish with change in size and bag limits

2) Require the mandatory full-time attendance of all recreational large mesh gill nets
   + Reduce the amount of discarded legal fish in the fishery
   - Additional burden on fishermen and law enforcement
   - Requires additional rules or proclamations

Research Needs

1) Collect selectivity data for gill nets with 5, 5¼, 5½, 5¾, 6, and 6½-inch mesh.

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13.1.4 Bycatch in the Commercial Flounder Gill Net Fishery

Issue

Characterize bycatch in the commercial flounder gill net fishery.

Definitions

Fishery Definition

Flounder gill nets are set nets of large mesh (5-inch and larger stretched mesh length) targeting flounder that are deployed and normally left overnight (but set time may range from only a few hours up to a few days depending on water temperature and depth). There are two basic types of flounder gill net operations which can be broken down by vessel size: smaller boats (8-25 feet) that fish near shore in shallow (< 10 feet) water and larger vessels (> 25 feet) that fish in deepwater (> 10 feet). Nets set in water greater than six feet usually fish the gill net near the bottom to increase the amount of bag in the net and improve the capture of flounder. Small and large mesh gill nets are not specified on the North Carolina Division of Marine Fisheries (NCDMF) trip ticket. An estuarine gill net trip is designated as a flounder gill net trip when 50% of the total weight of the catch consists of flounder. This flounder gill net fishery definition accounts for 93% of the flounder recorded in all (both large and small mesh) estuarine gill nets.

Bycatch Definition

Bycatch is defined by the Atlantic States Marine Fisheries Commission as "the portion of a catch taken incidentally to the targeted catch because of non-selectivity of the fishing gear to either species or size differences" (ASMFC 1994). Bycatch can be divided into two components: incidental catch and discarded catch. Incidental catch refers to retained 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.

Area Definition

The Albemarle Sound includes all inside waters designated as the Albemarle Sound Management Area (ASMA) from the Virginia-North Carolina line, including Currituck Sound, the Albemarle Sound and all tributaries, and Croatan Sound, except for Roanoke Sound to the south end of Roanoke Marshes across to Eagle Nest Bay, below Oregon Inlet. Pamlico Sound includes all water south of the ASMA line with the addition of Roanoke Sound, and Core Sound to Beaufort Inlet including the Newport River. The Rivers include the New, Neuse, Pamlico, and Pungo rivers. The Southern area includes the remainder of the State south of Beaufort inlet.

Prepared by the North Carolina Division of Marine Fisheries on April 5, 2004.

Background

Estuarine gill nets are one of the dominant finfish gear types in North Carolina based on the amount of gear utilized and number of people involved. The average annual reported use of flounder gill nets from 2000-2002 was 1,497,165 yards (fiscal year data, July 1-June 30; NCDMF License data). Gill nets were the most widely used commercial finfish gear during the 2000-2002 trip ticket report period, comprising 17.4% of the total trips reported in both inside and ocean waters for all fisheries (NCDMF 2004). A major component of the estuarine gill net fishery, the flounder gill net fishery occurs throughout the year with the peak landings and trips occurring from July - November. The Albemarle Sound area is the predominant fishing locale for flounder gill net trips, followed by Pamlico Sound, the Rivers, and the Southern area (Table 13.23). Albemarle Sound area also has the most participants (327 fishermen) (Table 13.23).

Historically, two large mesh ($\geq$ 5 inches stretch mesh) gill net fisheries operated in Pamlico Sound from September through December (Gearhart 2002). These consisted of a shallow water fishery (< 5 feet deep) along the Outer Banks, and a deep water fishery (10 – 20 feet deep) further from shore along a slope adjoining the main basin of Pamlico Sound (Figure 13.21). Both of these fisheries targeted southern flounder. Beginning in 1999 increased observations of sea turtle strandings were made by the National Marine Fisheries Service (NMFS), the NCDMF, and the North Carolina Wildlife Resources Commission (NCWRC). It was determined the flounder fishery was interacting with sea turtles and the NMFS issued an emergency rule closing southeastern Pamlico Sound to gill nets larger than 5-inch stretched mesh to protect endangered and threatened sea turtles for the remainder of the year on December 16, 1999 (64 FR 70,196, December 16, 1999). On October 5, 2000, the NMFS issued an Incidental Take Permit (ITP) #1259 to the NCDMF (65 FR 65,840, November 2, 2000). The ITP established the Pamlico Sound Gill Net Restricted Area (PSGNRA) and imposed strict gill net fishery management measures. The NCDMF closed the PSGNRA to the use of large mesh gill nets effective October 27, 2000. These observations and monitoring data acquired in 2000 sparked the NMFS to close all potential fishing grounds utilized by the deep water large mesh gill net fishery for the 2001 fishing season (Figure 13.22, 66 FR 50,350, October 3, 2001). In

Table 13.23. Average landings, participants, and trips from 2000-2002 for the North Carolina flounder gill net fishery.

Area	Pounds Landed	Trips	Participants
Albemarle Sound area	1,019,381	7,062	327
Pamlico Sound area	557,284	5,035	316
Rivers area	368,256	4,262	274
Southern area	76,610	1,118	129
Total	2,021,531	17,477	

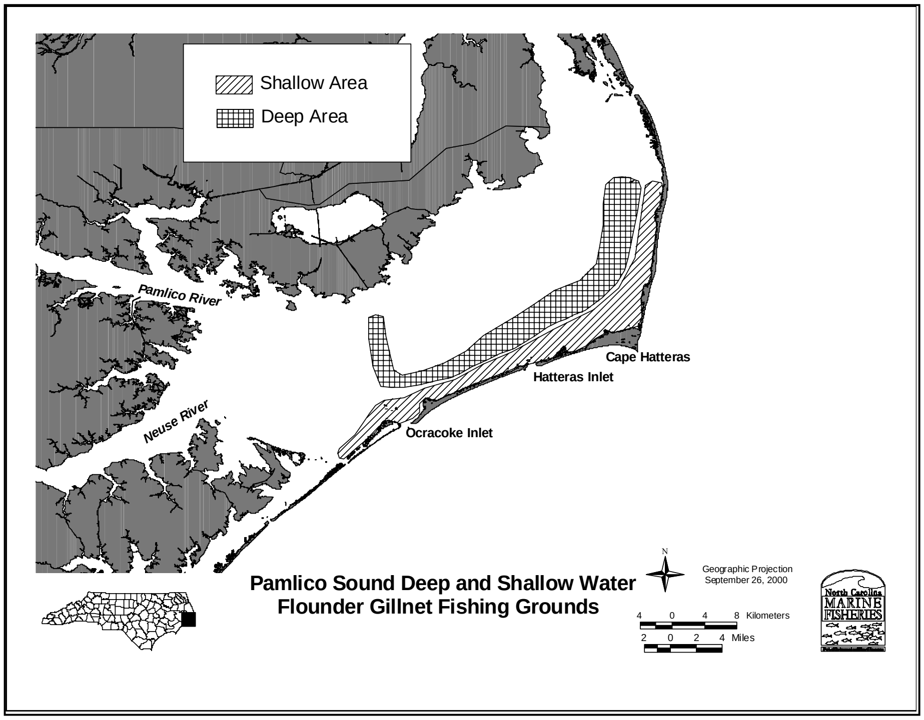

Figure 13.21. North Carolina estuarine flounder gill net fishing grounds in southeastern Pamlico Sound.

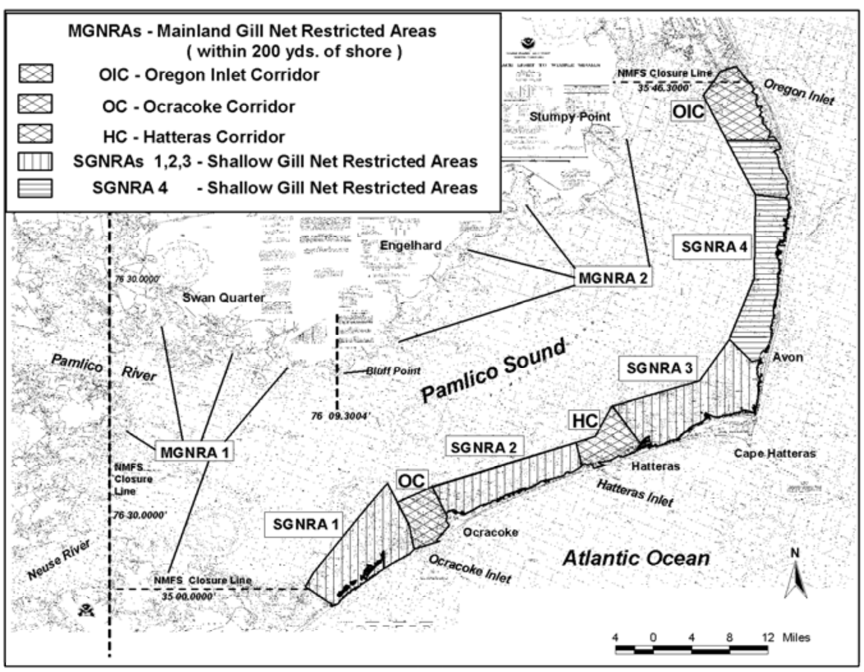

Figure 13.22. North Carolina estuarine flounder gill net fishing grounds from September – December of the PSGNRA. Map depicts Outer Banks restricted fishing areas (S1, S2, S3, S4), and mainland sites, where fishing is only allowed within 200 yards of shore (M1, M2).

this PSGNRA, the deep water fishery remains closed from September 15 through December 31, but the shallow water fishery continues to operate under a federal incidental take permit that imposes a number of stipulations including: permitted entry, restricted areas, a 2,000 yard limit for all gill net operations, weekly fishermen reporting, and mandatory scientific observer coverage.

The management regime in the ASMA is dictated by measures to reduce the bycatch of striped bass (*Morone saxatilis*). Management measures in place for the flounder gill net fishery there consist of a flounder gill net definition, in which nets must be a minimum of 5¼-inch stretched mesh. Flounder gill nets must also be set as to fish no more than 48 inches from the bottom and are not to exceed 3,000 yards in length. In the remainder of the State there are no yardage, minimum mesh size, or tie down restrictions for the commercial flounder gill net fishery.

Incidental Take (Retained Catch)

The retained species in the flounder gill net fishery are shown in Table 13.24 for the State. The target species, flounder, represents, on average (2000-2002), 87.8% of the catch by weight. Based on NCDMF fish house sampling the flounder species composition consists of 99.6% southern flounder and 0.4% summer flounder in estuarine flounder gill nets. Seventy-seven different species are taken with the following incidental species accounting for the top ten: black drum (*Pogonias cromis*), red drum (*Sciaenops ocellatus*), catfish (*Ictaluridae* and *Ariidae*), bluefish (*Pomatomus saltatrix*), sheepshead (*Archosargus probatocephalus*), striped bass, Atlantic croaker (*Micropogonias*

Table 13.24. Average landings and ex-vessel value of flounder and the top ten species from 2000-2002 marketed in the North Carolina estuarine flounder gill net fishery.

Species	Pounds	% Pounds	Value	% Value
Flounders (Paralichthid)	1,789,211	87.78%	$2,860,390	94.91%
Black drum	43,378	2.13%	$10,352	0.34%
Red drum	35,524	1.74%	$39,412	1.31%
Catfish	25,242	1.24%	$6,733	0.22%
Bluefish	18,288	0.90%	$4,881	0.16%
Sheepshead	15,516	0.76%	$5,586	0.19%
Striped bass	14,138	0.69%	$16,471	0.55%
Atlantic croaker	13,868	0.68%	$3,683	0.12%
Weakfish	13,469	0.66%	$7,480	0.25%
Blue crabs, hard	12,357	0.61%	$15,227	0.51%
Spot	9,754	0.48%	$4,113	0.14%
Total	1,990,745	97.66%	$2,974,328	98.69%

undulatus), weakfish (*Cynoscion regalis*), blue crabs (*Callinectes sapidus*), and spot (*Leiostomus xanthurus*). Other commercially viable species which combined made up only 1.26% by weight of the landings included: spotted seatrout (*Cynoscion nebulosus*), striped mullet (*Mugil cephalus*), spadefish (*Chaetodipterus faber*), white perch (*Morone americana*), American shad (*Alosa sapidissima*), kingfish (*Menticirrhus* sp.), menhaden (*Brevoortia tyrannus*), and Spanish mackerel (*Scomberomorous maculatus*).

The species compositions of flounder gill net observations from the NCDMF observer program in Pamlico Sound also indicates what species are kept and marketed from the flounder gill net fishery. The majority of fish that were retained (kept) included the target species, southern flounder (*Paralichthys lethostigma*), which represented 73% of the total species composition for 2001 to 2003. Other predominant species kept in the flounder gill net fishing operations included summer flounder (*P. dentatus*) (12%), gulf flounder (*P. albigutta*) (4%), bluefish (6%), and black drum (5%).

<u>Discards</u>

NCDMF data from the observer coverage and NCDMF fishery independent surveys were used to assess the discard (bycatch not kept due to regulatory, economic or personal reasons) in the flounder gill net fishery. Fishery independent gill net surveys are used by the NCDMF to further characterize discard takes in North Carolina fisheries. These surveys are used because accurate estimates of numbers and sizes of fish captured in fishery dependent studies (i.e. commercial fishery observations such as the trip ticket program) are often difficult to obtain due to culling of the catch while on the water.

<u>Data Sources and Analysis Methods</u>

DMF Observer Program (Program 466)

As part of the requirements in the PSGNRA, permit holders were required to have mandatory observer coverage for the large mesh gill net fishery throughout Pamlico Sound. A list of permit holders was utilized to randomly assign scientific observers to vessels by area (Outer Banks or Mainland) and by port. Outer Banks ports included Rodanthe, Avon, Buxton, Hatteras, Ocracoke, and Cedar Island. Mainland ports (Hyde County) included Stumpy Point, Engelhard, Gull Rock, Swan Quarter, Rose Bay, Germantown, and Hobuken.

Observers collected data on location, gear parameters, catch, and bycatch for each haul. Species status (kept, unmarketable discard, and regulatory discard) was recorded for each species on each haul. The landed catch was sampled throughout each trip and total flounder weights were obtained. All observers were debriefed within 24 hours of each trip to obtain data on flounder catch, set locations, gear parameters, observed bycatch (regulatory and spoiled), and sea turtle interactions. Data was used from this program from September to December for years 2001 to 2003 and only include large mesh nets.

Albemarle Sound Independent Gill Net Survey (Program 135)

The NCDMF independent gill net survey for the Albemarle Sound provides catches in varying mesh sized gill nets. From November – February of each year, two survey crews fish replicate 40-yard anchored, floating, and sinking monofilament gill nets from 2½ through 7-inch stretched mesh in one-half inch increments. Eight and 10-inch stretched mesh heavy twine are also employed. The areas covered include the Albemarle Sound and Croatan Sound (Figure 13.23). From March – May of each year sampling is reduced to one survey crew and confined to the western Albemarle Sound near the mouths of the Roanoke and Chowan rivers. Only large mesh nets (5-inch stretched mesh and greater) were used in the analysis. These surveys use stratified random sampling. Nets are set for two 24-hour periods in one area. These gill nets are set in both shallow (≤ 6 feet) and deep (> 6 feet) waters in areas traditionally utilized by commercial fishermen. Data collected from independent gill net surveys include: net set and retrieval locations and times, water depth, relevant environmental data noted, and biological sampling. Upon retrieval of the nets, fish were enumerated by mesh size, and measured. Individual weights were calculated based on length/weight relationships obtained from NCDMF age sampling. The general condition of the fish (alive, dead, spoiled) captured was recorded for 2002 and 2003. The analysis period includes January 2001 to December 2003 with seasons covering January to March, April to May and November to December.

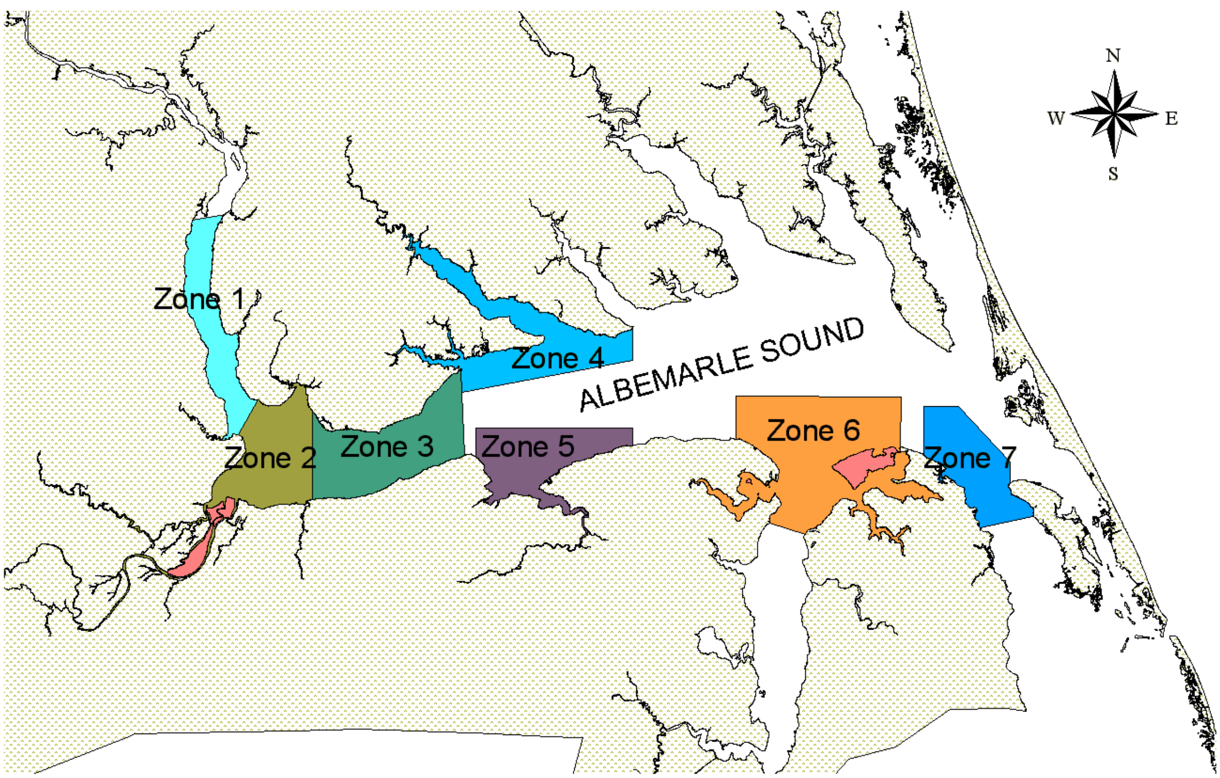

Figure 13.23. Albemarle Sound independent gill net survey sampling areas (zones).

Commercial Sampling of the Estuarine Gill Net Fishery (Program 461)

Sampling of the estuarine gill net fishery was initiated by the NCDMF in April 1991 to determine relative abundance, age, size, and composition of species taken in the fishery. Some at-sea sampling was conducted under this sampling program in the summer months in the Albemarle Sound since 1996. NCDMF staff were placed on boats involved in the flounder fishery to monitor the gear interactions with striped bass. Trip information was gathered on: general location or waterbody, total length of nets (feet), soak time (minutes), specific net type (i.e. float, sink, etc.), mesh size (bar mesh, inches), net depth (float nets, recorded in feet), vertical fishing depth (sink nets, recorded in feet), twine size, average water depth (meters), and incidental species. Fish were categorized into market and discard groups (based in size limits and marketability). Each category (market or discard) was separated into species groups. Commercially important species from each category were counted, measured to the nearest millimeter (fork length or total length), and weighed by species aggregates to the nearest 0.1 kilograms. Counts and total weights (kilograms) by species were obtained for the non-marketable species within the discard portion. Weights were estimated for discarded fish that were shaken free from the net during the gear retrieval process. The analysis period includes seasons: June and October only of 2002, June to August 2001 and 2003, and October 2001.

Pamlico Sound Independent Gill Net Survey (IGNS) (Program 915)

The NCDMF independent gill net survey provides catches in varying mesh sized gill nets (3, 3½, 4, 4½, 5, 5½, 6, and 6½-inch stretched mesh), and estimates species abundance. Only 5-inch or greater mesh nets were used in the flounder gill net analysis. The areas covered include the Outer Banks (Roanoke Sound to Portsmouth Island) and mainland side of Pamlico Sound (Stumpy Point to Abels Bay). This survey is a stratified random sampling. Nets are soaked overnight and retrieved the following morning for approximately 12-hour sets. These gill nets are set in both shallow ($\leq$ 6 feet) and deep (> 6 feet) waters in areas traditionally utilized by commercial fishermen. Data collected from independent gill net surveys include: net set and retrieval locations and times, water depth, relevant environmental data noted, and biological sampling. Upon retrieval of the nets, fish were enumerated by mesh size, and measured and group weighed. Individual weights were calculated based on length/weight relationships obtained from NCDMF age sampling. The general condition (alive, dead, spoiled) of the fish captured was recorded. Analyses of the data for this issue are restricted temporally (January - March and April - August), and spatially (Outer Banks and mainland side of Pamlico Sound) and covers the period May 2001 to September 2003.

Neuse, Pamlico, and Pungo Rivers Sampling (Program 915)

This study is the same as the independent gill net study in the Pamlico Sound, but was completed in the Neuse, Pamlico, and Pungo rivers in 2000. The program was re-instated in the rivers in July of 2003. The methodology and design is the same as the Pamlico Sound independent gill net study noted above, using stratified random sampling in the river systems with varying mesh sized gill nets set in shallow and deep waters in overnight sets. Data collected from the survey included: net set and retrieval locations and times, water depth, relevant environmental data, and biological sampling. Upon retrieval of the nets, fish were enumerated by mesh size, measured, and group weighed. Individual weights were calculated based on length/weight relationships obtained from NCDMF age sampling. The general condition (alive, dead, spoiled) of the fish captured was recorded. Data were analyzed using the same temporal separations (January - March, April - August, and September - December) for large mesh gill nets and for data only collected in 2000.

Data Analysis for Regulatory and Spoiled Discards

Five commercially important species have discards in the flounder gill net fishery due to regulations imposed on these species for size and trip limits: southern flounder, striped bass, red drum, spotted seatrout, and weakfish (Table 13.25).

Bycatch estimates for striped bass were taken from the Striped Bass Fishery Management Plan for the Central/Southern and Albemarle Sound Management Areas. Discards from the anchored gill net fishery in the ASMA has been reported to the Atlantic States Marine Fisheries Commission as a compliance issue since 1994. Estimates for both the ASMA and the Central/Southern Management Area (CSMA) were developed for the North Carolina Estuarine Striped Bass Fisheries Management Plan. Methodology for estimating discard mortality differed from that used for the other species addressed in this issue paper. For striped bass, CPUE values from independent gill net surveys were used, in conjunction with average yardage fished in the commercial fishery to calculate the number of striped bass encountered. The number of fish harvested by the fishery was then subtracted from the estimated fish encountered. Mortality rates, by season, were applied to the remainder of the encountered striped bass to determine discard mortality. For the ASMA, because of a defined flounder net definition and other gill net restrictions, gill net effort and average yardage for the flounder fishery was able to be determined. This allowed discard mortality to be estimated for the flounder fishery by itself (Striped Bass FMP Sec. 10.3.2.1). In the CSMA, which includes the Pamlico Sound, south to the North Carolina/South Carolina, this was not possible. Gill net restrictions are not as extensive in these areas, so it is difficult to break trip ticket data down to a single fishery. In the CSMA, discards of striped bass were calculated for large and small mesh. The large mesh fishery includes trips that targeted flounder and shad. For the CSMA, a majority of the striped bass discards are attributed to the shad fishery in the rivers (Striped Bass FMP Sec. 10.4.3.2).

Bycatch estimates for species other than striped bass were determined in a four-stage process from four NCDMF sampling programs in Albemarle Sound, Pamlico Sound, and the Neuse, Pamlico, and Pungo Rivers (Table 13.26). Estimates for the Southern area were unavailable so rates were used from sampling done in the Rivers because length frequencies of fish from the Rivers and Southern area show similar size class distributions (NCDMF 2001). This procedure focused solely on size restrictions because data limitations precluded investigations of discards due to fishery closures or bag limits on red drum.

Table 13.25. Commercial size restrictions and trip limits for internal coastal waters of North Carolina.

Species	Size Limit	Other Regulations	Rule or Proclamation and Date Started
Southern flounder	13" TL	none	3M .0503 (a); 1991
Red drum	18 – 27" TL	7 per day and must be exceeded by weight of the combined catch of all other finfish excluding menhaden; annual landings cap	FF-47-2001; Sep. 6, 2001
Striped bass	18" TL	ASMA 2001 Jan 5-Mar 25: 5 fish Mar 26-Apr 14: 10 fish Nov 19-Dec 21: 5 fish 2002 Jan 7-Apr 14: 5 fish Nov 4-Dec 20: 5 fish 2003 Jan 6-Mar 19: 5 fish Mar 20-Apr 14: 10 fish Oct 27-Dec 31: 5 fish CENTRAL 2001 Feb 12-Mar 2: 5 fish Dec 4-Dec 14: 5 fish 2002 Feb 25-Mar 16: 5 fish Dec 2-Dec 13: 5 fish 2003 Mar 3-Apr 1: 5 fish Dec 1-Dec21: 5 fish SOUTHERN 2001 Jan 8-Apr 30: 10 fish 2002 Jan 7-Apr 30: 10 fish 2003 Jan 9-Apr 30: 10 fish	Striped Bass Fishery Management Plan
Weakfish	12" TL	none	3M .0504 (a) (1); 1991
Spotted seatrout	12" TL	none	3M .0504 (b) (1) (E);

Table 13.26. **NCDMF fishery dependent and fishery independent data sampling programs used to estimate discard in the flounder gill net fishery.**

Area	Season	Time Period	NCDMF Program
Albemarle Sound area	Jan-Mar, Nov-Dec; May	2001-2003; 2002	135
Albemarle Sound area	Apr-Aug	2001 and 2003	461, observed
Pamlico Sound area	Jan-Mar, Apr-Aug	2001-2003	915
Pamlico Sound area	Sep-Dec	2001-2003	466
Neuse, Pamlico, and Pungo Rivers	Jan-Mar, Apr-Aug, Sep-Dec	2000	461,915

The calculations for the remaining species were made by area. For each area the discard estimate procedure was as follows: First, mortality estimates of the select species in flounder gill nets were determined for the areas and time periods the data was available. The mortality was based on the percent dead at the time the gear was fished and did not account for delayed mortality. Also the mortality rates were only recorded for red drum in the observer program and applied to only the observer program data in Pamlico Sound from September to December. The mortality estimates from the Program 915 in Pamlico Sound were used for all other species and seasons, and provided the bulk of the mortality rates for the Pamlico Sound and Albemarle Sound areas. The Rivers mortality estimates came directly from the independent program in the rivers.

The number at size and the weight at size distributions of the select species were identified to determine the number and the weight of undersized or oversized fish in the samples. The mortality estimates were applied to only the undersized and oversized fish in the samples to calculate the number and weight of dead fish discarded. The number and weight of spoiled, unmarketable fish was also identified to the appropriate time periods and added to the total number and total weight of the dead discard. The ratio of the dead discard (weight) to the kept or marketed (retained weight) was the factor that was used to solve for the fishery dead discard estimate based on the marketed landings of the species from the trip ticket program [(sample dead discard weight / sample retained weight) * trip ticket landings = dead discard estimate for the fishery].

Comparisons of the discard rates between the fishery dependent observer program and applicable portions of the independent gill net studies were made for the same time period (September-December; 2001-2003). Species discard percentages were similar but the independent gill net survey was generally lower. In the Albemarle Sound limited fishery dependent data was available to compare catch rates of the gill net survey. Since comparison rates were similar it was assumed calculations using the fishery independent sampling for the part of the year or areas not covered with the fishery dependent observations could be used for discard estimates. These estimates would most likely under represent the true magnitude of the discards. Another deviation from the stated analysis procedure occurred with the analysis for the potential discard of 14-inch flounder in the Rivers. Due to inadequate samples obtained in the 13 to 14-inch size class in program 915, the quantity of flounder less than 14 inch sampled from the Rivers in the dependent program 461 was used as a surrogate rate for the "All discard cell" and the other cells adjusted based on the new rate. The following discard dead estimates are based on the best available information and are intended only to provide a starting point for discussion. The estimates should not be taken as absolutes due to limitations of the data sources and expansion methodology such as minimal sample sizes in some cases and differences in gear construction and fishing techniques (i.e. NCDMF fishery independent programs limited to a 12-hour soak time when commercial fishing operations have an average of 24-hour soak time (NCDMF 2004). The analysis does, however, give a good indication of the magnitude of the issue for each of the species. Only with increased observer coverage throughout all areas will more reliable estimates be possible in the future.

Discard Species Composition

From the NCDMF Observer Program, unmarketable discards for 2001-2003 combined consisted of Atlantic menhaden (*Brevortia tyrannus*), (58%), rays (*Rajiformes*), bluefish (spoiled, predation), and blue crabs (Table 13.27). Of the regulatory discards, red drum (41%), southern flounder (36%), and gulf flounder (13%) represented the majority (Table 13.28).

Discard Rates from Regulatory and Spoiled Discards

Southern Flounder at 13-Inch Minimum Size

Dead discard rates were highest for southern flounder at 13-inch minimum size in the Rivers followed by Pamlico Sound, and Albemarle Sound and accounted for an annual rate from 0.08-1.81% (Table 13.29). The average of dead discards accounted for 10,302 pounds annually from 2000-2002 at a rate of 0.58% of the southern flounder landings in the flounder gill net fishery (Table 13.30).

Southern Flounder at 14-Inch Minimum Size

Dead discard rates were highest for southern flounder at 14-inch minimum size in the Rivers followed by Pamlico Sound, and Albemarle Sound and accounted for an annual rate from 0.50-7.06% (Table 13.31). The average of dead discards accounted for 36,518 pounds annually from 2000-2002 at a rate of 2.06% of the southern flounder landings in the flounder gill net fishery (Table 13.32).

Red Drum

Dead discard rates were highest for red drum at 18 inch minimum and 27-inch maximum size in the Rivers followed by Pamlico Sound, and Albemarle Sound and accounted for an annual rate from 15.17-96.07% (Table 13.33). The average of dead discards accounted

Table 13.27. Species composition (by number) of unmarketed (spoiled, predation) discards from the Observer Program in Pamlico Sound, 2001-2003 combined.

Species	Number	Percent	Species	Number	Percent
Atlantic menhaden	4,403	58.72	Bullnose ray	5	0.07
Cownose ray	557	7.43	Common carp	5	0.07
Bluefish	370	4.93	Striped mullet	5	0.07
Blue crab	306	4.08	Smooth dogfish	4	0.05
Stingrays	275	3.67	Southern kingfish	4	0.05
Southern flounder	192	2.56	Butterfish	4	0.05
Clearnose skate	174	2.32	Spider crab	3	0.04
Pinfish	143	1.91	Smooth butterfly ray	3	0.04
Rays	107	1.43	Fourspot flounder	3	0.04
Atlantic stingray	106	1.41	Blacktip shark	2	0.03
Horseshoe crab	98	1.31	Oyster toadfish	2	0.03
Atlantic croaker	98	1.31	Atlantic flyingfish	2	0.03
Lyre goby	69	0.92	searobins	2	0.03
Inshore lizardfish	61	0.81	Striped searobin	2	0.03
Spotted seatrout	60	0.8	Striped bass	2	0.03
Red drum	57	0.76	Northern stargazer	2	0.03
Windowpane	54	0.72	Hogchoker	2	0.03
Weakfish	45	0.6	Whelks	1	0.01
Black drum	39	0.52	Lesser blue crab	1	0.01
Stargazers	37	0.49	Florida stone crab	1	0.01
Pigfish	30	0.4	Nurse shark	1	0.01
Skates	27	0.36	Bluntnose stingray	1	0.01
Sheepshead	20	0.27	Butterfly rays	1	0.01
Southern stingray	16	0.21	Ladyfish	1	0.01
Cat sharks	14	0.19	Amercian shad	1	0.01
Atlantic spadefish	14	0.19	Lizardfishes	1	0.01
Gizzard shad	10	0.13	Jack crevalle	1	0.01
Spotted seatrout	10	0.13	Florida pompano	1	0.01
Summer flounder	10	0.13	Northern kingfish	1	0.01
Gulf flounder	10	0.13	Mullets	1	0.01
Kingfishes	6	0.08	Barracudas	1	0.01
Southern stargazer	6	0.08	Spanish mackerel	1	0.01
Northern puffer	6	0.08	Puffers	1	0.01

Table 13.28. **Species composition (by number) of regulatory discards from the Observer Program in Pamlico Sound 2001-2003 combined.**

Species	Number	Percent
Red drum	585	41.76
Southern flounder	519	37.04
Gulf flounder	187	13.35
Summer flounder	54	3.85
Weakfish	29	2.07
Flounders	10	0.71
Spotted seatrout	7	0.5
Striped bass	6	0.43
Atlantic sharpnose shark	1	0.07
Atlantic sturgeon	1	0.07
Cobia	1	0.07
Spotted seatrout	1	0.07
Total	1,401	100

Table 13.29. **Sampling dead discard rates by weight and number for southern flounder in all areas. Dead discards include dead undersized (less than 13 inches) and spoiled fish. All discards include both alive and dead fish.**

Area	Year	Mortality (%)	Total Landings	Dead (lbs)	Percent Dead (lbs)	Percent Dead (#)	All (lbs)	Percent All
Albemarle Sound	2001	0, 4, 1	920,552	644	0.07	0.36	32,588	3.54
	2002	0, 3, 2	682,345	409	0.06	0	379	2.84
	2003	0, 2, 3	407,027	611	0.15	0.23	22,468	5.52
				Overall	0.08	0.26		3.71
Pamlico Sound	2001	0, 4, 1	494,503	2,522	0.51	0.89	11,027	2.23
	2002	0, 3, 2	521,787	2,452	0.47	1.28	10,384	1.99
	2003	0, 2, 3	450,609	2,028	0.45	2.82	15,591	3.46
				Overall	0.48	1.57		2.52
Rivers	2000	0, 23, 4	326,784	5,914	1.81	1.04	11,274	3.45
Southern*	2000	0, 23, 4	72,475	1,312	1.81	1.04	2,500	3.45

* Data are unavailable for the Southern area. The discard estimates calculated using the rates from the Rivers.

Table 13.30. Southern flounder landings in large mesh gillnets, all gears combined, and estimated discards for 2000-2002. Dead discards include dead undersized (less than 13 inches) and spoiled fish. The calculated State average of discards compared to landings was 0.58%.

Area	2000 landings (lbs.)	2000 estimated dead discards (lbs.)	2001 landings (lbs.)	2001 estimated dead discards (lbs.)	2002 landings (lbs.)	2002 estimated dead discards (lbs.)	Average landings 2000-02	Average total dead discard 2000-02
Albemarle Sound	948,289	759	920,552	644	682,345	437	850,395	604
Pamlico Sound	572,616	2,749	494,503	2,522	521,787	2,452	529,635	2,540
Rivers	326,784	5,915	290,470	5,258	365,301	6,612	327,518	5,928
Southern	72,475	1,312	56,598	1,024	74,829	1,354	67,967	1,230
Large mesh gill nets	1,920,164	10,734	1,761,824	9,448	1,644,261	10,724	1,775,416	10,302

* When an actual value from the preceding table was not available, the cell value given is calculated from the overall rate percent discard dead (lbs.) for the applicable area.

Table 13.31. Discard rates by weight and number for southern flounder in all areas. Discards include dead undersized (less than 14 inches) and spoiled fish. All discards include both alive and dead discards.*

Area	Year	Mortality (%)	Total Landings	Dead (lbs)	Percent Dead (lbs)	Percent Dead (#)	All (lbs)	Percent All
Albemarle Sound	2001	0, 4, 1	920,552	8,929	0.97	1.85	231,059	25.1
	2002	0, 3, 2	682,345	1,842	0.27	0.51	71,998	10.55
	2003	0, 2, 3	407,027	3,508	0.86	1.31	127,033	31.21
				Overall	0.5	1.36		21.39
Pamlico Sound	2001	0, 4, 1	494,503	2,621	0.53	1.02	24,082	4.87
	2002	0, 3, 2	521,787	2,766	0.53	1.49	36,369	6.97
	2003	0, 2, 3	450,609	7,030	1.56	2.94	28,343	6.29
				Overall	0.85	1.71		6.05
Rivers	2000	0, 23, 4	326,784	23,096	7.06	4.95	100,421	30.73
Southern*	2000	0, 23, 4	72,475	5,117	7.06	4.95	22,272	30.73

* Program 915 samples inadequate, quantity of under 14 inch from program 461 used as a surrogate value.

** Data are unavailable for the Southern area. The discard estimates calculated using the rates from the Rivers.

Table 13.32. Southern flounder landings in large mesh gillnets, all gears combined, and estimated discards for 2000-2002. Discards include dead undersized (less than 14 inches) and spoiled fish. The calculated State average of discards compared to landings was 2.06%.

Area	2000 landings (lbs.)	2000 estimated dead discards (lbs.)	2001 landings (lbs.)	2001 estimated dead discards (lbs.)	2002 landings (lbs.)	2002 estimated dead discards (lbs.)	Average landings 2000-02	Average total dead discard 2000-02
Albemarle Sound	948,289	4,741	920,552	8,929	682,344	1,842	850,395	5,171
Pamlico Sound	572,616	4,867	494,503	2,621	521,787	2,765	529,635	3,418
Rivers	326,784	23.096	290,470	20,507	365,301	25,790	327,518	23,131
Southern	72,475	5,117	56,598	3,996	74,829	5,283	67,967	4,798
Large mesh gill nets	1,920,164	37,827	1,761,824	36,053	1,644,261	35,680	1,775,416	36,518

* When an actual value from the preceding table was not available, the cell value given is calculated from the overall rate percent discard dead (lbs.) for the applicable area.

Table 13.33. Discard rates by weight and number for red drum in all areas. Discards include dead undersized and oversized discards (less than 18 inches and greater than 27 inches) and spoiled fish. All discards include both alive and dead fish.

Area	Year	Mortality (%)	Total Landings	Dead (lbs)	Percent Dead (lbs)	Percent Dead (#)	All (lbs)	Percent All
Albemarle Sound	2001	0, 64, 32	2,547	885	34.75	100	1,495	58.7
	2002	0, 65, 46	3,616	605	16.73	50	1,313	36.31
	2003	5, 43, 42	3,662	0	0	0	0	0
				Overall	15.17	50		28.58
Pamlico Sound	2001	0, 64, 32	21,229	15,858	74.7	114.55	27,260	128.41
	2002	0, 65, 46	19,761	18,152	91.86	191.3	32,218	163.04
	2003	5, 43, 42	30,285	14,906	49.22	43.59	21,402	70.67
				Overall	72.61	121.94		121.86
Rivers	2000	0, 14, 8	6,910	6,638	96.07	40	7,548	109.23
Southern*	2000	0, 14, 8	3,541	3,402	96.07	40	3,868	109.23

* Data are unavailable for the Southern area. The discard estimates calculated using the rates from the Rivers.

for 27,490 pounds annually from 2000-2002 at a rate of 79.12% of the red drum landings in the flounder gill net fishery (Table 13.34).

Spotted Seatrout

Dead discard rates were highest for spotted seatrout at 12-inch minimum size in the Rivers followed by Pamlico Sound and accounted for an annual rate from 10.75-78.78% (Table 13.35). No estimates were available from the Albemarle Sound at this time. The average of dead discards accounted for 3,544 pounds. annually from 2000-2002 at a rate of 42.78% of the spotted seatrout landings in the flounder gill net fishery (Table 13.36).

Weakfish

Dead discard rates were highest for weakfish at 12-inch minimum size in the Albemarle Sound, followed by Pamlico Sound, and then the Rivers, and accounted for an annual rate from 0.74-57.33% pounds (Table 13.37). The average of dead discards accounted for 3,910 pounds annually from 2000-2002 at a rate of 29.46% of the weakfish landings in the flounder gill net fishery (Table 13.38).

Striped Bass

Dead discard rates were highest for striped bass at 18-inch minimum size in the Rivers, followed by Albemarle Sound, and then the Pamlico Sound, and accounted for an annual rate from 89.29-272.47% (Table 13.39). The average of dead discards accounted for 21,400 pounds annually from 2000-2002 at a rate of 151.53% of the striped bass landings in the flounder gill net fishery (Table 13.40).

Discussion

Fishery managers continually face the issue of bycatch and discards in fisheries throughout the world (Gray 2002). Discards impact fishery yields and fishery managers' ability to accurately assess fish stocks (Fennessy 1994, Hall 1999). In November 1991 the North Carolina Marine Fisheries Commission adopted a policy directing the DMF to establish the goal of reducing bycatch to the absolute minimum and incorporate that goal into its actions. The general reasons for a species to be discarded can be categorized as follows: (1) physical-biological interaction, (2) economic, (3) legal, and (4) personal value considerations. In looking at ways to reduce discard there are just three basic ways to accomplish it (FAO1994):

1) Catch fewer numbers of the individuals/species.

2) Reduce the mortality of the individuals/species being discarded.

3) Use a greater spectrum of the species or sizes of species normally caught and discarded.

Table 13.34. Red drum landings in large mesh gillnets, all gears combined, and estimated discards for 2000-2002. Discards include dead undersized and oversized discards (less than 18 inches and greater than 27 inches) and spoiled fish. The calculated State average of discards compared to landings was 79.12%.

Area	2000 landings (lbs.)	2000 estimated dead discards (lbs.)	2001 landings (lbs.)	2001 estimated dead discards (lbs.)	2002 landings (lbs.)	2002 estimated dead discards (lbs.)	Average landings 2000-02	Average total dead discard 2000-02
Albemarle Sound	3,405	517	2,547	885	3,616	605	3,189	669
Pamlico Sound	21,924	15,919	21,229	15,858	19,761	18,152	20,971	16,656
Rivers	6,910	6638	6,641	6,376	8,261	7,931	7,271	6,981
Southern	3,541	3402	3,092	2,969	3,317	3,185	3,317	3,184
Large mesh gill nets	35,779	26,476	33,508	26,088	34,954	29,873	34,748	27,490

* When an actual value from the preceding table was not available, the cell value given is calculated from the overall rate percent discard dead (lbs.) for the applicable area.

Table 13.35. Discard rates by weight and number for spotted seatrout in all areas. Discards include dead undersized discards (less than 12 inches) and spoiled fish. All discards include both alive and dead fish.

Area	Year	Mortality (%)	Total Landings	Dead (lbs)	Percent Dead (lbs)	Percent Dead (#)	All (lbs)	Percent All
Albemarle Sound	2001	0,25,50	296	0	0	0	0	0
	2002	0,100,50	372	0	0	0	0	0
	2003	0,100,70	311	0	0	0	0	0
				Overall	0	0		0
Pamlico Sound	2001	0,25,50	2,242	497	22.17	30.77	509	22.69
	2002	0,100,50	3,240	121	3.73	13.79	348	10.75
	2003	0,100,70	2,573	272	10.57	52.94	451	17.51
				Overall	11.04	23.86		14.30
Rivers**	2000	0,100,17	3,360	2,647	78.78	22,22	2,647	78.78
Southern*	2000	0,100,17	382	301	78.78	22,22	301	78.78

* Data are unavailable for the Southern area. The discard estimates calculated using the rates from the Rivers.
** Small sample size.

Table 13.36. Spotted seatrout landings in large mesh gillnets, all gears combined, and estimated discards for 2000-2002. Discards include dead undersized (less than 12 inches) and spoiled fish. The calculated State average of discards compared to landings was 42.78%.

Area	2000 landings (lbs.)	2000 estimated dead discards (lbs.)	2001 landings (lbs.)	2001 estimated dead discards (lbs.)	2002 landings (lbs.)	2002 estimated dead discards (lbs.)	Average landings 2000-02	Average total dead discard 2000-02
Albemarle Sound	987	0	296	0	372	0	552	0
Pamlico Sound	5,822	643	2,242	497	3,240	121	3,768	420
Rivers	3,360	2,647	1,908	1,503	5,601	4,412	3,623	2,854
Southern	382	301	253	199	391	308	342	269
Large mesh gill nets	10,551	3,591	4,699	2,199	9,604	4,841	8,285	3,544

* When an actual value from the preceding table was not available, the cell value given is calculated from the overall rate percent discard dead (lbs.) for the applicable area.

Table 13.37. Discard rates by weight and number for weakfish in all areas. Discards include dead undersized discards (less than 12 inches) and spoiled fish. All discards include both alive and dead fish.

Area	Year	Mortality (%)	Total Landings	Dead (lbs)	Percent Dead (lbs)	Percent Dead (#)	All (lbs)	Percent All
Albemarle Sound	2001	0, 79, 42	3,856	1,001	25.96	60	1,266	32.83
	2002	100, 79, 71	2,415	1,044	43.23	105.26	1,471	60.91
	2003	57, 68, 68	885	2,057	286.78	300	3,026	341.92
				Overall	57.33	96.67		80.53
Pamlico Sound	2001	0, 79, 42	5,089	921	18.1	15.25	1,147	22.55
	2002	100, 79, 71	3,509	188	5..35	9.65	225	6.4
	2003	57, 68, 68	2,387	556	23.3	10.58	564	23.61
				Overall	12.65	11.23		14.32
Rivers	2000	0, 94, 92	2,847	21	0.74	5.26	244	8.58
Southern*	2000	0, 94, 92	110	1	0.74	5.26	9	8.58

* Data are unavailable for the Southern area. The discard estimates calculated using the rates from the Rivers.

Table 13.38. Weakfish landings in large mesh gillnets, all gears combined, and estimated discards for 2000-2002. Discards include dead undersized discards (less than 12 inches) and spoiled fish. The calculated State average of discards compared to landings was 29.46%.

Area	2000 landings (lbs.)	2000 estimated dead discards (lbs.)	2001 landings (lbs.)	2001 estimated dead discards (lbs.)	2002 landings (lbs.)	2002 estimated dead discards (lbs.)	Average landings 2000-02	Average total dead discard 2000-02
Albemarle Sound	5,631	5,175	3,856	1,930	2,415	2,109	3,967	3,071
Pamlico Sound	10,612	1,342	5,089	921	3,509	188	6,403	817
Rivers	2,847	21	2,468	18	3,203	24	2,839	21
Southern	110	1	24	0	50	0	61	0
Large mesh gill nets	19,200	6,540	11,437	2,869	9,177	2,321	13,271	3,910

* When an actual value from the preceding table was not available, the cell value given is calculated from the overall rate percent discard dead (lbs.) for the applicable area.

Table 13.39. Average striped bass discard and landings by area, 2000–2001 (NCDMF 2004).

Area	Dead Discards (lbs)	Pounds Landed	Dead Discard Rate (%)
Albemarle Sound Management Area	16,687	14,326	116.48
Rivers (Pamlico, Pungo, New, and Neuse)*	48,258	17,711	272.47
Pamlico Sound	7,420	8,310	89.29
Southern	Insufficient data	0	n/a

* Includes the shad fishery. The majority of the discards in the Rivers is attributed to the shad fishery.

Table 13.40. Striped bass landings in large mesh gillnets, all gears combined, and estimated discards for 2000-2002. Discards include dead undersized discards (less than 18 inches) and spoiled fish. The calculated State average of discards compared to landings was 151.53%.

Area	2000 landings (lbs.)	2000 estimated dead discards (lbs.)	2001 landings (lbs.)	2001 estimated dead discards (lbs.)	2002 landings (lbs.)	2002 estimated dead discards (lbs.)	Average landings 2000-02	Average total dead discard 2000-02
Albemarle Sound	19,150	18,328	8163	15,046	9750	21,992	12,354	18,455
Pamlico Sound	902	2,458	594	1,618	745	2,030	747	2,035
Rivers	2,183	1,949	359	321	513	458	1,018	909
Southern	0	0	0	0	11	0	4	0
Large mesh gill nets	22,235	22,735	9,116	16,985	11,019	24,480	14,123	21,400

* When an actual value from the preceding table was not available, the cell value given is calculated from the overall rate percent discard dead (lbs.) for the applicable area.

Gear restrictions (mesh sizes, yardage limits, and attendance) and area (including distance set from shore) and season closures have been used to limit discard losses in a number of North Carolina fisheries.

There is potential for an increase in discards for all species due to expansion in effort and changes in regulations. Southern flounder minimum size limits at 13 and 14 inches are presented in this paper to indicate how a size limit increase might impact discards. Dead discard rates for southern flounder would increase slightly with this size change (from 0.58% to 2.06%) to the overall landings. From the available NCDMF data, dead discards of southern flounder are few and only really increase in events of "dead water" which most fishermen try to avoid since it is detrimental to the entire marketable catch.

Striped bass and red drum pose the greatest problem with the most discards of all the species due to strict size and bag limits. The Albemarle Sound area has imposed tie-down measures to reduce the capture of striped bass in the nets in recent years and the Estuarine Striped Bass FMP includes a number of management measures to address discards. The Red Drum FMP imposed attendance in small mesh gill nets in warm weather months (May - October) to reduce discards in the small mesh gill net fishery. Also, the PSGNRA restrictions have reduced flounder gill net effort in Pamlico Sound during the late fall. Investigating gear modifications may help to avoid these species in areas where incidental capture is highest.

For the two trout species, the discard estimates were relatively high for spotted seatrout at 43% and somewhat high for weakfish at 29% but landings of these species are fairly low in the flounder gill net fishery (less than 4,000 lbs. a year). These fish are taken mainly by the small mesh fishery which targets round fish. In 2002, small mesh gill nets accounted for 92.3% of the spotted trout and 90.4% of the weakfish landings in all estuarine gill nets (small and large mesh combined) Further investigation with at-sea observations across the entire State would help acquire a better estimate for these species

Participation, effort, and landings within the flounder gill net fishery have increased since the early 1990s and peaked in 1997. Since 1997, there has been a decline most likely due to adverse weather events (i.e. hurricanes), increased participation in other fisheries (i.e.: crab pots), and restrictions occurring in specific areas to alleviate interactions with target species of concern (i.e. red drum and striped bass). The expansion of the gill net fishery was related to the increase demand for flounder and the displacement of fishermen from other states and fisheries. The initial set up cost for gill nets is minor when compared to other gears. This allows a larger group of fishermen to be involved on a part-time basis and increase landings at a sudden rate because of the high number of participants that can actively work in the fishery.

Management Options/Impacts

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

1) Status quo
   + No rule changes or Legislative actions
   + No additional restrictions on fishing practices
   - Continued harvest of sublegal flounder in the fishery

2) Mesh size restrictions
   + Will reduce the number of sublegal fish caught
   + Will reduce the number of legal fish harvested in the catch
   - Increase the burden on enforcement

3) Net length restriction
   + May reduce some of the amount of sublegal fish taken in the fishery
   + Maintains effort at a consistent level for each participant
   + Reduces the amount of nets in the water
   - Some areas of the State may be more heavily impacted than others
   - Increases the burden on enforcement

4) Specified fishing time periods

   a) Season closures
      + May reduce some of the amount of sublegal fish taken by the fishery
      + No additional resources required to implement
      + No reporting burden on fishermen or dealers
      + Reduces effort from current level

- Forces fishermen to search for other sources of income
- Weather may prevent fishing during open periods
- Maintenance of fishing mortality at or below F_{target} may not be achieved
- Effort may be increased during the open periods, thus reducing the effectiveness of the closure

b) Area closures
   + May reduce some of the amount of sublegal fish taken by the fishery
   + No additional resources required to implement
   + Reduces effort from current level
   + No reporting burden on fishermen or dealers
   - Forces fishermen to search for other sources of income
   - Weather may prevent fishing during open periods
   - Effort may be increased during the open periods, thus reducing the effectiveness of the closure

5) Trip/vessel harvest limits
   + Reduces effort in the fishery
   - May adversely impact some fisheries and fishermen more than others
   - Would not guarantee reduction of fishing mortality to the target level

6) Attendance requirements
   + May reduce mortality of sublegal fish taken by the fishery
   - Forces fishermen to stay out for longer periods of time and increase incidences of being in unsafe conditions
   - Reduces opportunity of fishermen to participate in more than one fishery at a time

7) Regional management
   + May reduce some of the amount of sublegal fish taken by the fishery
   + Focuses on smaller areas where the problems are highest
   - Forces fishermen to work in other areas or search for other sources of income
   - Inequity of some areas to have more regulations than other areas

8) Endorsement of additional research (see research recommendations)
   + Increases funding of research pertaining to large mesh estuarine gill net targeting flounder
   + Increases the understanding of the fishery and its components
   + May provide alternative means for reducing sublegal species harvest in the fishery
   - Added cost for funding research

Research Recommendations

1) Increase at-sea sampling to determine the number of undersized and oversized fish caught in all mesh sizes of actual fishing operations.

2) Determine mortality of the undersized fish returned to the water.

3) Expand the observer program (Program 466) to sample more areas and seasons in the State. Also, initiate an independent gill net survey in the Neuse, Pamlico, and Pungo rivers.

4) Expand the trip ticket to include more specific gear parameters, such as mesh size, to more easily identify between large and small mesh gill nets.

5) Investigate gear modification to reduce regulatory discards, including mesh selectivity studies.

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13.1.5 Incidental Capture of Non-Target Species of Concern in the Commercial Large Mesh Estuarine Flounder Gill Net Fishery

Issue

Management actions for North Carolina's commercial large mesh estuarine flounder gill net fishery addressing incidental capture of non-target species of concern.

Definition

Flounder gill nets are considered set nets of large mesh (5-inch and larger stretched mesh length) that are deployed and left from only a few hours to several days depending on water temperature and depth. There are at least two types of flounder gill net operations, which can be broken down by vessel size: smaller boats (8-25 feet) that fish nearshore in shallow (< 10 feet) water pulling the nets in by hand or net reels, and larger vessels (> 25 feet) that fish in deepwater (> 10 feet) and use mechanical net reels to haul in the net. Nets set in water greater than six feet usually have tie downs to restrict the gill net near the bottom to increase the amount of bag in the net and improve the capture of flounder.

Background

Some of the general public's negative perception of the gill net fisheries stems from the incidental capture of non-target species of concern, particularly marine mammals, birds, and sea turtles. Environmental, conservation, and sportfishing organizations have cited these catches to support the ban of any and all commercial gill net fishing operations. The controversy has intensified recently because of record incidences of sea turtle strandings in North Carolina coastal waters. Anglers and conservation groups have lobbied a number of state legislatures to eliminate the use of gill nets. Gill nets have been banned in other states, which has added pressure to states that still fish with this gear.

Area, season, mesh size, yardage, attendance of gear, and combinations of these restrictions are available for resource management and are currently used at various times of the year to prevent the waste of fish, to protect particular fish stocks (i.e. striped bass and red drum), and reduce the capture of non-targeted species. Gear modifications, such as multifilament gill nets, acoustic reflective gill nets, and sonic avoidance devices or pingers, have been utilized in ocean studies to avoid sea bird and mammal interactions with some positive consequences (NFCC 2000, Smith 2001). Looking for alternative solutions to allow fishing to occur while reducing interactions with non-target species is a more equitable approach for the fishermen involved.

Most of the species listed are under federal jurisdiction either with the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS). It is difficult

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to recommend options to reduce the impact large mesh estuarine gill nets have on capturing these species since most of the regulations are mandated by federal agencies. The North Carolina Division of Marine Fisheries (NCDMF) is currently working with the NMFS on reducing the sea turtle and bottlenose dolphin captures in estuarine waters and considering a permit systems and recommend options which would allow the fisheries to continue operating.

Current Authority

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)

3I .0107 ENDANGERED OR THREATENED SPECIES

Discussion

The following information will describe endangered, threatened, and non-listed species in North Carolina that can potentially be captured in estuarine gill nets. Known interactions in estuarine gill nets will be addressed and the estimated number of interactions reviewed.

The following is a list of endangered or threatened species that may occur in inshore waters of North Carolina (this list was generated from the web page of the U.S. Fish & Wildlife Service for North Carolina: www.fws.gov/r4eao):

FISH
- Shortnose sturgeon (*Acipenser brevirostrum*)

BIRDS
- Bald eagle (*Haliaeetus leucocephalus*)
- Roseate tern (*Sterna dougallii dougallii*)
- Piping plover (*Charadrius melodus*)

MAMMALS
- West Indian manatee (*Trichechus manatus*)

REPTILES
- Kemp's Ridley sea turtle (*Lepidochelys kempii*)
- Hawksbill sea turtle (*Eretmochelys imbricata*)
- Leatherback sea turtle (*Dermochelys coriacea*)
- Green sea turtle (*Chelonia mydas*), and
- Loggerhead sea turtle (*Caretta caretta*)

The following is a list of non-listed species occurring in inshore waters and captured in gill nets:

FISH

Atlantic sturgeon (*Acipenser oxyrhyncus*)

BIRDS

Pied-billed grebe (*Podilymbus podiceps*)
Common loon (*Gavia immer*)
Double crested cormorant (*Phalacrocorax auritus*)
Red throated loon (*Gavia stellata*)
Greater scaup (*Aythya marila*)
Lesser scaup (*Aythya affinis*)
Canvasback (*Aythya valisineria*)
Redhead (*Aythya americana*)
Red-breasted merganser (*Mergus serrator*)
Ruddy (*Oxyura jamaicensis*)

MAMMALS

Bottlenose dolphin (*Tursiops truncatus*)

Of the listed endangered or threatened species only the shortnose sturgeon and turtles have become entangled in gill nets.

Listed endangered or threatened species with the potential to be captured in estuarine gill nets.

<u>Fish</u>

Shortnose sturgeon
Status: Endangered
Listed: 3/11/67 (32 FR 40001)
Population in North Carolina: Unknown

Documented reports of the shortnose sturgeon in North Carolina are limited to two areas: western Albemarle Sound (1881 and 1998) and the Cape Fear River (1987) (Ross et al. 1988). These two areas harbor distinct population segments, however the Cape Fear population numbers less than 50 fish and the recent number from the Albemarle region consists of a single adult male in 1998. Only two were captured in large mesh estuarine gill nets in recent years. Historical reports from the 19th century indicate that shortnose sturgeon inhabited the Pamlico and Neuse Rivers, but obstructions and poor water quality have eliminated shortnose sturgeon from these rivers since that century.

Birds

Bald eagle
Status: Threatened
Listed: 7/12/95
Population in North Carolina: Unknown

The preferred habitats of bald eagles in North Carolina include coastal areas, marshes, lakes, and rivers. Nesting activity has been reported from the Outer Banks in Dare County, and in Beaufort, Hyde, and Washington counties (Lee and Parnell 1990). There is no reported incidence of a bald eagle captured in gill nets in North Carolina.

Roseate tern
Status: Threatened
Listed: 11/2/87
Population in North Carolina: Unknown

Roseate terns have been observed along the Outer Banks in the Cape Lookout area. There are two confirmed nesting records for North Carolina, one in Oregon Inlet in 1939, and the other in Lighthouse Bay, Carteret County in 1973 (Lee and Socci 1989). North Carolina State Museum records indicate that migrating individuals occur in May, and from August through September (Lee and Socci 1989; Lee and Parnell 1990). The majority of these birds transit the State over near shore or coastal waters. Roseate terns feed on small, schooling fishes that are captured by diving from the air into the water (plunge-diving). Migrating roseate terns pass the Outer Banks on the ocean side. This species feeds on schooling bait fish and it is extremely unlikely that it will interact with estuarine gill nets of North Carolina.

Piping plover
Status: Threatened
Listed: 1/10/86
Population in North Carolina: 46 breeding pairs in 1998

In North Carolina, nest sites have been noted along barrier beaches from Pea Island to Shackleford Banks, with Sunset Beach being the southern most nesting site. Most nesting occurs north of Cape Lookout. Recent decline in the population has been attributed to human development in the breeding habitat. Critical breeding habitat has been identified in pieces along the Outer Banks from south of Oregon Inlet to the North Carolina-South Carolina state line (USFWS 2001). Since it is an ocean based species it is unlikely to interact with estuarine gill nets of North Carolina.

Mammals

West Indian manatee
Status: Endangered
Listed: 3/11/67
Population in North Carolina: Unknown

Two manatee sightings have occurred in the Pamlico Sound in the last 20 years. The peak warm season population in North Carolina is not thought to exceed a dozen or so individuals (Lee and Socci 1989). There has not been any recorded stranding of manatees resulting from interactions with gill nets along the southeastern United States from 1993 through 1999 (NMFS Southeast Region Marine Mammal Human Interaction Summary 1999). Due to their low abundance in North Carolina, interactions between estuarine gill nets and manatees are unlikely to occur.

Reptiles

Sea turtle strandings in the southeastern portion of Pamlico Sound increased significantly in November 1999. The deep-water large mesh gill net fishery for flounder in the southeastern Pamlico Sound was suspected of being responsible for most of the strandings. On December 10, 1999, the NMFS issued an emergency rule closing the southeastern Pamlico Sound to the use of gill nets larger than five-inch stretch mesh in an attempt to protect endangered and threatened sea turtles. Strandings decreased after the closure, however the decline may have been because many fishermen stopped fishing for flounder prior to the rules' implementation.

The NCDMF applied for an individual incidental take permit (Section 10) under the endangered species act of 1973 in order to allow gill net fishing to occur in the southeastern Pamlico Sound region during the fall 2000 flounder fishing season. The NCDMF proposed four levels of management measures for the fall fishery in the Pamlico Sound Gill Net Restricted Area (PSGNRA). The first measure described below was implemented at the beginning of the large mesh gill net fishing season. The second, third, and fourth management measures were dependent on observed turtle mortality from gear interactions and strandings.

The first measure was effective from September 15, 2000 through December 15, 2000. During this measure fishermen were required to obtain a permit from NCDMF to participate in the large mesh gill net fishery in the southeastern Pamlico Sound region known as the Gillnet Restricted Area (GRA). The permit allowed fishermen to set a maximum of 3,000 yards of 5-inch or larger mesh gill net in the GRA. The yardage restriction represented a 37% reduction in the amount of gill net set by fishermen in this area as compared to the November-December 1999 season. Fishermen with the permit had to allow observers onboard to collect data on gear, catch, and sea turtle interactions to monitor the effectiveness of the management measures. Fishermen making unmonitored trips were required to report all gear interactions with sea turtles within 24-hours of the event to the NCDMF communications center or the North Carolina Marine

Patrol. Fishermen were also required to submit a weekly report of their fishing activities to the NCDMF.

On October 27, 1999, the NCDMF and the NMFS closed the PSGNRA to large mesh gill nets (greater than 5-inch stretched mesh). Both agencies wanted to reduce the number of strandings by 50% from 1998 and establish a stranding threshold of 45 turtles for the 2000 season. From September 15 - Decmber 15, 2000 a total of 79 strandings occurred (28 green turtles, 25 loggerheads, and 26 Kemp's ridleys) within the GRA (NCDMF 2001). Twenty strandings occurred while the fishery was still open between September 15-October 27, and 59 strandings occurred after the closure, with a majority of these individuals succumbing to sudden exposure to cold temperatures.

The NCDMF is currently working with the NMFS and other federal and state agencies to find ways to protect sea turtles and allow commercial and recreational fishermen to continue harvesting seafood. At the Marine Fisheries Commission on June 8, 2001, NCDMF announced proposed sea turtle conservation measures for Pamlico Sound for 2001 sent a proposal outlining these measures to the NMFS as a Section 10 Incidental Take Permit. Conditions of the permit are as follows: there is a designated closed area and five restricted areas around the closed area for large mesh nets greater than 4¼-inch stretch (Figure 13.24). Monitoring will begin on July 1, 2001 with a minimum of 20% coverage in observed trips. Net length limits and mesh size restrictions are set specific to the restricted areas throughout three timeframes from July 1-December 15 (Table 13.41). The number of incidental captures of sea turtles is determined to be 350 alive and 175 dead based on extrapolations. At this point, the Section 10 is under review by federal agencies and has not been accepted for the upcoming estuarine gill net season.

Kemp’s Ridley sea turtle
Status: Endangered
Listed: 12/2/70
Population in North Carolina: Unknown

The Kemp’s Ridley turtle is considered the most endangered sea turtle. Juveniles occur year-round within the sounds, bays, and coastal waters of North Carolina. During November and December 1999 the Kemp’s ridley turtle accounted for 47% of the turtle standings in Pamlico Sound and 33% of the strandings in the fall of 2000. Most of these standings were attributed to large mesh (greater than 5-inch stretch) flounder nets.

Hawksbill sea turtle
Status: Endangered
Listed: 6/2/70
Population in North Carolina: Unknown

Sightings of this turtle north of Florida are considered rare. Hawksbill turtles have been reported off the coast of North Carolina during the months of June, July, October and November. One stranding of a hawksbill sea turtle was reported from Pamlico Sound in

Table 13.41. Proposed NCDMF 2001 sea turtle conservation measures for Pamlico Sound. Shaded blocks indicate time/area closures for large mesh gillnets (> 4¼-inch stretched mesh). SGNRAs = Shallow water Gillnet Restricted Area; WGNRA = Western Gillnet Restricted Area; NGNRA = Northern Gillnet Restricted Area; CA = Closed Area; OC = Ocracoke Corridor; HC = Hatteras Corridor.

2001 Pamlico Sound Sea Turtle Conservation Measures						
	SGNRAs	**WGNRA**	**NGNRA**	**CA**	**OC**	**HC**
Jul 1, 2001 thru Sep 14, 2001	2,000 Yard Limit All Mesh Sizes	2,000 Yard Limit Small Mesh Gillnets (≤ 4 1/4 -inch) Closed Large Mesh Gillnets (> 4 1/4 -inch)	2,000 Yard Limit Small Mesh Gillnets (≤ 4 1/4 -inch) Closed Large Mesh Gillnets (> 4 1/4 -inch)	2,000 Yard Limit Small Mesh Gillnets (≤ 4 1/4 -inch) Closed Large Mesh Gillnets (> 4 1/4 -inch)	2,000 Yard Limit All Mesh Sizes	2,000 Yard Limit All Mesh Sizes
Sep 15, 2001 thru Sep 30, 2001	2,000 Yard Limit Small Mesh Gillnets (≤ 4 1/4 -inch) 2,000 Yard Limit GNRA Permit Required Large Mesh Gillnets (> 4 1/4 -inch)	Same as Above	Same as Above	Same as Above	2,000 Yard Limit Small Mesh Gillnets (≤ 4 1/4 -inch) Closed Large Mesh Gillnets (> 4 1/4 -inch)	2,000 Yard Limit Small Mesh Gillnets (≤ 4 1/4 -inch) Closed Large Mesh Gillnets (> 4 1/4 -inch)
Oct 1, 2001 thru Dec 15, 2001	Same as Above	2,000 Yard Limit Small Mesh Gillnets (≤ 4 1/4 -inch) 5,000 Yard Limit GNRA Permit Required Large Mesh Gillnets (> 4 1/4 -inch)	2,000 Yard Limit Small Mesh Gillnets (≤ 4 1/4 -inch) 5,000 Yard Limit GNRA Permit Required Large Mesh Gillnets (> 4 1/4 -inch)	Same as Above	Same as Above	Same as Above
Shaded areas indicate time/area closures to large mesh gillnets (greater than 4 1/4 - inch stretched mesh)						

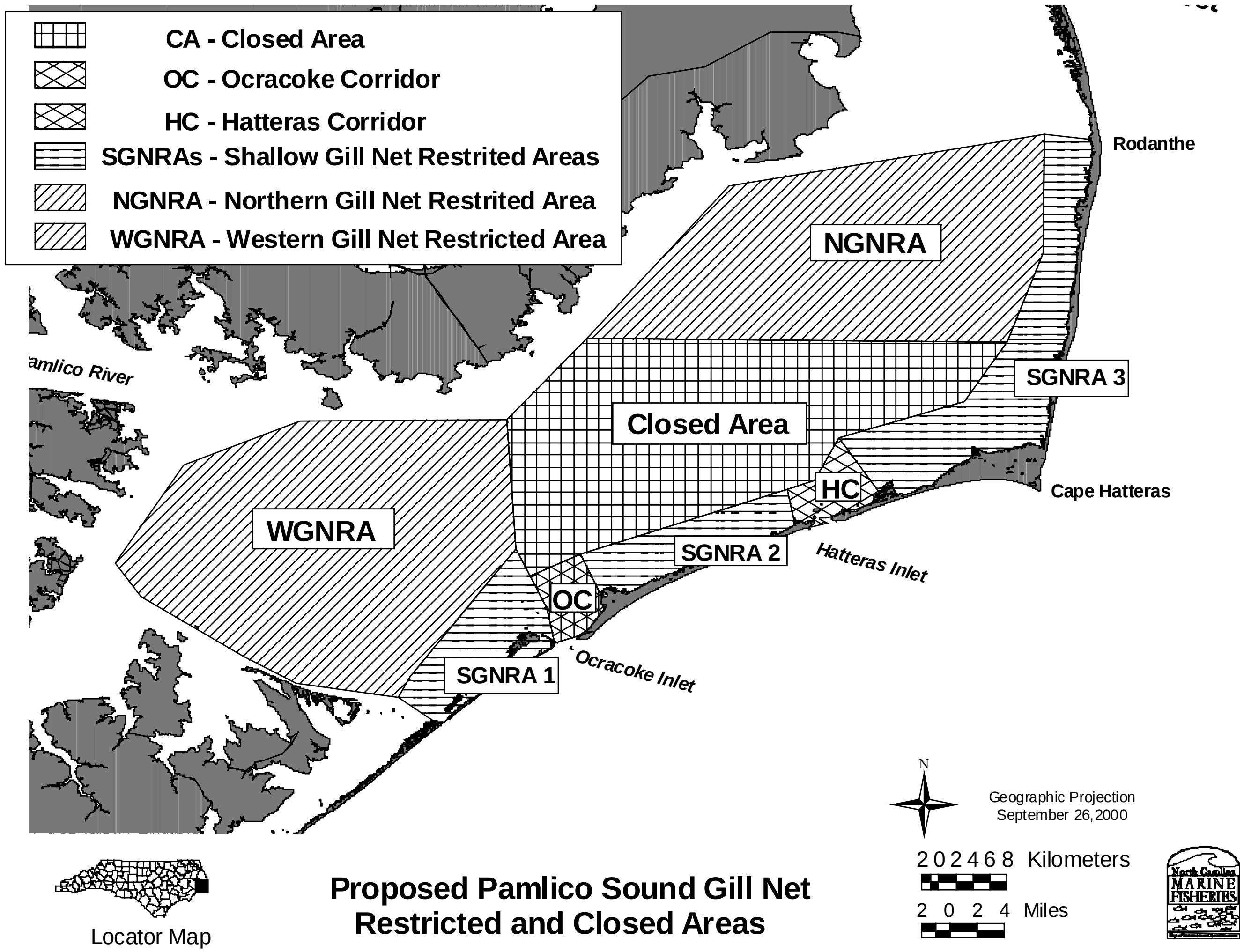

Figure 13.24. Proposed NCDMF Gillnet Restricted and Closed Areas for the 2001 flounder gill net fisheries. SGNRA = Shallow water Gillnet Restricted Area; WGNRA = Western Gillnet Restricted Area; NGNRA = Northern Gillnet Restricted Area; CA = Closed Area; OC = Ocracoke Corridor; HC = Hatteras Corridor.

1988. Sightings of this species are limited to offshore waters and this species is not expected to occur in inside waters of North Carolina.

Leatherback sea turtle
Status: Endangered
Listed: 6/2/70
Population in North Carolina: Unknown

Leatherbacks display a north-south migration pattern. This species is found off the coast of North Carolina from April to October with occasional sightings into the winter. There is one record of a nesting site at Cape Lookout in 1966 (Lee and Socci 1989), an additional nesting site was reported near Hatteras in 2000. As is the case with hawksbill's turtles, leatherbacks are not likely to occur in estuarine waters of North Carolina. There have been 23 reported strandings of leatherbacks from inside waters since 1981.

Green sea turtle
Status: Threatened
Listed: 7/28/78
Population in North Carolina: Unknown

Adult and juvenile green turtles are sighted in oceanic waters and within the sounds of North Carolina during the period from May through October. There have been two reported (1987, Baldwin Island and 1989, Cape Hatteras) and one confirmed (1979, Camp Lejeune) nesting sites in North Carolina. Twenty-one percent of the turtle strandings in Pamlico Sound for November and December 1999 and 35% of the sea turtle strandings for the fall of 2000 were green turtles.

Loggerhead sea turtle
Status: Threatened
Listed: 7/28/78
Population in North Carolina: Unknown

Nesting occurs along the U.S. Atlantic coast from New Jersey to Florida. However, the majority of nesting activity occurs from South Carolina to Florida. In North Carolina nesting activity has been reported from April to September. The highest nesting densities are reported south of Cape Lookout. Loggerhead turtles accounted for 32% during 1999 and 32% during 2000 of the sea turtle strandings in Pamlico Sound.

Non-listed species potentially captured in estuarine gill nets.

Fish

Longnose or Atlantic sturgeon

The Atlantic sturgeon was commonly harvested in North Carolina in the 1800s for caviar and as a food fish (Yarrow 1874; Moseley et al. 1877; Leary 1915). Today, the directed harvest of Atlantic sturgeon has been outlawed since 1991 (NCMFC 1991).

A Fisheries Resource Grant (FRG) conducted in the Albemarle Sound from 1998-2000, characterized the survival of Atlantic sturgeon captured during ordinary fishing activities of a southern flounder gill net operation (White and Armstrong 2000). A total of 131 Atlantic sturgeon was captured, nine of which were recaptured, and no mortality occurred during the study. Survival could not be estimated, but most sturgeon were healthy upon release and other studies have indicated there is low release mortality. The lengths of the sturgeon captured were between 12-44 inches, which indicates they were juveniles or subadults (Smith et al. 1982; White and Armstrong 1999). Gill netters fishing for southern flounder in the Albemarle Sound fish mostly on nearshore sandy shoals, and Atlantic sturgeon are captured closer to the shoreline. The peak capture of Atlantic sturgeon coincides with the peak of the southern flounder fishery in the Albemarle Sound, therefore it is difficult to determine if flounder gill netting and Atlantic sturgeon captures can be avoided (White and Armstrong 2000).

Little information is available on Atlantic sturgeon for the rest of the State. In 1999, National Oceanic and Atmospheric Administration (NOAA) enforcement officers found a sturgeon in a large mesh flounder gill net in the Pamlico Sound but were unable to identify which species of sturgeon. Most likely it was an Atlantic sturgeon due to the limited number of shortnose sturgeon in the State (NMFS 2001).

Birds

Two FRG's were conducted to assess the capture of sea birds in large mesh gill nets in the Albemarle Sound, Pamlico Sound, and the Neuse River. The report from the Pamlico Sound and Neuse River was conducted from January 1 - August 1, 2000 (Darna 2000). The main objective of this study was to show the use of multifilament webbing could reduce the capture of sea birds, rather than using the normal monofilament gill net arrangement. Two sets of 500 yards of 5 to 5½-inch mesh gill nets in 100-yard lengths of monofilament and a multifilament design were used. Only two species of sea birds were capture, cormorants and loons. There were fewer sea birds captured in the multifilament gill nets, but there was also a significant reduction in the directed harvestable catch. Further this study indicated that a more realistic approach to reduce mortality on entangled sea birds would be educating fishermen to use more careful disentangling techniques on live sea birds.

The FRG report from the Albemarle Sound was conducted from January 1 - April 15, 2000 (Rose 2000). The main objective of the study was to investigate whether floating or submerged shad gill nets had a higher incidental bycatch of migrating birds. Two sets of 500 yards of 5½-inch mesh gill nets were used, set to either be submerged or floating, and compared. The nets were fished a total of 89 days and only three species of birds were encountered, all in the submerged nets. The three species encountered were the red-throated loon, the double-crested cormorant, and the pied-billed grebe. All birds (n = 12) were found dead in the submerged nets.

Fishery independent studies by NCDMF have also captured diving birds, such as:

Greater scaup (*Aythya marila*)
Lesser scaup (*Aythya affinis*)
Canvasback (*Aythya valisineria*)
Redhead (*Aythya americana*)
Red-breasted merganser (*Mergus serrator*)
Ruddy (*Oxyura jamaicensis*)
Old squaw (*Fuligula glacialis*)

These species are common except old squaw, which is indigenous to colder environments and are more common in northern Europe, and Iceland. Incidences of capture have been few for all species. They are not noted in detail because capture numbers are not available and their populations are relatively stable and not considered in jeopardy from gill net interactions.

Pied-billed grebe

Only one pied-billed grebe was captured and killed in the FRG conducted in the Albemarle Sound (Rose 2000). Since this bird is more common in freshwater areas it is unlikely that captures in the estuarine gill net fishery will directly affect the population of this species.

Double-crested cormorant

The double-crested cormorant is one of the most common cormorants in North America and is distributed worldwide (Gough et al. 1998). In the Albemarle Sound FRG, 8 double-crested cormorants were captured and killed in submerged large mesh nets (Rose 2000). In the Pamlico Sound and Neuse River FRG, 81 cormorants were captured and 28.4% (n = 23) were killed in the nets (Darna 2000). Because this species is a diving bird, feeding mainly on fish and is quite common in North Carolina**,** it is most likely going to be entangled in estuarine gill nets. The actual numbers caught each year in the estuarine gill net fishery is unknown. This species is considered a nuisance in many states and it is showing expansion into areas where it has not been observed in recent memory. The population of double-crested cormorants is most likely not directly affected by captures in the estuarine gill net fishery.

Red-throated loon

The red-throated loon is considered the smallest and most primitive of the five loon species. A population estimate of this species is unknown because of its distribution in many remote inland lakes (Gough et al. 1998). In the Albemarle Sound FRG there were 3 red-throated loons captured and killed in the submerged gill nets (Rose 2000). The FRG in the Pamlico Sound and Neuse River captured 24 loons total and 33.3% (n = 8) were killed in the monofilament net (Darna 2000).

Mammals

Bottlenose dolphin

Bottlenose dolphins are found worldwide located between the 45th parallel in temperate and tropical waters (ACS 2001). The bottlenose dolphin is protected under the Marine Mammal Protection Act (MMPA) and considered depleted along the western North Atlantic. Dolphins are vulnerable to pollution and human disturbance, and several die-offs have occurred in this century. The last major die-off occurred in 1987-1988 along the Atlantic coast of the United States and tissue analysis indicated that it was caused by a morbillivirus. Diseased dolphins also had higher levels of PCBs in the tissue, which was probably the trigger for these events.

There are two distinct populations of bottlenose dolphin in the western North Atlantic that can be separated into nearshore and offshore groups (NOAA 2001). The population density seems to be higher in the coastal population (ACS 2001). The stock structure in the western North Atlantic is complex. Further evidence suggests there may be even more division into localized year-round residents and those with an extended home range along coastal waters especially along large sound and bay areas like North Carolina (Koster et al. 2000). The overall population estimate for the coastal stock is estimated at 2,452 individuals.

Presently, North Carolina is going through a re-evaluation process on the status of interactions between inshore gill nets and bottlenose dolphins. On January 22, 2001 a rule was proposed in the Federal Register (50 CFR Part 229) under the MMPA and NMFS. The new rule reflects new information and places a commercial fishery in one of three categories based on the level of injury and mortality from incidental interactions with marine mammals. The North Carolina inshore gill net fishery was elevated to a Category II fishery, and therefore owners of vessels or gear engaging in a Category II fishery are required to obtain a marine mammal authorization. Elevation to a Category II level was based on 12 bottlenose dolphin deaths attributed to fishery interactions between 1993-1997. Eight of the twelve carcasses displayed evidence of gill net interactions and two had actual gear attached to the bodies. The two dolphins were captured in the Brunswick River (1995) in a shad gill net and Snow's Cut of the Intracoastal Waterway, New Hanover County (April 1996) in an undetermined net type (Diane Borggaard, personal communication, May 23, 2001). The average number of dead dolphins per year was estimated at 0.4 by the Southeast U.S. stranding network using only the two definite gear related deaths over the five-year timeframe. Since the population estimate is so low (n=2,452) the incidental "take" factor is also very low (n=25) for all fisheries combined and it is very easy to be considered a Category II fishery. The North Carolina inshore gill net fishery is designated as a Category II because mortality and serious injury of bottlenose dolphins is estimated at 1.6% that falls between one and 50 percent of the Potential Biological Removals (PBR) level designated for this category.

Population estimates are still not accurate because the aerial surveys do not cover the full range across all seasons. The estimates are derived from several different counts and also come from projects not designed to estimate numbers (Smith 2001a). This estimate overlaps between the three groups and the total population size is still questionable. The NMFS would rather use caution and use the more conservative estimate of 2,452 individuals for the coastal western Atlantic stock. The latest estimate counts 5,456 animals in the northern part of the coastal migratory stock that move between northern North Carolina and New York; another 2,411 move from Cape Lookout, NC to the Virginia state line; and an additional 1,154 reside in the estuarine regions of North Carolina (Smith 2001a, Henderson 2001). During the winter all three groups mix into a combined estimate of 8,304 from northern to southern North Carolina and another group of 9,443 individuals exist from South Carolina to Florida. These numbers are significantly higher than suggested in the latest marine mammal stock assessment overall but is even more restrictive on the number of captures allowed in estuarine waters of North Carolina (NOAA 2001; Diane Borggaard, personal commercial, May 30, 2001). The new estimates separate the population by regions and seasons. The PBR for the summer months (May-October) would allow for only six captured dolphins in all fisheries combined in estuarine waters of North (Table 13.42).

Table 13.42. The best abundance estimate, $N_{min.}$ and the Potential Biological Removals (PBR) for bottlenose dolphin along the east coast of the United States. PBR= N_{min} * ½R_{max} * F_r, where R_{max} = 0.04 and F_r = 0.5. *

	Best abundance			PBR	
Management Units	Estimate	% CV	Nmin	Annual	½ year
Summer (May-October)					
Coastal migratory	5,456	18.1	4,691	47	24
Northern NC – oceanic	2,411	35.4	1,805	18	9
Northern NC – estuary	1,154	8	1,079	11	6
Southern NC	Unknown	Unknown	Unknown	Unknown	Unknown
South of NC	Unknown	Unknown	Unknown	Unknown	Unknown
Winter (November- April)					
NC (coastal migratory, N. NC, and S. NC)	8,304	43.5	5,849	59	30
South of NC	9,443	21.4	7,902	79	40

* Table produced from a fax sent from Diane Borggaard (NOAA Beaufort Lab) on May 30, 2001. Best estimate of abundance was derived from six abundance surveys (Palka et al. 2001).

Management Options

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

1) Status quo; the NCDMF will continue working with federal agencies on the problem
   + Less administrative costs for meetings
   - Not all user groups involved in the process
   - Limited communication between management and user groups

2) Establish a stakeholder group, such as the Bottlenose Dolphin Take Reduction Team, to address interactions and management between large mesh estuarine gill nets and high profile species.
   + Increases communication between user groups and management agencies
   + Allows further development of alternate solutions to the problem
   - Administrative costs increase to cover meetings and added expenses with more people involved in the process

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13.1.6 Update on the Incidental Capture of Non-Target Species of Concern in the Commercial Large Mesh Estuarine Flounder Gill Net Fishery

Issue

Update on the management actions for North Carolina's commercial large mesh estuarine flounder gill net fishery addressing incidental capture of non-target species of concern.

Background

This paper is an update of the original issue paper presented to the Southern flounder advisory committee on June 28, 2001. Only species where management practices or listings have changed are identified in detail.

Current Authority

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)

3I .0107 ENDANGERED OR THREATENED SPECIES

Discussion

The following information will describe endangered, threatened, and non-listed species in North Carolina that can potentially be captured in estuarine gill nets. Known interactions in estuarine gill nets will be addressed and the estimated number of interactions reviewed.

The following is a list of endangered or threatened species that may occur in inshore waters of North Carolina (this list was generated from the web page of the U.S. Fish & Wildlife Service for North Carolina: www.fws.gov/r4eao):

REPTILES – New management policies noted below
- Kemp's Ridley sea turtle (*Lepidochelys kempii*)
- Hawksbill sea turtle (*Eretmochelys imbricata*)
- Leatherback sea turtle (*Dermochelys coriacea*)
- Green sea turtle (*Chelonia mydas*), and
- Loggerhead sea turtle (*Caretta caretta*)

Prepared by the North Carolina Division of Marine Fisheries on April 5, 2004.

The following is a list of non-listed species occurring in inshore waters and captured in gill nets:

REPTILES
Diamondback terrapin (*Malaclemys terrapin*)

MAMMALS
Bottlenose dolphin (*Tursiops truncates*)

Of the listed endangered or threatened species only the shortnose sturgeon and turtles have become entangled in gill nets.

Listed endangered or threatened species with the potential to be captured in estuarine gill nets.

Reptiles

Sea turtle strandings in the southeastern portion of Pamlico Sound increased significantly in November 1999. Three active fisheries were identified: the shrimp trawl fishery; the large mesh (> 5-inch stretched mesh) flounder gill net fishery; and the small mesh (< 5-inch stretched mesh) spotted seatrout gill net fishery (Gearhart 2002 and 2003). It was determined the flounder fishery was interacting with sea turtles and the National Marine Fisheries Service (NMFS) issued an emergency rule closing southeastern Pamlico Sound to gill nets larger than 5-inch stretched mesh to protect endangered and threatened sea turtles (64 FR 70,196, December 16, 1999).

Monitoring conducted by the North Carolina Division of Marine Fisheries (NCDMF) during the 2000 fishing season indicated that the Pamlico Sound large mesh gill net fishery consisted of two major components (Gearhart 2001). First, a shallow water fishery, which occurred along the Outer Banks and secondly, a deep water component, which operated further from shore along a slope adjoining the main basin of Pamlico Sound. Monitoring during the 2000 fishing season also identified two small mesh gill net fisheries, which operated along the Outer Banks in the same areas the shallow water large mesh fishery operated.

On October 5, 2000, the NMFS issued an Incidental Take Permit (ITP) #1259 to the NCDMF (65 FR 65,840, November 2, 2000). The ITP established the Pamlico Sound Gill Net Restricted Area (PSGNRA) and imposed strict gill net fishery management measures (Figure 13.25). The goal was to reduce strandings along the Outer Banks by 50% relative to 1999. Subsequently, observed levels of gill net/sea turtle interactions and strandings reached thresholds specified in the ITP for closure. The NCDMF closed the PSGNRA to the use of large mesh gill nets effective October 27, 2000. Results of monitoring conducted aboard commercial vessels during the 2000 fishing season indicated that there were a greater number of interactions occurring in the deep water large mesh gill net fishery (n = 14) than in the shallow water fishery (n = 4, Gearhart 2001).

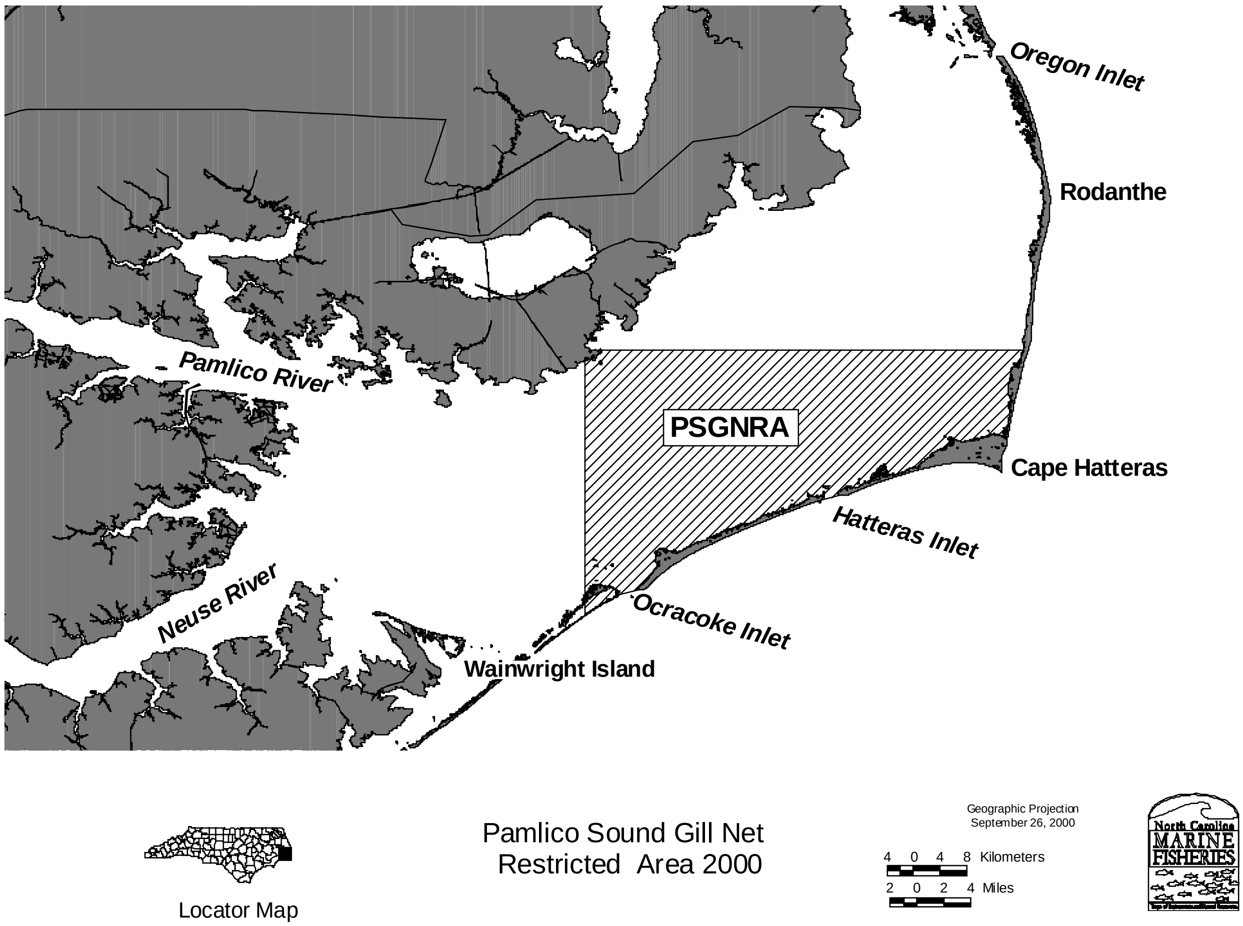

Figure 13.25. Map of southeastern Pamlico Sound and the 2000 Pamlico Sound Gill Net Restricted Area (PSGNRA) (Gearhart 2001).

Considering the 2000 monitoring data, the NMFS closed all potential fishing grounds utilized by the deep water large mesh gill net fishery for the 2001 fishing season (Figure 13.26, 66 FR 50,350, October 3, 2001). In 2001, the NCDMF again consulted with the NMFS and was issued ITP #1348 on October 5, 2001 (66 FR 51,023, October 5, 2001). The ITP authorized management measures during the fall of 2001 to protect sea turtles while allowing gill net fisheries to be prosecuted within Pamlico Sound (Figure 13.26 and Table 13.43). New management measures had to be considered, which included: the elimination of the deep water flounder gill net fishery; expansion of the shallow water area covered by the ITP; and the addition of the small mesh gill net fishery. It was assumed that these modifications would significantly reduce sea turtle mortality, and at the same time not alter the amount of gear covered by the ITP. New take levels were set for the 2001 season based on these management changes and assumptions. Maximum allowable take levels remained nearly constant, while allowable lethal takes were reduced significantly. Observed levels of gill net/sea turtle interactions during the 2001 season remained below thresholds specified in the ITP. Five sea

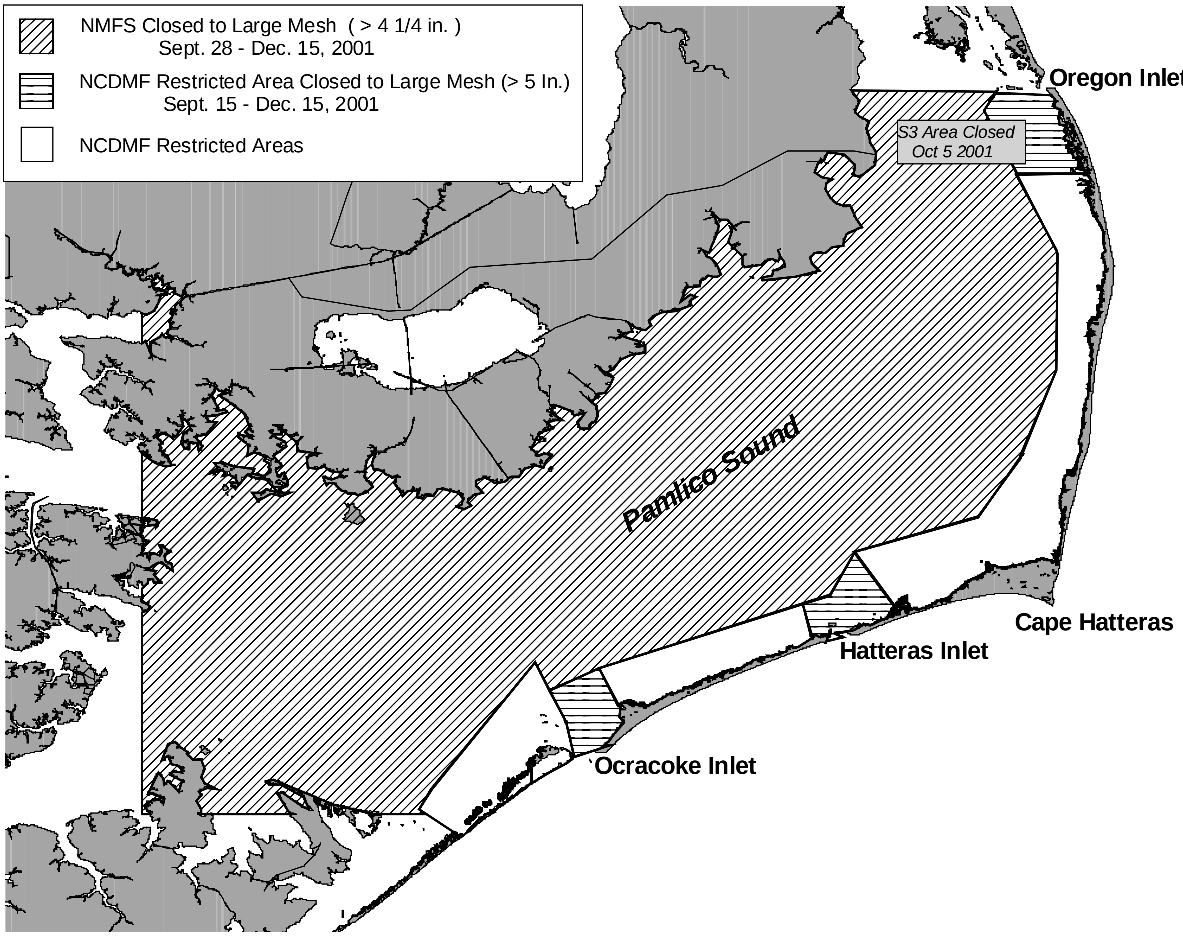

Figure 13.26. **NCDMF 2001 Pamlico Sound Gill Net Restricted Area (PSGNRA) and NMFS closed area. S1=Shallow Water Gill Net Restricted Area 1; S2=Shallow Water Gill Net Restricted Area 2; S3=Shallow Water Gill Net Restricted Area 3; OC=Ocracoke Inlet Corridor; HC=Hatteras Inlet Corridor (Gearhart 2002).**

turtle takes were observed and all were taken in the large mesh fishery with four of the turtles released alive (Gearhart 2002).

During 2002, the NMFS reviewed the NCDMF monitoring data and chose to issue a final rule that would implement the Pamlico Sound large mesh (> 4¼-inch) gill net closure each year from September 1 through December 15 (Figure 13.27, 67 FR 56,931, September 6, 2002). Corresponding, to the development of the NMFS final rule, the NCDMF again prepared an application for an ITP under Section 10 of the ESA (67 FR 49,009, July 29, 2002). After reviewing the 2000 and 2001 monitoring data, several changes were made to the 2002 application. First, the application was set for three years, while previous permits had only covered one fishing season. Management measures imposed in 2001 were sufficient to reduce takes below acceptable levels, and a longer term would allow the NCDMF to establish a

Table 13.43. Proposed NCDMF 2001 sea turtle conservation measures for Pamlico Sound. Shaded blocks indicate time/area closures for large mesh gillnets (> 4¼-inch stretched mesh). SGNRAs = Shallow water Gillnet Restricted Area; WGNRA = Western Gillnet Restricted Area; NGNRA = Northern Gillnet Restricted Area; CA = Closed Area; OC = Ocracoke Corridor; HC = Hatteras Corridor.

2001 Pamlico Sound Sea Turtle Conservation Measures

	SGNRAs	WGNRA	NGNRA	CA	OC	HC
Jul 1, 2001 thru Sep 14, 2001	2,000 Yard Limit All Mesh Sizes	2,000 Yard Limit Small Mesh Gillnets (≤ 4 1/4 -inch) Closed Large Mesh Gillnets (> 4 1/4 -inch)	2,000 Yard Limit Small Mesh Gillnets (≤ 4 1/4 -inch) Closed Large Mesh Gillnets (> 4 1/4 -inch)	2,000 Yard Limit Small Mesh Gillnets (≤ 4 1/4 -inch) Closed Large Mesh Gillnets (> 4 1/4 -inch)	2,000 Yard Limit All Mesh Sizes	2,000 Yard Limit All Mesh Sizes
Sep 15, 2001 thru Sep 30, 2001	2,000 Yard Limit Small Mesh Gillnets (≤ 4 1/4 -inch) 2,000 Yard Limit GNRA Permit Required Large Mesh Gillnets (> 4 1/4 -inch)	Same as Above	Same as Above	Same as Above	2,000 Yard Limit Small Mesh Gillnets (≤ 4 1/4 -inch) Closed Large Mesh Gillnets (> 4 1/4 -inch)	2,000 Yard Limit Small Mesh Gillnets (≤ 4 1/4 -inch) Closed Large Mesh Gillnets (> 4 1/4 -inch)
Oct 1, 2001 thru Dec 15, 2001	Same as Above	2,000 Yard Limit Small Mesh Gillnets (≤ 4 1/4 -inch) 5,000 Yard Limit GNRA Permit Required Large Mesh Gillnets (> 4 1/4 -inch)	2,000 Yard Limit Small Mesh Gillnets (≤ 4 1/4 -inch) 5,000 Yard Limit GNRA Permit Required Large Mesh Gillnets (> 4 1/4 -inch)	Same as Above	Same as Above	Same as Above

Shaded areas indicate time/area closures to large mesh gillnets (greater than 4 1/4 - inch stretched mesh)

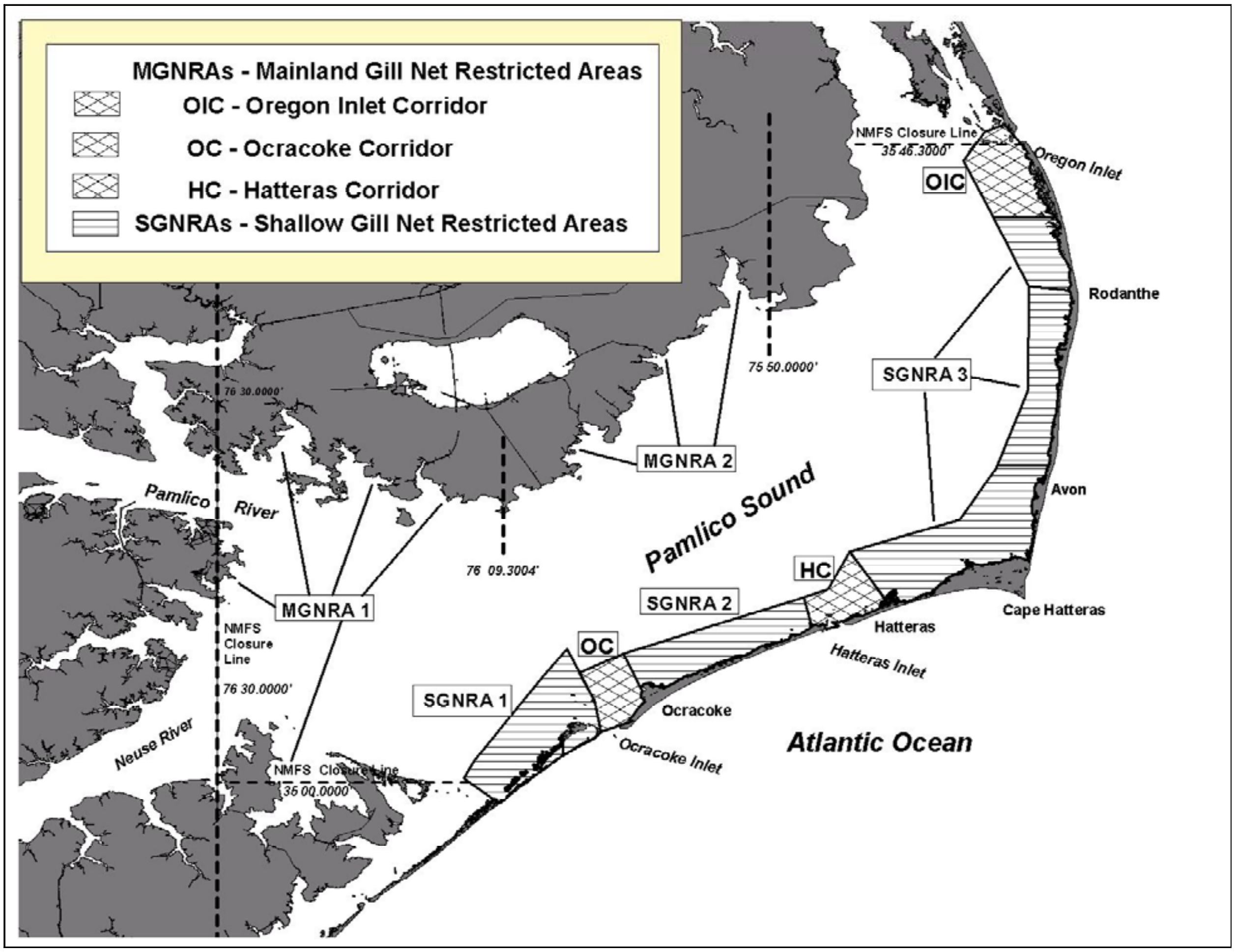

Figure 13.27. NCDMF 2002 Pamlico Sound Gill Net Restricted Area (PSGNRA) and NMFS closed area. SGNRA1=Shallow Water Gill Net Restricted Area 1; SGNRA2=Shallow Water Gill Net Restricted Area 2; SGNRA3=Shallow Water Gill Net Restricted Area 3; MGNRA1=Mainland Gill Net Restricted Area 1; MGNRA2=Mainland Gill Net Restricted Area 2; OIC=Oregon Inlet Corridor; OC=Ocracoke Inlet Corridor; HC=Hatteras Inlet Corridor (Gearhart 2003).

comprehensive conservation plan and establish a long term monitoring program. The second change was the designation of the PSGNRA from September 1 through December 15, 2002. The initial restriction date was moved two weeks prior to September 15. This would capture fishing effort and possible interactions that might occur during the first two weeks of September. Many of the 2000 and 2001 shallow water gill net interactions occurred early in the season (Gearhart 2001, 2002, and 2003). In addition, shallow water gill net effort peaked during the first week (September 15-22) of the 2001 fishing season, indicating that a substantial amount of effort occurs prior to September 15 (Gearhart 2002). The third change to the 2002 application was the addition of Mainland Gill Net Restricted Areas (MGNRAs) to the PSGNRA.

Two adjacent MGNRAs were established along the western shore of Pamlico Sound. The MGNRAs consisted of the areas along the mainland side of Pamlico Sound, from the shoreline out to 200 yards, west of the 75° 50’ longitude line. The fourth management change was the creation of the Oregon Inlet Corridor. This area just south of Oregon Inlet was closed during the 2001 season, due to a number of sea turtle interactions that occurred in close proximity to the inlet (Gearhart 2002). For the 2002 season, this area was expanded to encompass the entire inlet and large mesh gill nets were prohibited in this area for the entire season. The final change to 2002-2004 ITP application was the removal of small mesh gill nets from the PSGNRA permitting requirements. This gear was dropped for two reasons. First, the addition of the MGNRAs would result in a substantial increase in the number of permits and subsequent logbook reports required to monitor fishermen in the new areas. Secondly, the lack of observed interactions in the small mesh fishery during the 2000 and 2001 fishing seasons indicate that takes are nonexistent in this gear and more effort should be placed on providing better coverage of the large mesh fisheries, which have historically had more sea turtle interactions.

The gill net management measures imposed by the NCDMF and the NMFS in Pamlico Sound during the 2002 fishing season were successful in reducing sea turtle bycatch, while allowing fisheries to operate (Gearhart 2003). Although observed takes of sea turtles increased from levels observed in 2001, mortalities decreased. There was a 25.8% mortality rate for 2001 versus a 4.7% mortality rate for 2002. This change can be attributed to the increased number of takes observed in 2002 (12) compared to 2001 (5) with the number of mortalities (1) remaining the same for each year (Gearhart 2002). Only one of the 2002 takes occurred in the MGNRA, while 11 takes occurred in the southern portion of SGNRA3. All takes observed occurred in large mesh gill nets. This prompted a closure to the southern portion of SGNRA3 to large mesh gill nets on October 20, 2002 and remained closed for the rest of the season.

No sea turtle interactions were observed in the small mesh gill net fisheries during the 2001 or 2002 fishing seasons. During each of these years, attendance requirements prior to November 1 reduced small mesh set net effort and the primary mode of fishing was the runaround method. Characteristics of the runaround method include visually targeting schools of fish, short soak times (< 1 hour), and shallow water depths (< 3 feet). All of these characteristics help to minimize bycatch and reduce mortality.

Successful management of the Pamlico Sound gill net fisheries in 2002 indicates that the management measures imposed were sufficient for future use in reducing sea turtle strandings in the region. Since a successful management strategy was identified through the NCDMF data collections, future management plans for this area should be long term (> 3 years) and should seek to minimize intensive monitoring. The large area covered by the management measures requires a large number of observer trips to achieve adequate coverage. A more efficient monitoring strategy could utilize stranding network data to identify “hot spots,” and trigger intensive observer monitoring in the vicinity of stranding events. This would provide a means of identifying causes related to future stranding events and allow for more efficient use of staff.

Sea turtle interactions in the large mesh flounder gill net fishery in Pamlico Sound have been significantly reduced for the last three years. There were only four actual observed sea turtle interactions in the PSGNRA during the 2003 fishing season. The reduction in these interactions can be attributed to stringent management, increased awareness, and compliance of commercial fishermen in Pamlico Sound from September to December of each year. By informing commercial fishermen through scientific observer coverage, fishermen have gained a better understanding of the need to protect endangered/ threatened species, and the need to continue efforts to reduce interactions with these species in commercial fisheries. Continued management in the Pamlico Sound gill net fishery from September to December of each year will ensure the sustainability of this economically important fishery, while minimizing interactions with endangered/ threatened species.

A sea turtle advisory committee was created by the NCDMF in 2003. The committee members include: fishermen, scientists, conservationists, and state and federal officials. The group has had three meetings since its inception. Discussions have included presentations from the NMFS on procedures for completing the ITP; in addition, State officials from Georgia presented information on abundance estimates and nesting site indices in Georgia for major sea turtle stocks, which migrate into waters of North Carolina.

Kemp's Ridley sea turtle
Status: Endangered
Listed: 12/2/70
Population in North Carolina: Unknown

The Kemp's Ridley turtle is considered the most endangered sea turtle. Juveniles occur year-round within the sounds, bays, and coastal waters of North Carolina. During November and December 1999 the Kemp's Ridley turtle accounted for 47% of the turtle standings in Pamlico Sound and 33% of the strandings in the fall of 2000. Most of these standings were attributed to large mesh (greater than 5-inch stretch) flounder nets.

Hawksbill sea turtle
Status: Endangered
Listed: 6/2/70
Population in North Carolina: Unknown

Sightings of this turtle north of Florida are considered rare. Hawksbill turtles have been reported off the coast of North Carolina during the months of June, July, October and November. One stranding of a hawksbill sea turtle was reported from Pamlico Sound in Table 13.14. Proposed NCDMF 2001 sea turtle conservation measures for Pamlico Sound. Shaded blocks indicate time/area closures for large mesh gillnets (> 4¼-inch stretched mesh). SGNRAs = Shallow water Gillnet Restricted Area; WGNRA = Western Gillnet Restricted Area; NGNRA = Northern Gillnet Restricted Area; CA = Closed Area; OC = Ocracoke 1988. Sightings of this species are limited to offshore waters and this species is not expected to occur in inside waters of North Carolina.

Leatherback sea turtle
Status: Endangered
Listed: 6/2/70
Population in North Carolina: Unknown

Leatherbacks display a north-south migration pattern. This species is found off the coast of North Carolina from April to October with occasional sightings into the winter. There is one record of a nesting site at Cape Lookout in 1966 (Lee and Socci 1989), an additional nesting site was reported near Hatteras in 2000. As is the case with hawksbill's turtles, leatherbacks are not likely to occur in estuarine waters of North Carolina. There have been 23 reported strandings of leatherbacks from inside waters since 1981.

Green sea turtle
Status: Threatened
Listed: 7/28/78
Population in North Carolina: Unknown

Adult and juvenile green turtles are sighted in oceanic waters and within the sounds of North Carolina during the period from May through October. There have been two reported (1987, Baldwin Island and 1989, Cape Hatteras) and one confirmed (1979, Camp Lejeune) nesting sites in North Carolina. Twenty-one percent of the turtle strandings in Pamlico Sound for November and December 1999 and 35% of the sea turtle strandings for the fall of 2000 were green turtles.

Loggerhead sea turtle
Status: Threatened
Listed: 7/28/78
Population in North Carolina: Unknown

Nesting occurs along the U.S. Atlantic coast from New Jersey to Florida. However, the majority of nesting activity occurs from South Carolina to Florida. North Carolina nesting activity has been reported from April to September, with the highest nesting densities reported south of Cape Lookout. Loggerhead turtles accounted for 32% of the sea turtle strandings in Pamlico Sound for 1999 and 2000.

Non-listed species potentially captured in estuarine gill nets.

Diamondback terrapin
Population in North Carolina: unknown

The diamondback terrapin has been under status review by the USFWS for over ten years (www.tortoisereserve.org/Research/Diamondback_Body2.html). Its conservation status has remained unchanged because most states, including North Carolina, have little information concerning current population trends. Investigations have occurred in the crab pot fishery on the effects of "ghost pots" capturing and drowning terrapins.

Interactions in flounder gill nets are probable but at this time impacts from this fishery to the population are unknown.

Mammals

Bottlenose dolphin

Bottlenose dolphins are found worldwide located in temperate and tropical waters (ACS 2001). The bottlenose dolphin is protected under the Marine Mammal Protection Act (MMPA) and considered depleted along the western North Atlantic. Dolphins are vulnerable to pollution and human disturbance, and several die-offs have occurred in this century. The last major die-off occurred in 1987-1988 along the Atlantic U.S. Tissue analysis indicated a morbillivirus as the cause of death. Further tissue analysis suggested higher levels of PCBs in the tissue as the probable trigger for these events. Strandings of bottlenose dolphin were recorded since November 1997 (Byrd et al. 2003). Eleven of 58 total strandings from November 1997 to April 2003 were concluded to be from interactions with fisheries from inside waters of North Carolina (Table 13.44).

There are two distinct assemblages of bottlenose dolphin in the western North Atlantic that can be separated into nearshore and offshore groups (NOAA 2001). The population density seems to be higher in the coastal group (ACS 2001). Recent genetic evidence indicates a minimum of four populations of bottlenose dolphins in the coastal group (NOAA 2002). There may be a resident population in the Pamlico Sound or they may represent a component of the migratory animals that spend summers at the northernmost end of the range and winter in Pamlico Sound. This resident population from Pamlico Sound may move into coastal ocean waters when the sounds have inadequate resources for their survival in the winter months. Estimated overall abundance was 9,206 from the summer surveys and 19,459 from the winter surveys, with 1,060 individuals estimated in inside waters of North Carolina (Table 13.45; NOAA 2002).

New population abundance estimates presented in this issue paper are much higher than previous estimates but there still remain biases to the numbers (NOAA 2002). Since Potential Biological Removal (PBR) or the number of bottlenose dolphin that can be removed from the population annually without impacting the overall stock is a direct estimate from population abundance, it is imperative that the estimates be as accurate and precise as possible. If the PBR is overestimated then the stock may be exposed to excessive levels of risk from human-caused mortality and the stocks would decline. On the other hand, if PBR estimates are underestimated then fisheries may be overly restrained by unnecessary regulations. Aerial survey estimates are biased because they do not correct for the probability of detecting a group directly under the aircraft and the survey lacks precision. Also, there is still incomplete coverage of some seasonal management units.

Table 13.44. **Strandings of bottlenose dolphins (<117 cm) in sound side beaches in northern counties (Curritcuck, Dare, Hyde, Carteret, Craven, Beaufort, and Pamlico) and southern counties (Onslow, Pender, New Hanover, Brunswick) of North Carolina during winter (November-April) and summer (May-October) seasons from November 1997-March 10, 2003. Stranding data are stratified according to fishery interaction (carcasses pulled from active gear, carcasses with nets attached, or net line impressions in the epidermis), other human interactions (body mutilation, propeller wounds), no sign of interaction, and could not be determined (Byrd et al. 2003)**

Season	Northern Counties - Sound Side					Southern Counties - Sound Side				
	Fishery Interaction	Other Human Interactions	No Interaction	Could Not Be Determined	Total	Fishery Interaction	Other Human Interactions	No Interaction	Could Not Be Determined	Total
Winter (Nov-Apr)	0	0	0	3	3	0	0	0	0	0
Summer (May-Oct)	2	0	1	3	6	0	0	0	0	0
Winter (Nov-Apr)	1	0	0	2	3	0	0	0	1	1
Summer (May-Oct)	1	0	2	1	4	0	0	0	0	0
Winter (Nov-Apr)	0	0	0	2	2	0	0	0	0	0
Summer (May-Oct)	1	0	1	3	5	1	0	0	0	1
Winter (Nov-Apr)	1	0	0	1	2	0	0	1	0	1
Summer (May-Oct)	0	0	1	8	9	0	0	0	0	0
Winter (Nov-Apr)	1	0	0	5	6	0	0	1	1	2
Summer (May-Oct)	3	0	2	3	8	0	0	1	1	2
Winter (Nov-Apr)	0	0	0	2	2	0	0	0	1	1
Nov 1997 - Mar 15, 2003	10	0	7	33	50	1	0	3	4	8

Table 13.45. Estimates of abundance and the associated CV, nmin, and PBR for each management unit of WNA coastal bottlenose dolphin (from Palka et al. 2001). The PBR for the Northern Migratory, Northern NC, and Southern NC management units are applied biannually. For management units south of NC, the PBR is applied annually (NOAA 2002)

Season	Management Unit	Best Abundance		N_{min}	PBR	
		Estimate	CV		Annual	1/2 Year
Summer (May - Oct)	Northern Migratory	5,681	24.4	4,640	-46	23
	Northern North Carolina	4,302	33	3,281	-33	16
	Oceanic	3,383	41.8	2,413	-24	12
	Estuary	919	12.5	828	-8.3	4.2
	Southern North Carolina	1,298	44.6	907	-9.1	4.5
	Oceanic	1,157	50	777	-7.8	3.9
	Estuary	141	15.2	124	-1.2	0.6
Winter (Nov - Apr)	North Carolina mixed *	6,474	39.7	4,691	-47	23
	South Carolina	3,513	47	2,412	24	na
	Georgia	767	78.4	428	4.3	na
	Northern Florida	354	56	228	2.3	na
	Central Florida	10,652	45.8	7,377	74	na

*Northern migratory, Northern North Carolina and Southern North Carolina

The NMFS convened a bottlenose dolphin take reduction team (BDTRT) in November 2001 as stipulated by the Marine Mammal Protection Plan. The BDTRT is composed of over 40 members, including fishermen, scientists, conservationists, and state and federal officials from New York to Florida (Fredt and Neuhauser 2002a). The task for the BDTRT was to develop a consensus-based draft take reduction plan to reduce bottlenose dolphin mortality and serious injuries to less than the potential biological removal level within six months of plan implementation. The BDTRT met five times from November 2001 to April 2002 and submitted a report to NOAA Fisheries with recommendations. NOAA Fisheries conducted additional field studies to gather data on abundance estimates and the BDTRT chose to await the results of the studies before finalizing the Plan. The BDTRT met in April 2003 to consider new abundance estimates and resulting PBRs to refine their management recommendations (Fedt and Neuhauser 2003). The BDTRT's consensus final summary included regulatory recommendations, based on management units that apply to specific fisheries and generally seek to reduce soak time, the amount of gear in the water at any given time, or to modify practices to limit interactions with and take of bottlenose dolphin. The BDTRT strongly recommended that the NMFS design and conduct rigorous scientific surveys to provide unbiased and precise abundance estimates for the stocks under consideration (Fedt and Neuhauser 2002f). The BDTRT also adopted education and outreach recommendations, as well as research recommendations to improve monitoring, stranding data, and observer coverage. The

NMFS is currently reviewing documents from the BDTRT and is expected have measures in place some time in May 2004 to reduce incidental mortality and serious injury of marine mammals incidentally taken in commercial fishing operations within five years of the plan implementation.

North Carolina Sea Grant Fishery Resource Grant Program has completed two studies to look at the effects of gear modifications to reduce interactions with bottlenose dolphin in the gill net fisheries. Read (2002) and Read and Swanner (2003) studied the behavior of bottlenose dolphins to the use of pingers and acoustically reflective devices attached to the gill nets. Other studies under investigation at the moment include describing the interaction between bottlenose dolphins in the Spanish mackerel fishery in North Carolina (Read 2004 in progress) and studying the effects of low profile gill nets to reduce interactions with bottlenose dolphins (Thorpe and Beresoff, in progress).

Management Options

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

1) Status quo; the NCDMF will continue working with federal agencies on the problem
   + Less administrative costs for meetings
   - Not all user groups involved in the process
   - Limited communication between management and user groups

2) Establish a stakeholder group, such as the Bottlenose Dolphin Take Reduction Team, to address interactions and management between large mesh estuarine gill nets and high profile species.
   + Increases communication between user groups and management agencies
   + Allows further development of alternate solutions to the problem
   - Administrative costs increase to cover meetings and added expenses with more people involved in the process

A bottlenose dolphin take reduction team was created by the NMFS and completed talks in May 2003 to establish a Take Reduction Plan for the Northwest Atlantic coastal migratory stocks.

A sea turtle advisory committee was created by the NCDMF to address issues concerning sea turtle strandings in the State.

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13.1.7 Gear Requirements in the Flounder Pound Net Fishery

Issue

Establishing regulations for the pound net fishery to minimize the bycatch of under-sized southern flounder.

Background

The North Carolina Division of Marine Fisheries (NCDMF), in cooperation with net makers and commercial fishermen developed escape panels for flounder pound nets in 1988 in Core Sound. Development of these panels was in response to an increase in the minimum size limit for flounder from 11 to 13 inches. Work to test panels began October 11, 1988 in Core Sound, near Atlantic. Three panel sizes were tested (5, 5¾, and 6-inch mesh) and compared to control pound nets with a 4-inch mesh throughout. Results from this work showed flounder less than 13-inch retained in the test pounds range from 60% in the 4-inch mesh to 15% in the 6-inch mesh. Based on this research the NCDMF Director issued proclamations requiring escape panels with 5½-inch mesh in flounder pound nets in the fall of 1991, 1992, and 1993. The area where these panels were initially required was limited to Core Sound and the extreme southeastern portion of Pamlico Sound.

Expansion of the requirement, by proclamation, northward met with opposition from pound netters from the Hatteras and Ocracoke areas. NCDMF staff repeated the testing of the escape panels in fishermen's nets in the Hatteras and the Manns Harbor areas. This work began October 17, 1994 in Hatteras and Manns Harbor and September 21, 1995 in only the Manns Harbor area. Two mesh sizes were tested (5½ and 5¾-inch mesh) and compared to control pound nets with either 4 or 5-inch mesh throughout. Results showed a reduction in retention of flounder less than 13 inches that ranged from 33% in the 4-inch control and 25% in the 5-inch control to 4% in the 5½-inch panels and less than 1% in the 5¾-inch panels in Manns Harbor. Because of the amount of reduction that occurred in the nets with 5¾-inch panels in Manns Harbor, it was decided to test only 5½-inch mesh panels during 1995. The reduction in retention of flounder less than 13 inches during testing in Hatteras ranged from 31% in the 4-inch control to 10% retention with the 5¾-inch panels. Reports from fishermen who used the panels were very positive, indicating the culling time at the nets was greatly reduced because of the decreased catch of undersized fish.

Fishermen who fished west of the Alligator River in Albemarle Sound persuaded the North Carolina Marine Fisheries Commission (NCMFC) to exempt them from the rule implemented in 1999 requiring 5 ½ escape panels in all pound nets. These fishermen insisted that these flounder were morphometrically different from flounder caught in other areas of the State.

Prepared by the North Carolina Division of Marine Fisheries on April 26, 2004.

Albemarle Sound escape panel research took place beginning October 4, 1998 and September 21, 2001. Problems from hurricanes in 1999 and poor fishing in 2000 prevented research from taking place during those years. Two control mesh sizes of 4-inch and 5-inch nets were compared to nets with 5¼-inch escape panels. The original experimental design was to compare controls to nets with 5½-inch escape panels, however, the 5½-inch mesh purchased by the fisherman aiding with the study shrunk to 5¼ inches after application of copper and being soaked in water. Therefore, comparisons are based on escape panels with 5¼-inch mesh. Reductions in the retention of flounder less than 13-inches ranged from 20% in the 4-inch control nets and 17% in the 5-inch control nets to 12% in the pound nets with the 5¼-inch escape panels.

Current Authority

<u>North Carolina Fisheries Rules for Coastal Waters (15A NCAC)</u>

3J .0107 POUND NET SETS

Discussion

Pound net escape panels could potentially decrease culling time and increase the reduction of flounders less than 14-inches retained throughout the flounder pound net fishery, including the area of Albemarle Sound currently exempted from the 5½-inch escape panel requirement. Data collected from middle Albemarle Sound in 1998 and 2001 show reductions of flounder less than 14 inches retained in nets ranging from 52% in 5-inch mesh control pound nets to 49% in the pound nets with 5¼-inch escape panels (Table 12.46). Statewide results from all studies combined (Core Sound, Manns Harbor, middle Albemarle Sound, and Hatteras) show a reduction of flounder less than 14 inches retained range from 69% in a 4-inch control net to 32% in a net with 5½-inch escape panels (Table 13.47).

Table 13.46. Middle Albemarle Sound Escape panel study (1998 and 2001).

Mesh Size	Pound Nets Sampled	Number of Flounder Sampled	Percent Retained Less Than 14 Inches
4-inch control	5	352	55%
5-inch control	3	785	52%
5¼-inch escape panels	8	710	49%

Table 13.47. Statewide Escape panel study (1988, 1994, 1995, 1998, and 2001).

Mesh Size	Pound Nets Sampled	Number of Flounder Sampled	Percent Retained Less Than 14 Inches
4-inch control nets	27	2,603	69%
5-inch control nets	13	1,218	55%
5¼-inch escape panels	8	710	49%
5½-inch escape panels	7	414	32%
5¾-inch escape panels	4	288	7%

As the escape panel size increases there is a shift to larger sized flounder retained within the pounds (Figures 13.28 and 13.29). This retention of larger fish would benefit fishermen by reducing cull time while fishing the pound as well as increasing escapes of live undersized flounder.

Management Options

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

1) Status quo (no change)
   + No rule changes or Legislative actions
   + No additional restrictions on fishing practices
   - Continued harvest and discard of sub-legal southern flounder in Albemarle Sound

2) Require 5¼-inch escape panels in Albemarle Sound
   + Reduce the retention of 14-inch flounder to 49%
   + Decrease culling time of fishermen in Albemarle Sound
   - Increase financial burden on fishermen to modify nets

3) Require 5½-inch escape panels Statewide
   + Possible reduction of 14-inch flounder retention to 32% in Albemarle Sound
   + Decrease culling time of fishermen in Albemarle Sound
   - Increase financial burden on fishermen in Albemarle Sound to modify nets

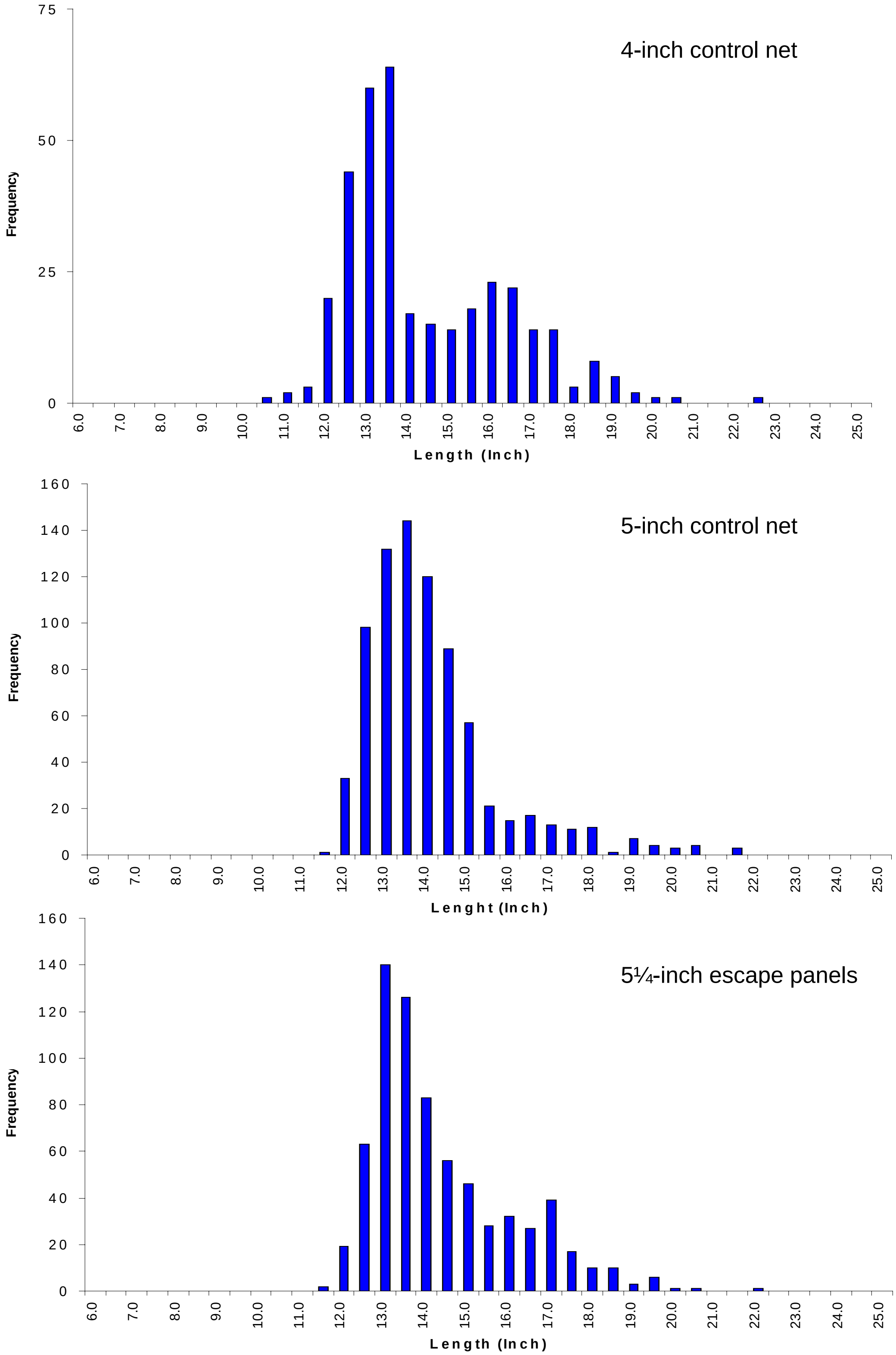

Figure 13.28. Middle Albemarle Sound length/frequencies by escape panel size.

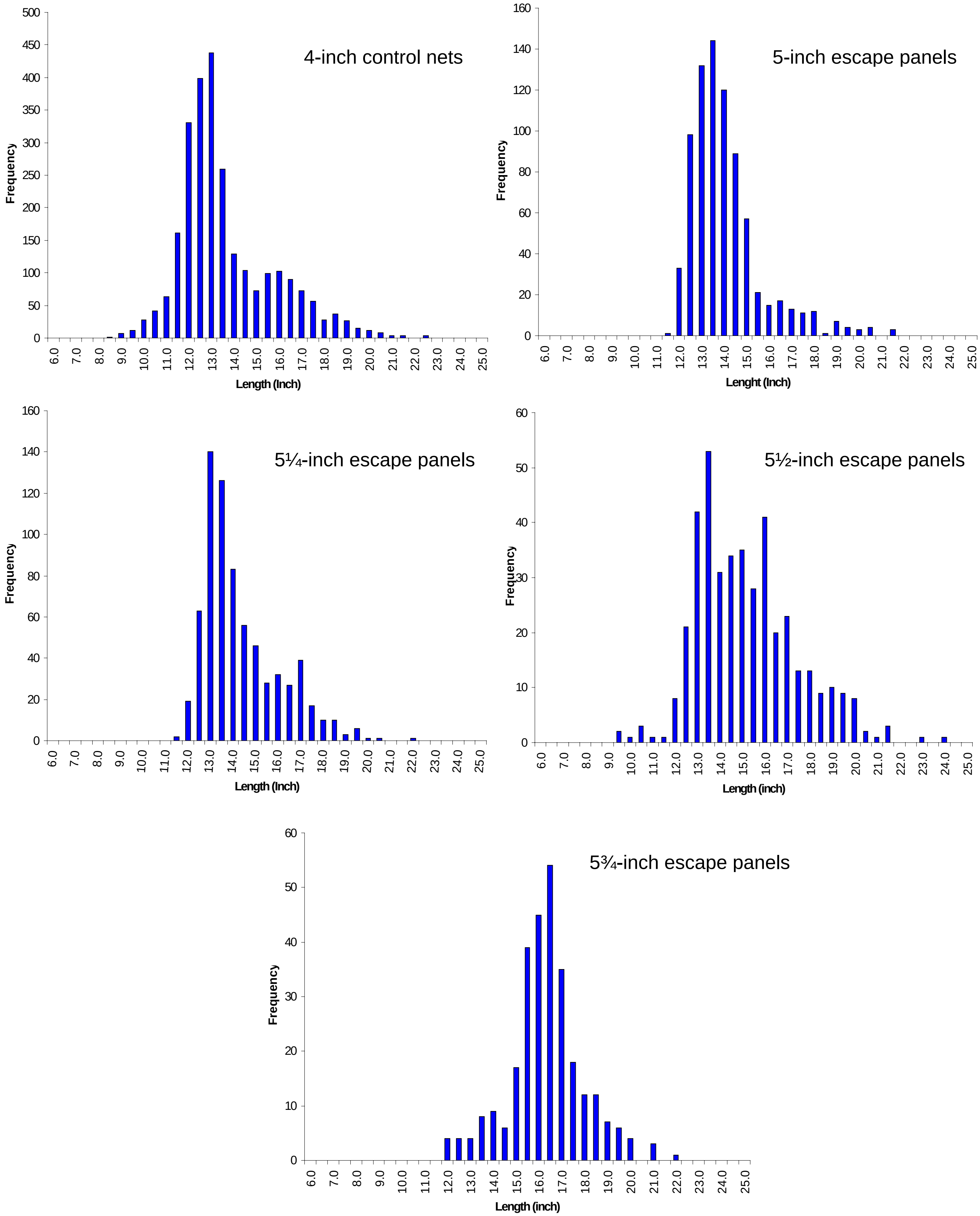

Figure 13.29. Statewide flounder length/frequencies by panel size.

4) Require 5¾-inch escape panels Statewide
   + Possible reduction of 14-inch flounder retention to 7% in Albemarle Sound
   + Decrease culling time of fishermen in Albemarle Sound
   - Increase financial burden on fishermen in Albemarle Sound to modify nets

Research Needs

1) Conduct further and more intensive studies into the level of bycatch and sublegal flounder reduction in pound nets that each of the different mesh sizes provides. Studies should include 5½, 5¾, 6, 6¼, and 6½-inch escape panels.

2) Conduct studies to test the effectiveness of increasing the mesh size in the heart or crib of the net in pound nets without escape panels in releasing bycatch and sublegal flounder.

13.1.8 Bycatch in the Flounder Pound Net Fishery

Issue

A wide diversity of species are captured incidental to flounder in the directed flounder pound net fishery. Marketable species are landed, and non-marketable species are typically released alive at the net.

Background

The North Carolina pound net fishery for flounder targets Paralichthid flounders. The fishery takes place along the mainland and barrier island shorelines of sounds from Albemarle Sound south to Back Sound, near Cape Lookout during the months of September to December. The contribution, in weight, of the flounder pound net fishery to the annual State edible finfish landings was 2-4% from 2000-2002, and represented 4-7% of the total value of edible finfish landings.

Annual total landings for 2000-2002 ranged from 1.0-1.7 million pounds and values of greater than 1.6-2.2 million dollars, of which flounder alone were valued at greater than 1.5-2.0 million dollars (Table 13.48). Landings and values for 2003 represented only one percent of edible finfish landings and 2.8% of the value, but were unusually low due to a shortened fishing season attributable to the damaging effects of Hurricane Isabel. Consequently, in 2003, both annual landings (554,323 pounds) and value ($816,500) were approximately 60% lower than the mean values for 2000-2002. The average price per pound of flounder was $1.47-$1.59 for 2000-2003.

The North Carolina Division of Marine Fisheries (NCDMF) initiated sampling of the Core Sound flounder pound net fishery for flounder in Core Sound in 1976 (Wolff 1977) and 1979 (De Vries 1981), then started sampling on a Statewide basis in 1989, and has continued to present. Marketable and non-marketable bycatch was documented through biological sampling at the fish houses.

A pound net is a passive fishing gear that traps fish allowing the catch to swim freely until the net is fished. Discard mortality in this fishery is very low because few fish are gilled and the catch is bailed out of the net using "dip" nets or hands. Sea sampling by NCDMF staff provided documentation of unmarketable and/or regulatory discards, which are released at the net. Sea sampling of flounder pound nets occurred while testing the efficacy of escape panels. Escape panels were tested in Back and Core sounds (1988), eastern Pamlico Sound near Hatteras (1994), eastern Albemarle Sound near Mashoes (1994, 1995), and in central Albemarle Sound (1998, 2001).

Prepared by the North Carolina Division of Marine Fisheries on June 15, 2001; updated on April 14, 2004.

Table 13.48. **North Carolina flounder pound net reported commercial landings (pounds) and value (thousand dollars) for selected species, 2000-2003, including the relative contribution of the species to the fishery (courtesy of the NCDMF Trip Ticket Program).**

Species	2000			2001			2002			2003		
	Pounds	% of Fishery	Value (Thousands)	Pounds	% of Fishery	Value (Thousands)	Pounds	% of Fishery	Value (Thousands)	Pounds	% of Fishery	Value (Thousands)
Atlantic croaker	1,150	0.1	0.3	1,371	0.1	0.3	459	<0.1	0.1	107	<0.1	<0.1
Black drum	15,047	1.5	3.8	15,069	1	4.4	239,782	14.2	53.3	8,913	1.6	2
Bluefish	2,110	0.2	0.7	3,863	0.3	0.9	3,857	0.2	1.1	861	0.2	0.2
Butterfish	74,113	7.4	34.1	42,946	2.9	21.7	36,610	2.2	16.6	849	0.2	0.4
Florida pompano	11,686	1.2	16.8	13,958	0.9	15.4	14,965	0.9	14.9	1,094	0.2	1.6
Flounders	789,787	78.6	1,485.50	1,223,283	82.8	2,024.00	1,286,176	76.3	2,049.30	502,069	90.6	795
Harvestfish	32,709	3.3	25	64,403	4.4	52.9	28,007	1.7	18.6	2,193	0.4	1.5
Red drum	3,330	0.3	3.6	4,317	0.3	4.9	5,032	0.3	5.5	1,712	0.3	1.9
Spanish mackerel	720	0.1	0.5	1,978	0.1	1.5	1,137	0.1	0.9	254	<0.1	0.2
Spot	1,685	0.2	0.7	38,050	2.6	16	1,245	0.1	0.5	321	0.1	0.1
Spotted seatrout	1,229	0.1	1.5	252	<0.1	0.3	369	<0.1	0.5	329	0.1	0.4
Striped bass	2,422	0.2	2.8	2,300	0.2	2.7	5,123	0.3	6.2	3,378	0.6	4.1
Weakfish	1,418	0.1	0.9	6,756	0.5	3.2	1,657	0.1	0.9	96	<0.1	0.1
All others	67,255	6.8	21.5	58,925	3.8	20	60,716	3.6	18.7	32,147	5.7	8.9
Total	1,004,661	100	1,597.70	1,477,471	100	2,168.20	1,685,135	100	2,187.10	554,323	100	816.5

Flounder Pound Net includes gear 275, Beaufort, Carteret, Hyde and Tyrrell counties for September and Beaufort, Carteret, Dare, Hyde and Tyrrell counties for October through December.

Current Authority

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)

3J .0107 POUND NET SETS
3M .0501 RED DRUM
3M .0508 STURGEON
3M .0516 COBIA
3M .0509 TARPON

Discussion

Marketable Bycatch

For 2000-2002, marketable bycatch, by weight, represented 17-24% of the reported landings, and was valued at $112,200-$144,200, an estimated 6.7-7.6% of the total value of flounder landed by the fishery (Table 13.48). However, in 2003, due to Hurricane Isabel, marketable bycatch was severely reduced along with the landings of flounder. Marketable bycatch represented only 9.4% of the reported flounder pound net landings this season, and a value of $21,500, an estimated ~2.7% of the total value of flounder landed by the fishery during 2003 ($795,000).

Flounder species targeted and captured by flounder pound nets are predominantly southern flounder, as they accounted for 71-93% of the landed catch, by weight for 2000-2003, but may include catches of gulf and summer flounder (Tables 13.49, 13.50, 13.51, and 13.52). All species of flounder combined make up the majority (73-95%, by weight) of the flounder pound net catch (Tables 13.49, 13.50, 13.51, and 13.52), but other economically important species are incidentally captured as well. These species include: harvestfish, butterfish, sheepshead, Atlantic spadefish, Atlantic menhaden, Florida pompano, Spanish mackerel, weakfish, Atlantic croaker, striped mullet, kingfishes, striped bass, catfishes, tripletail, tautog, hickory shad, pinfish, pigfish, blue crab, yellow perch, white perch, red drum, and black drum.

Flounder comprised 83-96%, by weight, of the catches sampled from 1989-2001and 2003, but composed only 73% of the catches sampled in 2002. Catch composition was unique in 2002 when black drum comprised a significant proportion (18%) of the flounder pound net catches (Tables 13.49, 13.50, 13.51, and 13.52). Black drum were ever-present in all areas sampled in 2002, as they were the second most dominant species, by weight, in each of the areas sampled, and constituted as much as 38% of the catches sampled in the Albemarle Sound area (Tables 13.53, 13.54, 13.55, and 13.56).

Bycatch in flounder pound nets varied little between the areas fished, with the most notable differences occurring between catches in the Albemarle Sound-Manns Harbor

Table 13.49. Overall species composition and mean catch per trip of North Carolina flounder pound net catches during 2000 (n = 66).

Species	Weight (Pounds)		Number	
	Mean	Percent	Mean	Percent
Southern flounder	767.0	84.0	426.0	49.7
Harvestfish	65.7	7.2	388.0	45.2
Sheepshead	30.9	3.4	12.0	1.4
Black drum	21.4	2.3	9.0	1.0
Atlantic spadefish	6.4	0.7	3.0	0.3
Summer flounder	4.4	0.5	3.0	0.3
Gulf flounder	2.6	0.3	2.0	0.3
Florida pompano	2.4	0.3	3.0	0.2
Spanish mackerel	1.5	0.2	1.0	0.1
Red drum	1.5	0.2	<1.0	<0.1
Spotted seatrout	1.5	0.2	<1.0	<0.1
Bluefish	1.1	0.1	<1.0	<0.1
Atlantic croaker	1.1	0.1	<1.0	<0.1
Butterfish	0.9	0.1	<1.0	<0.1
Blue crab	0.7	0.1	<1.0	<0.1
White catfish	0.7	0.1	<1.0	<0.1

Observed Species

Catfishes (*Ictalurus*)	Hickory shad	Lookdown
Striped bass	White perch	Scup
Gizzard shad	Jacks (*Caranx*)	Northern kingfish
Spot	American shad	Windowpane flounder
Weakfish	Oyster toadfish	Oceanic puffer
Pinfish	Hogfish	Northern puffer
Stargazers (*Astroscopus*)	Gulf kingfish	

Table 13.50. Overall species composition and mean catch per trip of North Carolina flounder pound net catches during 2001 (n = 70).

Species	Weight (Pounds)		Number	
	Mean	Percent	Mean	Percent
Southern flounder	1331.8	88.0	722.0	59.9
Harvestfish	74.7	4.9	372.0	30.9
Butterfish	15.9	1.1	53.0	4.4
Sheepshead	14.8	1.0	4.0	0.3
Atlantic spadefish	11.9	0.8	3.0	0.3
Florida pompano	11.9	0.8	19.0	1.6
Black drum	10.8	0.7	4.0	0.3
Gulf flounder	10.4	0.7	9.0	0.9
Summer flounder	9.0	0.6	6.0	0.6
Spot	4.2	0.3	3.0	0.3
Red drum	3.3	0.2	0.0	0.0
Spanish mackerel	2.9	0.2	2.0	0.2
Atlantic croaker	2.4	0.2	1.0	0.2
Catfishes (*Ictalurus*)	2.2	0.1	<0.1	<0.1
Tripletail	1.1	0.1	<0.1	<0.1
Bluefish	1.1	0.1	<0.1	<0.1
Stargazers (*Astroscopus*)	1.1	0.1	<0.1	<0.1
Weakfish	1.1	0.1	<0.1	<0.1

Observed Species

Striped mullet	Gizzard shad	Lookdown
Cobia	Permit	Striped searobin
Jacks (*Caranx*)	Kingfishes	Windowpane flounder
Striped mullet	Atlantic menhaden	Northern puffer
Spotted seatrout	Pigfish	Striped burrfish
Blue crab	Pinfish	

Table 13.51. Overall species composition and mean catch per trip of North Carolina flounder pound net catches during 2002 (n = 63).

Species	Weight (Pounds)		Number	
	Mean	Percent	Mean	Percent
Southern flounder	1,174.2	71.3	531.0	57.6
Black drum	303.1	18.4	122.0	13.3
Harvestfish	46.3	2.8	165.0	17.9
Sheepshead	29.8	1.8	16.0	1.7
Atlantic spadefish	22.9	1.4	9.0	1.0
Gulf flounder	15.0	0.9	12.0	1.3
Florida pompano	12.1	0.7	17.0	1.2
Butterfish	9.9	0.6	11.0	1.4
Summer flounder	8.6	0.5	6.0	0.8
Spanish mackerel	7.9	0.5	8.0	0.9
Bluefish	7.1	0.4	1.0	0.2
Red drum	3.7	0.2	1.0	0.1
Striped bass	2.4	0.1	0.0	0.0
Tripletail	1.3	0.1	0.0	0.0
Weakfish	0.9	0.1	0.0	0.0
Spot	0.9	0.1	1.0	0.1

Observed Species

Striped mullet	Permit	Moonfish
Jacks (*Caranx*)	Pinfish	Stargazers (*Astroscopus*)
Atlantic croaker	Tautog	Orange filefish
Common carp	White perch	Planehead filefish
Catfishes (*Ictalurus*)	Florida pompano	Northern puffer
Lookdown	Striped searobin	Striped burrfish
Spotted seatrout	African pompano	

Table 13.52. Overall species composition and mean catch per trip of North Carolina flounder pound net catches during 2003 (n = 43).

Species	Weight (Pounds)		Number	
	Mean	Percent	Mean	Percent
Southern flounder	932.1	93.3	452	93.2
Sheepshead	20.5	2	6	1.2
Atlantic spadefish	11.5	1.2	3	0.6
Gulf flounder	7.1	0.7	4	0.9
Summer flounder	6.8	0.7	5	0.9
Black drum	4.6	0.5	1	0.1
Striped bass	3.7	0.4	0	0
Harvestfish	3.5	0.3	11	2.2
Channel catfish	2.6	0.3	1	0.2
Spanish mackerel	1.8	0.2	<1	<0.1
Bluefish	0.9	0.1	<1	<0.1
Common carp	0.7	0.1	<1	<0.1
Butterfish	0.7	0.1	<1	<0.1
Red drum	0.7	0.1	<1	<0.1
Tripletail	0.7	0.1	<1	<0.1
Observed Species				
Florida pompano	Lookdown		Pinfish	
Spot	Striped burrfish		Jacks (*Caranx*)	
Weakfish	White perch		Horseshoe crab	
Spotted seatrout	Atlantic croaker		Blue crab	
Striped mullet	Southern kingfish		Northern puffer	

Table 13.53. Species composition and mean catch per trip of North Carolina flounder pound net catches sampled by area during 2000.

Albemarle Sound (n = 8)			Mashoes-Manns Harbor (n = 5)			Outer Banks (n = 41)			Back and Core Sounds (n = 12)		
Species	Weight (Pounds)		Species	Weight (Pounds)		Species	Weight (Pounds)		Species	Weight (Pounds)	
	Mean	Percent		Mean	Percent		Mean	Percent		Mean	Percent
Flounders	216.7	84.1	Flounders	2,536.8	91.7	Flounders	807.1	81.7	Flounders	297.2	92.1
Black drum	11.0	4.3	Sheepshead	119.7	4.3	Harvestfish	105.2	10.6	Black drum	10.6	3.3
Sheepshead	10.1	3.9	Black drum	87.7	3.2	Sheepshead	33.1	3.4	Spotted seatrout	5.5	1.7
Catfishes	6.6	2.6	Catfishes	8.4	0.3	Balck drum	18.5	1.9	Harvestfish	2.4	0.8
Blue crab	5.1	1.9	Atlantic croaker	4.9	0.2	Spadefish	10.1	1.0	Northern puffer	2.0	0.6
Striped bass	3.5	1.4	Red drum	4.2	0.2	Florida pompano	3.6	0.4	Florida pompano	1.1	0.4
Gizzard shad	3.3	1.3	Spotted seatrout	2.4	0.1	Spanish mackerel	2.0	0.2	Atlantic spadefish	1.1	0.3
Atlantic croaker	2.9	0.2				Bluefish	1.8	0.2	Red drum	0.7	0.2
White perch	0.4	0.2				Red drum	1.8	0.2	Striped mullet	0.4	0.2
Spot	0.2	0.1				Butterfish	1.3	0.1	Hickory shad	0.4	0.1
						Atlantic croaker	1.1	0.1	American shad	0.2	0.1
						Spot	0.7	0.1	Sheepshead	0.2	0.1
						Weakfish	0.4	0.1			
Observed Species			***Observed Species***			***Observed Species***			***Observed Species***		
			Weakfish	White perch		Spotted seatrout	Gizzard shad		Northern kingfish	Weakfish	
			Spot			Pinfish	Gulf kingfish		Lookdown	Butterfish	
						Striped mullet	Hickory shad		Scup		
						Stargazers	Windowpane flounder				
						Jacks (*Caranx*)	Oceanic puffer				
						Oyster toadfish	Northern puffer				
						Pigfish					

Table 13.54. Species composition and mean catch per trip of North Carolina flounder pound net catches sampled by area during 2001.

Albemarle Sound (n = 5)			Mashoes-Manns Harbor (n = 7)			Outer Banks (n = 45)			Back and Core Sounds (n = 12)		
Species	Weight (Pounds)		Species	Weight (Pounds)		Species	Weight (Pounds)		Species	Weight (Pounds)	
	Mean	Percent		Mean	Percent		Mean	Percent		Mean	Percent
Flounders	1,323.2	97.4	Flounders	2,147.1	96.1	Flounders	1,359.1	86.7	Flounders	978.4	91.3
Sheepshead	11.9	0.9	Black drum	32.2	1.4	Harvestfish	103.2	6.6	Harvestfish	48.3	4.5
Black drum	10.4	0.8	Catfishes (Ictalurus)	17.6	0.9	Butterfish	18.7	1.2	Butterfish	22.7	2.1
Catfish (*Ictalurus*)	6.2	0.5	Sheepshead	16.3	0.4	Sheepshead	18.7	1.2	Black drum	6.0	0.6
Blue crab	2.0	0.1	Atlantic croaker	10.6	0.5	Atlantic Spadefish	18.5	1.2	Florida pompano	5.1	0.5
Gizzard shad	1.5	0.1	Striped mullet	3.7	0.2	Florida pompano	17.2	1.1	Red drum	4.9	0.4
Striped mullet	0.9	0.1	Red drum	3.3	0.1	Black drum	9.0	0.6	Sheepshead	2.2	0.2
Atlantic croaker	0.9	0.1	Weakfish	1.1	0.1	Spot	5.9	0.4	Spot	1.5	0.1
						Spanish mackerel	4.2	0.3	Atlantic croaker	0.9	0.1
						Red drum	3.3	0.2	Spanish mackerel	0.7	0.1
						Tripletail	1.8	0.1	Striped mullet	0.4	0.1
						Atlantic croaker	1.8	0.1			
						Stargazer	1.5	0.1			
						Bluefish	1.5	0.1			
						Weakfish	1.3	0.1			
Observed Species			***Observed Species***			***Observed Species***			***Observed Species***		
Bluefish	Spot		Spot	Bluefish		Cobia	Pinfish		Weakfish	Southern kingfish	
Atlantic menhaden	Croaker		Atlantic menhaden	Spotted seatrout		Jacks (*Caranx*)	Lookdown		Atlantic spadefish	Northern puffer	
			Spanish mackerel	Blue crab		Spotted seatrout	Atlantic menhaden				
						Striped mullet	Striped searobin				
						Permit	Windowpane				
						Pigfish	Northern puffer				
						Kingfishes	Striped burrfish				

Table 13.55. Species composition and mean catch per trip of North Carolina flounder pound net catches sampled by area during 2002.

Albemarle Sound (n = 4)			Mashoes-Manns Harbor (n = 5)			Outer Banks (n = 47)			Back and Core Sounds (n = 7)		
Species	Weight (Pounds)		Species	Weight (Pounds)		Species	Weight (Pounds)		Species	Weight (Pounds)	
	Mean	Percent		Mean	Percent		Mean	Percent		Mean	Percent
Flounders	1,233.5	56.5	Flounders	2,236.1	74.4	Flounders	1,176.4	74.1	Flounders	577.8	74.5
Black drum	833.6	38.2	Black drum	471.3	15.7	Black drum	274.3	17.3	Black drum	75.2	9.7
Sheepshead	88.6	4.1	Sheepshead	98.5	3.3	Harvestfish	51.1	3.2	Butterfish	48.9	6.3
Striped bass	17.9	0.8	Bluefish	62.2	2.1	Atlantic spadefish	26.2	1.7	Harvestfish	32.4	4.2
Red drum	8.2	0.4	Harvestfish	56.4	1.9	Sheepshead	20.9	1.3	Florida pompano	17.4	2.2
Weakfish	1.3	0.1	Atlantic spadefish	34.0	1.1	Florida pompano	13.9	0.9	Sheepshead	6.6	0.8
			Red drum	17.2	0.6	Spanish mackerel	10.4	0.7	Red drum	6.0	0.8
			Striped bass	16.1	0.5	Butterfish	6.0	0.4	Atlantic spadefish	5.7	0.7
			Crevalle jack	3.7	0.1	Bluefish	2.4	0.2	Tripletail	2.0	0.3
			Common carp	2.9	0.1	Red drum	1.5	0.1	Bluefish	2.0	0.2
			Atlantic croaker	1.5	0.1	Tripletail	1.5	0.1	Striped mullet	1.1	0.1
						Spot	0.9	0.1	Atlantic croaker	0.4	0.1
						Weakfish	0.9	0.1			
Observed Species			***Observed Species***			***Observed Species***			***Observed Species***		
Atlantic croaker	White perch		Spot	Weakfish		Striped mullet	Striped bass		Spanish mackerel	Northern puffer	
Harvestfish			Catfish (*Ictalurus*)	Spanish mackerel		Atlantic croaker	African pompano		Permit		
			Spotted seatrout			Lookdown	Atlantic moonfish				
						Pinfish	Stargazers				
						Permit	Orange filefish				
						Tautog	Planehead filefish				
						Northern searobin	Northern puffer				
						Striped searobin	Striped burrfish				

Table 13.56. Species composition and mean catch per trip of North Carolina flounder pound net catches sampled by area during 2003.

Albemarle Sound (n = 0)			Mashoes-Manns Harbor (n = 1)			Outer Banks (n = 32)			Back and Core Sounds (n = 8)		
Species	Weight (Pounds)		Species	Weight (Pounds)		Species	Weight (Pounds)		Species	Weight (Pounds)	
	Mean	Percent		Mean	Percent		Mean	Percent		Mean	Percent
			Flounders	3,832.0	95.3	Flounders	824.7	95.0	Flounders	1,075.2	92.8
			Catfish, Channel	110.0	2.7	Sheepshead	24.5	2.8	Atlantic spadefish	59.3	5.1
			Sheepshead	52.9	1.3	Striped bass	5.1	0.6	Harvestfish	15.2	1.3
			Black drum	20.1	0.5	Black drum	4.9	0.6	Sheepshead	2.4	0.2
			White perch	3.1	0.1	Spanish mackerel	2.2	0.3	Black drum	2.0	0.2
						Bluefish	1.1	0.1	Butterfish	1.8	0.1
						Common carp	0.9	0.1	Florida pompano	1.3	0.1
						Red drum	0.9	0.1	Lookdown	0.7	0.1
						Tripletail	0.7	0.1			
						Harvestfish	0.7	0.1			
						Butterfish	0.4	0.1			
			Observed Species			***Observed Species***			***Observed Species***		
			Spot			Spot	Pinfish		Striped burrfish		
						Atlantic spadefish	Jacks (*Caranx*)		Striped mullet		
						Florida pompano	Horseshoe crab		Spot		
						Weakfish	Blue crab		Northern puffer		
						Spotted seatrout	Lookdown				
						Atlantic croaker	Northern puffer				
						Southern kingfish	Striped burrfish				
						Striped mullet					

vicinity and areas closer to the inlets. With the exception of black drum and sheepshead, gizzard shad and catfish contributed to the bycatch of this fishery in the Albemarle Sound area (Monaghan 1992), unlike southeastern Pamlico and Core Sounds where the bycatch was predominantly harvestfish, butterfish, and Atlantic spadefish.

Blue crabs are ubiquitous in pound net catches, but landings are largely dependent on market demand. Blue crabs may be released by escape panels, as the relative abundance of blue crabs was highest in samples collected in the northernmost areas where escape panels are not required. Blue crabs were the fifth most abundant species in Albemarle Sound catches by weight (Tables 13.53, 13.54, 13.55, and 13.56). For at-sea samples, blue crabs represented 12% of the weight of the central Albemarle Sound catches (Table 13.57).

Non-Marketable Bycatch

Non-marketable bycatch caught in flounder pound nets is rarely observed because it is typically released at sea. Such species include various species of stingray (cownose, bullnose, southern, and Atlantic stingrays), stargazers, horseshoe crabs, or regulatory discards released due to closed seasons, size restrictions or during times when there are number or poundage restrictions (striped bass, red drum, cobia), or illegal commercial take (tarpon). Other bycatch includes protected species including sturgeon and sea turtles. In the northernmost areas, many more striped bass are caught than landings and samples indicate because they are released alive due to commercial harvest restrictions. While conducting escape panel research, the nets were often so full of striped bass that fishermen were frequently required to bail striped bass out of their pound before sampling could begin. Therefore, it should be noted that if it were not for the current harvest restrictions on striped bass, this species would make up a much larger component of the pound net fishery in the Albemarle and Croatan Sounds. Although a much smaller component than striped bass, landings of red drum are also an underestimate, as the commercial harvest was restricted to limit catches to 100 pounds per trip (3M .0501) and more recent restrictions limit catches to seven fish 18-27 inches total length (TL) a day (Proclamation FF-47-2001). Other species incidentally caught by this fishery but not evident in landings due to harvest restrictions include: cobia, with commercial harvest restricted to two fish 33 inches fork length (FL) (3M .0516); tarpon, which cannot be sold commercially (3M .0509); and sturgeon, which are unlawful to possess in North Carolina (3M .0508).

Non-marketable bycatch, which is brought to shore, is typically bought and sold as “bait” or discarded. Bait comprised only 1% of the biological samples collected from 1990-2003. Species composition of the few bait catches sampled was primarily harvestfish, butterfish, or spadefish too small to market, Atlantic menhaden, and southern flounder which may have been mutilated (“busted gut”, eaten by crabs, etc) in some way such that they were unmarketable (Table 13.58). Other species sampled in the bait that were too small to market included spot, pinfish, Atlantic croaker, jack crevalle, and southern kingfish. Species that are not marketed as edible finfish but often discarded at the dock

Table 13.57. Weight, when available, and number of species captured while at-sea sampling of North Carolina flounder pound net escape panels, by area during 1988, 1994,1995, 1998, and 2001.

Albemarle Sound			Mashoes-Manns Harbor			Outer Banks			Back and Core Sounds		
Species	Weight (Pounds)		Species	Weight (Pounds)		Species	Weight (Pounds)		Species	Weight (Pounds)	
	Mean	Percent		Mean	Percent		Mean	Percent		Mean	Percent
Marketable			***Marketable***			***Marketable***			***Marketable***		
Southern flounder	1,030.0	98.0	Southern flounder	2,063.0	83.3	Southern flounder	632.0	97.4	Flounder sp.	1,547.0	100.0
Blue crab	6.0	0.6	Summer flounder	50.0	2.0	Summer flounder	6.0	0.9			
Striped bass	12.0	1.1	Black drum	36.0	1.5	Gulf flounder	10.0	1.5			
Striped mullet	1.0	<0.1	Harvestfish	28.0	1.1						
Red drum	1.0	<0.1	Blue crabs	12.0	0.5						
Black drum	1.0	<0.1	Sheepshead	11.0	0.4						
Sheepshead			Striped bass	7.0	0.3						
			Weakfish	4.0	0.2						
			Atlantic croaker	3.0	0.1						
			Channel catfish	3.0	0.1						
			Striped mullet	3.0	0.1						
			Spotted seatrout	2.0	0.1						
			Atlantic menhaden	1.0	<0.1						
			Northern puffer	1.0	<0.1						
			Red drum	1.0	<0.1						
			Spot	1.0	<0.1						
Not Marketable			***Not Marketable***								
Gizzard shad			Gizzard shad	Windowpane							
			Planehead filefish								

Table 13.58. Species composition of bait **sampled and mean catch of North Carolina flounder pound net catches sampled, by year during 1992 (n=3), 1994 (n=1), 1995 (n=1), 2000 (n=1), and 2001 (n=1).**

Year	Species	Weight (Pounds)	
		Mean	Percent
1992	Atlantic menhaden	82	30.2
	Southern flounder	62	22.7
	Lookdown	45	16.7
	Spadefish	38	14.0
	Pinfish	21	7.9
	Harvestfish	16	5.9
	Atlantic croaker	3	1.2
	Spanish mackerel	1	0.4
	Spot	<1	0.3
	Gizzard shad	<1	0.2
	Planehead filefish	<1	0.1
	Atlantic bumper	<1	0.1
	Striped burrfish	<1	0.1
	Jack crevalle	<1	<0.1
	Windowpane	<1	<0.1
1994	Butterfish	5	30.5
	Lookdown	3	15.9
	Striped burrfish	3	15.9
	Spadefish	2	13.3
	Spot	1	8.0
	Pinfish	1	5.3
	Atlantic croaker	1	5.3
	Windowpane	<1	2.7
	African pompano	<1	2.0
	Southern kingfish	<1	1.1
1995	Harvestfish	256	91.6
	Lookdown	20	7.2
	Spadefish	3	1.2
2000	Harvestfish	299	100.0
2001	Atlantic menhaden	2	100.0

included lookdowns, orange and planehead file fish, windowpane, African pompano, Atlantic bumper, striped burrfish, and gizzard shad. The species composition of unmarketable bycatch is similar whether from observations at-sea (Table 13.56) or from commercial fish house observations (Table 13.57).

Sea Turtles Bycatch

Pound nets are so successful in catching live sea turtles that the National Marine Fisheries Service (NMFS) staff relies on this gear as a primary source for the collection of turtles for tagging surveys, and valuable biological data. Studies conducted by the NMFS Beaufort laboratory support the success of catch and release of sea turtles in pound nets (Tables 13.59, 13.60, and 13.61). Effort data available for 1995-1997 allowed investigators to predict total estimated catch from flounder pound nets (Table 13.59). The NMFS estimates indicate as many as 2,898 loggerhead turtles, 935 green turtles, and 221 Kemp's Ridley caught in the flounder pound nets with only 1-3 mortalities. Effort data was not available for 1998-2003, but observed turtle takes in nets known to capture turtles were documented (Table 13.61). Observations of turtles taken in the flounder pound nets were notably higher in 1998 (398 turtles) than in other years. Nevertheless, mortalities for the season were only two green and one Kemp's Ridley sea turtle. During 2001-2003, an "Index of Abundance" study was conducted utilizing randomly selected pound net fishermen (Table 13.60). Effort and observations were recorded, then weighted by an estimate of the proportion of sampling coverage to total fishing effort within the study area for the selected time period.

Marine Mammal Bycatch (c/o Federal Register/Vol. 66, No. 14/Monday, January 22, 2001)

Under section 118 of the Marine Mammal Protection Act (MMPA), the NMFS must publish, at least annually, a List of Fisheries (LOF) that places all U.S. commercial fisheries into one of three categories based on the level of incidental serious injury and mortality of marine mammals that occurs in each fishery (65 FR 24,448 April 26, 2000; Steve et al 2001). Category I designates commercial fisheries with frequent incidental mortalities or serious injuries of marine mammals; Category II designates fisheries with occasional incidental mortalities or serious injuries of marine mammals; Category III designates fisheries with a remote likelihood or no known mortalities or serious injuries (50 FR 229.2).

In recognition that the levels of takes have to be measured and monitored, an additional provision of Section 118 includes an authorization and reporting program (Marine Mammal Authorization Program - MMAP) and a monitoring or observer program. Both programs are administered by NMFS. The MMAP exempts Category I, II, and III commercial fishers from MMPA prohibitions of taking marine mammals provided they abide by certain regulations. For example, fishers in Category I, II and III are required to report to NMFS any incidental mortality or serious injury to marine mammals that occur. Also, Category I and II fishermen must register with MMAP and receive

Table 13.59. **Survey of turtles observed and turtle mortalities by species in Pamlico Sound flounder pound nets during 13 weeks from September 17 through December 14 1995-1997, NMFS, Beaufort. Includes extrapolated estimates of numbers of turtles for this period (personal communication, JoAnne McNeill).**

Year	# of Pound Nets Sampled	Disposition	Loggerhead	Green	Kemp's Ridley
1995	1,084	Observed	111	42	1
		Estimated	2,372	935	32
		Mortality	1	1	-----
1996	1,084	Observed	97	32	4
		Estimated	1,842	705	75
		Mortality	1	3	-----
1997	1,162	Observed	156	30	10
		Estimated	2,898	531	221
		Mortality	-----	3	-----

Table 13.60. **Index of Abundance Study, randomly selected pound net fishers sampled for estimate, Pamlico Sound flounder pound nets during 13 weeks from September through December 2001-2003, NMFS, Beaufort. Includes extrapolated estimates of numbers of turtles for this period (personal communication, JoAnne McNeill).**

Year	Week	Coverage	Disposition	# Total	Loggerhead	Green	Kemp's Ridley
2001	9/17-12/16	21%	Observed alive	305	218	59	28
			Estimate	3,164	2,264	593	307
			Observed mortality	0	-----	-----	-----
2002	9/16-12/15	32%	Observed alive	246	185	43	18
			Estimate	3,296	2,444	612	240
			Observed mortality	4	-----	3	1
2003	9/15-12/14	43%	Observed alive	174	140	26	8
			Estimate	1,276	1,031	201	44
			Observed mortality	3	1	2	-----

Table 13.61. Survey of turtles observed and turtle mortalities by species in Pamlico Sound flounder pound nets during the fall of 1998-2003, NMFS, Beaufort. Fishing effort was not random and pound nets that were known to capture turtles were targeted (personal communication, JoAnne McNeill).

Year	Disposition	Total # of Turtles	Loggerhead	Green	Kemp's Ridley
1998	Observed	398	355	37	6
	Mortality	3	-----	2	1
1999	Observed	185	157	19	9
	Mortality	4	2	2	-----
2000	Observed	343	269	65	9
	Mortality	3	2	1	-----
2001	Observed	207	157	35	15
	Mortality	6	2	4	-----
2002	Observed	189	165	19	5
	Mortality	6	2	2	2
2003	Observed	147	129	8	10
	Mortality	2	-----	2	-----

authorization to take marine mammals and may be required to carry an observer upon request by the NMFS (MMPA Section 118 (c)(d)).

The NMFS proposed to add the Mid-Atlantic Pound Net Fishery to the LOF as a Category II fishery. Stranding data for 1993-1997 suggests that this fishery has occasional takes of coastal bottlenose dolphins. Stranding network members who have observed dolphin behavior around pound nets report that dolphins play and feed around pound nets and can become entangled in the "leader" part of the nets (the "leader" is defined as the net that guides fish into the pound net). Data from Chesapeake Bay suggest that the likelihood of bottlenose dolphins entanglement in pound net leads may be affected by the mesh size of the lead net, but the information is inconclusive. A study conducted by the NMFS Beaufort Laboratory from 1988 to 1999 observing sea turtles in North Carolina sciaenid pound nets, which have small mesh leads ($\leq$ 8 inches or 203 mm), resulted in no observations of bottlenose entanglements. The NMFS requests further public comment on the issue of whether different mesh sizes used in pound net leads would result in differential bycatch rates of bottlenose dolphins or other marine mammals.

The NMFS proposes to specify the northern boundary of the Mid-Atlantic Pound Net fishery based on bottlenose dolphin distributions and the southern boundary as the North Carolina/South Carolina border. The NMFS will revisit this gear type and similar gear types (e.g., staked traps, weirs) in a future LOF. The NMFS has not yet analyzed all data on marine mammal interactions or fishing effort for this fishery complex and are therefore not prepared to propose a comprehensive change at this time. The NMFS initially proposed classification of the Mid-Atlantic Pound Net fishery as a Category II fishery. However, due to the differences in lead mesh sizes utilized in Virginia versus North Carolina pound nets, the NMFS has proposed modified classifications. Virginia pound nets which have larger lead mesh sizes (10-14 inches) will be classified as a Category II fishery, but North Carolina pound nets which use smaller lead mesh size (7-10 inches) would be classified as a Category III fishery (personal comm. Carolyn Steve, NMFS SEFSC).

<u>Shore Birds</u>

Although little research has documented the subject, shore birds can get caught in the extensive webbing of flounder pound net stands. Brown pelicans like to perch on the top lines of the nets, and can be seen diving on fish within the pound. Double crested cormorants, common and red-throated loons, and pied-billed grebe, are all non-endangered species that occur in inshore waters and have been captured in gill nets (Darna 2000, Rose 2000). It is possible that flounder pound nets could catch these same species.

Management Options/Impacts

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

1) Status quo
   + No rule changes
   + No additional restrictions on fishing practices
   - Continued incidental mortalities of non-target species, undersized non-marketable species, and/or shorebirds

2) Establish a joint working group of all state and federal agency and industry people involved with interactions and management between pound nets and high profile species.
   + Increases communication between user groups and management agencies
   + Identify whether a problem exists
   + Allows further development of alternate solutions to any problems
   - Administrative costs increase to cover meetings and added expenses with more people involved in the process

Literature Cited

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Steve, C., J. Gearhart, D. Borrgard, L. Sabo, and A. Hohn. 2001. Characterization of the North Carolina fisheries with occasional interactions with marine mammals. NOAA Technical Memorandum NMFS-SEFSC-458. US Department of Commerce. National Oceanic and Atmospheric Administration, National Marine Fisheries Service Center for Coastal Fisheries and Habitat Research. Beaufort, NC, 57 p.

Wolff, M. W. 1977. Preliminary stock assessment, North Carolina: Flounder (*Paralichthys spp*.). Completion Report, Project 2-294-R, North Carolina Department of Natural Resources and Community Development, Division of Marine Fisheries, 18 p.

13.1.9 Southern Flounder Bycatch in the Shrimp Trawl Fishery

Issue

Southern flounder bycatch in the inshore shrimp trawl fishery.

Background

Inshore Shrimp Trawl Fishery. Landings in the inshore shrimp trawl fishery in North Carolina are highly variable between years with no apparent trends (Figure 13.30). The ex-vessel value, or the value of the catch when landed, has undergone yearly fluctuations as well, but has exhibited a steadily increasing trend overall. On average between 1994 and 2002, there have been approximately 914 vessels participating in the fishery annually. Since 1994, yearly participation has ranged from 690 to as high as 1,072 vessels (NCDMF Trip Ticket Program). Many of the participants, however, are not active in the fishery throughout he entire year, but instead move from fishery to fishery depending on which is the most lucrative at a given time.

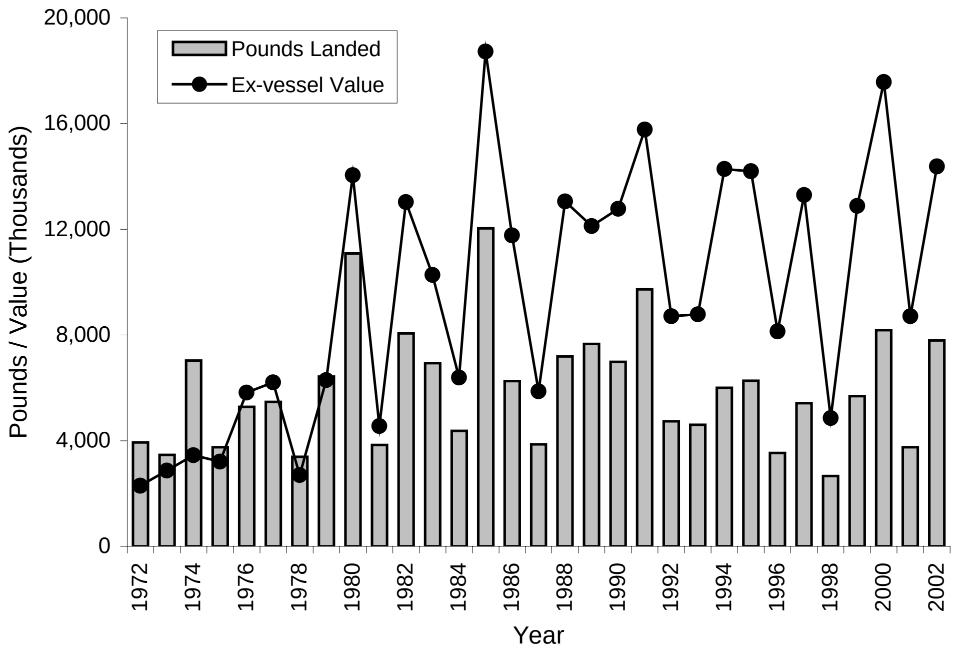

Figure 13.30. Annual landings and ex-vessel value for the inshore shrimp trawl fishery in North Carolina during 1972-2002 (courtesy of the NCDMF Trip Ticket Program).

Prepared by the North Carolina Division of Marine Fisheries on July 10, 2001; updated on March 15, 2004.

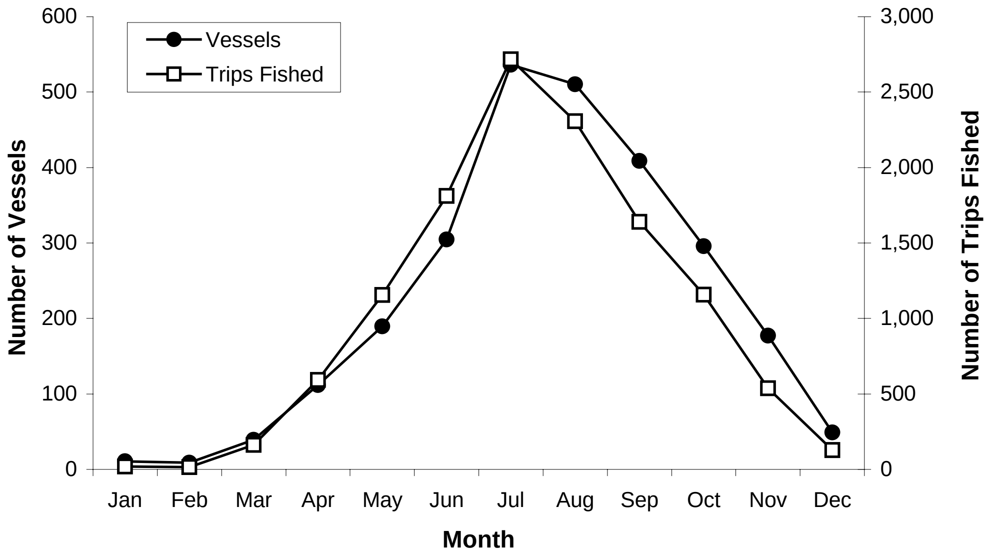

Figure 13.31. The average monthly number of vessels and trips fished using inshore shrimp trawls in North Carolina during 1994-2000 (courtesy of the NCDMF Trip Ticket Program).

The majority of the effort in the inshore shrimp trawl industry, based on number of trips and vessel participation, take place between April and November, with a peak occurring around July and August (Figure 13.31). Landings of shrimp begin to pick up around May and June, increasing to a high in July and August, and then gradually declining through November (Figure 13.31). Southern flounder landings begin picking up the same time as shrimp, but do not peak until September and October (Figure 13.32).

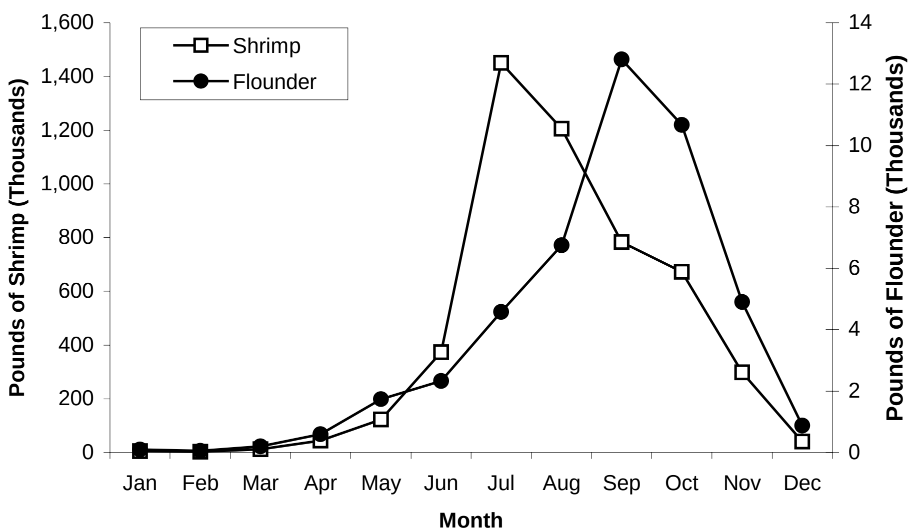

Figure 13.32. Average pounds of shrimp and southern flounder landed by the inshore shrimp trawl fishery each month during 1994-2002 (courtesy of the NCDMF Trip Ticket Program).

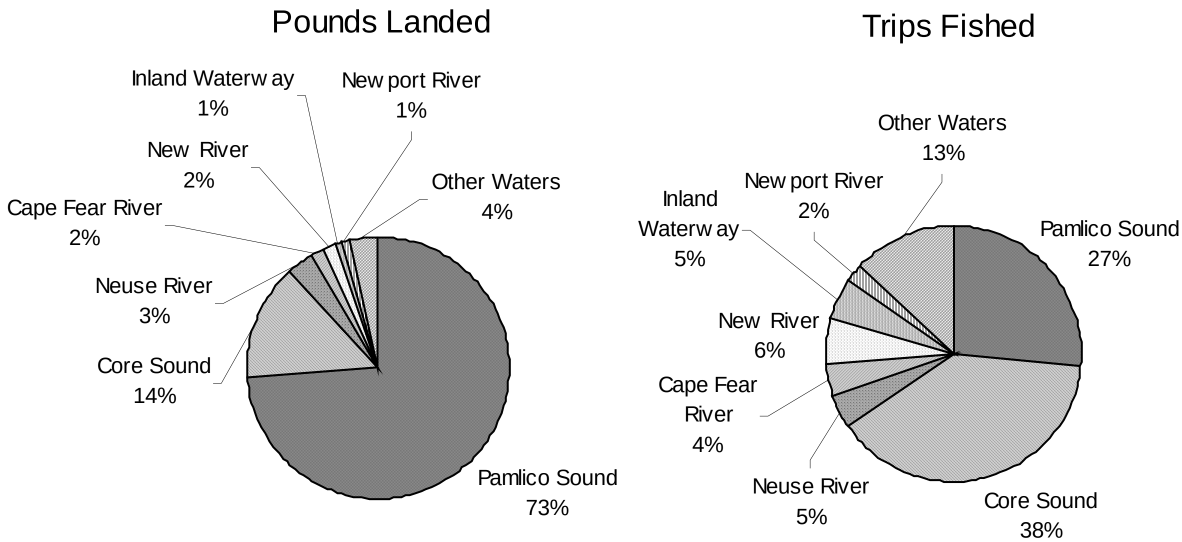

Figure 13.33. The average annual percentage of trips fished and pounds landed in the inshore shrimp trawl fishery by waterbody during 1994-2002 (courtesy of the NCDMF Trip Ticket Program).

Pamlico and Core sounds are the two most heavily fished areas within the inshore shrimp trawl fishery, together accounting for 65% of the trips and 87% of the total landings (Figure 13.33). While 38% of the trips occurred in Core Sound, this area only accounted for 14% of the total landings. In contrast, the Pamlico Sound produced 73% of the landings, but only accounted for 27% of the total trips made fishing shrimp trawls. As a result of the inshore shrimp trawl fishery focusing primarily on the Core and Pamlico sounds, counties adjacent to these waters also comprise the highest percentage of trips made and landings, particularly Carteret, Pamlico, and Hyde counties (Figure 13.34).

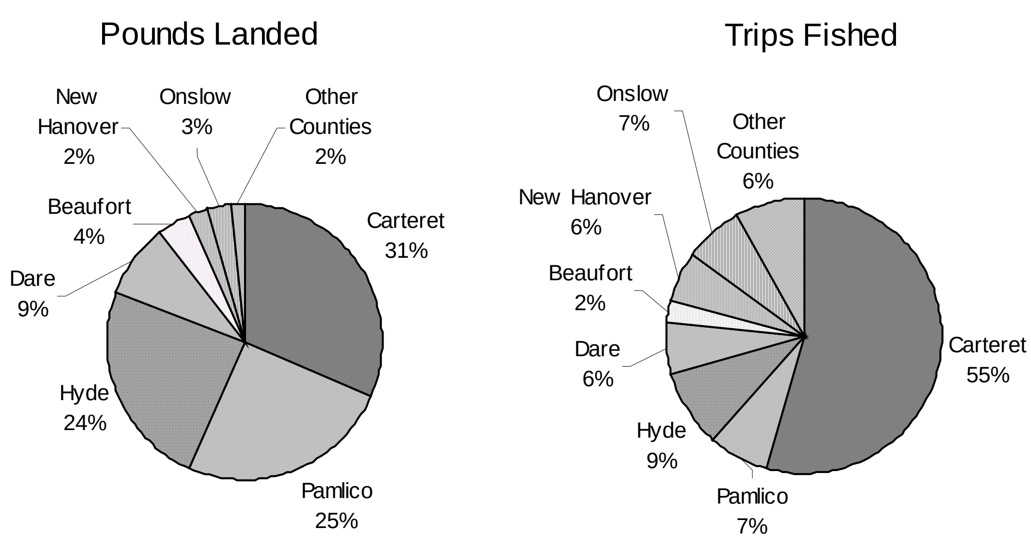

Figure 13.34. The average annual percentage of trips fished and pounds landed in the inshore shrimp trawl fishery by county during 1994-2002 (courtesy of the NCDMF Trip Ticket Program).

Shrimp Trawl Studies. Little work has been done to evaluate bycatch in the shrimp trawl fishery in North Carolina since the early 1950s when preliminary investigations were conducted in Pamlico Sound (Roelofs 1950, Latham 1951) and again in 1972 in Core and Pamlico sounds (Wolff 1972). The most recent efforts to characterize shrimp trawl bycatch in North Carolina occurred in 1995 (Diamond-Tissue 1999) and in 2000 (Johnson, in prep). During the Diamond-Tissue (1999) study, a total of 52 tows were examined from 15 shrimp trawl trips sampled between July and October. Of the tows, 16 were sampled from the Pamlico Sound, 24 from the Cape Fear River, four from Core Sound, and eight from along Carolina Beach. Southern flounder were captured in ten out of the 52 tows sampled, resulting in an estimated harvest of 331 fish (Table 13.62). Of those ten tows, southern flounder comprised between 0.31% and 3.21% of the total catch by number and between 0.20% and 3.34% by weight. The sizes of the flounder were not recorded.

In the more recent study by Johnson (in prep), 56 shrimp trawl tows were examined during 1999 and 2000. The characterizations occurred between March and September in various areas of the State ranging from the lower Neuse River to the straits off of Harkers Island (Table 13.63). Southern flounder were captured in 23 of the 56 tows sampled, resulting in a harvest of 394 fish, all juveniles (Table 13.64). Of the 23 tows, on average southern flounder made-up less than one percent of the total catch by weight (Table 13.65). The highest concentrations of southern flounder were found in Adams Creek and Core Sound. The average size of the southern flounder caught ranged between 101 - 167 mm (4 – 6½ inches) depending on the area fished.

In addition to the characterization studies, there have also been several bycatch reduction device (BRD) studies conducted in North Carolina waters (McKenna and Monaghan 1993, Coale et al. 1994, Murray et al. 1995, McKenna et al. 1996). However, BRD studies should not be used for characterization analysis of bycatch in the fishery (NCDMF 1999). BRD studies are often relegated to times of low shrimp catch rates, and therefore, the bycatch data are not representative of actual rates indicative to the fishery during the typical season when shrimp catches are higher. For example, the fish to shrimp ratio for the 1994 BRD study (McKenna et al. 1996) was 5.5 to 1, while in the 1995 characterization study (Diamond-Tissue 1999 unpublished) the ratio was

Table 13.62. The number and weight of southern flounder observed in sampled shrimp trawl catches from different areas of the State between July and October 1995 (Diamond-Tissue 1999).

	Pamlico Sound (16 tows)	Core Sound (4 tows)	Carolina Beach (8 tows)	Cape Fear River (24 tows)
Number of flounder	212	47	25	47
Weight of flounder (lbs)	17.11	2.07	1.90	11.13
Total tows catching flounder	4	2	1	3
Total nets fished	5	4	2	6

Table 13.63. The number of monthly tows characterized from each body of water during 1999 and 2000 (Johnson, in prep).

Location	1999				2000				Total
	Jun	Jul	Aug	Sep	Mar	Apr	Jun	Jul	
Core Sound	10	10	2	-----	1	4	4	-----	31
Pamlico Sound	2	-----	-----	-----	-----	-----	-----	-----	2
Marshallberg Harbor	-----	4	-----	-----	-----	-----	4	-----	8
Straits off Harkers Island	-----	4	-----	-----	1	-----	3	-----	8
Adams Creek	-----	-----	-----	1	-----	-----	-----	4	5
Lower Neuse River	-----	-----	-----	1	-----	-----	-----	-----	1
Off Great Marsh	-----	-----	-----		-----	-----	1	-----	1

Table 13.64. The number of tows observed landing southern and summer flounder during 1999 and 2000 (Johnson, in prep).

Type of Tows	Year		Total
	1999	2000	
Total tows observed	34	22	56
Southern flounder			
Tows	11	12	23
Percent	32%	55%	41%
Summer flounder			
Tows	25	16	41
Percent	71%	73%	71%

Table 13.65. The number, weight, and size of southern flounder landed in shrimp trawl tows from each area during 1999 and 2000. Also included in the table are the total weight and number of southern flounder, the percent of the total tow weight southern flounder comprised, and the total number of tow made that caught southern flounder (Johnson, in prep).

	Adams Creek (4 tows)	Core Sound (31 tows)	Lower Neuse River (1 tow)	Marshallberg Harbor (8 tows)	Off Great Marsh (1 tow)	Pamlico Sound (2 tows)	Straits off Harkers Island (8 tows)
Ave. number per tow	28	20	0	3	5	0	5
Ave. weight per tow (lbs)	5.09	0.39	-----	0.30	0.50	-----	1.37
Ave. size (mm)	167.6	101.2	-----	123.5	143.0	-----	134.3
Ave. size (in)	6.6	4.0	-----	4.9	5.6	-----	5.3
Total number of southern flounder	112	257	0	5	5	0	15
Total weight of southern flounder (lbs)	10.19	2.70	-----	0.30	0.50	-----	1.37
Percent of tow, by weight	0.93%	0.07%	0.00%	0.00%	0.48%	0.00%	0.20%
Total tows catching southern flounder	4	13	0	2	1	0	3

approximately 1.6 to 1. In addition, the data from BRD studies are typically not analyzed to the same degree as in characterization studies. When evaluating the effectiveness of BRD's, only a select number of species and species groups are separated from the catch, as opposed to characterization studies where all species are identified and analyzed.

While not adequate for characterizing bycatch, data from the BRD studies can be used to determine what size range of southern flounder are susceptible to shrimp trawls. Table 13.66 provides the size range and mean size of southern and summer flounder taken during BRD testing in 1994 (McKenna et al. 1996). The control net in each study represents a shrimp trawl with no BRD, while the net with the BRD reflects what is currently required in all shrimp trawls in North Carolina. As indicated by the data, southern flounder between the sizes of 88 to 420 mm are susceptible to shrimp trawls. It is also apparent that the current BRD requirements for shrimp trawls have little impact on the amount of flounder harvested by the gear.

Table 13.66. 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

Current Authority

<u>North Carolina Fisheries Rules for Coastal Waters (15A NCAC)</u>

3J .0104 TRAWL NETS
3J .0202 ATLANTIC OCEAN
3L .0103 PROHIBITED NETS AND MESH SIZES

Discussion

There is little data available to adequately assess the impact shrimp trawling has on southern flounder. It is apparent from both the Johnson (in prep) characterization study and the BRD studies (McKenna and Monaghan 1993, McKenna et al. 1996) that juvenile flounder are susceptible to the gear (Tables 13.65 and 13.66). It is also obvious, that while the requirement of BRD's in shrimp trawls may reduce the bycatch of some species, it has little effect on inhibiting the capture and retention of southern flounder in the nets.

However, based on the two characterization studies, few southern flounder are taken in shrimp trawls. In the Diamond-Tissue (1999) study, out of 52 tows sampled, only 331 southern flounder were estimated to have been captured. In the Johnson (in prep) study, an estimated total of 394 southern flounder were taken in 56 tows. In both studies, southern flounder typically accounted for less than one percent of the total catch weight.

While the available data may not provide enough insight on the effect shrimp trawling is having on the southern flounder population, it does point out areas that need to be focused on to better assess the situation. Such areas of research include additional long-term characterization studies throughout the State to obtain a better understanding of the current levels of bycatch. Additionally, fish excluder devices need to be developed that have a greater success at releasing flounder than the BRD's currently in use.

Research Needs

1) Shrimp trawl bycatch characterization studies involving at-sea observers covering a broad regionalized sampling base over an extended period of time (at least three years) to minimize yearly variances.

2) Investigations into fish excluder devices with a higher success rate for reducing the harvest and retention of flounder in shrimp trawls.

Management Options / Impacts

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

1) No action
   + No rule changes or Legislative actions
   + No additional restrictions on fishing practices
   - Continued uncertainty of the impact shrimp trawls are having on the southern flounder population
   - Continued harvest of juvenile southern flounder

2) Limit/prohibit the use of shrimp trawls by time and area
   + Prevents sublegal flounder from being taken by the fishery during the time of year and in areas that they are the most susceptible
   - Closes the shrimp trawl fishery during certain times and in certain areas
   - Forces fishermen to search for other avenues of income during the closed period

3) Endorsement of additional research (see research needs)
   + Increases funding priority of research pertaining to shrimp trawl bycatch
   + Increases understanding of the fishery and its components
   + May provide a means for reducing sublegal flounder harvest in the fishery
   - Data will not be available for several years
   - Funding will have to be obtained to conduct the research

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13.1.10 Southern Flounder Bycatch in the Crab Trawl Fishery

Issue

The reduction of sublegal southern flounder bycatch in the crab trawl fishery.

Background

Crab Trawl Fishery

The crab trawl fishery in North Carolina consists of few trawlers that harvest crabs exclusively. Most of the participants move from fishery to fishery, particularly shrimp and flounder trawling, depending on which will produce the highest economic yield at a given time. Since 1994, annual participation in the crab trawl fishery has ranged from 179 to 418 vessels, and averaged about 290 vessels (NCDMF Trip Ticket Program). Landings in the fishery over the last three decades have been relatively constant, ranging from 1 to 4 million pounds per year, with the exception of a large peak between 1978 and 1984 when landings rose to as high as seven million pounds. Since 1994 total annual landings in this fishery have averaged two million pounds, ranging from 1 to 3.4 million pounds (NCDMF Trip Ticket data 1994-2002). Blue crabs (hard, soft and peeler) account for 95% of the total landings followed by finfish (4%), mollusks (0.45%; conchs/whelks, squid, and clams), and other invertebrates (0.68%; horseshoe crabs, stone crabs, and shrimp).

Overall hard crab landings from crab trawls account for four percent of the total Statewide landings for this species (1994-2002 Trip Ticket Program). Since 1994 hard crab landings from crab trawls have averaged 1.8 million pounds annually and account for 94% of the total landings for this gear (Table 13.67). Hard crab landings are reported from every month with the highest percentage occurring in November (15%) and March [13% (Table 13.69)]. November and December have the highest catch-per-unit-effort (CPUE), or catch per trip, for hard crabs, 1,668 and 1,487 pounds respectively, while most trips occur in May (Table 13.68). Crab trawl landings have been reported from 22 waterbodies in the State (NCDMF Trip Ticket data 1994-2002). Pamlico Sound accounts for 47% of all hard crabs landed by crab trawls and 24% of all trips landing hard crabs (Table 13.68). Other areas with significant hard crab landings from crab trawl are Pamlico (17%), Neuse (9%), Pungo (9%), and Bay rivers (6%). Pamlico Sound has the highest CPUE (1,212 pounds per trip) for hard crabs followed by Bay River (653 pounds), Croatan Sound (610 pounds), and the Pamlico River (458 pounds per trip).

Prepared by the North Carolina Division of Marine Fisheries on April 5, 2001; updated on March 16, 2004.

Table 13.67. Yearly crab trawl landings (pounds) for North Carolina during 1994–2002.

Species	Year									Total	Average	Percent of Total
	1994	1995	1996	1997	1998	1999	2000	2001	2002			
Hard crabs	1,865,154	1,045,482	3,073,244	3,267,234	3,063,173	1,794,072	917,568	983,370	1,011,788	17,021,084	1,891,232	93.78
Flounders	104,251	58,468	84,704	78,411	92,395	69,917	61,592	52,208	30,408	632,351	70,261	3.48
Peeler crabs	17,977	15,512	11,775	17,523	14,941	10,547	18,140	11,794	4,885	123,095	13,677	0.68
Horseshoe crab	N/R	N/R	583	4,500	17,440	8,832	9,297	18,780	34,579	94,011	10,446	0.52
Catfish	7,687	3,227	14,689	14,061	14,226	16,615	2,902	1,136	3,109	77,651	8,628	0.43
Conchs/Whelk	3,210	34	28,362	15,291	8,858	4,572	1,828	9,157	34	71,346	7,927	0.39
Soft crabs	6,683	4,062	3,341	4,988	5,718	7,724	1,429	1,807	150	35,902	3,989	0.2
Shrimp	295	12,425	371	2,988	732	1,144	197	216	514	18,883	2,098	0.1
Croaker	768	298	1,073	1,659	512	2,524	1,740	6,586	350	15,510	1,723	0.09
Squid	8,156	138	15	288	193	N/R	130	1,149	N/R	10,069	1,119	0.06
Southern kingfish	933	1,165	781	1,521	1,526	795	316	1,424	693	9,152	1,017	0.05
Spot	551	117	2,403	319	1,487	432	391	1,884	629	8,212	912	0.05
Gray trout	573	325	694	2,916	873	517	181	280	81	6,438	715	0.04
Mixed fish	361	402	172	3,286	96	135	690	319	N/R	5,461	607	0.03
Speckled trout	345	1,511	370	140	294	634	2,019	43	15	5,370	597	0.03
Black drum	96	380	224	1,821	81	256	11	213	1,256	4,338	482	0.02
Bluefish	N/R	11	123	474	91	N/R	3,102	14	5	3,820	424	0.02
White perch	81	14	76	40	280	67	964	N/R	2	1,524	169	0.01
Bait	N/R	N/R	424	407	47	N/R	N/R	126	4	1,008	112	0.01
Puffer	N/R	3	N/R	526	88	N/R	N/R	180	10	807	90	0
Sheepshead	279	62	53	6	103	130	9	146	13	800	89	0
Mullet	31	312	89	70	89	16	104	22	27	760	84	0
Yellow perch	9	N/R	1	206	422	N/R	74	N/R	N/R	712	79	0
Smooth dogfish	N/R	78	58	412	N/R	N/R	N/R	N/R	N/R	548	61	0
Red drum	289	2	18	3	23	33	20	2	7	396	44	0
Striped Bass	N/R	42	17	206	118	N/R	8	N/R	N/R	391	43	0
Butterfish	13	1	51	119	7	22	1	27	62	303	34	0

Table 13.67. Continued.

Species	Year									Total	Average	Percent of Total
	1994	1995	1996	1997	1998	1999	2000	2001	2002			
Monkfish	3	138	N/R	25	53	N/R	2	N/R	N/R	221	25	0
Stone crabs	155	N/R	N/R	65	N/R	N/R	N/R	N/R	N/R	220	24	0
Menhaden	N/R	N/R	N/R	N/R	40	N/R	N/R	86	N/R	126	14	0
Hakes	N/R	N/R	N/R	94	N/R	N/R	N/R	N/R	N/R	94	10	0
Harvestfish	4	15	4	N/R	40	1	16	3	N/R	83	9	0
Spiny dogfish	N/R	64	N/R	N/R	N/R	N/R	N/R	N/R	N/R	64	7	0
Hickory Shad	N/R	N/R	N/R	5	20	32	N/R	2	N/R	59	7	0
Shad	5	18	2	N/R	N/R	N/R	N/R	N/R	N/R	25	3	0
Hard clam	N/R	7	N/R	12	N/R	N/R	N/R	N/R	N/R	19	2	0
Black sea bass	N/R	10	N/R	9	N/R	N/R	N/R	N/R	N/R	19	2	0
Tautog	N/R	N/R	N/R	11	N/R	N/R	N/R	N/R	N/R	11	1	0
Pigfish	N/R	6	N/R	4	N/R	N/R	N/R	N/R	N/R	10	1	0
Carp	9	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	9	1	0
Spanish mackerel	N/R	N/R	8	N/R	1	N/R	N/R	N/R	N/R	9	1	0
Eels	N/R	N/R	N/R	N/R	N/R	N/R	N/R	5	N/R	5	1	0
Spadefish	N/R	3	N/R	N/R	N/R	N/R	N/R	N/R	N/R	3	0	0
Herring	N/R	N/R	N/R	N/R	3	N/R	N/R	N/R	N/R	3	0	0
Oyster Toad	N/R	N/R	N/R	2	N/R	N/R	N/R	N/R	N/R	2	0	0
Skates	N/R	N/R	2	N/R	N/R	N/R	N/R	N/R	N/R	2	0	0
Pompano	N/R	N/R	N/R	1	N/R	N/R	N/R	N/R	N/R	1	0	0
Total	2,017,916	1,144,330	3,223,725	3,419,640	3,223,968	1,919,016	1,022,730	1,090,977	1,088,621	18,150,924	2,016,769	100

Table 13.68. Total monthly hard blue crab catches, trips, and CPUE for crab trawls in North Carolina during 1994-2002.

Month	Pounds			Trips			CPUE (lbs./trips)
	Total	Average	Percent	Total	Average	Percent	
January	363,108	40,345	2.13	498	55	1.79	729
February	1,100,072	122,230	6.46	1,444	160	5.19	762
March	2,267,730	251,970	13.32	3,731	415	13.41	608
April	1,639,846	182,205	9.63	4,038	449	14.52	406
May	1,221,931	135,770	7.18	4,508	501	16.21	271
June	1,812,467	201,385	10.65	3,878	431	13.94	467
July	1,452,571	161,397	8.53	2,079	231	7.47	699
August	951,495	105,722	5.59	1,700	189	6.11	560
September	1,256,970	139,663	7.38	1,907	212	6.86	659
October	1,017,654	113,073	5.98	1,566	174	5.63	650
November	2,523,401	280,378	14.83	1,513	168	5.44	1,668
December	1,413,840	157,093	8.31	951	106	3.42	1,487
Total	17,021,084	1,891,232	100	27,813	3,090	100	612

Table 13.69. Hard crab landings and CPUE for crab trawls for various waters in North Carolina during 1994-2002.

Waterbody*	Pounds			Trips			CPUE (lbs./trip)
	Total	Average	Percent	Total	Average	Percent	
Pamlico Sound	7,943,108	882,568	46.67	6,554	728	23.56	1,212
Pamlico River	2,817,316	313,035	16.55	6,158	684	22.14	458
Neuse River	1,509,773	167,753	8.87	3,764	418	13.53	401
Pungo River	1,485,376	165,042	8.73	4,837	537	17.39	307
Croatan Sound	1,076,058	119,562	6.32	1,763	196	6.34	610
Bay River	1,073,978	119,331	6.31	1,645	183	5.91	653
Core Sound	784,525	87,169	4.61	1,973	219	7.09	398
New River	160,455	17,828	0.94	682	76	2.45	235
Roanoke Sound	126,952	14,106	0.75	299	33	1.08	425
Newport River	10,973	1,219	0.06	47	5	0.17	233
North River	5,748	639	0.03	19	2	0.07	303
Ocean > than 3 miles	2,490	277	0.01	6	1	0.02	415
Inland Waterway	1,952	217	0.01	13	1	0.05	150
Ocean < than 3 miles	1,363	151	0.01	13	1	0.05	105
Bogue Sound	355	39	0	6	1	0.02	59
Grand Total (all 22 waterbodies)	17,000,422	1,888,936	100	27,779	3,085	100	612

* Minimum of five trips to be included

Finfish landings by crab trawls average 86,255 pounds per year (NCDMF Trip Ticket data 1994-2002). The main species landed is southern flounder accounting for 82% of the total finfish landed by crab trawls (Table 13.70). Southern flounder landings from crab trawls average 70,261 pounds per year and account for 2% of the total State landings for this species. On average flounder are landed from 47% (average 1,441 trips out of 3,090 crab trawl trips per year) of the crab trawl trips each year. The months of February, March, and April account for 66% of the pounds and 48% of the trips landing flounder from crab trawls (Table 13.71). For all crab trawl trips the average CPUE for flounder is 22.74 pounds per trip, for trips with flounder landings the CPUE is 48.74 pounds per trip. From late fall (November) through early spring (March) the CPUE's for flounder are 60 pounds or greater with March having the highest monthly CPUE [84 pounds/trip (Table 13.70)]. Flounder landings from crab trawls have been reported from 15 waterbodies. Eighty-nine percent of the flounder landed by crab trawls and 77% of the trips come from three areas, Pamlico Sound, Pamlico and Pungo rivers (Table 13.71). Pamlico Sound has the highest CPUE with 78 pounds of flounder landed per trip (Table13.72). This is followed by Pamlico (48 pounds/trip), Neuse (38 pounds/trip), Bay (38 pounds/trip) and Pungo (28 pounds/trip) rivers (Table 13.72).

Crab Trawl Studies

There have been four studies conducted in recent years to characterize the bycatch in the crab trawl fishery in North Carolina's estuarine waters, both through the North Carolina Division of Marine Fisheries (NCDMF) and by commercial fishermen through Fishery Resource Grants (FRG). All four studies have focused on the crab trawl fishery in the Pamlico Sound and its tributaries. The first study served to identify the extent to which bycatch was occurring in the fishery, while the remaining three studies have tested the effect different mesh sizes in the tailbag may have on reducing the levels of bycatch.

An initial analysis of the crab trawl fishery to characterize bycatch was conducted by the NCDMF between November 1990 and November 1991 (McKenna and Camp 1992). During this time, 15 trips were made aboard commercial crab trawlers in the Pamlico-Pungo river complex. A total of 50 tows, all but three of which were conducted at night, were performed during these trips using either a 3 or 4-inch tailbag. Tow times ranged from one to four hours with a mean of 2.87 hours per tow. On average, southern flounder comprised 47% of the total catch weight and 95% of the total fish weight, while blue crabs made up 33% of the total catch weight and 96% of the total invertebrate weight. Over 50% of the flounder, by weight, from these tows were sublegal (less than 13 inches). There was no significant decrease in the weight of legal flounder caught using the 4-inch tailbag as opposed to the 3-inch tailbag; however, there was a 41% reduction of sublegal flounder when fishing the larger mesh. For blue crabs, 36% by weight or 54% by number of the total catch was sublegal (less than 5 inches carapace width) using both tailbag sizes. Fifty-seven percent, by number, of the crabs in the 3-inch tailbag were under-sized, while 38%, by number, were sublegal from the 4-inch tailbag. The average catch per tow of both legal and sublegal crabs was significantly greater in the 3-inch tailbag compared to catches in the 4-inch tailbag.

Table 13.70. Finfish landed by crab trawls in North Carolina during 1994-2002.

Species	Year									Total	Average	Percent of Total
	1994	1995	1996	1997	1998	1999	2000	2001	2002			
Flounders	104,251	58,468	84,704	78,411	92,395	69,917	61,592	52,208	30,408	632,351	70,261	81.46
Catfish	7,687	3,227	14,689	14,061	14,226	16,615	2,902	1,136	3,109	77,651	8,628	10
Croaker	768	298	1,073	1,659	512	2,524	1,740	6,586	350	15,510	1,723	2
Southern kingfish	933	1,165	781	1,521	1,526	795	316	1,424	693	9,152	1,017	1.18
Spot	551	117	2,403	319	1,487	432	391	1,884	629	8,212	912	1.06
Gray trout	573	325	694	2,916	873	517	181	280	81	6,438	715	0.83
Mixed fish	361	402	172	3,286	96	135	690	319	N/R	5,461	607	0.7
Speckled trout	345	1,511	370	140	294	634	2,019	43	15	5,370	597	0.69
Black drum	96	380	224	1,821	81	256	11	213	1,256	4,338	482	0.56
Bluefish	N/R	11	123	474	91	N/R	3,102	14	5	3,820	424	0.49
White perch	81	14	76	40	280	67	964	N/R	2	1,524	169	0.2
Bait	N/R	N/R	424	407	47	N/R	N/R	126	4	1,008	112	0.13
Puffer	N/R	3	N/R	526	88	N/R	N/R	180	10	807	90	0.1
Sheepshead	279	62	53	6	103	130	9	146	13	800	89	0.1
Mullet	31	312	89	70	89	16	104	22	27	760	84	0.1
Yellow Perch	9	N/R	1	206	422	N/R	74	N/R	N/R	712	79	0.09
Smooth dogfish	N/R	78	58	412	N/R	N/R	N/R	N/R	N/R	548	61	0.07
Red drum	289	2	18	3	23	33	20	2	7	396	44	0.05
Striped Bass	N/R	42	17	206	118	N/R	8	N/R	N/R	391	43	0.05
Butterfish	13	1	51	119	7	22	1	27	62	303	34	0.04
Monkfish	3	138	N/R	25	53	N/R	2	N/R	N/R	221	25	0.03
Menhaden	N/R	N/R	N/R	N/R	40	N/R	N/R	86	N/R	126	14	0.02
Hakes	N/R	N/R	N/R	94	N/R	N/R	N/R	N/R	N/R	94	10	0.01
Harvestfish	4	15	4	N/R	40	1	16	3	N/R	83	9	0.01

Table 13.70. Continued.

Species	Year 1994	1995	1996	1997	1998	1999	2000	2001	2002	Total	Average	Percent of Total
Spiny dogfish	N/R	64	N/R	N/R	N/R	N/R	N/R	N/R	N/R	64	7	0.01
Hickory Shad	N/R	N/R	N/R	5	20	32	N/R	2	N/R	59	7	0.01
Shad	5	18	2	N/R	N/R	N/R	N/R	N/R	N/R	25	3	0
Black sea bass	N/R	10	N/R	9	N/R	N/R	N/R	N/R	N/R	19	2	0
Tautog	N/R	N/R	N/R	11	N/R	N/R	N/R	N/R	N/R	11	1	0
Pigfish	N/R	6	N/R	4	N/R	N/R	N/R	N/R	N/R	10	1	0
Carp	9	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	9	1	0
Spanish mackerel	N/R	N/R	8	N/R	1	N/R	N/R	N/R	N/R	9	1	0
Eels	N/R	N/R	N/R	N/R	N/R	N/R	N/R	5	N/R	5	1	0
Spadefish	N/R	3	N/R	N/R	N/R	N/R	N/R	N/R	N/R	3	0	0
Herring	N/R	N/R	N/R	N/R	3	N/R	N/R	N/R	N/R	3	0	0
Oyster Toad	N/R	N/R	N/R	2	N/R	N/R	N/R	N/R	N/R	2	0	0
Skates	N/R	N/R	2	N/R	N/R	N/R	N/R	N/R	N/R	2	0	0
Pompano	N/R	N/R	N/R	1	N/R	N/R	N/R	N/R	N/R	1	0	0
Total	2,017,916	1,144,330	3,223,725	3,419,640	3,223,968	1,919,016	1,022,730	1,090,977	1,088,621	776,295	86,255	100

Table 13.71. Average monthly flounder catches and CPUE from crab trawls in North Carolina during 1994-2002.

Month	Pounds			Trips			CPUE (lbs./trip)
	Total	Average	Percent	Total	Average	Percent	
January	26,185	2,909	4.14	327	36	2.52	80.07
February	75,762	8,418	11.98	981	109	7.56	77.23
March	223,278	24,809	35.31	2,673	297	20.60	83.53
April	117,192	13,021	18.53	2,531	281	19.51	46.30
May	22,044	2,449	3.49	1,548	172	11.93	14.24
June	10,333	1,148	1.63	936	104	7.21	11.04
July	3,205	356	0.51	351	39	2.71	9.13
August	2,156	240	0.34	300	33	2.31	7.19
September	13,399	1,489	2.12	722	80	5.56	18.56
October	23,122	2,569	3.66	849	94	6.54	27.23
November	64,939	7,215	10.27	1,077	120	8.30	60.30
December	50,738	5,638	8.02	680	76	5.24	74.61
Total	632,351	70,261	100.00	12,975	1,442	100.00	48.74

Table 13.72. Flounder landings from crab trawls and CPUE for various waters in North Carolina: 1994 - 2002.

Waterbody*	Pounds			Trips		
	Total	Average	Percent	Total	Average	Percent
Pamlico Sound	353,111	39,235	55.84	4,505	501	34.72
Pamlico River	137,126	15,236	21.69	2,862	318	22.06
Pungo River	73,136	8,126	11.57	2,662	296	20.52
Neuse River	28,069	3,119	4.44	749	83	5.77
Croatan Sound	17,295	1,922	2.73	1,030	114	7.94
Bay River	9,738	1,082	1.54	261	29	2.01
Core Sound	6,844	760	1.08	531	59	4.09
New River	3,330	370	0.53	218	24	1.68
Roanoke Sound	2,046	227	0.32	122	14	0.94
Total (all 15 waters)	632,351	70,261	100.00	12,975	1,442	100.00

* Minimum of five trips to be included

Additional characterization work was conducted between June 1996 and April 1997. Nine trips were made aboard a commercial crab trawler working the Pamlico-Pungo river complex. Eighteen tows using a 4-inch tailbag were examined. Tow times ranged from one to three hours with a mean of 1.48 hours per tow. Blue crabs made up 86% of the total catch, while finfish made up the remaining 14%. Southern flounder contributed 41% to the finfish catch and 4% of the total catch. Forty-five percent of the blue crabs and 37% of the southern flounder captured were legal by weight.

Since the completion of the characterization study, which established that bycatch was an issue in the crab trawl fishery that needed to be addressed, three additional studies have been completed to determine the feasibility of reducing bycatch through the alteration of the mesh size within the tailbag. The first of the three studies (McKenna and Clark 1993) testing the effects of different tailbag mesh sizes on reducing bycatch was conducted immediately following the completion of the characterization study. This one-year study was performed by the NCDMF between November 1991 and November 1992. The testing was conducted in the Pamlico, Pungo, and Neuse rivers during the fall and winter and in Adam's Creek during the summer using 3-inch, 4-inch, and 4½-inch tailbags. Seventy-one tows were conducted aboard a research vessel towing two nets at a time, the control net with the 3-inch tailbag and the test net with either the 4-inch tailbag (31 tows) or 4½-inch tailbag (40 tows). Tow times were one hour at night during the winter and spring and 30 minutes during the day in the summer. All tows were pulled with the prevailing wind at a speed of 2.5 knots.

The second of the three studies (Lupton 1996) to determine the selectivity of different tailbag mesh sizes for crab trawls was conducted by the Pamlico County Schools between June 1995 and May 1996 through a FRG. One objective of this study was to see if the results obtained in the comparison by McKenna and Clark (1993) would be the same with an increased amount of test tows. As with the NCDMF study, a 4-inch tailbag and a 4½-inch tailbag were tested against a 3-inch tailbag. Two hundred twenty tows were conducted during the day in the Bay River aboard a research vessel towing two nets at a time, the control net with the 3-inch tailbag and the test net with either the 4-inch tailbag (110 tows) or 4½-inch (110 tows) tailbag. Tow times were one hour during the winter and spring and 30 minutes in the summer. All tows were pulled at a speed of 2.5 knots.

The final study (Hannah and Hannah 2000) on mesh size selectivity was conducted by commercial fishermen through a FRG. The intent of the study was to evaluate whether an increase in the tailbag mesh size would yield the same reduction rates in the eastern Pamlico Sound as was found by McKenna and Clark (1993) and Lupton (1996) for the western Pamlico Sound. The study was conducted during 1998 and 1999 in both the eastern and the western potions of the Pamlico Sound; however, the eastern portion was only sampled during the winter and spring. The eastern areas of the Pamlico Sound included Stumpy Point Bay, Croatan Sound, Bluff Shoal, and the Outer Banks. The western Pamlico Sound areas were comprised of the Pamlico and Pungo rivers, Goose Creek, and Rose Bay. During each tow, two nets were fished, the control net with a 3-inch tailbag and a test net with either a 4-inch (39 tows) or a 4½-inch (41 tows) tailbag.

All tows were an hour in duration, carried out between sunrise and sunset, and pulled at a vessel speed of 2.5 knots.

Tables 13.73 and 13.74 provide a comparison of the results of each of the studies testing a 4-inch and a 4½-inch tailbag against the commercial standard of 3 inches. The variability of bycatch and reduction estimates seen in the various crab trawl studies, reflects seasonal, annual, and area variability in the distribution of target and non-target species and to a lesser extent regulatory changes. In lieu of more stringent regulations including quotas, limited entry, or spatial and temporal closures, the control of net selectivity is the preferred method for reducing incidental harvest. Minimum mesh size regulations for trawls are the principle approach taken to regulate fishing mortality on fish populations (Smolowitz 1983). The intent of mesh size regulation is to allow under-sized fish and invertebrates to escape from the tailbag and survive to contribute to the future spawning stock biomass. Studies on the survival of fish escaping from the tailbags of trawls support the use of minimum mesh sizes as a means of reducing fishing mortality on juvenile fish (Main and Sangster 1988, Simpson 1990). In contrast, fish and invertebrates discarded from the landed catch following the completion of a tow, have considerably lower survival rates (Jean 1963, Neilson et al 1989, Wassenberg and Hill 1989).

Current Authority

<u>North Carolina Fisheries Rules for Coastal Waters (15A NCAC)</u>

3J .0104 TRAWL NETS
3J .0202 ATLANTIC OCEAN
3L .0103 PROHIBITED NETS AND MESH SIZES
3L .0202 CRAB TRAWLING
3N .0105 PROHIBITED GEAR, SECONDARY NURSERY AREAS
3R .0106 TRAWL NETS PROHIBITED

Discussion

Based on the study by McKenna and Camp (1992), which characterized the level of crab trawl bycatch, it is evident that some measures need to be taken to reduce the levels of bycatch, particularly of sublegal flounder and crabs, that are occurring within the fishery. There are several methods by which bycatch can be reduced with varying degrees of success. The management options for achieving the goal of bycatch reduction are detailed below:

Increase in the Tailbag Mesh Size

In a multispecies fishery, such as the crab trawl fishery, determination of the best practical tailbag size may require accepting a design with less than optimal selection performance for some species. Although the crab trawl fishery primarily targets blue crabs, there is also the potential for unlimited harvest of sublegal southern flounder. Numerous other marketable species of finfish, including spot, croaker, and catfish, are also taken incidentally. The current industry standard for the mesh size in the tailbag of a crab trawl is 3 inches. Increasing the mesh size to 4 or 4½ inches has been shown to have some success in reducing the amount of bycatch caught by the gear, particularly in the western portion of the Pamlico Sound (McKenna and Clark 1993, Lupton 1996, Hannah and Hannah 2000). If the only concern in the fishery was to reduce the amount of sublegal flounder taken as bycatch, this would typically be accomplished by setting the minimum mesh size requirement to match the mesh size at which a desired percentage of the catch would be sublegal. In the case of the trawling, this percentage is usually set at 50%, or L_{50}. Based on a net mesh selectivity study conducted in North Carolina, to achieve an L_{50} of around 13 inches for flounder (the legal size limit in inshore waters), the mesh size of the tailbag would need to be between 5 and 5¼ inches (Gillikin et al 1981). However, in the case of crab trawling, increasing the mesh size to that degree would be economically detrimental to the industry by allowing too much of the main product, crabs, to escape from the tailbag. Hence, a more moderate approach of a 4-inch or 4½-inch tailbag should be considered. Table 13.75 provides an overview of the percentage of flounder that were sublegal in each of the mesh size selectivity studies.

While the 4½-inch stretched mesh tailbag exhibits the greatest reduction in the take of undersized flounder (~50-82%), it also demonstrates a substantial loss of legal crabs (~17-26%, Table 13.74). These individuals, however, would remain available to the fishery in subsequent tows. In addition, the reduction of the fishing mortality on sublegal crabs (~44-62%) should increase the overall harvest of legal blue crabs, and therefore the amount of biomass landed. The initial burden on fishermen could be alleviated somewhat by opting to use a 4-inch tailbag rather than the 4½-inch. This size mesh was found to have little impact on the catch of legal crabs (a reduction of ~0-7%); however, a 4-inch tailbag would also have less of an impact on the reduction of sublegal flounder (~29-40%) and crabs (~13-31%), as well (Table 13.73). The estimated reduction of sublegal flounder with a 4-inch tailbag would be between 20,376 and 47,854 pounds annually. A 4½-inch tailbag would reduce sublegal southern flounder from 35,131 to 98,099 pounds annually.

Seasonal Limits

Another option for managing the take of sublegal southern flounder in the crab trawl fishery would be to implement seasonal restrictions. According to Lupton (1996), fewer sublegal flounder are taken during the winter and spring than in the summer. It is also important to note that for southern flounder, the season of catch has a large impact on its composition. Lupton (1996) found that catches occurring in the winter and spring had

Table 13.73. Comparison of the reduction rates for southern flounder and blue crabs using a 4-inch tailbag versus a 3-inch tailbag in the Pamlico Sound and its tributaries.

	McKenna and Clark (1993)		Lupton (1996)		Hannah and Hannah (2000)	
	Weight	Numbers	Weight	Numbers	Weight	Numbers
Total flounder	-30.98%	-39.66%	-14.81%	-26.16%	-22.84%	-26.96%
Legal flounder	*	-41.18%	+40.61%	+34.37%	-19.96%	-11.83%
Sublegal flounder	*	-39.58%	-22.31%	-28.63%	-27.06%	-37.23%
Total blue crabs	-12.20%	-10.99%	-8.94%	-3.82%	-7.22%	-9.75%
Legal blue crabs	*	-7.27%	-3.57%	-5.97%	-4.14%	-0.21%
Sublegal blue crabs	*	-12.67%	-11.27%	-22.55%	-26.95%	-31.00%
Other finfish	-44.40%	*	-26.44	-36.14%	*	*

* Data not available for calculation of reduction rate.

Table 13.74. Comparison of the reduction rates for southern flounder and blue crabs from using a 4½-inch tailbag versus a 3-inch tailbag in the Pamlico Sound and its tributaries.

	McKenna and Clark (1993)		Lupton (1996)		Hannah and Hannah (2000)	
	Weight	Numbers	Weight	Numbers	Weight	Numbers
Total flounder	-54.53%	-72.49%	-73.11%	-80.14%	-36.31%	-46.43%
Legal flounder	*	+12.50%	-40.57%	-40.00%	-36.57%	-41.23%
Sublegal flounder	*	-75.87%	-80.00%	-82.35%	-35.93%	-49.48%
Total blue crabs	-35.81%	-42.08%	-34.47%	-34.39%	-38.83%	-36.70%
Legal blue crabs	*	-17.48%	-15.61%	-17.25%	-36.52%	-25.55%
Sublegal blue crabs	*	-52.68%	-46.35%	-44.21%	-54.11%	-61.84%
Other finfish	-80.00%	*	-86.30%	-85.40%	*	*

* Data not available for calculation of reduction rate.

Table 13.75. The percent composition of the total catch of blue crabs and flounder that were sublegal for each tailbag mesh size tested (Lupton 1996).

Tailbag size	Winter/Spring		Summer	
	Blue Crabs	Flounder	Blue Crabs	Flounder
3-inch	23.98%	64.78%	69.28%	98.62%
4-inch	18.70%	56.63%	63.42%	98.66%
4½-inch	23.14%	51.52%	58.65%	92.03%

substantially fewer sublegal flounder compared to legal flounder than catches taken during the summer (Table 13.75). This also corresponds with the landings that show that most of the legal southern flounder occur between November and April (Table 13.71). Throughout the summer, landings of legal flounder are minimal. During these warmer months, most of the flounder being caught are sublegal and end up being culled from the catch. Lupton (1996) pointed out that nearly all of the southern flounder caught during the summer months were dead when returned to the water. In contrast, little immediate mortality was observed in the cooler months. A study conducted by the NCDMF during January and February of 1991 found that the survival rate for southern flounder caught in crab trawls and held for 48 hours was greater than 95% (NCDMF unpublished data). Other critical factors which affect the survival of fish from trawl catches include tow duration, scale loss, total biomass of catch, handling and sorting time, and maximum depth fished (Jean 1963, Neilson et al 1989, Wassenburg and Hill 1989, Simpson 1990).

Minimum Distance from the Shoreline

The distance a crab trawl is towed from the shoreline has an impact on the composition of the catch. Table 13.76 provides a comparison of tows in the nearshore shallow waters versus tows over a deeper uniform bottom. During the characterization study of the crab trawl fishery on commercial trawlers (McKenna and Clark 1992), all tows were conducted on the shallow water slopes of the rivers where the fishery typically operates. While characterizing the catch, it was found that southern flounder comprised a larger percentage of the catch, by weight, than blue crabs. In contrast, in the three studies done examining tailbag mesh sizes (McKenna and Camp 1993, Lupton 1996, Hannah and Hannah 2000), flounder only made up 8-14% of the catch compared to blue crabs. During these studies, the tows had to be performed over a uniform bottom depth to insure both nets, the control net with the 3-inch tailbag and the test net with either the 4-inch or 4½-inch tailbag, were being fished equally. Therefore, none of the tows during these studies were conducted on the shallow water slopes where the commercial fishery typically focuses. By limiting the trawlers to deeper water, the amount of southern flounder taken in the fishery should be substantially reduced.

Table 13.76. The percent southern flounder comprised of crab trawl catches compared to blue crabs based on distance from shore the trawl was fished.

Tailbag Mesh Size	Nearshore Shallow Water	Deeper Water with Uniform Bottom		
	McKenna and Clark (1992)	McKenna and Camp (1993)	Lupton (1996)	Hannah and Hannah (2000)
3-inch tailbag	52.90%	13.06%	11.92%	10.97%
4-inch tailbag	73.29%	13.67%	11.91%	8.72%
4½-inch tailbag	*	8.03%	4.95%	12.01%

* Data not available because commercial trawlers sampled were not fishing 4½-inch mesh tailbags.

Area Closures

Closing the rivers (Pamlico, Pungo, Bay, and Neuse) to crab trawling would reduce the amount of legal and sublegal flounder caught by this gear. The reduction of the legal flounder catch would be approximately 39% (approximately 27,563 pounds per year) of the total crab trawl flounder landings, and 0.81% of the total southern flounder landings. Reduction in sublegal flounder bycatch would be between 27,563 and 46,932 pounds per year (estimates of sublegal to legal flounder in this gear are 50 to 64% by weight in the rivers). However the reduction in legal hard crab catch would be approximately 765,392 pounds per year ($529,244) or 40% of the total hard crab landings from this gear. An additional 2,489 ($4,596) pounds of peeler crabs and 2,502 ($9,198) pounds of soft crabs would be lost.

Management Options / Impacts

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

1) Status quo
   + No rule changes or Legislative actions
   + No additional restrictions on fishing practices
   - Continued harvest of large quantities of sublegal southern flounder

2) Increase the mesh size of the tailbag to 4 inches
   + Reduces the harvest of sublegal southern flounder by approximately 29-40%
   + Reduces the harvest of sublegal blue crabs by approximately 13-31%
   + Potential increase in the biomass and value of catch over the long-term
   - Reduces the harvest of legal blue crabs by up to 6%
   - Potential short-term decrease in harvest and value of catch for fishermen
   - Fishermen would need to purchase and rig new gear

3) Increase the mesh size of the tailbag to 4½ inches
   + Reduces the harvest of sublegal southern flounder by approximately 49-82%
   + Reduces the harvest of sublegal blue crabs by approximately 44-62%
   + Potential increase in the biomass and value of catch over the long-term
   - Reduces the harvest of legal blue crabs by 17-26%
   - Potential short-term decrease in harvest and value of catch for fishermen
   - Fishermen would need to purchase and rig new gear

4) Limit crab trawls to deeper waters
   + Greatly reduces the amount of southern flounder harvested in the fishery
   + Blue crabs make up a higher percentage of the overall catch leading to decreased culling time
   - Fewer blue crabs harvested per tow
   - Limits the areas fishermen can utilize

5) Prohibit use of crab trawls during the summer months
   + Prevents sublegal southern flounder from being taken by the fishery during the time of year when the highest number are captured and few would survive the culling process
   + Reduces the amount of sublegal blue crabs harvested
   - Closes the crab trawl fishery for an entire season
   - Forces fishermen to search for other avenues of income during closed season

6) Prohibit crab trawling in the Pamlico, Pungo, Bay, Neuse, and New rivers.
   + Reduce the harvest of sublegal flounder
   + Opens areas for other fisheries to operate
   + Reduces the amount of sublegal blue crabs harvested
   - Loss of blue crab harvest and income (~ $540,000 per year)
   - Effort shifted to other fisheries
   - Forces some fishermen to search for other avenues of income
   - Only effective with reciprocal measures in the shrimp trawl fishery

7) Prohibit the use of crab trawls
   + Eliminates the harvest of sublegal southern flounder and blue crabs, allowing them to reach maturity and contribute to both the reproductive potential and the biomass of the population
   + Opens areas for other fisheries to operate
   + Alleviates potentially detrimental effects of trawling on ecosystem

- Forces fishermen to search for other avenues of income
- Effort shifted to other fisheries
- Only effective with reciprocal measures in the shrimp trawl fishery

Research Needs

1) Long-term (3 years) characterization studies of bycatch in the crab trawl fishery.

2) Further evaluation of tailbag mesh sizes throughout the State.

3) Development and testing of other gears, methods, and/or techniques for reducing bycatch within the fishery.

4) In-depth assessment of the full-time and part-time participants in the crab trawl fishery, including the level of economic dependence most of the participants have on the fishery.

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13.1.11 Southern Flounder Bycatch in the Crab Pot Fishery

Issue

Flounder bycatch in crab pots.

Background

On average, 65,352 pounds of marketable finfish have been landed annually from crab pot (hard and peeler pots combined) catches since 1994 [North Carolina Division of Marine Fisheries (NCDMF) Trip Ticket Program, 1994-2002]. In 2002, 28 species of finfish were landed by crab pots. Composition of the landed catch was dominated by catfish (44%), followed by flounder (27%), with 26 species making up the remainder of the catch. Landings of flounder from crab pots have averaged 14,822 lbs. per year (NCDMF Trip Ticket Program, 1994-2002). Flounder landings from crab pots are most common in the following waterbodies: Albemarle Sound (25%; average 3,765 pounds per year), New River (13%; average 1,978 pounds per year), Pamlico Sound (11%; average 1,645 pounds per year), Pamlico River (11%; average 1,626 pounds per year), and Currituck Sound (5%; average 775 pounds per year) (NCDMF Trip Ticket Program, 1994-2002). The remaining 34% of the landings were reported from 22 waterbodies.

Two issues relating to finfish bycatch in crab pots are of concern to fishermen and managers alike. These are the composition, quantity, and fate of the unmarketable bycatch in actively fished pots and of marketable and unmarketable bycatch in "ghost pots". The North Carolina Blue Crab Fishery Management Plan (BCFMP) identified these two issues as high priority research needs.

In 1999, a Fishery Resource Grant (FRG) was funded to examine bycatch in hard and peeler pots in the Neuse River (Doxey 2000). Four crab pot fishermen kept records of bycatch in their hard and peeler pots from March through October 1999. Hard crab pot data was collected from 283 trips during which 149,649 hard crab pots were fished. Peeler pot data was collected from 11 trips taken in May during which 1,950 peeler pots were fished. A total of 1,062 bycatch organisms (19 species of fish and 9 turtles) were caught in hard crab pots. Three hundred and fifty nine flounder were caught (34% of the total bycatch). Catch-per-unit-effort (CPUE) for flounder was 1.26 fish per trip and 0.002 fish per pot fished. The monthly contribution of flounder catches to the total flounder bycatch is shown in Figure 13.35. Data on the fate of 216 of the 359 flounder was recorded. Seventy-six percent (n = 163) of the flounder were undamaged and released alive, 10% (n = 22) showed some sign of injury and were released, and 14% (n = 31) were dead and/or partially eaten. The average size of captured flounder was 9.96 inches (n = 187) and ranged from 4 to 17 inches. Seventy-nine percent of the captured flounder were undersized. Nine finfish species were captured in peeler pots. Of the 300

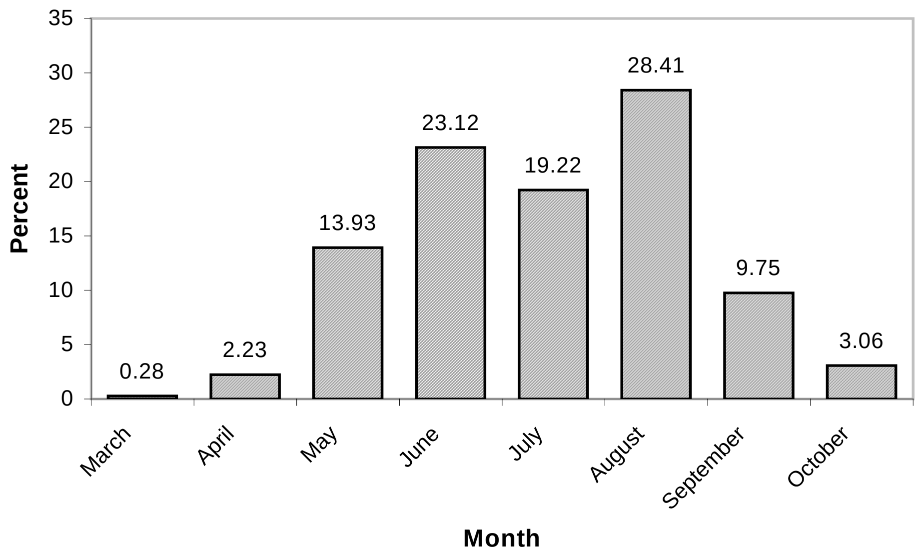

Figure 13.35. Monthly contribution of flounder (by number) to total flounder bycatch in hard crab pots (Doxey 2000).

fish (9 species) captured in peeler pots, 19 (6%) were flounder. The CPUE of flounder in peeler pots was 1.5 per trip and 0.01 per pot. All flounder were sublegal (average size 6.3 inches; range 5-10 inches) and released alive.

Ghost pots are pots that, either through abandonment or loss (float lines cut by props, storm events, etc.), continue to catch crabs and finfish. Concern stems from the significant increase in the numbers of crab pots, the long life of vinyl coated pots, and the pots ability to continue to trap crabs and finfish. McKenna and Camp (1992) reported annual estimates of 14% hard crab pot loss for Pamlico and Pungo rivers. In a 1999 survey of crab license holders in North Carolina, Statewide pot loss for hard crab pots was 17% while peeler pot loss was reported at 11%. Total pot use for the same time frame was 853,766 hard crab pots and 163,151 peeler pots (NCDMF unpublished data, 1998). While data exist on the fate and quantity of blue crabs in ghost pots, little information is available on finfish bycatch since dead fish are quickly consumed by blue crabs, leaving only bones and fins (Guillory 1993, NCDMF unpublished data). In a Louisiana ghost pot study, an average of 8.6 fish per trap-year was found (Guillory 1993).

The issue of ghost pots is a major concern in other pot fisheries: Caribbean spiny lobster (Seaman and Aska 1974), Dungeness crab (Breen 1987), American lobster (Sheldon and Dow 1975), snow crab (Gagnon and Boudreau 1991), and sablefish (Scarsbrook et al. 1988). For the most part, these fisheries now require that some sort of escape mechanism be incorporated into the various pot designs. In 1976, the State of Alaska passed legislation that required all pots (crab and fish) to have a biodegradable termination device that in time breaks down and allows crabs and fish to escape (Paul et al. 1993). The State of Florida is the only blue crab-producing state that requires biodegradable panels in blue crab pots. However, several other states are looking at this issue: Louisiana, Maryland, and Virginia.

Current Authority

North Carolina Fisheries Rules for Coastal Waters (15A NCAC)

3I .0105 LEAVING DEVICES UNATTENDED
3J. 0302 POTS

Discussion

Studies in other waterbodies need to be conducted to determine the fate, quantity, and composition of finfish bycatch [Neuse River contributes 3% (447 pounds per year) to the total flounder landings from crab pots each year]. Preliminary bycatch data from actively fished hard and peeler pots in the Neuse River indicate that while flounder and other finfish species are captured in these gears, overall survival rates are high (70% hard crab pots; 99% peeler pots).

The mortality caused by ghost pots is directly related to the durability of the pot and its retention capability. The use of vinyl-coated wire in crab pot construction has increased the life of crab pots. When lost, these pots do not degrade quickly, thereby increasing the potential for ghost fishing. The use of escape rings in hard crab pots significantly reduces ghost fishing mortality in sublegal blue crabs (Arcement and Guillory 1994). Since peeler pots are exempt from the escape ring requirement in North Carolina, this gear has a much greater potential for ghost fishing mortality than hard crab pots. By minimizing pot loss and by incorporating design features into pots to prevent or reduce ghost fishing, significant reductions in ghost fishing mortality in blue crab pots could be achieved. Actions have been taken to minimize pot loss (sinking lines and a shorter attendance period) and escapement mechanisms were evaluated by the NCDMF in 1993 and tested under commercial conditions in 1995 (Hooker 1996). While results from these studies are encouraging, more data is needed on size and placement of openings to maximize finfish escapement.

Management Options/Impacts

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

1) Options to reduce finfish bycatch in actively fished hard and peeler pots

    a) Status quo (no action)
        + No new regulations

- Potential waste of finfish resource

b) Require finfish excluders in hard and peeler crab pots
   + Reduce unmarketable finfish bycatch
   - Reduction in marketable finfish bycatch
   - Possible loss of legal crabs

2) Options to minimize ghost pot fishing mortality

a) No action
   + No new regulations
   - Continued problem with ghost pot fishing mortality

b) Require biodegradable panels in crab pots
   + Reduce waste of the blue crab resource
   + Increase harvest of blue crabs
   + Reduce finfish bycatch in ghost pots
   - Possible loss of legal catch due to premature failure of panel

Research Needs

1) Collect baseline data on the composition, quantity, and fate of unmarketable finfish bycatch in the crab pot (hard and peeler) fishery, by season and area.

2) Develop a flounder bycatch reduction device for hard and peeler crab pots.

3) Test galvanic time-release devices, natural twine, and non-coated steel (24 gauge or less) across a wide range of salinities.

4) Determine the optimal panel location for finfish and crab escapement.

5) Determine minimum panel size for blue crab and finfish escapement.

6) Determine desired release time for blue crabs and finfish.

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13.1.12 Stock Enhancement of Southern Flounder

Issue

Conduct the necessary research in North Carolina to determine if stock enhancement of southern flounder is economically feasible and ecologically responsible.

Background

Stock enhancement is the stocking of fish to enhance or improve the condition or distribution of a wild stock. North Carolina State University (NCSU) initiated a series of workshops on stock enhancement in North Carolina in the mid-1990s. This effort brought together fish ecologists, culturists, and managers from around the world and was a good forum to discuss successes and failures in aquaculture and stock enhancement. Consensus among participants was that southern flounder is a good candidate for stock enhancement and North Carolina had resources available to start pilot-scale releases.

The Japanese have implemented stock enhancement strategies throughout their country in an attempt to improve severely overfished wild stocks. Japanese scientists have developed several successful culture operations for flounder, scallops, salmon, and other species, and have reared these species and stocked animals as part of a massive enhancement program. Stock enhancement in Japan began with wholesale stocking of fingerlings without first gathering information on natural populations, food availability, genetics, and parasites. Since that time, Japanese scientists have conducted research in these important areas to optimize stocking success and minimize effects on natural populations.

Stock enhancement research has taken place in other countries as well, including the United States. Salmon, cod, and lobster have been stocked in Norway; however, the Norwegians have been unable to show any effect on natural populations. Possible negative effects on natural populations by stocked fish may include genetic dilution, introduction of parasites, and increased mortality due to competition for resources. Todd Kellison (personal communication) found hatchery reared flounder had a lower survival rate than wild flounder due to inexperience with predators. Red drum have been stocked in southeastern states including Texas, South Carolina, and Florida with mixed results.

A consensus on the benefits and drawbacks of stock enhancement has not been reached. Some have suggested that augmenting natural stocks with hatchery-reared fish is an admission that traditional management measures have failed (Steve Ross, personal communication) and others have claimed that stocking fish because the technology is available, and without proper regard for potential negative impacts, may be arrogant (Grimes 1998). Others see the advent of successful culture techniques for southern flounder coupled with the insight we have learned from recent attempts in stock

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Prepared by the NC Division of Marine Fisheries and North Carolina State University on June 15, 2001.

enhancement, as providing managers with a great opportunity to increase the quality and quantity of fish available to the public and advance our understanding of the biology and ecology of southern flounder, which will aid in developing future management strategies.

Discussion

Before any real effort is made to enhance the stock, several questions need to be answered (see below). Primary among them is whether or not the system can support an increased population. Adding fish to habitats that are saturated will result in, among other things, increased mortality (likely for both stocked and wild fish) and increased incidence of disease. So the question remains, "Are there existing, underutilized, high-quality flounder habitats?"

Most fishery managers evaluate habitat quality by measuring the number of individuals at various locations. The implication is that areas with high abundance of flounder are good habitats and areas with low abundance (or no fish at all) are poor habitats. However, this method of habitat evaluation assumes an ideal free distribution; that is, fish have equal access to, and perfect knowledge of, all habitats in the system. This assumption does not allow for under-utilized (yet high quality) habitats (areas where stock enhancement efforts would be focused). Below are two examples demonstrating the problems associated with assuming fish will distribute themselves according to habitat quality:

1) We know from previous research (Miller et al. 1984) that larval fish use water currents to aid movement into the estuary. Therefore, the direction of the prevalent water flow is likely the direction the fish will travel. From March 8 to 28, 1975, average wind direction was from the northwest (average speed, 4 m/s). From February 28 to March 18, 1977, the average wind direction was from the southwest (average speed, 5.25 m/s). These winds drive water movement in Pamlico Sound and affect larval fish transport. As a result of the differing prevalent winds in these two years, the spatial distribution of larval and juvenile fish catch was markedly different (Figure 13.36 and Table 13.77). Although this information does not prove water movement is the sole determinant of the local abundance of fish, it does point out that fish abundance will vary from year to year, and that, in any given year, certain habitats will be less accessible than others.

2) Poor recruitment (to a particular area) could be just as likely to result in low abundance as poor quality habitat. Guindon and Miller (1995) placed southern flounder in cages in four tributaries of the Pamlico River (Figure 13.37) to measure their growth rate. These locations were also sampled as part of the North Carolina Division of Marine Fisheries' (NCDMF) estuarine trawl survey for juvenile fishes.

Fish with the highest growth rate were located in a habitat where wild fish are almost never caught (Figure 13.38, Whitehurst Creek). There seems to be no relationship between the abundance of juvenile flounder in a location and the potential growth rate. Again, this does not prove that accessibility is the sole determinant of flounder abundance. However, it provides yet more evidence that flounder do not distribute themselves according to habitat quality.

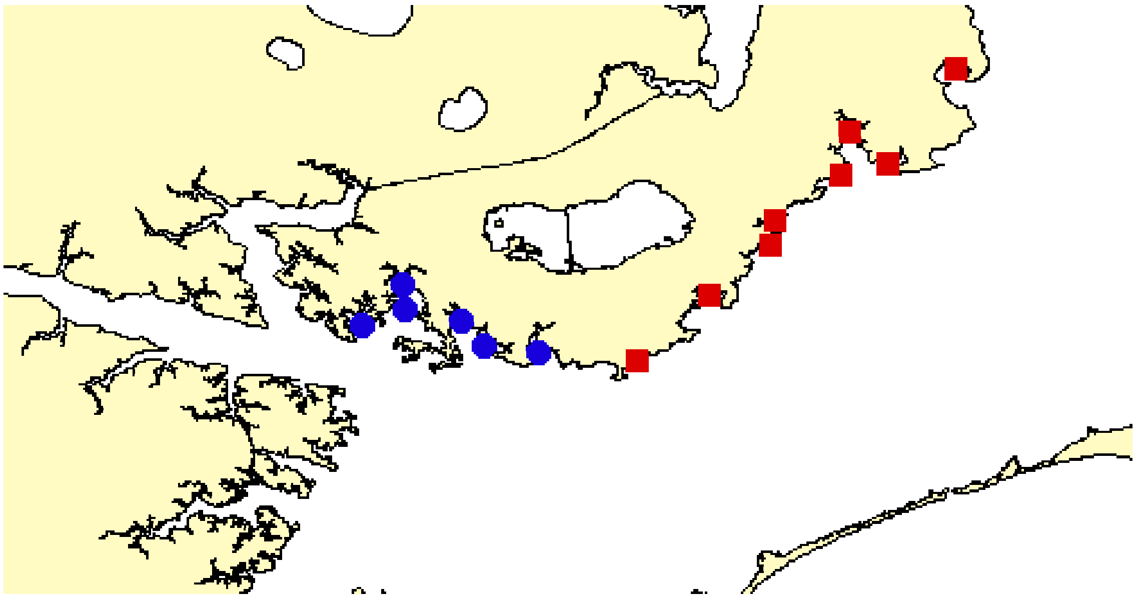

Figure 13.36. Sampling locations (Pietrafesa et al. 1986).

Table 13.77. Mean catch per unit effort (Pietrafesa et al.1986).

	Wind Direction	South (Circles)	North (Squares)
March, 1975	NW	10	478
March, 1977	SW	419	51

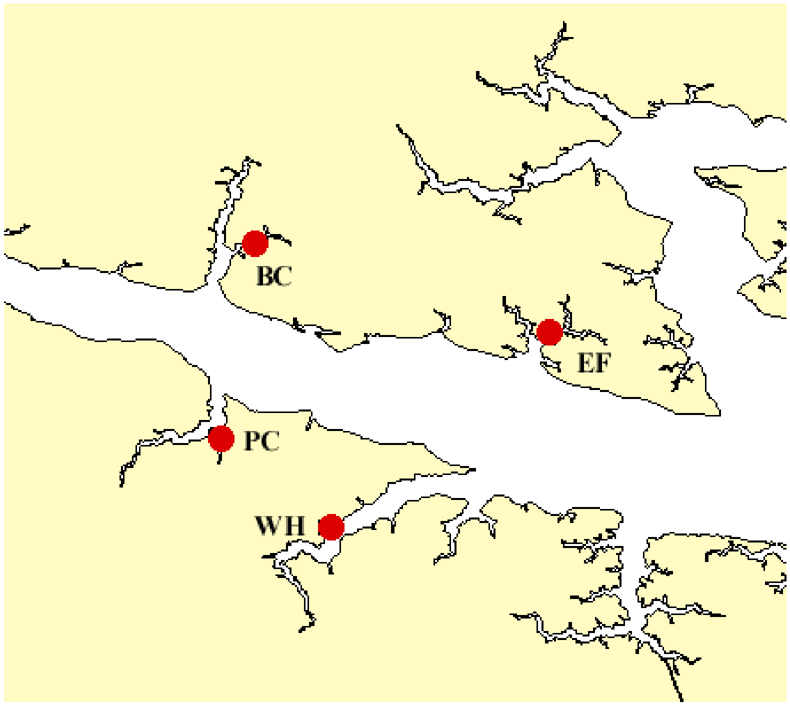

Figure 13.37. Locations of NCDMF sampling and cage study (Guindon and Miller 1995). BC = Back Creek, EF = East Fork, PC = Porter Creek, WH = Whitehurst Creek.

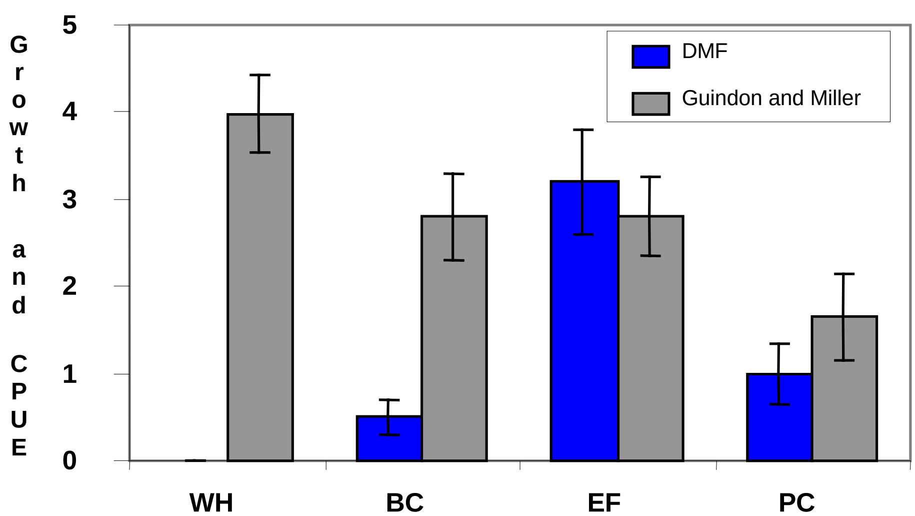

Figure 13.38. NCDMF's trawl survey (mean number of fish caught per minute of tow from 1985 to 1992) and mean instantaneous growth rate (Guindon and Miller, 1995). BC = Back Creek, EF = East Fork, PC = Porter Creek, WH = Whitehurst Creek.

These two examples were provided to illustrate a) our lack of understanding of the mechanisms driving flounder abundance and distribution and b) the evidence available that suggests there is high quality habitat being under-utilized. Both suggest the need for more research. If the State were to decide that stock enhancement could help our fisheries, this information could be invaluable.

North Carolina is in a unique position to move forward in a logical, pragmatic approach to investigating southern flounder stock enhancement, and stock enhancement in general. Techniques have been developed to produce southern flounder fingerlings in sufficient quantities for stock enhancement research (Waters 1998, Daniels 2000). There is a history of collaborative research between the NCDMF, the National Oceanographic and Atmospheric Administration, NCSU, and other national and international researchers on stock enhancement issues (Tanaka et al. 1997; Burke et al 2000; Taylor and Monaghan, in prep). The time is right to seek support to use this knowledge to move forward with stock enhancement research.

Questions (portions taken from “The Potential for Flounder and Red Drum Stock Enhancement in North Carolina”)**:**

1) Do the State’s nursery areas have excess capacity, or would stocked fish displace (or compete with) wild fish?

2) What does the genetic stock structure of flounder look like, and what should be the genetic profile(s) of released fish to sustain diversity?

3) What would be the impact of released fish on receiving waters, and how can we evaluate this?

4) How can we screen for potential diseases and diagnose and treat disease outbreaks if they occur?

5) Would stocking facilitate or impede traditional management?

6) What are the migration patterns of southern flounder, and will stocked fish leave North Carolina waters permanently before they mature?

7) What are the optimal release strategies?

8) What are the key measures of suitable flounder habitat (and suitable release habitat)?

9) What options other than stock enhancement are available? E.g. would habitat restoration aid the fishery?

10) Does the level of demand for flounder (present or future) justify the cost of exploring stock enhancement?

11) To what extent is experience in other states and countries transferable to North Carolina?

A responsible approach (portions taken from "The Potential for Flounder and Red Drum Stock Enhancement in North Carolina") would:

- Identify genetic and harvest objectives
- Define quantitative measures of success
- Incorporate genetic, disease, and health management
- Identify or develop a reliable hatchery source
- Use pilot releases to identify optimum release protocols (size, time of year, location, etc.)
- Mark hatchery fish to assess stocking impact (may suffice to use coloration on underside of flounder, may not)
- Consider ecological and biological impacts
- Identify economic and policy guidelines
- Use adaptive management to integrate new information
- Make a minimum five-year commitment to the program

Research Needs

1) Seek funding for research

2) Conduct pilot-scale research on the feasibility of southern flounder stock enhancement. Research would focus on the following key areas:
   - Identify optimal southern flounder habitat;
   - Identify pathogens in wild and cultured fish;
   - Establish a baseline of genetic diversity of wild fish;
   - Measure the impacts of stocked fish on the wild population;
   - Determine the fate of stocked individuals (mortality, emigration, etc.);
   - Develop optimal stocking strategies.

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13.2 Appendix 2 – Research Needs

Research needs identified during the development of the North Carolina Southern Flounder Fishery Management Plan:

- Increase fishery specific age, growth, and sex samples across all sizes with special attention to spatial specific information to better quantify southern flounder life-history and fishery specific datasets.

- Collect data on the harvest and effort in the recreational gig fishery on an annual basis.

- Develop an annual fishery-independent survey (CPUE) for inshore adult flounder.

- Obtain discard estimates from the commercial fishery, as well as from the recreational gig fishery.

- Develop an age-specific natural mortality rate for southern flounder to improve estimates of recruitment and total population abundance.

- Examine southern flounder maturation on a regional level.

- Investigate the potential for a portion of the flounder population to remain offshore following the spawning period, thus avoiding fishing pressure.

- Collect selectivity data for large mesh gill nets of varying mesh sizes.

- Increase at-sea sampling to determine the number of undersized and oversized fish caught in all mesh sizes of actual large mesh gill net fishing operations.

- Determine mortality of the undersized fish returned to the water from large mesh estuarine gill nets.

- Expand the observer program (Program 466) to sample more areas and seasons in the State. Also, initiate an independent gill net survey in the Neuse, Pamlico, and Pungo Rivers.

- Expand the trip ticket to include more specific gear parameters, such as mesh size, to more easily identify between large and small mesh gill nets.

- Investigate gear modifications to reduce regulatory discards, including mesh selectivity studies.

- Conduct further and more intensive studies into the level of bycatch and sublegal flounder reduction in pound nets that each of the different mesh sizes provides.

Studies should include escape panels with mesh sizes in quarter inch increments from 5½ to 6½ inches.

- Conduct studies to test the effectiveness of increasing the mesh size in the heart or crib of the net in pound nets without escape panels in releasing bycatch and sublegal flounder.

- Shrimp trawl bycatch characterization studies involving at-sea observers covering a broad regionalized sampling base over an extended period of time (at least three years) to minimize yearly variances.

- Investigations into fish excluder devices with a higher success rate for reducing the harvest and retention of flounder in shrimp trawls.

- Long-term (three years or more) characterization studies of bycatch in the crab trawl fishery.

- Further evaluation of tailbag mesh sizes for crab trawls throughout the State.

- Development and testing of other gears, methods, and/or techniques for reducing bycatch within the crab trawl fishery.

- In-depth assessment of the full-time and part-time participants in the crab trawl fishery, including the level of economic dependence most of the participants have on the fishery.

- Collect baseline data on the composition, quantity, and fate of unmarketable finfish bycatch in the crab pot (hard and peeler) fishery, by season and area.

- Develop a flounder bycatch reduction device for hard and peeler crab pots.

- Test galvanic time-release devices, natural twine, and non-coated steel (24 gauge or less) in crab and peeler pots across a wide range of salinities.

- Determine the optimal panel location for finfish and crab escapement in crab and peeler pots.

- Determine minimum panel size in crab and peeler pots for blue crab and finfish escapement.

- Determine desired release time for blue crabs and finfish from crab and peeler pots.

- Conduct pilot-scale research on the feasibility of southern flounder stock enhancement. Research would focus on the following key areas:
    - Identify optimal southern flounder habitat;
    - Identify pathogens in wild and cultured fish;

- Establish a baseline of genetic diversity of wild fish;
- Measure the impacts of stocked fish on the wild population;
- Determine the fate of stocked individuals (mortality, emigration, etc.);
- Develop optimal stocking strategies.

13.3 Appendix 3—Proposed Rule Changes

PROPOSED SOUTHERN FLOUNDER FMP RULES

10.1 Achieving Sustainable Harvest

Selected Management Strategy

A December 1 – 31 closed season for the commercial fishery to create a reduction in harvest. The closure would prohibit the harvest and landing of flounder by any means other than trawls in the Atlantic Ocean. The flounder size limit for the commercial fishery will be 14 inches.

A 14-inch minimum size limit and an 8-fish bag limit in all internal state waters for recreational fisheries.

DMF recommended rule wording

The DMF position is to address the management strategies through the recently adopted proclamation authority. The size limits and harvest season closure identified above would be specified in initial proclamations but could be changed quickly as conditions and assessments warrant. Rules exempting flounder aquaculture operations from size and season requirements were added by the DMF Rules Advisory Team. These rules were not required under previous rule wording.

03M .0503 FLOUNDER

(a) It is unlawful to possess flounder less than 14 inches total length taken from the Atlantic Ocean in a commercial fishing operation.

(b) From October 1 through April 30, it shall be unlawful to use a trawl in the Atlantic Ocean within three miles of the ocean beach from the North Carolina/Virginia state line ~~(35° 33'N)~~ (36° 33.0000' N) to Cape Lookout ~~(34° 36'N)~~ (34° 36.0000' N) unless each trawl has a mesh length of 5 1/2 inches or larger diamond mesh (stretched) or 6 inches or larger square mesh (stretched) applied throughout the body, extension(s) and the cod end (tailbag) of the net except as provided in Paragraphs (g) and (h) of this Rule.

(c) License to Land Flounder from the Atlantic Ocean:

(1) It is unlawful to land more than 100 pounds per trip of flounder taken from the Atlantic Ocean unless the owner of the vessel or in the case of Land or

Sell Licenses, the responsible party, has been issued a License to Land Flounder from the Atlantic Ocean and the vessel in use is the vessel specified on the License to Land Flounder from the Atlantic Ocean.

(2) It is unlawful for a fish dealer to purchase or offload more than 100 pounds of flounder taken from the Atlantic Ocean by a vessel whose owner, or in the case of Land or Sell Licenses, the responsible party, has not first procured a valid North Carolina License to Land Flounder from the Atlantic Ocean and the vessel in use is the vessel specified on the License to Land Flounder from the Atlantic Ocean.

(3) It is unlawful for any person to land flounder from the Atlantic Ocean under a License to Land Flounder from the Atlantic Ocean unless that person is the holder of the license or the master designated on the license.

(4) 15A NCAC 03O .0503 and It is unlawful for any individual to land flounder from the Atlantic Ocean without having ready at hand for inspection a valid License to Land Flounder from the Atlantic Ocean, except as specified in Subparagraph (c)(1) of this Rule.

(d) All fish dealer transactions in flounder landed from the Atlantic Ocean must be conducted in accordance with the Atlantic Ocean Flounder Dealer Permits in related rules in 15A NCAC 03O .0500.

(e) It is unlawful to transfer flounder taken from the Atlantic Ocean from one vessel to another.

(f) Tailbag liners of any mesh size, the multiple use of two or more cod ends, or other netting material that in any way could restrict the legal size mesh shall not be used or possessed on the deck of a vessel in the Atlantic Ocean from October 1 through April 30 from the North Carolina/Virginia state line ~~(36° 33'N)~~ (36° 33.0000' N) to Cape Lookout ~~(34° 36'N).~~ (34° 36.0000' N).

(g) Trawls with a cod end mesh size smaller than described in Paragraph (b) of this Rule may be used or possessed on the deck of a vessel provided not more than 100 pounds of flounder per trip from May 1 through October 31 or more than 200 pounds from November 1 through April 30 is possessed aboard or landed from that vessel.

(h) Flynets are exempt from the flounder trawl mesh requirements if they meet the following definition:

(1) The net has large mesh in the wings that measure 8 inches to 64 inches;

(2) The first body section (belly) of the net has 35 or more meshes that are at least 8 inches; and

(3) The mesh decreases in size throughout the body of the net to as small as 2 inches or smaller towards the terminus of the net.

(i) Commercial Season.

(1) The North Carolina season for landing ocean-caught flounder shall open January 1 each year. If ~~70~~ 80 percent of the quota allocated to North Carolina in accordance with the joint Mid-Atlantic Fishery Management Council/Atlantic States Marine Fisheries Commission Fishery

Management Plan for Summer Flounder is projected to be taken, the Fisheries Director shall, by proclamation, close North Carolina ports to landing of flounder taken from the ocean.

(2) The season for landing flounder taken in the Atlantic Ocean shall reopen November 1 if any of the quota allocated to North Carolina in accordance with the joint Mid-Atlantic Fishery Management Council/Atlantic States Marine Fisheries Commission Fishery Management Plan for Summer Flounder remains. If after reopening, 100 percent of the quota allocated to North Carolina in accordance with the joint Mid-Atlantic Fishery Management Council/Atlantic States Marine Fisheries Commission Fishery Management Plan for Summer Flounder is projected to be taken prior to the end of the calendar year, the Fisheries Director shall, by proclamation, close North Carolina ports to landing of flounder taken from the ocean.

(3) During any closed season prior to November 1, vessels may land up to 100 pounds of flounder per trip taken from the Atlantic Ocean.

(j) The Fisheries Director may, by proclamation, establish trip limits for the taking of flounder from the Atlantic Ocean to assure that the individual state quota allocated to North Carolina in the joint Mid-Atlantic Fishery Management Council/Atlantic States Marine Fisheries Commission Fishery Management Plan for Summer Flounder is not exceeded.

(k) The Fisheries Director may, by proclamation, based on variability in environmental and local stock conditions, take any or all of the following actions in the flounder fishery:

(1) Specify size;
(2) Specify season;
(3) Specify area;
(4) Specify quantity;
(5) Specify means/methods; and
(6) Require submission of statistical and biological data.

<u>(l) Possession and sale of flounder by a hatchery or flounder aquaculture operation and purchase and possession of flounder from a hatchery or flounder aquaculture operation shall be exempt from season and size limit restrictions set under Paragraph (k) of this Rule. It is unlawful to possess, sell, purchase, or transport such flounder unless they are in compliance with all conditions of the Aquaculture Operations Permit.</u>

History Note: Filed as a Temporary Amendment Eff. November 1, 1995 for a period of 180 daysor until the permanent rule becomes effective, whichever is sooner;
Authority G.S. 113-134; 113-169.5; 113-182; 113-221; 143B-289.52;
Eff. January 1, 1991;
Amended Eff. March 1, 1996; February 1, 1992;
Temporary Amendment Eff. December 23, 1996;

Amended Eff. April 1, 1997;
Temporary Amendment Eff. June 1,1998; August 18, 1997;
Amended Eff. April 1, 1999;
Temporary Amendment Eff. May 1, 2000; July 1, 1999;
Amended Eff. <u>?????????, 2005;</u> September 1, 2004; August 1, 2000.

The following rule change is required to implement **03M .0503 (l)** above.

03I .0120 POSSESSION OR TRANSPORTATION LIMITS

(a) It is unlawful to possess any species of fish which is subject to size or harvest restrictions, while actively engaged in a fishing operation, unless all fish are in compliance with the restrictions for the waterbody and area being fished.

(b) It is unlawful to import into the state species of fish native to North Carolina for sale in North Carolina that do not meet established size limits, except as provided in 15A NCAC 03K .0202 (c), ~~03K .0207~~ ~~and 03K .0305.~~ <u>03K .0207,</u> <u>03K .0305, and 03M .0503.</u>

History Note: Authority G.S. 113-134; 113-170; 113-170.4; 113-170.5; 113-182; 143B-289.52;
Temporary Adoption Eff. July 1, 1999.
Eff. August 1, 2000;
Temporary Amendment Eff. October 1, 2001;
Amended Eff. <u>??????????, 2005</u>; April 1, ~~2003 (pending legislative action).~~ <u>2003.</u>

10.2 Minimum Distance Between Gears

Selected Management Strategy

Maintain the 1,000-yard limit between new and existing pound net sets. **[Already in permanent rule 03J .0107 (d) (4)]**

Maintain a 200-yard limit between gill nets and active pound nets Statewide with the exception of the Albemarle Sound, excluding tributaries, west of a line between Caroon Point and Powell Point, from August 15 – December 31, when the minimum distance will be 500 yards.

DMF recommended rule wording

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

(a) It is unlawful to use a gill net with a mesh length less than 2½ inches.
(b) The Fisheries Director may, by proclamation, limit or prohibit the use of gill nets or seines in coastal waters, or any portion thereof, or impose any or all of the following restrictions on the use of gill nets or seines:

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

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

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

(d) It is unlawful to use gill nets:

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

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

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

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

(g) It is unlawful to use unattended gill nets with a mesh length less than five inches in a commercial fishing operation in the gill net attended areas designated in 15A NCAC 03R .0112 <u>(a)</u>.
(h) It is unlawful to use unattended gill nets with a mesh length less than five inches in a commercial fishing operation from May 1 through October 31 in the internal coastal and joint waters of the state designated in 15A NCAC 03R .0112 <u>(b)</u>.

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

10.3 Gear Requirements in the Flounder Gill Net Fishery
10.4 Bycatch in the Commercial Flounder Gill Net Fishery

Selected Management Strategy

Implement a 3,000-yard maximum limit per fishing operation and minimum 5 ½ inch stretched mesh on all large mesh flounder gill nets.

Require Recreational Commercial Gear License holders attend their large mesh gill nets at all times from west and south of the Highway 58 Bridge at Emerald Isle.

DMF recommended rule wording.

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

(a) It is unlawful to use ~~a~~ gill ~~net~~ <u>nets:</u> ~~with a mesh length less than 2½ inches.~~
<u>(1) With a mesh length less than 2 ½ inches.</u>
<u>(2) In internal waters from April 15 through December 15, with a mesh length 5 inches or greater and less than 5 ½ inches.</u>
(b) The Fisheries Director may, by proclamation, limit or prohibit the use of gill nets or seines in coastal waters, or any portion thereof, or impose any or all of the following restrictions on the use of gill nets or seines:
(1) Specify area.
(2) Specify season.
(3) Specify gill net mesh length.
(4) Specify means/methods.
(5) Specify net number and length.

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

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

(d) It is unlawful to use gill nets:

(1) Within 200 yards of any pound net set with lead and either pound or heart in use;
(2) From March 1 through October 31 in the Intracoastal Waterway within 150 yards of any railroad or highway bridge.

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

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

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

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

(h) It is unlawful to use unattended gill nets with a mesh length less than five inches in a commercial fishing operation from May 1 through October 31 in the internal coastal and joint waters of the state designated in 15A NCAC 03R .0112 (b).

(i) It is unlawful to use more than 3,000 yards of gill net with a mesh length 5 1/2 inches or greater per vessel in internal waters regardless of the number of individuals involved.

History Note: Authority G.S. 113-134; 113-173; 113-182; 113-221; 143B-289.52;

Eff. January 1, 1991;
Amended Eff. August 1, 1998; March 1, 1996; March 1, 1994; July 1, 1993; September 1, 1991;
Temporary Amendment Eff. October 2, 1999; July 1, 1999; October 22, 1998;
Amended Eff. April 1, 2001;
Temporary Amendment Eff. May 1, 2001;
Amended Eff. ??????????, 2005; August 1, 2004; August 1, 2002.

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 are not authorized for recreational purposes, including but not limited to, hand winches and block and tackle;

(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 (5) (C) of this Rule. Attendance ~~is~~ 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 (5) (C) of this Rule. Attendance ~~is~~ 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.

(b) It is unlawful to use more than the quantity of authorized gear specified in Subparagraphs (a)(1) - (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; 1999.
Amended Eff. August 1, 2000;
Temporary Amendment Eff. August 1, 2000;
Amended Eff. ??????????, 2005; August 1, 2002.

10.6 Bycatch in the Flounder Pound Net Fishery

Selected Management Strategy

Require escape panels with 5½-inch webbing in flounder pound nets Statewide.

DMF recommended rule wording

15A NCAC 03J .0107 POUND NET SETS

(a) All initial, renewal or transfer applications for Pound Net Set Permits, and the operation of such pound net sets, shall comply with the general rules governing all permits in 15A NCAC 03O .0500. The procedures and requirements for obtaining permits are also found in 15A NCAC 03O .0500.

(b) It is unlawful to use pound net sets in coastal fishing waters without the permittee's identification being clearly printed on a sign no less than six inches square, securely attached to the outermost stake of each end of each set. For pound net sets in the Atlantic Ocean using anchors instead of stakes, the set ~~must~~ shall be identified with a yellow buoy, which shall be of solid foam or other solid buoyant material no less than five inches in diameter and no less than 11 inches in length. The permittee's identification shall be clearly printed on the buoy. Such identification on signs or buoys ~~must~~ shall include the pound net set permit number and the permittee's last name and initials.

(c) It is unlawful to use pound net sets, or any part thereof, except for one location identification stake or identification buoy for pound nets used in the Atlantic Ocean at each end of proposed new locations, without first obtaining a Pound Net Set Permit from the Fisheries Director. The applicant ~~must~~ shall indicate on a base map provided by the Division the proposed set including an inset vicinity map showing the location of the proposed set with detail sufficient to permit on-site identification and location. The applicant ~~must~~ shall specify the type(s) of pound net set(s) requested and possess proper valid licenses and permits necessary to fish those type(s) of net. A pound net set shall be deemed a flounder pound net set when the catch consists of 50 percent or more flounder by weight of the entire landed catch, excluding blue crabs. The type "other finfish pound net set" is for sciaenid (Atlantic croaker, red drum, weakfish, spotted seatrout, spot, for example) and other finfish, except flounder, herring, or shad, taken for human consumption. Following are the type(s) of pound net fisheries that may be specified:

(1) Flounder pound net set;
(2) Herring/shad pound net set;
(3) Bait pound net set;
(4) Shrimp pound net set;
(5) Blue crab pound net set;
(6) Other finfish pound net set.

(d) For proposed new locations, the Fisheries Director shall issue a public notice of intent to consider issuance of a Pound Net Set Permit allowing for public comments for 20 days, and after the comment period, may hold public meetings to take comments on the proposed pound net set. If the Director does not approve or deny the application within 90 days of receipt of a complete and verified application, the application shall be deemed denied. The applicant shall be notified of such denial in writing. For new locations, transfers and renewals, the Fisheries Director may deny the permit application if the Director determines that granting the permit will be inconsistent with one or more of the following permitting criteria, as determined by the Fisheries Director:

(1) The application ~~must~~ shall be in the name of an individual and shall not be granted to a corporation, partnership, organization or other entity;
(2) The proposed pound net set, either alone or when considered cumulatively with other existing pound net sets in the area, ~~will~~ shall not interfere with public navigation or with existing, traditional uses of the area other than navigation, and ~~will~~ shall not violate 15A NCAC 03J.0101 and .0102;
(3) The proposed pound net set ~~will~~ shall not interfere with the rights of any riparian or littoral landowner, including the construction or use of piers;
(4) The proposed pound net set ~~will~~ shall not, by its proximate location, interfere with existing pound net sets in the area. Except in Chowan River as referenced in 15A NCAC 03J .0203, proposed new pound net set locations

shall be a minimum of 1,000 yards as measured in a perpendicular direction from any point on a line following the permitted location of existing pound net sets;

(5) The applicant has in the past complied with fisheries rules and laws and does not currently have any licenses or privileges under suspension or revocation. In addition, a history of habitual fisheries violations evidenced by eight or more convictions in ten years shall be grounds for denial of a pound net set permit;

(6) The proposed pound net set is in the public interest; and

(7) The applicant has in the past complied with all permit conditions, rules and laws related to pound nets.

Approval shall be conditional based upon the applicant's continuing compliance with specific conditions contained on the Pound Net Set Permit and the conditions set out in Subparagraphs (1) through (7) of this Paragraph. The final decision to approve or deny the Pound Net Set Permit application may be appealed by the applicant by filing a petition for a contested case hearing, in writing, within 60 days from the date of mailing notice of such final decision to the applicant, with the Office of Administrative Hearings.

(e) An application for renewal of an existing Pound Net Set Permit shall be filed not less than 30 days prior to the date of expiration of the existing permit, and shall not be processed unless filed by the permittee. The Fisheries Director shall review the renewal application under the criteria for issuance of a new Pound Net Set Permit, except that pound net sets approved prior to January 1, 2003 do not have to meet the 1,000 yard minimum distance requirement specified in Subparagraph (d)(4) of this Rule. The Fisheries Director may hold public meetings and may conduct such investigations necessary to determine if the permit should be renewed.

(f) A Pound Net Set Permit, whether a new or renewal permit, shall expire one year from the date of issuance. The expiration date shall be stated on the permit.

(g) Pound net sets, except herring/shad pound net sets in the Chowan River, shall be operational for a minimum period of 30 consecutive days during the permit period unless a season for the fishery for which the pound net set is permitted is ended earlier due to a quota being met. For purposes of this Rule, operational means with net attached to stakes or anchors for the lead and pound, including only a single pound in a multi-pound set, and a non-restricted opening leading into the pound such that the set is able to catch and hold fish. The permittee, including permittees of operational herring/shad pound net sets in the Chowan River, shall notify the Marine Patrol Communications Center by phone within 72 hours after the pound net set is operational. Notification shall include name of permittee, pound net set permit number, county where located, a specific location site, and how many pounds are in the set. It is unlawful to fail to notify the Marine Patrol Communications Center within 72 hours after the pound net set is operational or to make false notification when said pound net set is not operational. Failure to comply with this Paragraph shall be grounds for the Fisheries Director to revoke this and any other pound net set permits held by the permittee and for denial of any future pound net set permits.

(h) It is unlawful to transfer a pound net set permit without a completed application for transfer being submitted to the Division of Marine Fisheries not less than 45 days before the date of the transfer. Such application shall be made by the proposed new permittee in writing and shall be accompanied by a copy of the current permittee's permit and an application for a pound net set permit in the new permittee's name. The Fisheries Director may hold a public meeting and may conduct such investigations necessary to determine if the permit should be transferred. The transferred permit shall expire on the same date as the initial permit. Upon death of the permittee, the permit may be transferred to the Administrator/Executor of the estate of the permittee if transferred within six months of the Administrator/Executor's qualification ~~under G.S. 28A.~~ in accordance with Chapter 28A of the North Carolina General Statutes. The Administrator/Executor ~~must~~ shall provide a copy of the deceased permittee's death certificate, a copy of the certificate of administration and a list of eligible immediate family members as defined in G.S. 113-168 to the Morehead City Office of the Division of Marine Fisheries. Once transferred to the Administrator/Executor, the Administrator/Executor may transfer the permit(s) to eligible family members of the deceased permittee. No transfer is effective until approved and processed by the Division.

(i) Every pound net set in coastal fishing waters shall have yellow light reflective tape or yellow light reflective devices on each pound. The light reflective tape or yellow light reflective devices shall be affixed to a stake of at least three inches in diameter on any outside corner of each pound, shall cover a vertical distance of not less than 12 inches, and shall be visible from all directions. In addition, every pound net set shall have a marked navigational opening of at least 25 feet in width at the end of every third pound. Such opening shall be marked with yellow light reflective tape or yellow light reflective devices on each side of the opening. The yellow light reflective tape or yellow light reflective devices shall be affixed to a stake of at least three inches in diameter, shall cover a vertical distance of not less than 12 inches, and shall be visible from all directions. If a permittee notified of a violation under this Paragraph fails or refuses to take corrective action sufficient to remedy the violation within 10 days of receiving notice of the violation, the Fisheries Director shall revoke the permit.

(j) In Core Sound, it is unlawful to use pound net sets in the pound net sets prohibited areas designated in 15A NCAC 03R .0113 except that only those pound net set permits valid within the specified area as of March 1, 1994, may be renewed or transferred subject to the requirements of this Rule.

(k) Escape Panels:

(1) The Fisheries Director may, by proclamation, require escape panels in pound net sets and may impose any or all of the following requirements or restrictions on the use of escape panels:
    (A) Specify size, number, and location.
    (B) Specify mesh length, but not more than six inches.
    (C) Specify time or season.
    (D) Specify areas.

(2) It is unlawful to use flounder pound net sets without four unobstructed escape panels in each ~~pound south and east of a line beginning at a point 35° 57.3950' N - 76° 00.8166' W on Long Shoal Point; running easterly to a point 35° 56.7316' N - 75° 59.3000' W near Marker "5" in Alligator River; running~~

~~northeasterly along the Intracoastal Waterway to a point 36° 09.3033' N - 75° 53.4916' W near Marker "171"at the mouth of North River; running northwesterly to a point 36° 09.9093' N - 75° 54.6601' W on Camden Point~~. pound. The escape panels ~~must~~ shall be fastened to the bottom and corner ropes on each wall on the side and back of the pound opposite the heart. The escape panels ~~must~~ shall be a minimum mesh size of five and one-half inches, hung on the diamond, and ~~must~~ shall be at least six meshes high and eight meshes long.

(l) Pound net sets are subject to inspection at all times.
(m) Daily reporting may be a condition of the permit for pound net sets for fisheries under a quota.
(n) It is unlawful to fail to remove all pound net stakes and associated gear within 30 days after expiration of the permit or notice by the Fisheries Director that an existing pound net set permit has been revoked or denied.
(o) It is unlawful to abandon an existing pound net set without completely removing from the coastal waters all stakes and associated gear within 30 days.

History Note: Authority G.S. 113-134; 113-182; 113-182.1; 113-221; 143B-289.52
Eff. January 1, 1991;
Amended Eff. April 1, 1999; March 1, 1996; March 1, 1994; September 1, 1991; January 1, 1991;
Temporary Amendment Eff. September 1, 2000; August 1, 2000;
Amended Eff. August 1, 2002; April 1, 2001;
Temporary Amendment Eff. February 10, 2003;
Amended Eff. ??????????, 2005; August 1, 2004.

10.8 Southern Flounder Bycatch in the Crab Trawl Fishery

Selected Management Strategy

Allow the Fisheries Director to specify a 4-inch crab trawl mesh size in western Pamlico Sound and tributaries and a 3-inch crab trawl tailbag mesh size on the eastern side of Pamlico Sound. A line dividing Pamlico Sound down the middle would be established by proclamation. Note: this strategy mirrors the strategy adopted for crab trawl mesh size in the NC Blue Crab Fishery Management Plan.

DMF recommended rule wording

15A NCAC 03L .0202 CRAB TRAWLING

(a) It is unlawful to take or possess aboard a vessel crabs taken by trawl in internal waters except in areas and during such times as the Fisheries Director may specify by proclamation.
(b) It is unlawful to use any crab trawl with a mesh length less than three inches for taking hard crabs, except that the Fisheries Director may, by proclamation, increase

the minimum mesh length to ~~not~~ no more than four ~~inches.~~ inches, and specify areas for crab trawl mesh size use.

(c) It is unlawful to use trawls with a mesh length less than two inches or with a combined total headrope length exceeding 25 feet for taking soft or "peeler" crabs.

History Note: Authority G.S. 113-134; 113-182; 113-221; 143B-289.52;
Eff. February 1, 1991;
Amended Eff. ??????????, 2005; August 1, 2004; March 1, 1994; September 1, 1991.